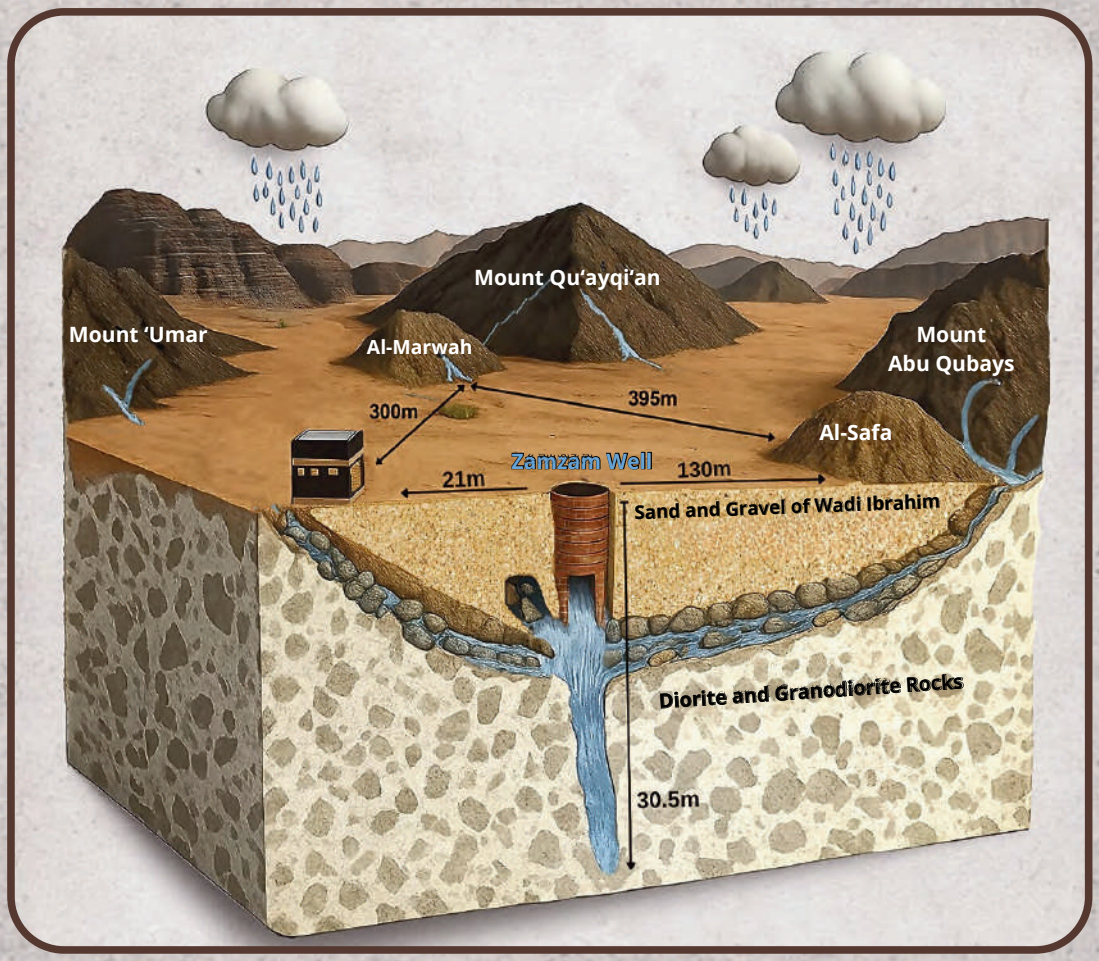
Global ZamZam Encyclopedia 2 موسوعة زمزم العالمية

ZamZam Water

The Eternal Miracle Bridging Faith, Science and Artificial Intelligence



Abdullah Mohammed Al-Amri

ZAMZAM WATER

An Eternal Miracle Bridging Faith, Science, and Artificial Intelligence

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2026

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﴿Ya Tuhan kami, sesungguhnya aku telah menempatkan sebahagian keturunanku di sebuah lembah yang tidak subur berhampiran Rumah-Mu yang Suci, ya Tuhan kami, supaya mereka mendirikan solat. Maka jadikanlah hati-hati manusia cenderung kepada mereka dan sediakanlah untuk mereka rezeki daripada buah-buahan agar mereka bersyukur.﴾ [Ibrāhīm: 14 : 37].

﴿Dan [sebutkan] ketika Ibrahim berkata, 'Ya Tuhanku, jadikanlah bandar ini aman dan berikanlah buah-buahan kepada penduduknya—siapa sahaja di antara mereka yang beriman kepada Allah dan Hari Kiamat﴾ [Al-Baqarah 2 : 126].

﴿Sesungguhnya, rumah [ibadat] pertama yang didirikan untuk manusia ialah yang di Bakkah—yang diberkati dan menjadi petunjuk bagi alam semesta﴾ [Aal 'Imran: 3 : 96].

ज़मज़म
ZemZem
ЗамЗам
ZamZam
زمزم
موسوعة زمزم العالمية
Global ZamZam Encyclopedia

Dedication

♦ To All in every time and place,

- To those who have tasted **ZamZam** and found their hearts quenched before their bodies,
- To those whose feet have not reached the Sacred Sanctuary, yet whose souls have made pilgrimage there out of longing,
- To every researcher and seeker who has blended the light of revelation with the method of science, and in **ZamZam** beheld a renewed sign and a miracle ever-flowing,
- To **ZamZam** - the water whose radiance has never dimmed, whose message has never run dry, an eternal witness to a divine promise fulfilled, and a word inscribed by heavenly power: "**Be!" and it was.**

♦ I dedicate this humble work:

- To all who unite the light of faith with the guidance of knowledge - understanding, reflecting, and growing in certainty,
- To those who believe that science does not exclude faith, but rather deepens and illumines it,
- To those who see in **ZamZam** a story without end… one that begins a new whenever people think it has ended.

Acknowledgments

All praise is due to Allah—first and last, outwardly and inwardly—by whose grace all good deeds are brought to completion and by whose guidance all endeavors are fulfilled. I praise Him, the Most Exalted, for granting me the ability to complete this work, which I consider among the most valued of my scholarly contributions: The Global **ZamZam** Encyclopedia, published in fifteen languages. It is the fruit of many years of sustained research and the culmination of a long intellectual and scientific journey shaped by reflection, study, and experience.

As this work stands at the intersection of knowledge and faith, and of history and science, it is not the product of individual effort but rather the outcome of the collective contributions of sincere minds, devoted hearts, and generous efforts. From this perspective, it is my great pleasure to express my deep gratitude and sincere appreciation to all those who contributed to its realization-through an idea that illuminated the path, counsel that guided the course, words that strengthened resolve, or constructive criticism that refined and enriched this work.

I am especially indebted—without titles and listed in alphabetical order to a distinguished group of colleagues, researchers, and loyal companions whose names are forever inscribed in the memory of this encyclopedia: Abdu Al-Razzaq Al-Harbi, Abdullah bin Othman, Abdulsalam Al-Rajhi, Ayman Al-Ruhaili, Badr Al-Amri, Hamzah Al-Amri, Homoud Al-Theaib, Khalid Al-Issa, Mashael Al Saud, Mohammed Al-Ahmari, Mohammed Al-Furaih, Mohammed Al-Muhanna, Mohammed Ibn Arraj, Mohammed Yousuf, Mohammed Al-Issa, Nasser Al-Khomashi, Najeeb Al-Sharqi, Naif Al-Otaibi, Omar Al-Amri, Omar Lafouza, Sarah Al-Amri, Sayer Basmatjie, Thamer Al Da'jani, Yahya Ibrahim, and Zekai Sen.

Finally, I extend my deepest gratitude and enduring love to my beloved family-my mother, my wife, and my children—for their patience, sacrifice, and unwavering support, which provided me with strength, stability, and inspiration throughout this journey.

Author's Preface

This work was not born of a passing idea, but rather of a research journey that extended over many years, bringing together the humility of faith and the curiosity of knowledge. **ZamZam** water is no longer viewed merely as a historical well or sacred water; it is a unique phenomenon where spiritual values intersect with scientific research and civilizational study. The Prophet Muhammad (peace be upon him) described **ZamZam** water, saying: "The water of ZamZam is for whatever it is drunk for," and he also said: "It is blessed; it is nourishment."

Across the centuries, this water has remained a witness to a continually renewed miracle, flowing consistently while preserving its purity and clarity despite environmental changes and the passage of time. It stands as a living symbol of divine generosity that never ceases.

From this perspective, the **ZamZam** Encyclopedia has emerged as a scientific and intellectual project that seeks to present a comprehensive vision of this blessed water, which has been intrinsically connected to the history of Makkah, the rituals of Islam, and the consciousness of millions of believers throughout the ages. Since **ZamZam** cannot be understood in isolation from Makkah, an introductory chapter has been dedicated to presenting this sacred city, which has, throughout history, served as a spiritual and civilizational center of the Islamic world and a destination toward which the hearts of believers from all parts of the world are drawn.

In recognition of the universal message of Makkah, this Encyclopedia has been published in fifteen international languages: **Arabic, English, French, Russian, Turkish, Chinese, Malay, Persian, Hebrew, Urdu, Spanish, Hindi, Bengali, Japanese, and Swahili**. The selection of these languages was not arbitrary; rather, it reflects the broad human reach of the **ZamZam** message. Today, more than two billion Muslims live across all continents, and millions of pilgrims and Umrah performers from over 170 countries visit Makkah annually, bringing with them diverse languages and cultures. It was therefore essential that the story of **ZamZam**, along with its scientific and spiritual knowledge, be presented in multiple languages so that

its message may reach the Guests of Allah, researchers, and readers across different cultures and civilizations.

This Encyclopedia seeks to bring together the reverence of history and the precision of science. It examines **ZamZam** water from multiple perspectives, including its geological, hydrological, chemical, physical, medical, and radiological characteristics. It also discusses its role in water sustainability within a desert environment considered among the driest regions in the world. Furthermore, it explores the potential of modern technologies, such as artificial intelligence and big data analysis, in studying this unique resource and monitoring its properties, contributing to its protection and preservation for future generations.

This work also records a notable scientific attempt to study the age of **ZamZam** water and its water signature using **Carbon-14** dating technology, as part of a research effort aimed at shedding further scientific light on the history of this blessed water and its exceptional characteristics, while enriching scientific knowledge about one of the most unique water resources in the world.

In conclusion, this Encyclopedia is not merely a chronicle of a well; rather, it is a bridge between the world of faith and the world of science. It tells the story of water whose blessing descended from the heavens and whose value has remained eternal on earth. It is for everyone who wonders: how can a well in the heart of the desert remain alive for thousands of years? And how can water touch the body, mind, and soul all at once?

I dedicate this work to every believer who sees in **ZamZam** water a link between heaven and earth, and to every researcher who is convinced that religion and science do not contradict one another, but rather complement each other.

If this work succeeds, it is by the grace and guidance of Allah; and if there is any shortcoming, it is from the limits of human effort. I ask Allah to make it beneficial knowledge and a service to this blessed resource.

Introduction

Since the dawn of history, the water of **ZamZam** has remained one of the greatest living symbols that unite religious sanctity with scientific wonder. It is a water deeply connected to the holiest place on earth, passed down through generations as a renewed miracle and as a testimony to divine care that has endured for thousands of years. While believers have long regarded it as an inexhaustible blessing, scientists have viewed it as a unique hydrological phenomenon worthy of careful observation and study. From this perspective emerges the importance of researching **ZamZam**, for this water stands at a rare point of convergence between the world of faith and the world of science, where religious texts intersect with geological, hydrological, environmental, and medical knowledge.

This encyclopedia proceeds from the firm belief that **ZamZam** rep resents a multidimensional phenomenon in which religious and historical sig nificance converge with the sciences of geology and hydrology, chemical and physical analyses, medical and health studies, and the latest applications of artificial intelligence and the Internet of Things. In this work, I have adhered to an analytical research methodology that combines authenticated religious interpretation drawn from the Holy Qur'an and the Prophetic Sunnah, his torical documentation tracing the care and stewardship of the well across the centuries, precise scientific analysis of its properties, and environmental and geological studies of the Makkah region using advanced computational models. In addition, the encyclopedia reviews medical and clinical research related to its therapeutic benefits and explores pathways for ensuring its sus tainability through the technologies of the modern era.

The reader's journey in this encyclopedia begins in Makkah, where the **first chapter** offers a spiritual and historical reflection on this sacred city— not merely as a geographical location, but as a cosmic center of sanctity and revelation. **ZamZam** is inseparably linked with every

dimension of Makkah: the Sacred Mosque embraces it, the holy rites are nourished by it, and the temporal and spatial rhythms of worship are connected to practices in which **ZamZam** forms an integral part. In this way, the narrative transcends the boundaries of geography and enters the broader realm of faith.

From there, the **second chapter** guides the reader into the world of sacred texts, examining the Qur'anic verses and Prophetic traditions that refer to **ZamZam**. It also discusses the juristic rulings related to drinking it, seeking blessing through it, transporting it, and using it for healing. In addition, the chapter reviews the various names attributed to ZamZam and the theological and spiritual meanings they carry.

The **third chapter** then takes the reader on a journey through history, beginning with the era of Prophet Ibrahim (Abraham) and his son Ismail (Ish mael), peace be upon them, continuing through the efforts of 'Abd al-Muttal ib, the period of the Rightly Guided Caliphs, and the great Islamic states—the Umayyad, Abbasid, Mamluk, and Ottoman periods—culminating in the mod ern Saudi era. During this time, **ZamZam** witnessed a significant transfor mation in management, technology, and organization, and the traditional role of the **ZamZam** is evolved from a community-based service into a formally organized institutional system.

In the **fourth chapter**, we delve into the natural phenomena surrounding Makkah, examining its topography and rock formations, as well as its struc tural faults and seismic and volcanic activity. This exploration helps us under stand how these geological factors influence the groundwater system of the region and how urban expansion and the construction of high-rise buildings may affect the water level of the **ZamZam** well.

The **fifth chapter** then reveals the scientific dimensions of the miracle itself, exploring the geological structure of the well and the sources that re plenish it—whether through surface runoff from seasonal floods or through rare deep geological formations. The chapter also examines its physical and chemical properties, the stability of its mineral concen-

trations, the balance of its pH level, its optical and radiological purity, and its resistance to bacterial contamination.

The **sixth chapter** forms the core of the advanced scientific analysis pre sented in this encyclopedia and serves as an intellectual bridge between the rich legacy of **ZamZam** and the frontiers of modern science. In this chapter, the most advanced analytical tools are employed to study the unique proper ties of this remarkable water. The discussion begins with the analysis of its chemical fingerprint and the determination of its geological and chronolog ical age using **Carbon-14** isotopic techniques. It then proceeds to precise comparative analyses supported by mathematical models that examine the behavior of ZamZam water when mixed with other drinking waters, revealing the stability and distinctive characteristics of its composition. The chapter fur ther explores the application of advanced technologies—including artificial intelligence, machine learning, and the Internet of Things—in monitoring the properties of **ZamZam** water and analyzing its geological and hydrological data with high precision. These approaches lead to practical models that con tribute to understanding this unique resource and ensuring its sustainability and quality for future generations.

The journey concludes in the **seventh chapter**, where medicine and faith converge. Here we present a rich record of its documented benefits in the treatment of oral and dental diseases, cancer, liver and kidney conditions, skin disorders, digestive ailments, hypertension, and resistance to fungi and microbes. These discussions are supported by scientific studies and historical experiences extending from the era of the Companions of the Prophet to the present day.

Global ZamZam Encyclopedia

موسوعة زمزم العالمية

Link https//alamrigeo.com/zamzam/

1

موسوعة زمزم العالمية

المُعجِزَةُ الخَالِدَة بَينَ الإيمَانِ وَالعِلم و الذَّكَاءِ الإصطِنَاعِيّ

2

Global ZamZam Encyclopedia

The Eternal Miracle Bridging Faith, Science and Artificial Intelligence

3

Encyclopédie mondiale de Zamzam

Le Miracle éternel reliant la foi, la science et l'intelligence artificielle

4

Ensiklopedia Zamzam Global

Mukjizat Abadi yang Menghubungkan Iman, Sains dan Kecerdasan Buatan

5

عالمی زَمزم انسائیکلوپیڈیا

ایمان، علم اور مصنوعی ذہانت کے درمیان ابدی معجزہ

6

ज़मज़म अंतर्राष्ट्रीय विश्वकोश

বিশ্বাস, বিজ্ঞান এবং কৃত্রিম বুদ্ধিমত্তার মধ্যে সেতুবন্ধনকারী চিরন্তন অলৌকিকতা

7

ग्लोबल ज़मज़म विश्वकोश

आस्था, विज्ञान और कृत्रिम बुद्धिमत्ता के बीच सेतु बनाने वाला शाश्वत चमत्कार

8

دایرۃالمعارف جھانی زمزم

معجزۂ جاودان میان ایمان، علم و هوش مصنوعی

9

Zemzem Dünya Ansiklopedisi

İman, bilim ve yapay zekâ arasında köprü kuran ebedî mucize

10

Ensiklopidia ya Zamzam ya Dunia

Muujiza wa milele unaounganisha imani, sayansi na akili bandia

11

Глобальная энциклопедия Замзам

Вечное чудо между верой, наукой и искусственным интеллектом

12

扎姆扎姆世界百科全书

连接信仰、科学与人工智能的永恒奇迹

13

Enciclopedia Mundial de Zamzam

,El milagro eterno que conecta la fe la ciencia y la inteligencia artificial

14

ザムザム世界百科事典

信仰・科学・人工知能をつなぐ永遠の奇跡

15

האנציקלופדיה העולמית של זמזם

הנס הנצחי המחבר בין אמונה, מדע ובינה מלאכותית

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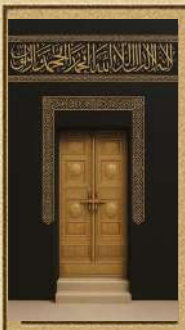
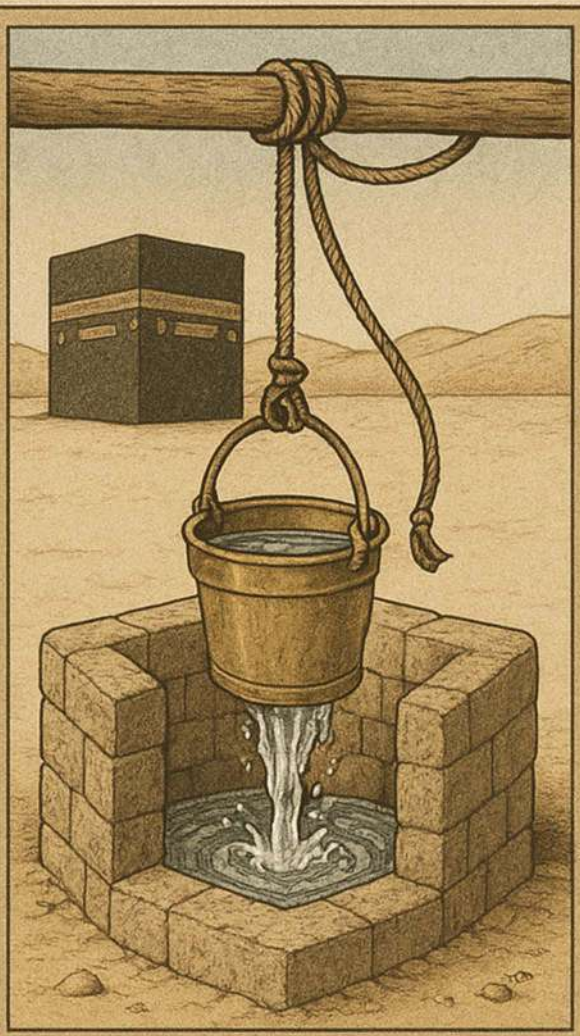


Chapter One

Makkah Al-Mukarramah: The Religious and Historical Dimensions Reflected in ZamZam

Historical Dimension of Makkah



Religious and Scientific Miracles

Makkah from a Religious Perspective

Water Security in Makkah

Boundaries of the Sacred Mosque

Sacred Ritual Sites

Temporal and Spatial Miqats

Sacred Historical Sites

Introduction

A reflective reader of this book—centered on the topic of **ZamZam** water—might understandably wonder why an entire chapter is dedicated to Makkah, even though the central focus is on this sacred water. This question is valid, and the response stems from firsthand experience and meaningful interaction with readers of the first edition of the book.

I received numerous comments from readers across various parts of the Islamic world, expressing a deep desire to learn more about Makkah—not merely as the location of the **ZamZam** Well, but as a sacred city in its entirety, one that carries within its folds profound historical and spiritual dimensions inseparable from the context of faith and the story of **ZamZam** itself.

Given that this book will be published in multiple languages and made accessible to Muslims across the globe, I felt a heightened sense of responsibility to offer a comprehensive and insightful portrayal of Makkah, especially for those who have never had the opportunity to visit the city or who may lack sufficient knowledge of its spiritual and historical significance.

For this reason, I made a conscientious effort to write this chapter, although the subject lies outside my immediate academic specialization. I did so out of a firm conviction that knowledge should not be confined within the rigid boundaries of disciplinary expertise. Rather, it must serve truth and convey knowledge in its most illuminating and heartfelt form to readers.

In this pursuit, I found that modern artificial intelligence technologies significantly supported this endeavor. Today, it is possible to track readers' interests, analyze their inquiries, and identify the topics that receive widespread global attention. Advanced digital analytics have revealed that "Makkah al-Mukarramah" ranks among the most frequently searched terms by non-Arab Muslims, particularly during the Hajj and ʿUmrah seasons. Furthermore, AI-driven content analysis models have highlighted a clear knowledge gap

among non-Arabic-speaking Muslims in understanding the sacred sites and landmarks of Makkah. This insight offered an additional motivation to include this introductory chapter in the new edition of the book.

Makkah is not merely a city; it is the pulsating heart of the Islamic world. It is therefore imperative to pause and reflect upon it—unveiling its mysteries, shedding light on its majesty, linking its sanctity with its history, and introducing its unforgettable landmarks.

In this chapter, we invite the reader on a spiritually and historically enriching journey. We begin with al-Masjid al-Ḥarām (the Sacred Mosque), the Kaʿbah, the boundaries of the sanctuary (al-Ḥaram), and the designated spatial miqāt points. We then proceed to the sacred sites of Minā, Muzdalifah, and ʿArafāt, highlighting their ritual functions and contemplating the unique character of each. Additionally, we explore the prominent landmarks frequently visited by pilgrims seeking blessing and spiritual reflection, such as the Cave of Ḥirāʾ, the Cave of Thawr, the Valley of Abū Ṭālib, Jabal al-Raḥmah (Mount of Mercy), and Masjid al-Tanʿīm, among others—sites that still echo with the fragrance of prophethood and the eternal call of monotheism.

This distinctive introductory chapter serves as a conceptual primer, bridging the symbolic significance of **ZamZam** as a source of spiritual sustenance and Makkah as the cradle of faith, while establishing a nuanced connection between creed and knowledge..

The Historical Dimension of Makkah al-Mukarramah

Despite the diversity of opinions among historians, narrators, and scholars about the exact date when Makkah al-Mukarramah was founded, there is broad consensus on its profound historical significance. Makkah is not just one of the oldest known cities in the world; it is also considered one of the earliest human settlements overall—whether these settlements are well documented or remain obscured by history. It is believed that Makkah dates back more than two thousand years before the Common Era, even before the establishment of the Sacred House (al-Bayt al-Ḥarām) by the Prophet Abraham (Ibrāhīm, **PBUH**) in the 19th century BCE.

The historian al-Masʿūdī notes that the tribe of ʿAmālīq (Amalekites) was among the earliest inhabitants of Makkah. Initially, Makkah was a small settlement populated by the descendants of Adam, but it was destroyed by the Great Flood during the era of the Prophet Noah (Nūḥ, **PBUH**), transforming it into a dry valley surrounded by mountains on all sides.

With the advent of the Prophet Abraham and his son Ishmael (Ismāʿīl, **PBUT**), life returned to this valley. The miraculous gushing forth of the **ZamZam** Well beneath the feet of the infant Ishmael drew people to settle in the area. The tribe of Jurhum was the first to settle in Makkah following the emergence of the well. Ishmael grew up under their care, and the Jurhumites retained dominance over Makkah and the Sacred Kaʿbah for an extended period. During their rule, however, they eventually buried the **ZamZam** Well and continued to control the city until the late third century CE, when the Yemeni tribe of Khuzaʿah seized authority.

Khuzaʿah governed Makkah for nearly three centuries, until the mid-fifth century CE, when the tribe of Kinānah assumed sovereignty over the Sacred House. This leadership transition eventually led to the rise of the Quraysh tribe—a branch of Kinānah descending from al-Naḍr ibn Kinānah—under the leadership of Quṣayy ibn Kilāb, the fourth great-grandfather of the Prophet Muhammad (**PBUH**). Quṣayy established Dār al-Nadwah (the House of Assembly) and distributed responsibilities related to the Kaʿbah and the

Sacred Mosque among his four sons. His son ʿAbd Manāf ibn Quṣayy—the Prophet›s third great-grandfather—was entrusted with the duties of watering the pilgrims (siqāyah), providing food (rifādah), and leadership.

After the death of ʿAbd Manāf, his son Hāshim ibn ʿAbd Manāf assumed leadership, and these responsibilities were later passed to ʿAbd al-Muṭṭalib ibn Hāshim, the grandfather of the Prophet Muhammad (**PBUH**). Among his most notable achievements was the rediscovery and re-excavation of the **ZamZam** Well in 540 CE. His lifetime also witnessed the attempted attack on the Kaʿbah by Abraha al-Ashram in 571 CE—the year known as the Year of the Elephant, which also marked the birth of the Prophet Muhammad (**PBUH**).

In the 7th century CE, the dawn of Islam emerged from Makkah through the prophetic mission of the Prophet Muhammad (**PBUH**), who called people to monotheistic worship and the oneness of God. As the Quraysh intensified their persecution of Muslims—especially the vulnerable and marginalized—the Prophet (**PBUH**) permitted his companions to emigrate to Abyssinia. As the persecution continued, he later instructed them to migrate to Yathrib (al-Madīnah al-Munawwarah), after receiving allegiance from members of the Aws and Khazraj tribes who pledged to support and protect him. Thus, the Prophet (**PBUH**) migrated to Madinah, where he established the Islamic state.

Following the Hijrah (Migration), several major battles occurred between the Muslims and the Quraysh, most notably Badr, Uḥud, and the Trench (al-Khandaq). In Shawwāl of the sixth year after Hijrah (corresponding to 628 CE), the Prophet (**PBUH**) set out with a group of his companions toward Makkah to perform ʿUmrah. Upon reaching the area of al-Ḥudaybiyyah, Quraysh barred them from entering the city, which led to the signing of the Treaty of al-Ḥudaybiyyah between the two parties.

Two years later, Quraysh violated the terms of the treaty. The Prophet **(PBUH)** then commanded his companions to prepare for the conquest of Makkah. In the eighth year after Hijrah, the Prophet (**PBUH**) entered Makkah with a large army without resistance. He removed the idols from the Kaʿbah, declared a general amnesty for its inhabitants, and then returned to al-Madīnah al-Munawwarah.

From the Conquest of Makkah until the death of the Prophet (**PBUH**) in the eleventh year after Hijrah (632 CE), the city witnessed a period of political and religious stability. However, a phase of internal unrest began in 35 AH (656 CE), when the Islamic state became embroiled in civil strife, most notably the Battles of the Camel, Ṣiffīn, and al-Nahrawān. In 41 AH (661 CE), the Umayyad Caliphate assumed power and initiated numerous reforms in Makkah, including the construction of roads and the advancement of religious and scholarly affairs. One of their most prominent achievements was the expansion of the Sacred Mosque and the roofing of its porticos in 91 AH (710 CE).

The Umayyad rule continued until 132 AH (750 CE), when the ʿAbbāsid Caliphate emerged. The ʿAbbāsids also paid great attention to the architecture and maintenance of the Sacred Mosque, and Makkah witnessed further expansions and services during their rule. As ʿAbbāsid influence waned, Makkah came under the authority of several successive states, including the Ikhshidid, Fāṭimid, Ayyūbid, and Ottoman dynasties. Among the Ottomans' notable contributions was the construction of the Hijaz Railway.

In the 7th century AH, specifically in the year 597 AH (1200 CE), the Hashemites began ruling the Hijaz region, and their authority continued until the establishment of the third Saudi state. This took place under the leadership of King ʿAbd al-ʿAzīz Āl Suʿūd, who entered Makkah in 1351 AH (1932 CE), declaring the unification of the Kingdom of Saudi Arabia under a single banner.

Makkah from the Religious Perspective

Makkah al-Mukarramah is the most honored and blessed land on Earth—an exalted sanctuary toward which the hearts of believers are drawn from every direction. It is home to numerous sacred Islamic landmarks, foremost among them al-Masjid al-Ḥarām—the most revered site on Earth for Muslims. Within it stands the Kaʿbah, the qiblah (direction of prayer) for all Muslims and one of the three mosques to which pilgrimage is religiously encouraged. Furthermore, Makkah is the ultimate destination for Muslims performing Ḥajj and ʿUmrah, as it encompasses the sacred sites of Muzdalifah, Minā, and ʿArafāt.

God Almighty described it in His Noble Book as "the first House established for mankind—blessed and a guidance for the worlds" and made it a sanctuary and a secure place, in response to the supplication of Prophet Abraham (**PBUH**), who said:

﴿*My Lord, make this a safe city and provide its people with fruits…*﴾ [al-Baqarah: 126].

Makkah is a sanctified land where no blood may be shed, no hunting is permitted, and no trees or vegetation are to be cut. Within it, the reward for righteous deeds is multiplied. Among its most revered symbols is the Black Stone, a unique and sacred relic from Paradise, as confirmed by prophetic tradition, and one that is legislated to be kissed during circumambulation of the Kaʿbah.

Makkah is one of the most honored and well-known cities in the world. No other city has received the degree of veneration and exaltation that Makkah has attained. It is a great honor for Makkah that God blessed it and made it the first place on Earth where He was worshipped by the father of humanity, Adam (**PBUH**). Thereafter, He chose it—after a long period—as the qiblah for Muslims across the East and West, following divine instruction given to the Prophet Abraham and his son Ishmael (**PBUT both**) to reconstruct the Sacred House.

Makkah is the most beloved land to Allah and His Messenger (**PBUH**). Al-Tirmidhī narrated that the Messenger of Allah (**PBUH**) said:
"By Allah, you are the best land of Allah and the most beloved land to Allah. Had I not been driven out of you, I would not have left." (Ḥasan Gharīb Ṣaḥīḥ).

God has honored Makkah above all other lands and increased its prestige, sanctity, and elevation. One of the manifestations of this divine honor is that He referred to it by several noble names in the Qur'an:

- It is "Makkah":

﴿*Indeed, they who disbelieved and averted [people] from the way of Allah and [from] al-Masjid al-Ḥarām…*﴾ [al-Fatḥ: 23].

- It is "Bakkah":

﴿*Indeed, the first House [of worship] established for mankind was that at Bakkah—blessed and a guidance for the worlds.*﴾ [Āl ʿImrān: 96–97].

- It is "al-Masjid al-Ḥarām":

﴿*And He restrained their hands from you and your hands from them within the area of Makkah after He caused you to overcome them…*﴾ [al-Fatḥ: 24].

- It is "Umm al-Qurā" (Mother of Cities):

﴿*That you may warn the Mother of Cities and those around it…*﴾ [al-Anʿām: 92]

It is "al-Balad" (The City):

﴿*I swear by this city (al-Balad)…*﴾ [al-Balad: 1].

- It is "the secure city":

﴿*By the fig and the olive, and [by] Mount Sinai, and by this secure city (Makkah)…*﴾ [al-Tīn: 1–3].

Moreover, God ascribed Makkah to Himself in the verse:

﴿*And [mention] when We made the House a place of return for the people and [a place of] security…*﴾ [al-Baqarah: 125].

Makkah is the spiritual, cultural, and social hub for all Muslims everywhere, across time and place. It is the spiritual destination of their hearts. God Almighty has distinguished it with safety, security, and tranquility, as He says:

﴿*Have they not seen that We made [Makkah] a safe sanctuary, while people are being taken away all around them?*﴾ [al-ʿAnkabūt: 67].

This security encompasses all beings within the city, including humans, animals, and plants. Al-Bukhārī and Muslim (with the wording from Muslim) narrated from Ibn ʿAbbās (may Allah be pleased with him) that the Messenger of Allah (**PBUH**) said:

"Indeed, this city was made sacred by Allah on the day He created the heavens and the earth. So it is sacred by Allah's sanctity until the Day of Resurrection. Fighting was not permitted for anyone before me, and it was only permitted for me for a short portion of the day. It will remain sacred by Allah's decree until the Day of Resurrection."

Generally, the concept of security in Makkah can be divided into two principal types:

- **Divine (Qadarī) Security:**

This is the security guaranteed by Allah Himself—that no disbelieving army will ever conquer Makkah after its liberation, that the Antichrist (al-Dajjāl) will never enter it, and that its people will not suffer hunger, for fruits are brought to it from all directions. **ZamZam** water was made nourishing and sustaining, and the rites of Islam—such as the Kaʿbah, Maqām Ibrāhīm, and the hills of Ṣafā and Marwah—were entrusted to it. All of these remain safe by Allah's divine protection of Makkah.

- **Human (Sharʿī) Security:**

This refers to the security established through Islamic legislation, whereby the residents and visitors of Makkah are commanded to maintain peace and protection among themselves, to safeguard its trees, wildlife, and property. Properly applying these rulings makes Makkah a living embodiment of divine security. The end of human history on Earth begins when Makkah's sanctity is violated. This violation occurs when its people permit what God has prohibited and desecrate its sacredness. Once this happens, God permits their destruction, just as He has with previous nations.

Ultimately, the discussion of Makkah, al-Masjid al-Ḥarām, and the sacred sites is inexhaustible. These places remain ever-present in the hearts of Muslims and will keep doing so until Allah inherits the Earth and all its inhabitants. Makkah symbolizes the beating spiritual heart of the Islamic

world—the cherished destination of believers and the central axis toward which hearts are drawn before sights. Studying the religious concept and spiritual dimension of Makkah opens the door to a deeper understanding of its place within Islamic doctrine, devotional rituals, and the civilizational history of the Muslim ummah.

Makkah is not merely a geographic location; it is a manifestation of profound spiritual meanings—a symbol of the intimate bond between the Muslim and their Lord, beginning with the moment when Abraham (**PBUH**) raised the foundations of the House with a pure invocation and perfect obedience to divine command.

Makkah holds a distinctive position in the collective imagination of the Muslim community, transcending geographical bounds to become a universal symbol of unity, belonging, and devoted service to Allah Almighty. Muslims from every corner of the Earth gather there, differing in language, skin color, ethnicity, and culture, yet united in purpose and direction. The Ḥajj pilgrimage serves as a powerful example of Islamic unity—an annual event where social and class divisions dissolve, and the principles of equality, humility, and brotherhood among humanity are revived.

In the white garments of iḥrām, national identities fade away and worldly appearances vanish, leaving only the essence of the human being—standing before their Lord in the most sacred of places.

From this perspective, understanding the religious dimension of Makkah is incomplete without recognizing its role in shaping the unified Islamic identity and reinforcing the values of obedience, submission, and belonging to one ummah—united by its qiblah, its law, and its divine message.

Reflections and Wisdom Inspired by the Sacred Sanctuary of Makkah

● Derivation of "Bakkah" (with the letter Bāʾ)

Linguistic sources explain that *Bakk* denotes crowding and congestion—signifying that people *tabākkū* (throng together) around the Sacred House. This connotation evokes proximity to the Divine, and competition in worship—not worldly matters. *Bakk* also carries the meaning of humility and weeping, reflecting the spiritual brokenness one experiences at the House of God. In this context, the weeping becomes a manifestation of closeness, not sorrow.

There is also an uncommon linguistic theory that connects *Bakkah* to *barakah* (blessing), possibly originating from a Syriac or Aramaic root, as previously noted. This suggests a possible convergence of Semitic languages around the root *Bakk*, conveying sanctity, supplication, and divine grace.

Bakkah is believed to be the site where the Divine command "Be!" (*Kun*) was enacted, and the Sacred House was established. In this light, *Bakkah* symbolizes the moment of primordial light and foundational blessing.

● Derivation of "Makkah" (with the letter Mīm)

The root *Makk* denotes pulling or attracting—as in *yamukk al-shayʾ*, meaning to draw something in. Thus, the name "Makkah" alludes to spiritual and emotional attraction, in harmony with the verse: ﴿*...That they may witness benefits for themselves...*﴾ [al-Ḥajj: 28].

Other linguistic meanings of *Makk* relate to crushing or defeating falsehood—as in *makk fulānan*, which means to humiliate or destroy someone. This meaning becomes evident during the conquest of Makkah, when polytheism and its adherents were subdued.

Makkah is thus the place where empowerment was realized, where victory occurred, and where falsehood was eradicated.

Hājar's Patience and Her Striving: A Lesson in Certainty and Reliance

When Hājar was left with her infant son Ishmael in a barren valley, her patience was not mere passive endurance—it was active striving. Her journey between Ṣafā and Marwah was a search for a trace of mercy. At the end of her effort, **ZamZam** gushed forth beneath Ishmael's feet, becoming a symbol of divine provision arriving at the brink of despair.

Moral: "God does not forsake those who rely upon Him." Striving, when accompanied by unwavering certainty in God, transforms barren deserts into gardens, and thirst into an eternal spring.

Ishmael's Submission: A Lesson in Absolute Surrender

When Ishmael said to his father Abraham:

﴿O my father, do as you are commanded. You will find me, if God wills, among the patient﴾. [al-Ṣāffāt: 102].

His willingness to be sacrificed represented the highest expression of servitude. It was not the knife that saved him—but the Divine call:

﴿And We ransomed him with a great sacrifice﴾.

Moral: "Elevation comes through surrender, not through escape." When the servant entrusts their affair to God, He transforms their sacrifice into relief and their trial into triumph.

Abraham Raising the Foundations: A Lesson in Building upon Piety

Abraham did not construct the Kaʿbah with stones alone, but with the tears of supplication: *﴿Our Lord, accept [this] from us. Indeed, You are the Hearing, the Knowing﴾* [al-Baqarah: 127].

The Sacred Sanctuary stands as a witness that deeds are sanctified by intention.

Moral: "When hearts are built on faith, the earth flourishes with blessings".

- **ʿAbd al-Muṭṭalib Redeeming ʿAbdullāh: A Lesson in Redemption and Prophethood**

When ʿAbd al-Muṭṭalib intended to sacrifice his son ʿAbdullāh—the father of the Prophet (**PBUH**)—he ultimately ransomed him with a hundred camels. This event was, in truth, divine preparation for the birth of the Seal of the Messengers.

Moral: ﴿What appears to be a trial may in fact be a prelude to the greatest of blessings.﴾ What ʿAbd al-Muṭṭalib perceived as misfortune was in reality the beginning of the Muhammadan Prophethood.

- **Yūnus in the Belly of the Whale: A Lesson in Repentance and Return**

When Prophet Yūnus left his people in anger, he was swallowed by the whale. From the depths of darkness, he cried out:

﴿*There is no deity but You. Glory be to You! Indeed, I was of the wrongdoers*﴾ [al-Anbiyā : 87].

God answered his call.

Moral: ﴿There is no darkness deeper than that of resenting Divine decree, and no light more radiant than the light of repentance.﴾

This divine journey calls you: do not merely read it with your eyes—walk through it with the feet of Hājar, weep with Abraham's tears, surrender like Ishmael, and repent like Yūnus—so that you may embody the verse:

﴿*...and fear Me, O you of understanding*﴾ [al-Baqarah: 197].

- **In the Sacred Sanctuary, Distinctions Disappear**

"In the Ḥaram, the masks fall." Here, adornment and vanity hold no value. The garments are white, and hearts are revealed. God does not look at appearances, but at hearts.

"In the courtyard of Ṭawāf, titles dissolve: there is no rich or poor, no prince or laborer—all are servants of God, equal in their love and humility toward Him."

As you circumambulate the Kaʿbah in harmony, make your life a circle of obedience, revolving constantly around God, not the world.

● Every Step in Makkah is an Intention

"In Makkah, even walking to the mosque is worship, gazing at the Kaʿbah is supplication, silence is reflection, and a tear is repentance."

Not everyone who visits Makkah truly experiences its essence. Only those who arrive with a humble heart can savor its sweetness and bask in its spiritual light. Within its sacred walls, the seeker finds safety; whoever sincerely supplicates within it finds their prayers answered; and whoever intends good therein is rewarded manifold.

"Hearts that have sincerely performed Ḥajj never return the same—for they have tasted the purity of intimate devotion in the holiest of places."

● ZamZam Quenches the Heart Before the Body

"ZamZam is not merely for physical thirst—it is for the thirst of the soul. Whoever drinks it with faith is quenched with certainty and filled with security."

● On "Placement" and "Elevation"

The term *wuḍiʿa* (was placed) implies a divine foundation, established without human intervention, and suggests deep-rooted permanence on Earth. In contrast, *banāʾ* (building) suggests visible, material construction.

Thus, when God says: ﴿*Indeed, the first House [of worship] established for mankind…*﴾ [Āl ʿImrān: 96].

He refers to the existential reality of the Sacred House before it becomes visible—its metaphysical roots in creation. As for raising the foundations:

"And [mention] when Abraham raised the foundations of the House…" This indicates that the foundations already existed—buried or hidden—and that Abraham did not create them from anything, but revealed them. This implies that the *placement* preceded the *raising* and that Abraham was a "raiser," not a "founder."

- **The Black Stone**

Described as a heavenly ruby, the Black Stone was originally pure white but turned black—symbolizing a profound spiritual metaphor:

- Its whiteness: innate purity.
- Its blackness: the imprint of human sin.
- Its endurance: the perpetuation of the covenant.

This represents the intersection between divine light and human nature. Touching and kissing the Black Stone is thus a symbolic pledge—not an act of worship.

Religious and Scientific Miracles in Makkah al-Mukarramah

The topic of religious and scientific miracles in Makkah al-Mukarramah captures many people's interests, given the city's immense religious status among Muslims. Makkah is not merely a historical or religious city—it is an eternal symbol embedded in the conscience of the Islamic ummah, a spiritual and scientific center with multidimensional significance that defies simple categorization.

Religious Miracles

- **Makkah encompasses unique attributes found nowhere else on Earth**: it is home to the Kaʿbah—the first House established for humanity, and the place where revelations descended and civilizations converged.
- **Makkah is the qiblah (direction of prayer) for all Muslims**, and millions journey to it annually for Ḥajj and ʿUmrah.
- **The miraculous Night Journey and Ascension (al-Isrāʾ wa al-Miʿrāj)** formed an eternal and unbreakable link between al-Masjid al-Ḥarām in Makkah and al-Masjid al-Aqṣā in Jerusalem.
- **One of the greatest miracles that occurred in Makkah** is the revelation of the Qur›an to Prophet Muhammad (**PBUH**) in the Cave of Ḥirāʾ—arguably the most significant event in Islamic history.
- **The entrance to the Cave of Ḥirāʾ is narrow and small**, accommodating only one or two individuals. It was here that prophethood began, when the angel Jibrīl (Gabriel, **PBUH**) descended upon the Prophet Muhammad (**PBUH**) during a state of deep devotion and reflection. What occurred in the cave symbolizes a direct connection between heaven and earth.
- **Following the Treaty of al-Ḥudaybiyyah**, people began embracing Islam in large numbers. Islam spread freely, unhindered by warfare—

an outstanding example of strategic and daʿwah (missionary) foresight. Indeed, this "clear conquest" shifted the geopolitical balance and paved the way for the Conquest of Makkah and the widespread dissemination of Islam.

- **When Quraysh rejected the Prophet's title "Messenger of Allah" in the treaty and insisted on using "Muḥammad, son of** ʿAbdullāh**,"** the Prophet (**PBUH**) agreed—despite his companions' objections. This prophetic flexibility enabled the treaty to proceed and opened the door to daʿwah.

- **Makkah is the site of momentous religious events**, most notably the commissioning of Prophet Muḥammad (**PBUH**), and the starting point of the Hijrah to Madinah—the pivotal moment in Islamic history.

- **The rites of ṭawāf and saʿī,** performed during Ḥajj and ʿUmrah in Makkah, are deeply spiritual and linked to three great prophets: Abraham, Ishmael, and Muḥammad **(PBUT all)**.

- **Adam (PBUH) was the first to lay the foundations of the Kaʿbah** by divine command. The structure was later lost to floods or decayed over time. God then commanded Abraham to rebuild it. The Maqām Ibrāhīm (Station of Abraham) marks the spot where he stood during construction, assisted by his son Ishmael in transporting stones.

- **Makkah is mentioned multiple times in the Qur›an**, including:

﴿Indeed, the first House [of worship] established for mankind was that at Bakkah—blessed and a guidance for the worlds.﴾ [Āl ʿImrān: 96] and God swore by it: *﴿I swear by this city…﴾* [al-Balad: 1–3].

These verses alone attest to Makkah's unique spatial and temporal sanctity. Al-Tirmidhī narrates that the Prophet (**PBUH**) said:

"Indeed, Allah sanctified Makkah, and it was not the people who sanctified it".

The Kaʿbah is cubic, with its four sides oriented precisely to the cardinal directions. The side that faces Ḥijr Ismāʿīl (which contains the Iraqi and Levantine corners) is aligned to true north; opposite it lies the southern wall, which includes the Black Stone and Yamānī corners. The eastern wall—where the Kaʿbah's door and the Multazam are located—faces directly east, and its opposite wall, the western side, comprises the Levantine and Yamānī corners. The exact alignment to the cardinal directions—achieved thousands of years ago—makes it implausible that this orientation resulted from human effort alone; rather, it suggests a structure built by angels.

- **This blessed land is distinguished by properties found nowhere else**, including:
- The prohibition of warfare since the dawn of the prophetic message.
- The ban on hunting and cutting trees within its boundaries.
- The multiplication of rewards for acts of worship performed therein.
- The inclusion of sacred sites such as Minā, Muzdalifah, ʿArafāt, and Mount of Mercy.
- **Among the miracles of the Black Stone:** the ritual of ṭawāf begins and ends at it, and it will testify truthfully on the Day of Judgement. The Prophet (**PBUH**) said: **"**The Black Stone will come on the Day of Resurrection with two eyes to see and a tongue to speak, bearing witness for those who touched it with sincerity**".**
- **The Maqām Ibrāhīm is a historic stone bearing the footprint of Prophet Abraham** (**PBUH**). The imprints have remained preserved over the ages, still visible to this day. No other stone in the world possesses such a unique feature.
- **Minā** is the site of the stoning of the three Jamarāt and where pilgrims reside during the Days of Tashrīq. It is said to be the place where Abraham sacrificed the ram in place of his son Ishmael.

- ʿ**Arafāt** hosts the greatest pillar of Ḥajj: standing at ʿArafah. The Prophet (**PBUH**) said: *"*Ḥajj is ʿArafah." It is a majestic location where the entire Muslim ummah gathers in a single day. On this day, sins are forgiven like no other.

- **Muzdalifah** is the station where pilgrims spend the night after sunset on the Day of ʿArafah and gather pebbles for the stoning rites at Minā.

- **There is a cosmic parallel between heaven and earth, as referenced in numerous Qur›anic verses** and verified by authentic prophetic traditions. Al-Bayt al-Maʿmūr (the Frequented House) in the seventh heaven lies directly above the Kaʿbah, perfectly aligned with it, highlighting how the dimensions of the vast heavens correspond to those of Earth.

- **The Splitting of the Moon** is a miracle that occurred in Makkah when the disbelievers demanded a sign to confirm the Prophet's truthfulness. The Qur›an records this in Sūrat al-Qamar:

  ﴿*The Hour has drawn near, and the moon has split.*﴾ (al-Qamar: 1)
  The moon was split into two parts: one resting over Mount Abū Qubays, the other over Mount Quʿayqiʿān.

- **The Greek historian Ptolemy referred to Makkah in the second century CE** as *"Markoaba"*—meaning "House of the Lord." This is a significant reference, especially in light of Christian sources that mention it by the name *Bakkah* (*Baca*), recognizing it as the House of God.

- **The wisdom behind the number seven in Ḥajj rituals**—seven circuits of ṭawāf, seven laps between Ṣafā and Marwah, and seven pebbles for each Jamrah—reflects divine design. The entire universe is governed by God's will and order: seven heavens, seven earths, seven days of the week, seven colors in the visible spectrum, seven atomic shells, and so forth. Thus, the repeated use of the number seven in Ḥajj symbolizes God›s universal order and alludes to His absolute Oneness.

- **The uninterrupted flow of ZamZam water for nearly 5,000 years**—from highly crystallized igneous and metamorphic rocks—is astounding, especially considering the well was buried and excavated multiple times. Its water emerges from fine capillary fissures extending far beyond the limits of Makkah in all directions. This confirms the Prophet's (**PBUH**) description of the well as a result of a powerful strike, saying:

  "It is the gushing of Jibrīl and the provision of Allah for Ishmael".

- **Observers have noted that predatory animals do not fight within the Sacred Precinct of Makkah.** They coexist peacefully, even with species they would normally prey upon elsewhere. Similarly, birds seldom fly directly over the Kaʿbah; instead, they veer away, as if circumambulating it in reverence.

- **In the Valley of Muḥassir, near Makkah**, when Abrahah al-Ashram directed his elephant to destroy the Kaʿbah, the elephant knelt and refused to move forward. They beat it with iron axes, but it did not rise. When turned toward Yemen, it ran; when turned toward Syria or the east, it moved. But when directed toward the Kaʿbah, it knelt again. At that moment, God sent the flock of birds—abābīl—as mentioned in Sūrat al-Fīl (105:3).

- **God's will decreed that Abrahah survived the incident**, but died later in Yemen, serving as a sign for those who came after—just as Pharaoh, who arrogantly declared "I am your Lord, the Most High," was seized by God and his body was preserved as a lesson for future generations:

  ﴿*This day We will preserve your body so that you become a sign for those after you…*﴾ [Yūnus: 92].

Scientific Miracles

Makkah al-Mukarramah holds a central spiritual status in Islam and has been the focus of various studies attempting to link its location and natural phenomena to scientific or cosmic principles. While some of these studies may not meet the rigorous standards of empirical validation, they nonetheless inspire reflection and admiration among many believers. Scientific miracles in the Qur'an and religion should be approached with methodological caution to avoid unverified claims. Experimental science relies on observable evidence, and miracles alone cannot serve as conclusive proof of doctrinal beliefs.

- Several studies have proposed that Makkah lies at the geographic center of the Earth›s landmass, based on global map projections and geodetic measurements. While this claim may not be scientifically precise, it holds symbolic significance for Muslims and reinforces the city's spiritual centrality.

- **ZamZam Well**, located just 21 meters from the Kaʿbah, is considered one of the rarest wells on Earth in terms of depth, hydrological origin, and water characteristics. Despite lying in a harsh, arid, rocky terrain, its waters have flowed continuously for thousands of years. Advanced physicochemical analyses of **ZamZam** water have confirmed its exceptional purity and stable mineral composition compared to other groundwater sources.

- Numerous studies have indicated that Makkah's geographic coordinates exhibit remarkable alignment with the so-called Golden Ratio in the distribution of Earth's land and sea masses. This reinforces its symbolic portrayal as a point of planetary equilibrium. Additionally, some also suggest that Makkah's meridian (approximately 39.8° E) might correspond to a geomagnetic equilibrium or a balance of day and night durations. However, these hypotheses lack support from the mainstream scientific community and are often framed within theological or miraculous frameworks. For instance, **magnetic declination** in Makkah is not zero, and thus does not support claims of unique magnetic symmetry.

- During the **rituals of Ḥajj and ʿUmrah**, Muslims are required to circumambulate the Kaʿbah seven times, starting and ending at the Black Stone. This movement is performed counterclockwise, aligning with the direction of rotation observed in the universe-from subatomic particles to celestial bodies. Electrons rotate around their nuclei counterclockwise, mirroring the direction of ṭawāf. Makkah lies approximately 21.4° north of the equator, and it is generally observed that phenomena in the Northern Hemisphere exhibit counterclockwise motion, while those in the Southern Hemisphere tend to move clockwise. This is due to the Coriolis effect, resulting from Earth's tilted axial rotation. It is noteworthy that Muslims have been circumambulating the Kaʿbah in this direction for over 1400 years—long before the scientific discovery of the Coriolis force.

- The **Black Stone** was brought by the angel Jibrīl (Gabriel, **PBUH**) when Prophet Abraham (**PBUH**) was rebuilding the Kaʿbah. While its surface is blackened, its interior remains a brilliant white. Scientific studies have suggested that the stone is meteoritic in origin, with a unique mineralogical and chemical composition. It is said to float on water, resist heating by any conventional means, and emit various forms of non-visible radiation.

- **Geophysical studies** have recorded unusual magnetic anomalies in the Sacred Mosque area, with localized reductions in magnetic noise levels compared to surrounding regions.

- **Geologically**, Makkah is one of the most fortified locations, surrounded by robust mountain chains from most directions. This topography provides natural protection; however, it does not make Makkah immune to earthquakes. There is no textual evidence in the Qur'an or Sunnah to suggest that Makkah, despite its sanctity, is divinely shielded from natural disasters. Historical records show few instances of severe seismic activity within the city.

- While **no ancient or modern earthquake** has been recorded within the defined boundaries of the Sacred Precinct, historical data indicate that **12 earthquakes** have occurred in the broader Makkah region between **801 and 1963 CE**. The most severe of these was in **1121 CE,** which partially damaged the Yamānī corner of the Kaʿbah. Another strong quake occurred in **1710 CE**. In modern times, Makkah experienced two earthquakes: in **al-Sharāʾiʿ (1993)** and **Madrakah (1994)**—both originating **outside the Sacred Sanctuary**.

- Due to its position between the Tropic of Cancer and the Equator, specifically at latitude 21.4° N and longitude 39.8° E, Makkah experiences a notable astronomical phenomenon: the sun passes directly overhead the Kaʿbah twice annually at solar noon-on May 29 and July 16. This solar zenith alignment can be used worldwide to accurately determine or correct the direction of the qiblah from any location in the sunlit hemisphere during these two dates. At these times, the sun is directly vertical above Makkah, and shadows vanish beneath upright objects, offering a precise natural calibration for Islamic prayer orientation.

Water Security in Makkah: Past and Present

In ancient times, the people of Makkah prioritized securing water resources because their survival depended on them. They constantly searched for places where water was accessible to settle and build their civilization. They dug manual wells and created tools and devices to maximize water utilization.

In modern times, the concept of water security has evolved to encompass the availability of sufficient quantities of clean, usable water that meets various human needs in both quantity and quality—while ensuring sustainability and continuity without causing harm to future generations. Achieving this security depends on the optimal use of available resources, the advancement of water technologies, the development of existing water sources, and the exploration of alternatives.

Water Security in Ancient Makkah

The emergence of the **ZamZam** Well thousands of years ago can be considered the starting point of water security in Makkah. Historically, the people of Makkah relied entirely on water carriers (*saqāʾīn*) to transport water to their homes, due to the city›s rugged mountainous terrain. Residents had to descend to the wells surrounding the Ḥaram and carry water up to the higher elevations.

During the pre-Islamic era, the Quraysh tribe maintained several other wells in addition to **ZamZam**. Among the most prominent were:

- **al-Ṭawā**: Owned by ʿAbd Shams ibn ʿAbd Manāf, located in upper Makkah.
- **Badhar**: Belonging to Hāshim ibn ʿAbd Manāf, located at the entrance of the Valley of Abū Ṭālib.
- **Sijlah**: Owned by al-Muṭʿim ibn ʿAdī ibn Nawfal ibn ʿAbd Manāf.

- **al-Ḥufr**: Belonging to Umayyah ibn ʿAbd Shams.
- **Saqiyyah**: Owned by the Banū Asad ibn ʿAbd al-ʿUzzā.
- **Umm Aḥrād**: Belonging to the Banū ʿAbd al-Dār.
- **al-Sunbulah**: Owned by the Banū Jumāḥ, dug by Khalaf ibn Wahb.
- **al-Ghamr**: Belonging to the Banū Sahm.
- **Ram wa Ram**: Dug by Murrah ibn Kaʿb ibn Luʾayy.
- **Wakham**: Owned by the Banū Kilāb ibn Murrah.
- **al-Ḥufar** (a different well): Belonging to the Banū ʿAdī ibn Kaʿb ibn Luʾayy. (al-Ghubāshī, 1990 CE).

However, over time, people gradually stopped using these wells and instead began drawing water from **ZamZam**. Ibn Isḥāq stated:

"**ZamZam** replaced the other wells that had previously served the pilgrims, and people turned to it because of its proximity to al-Masjid al-Ḥarām, its superiority over other water sources, and because it was the well of Ishmael, son of Abraham. The Banū ʿAbd Manāf took pride in their association with it over all of Quraysh and the rest of the Arabs".

Musāfir ibn Abī ʿAmr ibn Umayyah ibn ʿAbd Shams ibn ʿAbd Manāf proudly boasted to Quraysh of the honor of providing water and hospitality to the pilgrims through **ZamZam**. He emphasized how the Banū ʿAbd Manāf, being one household, shared in the honor and nobility of the well. (al-Azraqī, 1969 CE).

Wells Dug During the Islamic Period

Numerous wells were excavated during the Islamic era to meet the growing water needs of Makkah's residents and pilgrims. Among them were:

- **al-Yāqūtah**: Located in Minā, dug during the caliphate of Abū Bakr al-Ṣiddīq (may Allah be pleased with him), and later developed by al-Ḥajjāj ibn Yūsuf.

- **Well of ʿUmar ibn ʿUthmān ibn ʿAffān:** Situated in Minā in the Valley of Āl ʿAmr.
- **Well of the Partners** (Biʾr al-Shurakāʾ): In Ajyād, belonging to the Banū Makhzūm.
- **Well of ʿIkrimah**: Located in the smaller Ajyād valley known as al-Aysar.
- **Well of al-Aswad ibn Sufyān ibn ʿAbd al-Asad al-Makhzūmī**: Also known as *Biʾr Banī Asad* or *Biʾr al-Ṣalā*, due to its proximity to the prayer area (*al-Ṣalā*). Originally, it was the well of Shafiyyah Umm Qirdān.
- **Well of al-Ṭulūb**: Belonging to ʿAmr ibn ʿAbd Allāh ibn Ṣafwān al-Jumaḥī, located in the Valley of ʿAmr near al-Ramḍah, below al-Maythab.
- **Well of Abū Mūsā al-Ashʿarī**: In al-Maʿāh at the mouth of Abī Dub near al-Ḥujūn, dug after returning from governance.
- **Well of Shawdhab**: Located at the Gate of the Banū Shaybah, later absorbed into al-Masjid al-Ḥarām during its expansion by Caliph al-Mahdī in 161 AH.
- **al-Barūd Well**: In Faḫkh, excavated by Khurāsh ibn Umayyah al-Khuzāʿī al-Kaʿbī.
- **Well of Bakkār**: Located in Dhū Ṭuwā near the watering station of Bakkār—a man from Iraq who settled in Makkah.
- **Well of Wardān**: Dug by Wardān, the freedman of al-Muṭṭalib ibn Abī Waddāʿah, in Dhū Ṭuwā near the water station of Sirāj in Faḫkh; Sirāj was the freedman of the Banū Hāshim.
- **Well of al-Ṣalāsil**: At the mouth of the Bayʿah Valley near the ʿAqabah of Minā.
- **Well of al-Suqyā**: Near the two mountain passes (al-Mażmayn) of ʿArafāt, excavated by ʿAbd Allāh ibn al-Zubayr ibn al-ʿAwwām. (al-Azraqī, 1969 CE).

Modern Water Security in Makkah

Due to the arid geographical nature of the Makkah region and the gradual depletion of natural water resources over time, the Kingdom of Saudi Arabia has undertaken numerous major projects in the water sector. These initiatives have placed particular and intensive focus on meeting the water needs of Makkah al-Mukarramah and the sacred sites, primarily to serve the guests of Allah (Ḍuyūf al-Raḥmān). Below is a brief overview of these achievements:

- **ZamZam water is distributed with meticulous care** in specially designated refrigerated containers throughout the Two Holy Mosques, following thorough sterilization procedures.
- **Water pipelines have been extended** to service the sites of Minā and ʿArafāt, ensuring the availability of water during the pilgrimage seasons.
- **Several projects have been completed** to improve the sources that supply Makkah's water network and to enhance its efficiency to meet the growing needs of pilgrims.
- **New wells have been drilled** to increase the water reserves of Makkah al-Mukarramah.
- **In anticipation of the future increase in the number of pilgrims**, a number of water infrastructure projects have been implemented to raise the volume of water supplied to the city.
- **Dedicated water storage tanks have been constructed** specifically to support Makkah's growing demand.
- **A series of projects has been executed** to expand both the water distribution and wastewater management networks in Makkah al-Mukarramah.

Landmarks of the Sacred Mosque (al-Masjid al-Ḥarām)

Understanding the landmarks of al-Masjid al-Ḥarām holds immense religious and historical significance. Many of the rituals and acts of worship performed by Muslims—such as ṭawāf (circumambulation), saʿī (ritual walking between Safa and Marwah), and ṣalāh (prayer)—require precise knowledge of these sacred landmarks, including the location of the Kaʿbah, the Black Stone, Maqām Ibrāhīm (Station of Abraham), the **ZamZam** Well, Ḥijr Ismāʿīl (the Enclosure of Ishmael), al-Multazam (the Clinging Place), and others. This understanding helps ensure that acts of worship follow the Sunnah (Prophetic tradition), emulating the Messenger of Allah (**PBUH**), who engaged with these sites during his devotions. Allah says: ﴿*That [is so]. And whoever honors the symbols of Allah—indeed, it is from the piety of hearts*﴾. (al-Ḥajj: 32).

To honor the symbols of Islam is to acknowledge their status and significance and interact with them with appropriate reverence and dignity. When a Muslim learns the history and importance of each landmark in the Sacred Mosque, their spiritual connection and humility in worship grow deeper, and their appreciation of the sacredness of the location is amplified-imparting a profound emotional and spiritual dimension to the rituals.

Thus, knowing the landmarks of al-Masjid al-Ḥarām is not merely an intellectual curiosity, but a religious and historical necessity that enhances the reverence of Islamic rituals, the validity of worship, and Muslims' connection to their religious and civilizational identity. It is therefore highly recommended—especially for pilgrims and visitors—to study these landmarks before their visit, and to reflect on their meanings while performing the rites, making their pilgrimage to the Sacred Sanctuary more conscious, profound, and sincere.

• al-Masjid al-Ḥarām (The Sacred Mosque)

It is the holiest mosque in Islam, located in the heart of Makkah, in a barren valley known as the Valley of Abraham (Wādī Ibrāhīm), surrounded by four mountains: Abū Qubays, Ajyād, Hindī, and ʿUmar. It sits at an elevation of 277 meters above sea level and is centered around the **Kaʿbah**, the first structure ever built on Earth and the most sacred site in Islam. The mosque is the qiblah (direction of prayer) for Muslims worldwide and is named *al-Ḥarām* (the inviolable) because fighting is prohibited within it. Its area is approximately **1,371,000 m²**.

The Kaʿbah

The Kaʿbah is a cube-shaped structure—hence its name (*Kaʿbah* meaning cube). It is built from solid stone, with a height of 15 meters. Its dimensions are as follows:

- From the side of **al-Multazam**: 12.84 meters.
- From the side of **Ḥijr Ismāʿīl**: 11.28 meters.
- Between the **Yamānī Corner** and **Ḥijr**: 12.11 meters.
- Between the **Yamānī** and **Shāmī Corners**: 11.52 meters (al-ʿUmari, 2023).

The Kaʿbah's foundation dates back to Prophet Adam (**PBUH**). Over time, it was destroyed and vanished, until Allah revealed its location to Prophet Abraham (**PBUH**) and commanded him to rebuild it. The angel Jibrīl (Gabriel, **PBUH**) brought him the Black Stone, which was originally dazzling white. The Kaʿbah has been rebuilt **twelve times** throughout history.

The Black Stone (al-Ḥajar al-Aswad)

The Black Stone is one of the Kaʿbah's integral components, located in its southeastern corner. It consists of eight small, irregularly sized pieces,

forming an oval-shaped stone that is black with reddish hues, interspersed with red spots and yellowish streaks. Its diameter is approximately 30 cm, and it is encased in a silver frame roughly 10 cm wide. It is called the «Black Corner» (*al-Rukn al-Aswad*) because it sits within the Kaʿbah's corner, positioned **1.5** meters above the ground, marking the starting and ending point of ṭawāf.

The stone is adorned with a protective silver casing. During the reconstruction of the Kaʿbah by Quraysh, the tribes disputed who would place the stone back in its position. They agreed to accept the judgment of the first person to enter the mosque—who turned out to be the Prophet (**PBUH**). He proposed placing the stone on a cloth, and each tribe held one edge of it, lifting it together. The Prophet (**PBUH**) then placed it with his own hands in its place. It is said that ʿAbd Allāh ibn al-Zubayr was the first to enshrine it in silver. According to some Prophetic traditions, Jibrīl brought the stone from Paradise and handed it to Abraham.

Ḥijr Ismāʿīl (The Enclosure of Ishmael, also known as al-Ḥijr or al-Ḥaṭīm)

This is an original part of the Kaʿbah structure, located between the **Shāmī** and ʿ**Irāqī** corners, on the left side of those performing ṭawāf. It forms a low, semi-circular wall. Islamic and historical sources unanimously agree that it is part of the Kaʿbah; therefore, **ṭawāf inside it is invalid**, and one must circumambulate around it. Praying inside it carries a reward similar to praying within the Kaʿbah itself, according to authentic traditions.

Alternate names for this area include:

- **al-Ḥijr**: as it was part of the original structure.
- **al-Jidr**: the Prophet (**PBUH**) referred to it as such, noting this as the correct name.
- **Ḥijr Ismāʿīl**: referring to Abraham's designation of the area as a shelter for Ishmael and his flocks.

- **Ḥufrat Ismāʿīl**: meaning "the hollow of Ishmael," referring to its earlier form before elevation.
- **al-Ḥaṭīm**: possibly due to its partial separation from the Kaʿbah or the loud invocations often made within it.

• al-Multazam

al-Multazam is the section of the Kaʿbah's eastern wall located **between the Black Stone and the Kaʿbah's door**, spanning approximately two meters. It is a site of **intense supplication and humility**, where Muslims cling to the wall in reverence and hope. ʿAbd Allāh ibn ʿAbbās (may Allah be pleased with him) narrated: "Between the Black Stone and the door, no one supplicates except that Allah answers him." This highlights the spiritual magnitude of the site.

• al-Shādhrawān

This is a **marble belt** constructed at the base of the Kaʿbah's wall—except on the side of al-Ḥijr. It secures the Kaʿbah's cloth via metallic rings and strengthens its foundation, particularly against flooding. The structure has been restored multiple times, most recently in **1437 AH (2016 CE),** when its marble was replaced and its golden rings renewed.

It comprises 36 marble slabs, each about 7 cm thick, weighing 110 kg on straight sides and 225 kg at the corners. Its total length is 48.7 meters.

• Maqām Ibrāhīm (Station of Abraham)

This is a soft stone, classified as a type of sedimentary rock, with a color blend of white, black, and yellow. It is the stone Abraham (**PBUH**) stood on as he built the elevated structure of the Kaʿbah. It is square-shaped and approximately half a meter in length.

Originally, the stone was adjacent to the Kaʿbah wall until Caliph ʿUmar

ibn al-Khaṭṭāb (may Allah be pleased with him) moved it back to create space for worshipers. The footprints of Abraham were visible on the rock in the early Islamic period but faded over time.

After ṭawāf, it is Sunnah to perform two units of prayer behind Maqām Ibrāhīm, as mentioned in the verse: ﴿*...And take the station of Abraham as a place of prayer.*﴾ (al-Baqarah: 125).

The stone is not kissed or touched; prayer behind it is the prescribed action. Muslim rulers throughout history have honored and safeguarded it, enclosing it in a golden cage, and later in a hexagonal brass structure with mesh sides allowing visibility of the stone. (Al-Amri, 2023).

• ZamZam Well

ZamZam is located east of the Kaʿbah, within the ṭawāf area, 18 meters south of Maqām Ibrāhīm, aligned with the Black Stone. It has a depth of approximately 30.5 meters, with an internal diameter ranging from 1.08 to 2.66 meters. It is one of the oldest wells in existence, dating back to the time of Prophets Abraham and Ishmael **(PBUT)**.

• al-Ṣafā and al-Marwah

These are two small mountains situated to the east of al-Masjid al-Ḥarām. al-Ṣafā marks the beginning of the saʿī ritual, and al-Marwah its end. They are mentioned in the Qur'an: ﴿*Indeed, al-Ṣafā and al-Marwah are among the symbols of Allah...*﴾ (al-Baqarah: 158).

The two hills were integrated into the mosque's architectural layout as part of the expansion of the saʿī area, allowing for seamless movement of pilgrims while preserving the site›s sanctity and historical significance.

- ❖ **Jabal al-Ṣafā** lies south-east of the Kaʿbah, about 130 meters **away**, and is a continuation of Mount Abū Qubays. It is said that Adam **(PBUH)** stood upon it, hence the name.

❖ **al-Marwah** is formed from white quartz stones tinged with reddish hues and is an extension of Mount Quʿayqiʿān, situated opposite al-Ṣafā, about 300 meters from the Kaʿbah. According to al-Aṣmaʿī, it was named for its bright white stones, and others say it was named because Eve stood upon it (*al-marʾah*, «the woman»).

The ritual of saʿī commemorates the story of Hājar, wife of Abraham, who ran between the two hills seeking water for her son Ishmael, symbolizing faith, trust, and confidence in God. It is one of the most vivid rituals in al-Ḥaram, enshrined as a pillar of both Ḥajj and ʿUmrah, representing a powerful narrative of spiritual resilience and deep reliance on the divine.

• Corners of the Kaʿbah (al-Arkān)

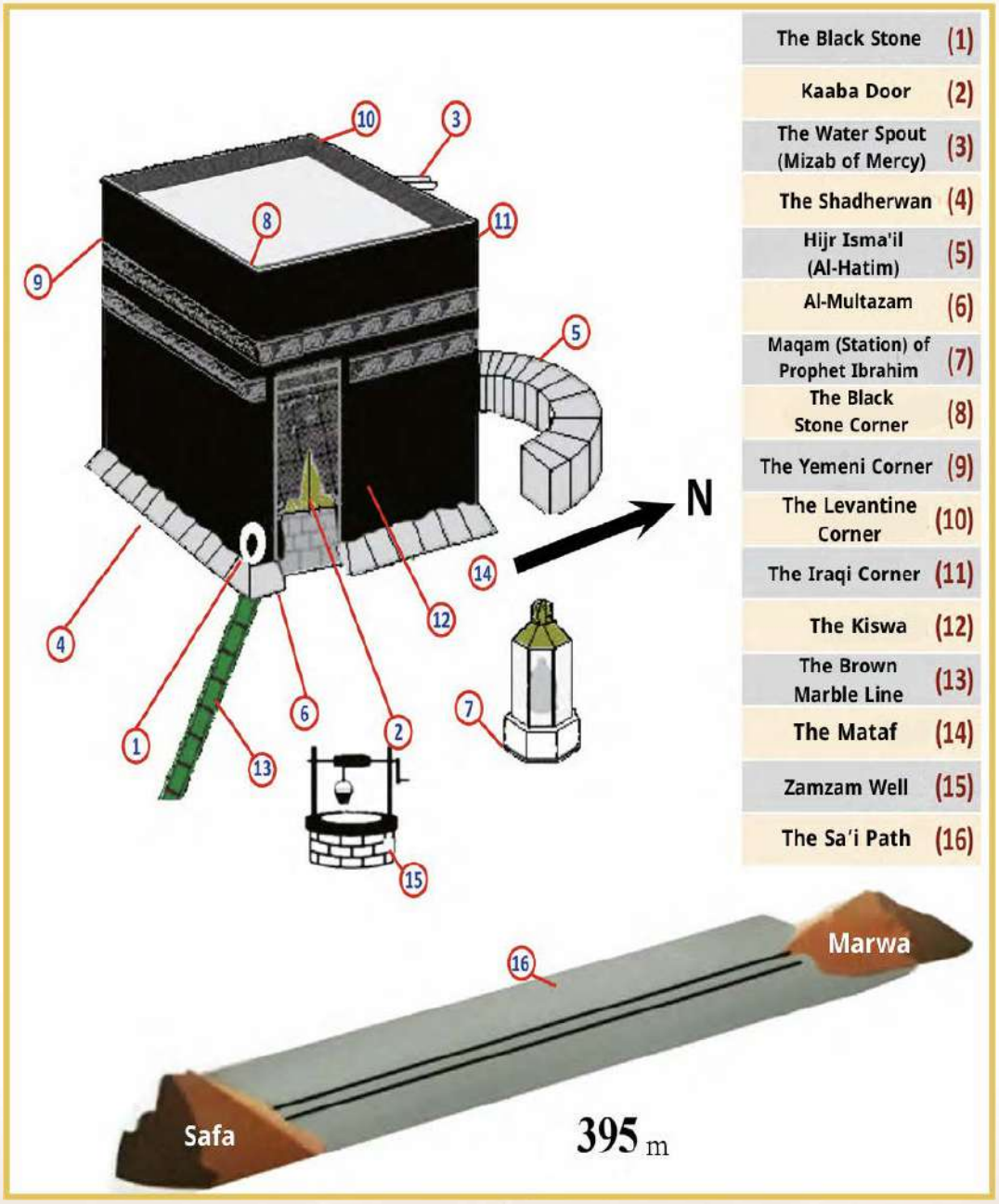
The Kaʿbah has four corners, each named based on geographic direction or religious significance:

1. **al-Rukn al-ʿIrāqī (Iraqi Corner)**: Faces north, named for its orientation toward Iraq. The distance between it and the Black Stone is 54 hand spans.

2. **al-Rukn al-Shāmī (Levantine Corner)**: Faces west, named for its alignment with the lands of al-Shām (Greater Syria).

3. **al-Rukn al-Yamānī (Yemeni Corner)**: Faces south, aligned with Yemen. It is the final corner passed during ṭawāf and is **to be touched (but not kissed)** according to Sunnah.

4. **al-Rukn al-Aswad (Black Corner)**: Faces east and contains the **Black Stone**. ṭawāf begins and ends here.



Principal Landmarks of Al-Masjid Al-Haram and the Holy Kaaba

Boundaries of the Sacred Mosque (al-Masjid al-Ḥarām)

It is unanimously agreed that the boundaries of the Sacred Sanctuary (al-Ḥaram) were originally designated by divine command to Prophet Abraham **(PBUH)**, and that their physical demarcation was renewed during the time of Prophet Muhammad (**PBUH**). This lends the boundaries of al-Ḥaram a deeply rooted historical and spiritual sanctity. Understanding these boundaries enables correct recognition of the sacred precincts as described in the Sunnah, and prevents misrepresentation, exaggeration, or shrinking of their extent. It also maintains the legitimate and architectural continuity of the Sacred Mosque.

These boundaries encompass the region where many pivotal events in the Prophetic biography unfolded. Knowing them allows Muslims to mentally map out the geography of the Prophetic era. Therefore, understanding the boundaries of al-Masjid al-Ḥarām is not merely a matter of geographic or historical interest, but an essential area of knowledge for every Muslim—particularly for pilgrims and visitors to the holy sites—due to its religious, legal, and historical significance.

Understanding the boundaries enables one to distinguish between what is inside al-Ḥaram and what lies in al-Ḥill (non-sacred land), which has practical legal implications. Among the jurisprudential rulings that depend on this distinction are:

- **The obligation to assume iḥrām (state of consecration)** for Ḥajj or ʿUmrah when entering the Ḥaram from outside (al-Ḥill).
- **The absence of this obligation** when leaving the Ḥaram without intending a ritual act (nusuk).
- **The validity of certain rituals**, such as the offering of sacrificial animals (hady), ṭawāf (circumambulation), and saʿī (ritual walking), is contingent upon performing them within the boundaries of the Sacred Mosque.

The delineation of the boundaries of al-Masjid al-Ḥarām is rooted in a foundational moment in Islamic tradition. It is narrated that Prophet Abraham

(PBUH) was the first to place the boundary markers (*anṣāb*) of the Ḥaram after being guided to their locations by the angel Jibrīl (Gabriel, **PBUH**). These markers were often natural features such as mountains and valleys and have been preserved and renewed over the centuries through various historical efforts.

The inviolability of these boundaries is clearly affirmed in Islamic texts. The Prophet **(PBUH)** said: "Indeed, Allah has made Makkah sacred, so its trees are not to be cut, and its game is not to be frightened away." (Ṣaḥīḥ al-Bukhārī, Muslim). The boundaries of the Sacred Sanctuary of Makkah are not only geographic but also possess a special religious status. Within these boundaries, the reward of prayers is multiplied, and certain legal rulings differ from those outside the Ḥaram—such as the prohibition of cutting trees or hunting animals within it. Therefore, pilgrims, visitors, and residents of Makkah must understand these sacred limits to properly observe the relevant legal rules.

Imām al-Nawawī stated: "The boundary of the Ḥaram from the direction of Madinah is at the houses of Banū Nifār, near al-Tanʿīm, three miles from Makkah; from the direction of Yemen, it is at Aḍāh Lin, seven miles from Makkah; from the Ṭā'if road, at ʿArafāt in the valley of Namirah, seven miles away; from the ʿIrāq road, at the mountain pass of al-Naqṭ, also seven miles away; from the direction of al-ʿIrānah, in the valley of the family of ʿAbd Allah ibn Khālid, nine miles away; and from the Jeddah road, at al-ʿAshāsh, ten miles from Makkah." (al-Majmūʿ, 7/463).

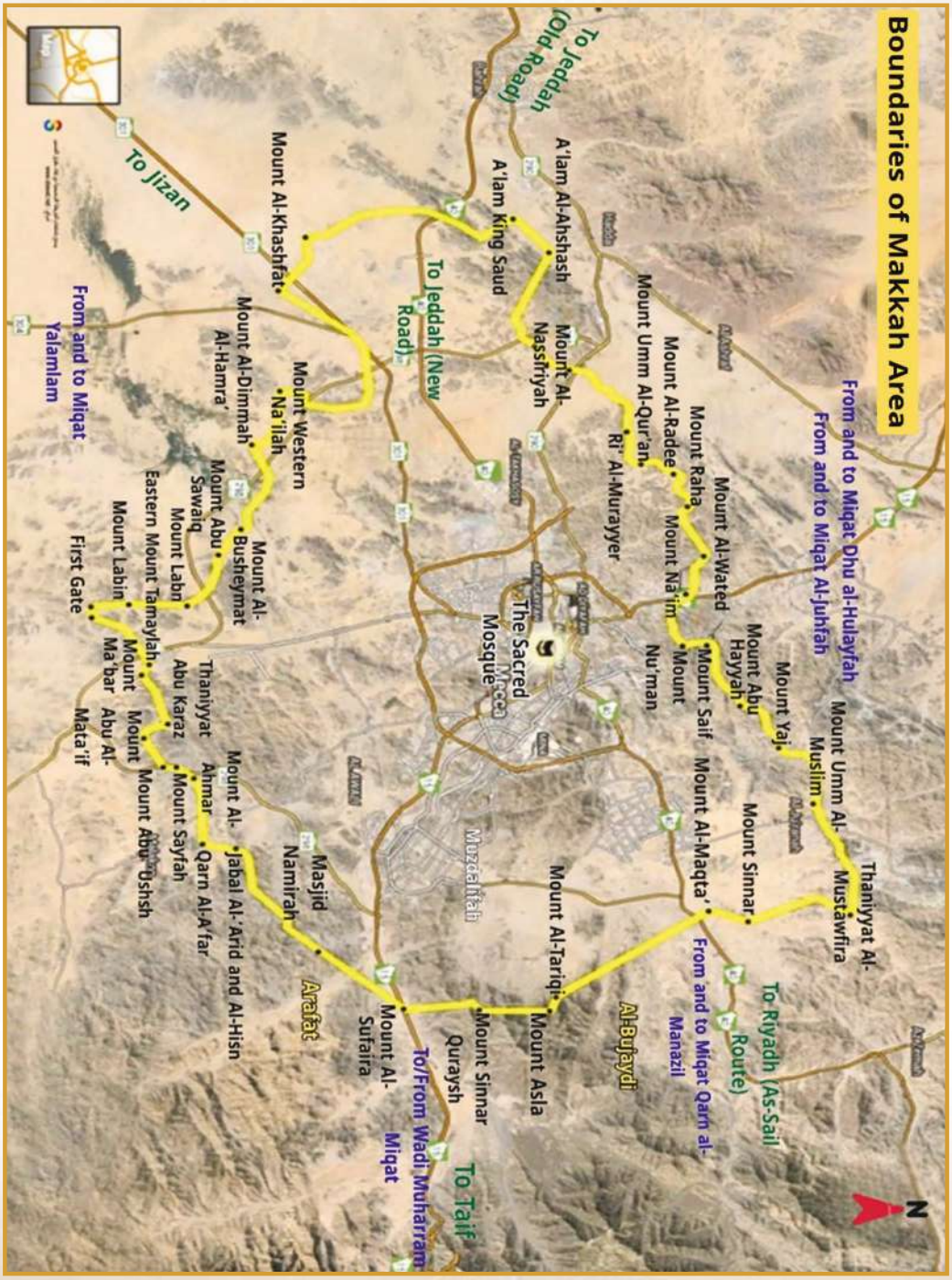
In general, the sacred boundaries of the Ḥaram in Makkah are demarcated by visible and identifiable markers (aʿlām) that encircle the city. These boundaries were precisely defined during the time of the Prophet **(PBUH)** and remain clearly indicated today. The Ḥaram is surrounded by a total of 1,104 **boundary markers**, distributed as follows:

- **650 markers on the northern boundary; 38 markers on the western boundary; 299 markers on the southern boundary; 117 markers on the eastern boundary.**

The Sacred Mosque lies at the center of a symbolic circle with a radius of approximately 8,752 meters in all directions from the Kaʿbah.

Key Boundary Locations of al-Ḥaram

Boundary	Landmark Location	Distance from the Kaʿbah	Notes
Northern Boundary	al-Thaniyyah Mountain (also known as al-Shuʿaybiyyah or al-Sharāʾiʿ)	**~15 km**	Marks the outer limit from Banū Nifār and al-Tanʿīm
Northwestern Boundary	al-Tanʿīm (Masjid ʿĀʾishah – the iḥrām point for Makkans)	**~7.5 km**	One of the most famous and closest boundaries used for iḥrām
Northeastern Boundary	al-Jiʿirānah (near Wādī Muḥassir)	**~16 km**	Formerly served as a miqāt for the people of Najd
Eastern Boundary	Wādī Nakhlah (near Mount al-Dāʾirī)	**~14 km**	Encompasses the Thabīr and Jiʿirānah area
Southern Boundary	Jabal ʿAyr (near the region of al-Abāṭiḥ)	**~12 km**	Marks the southern limit toward the valley leading to ʿArafāt
Southeastern Boundary	Aḍā Lib (Mount Aḍākh)	**~12 km**	Identifies the southeastern edge of the Ḥaram
Western Boundary	Wādī Muḥassir (extending westward)	**~18 km**	Forms part of the western limit of the sacred precinct
Southwestern Boundary	al-Ḥudaybiyyah (currently known as al-Shamīsī)	**~22 km**	A historic location known for the Treaty of al-Ḥudaybiyyah



Map Showing the Boundaries of the Sacred Sanctuary of Makkah

The Temporal and Spatial Miqāts of Ḥajj and ʿUmrah

The temporal and spatial *miqāts* (sacred boundaries) of Ḥajj and ʿUmrah are among the most critical elements that every Muslim should be familiar with, due to their significant legal, religious, historical, and civilizational importance. These miqāts are essential conditions for the validity of the rites (manāsik).

Among the requirements for the validity of Ḥajj and ʿUmrah is the obligation to enter the state of iḥrām (ritual consecration) from the designated spatial miqāt. Anyone who passes beyond a miqāt without assuming iḥrām is required to offer a sacrificial animal (dam). Similarly, one who intends to perform Ḥajj outside of its prescribed season will have their pilgrimage deemed invalid. Thus, the Ḥajj is not only a spiritual ritual but also one that is intimately tied to designated times and places, reinforcing the Muslim›s connection to the geography and history of faith.

Understanding these miqāts is not only a legal necessity but also an educational and historical imperative. They preserve the validity of worship, affirm adherence to the Prophet's Sunnah **(PBUH)**, and instill within the believer an awareness of the sanctity of both time and space.

The term *miqāt* (plural: *mawāqīt*) linguistically refers to a specific boundary or set time for performing a particular act. For example, *mawāqīt aṣ-ṣalāh* refers to the designated times for prayer. In the context of pilgrimage, a *spatial miqāt* denotes the place designated for initiating a specific form of worship. Technically, the term miqāt in Islamic jurisprudence refers to a particular time or location assigned for the performance of acts of worship such as Ḥajj and ʿUmrah.

These *mawāqīt* are regarded as sanctified boundaries instituted by divine command to honor the Sacred House and glorify the rites of Allah. God established a protective zone for Makkah and a holy buffer for the Ḥaram, with the miqāts forming the outermost perimeter. These boundaries must not be crossed without shedding ordinary attire and entering into the ritual state of iḥrām, accompanied by the intention and consciousness of the act's sacredness and location.

- ❖ The **temporal miqāt** refers to the legally prescribed time for performing a specific act of worship.
- ❖ The **spatial miqāt** refers to a designated location which cannot be passed by anyone intending to perform Ḥajj or ʿUmrah unless they have already entered the state of iḥrām.

Adhering to these miqāts is an expression of reverence for the Sacred House of Allah and respect for its sanctities, as reflected in the Qur'anic verse:

﴿*That [is so]. And whoever honors the symbols of Allah—indeed, it is from the piety of hearts*﴾ [*al-Ḥajj, 22:32*].

• Temporal Miqāts

The temporal miqāts refer to the periods during which the rites of Ḥajj must be performed, and these rites are only valid when undertaken during these specified times. They are identified in the following Qur'anic verses:

﴿*They ask you about the new moons. Say, 'They are measurements of time for the people and for Hajj*﴾ [*al-Baqarah, 2:189*].

﴿*Ḥajj is [in] well-known months...*﴾ [*al-Baqarah, 2:197*].

There is scholarly consensus that the months of Ḥajj are:

- ❖ **Shawwāl.**
- ❖ **Dhū al-Qaʿdah.**
- ❖ **The first ten days of Dhū al-Ḥijjah.**

As for ʿUmrah, it is permitted at any time of the year, including during the months of Ḥajj, according to the most widely accepted opinion among scholars.

• Spatial Miqāts

The spatial miqāts are specific locations designated by the Prophet Muhammad **(PBUH)** for those intending to perform Ḥajj or ʿUmrah. It is not permissible to pass them without entering the state of *iḥrām*. These include:

a. Dhū al-Ḥulayfah (Abyār ʿAlī)

- The miqāt for the people of **Madinah** and those who pass through it.
- Located **approximately** **450 km** from Makkah and **about** **14 km** from the Prophet's Mosque.
- Situated west of Wādī al-ʿAqīq.

b. Al-Juḥfah

- The miqāt for the people of **Shām (Levant)**, **Egypt**, **North and West Africa**.
- The original site is no longer in use.
- Pilgrims now enter *iḥrām* from **Rābigh**, a nearby city.
- Located **about** 180 km northwest of Makkah.

c. Qarn al-Manāzil (as-Sayl al-Kabīr)

- The miqāt for the people of **Najd**, the **Gulf states**, and those coming via their route.
- Located about 55 km north of Ṭā'if and **approximately** 75 km from Makkah.

d. Yalamlam

- The miqāt for the people of **Yemen** and southern regions.
- Pilgrims currently enter *iḥrām* at **Masjid as-Saʿdiyyah**, south of Makkah.
- Located **about** 130 km from Makkah.

e. Dhātu ʿIrq

- The miqāt for the people of ʿ**Irāq** and northern regions of Saudi Arabia.
- Named after a mountain with a black streak (ʿirq).
- Located **about** 100 km northeast of Makkah.

Other Recognized Miqāts

f. Wādī Muḥarram

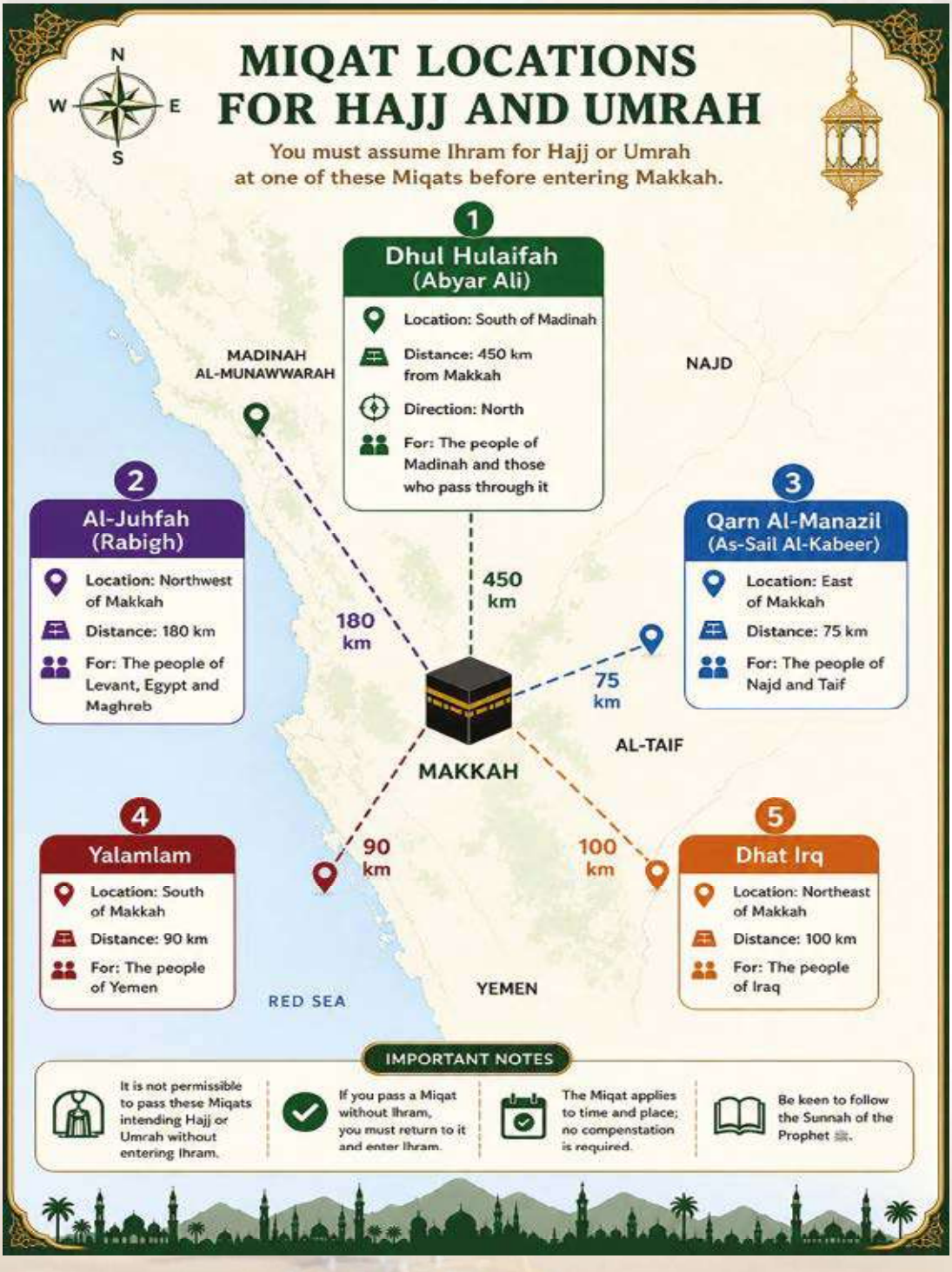
- An alternate miqāt for Qarn al-Manāzil, established after the construction of the al-Hadā road.
- Used by pilgrims from Ṭā'if and southern regions.
- Located **about 10 km** northwest of Ṭā'if.

g. Miqāt for the Residents of Makkah and Jeddah

- **Residents of Makkah**: Enter *iḥrām* for Ḥajj from their homes, but for ʿUmrah, they must go to a location outside the Ḥaram, such as **Masjid at-Tanʿīm** or **al-Jiʿirānah**.
- **Residents of Jeddah**: If within the boundary of the miqāt, they may enter *iḥrām* from their homes for both Ḥajj and ʿUmrah.

h. Miqāt for Air and Sea Travelers

- **Sea travelers**: Enter *iḥrām* upon aligning with the nearest miqāt.
- **Air travelers**: Must be prepared to enter iḥrām before crossing the miqāt. It is recommended that they enter iḥrām from their departure airports if they fear passing the miqāt without proper preparation.


MIQAT LOCATIONS FOR HAJJ AND UMRAH
You must assume Ihram for Hajj or Umrah at one of these Miqats before entering Makkah.
N
W
E
S
1
Dhul Hulaifah (Abyar Ali)
Location: South of Madinah
Distance: 450 km from Makkah
Direction: North
For: The people of Madinah and those who pass through it
2
Al-Juhfah (Rabigh)
Location: Northwest of Makkah
Distance: 180 km
For: The people of Levant, Egypt and Maghreb
3
Qarn Al-Manazil (As-Sail Al-Kabeer)
Location: East of Makkah
Distance: 75 km
For: The people of Najd and Taif
4
Yalamlam
Location: South of Makkah
Distance: 90 km
For: The people of Yemen
5
Dhat Irq
Location: Northeast of Makkah
Distance: 100 km
For: The people of Iraq
MADINAH AL-MUNAWWARAH
NAJD
450 km
180 km
75 km
90 km
100 km
MAKKAH
AL-TAIF
RED SEA
YEMEN
IMPORTANT NOTES
It is not permissible to pass these Miqats intending Hajj or Umrah without entering Ihram.
If you pass a Miqat without Ihram, you must return to it and enter Ihram.
The Miqat applies to time and place; no compenstation is required.
Be keen to follow the Sunnah of the Prophet ﷺ.

The Sacred Sites (al-Mashāʿir al-Muqaddasah)

The three sacred sites—**Minā**, ʿ**Arafāt**, and **Muzdalifah**—constitute central stations in the rites of Ḥajj. These locations hold profound religious significance, as they are directly connected to the essential pillars and rituals of the pilgrimage. They are blessed places chosen by Allah for His servants to perform acts of worship, highlighting their sanctity and elevated status. Within these sacred precincts, the pilgrim sheds worldly distractions and devotes themselves to remembrance, supplication, and tranquility, enveloped by divine mercy. These sites provide a spiritual atmosphere that encourages inner purification and renewed repentance.

These sacred sites are where the Prophet Muhammad **(PBUH)** stood and performed the rites of Ḥajj. He said: "Take your rites from me"—thus, knowing these locations and being present at the appropriate times is a fulfillment of his Sunnah. Historically, certain rituals at these sites are rooted in the story of Prophet Ibrāhīm (Abraham), such as the act of sacrifice in Minā, which connects Muslims to the legacy of monotheism and reflects the Abrahamic tradition in the pilgrimage rites.

Over the centuries, millions of Muslims of diverse ethnicities and languages have gathered at these sites to perform the same rituals at the same time and place. This has turned them into a symbol of spiritual continuity and civilizational unity throughout Islamic history. These sites—ʿArafāt, Muzdalifah, and Minā—also serve as key landmarks in the prophet's biography. During his Farewell Pilgrimage, the Prophet **(PBUH)** delivered his renowned sermon at these locations, establishing foundational principles of justice, equality, and human rights—imbuing these sites with immense civilizational and humanitarian value.

Moreover, the sacred sites serve as a historical model of Islamic organizational excellence in managing crowds and rituals. Caliphs, scholars, and rulers throughout Islamic history have implemented meticulous systems

to ensure safe and smooth performance of rites, marking these locations as milestones in the administrative and civilizational progress of the Muslim world.

These sites are situated within the sacred boundaries (*ḥaram*) of Makkah, except for ʿArafāt, which lies just outside the boundaries. Each site plays a pivotal role in the pilgrim's journey, beginning on the 8th of Dhū al-Ḥijjah (Yawm at-Tarwiyah) when pilgrims proceed to Minā, then to ʿArafāt on the 9th, and subsequently to Muzdalifah after sunset to spend the night there. They then return to Minā to perform the stoning ritual during the Days of Tashrīq.

Minā

The name *Minā* is pronounced with a short vowel on the 'm' (*Mi-nā*). Several explanations have been offered for its etymology:

- ❖ According to al-Wāqidī and al-Fākihī, the Arabs referred to any place where people gathered as Minā.
- ❖ Yāqūt al-Ḥamawī noted that it may derive from the word *yunā* (to shed blood), referring to the sacrificial slaughter.
- ❖ Some linguists linked it to *maniyyah* (destiny or decree).
- ❖ Ibn ʿUyaynah suggested it is related to *manāyā* (death or fate).

Location and Features:

- ❖ Minā lies between Makkah and Muzdalifah, approximately 8.4 km from the Sacred Mosque (al-Masjid al-Ḥarām).
- ❖ It is surrounded by mountains to the north and south, and bordered by Wādī Muḥassir on the side of Muzdalifah.

- It is the first sacred site visited by pilgrims on the 8th of Dhū al-Ḥijjah (Yawm at-Tarwiyah).
- Pilgrims spend the night there, then return after completing the rites at ʿArafāt and Muzdalifah to spend the Days of Tashrīq **(11th–13th of Dhū al-Ḥijjah)**.
- In Minā, pilgrims perform the ritual of stoning the three jamrāt (stone pillars): al-Ṣughrā (small), al-Wusṭā (medium), and al-ʿAqabah (large).

Landmarks and Infrastructure:

- Minā is renowned for its fire-resistant white tents and is listed in the Guinness World Records as the largest tent city in the world.
- The site contains **Masjid al-Khayf**, located on the southern slope of Mount Minā, which holds historical and religious significance.
- The three jamrāt are marked by **Jisr al-Jamarāt** (the Jamarāt Bridge), designed to accommodate up to 500,000 pilgrims per **hour** through its multi-level structure to ensure safety and fluid movement.

Historical Significance:

- Minā witnessed key events in early Islamic history, including the **First and Second Pledges of al-ʿAqabah**, which preceded the Prophet's migration.
- It is also reported that **Sūrat al-Mursalāt** was revealed to the Prophet **(PBUH)** in Minā, according to Ibn Masʿūd.

Arafāt

ʿArafāt is considered the culmination of the Ḥajj and its spiritual heart. It symbolizes the most profound station in the pilgrimage, where Muslims from all corners of the world gather in an awe-inspiring scene of unity and submission to Allah. On the 9th of Dhū al-Ḥijjah, pilgrims stand in humble supplication, seeking forgiveness and mercy, shedding their sins, and demonstrating true servitude. It is a day when Allah takes pride in His servants before the angels, emancipates souls from Hellfire, and answers supplications like no other time.

The Prophet **(PBUH)** said: "Ḥajj is ʿArafah", underscoring the fundamental importance of standing at ʿArafāt, without which the Ḥajj is invalid. It is also the site where Allah revealed the verse: ﴿*This day I have perfected your religion for you, completed My favor upon you, and have chosen for you Islam as your religion.*﴾ [*al-Mā'idah, 5:3*].

Etymological Interpretations of «ʿArafāt»:

- It is where **Adam met Ḥawwā' (Eve)**.
- Where **Jibrīl introduced Ibrāhīm** to the rites of pilgrimage.
- A place where people come to know one another (taʿāruf), according to Ibn Manẓūr.
- A place of **confession and repentance**, as mentioned by Yāqūt al-Ḥamawī.
- Derived from ʿarf (fragrance), indicating purity and goodness.

Although it appears plural in form, «ʿArafāt» is a singular name with a plural form. It is a wide plain enclosed by mountains that form an arc, with **Wādī** ʿUrānah running across its base.

Key Landmarks:

- **Jabal al-Raḥmah (Mount of Mercy):** The most prominent landmark, located at the center. Also known as Jabal al-Duʿāʾ, the Prophet **(PBUH)** stood here during ʿArafah, although standing on the mount is not a required rite.
- **Masjid Namirah:** One of the largest mosques in the sacred sites. Part of the mosque lies within ʿArafāt, and part in Wādī ʿUrānah. Standing outside the ʿArafāt boundary is not valid for the ritual.

Geographic Details:

- Distance from Minā: 10 km.
- From Muzdalifah: 6 km.
- From the Sacred Mosque: 20 km.
- Total area: 33 square **kilometers.**
- It is the **only sacred site located outside the Ḥaram** boundary.
- Other names include: **Jabal al-Raḥmah, Jabal Ilāl, al-Qarīn, al-Nābit**.

Muzdalifah

Muzdalifah is a major station in the Ḥajj journey where pilgrims spend the night of the **10th of Dhū al-Ḥijjah** after departing from ʿArafāt, in obedience to the divine command: ﴿*But when you depart from ʿArafāt, remember Allah at al-Mashʿar al-Ḥarām*﴾ [*al-Baqarah, 2:198*].

After leaving ʿArafāt, pilgrims arrive at Muzdalifah, where they perform the combined Maghrib and ʿIshāʾ prayers (Jamʿ Taʾkhīr) and stay overnight until after Fajr, before proceeding to Minā to perform the stoning of *Jamrat al-*ʿAqabah.

Etymology of «Muzdalifah»:

- Derived from *izdilāf* (to draw near), as pilgrims approach it.
- The place where **Adam and Ḥawwā' reunited**, according to Ibn Ḥajar.
- The place where **Maghrib and** ʿIshāʾ **are combined**, as suggested by Qatādah.
- A location reached **at night**, or **close to Minā**, hence its name.

Muzdalifah is also known as **«Jamʿ»**, due to the gathering of pilgrims therein.

Landmarks and Geography:

- **Al-Mashʿar al-Ḥarām Mosque**: Located at the center, where the Prophet **(PBUH)** stood to remember Allah.
- **Geographic boundaries**:
  - **West**: Wādī Muḥassir (dividing it from Minā)
  - **East**: Al-Mażamin (a mountain pass connecting it to ʿArafāt)
  - **North**: Jabal Thabīr al-Naṣʿ (also known as Jabal Muzdalifah)
- Situated between Minā and ʿArafāt, roughly **8 km** from the Sacred Mosque.
- Area exceeds 11.68 **million square meters**.
- Distance from:
  - **Masjid Namirah (ʿArafāt)**: ~7 km.
  - **Masjid al-Khayf (Minā)**: ~5 km.
  - **Rites of Ḥajj and** ʿUmrah.

The Rituals of Hajj and ʿUmrah

Since Ḥajj and ʿUmrah are among the greatest acts of worship legislated by Allah for His servants, their performance reflects the perfection of faith and fulfillment of Islam. Allah the Almighty says: ﴿*And proclaim the pilgrimage to mankind: they will come to you on foot and on every lean camel; they will come from every deep and distant pass.*﴾ [*al-Ḥajj: 27*].

Ḥajj is one of the five pillars of Islam and is obligatory once in a lifetime for those who are able. Performing Ḥajj and ʿUmrah brings a Muslim closer to Allah in seeking His pleasure and forgiveness.

Definitions

- **Manāsik (Rituals):** This term refers to the specific sites or acts through which Allah is worshipped. It is often used in the context of Ḥajj and ʿUmrah, including rites such as ṭawāf (circumambulation), saʿy (running between Ṣafā and Marwah), standing at ʿArafāt, and stoning the Jamārāt. Allah says: ﴿*And show us our rites and accept our repentance.*﴾ [*al-Baqarah: 128*].

- **Shaʿāʾir (Symbols):** This is a broader term that includes everything Allah has made as a sign of His religion and obedience to Him, whether related to Ḥajj or not, such as prayer, the call to prayer, sacrificial animals, the Ṣafā and Marwah hills, and the Sacred House. Allah says: ﴿*Whoever honors the symbols of Allah—indeed, it is from the piety of hearts.*﴾ [*al-Ḥajj: 32*].

First: The Rites of ʿUmrah

ʿUmrah is the pilgrimage to the Sacred House with the intention of performing specific acts of worship. It can be performed at any time of the year.

The pillars (arkān) of ʿUmrah:

- Iḥrām: The intention to enter the state of ritual sanctity.
- Ṭawāf: Circumambulation around the Kaʿbah (seven circuits).
- Saʿy: Walking between Ṣafā and Marwah (seven rounds).
- Shaving the head or trimming the hair.

Steps of ʿUmrah:

- Enter the state of iḥrām at the designated miqāt.
- Proclaim the intention: "Labbayka Allāhumma ʿumrah" ("O Allah, here I am for ʿUmrah").
- Enter the Sacred Mosque and perform ṭawāf (seven circuits).
- Pray two rakʿahs behind Maqām Ibrāhīm (if possible).
- Perform saʿy between Ṣafā and Marwah.
- Shave or shorten the hair (shaving is preferred for men).
- With that, ʿUmrah is complete.

Second: The Rites of Ḥajj

Ḥajj is the journey to Makkah during a specified period to perform specific rituals. It is the fifth pillar of Islam and is obligatory once in a lifetime for those who are able.

The pillars (arkān) of Ḥajj:

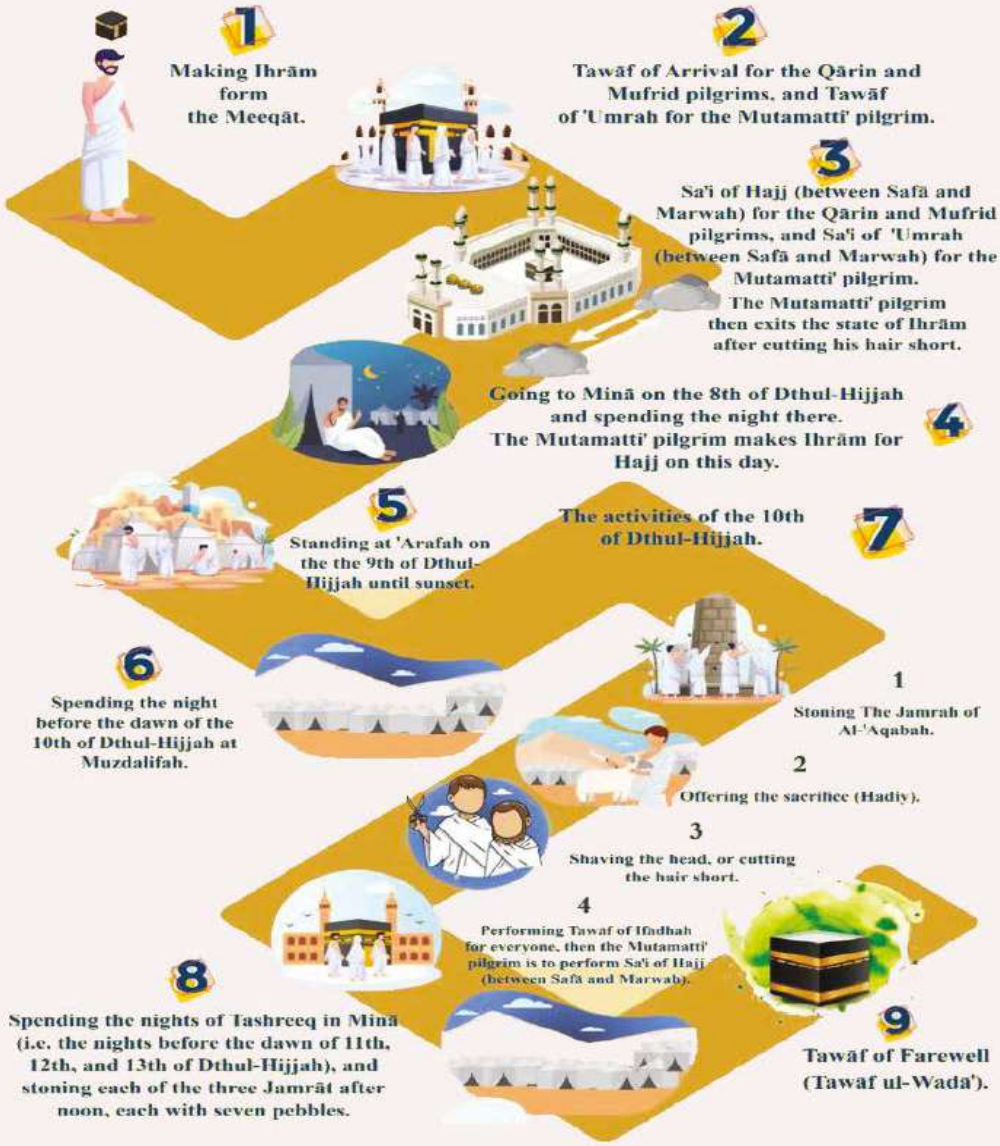
- Iḥrām.
- Standing at ʿArafāt (the greatest pillar).
- Ṭawāf al-Ifāḍah (circumambulation of the Kaʿbah).
- Saʿy between Ṣafā and Marwah.

Steps of Ḥajj (for the Tamattuʿ type):

- Enter iḥrām with the intention of ʿUmrah during the months of Ḥajj.
- Complete the ʿUmrah and exit the state of iḥrām.
- Re-enter iḥrām on the 8th of Dhū al-Ḥijjah (Yawm al-Tarwiyah) with the intention of Ḥajj.
- Spend the night in Minā.
- Proceed to ʿArafāt on the 9th of Dhū al-Ḥijjah and remain there until sunset.
- Depart for Muzdalifah and spend the night there.
- On the 10th of Dhū al-Ḥijjah:
  - ❖ Stone the Jamrat al-ʿAqabah (major pillar).
  - ❖ Offer the sacrificial animal.
  - ❖ Shave or trim the hair.
  - ❖ Perform Ṭawāf al-Ifāḍah and saʿy.
- Stay in Minā during the Days of Tashrīq (11th–13th of Dhū al-Ḥijjah). (Leaving on the 12th is permitted after throwing the stones.) Allah says: ﴿*And remember Allah during the appointed days. Then whoever hastens [his departure] in two days—there is no sin upon him; and whoever delays—there is no sin upon him…*﴾ [*al-Baqarah: 203*].
- Stone all three Jamārāt on each of the Days of Tashrīq.
- Perform the **Farewell Ṭawāf (Ṭawāf al-Wadāʿ)** upon departure from Makkah. Ibn ʿAbbās reported:

"The people were commanded that their last deed should be at the House..." *(Reported by al-Bukhārī: 1755 and Muslim: 1328).*

Steps and rulings of the Hajj rituals



(https://doa.eqtidaa.com/hajj.html)

Sacred Historical Sites in Makkah

Makkah is not only the qiblah (direction of prayer) for Muslims and the focal point of their devotion, but it is also a city richly steeped in historical landmarks that trace back to the roots of the Prophetic mission. These sites strengthen the spiritual and religious bond of its visitors. As the holiest city in Islam, Makkah possesses a distinctive character that blends sanctity with profound historical significance, making a visit to it a unique religious and cultural experience.

Scattered throughout the city are enduring landmarks that commemorate pivotal events and defining moments in the early stages of Islam. Among the most prominent are: the Cave of Ḥirāʾ, the Cave of Thawr, the Valley of Abū Ṭālib, the Mosque of al-Tanʿīm, the Mosque of the Jinn, al-Ḥudaybiyah, and the Valley of al-Mughammis, in addition to the Sacred Mosque (al-Masjid al-Ḥarām)—the beating heart of Makkah and the holiest place on Earth.

The Cave of Ḥirāʾ

The Cave of Ḥirāʾ is one of the most significant Islamic landmarks visited by pilgrims and tourists in Makkah, due to its profound historical and spiritual symbolism. It was here that the first moments of the Prophetic mission began, when the revelation first descended upon Prophet Muḥammad **(PBUH)** with the words of Allah: ﴿*Read in the name of your Lord who created.*﴾ [*al-*ʿAlaq*: 1*].

The cave is located at the summit of Jabal al-Nūr (Mountain of Light), northeast of the Sacred Mosque, on the left side of the road leading to ʿArafāt. It rises approximately 634 meters above sea level and lies about 5 kilometers from the Sacred Mosque.

The cave itself is a narrow opening in the rock, large enough to accommodate only one or two individuals. It measures approximately **4** meters in length and less than a meter in width.

The Prophet **(PBUH)** used to retreat there for worship and contemplation prior to the advent of the message, which gave the site a special place in the collective Islamic memory. It is narrated that the first stones used to construct the Kaʿbah were taken from Jabal al-Nūr itself, enhancing the mountain's distinction and spiritual status.

From the entrance of the cave, one can gaze upon the Kaʿbah in a majestic and awe-inspiring view that deeply moves the hearts of visitors. Climbing the mountain takes approximately one hour and requires a good level of physical fitness, as the slopes are steep and demanding.

Visitors are advised to wear suitable footwear, avoid climbing during hot weather, and those who are elderly or with children should take caution or avoid the climb altogether. The best times to visit the cave are during mild weather conditions.

• The Cave of Thawr (Ghār Thawr)

The Cave of Thawr is one of the most prominent historical landmarks in Makkah and holds a special place in the collective memory of Muslims. It is directly associated with one of the most significant events in the biography of the Prophet Muḥammad **(PBUH)**—the blessed Hijrah (migration) to al-Madīnah al-Munawwarah.

The cave is located on Mount Thawr, situated to the south of Makkah, and lies at a greater distance from the Sacred Mosque than the Cave of Ḥirāʾ. It is regarded as the largest cave among Makkah's mountains in terms of size.

Structurally, the cave resembles a hollowed-out rock formation at the mountain's summit, appearing like a sculpted vessel perched atop the peak. It features two openings, one facing east and the other west—with the latter serving as the entrance used by the Prophet **(PBUH)** and his companion Abū Bakr al-Ṣiddīq (may Allah be pleased with him) when they sought refuge from the Quraysh during their pursuit.

They remained inside the cave for three nights, while the Quraysh tracked their path until they reached the entrance of the cave—but failed to see them. This significant event is immortalized in the Qur'an, where Allah says: ﴿*If you do not aid him [the Prophet]—Allah has already aided him when those who disbelieved had driven him out as one of two, when they were in the cave and he said to his companion, 'Do not grieve; indeed Allah is with us*﴾ [*al-Tawbah: 40*].

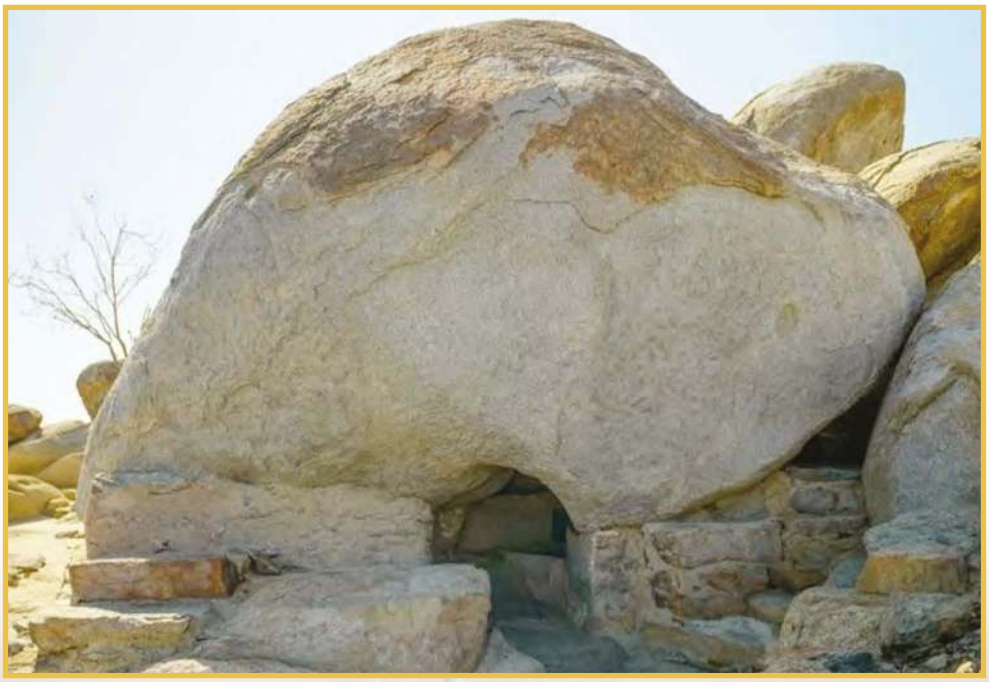
The cave extends internally to approximately 3.5 meters in length, with a similar width, while its height is around 1.25 meters, making the ceiling rather low.

Geologically, Mount Thawr is composed primarily of tonalite, an intrusive felsic igneous rock. It is characterized by its light gray color and coarse-grained texture, and it is mainly composed of plagioclase, quartz, biotite, and amphibole minerals.

Visiting the Cave of Thawr is a deeply reflective and spiritually enriching experience steeped in history and devotion. However, it demands physical endurance and patience. The ascent spans approximately 2 kilometers along steep mountain paths and takes about 52 minutes to complete.

It is highly recommended to visit the site after the dawn prayer (Ṣalāt al-Fajr) to avoid the intense daytime heat. Visitors are also advised to carry sufficient water, wear suitable hiking gear, and bring a sun umbrella for protection during the descent.

Hira Cave is located at the top of Jabal al-Nour, northeast of Makkah



Thawr Cave is located at the top of Jabal Thawr, south of Makkah.

Shiʿb Abī Ṭālib (Shiʿb Banī Hāshim)

In Lisān al-ʿArab, the term «shiʿb» is defined as the pass or ravine located between two mountains, or a pathway running through a mountain, and it can also refer to a watercourse in low-lying terrain. In this context, Shiʿb Abī Ṭālib—also known as Shiʿb Banī Hāshim—is one of the most significant historical locations in the Prophetic biography (Sīrah).

The site is situated within the vicinity of the Sacred Mosque, behind the mountains of al-Ṣafā and al-Marwah, stretching between the hills of Abū Qubays and Khandamah.

This site gained historical prominence as it is believed to be the birthplace of the Prophet Muḥammad **(PBUH)**. Moreover, it witnessed one of the most difficult and trying phases of the early Islamic mission. In the seventh year of Prophethood, the leaders of Quraysh decided to impose a harsh economic and social embargo on the clans of Banī Hāshim and Banī al-Muṭṭalib as a form of pressure to compel the Prophet **(PBUH)** to abandon his divine message. They unanimously agreed to a comprehensive boycott, prohibiting trade, marriage, and any form of interaction with the besieged Muslims.

Quraysh documented the terms of this boycott in a written decree, which was displayed inside the Kaʿbah as a binding covenant among them. The objective was to force the Prophet **(PBUH)** and his followers into surrender. This painful blockade lasted for three years, during which the Muslims from Banī Hāshim endured severe hunger, hardship, and isolation—until Allah granted them relief.

Allah revealed to His Prophet **(PBUH)** that a termite had devoured the contents of the parchment, sparing only the name of Allah. The Prophet **(PBUH)** informed his uncle, Abū Ṭālib, of this divine revelation. Abū Ṭālib then confronted the Quraysh, saying:

"If what my nephew says is true, then you must end this boycott; and if he is lying, I will hand him over to you."

The Quraysh leaders replied, "You have judged fairly." When they entered the Kaʿbah to examine the document, they found it had indeed been completely eaten away, leaving only the words "In the Name of Allah."

In the tenth year of Prophethood, the Banū Hāshim finally emerged from the ravine after the boycott was lifted, as even the Quraysh acknowledged the injustice and the truthfulness of the Prophet **(PBUH)**.

The significance of Shiʿb Abī Ṭālib lies not only in its association with hardship and steadfastness in the face of pagan hostility, but also in being the place where Lady Khadījah (may Allah be pleased with her)—the Prophet's wife, the first believer, and his most devoted supporter—passed away. Her death imbues this location with deep emotional and spiritual value in Islamic history.

Masjid al-Tanʿīm (Masjid of Lady ʿĀʾishah)

Masjid al-Tanʿīm, also known as Masjid ʿĀʾishah, is located in the northwestern sector of Makkah, approximately 7.5 kilometers from the Sacred Mosque (al-Masjid al-Ḥarām) along the Makkah–Madinah highway. It is considered the nearest point to the boundary of the Ḥaram on that side and lies within the al-Tanʿīm district, a name believed to be derived from the two surrounding mountains: Jabal Nāʿim and Jabal Naʿīm.

The mosque's historical and religious significance stems from the fact that ʿĀʾishah bint Abī Bakr (may Allah be pleased with her), the Mother of the Believers, entered into iḥrām from this location to perform ʿUmrah during the Farewell Pilgrimage in the ninth year of Hijrah, following the instruction of the Prophet Muḥammad **(PBUH)**. Since then, the mosque has served as a designated site for assuming iḥrām, particularly for residents of Makkah or pilgrims seeking to perform ʿUmrah, as it lies just outside the sacred precinct (al-Ḥaram).

Masjid al-Jinn (Mosque of the Jinn)

Located in the al-Ghazzah neighborhood, Masjid al-Jinn is situated less than 2 kilometers from the Sacred Mosque. It is one of the most religiously and historically significant mosques in Makkah, as it is associated with one of the profound events in the biography of the Prophet **(PBUH)**.

According to traditional narrations, one night the Companions of the Prophet **(PBUH)** were unable to locate him and searched until they found him returning from the direction of the al-Muʿallā Cemetery. The Prophet **(PBUH)** informed them that he had been meeting with a group of jinn, teaching them about Islamic monotheism and the tenets of faith. The jinn had listened attentively to the recitation of the Qur'an in that location, gathering around the Prophet **(PBUH)** in eagerness—some even climbing over one another to draw closer to him.

This momentous event is immortalized in the Qur'anic verse:

﴿*Say: It has been revealed to me that a group of the jinn listened and said, 'Indeed, we have heard a wondrous Qur'an.*﴾ [*al-Jinn, 72:1*].

Having embraced Islam, the jinn returned to their kind as messengers bearing glad tidings and warnings. As a result, the site was named Masjid al-Jinn (Mosque of the Jinn). It is also referred to as Masjid al-Bayʿah (Mosque of Allegiance) in reference to the pledge of allegiance by the jinn to the Prophet **(PBUH)**. Another traditional name is Masjid al-Ḥaras (Mosque of the Guards), as it was once the starting point for security patrols in the holy city.

According to historical reports, the Prophet **(PBUH)** also drew a protective line for his companion ʿAbdullāh ibn Masʿūd (may Allah be pleased with him) to sit within during his meeting with the jinn. This detail enhances the mosque's spiritual and historical resonance, and it highlights the universality of the Islamic message, which was revealed for both humankind and the jinn.

Al-Ḥudaybiyyah

Al-Ḥudaybiyyah is a historically significant area located on the outskirts of Makkah al-Mukarramah. It features flat plains bordering a volcanic ḥarrah (lava field). This location is closely associated with one of the pivotal moments in the Prophetic biography (Sīrah)—the Treaty of al-Ḥudaybiyyah, signed between the Prophet Muḥammad **(PBUH)** and the Quraysh tribe in the sixth year after Hijrah (628 CE). Today, the area is known as al-Shumaysī, and it lies approximately 22 kilometers from the Sacred Mosque (al-Masjid al-Ḥarām).

At this location, the Prophet's she-camel al-Qaṣwāʾ knelt and came to a halt. Some of the Companions exclaimed, "Al-Qaṣwāʾ has become stubborn!" But the Prophet **(PBUH)** replied:

"She has not become stubborn, nor is that her nature. Rather, she has been stopped by the One who stopped the elephant."

The treaty was finalized after the Prophet **(PBUH)** and 1,400 of his Companions were prevented from entering Makkah to perform ʿUmrah. Negotiations ensued between the Muslims and Quraysh, ultimately resulting in the signing of a ten-year truce. The terms stipulated that Muslims would return to Madinah without performing ʿUmrah that year, but would be permitted to return for ʿUmrah the following year.

One of the most significant events at al-Ḥudaybiyyah was the Bayʿat al-Riḍwān (Pledge of Allegiance under the Tree), during which the Companions pledged their loyalty to the Prophet **(PBUH)** under a tree later referred to as al-Shajarah al-Ḥadbāʾ. This profound moment is recorded in the Qur'an:

﴿*Indeed, those who pledge allegiance to you [O Prophet]—they are actually pledging allegiance to Allah*﴾ [*al-Fatḥ, 48:10*].

﴿*Certainly was Allah pleased with the believers when they pledged allegiance to you under the tree*﴾ [*al-Fatḥ, 48:18*].

The treaty played a critical role in paving the way for the Conquest of Makkah, which took place just two years later, as Allah declared:

﴿*Indeed, We have given you a clear conquest*﴾ [al-Fatḥ, 48:1].

One of the key landmarks at al-Ḥudaybiyyah is Masjid al-Ḥudaybiyyah, which remains a significant boundary marker of the Ḥaram in Makkah. It is considered the second most important site for assuming iḥrām outside the Sacred Boundary, after:

- **Masjid al-Jiʿirānah**: The place from which the Prophet **(PBUH)** entered into iḥrām for ʿUmrah.
- **Masjid al-Tanʿīm**: Also known as the Masjid of Lady ʿĀʾishah.
- **Any location beyond** the boundaries of the Ḥaram.

The Well of al-Ḥudaybiyyah still exists to this day, and the site stands as a living testament to one of the greatest demonstrations of prophetic wisdom and strategic foresight in Islamic history.

The site of the Treaty of Hudaybiyyah and the Pledge of al-Ridwan in 628 CE — the first peace treaty in the history of Islam.

Wādī al-Mughammis

Wādī al-Mughammis is one of the significant geographical sites located to the east of Makkah al-Mukarramah, approximately 20 kilometers from the city. It lies adjacent to the route that connects ʿArafāt to Wādī Ḥunayn, and is also known by the name "al-Wādī al-Akhdar" (the Green Valley).

The valley is characterized by its vast open plains, surrounded by towering mountain ridges, and stretches across a wide area, intersecting six prominent mountains in the Makkah region. These are:

- **Jabal al-Ṣafāḥ** to the north.
- **Jabal Saʿd** and **Jabal Kabkab** to the east.
- **Jabal al-Ṭāriqī** and **Jabal Sulaʿ** to the west.
- ending at the **Mountains of al-Khaṭm** in the south.

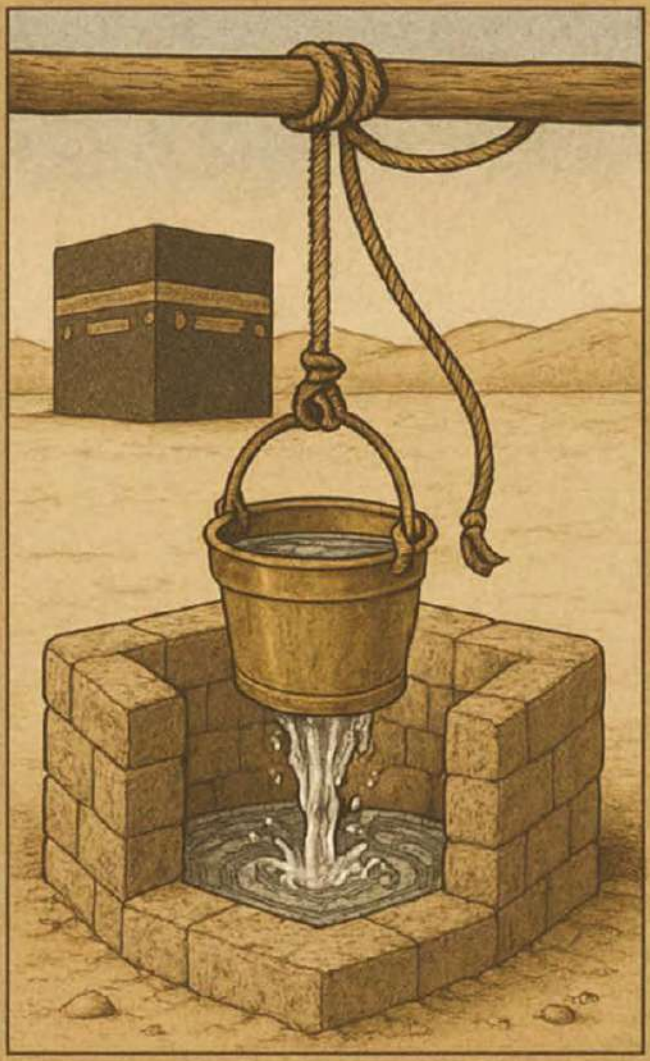
This location holds great historical significance because it was the encampment site of Abraha al-Ashram and his army during his campaign to destroy the Kaʿbah. This infamous event occurred in 571 CE, known as ʿĀm al-Fīl (The Year of the Elephant)—the same year in which the Prophet Muḥammad **(PBUH)** was born.

The divine intervention in this event is a cornerstone of Islamic tradition. According to the Qur'an, Allah sent flocks of birds (ṭayran abābīl) that destroyed Abraha's army, underscoring God's protection of His Sacred House and foreshadowing the emergence of the final divine message of Islam.

Chapter Two

The Legal Dimension of ZamZam Water: A Study of Its Virtues and Rulings

ZamZam Water in Quran and Sunnah



Water in the Quran

Names of ZamZam Well

The Story of ZamZam Water

The Benefits of ZamZam Water

ZamZam Water Linguistically and Terminologically

Shari'a Rulings Regarding ZamZam Water

Authentic Hadiths on ZamZam Water

Introduction

The foundations of the Kaaba were raised. Due to this early establishment, **ZamZam** water holds a highly revered status in both the Qur'an and the Sunnah. It played a central role in the Arab settlement around it in response to the supplication of the Prophet Ibrahim **(PBUH)**, as shown in the Qur'anic verse: ﴿*Our Lord, I have settled some of my descendants in an uncultivated valley near Your sacred House*﴾ [Ibrahim: 37].

This elevated status was reflected in the attention Arabs gave to **ZamZam** water in their language and beliefs, both before the advent of Islam and after its emergence. Evidence of this is found in the numerous names attributed to **ZamZam**, each reflecting its profound significance.

ZamZam is considered the best water on the face of the earth. It gushed forth by the command of Allah through the hand of the angel Jibril (Gabriel), in the holiest spot on earth. The heart of the Prophet Muhammad **(PBUH)** was washed with it multiple times, and he blessed it with his noble saliva.

The virtues of **ZamZam** are multifaceted and renowned among Muslims and non-Muslims alike. Historically, this sacred spring is believed to have emerged around five thousand years ago, miraculously continuing to flow with enduring blessings and divine grace. Due to its exceptional status, Islamic jurisprudence has prescribed specific rulings and etiquettes for its consumption and use, reflecting the deep reverence and appreciation for this sacred resource in the Islamic worldview.

This chapter explores the religious significance of **ZamZam** water. It begins by discussing the concept of water in the Qur'anic discourse, followed by linguistic and terminological definitions of **ZamZam**. The chapter also

narrates the historical story of **ZamZam**'s emergence and its vital role in the lives of Prophet Ibrahim and his son Ismail **(PBUT)**.

Furthermore, it delves into the Islamic legal rulings related to **ZamZam,** including the proper etiquette for drinking and benefiting from it, as well as the legislative principles Islam has established concerning it. The chapter presents the Qur'anic verses and authentic Prophetic traditions (hadiths) that speak of **ZamZam** and its virtues, along with the various names the well has been given throughout history and their meanings.

In conclusion, the chapter highlights the profound spiritual and physical benefits of **ZamZam** water, referencing both historical and contemporary accounts of its enduring blessings. Through this exploration, we deepen our appreciation for the importance of this sacred water in the Islamic faith.

Water in the Holy Quran

Water is the secret and essence of life. It is among the earliest and most fabulous creations. According to some scholars, water was created even before the Throne, as indicated by the verse in the Holy Qur'an: ﴿*And it is He who created the heavens and the earth in six days—while His Throne was upon water*﴾ [Hūd: 7]. Allah, the Exalted, made water the foundation of life, its beginning, and its sustainer. The Almighty says: ﴿*Do the disbelievers not realize that the heavens and the earth were once one mass, then We split them apart? And We created from water every living thing. Will they not then believe*﴾ [Al-Anbiyāʾ: 30].

Water is regarded as both the most accessible and the most precious of blessings. Allah made it a source of life, sustenance, and purification for humanity and the Earth. When water is abundant, its value is often overlooked. But when it becomes scarce, its absence can lead to catastrophic consequences. Undoubtedly, it stands as one of the most vital and irreplaceable blessings. While many regions around the globe may not experience water scarcity, it is a characteristic of human nature to take blessings for granted until they are lost.

Water is a divine gift conferred by Allah, and it has served as one of the foundational elements of both ancient and modern civilization. All living beings rely on it for their survival. The Qur'an frequently references water on the Earth, which would otherwise be barren or devoid of life were it not for Allah›s provision of water, this miraculous and divine elixir. The Almighty says: ﴿*Do you not see that Allah has sent down rain from the sky and the earth becomes green? Indeed, Allah is Subtle and Acquainted*﴾ [Al-Ḥajj: 63].

He also says: ﴿*And you see the earth lifeless, but as soon as We send down rain upon it, it begins to stir to life and swell, producing every type of pleasant plant.*﴾ [Al-Ḥajj: 5]. And in another verse: ﴿*And among His signs is that you see the earth devoid of life, but as soon as We send down rain upon it, it begins to stir [to life] and swell*﴾ [Fuṣṣilat: 39].

The word *"water"* is mentioned in the Holy Qur'an in approximately 63 verses, each conveying a unique context and meaning. It is mentioned in its indefinite form about 33 times, and in its definite form (al-māʾ) around 16 times. The predominance of the indefinite form may point to the universality of water's source, as it descends from the sky, and its diverse manifestations and functions in creation.

Water covers approximately 70% of the Earth›s surface. However, freshwater accounts for less than 1% of this total. Given its scarcity and critical importance, this precious resource must be used wisely and conserved responsibly. Scientifically, water is an inorganic compound with the chemical formula H_2O. It is a transparent, tasteless, odorless, and colorless chemical substance. It is also the main component of the Earth's water layer and the fluids of all known living organisms.

The Holy Qur'an refers to 23 distinct types of water, each with its unique characteristics and contextual significance. These types reflect both physical properties and spiritual or symbolic meanings. The following is a categorized presentation of these types, along with their Qur'anic references and interpretations:

- **Subsided Water:** This term refers to rainwater that falls from the sky and seeps into the ground. The verb «subsided» implies that the water lessened and diminished after fulfilling its purpose. Allah **(SWT)** says: ﴿*And the water subsided, and the matter was accomplished…*﴾ [Hūd:44].

- **Purulent Water:** This drink is described in the Qur'an as the beverage of the people of Hell. The word *"purulent"* refers to a disgusting mixture of pus and bodily fluids, which comes out from within the bodies of the disbelievers as a form of divine punishment. Allah (SWT) says: ﴿*Before him is Hell, and he will be given a drink of purulent water.*﴾ [Ibrahim: 16].

- **Water Like Molten Metal:** This pertains to a substance such as tar, molten metal, or boiling oil, characterized by its extreme heat and severe nature. It represents one of the torments that await the inhabitants of Hell. Allah **(SWT)** says: ﴿*When they cry for aid, they will be aided with water like molten metal, which will burn [their] faces.*﴾ — [Al-Kahf: 29].

- **Water of the Earth:** This refers to the water that was created alongside the formation of the Earth and continues to operate within a divinely established natural cycle until the Day of Judgment. Allah **(SWT)** says: ﴿*We send down rain from the sky in perfect measure, causing it to soak into the earth.*﴾ - [Al-Muminun: 18].

- **Pure Water:** This refers to water that is naturally fresh, clean, and purifying. It is pleasant to drink and is used for both physical hygiene and ritual purification. Allah **(SWT)** says: ﴿*And We send down from the sky pure water.*﴾ [Al Furqan: 48] .

- **Drinking Water:** This is the water that has been treated to make it suitable for human consumption. Allah **(SWT)** says: ﴿*He is the One Who sends down rain from the sky, from which you drink…*﴾ — [An-Naḥl: 10].

- **Bitter Water:** This refers to salty, undrinkable water that is unpleasant in taste and unsuitable for consumption. Allah **(SWT)** says: ﴿*And He is the One Who merges the two bodies of water: one fresh and palatable and the other salty and bitter.*﴾ — [Al-Furqan: 53]. Also: ﴿*One is fresh, palatable, and pleasant to drink; and the other is salty and bitter.*﴾ — [Fāṭir: 12] And: ﴿*If We willed, we could make it salty. Will you not then give thanks?*﴾ — [AlWāqiʿah:70].

- **Feeble Fluid:** This refers to a weak and insignificant fluid—namely, semen—from which human beings are created. The verse highlights both the fragility of human origin and the immense power of divine creation. Allah **(SWT)** says: ﴿*Then He made his descendants from an extract of a feeble fluid.*﴾ — *[As-Sajdah: 8]* And Allah (SWT) also says: *"Did We not create you from a feeble fluid"* — [Al-Mursalāt: 20].

- **Non-Stagnant Water:** This refers to flowing, fresh water that is constantly renewed and free from impurities. In contrast, stagnant water is water that has a changed taste, color, or smell, often resembling bitter water. The term" stagnate*"* and its verbal noun indicate water that has lost its freshness and becomes foul. Allah **(SWT)** says: ﴿*In it are rivers of unstagnant water.*﴾ — [Muḥammad: 15].

- **Scalding Water:** This refers to extremely hot, boiling water that causes severe burning. Allah **(SWT)** says: ﴿*And be given, to drink, scalding water, so that it cuts up their bowels.*﴾ — [Muḥammad: 15].

- **Blessed Rain:** This is rain that brings life to the land, nurtures plants, and spreads goodness and bounty. Allah (SWT) says: ﴿*And We send down blessed rain from the sky, bringing forth gardens and grains for harvest.*﴾ — [Qāf: 9].

- **Torrential Water:** This describes heavy, continuous rain that pours from the sky, often causing damage to crops and farmland. Allah **(SWT)** says: ﴿*So We opened the gates of the sky with torrential water.*﴾ — [Al-Qamar: 11].

- **Pouring Water:** Water that flows continuously without interruption, derived from the root meaning "to pour." This kind of water softens the earth and provides comfort and visual relief. Allah **(SWT)** says: ﴿*Extended shade, and flowing water.*﴾ — [Al-Wāqiʿah: 30].

- **Sunken Water:** Water that sinks into the earth becomes inaccessible and useless for human use. Allah **(SWT)** says: ﴿*Or its water may sink [into the earth], and then you will never be able to seek it out.*﴾ — [Al-Kahf: 41].

- **Flowing Water:** Visible, flowing water that runs on the Earth's surface. Allah **(SWT)** says: *Say, ﴿Have you considered: if your water was to become sunken* [into the earth]*, then who could bring you flowing water?﴾*— [Al-Mulk: 30].

- **Abundant Water:** This refers to a significant quantity of water, plentiful and generously available. It is mentioned in the context of reward and divine favor upon those who follow guidance. Allah **(SWT)** says: *﴿Had the deniers followed the Right Path, We would have certainly granted them abundant water to drink.﴾* — [Al-Jinn: 16].

- **Sweet Water:** Exceptionally fresh, palatable water—pleasant in taste and free of salt or bitterness. Allah **(SWT)** says: *﴿And given you fresh water to drink.﴾* — [Al-Mursalāt: 27].

- **Surging Water:** This is gushing water that pours continuously and abundantly, one stream following another, often used to describe heavy rainfall. Allah **(SWT)** says: *﴿And sent down from rainclouds surging water.﴾* — [An-Nabå: 14].

- **Spurting Fluid:** This refers to human semen, which comes out in spurts. It symbolizes the beginning of human creation. Allah **(SWT)** says: *﴿[They were] created from a spurting fluid.﴾* — [At-Ṭāriq: 6].

- **The Watering Place in Madyan:** This is the communal water source in the land of Madyan, where people gather to water their flocks. Allah **(SWT)** says: *﴿When he arrived at the watering [place] in Madyan…﴾* — [Al-Qaṣaṣ: 23].

- **Mirage-like Water:** This refers to what appears as water to the thirsty in the desert but is, in fact, an illusion. It is used metaphorically for the false hope of disbelievers. Allah **(SWT)** says: *﴿As for the disbelievers, their deeds are like a mirage in a desert, which the thirsty perceive as water…﴾* — [An-Nūr: 39].

- **Water of Rivers and Springs:** This is the water that falls from the sky and flows through rivers and underground springs, sustaining life. Allah **(SWT)** says: ﴿*Do you not see that Allah sends down rain from the sky—channelling it through springs in the earth…*﴾ — [Az-Zumar: 21].

- **Salsabila Water:** This is a spring in Paradise whose water is exquisitely sweet, smooth, and easy to swallow. The name *Salsabīl* refers to its gentleness and fluidity. Allah **(SWT)** says: ﴿*From a spring therein [Paradise] named Salsabīl*﴾ — [Al-Insān: 18].

ZamZam Water in Quran and Sunnah of the Prophet

ZamZam Water originates from the sacred site of the Holy House of Allah, even before the foundations were laid. This remarkable water is steeped in history and significance for countless individuals. Since its discovery, **ZamZam** has maintained a distinguished status, implicitly revered in the Qur'an and explicitly honored in the Sunnah of the Prophet **(PBUH)**. It played a pivotal role in the Arab's decision to settle in its vicinity, in response to the supplication of Prophet Ibrahim **(PBUH)**, who prayed: ﴿*So make hearts among the people incline toward them*﴾ — *[Ibrahim: 37]*. Consequently, **ZamZam** became a site of profound linguistic, cultural, and theological significance for the Arabs, both in the pre-Islamic and Islamic eras. This is evident in the many names they have attributed to it. **ZamZam** is regarded as the finest water on Earth, brought forth by the command of Allah through the Angel Jibril **(PBUH)**, who was present at the most sacred location on the planet. He appeared on multiple occasions to cleanse the heart of the Chosen One **(PBUH)**, and the water was also blessed by the noble saliva of the Prophet **(PBUH)**.

The virtues of **ZamZam** water are well known and widely acknowledged—not only among Muslims but also by many non-Muslims throughout history.

According to historical accounts, **ZamZam** Water is believed to have emerged approximately 5,000 years ago, and its flow continues uninterrupted to this day, considered a divine miracle and a perpetual blessing. Due to its immense value and sacred significance, numerous Islamic rulings and etiquettes have been established regarding the proper way to drink and derive benefits from it. While **ZamZam** Water is not explicitly mentioned by name in the Qur'an, some scholars and exegetes (mufassirūn) have interpreted specific verses as referring to it due to its exceptional status. Among these is

the verse in which Allah Almighty says: ﴿*Consider this: if your water were to sink ˹into the earth˺, then who ˹else˺ could bring you flowing water?*﴾ — [Al-Mulk: 30] .

Regarding this verse, Ibn ʿAbbās **(RA)** is reported to have said: "He [Allah] means **ZamZam** Water." Similarly, Muqātil ibn Sulaymān interpreted the verse as referring specifically to **ZamZam**, while also encompassing other forms of water in a general sense (Al-Azdī, 2002).

Some Qur›anic commentators have associated **ZamZam** water with the honorable responsibility of providing water to pilgrims during Hajj, a duty explicitly entrusted by the Prophet Muhammad **(PBUH)** to Al-›Abbās ibn ʻAbd al-Muṭṭalib and his family. This service held a prominent position in pre-Islamic Arabia and continued into the Islamic era with even greater religious significance. Scholars have interpreted the following verse considering this context: «Do you [pagans] consider providing water to the pilgrims and maintaining the Sacred Mosque as equal to believing in Allah and the Last Day and striving in the cause of Allah? ﴿*They are not equal in the sight of Allah. And Allah does not guide the wrongdoers.*﴾ — [At-Tawbah: 19]

Multiple narrations clarify the reason for this revelation. Among them is a report narrated by Al-Nuʿmān ibn Bashīr **(RA)**, and recorded by Muslim, Abū Dāwūd, Ibn Jarīr, and Ibn al-Mundhir: «I was at the pulpit of the Prophet **(PBUH)** with a group of his companions. A man said, ‹I consider providing water to the pilgrims the greatest deed after embracing Islam.› Another said, ‹Rather, maintaining the Sacred Mosque is better.› A third added, ‹No, striving in the cause of Allah is superior to what you both said.› ʻUmar **(RA)** rebuked them, saying, ‹Do not raise your voices at the pulpit of the Prophet **(PBUH)**, especially on Friday. After the Friday prayer, I will go to the Prophet **(PBUH)** and ask him about the matter you disputed.' Then

Allah revealed the verse: ﴿*Do you consider providing water for the pilgrims and maintaining the Sacred Mosque as equal to believing in Allah and the Last Day and striving in the cause of Allah?*﴾ — [At-Tawbah 9:19].

Similarly, Ibn Jarīr narrated from ʿUbayd ibn Sulaymān, who said: "I heard al-Ḍaḥḥāk explain this verse: The Muslims approached al-ʿAbbās and his companions, who had been taken captive at the Battle of Badr, and reproached them for their polytheism. Al-ʿAbbās replied, 'By Allah, we used to maintain the Sacred Mosque, release captives, protect the Sacred House, and provide water to the pilgrims.

Thereafter, Allah revealed the verse to clarify the accurate scale of virtue." These narrations emphasize that while physical service to the holy sites is noble, it must be evaluated in light of faith and sincere devotion to Allah. The esteemed scholar Muḥammad Rashīd Riḍā, author of *Tafsīr al-Manār*, commented on these reports, stating that among the various accounts of the verse's revelation, the narration of al-Nuʿmān ibn Bashīr is the most credible, due to the strength of its transmission and its alignment with the overall message of the verse.

The verse affirms that actions such as maintaining the Sacred Mosque or providing water to pilgrims, though honored, cannot be equated with believing in Allah and the Last Day, nor with striving in His cause through one's wealth, life, and emigration. Such deeds represent the highest forms of devotion, combining spiritual intention with material sacrifice. ﴿*They are not equal in Allah's sight. And Allah does not guide the wrongdoers*﴾ - [At-Tawbah: 19]. Both terms derive from their respective triliteral Arabic roots:

- **«Saqā»** — meaning to give water or offer a drink, an
- **«Amara»** — meaning to maintain, populate, or serve, especially in the context of sacred places.

In the pre-Islamic era, the Quraysh practiced Al-Saqāyah by offering pilgrims water infused with raisins, particularly during Hajj. This drink was prepared at a designated location and distributed to the pilgrims as an act of hospitality. Al-'Abbās ibn 'Abd al-Muṭṭalib **(RA)** was responsible for this noble task, a duty he continued to uphold even after the advent of Islam, which the Prophet **(PBUH)** approved and affirmed for him.

Al-Jamāl commented that Al-Saqāyah refers explicitly to the place where such drinks were prepared during the pilgrimage season. Raisins would be purchased and soaked in **ZamZam** water before being served to the pilgrims. Thus, the term in the verse denotes not merely the act of offering water but also the broader responsibility of ensuring refreshment and sustenance for Allah's guests.

On the other hand, Al-'Imārah of the Sacred Mosque encompasses acts of worship that involve maintaining its structure, serving it, and ensuring its cleanliness and sanctity. The phrase «Do you consider…?" in the verse is a rhetorical question intended for rebuke and denunciation, not for seeking an answer. Scholars have pointed out a subtle linguistic construction in this verse. Since «Saqāyah» and «'Imārah» are verbal nouns, they cannot logically be likened to concrete nouns without attributing to them an implicit descriptor or quality. Thus, the implied meaning of the verse becomes: «Have you made those who perform the acts of giving water to pilgrims and maintaining the Sacred Mosque equal in virtue to those who believe in Allah and the Last Day and strive in His cause?» This interpretation is supported by alternate Qur'anic recitations such as:

- **«Saqāyat al-ḥājj»** with Ḍammah on the «S», indicating a plural or collective noun,
- and **«'Imārat al-Masjid al-Ḥarām»** with Fatḥah on the 'Ayn and Mīm, denoting the plural of 'Āmir (those who maintain).

Depending on the grammatical estimation (taqdīr), the verse may be interpreted either by implied adjectives (i.e., the virtuous watering and virtuous maintenance) or by implied persons (i.e., those who perform these deeds), making them the subject of comparison.

Theological Implications. This verse addresses both: Certain believers, as in the hadith of An-Nu'mān ibn Bashīr, who preferred *serving the Sacred* Mosque or providing water over striving in Allah's cause.

And the idolaters of Quraysh, who took pride in their pre-Islamic roles of serving pilgrims while rejecting faith in Allah and His Messenger **(PBUH)**. The core message of the verse repudiates equating physical service with spiritual belief and sacrifice. As noble as it is to serve the pilgrims or the Sacred Mosque, it does not compare in Allah's scale to the ultimate acts of faith, such as belief in Him, the Last Day, and striving sincerely in His cause. This denunciation is articulated in Allah's statement: "They are not equal in Allah's sight," indicating that the first group has no equivalence to the second in Allah's judgment. The second group is bestowed with immense rewards from Allah due to their sincere faith and unblemished striving. The noble verse is then presented as a continuation to reaffirm and underscore this denunciation. Allah Almighty concludes the verse with His words: "And Allah does not guide the wrongdoing people"—implying that He does not confer success or guidance upon those who harm themselves and others, as they have deliberately chosen evil over good and misguidance over guidance.

ZamZam Water: Linguistic and Terminological Aspects

Linguistic Origins of the Term "ZamZam"

The name "**ZamZam**" consists of two repeated syllables and is the proper name of the well located in Makkah. According to Lisān al-ʿArab, several variants of the word are found in early Arabic usage. Ibn al-Aʿrabi listed forms such as **ZamZam**, **Zammām**, and Zumazim. Others, including Ibn Khālawayh, mentioned alternative names like Zuwāzim and Zamazim, while al-Qazzāz added further linguistic forms to the list. In certain lexical traditions, **ZamZam** is interpreted as denoting water with a unique taste that is between salty and sweet, or sweet water with a hint of bitterness. This interpretation is reflected in al-Laḥyānī's description of such water as "Ḥujāḥij": occupying a middle ground between freshness and saltiness. Alternatively, another etymological perspective links the term to the Arabic imperative "**Zam Zam**," which means "Stop!" or "Hold!" This interpretation is directly tied to the well-known narration wherein Hājar **(PBUH)**, upon witnessing water rapidly gushing beneath her infant son Ismāʿīl, exclaimed: "**Zam Zam**!", as if commanding the water to stop and gather so she could collect it. Classical scholars widely cite this interpretation, and it serves as both a linguistic and narrative root of the name. In other uses, the word "Mazm," a linguistic variant, refers to water that forcefully gushes between rocks, adding a dimension of powerful natural flow to the term.

Terminology Definition of ZamZam

Terminologically, **ZamZam** refers to the well-known source of water in Makkah, located roughly thirty-eight cubits (approx. 17–18 meters) from the Sacred Ka›bah. It is the spring from which Allah provided sustenance to the infant Ismāʿīl **(PBUH)** and his mother Hājar, during a time when there

was no water in the barren valley of Bakkah. **ZamZam** water springs forth abundantly and continuously, serving as a source of both physical nourishment and spiritual blessing for centuries. Its emergence is considered one of the manifest miracles of Allah, and its water is known for its purity, freshness, and healing properties.

From a scientific perspective, **ZamZam** is technically a natural spring, not a traditional well. A well implies human effort: drilling or digging through layers of earth and rock. In contrast, **ZamZam**'s water flows naturally, without artificial intervention. The association with the term "well" likely originates from its historical burial by the Jurhum tribe, and its later excavation by Abd al-Muṭṭalib, the grandfather of the Prophet **(PBUH)**. Over time, people came to refer to it as "Bi'r **ZamZam**" (the **ZamZam** well), although it was initially known as Ayn **ZamZam** (the spring of **ZamZam**).

Reason for the name

There are several stories regarding the origin of the name of the **ZamZam** well, the most common of which include the following:

- The abundance and profusion of its water, as it is said, "**ZamZam** water, Zamzoum, and Zamazam" to express the abundance of water.
- Hajar **(RA)** "Zamat", meaning tamped or covered the water with dirt when the well burst, so that the water would not scatter right and left.
- About the sound of the water and its gurgling "**ZamZama**" when it came out of the well.
- In reference to **ZamZamt** Jibril, meaning Jibril's murmuring when he told Hajar about the well, hitting it with his heel.

Other stories attribute the name **ZamZam** to different reasons, but these four reasons are the most common and likely to explain the origin of this blessed name. Imam al-Nawawi said in (al-Majmu' Sharh al-Muhadhdhab) that it was said **ZamZam** was named so due to the abundance of its water; hence the expressions: mả **ZamZam**, zamzum, and **zamazim**—used to describe plentiful water. Another opinion is that it was named after Hajar's action of gathering the water when it burst forth—zammat-hu (she contained it or scooped it together). A third view is that "**ZamZama**" refers to Jibril's (Jibril's) voice or speech. Others argue that the name is not derived (non-etymological). According to al-Ḥarbi, it was called **ZamZam** because of the sound or murmur of the water, which is reminiscent of the sound of a **ZamZam**a. (Al-Nawawi, 1928).

Al-Mas'udi stated: The murmur is a sound that horses make from their nostrils when drinking water. Al-Barqi mentioned that it was narrated from Ibn Abbas (Allah be pleased with them both) that the **ZamZam** well was named after it because it was tapped with dirt so that the water would not flow right and left. If left, it would flow across the ground until it filled everything (Al-Mas'udi, 1988).

Al-Manawi said: "Al-Barqi narrated from Ibn Abbas **(PBUH)** that it was named **ZamZam** because it was 'zummat' (tamped, contained, or restrained) with soil so that the water would not flow to the right and left. Had it been left, it would have spilled over the earth until it filled everything. He added: "Al-**ZamZam**a" also denotes abundance and gathering [of the water]. (Al-Manawi, 1938) AD).

Names of ZamZam Well

Al-Zubaidi, in his renowned work Tāj al-ʿArūs min Jawāhir al-Qāmūs, compiled over sixty names for **ZamZam** water from Hadith and classical Arabic sources. These names reflect the elevated status and sacred virtue of **ZamZam** in Islam and among Muslims. Biographers also mention several titles attributed to the Prophet Muhammad **(PBUH)** that are connected to **ZamZam**, such as «the **ZamZam**i Prophet» (al-Nabiyy al-**ZamZam**ī) and al-Mu**ZamZam**, due to the multiple occasions when his noble heart was washed with **ZamZam** water as recorded in the Sīrah. As a result, his heart **(PBUH)** became the purest, most righteous, and most refined of all hearts. (Al-Zubaidi, 2001).

Below are some of the names of **ZamZam** water, arranged alphabetically, with explanations of their meanings:

- **Barakah**: Meaning blessing, referring to growth, abundance, happiness, and goodness—all characteristics found in **ZamZam**.
- **Barrah**: Derived from al-birr (righteousness or goodness), either because Allah showed kindness to the father of Ismāʿīl **(PBUH)** through it, or because the water itself is a source of good and generosity.
- **Bushrā**: Meaning good news, because it was the glad tidings Hājar received when she found the spring after despairing during her search for water for herself and her son.
- **Baddah**: Meaning gently flowing or trickling water, as described in classical Arabic. (Al-Ḥamawī, 1995).
- **Tuktam / Maktūmah**: Meaning hidden or buried, referring to the period when the Jurhum tribe buried the well until ʿAbd al-Muṭṭalib later rediscovered it. (Al-Suhaylī, 2000).

- **Ḥaramiyyah**: Named in reference to Al-Masjid Al-Ḥarām, since the well is located within the Sacred Mosque.
- **Ḥufrat** al-ʿAbbās and Ḥufrat ʿAbd al-Muṭṭalib: Meaning the pits of al-ʿAbbās and ʿAbd al-Muṭṭalib, referring to their roles in protecting or rediscovering the well.
- **The Hiding Place of the Great Shaykh**: A reference to ʿAbd al-Muṭṭalib as described in his vision.
- **Rakdat Jibrīl / Hazmat Jibrīl**: Meaning the strike or step of Jibril. According to authentic narrations, Jibril **(PBUH)** struck the ground with his heel or wing, causing the water to gush forth. This act is mirrored in the Qur'anic verse: «Strike with your foot; this is a spring for a cool wash and drink» [Sād: 42].
- **Ar-Ruwā and Rawiyy**: Both relate to abundant water or the state of quenching thirst.
- **ZamZam** / Zamazim / Zamm: Said to originate from the root meaning to gather or to overflow. It may have been named for its abundance or for being measured evenly. Some say it is a proper name.
- **Zemzem**: Another variation, meaning rein or flowing water.
- **Sābiq**: Meaning «precedent,» emphasizing the superiority and priority of **ZamZam** water over others.
- **Salīmah**: Derived from salāmah (peace and wellness), symbolizing the safety and healing of **ZamZam**.
- **As-Saqyah**: The watering (ritual or act of providing water).
- **Saqyat Allāh Ismāʿīl**: Meaning «Allah›s watering of Ismāʿīl,» referring to the divine provision of water for Ismāʿīl and his mother.

- **Saqyat ar-Rawā**: Meaning «watering of refreshment» or for those in need of relief.
- **Saqyat al-Ḥajj**: Referring to the responsibility of providing water to pilgrims during Hajj, a task entrusted to al-ʿAbbās and his descendants by the Prophet **(PBUH)**.
- **Sayyidah**: Meaning «Lady» or «Mistress,» denoting its status as the finest and noblest of waters.
- **Shabāʿ / Shabāʿat al-Aʿyāl**: Meaning satisfaction or nourishment. The name is said to have existed even in pre-Islamic times due to the water›s ability to quench thirst and satisfy hunger.
- **Shiyāʿ**: Meaning widespread, as mentioned by al-Bakrī and al-Zamakhsharī.

These names not only reflect the physical characteristics of **ZamZam** but also embody its deep spiritual, historical, and linguistic significance in the Islamic tradition.

- **Quoting Al-Kharzanji**: Shia with a damma on the shin and a fatha on the ya, both lightened (Al-Suhayli, 2000 AD).
- **Sharab Al Abrar**: meaning drink of the righteous: Al-Abrar is the plural of Bar, derived from al-birr (righteousness or goodness). It signifies those who are abundant in goodness and virtue. The term al-Abrar is often specifically applied to the awliya' (saints), zuhhad (ascetics), and devoted worshippers. Because of this, you often find that most people of piety and righteousness are keen on drinking **ZamZam** water, appreciating its blessings and purity.
- **Sharabun Men Saghab**: meaning a drink of starvation (Al-Hilli, 1984 AD).

- **Safiyyah**: meaning pure from impurities and turbidities. Fresh water in Makkah was rare and could only be found in what was sweetened from the well of Maymun (located inside the palace of King Faisal - may Allah have mercy on him - in Al-Ma›badah). Safiyyah means chosen one (Al Mus̱tafah), beloved by the soul.

- **Tahera**: from purity and purification. It is free from all defects in itself. Ins̱tead, it is safe and beneficial for its drinker. It is also free from impurities, an honor to it, due to the virtues of this pure water that have been reported.

- **Taamen Taoum**: meaning «A nourishing food», as it was called in the previously mentioned Hadith. Whoever drinks it with the intention of satiation will experience it as food, providing nourishment and a sense of fullness.

- **Tayyiba**: (Pure and Pleasant): derived from ṭayyib, which refers to anything the senses find delightful—whether food, drink, or otherwise. **ZamZam** is pure, pleasing, and beloved to the believers. It has been called Ṭayyibah because it is meant for the pure among the descendants of Ibrahim and Ismail (Al-Suhayli 2000 AD).

- **Zahira**: meaning Manifes̱t, i.e., its benefit is apparent.

- **Zabiyah**: The **ZamZam** well was given this name by way of comparison to a ṭibiyyah—one of the ẓabiyat—which is a type of pouch or small container. A ẓabiyah is like a small bag, and a khariṭah is a container made of leather or other materials, tied tightly to secure its contents.

- **Afia**: meaning Well-being. This carries the same meaning as the other name: a cure for illness. Whoever drinks it seeking healing will, by Allah's permission, experience recovery and well-being from ailments and afflictions. How many times has Allah granted healing through it from diseases that even the mos̱t skilled physicians were unable to cure?

- **Awna**: meaning Support or Aid. It was named thus because it is a help to the family.

- **Ghayath**: Meaning Relief or Rescue. It was a means of relief for Hagar and her son Ismail **(PBUH)** after they had endured that hardship (Al-Hamawi, 1995 AD).

- **Karyet Al Namel**: meaning the village of ants, because that was evidence for Abdul Muttalib about the location of **ZamZam** Well, as previously mentioned, and it was noted by the author of Taj Al-Arous (Al-Hamawi, 1995 AD).

- **Kafeyaa**: meaning Sufficient because **ZamZam** suffices the need of whoever drinks it for what they intend. It also spares them from desiring or seeking any other water, as it provides fullness and satisfaction. (Al-Jurjani, n.d.).

- **La Tanzef Wa La Toudam**: meaning «It neither bleeds nor flows away»: meaning its water does not run out or diminish, no matter how much it is drawn from it.

The meaning of **"la tuthamm"**: it is not blamed or not found blameworthy. From the expression **«Azmamthu,»** which means I found it blameworthy. Another interpretation is that its water is never scarce. For example, **"bir dammah"** is a well with little water. This second meaning is preferred by Al-Suhayli, who argues that «la tuthamm» does not mean a lack of praise (i.e., it is not about being praised), because hypocrites might criticize its water. Alternatively, it means it does not harm, and there is no fear for anyone who drinks excessively from it, unlike other waters. Instead, it is a blessing in every case. Therefore, the consequence of drinking it is never to be blamed. This interpretation is reasonable and acceptable.

❖ **La Tunzaha:** Meaning its water is not uprooted or exhausted — it never runs out. This is confirmed by observation, as water is drawn from it day and night during the pilgrimage seasons and throughout the year. It has remained so continuously for fourteen centuries without ever drying up or being depleted, praise be to Allah.

❖ **Maatharet Al-Abbas bin Abdul Muttalib**: Meaning The Role of Al-Abbas bin Abdul Muttalib **(RA)**: The Prophet **(PBUH)** honored his uncle Al-Abbas by granting him and his family the duty of providing water (safayah), and similarly assigned the Banu Shaybah tribe the responsibility of Ḥijabah (guarding the Ka‘bah) and Sidanat al-Bayt (custodianship of the Ka›bah). They were entrusted with the care and service of the Ka‘bah, and the key to its door was kept in their hands.

❖ **Mubaraka**: Meaning Blessed.

❖ **Murwiyah**: meaning Quenching. Derived from riyy (to irrigate or quench thirst), which is the opposite of ‘atash (thirst). It is said that someone is ruwiya (quenched) from water or milk, like a satisfied child. The word appears in forms such as riya with a kasra (i.e., a short «i» vowel), riya with a fatḥa (a short «a» vowel), and rawa also with a kasra. It was named Murwiyah because of its strong ability to suppress intense thirst. (Al-Jurjani, n.d.).

❖ **Madnunah**: Meaning that which is withheld or hoarded due to its scarcity or preciousness. Wahb ibn Munabbih said it was called Madnunah because it was withheld from the disbelievers, so the hypocrites could not take advantage of it. It is also said that Abdul-Muttalib was told in a dream to dig al-Madnunah, meaning he should withhold it from the people, not worry about them. It was named this because people were stingy with it due to its rarity and value. Allah forbade some Arab tribes who lived nearby from accessing it because they disobeyed and neglected

the sanctity of the Ka'bah. Hence, Allah expelled them and deprived them of the water. (Al-Suhayli, 2000 AD) And (Al-Jarjani).

- **Muadhdhabah**: Derived from ʿudhubah (sweetness or pleasantness), where ʿadhb refers to pure, good-tasting water. It means preventing thirst due to its sweetness, implying that it is both sweet and refreshing. In essence, it is synonymous with Murwiyah (quenched or well-watered). (Al-Jarjani).

- **Mughdith**: meaning nourishing. Derived from ghidha' (nourishment) and refers to something that nourishes and strengthens the body.

- **Mufaddah**: from redemption, and what is meant by redemption is glorification and respect; Because a person does not redeem anyone except those who honor him, and **ZamZam** was called **"Mufaddah"** because when Abdul Muttalib, the grandfather of the Prophet **(PBUH)**, ordered the digging of **ZamZam**, and the Quraysh disputed with him about it and tried to prevent him, and the harm intensified upon him, he vowed to Allah **(SWT)**: If he dug it, and it was completed for him, and he had ten male children, he would slaughter one of them for Allah (Almighty), as the lot fell every time on his son Abdullah, the father of our Prophet of Allah **(PBUH)**, and he was the most beloved of his sons to him, then he redeemed him with one hundred camels, so he slaughtered them and distributed them, and that is why it was called: **Mufaddah**.

- **Maknoonah**: Meaning Hidden. Mentioned by Ibn Khalawiyyah in his book "Laysa fi Kalam al-Arab (Not Found in the Speech of the Arabs). Al-Ḥamawi said: Maknunah is as if derived from the verb kannanta (to conceal or protect something). Kannanta means to cover and preserve it. It is one of the names of **ZamZam**. (Al-Hamawi, 1995).

- Al **Mansuba**: Meaning Attributed (Al-Hilli, 1984).

- **Mu›nisah**: Meaning Comforting and Companionable. It originates from the word ‹uns›, which is the opposite of "Wahsha" (loneliness), as the believer finds comfort in drinking it, becomes familiar with it, and develops a fondness for it.

- **Maymunah**: Meaning Blessed. Derived from yumn, meaning blessing and good fortune. It is one of the names of **ZamZam**, alongside Barakah (Blessing) and Mubarak (Blessed). It was given this name because its blessings are well-known and well-attested. Many people from among the early generations and those who came after them have drunk from it, seeking various needs and goals, and indeed, they attained them. (Al-Jurjani, n.d.).

- **Nafi›ah**: Meaning Beneficial. It was named thus because of its numerous benefits, including the fact that drinking it strengthens the heart and brings peace to fearful thoughts (Al-Jurjani, Dt.).

- **Naqrat Al-Gharab Al-A›sam**: Meaning The Peck of the White-Feathered Crow. This was also a sign for ʿAbd al-Muṭṭalib that indicated the location of the **ZamZam** well. (Al-Hamawi, 1995).

The Story of ZamZam Water

Al-Bukhari narrated in his Sahih from Sa'id ibn Jubayr, who reported that Ibn 'Abbas said: The first woman to wear a waist wrap (mintaq) was the mother of Ismail, who did so to conceal her tracks from Sarah. Then, Ibrahim brought her along with her infant son, Ismail, whom she was nursing, and left them by the Sacred House near a tree above the site of **ZamZam**, in the upper part of the mosque, at a time when no one was around and there was no water available. He placed a bag of dates and a waterskin beside them, then turned and walked away.

The mother of Ismail followed him, saying, "O Ibrahim, where are you going and leaving us in this valley where there is no human being or anything at all?" She repeated this several times, but he did not look back. Finally, she asked, "Did Allah command you to do this?" He replied, "Yes." She said, "Then he will not abandon us." She returned to her place. Ibrahim continued walking until he reached the mountain pass known as al-Thaniyyah, the pass of the people of Madinah, now called al-Ḥajun and also known as Kada, where they could no longer see him. There, he turned to face the House, raised his hands in supplication, and said:

﴿*Our Lord, I have settled some of my descendants in a barren valley near Your Sacred House, our Lord, so that they may establish prayer. So, make hearts among the people incline toward them and provide for them from the fruits that they might be grateful*﴾ [Ibrahim:37].

The mother of Ismail continued to nurse her infant son and drink from the water until it was all gone. When the water skin was empty, both she and her son became parched with thirst. She looked at him twisting in agony, or as some narrations say, writhing, and, unable to bear the sight, she set out to find help. She ascended the nearest hill, al-Safa, and scanned the valley

below, searching for any sign of assistance, but saw no one. Undeterred, she descended from al-Safa, hastened across the valley, and ascended al-Marwah. She climbed it, looked around again, but saw no one. She repeated this back-and-forth movement between al-Safa and al-Marwah seven times as she desperately sought relief for her suffering child.

Ibn 'Abbas reported that the Prophet Muhammad **(PBUH)** said: "That is the origin of people's sa'iy (the ritual walking) between the two hills." On her seventh round at al-Marwah, she heard a sound and said to herself, "Hush!" as she tried to listen carefully. She heard it again and said, "You have made yourself heard, if you have any help to offer." Suddenly, she saw an angel at the location of **ZamZam**. The angel struck the ground with his heel, or as some narrations say, with his wing, until water gushed forth. She gathered the water with her hands, shaping a basin around it, and filled her water-skin as the spring continued to flow.

Ibn 'Abbas further said that the Prophet added, "May Allah have mercy on the mother of Ismail." Had she left **ZamZam** as it was—or as he said, had she not scooped from it—it would have become a flowing spring." So, she drank from the water and nursed her child. Then the angel reassured her: "Do not fear loss. This is the House of Allah, which this boy and his father will build. Moreover, Allah never neglects His people."

At that time, the House was a small mound on the ground, which floods would sweep past from right and left. They remained there until a passing caravan from the tribe of Jurhum came.

The Most Important Authentic Hadiths on ZamZam Water

There are numerous hadiths reported regarding **ZamZam** water, found in various collections, such as Sahih al-Bukhari, Sahih Muslim, the Sunan compilations, the Musnad compilations, and other books of the Sunnah. Among these narrations, some are authentically verified, while others are less so. Here, we present some of the most authentic hadiths as documented on the website Al-Sunan Al-Durriyah.

Authentic Hadiths about ZamZam Water

- **Cooling fever with ZamZam:** "I was sitting with Ibn Abbas in Makkah when a fever took me. He said, 'Cool it down with **ZamZam** water; for the Prophet of Allah said, 'Fever is from the heat of Hellfire, so cool it down with water.'" (Narrated by Abdullah ibn Abbas; collected by Al-Bukhari; Source: Sahih al-Bukhari) (Narrated by Hammam bin Yahya al-Basri on the authority of Abu Jamrah al-Dab'i).

- **The story of Umm Ismail and the Jurhum tribe:** "May Allah have mercy on Umm Ismail. If she had left **ZamZam** — or he said: If she had not drawn from the water — it would have been a flowing spring. Then Jurhum came and said, 'May we settle near you?' She said, 'Yes, but you have no right to the water.' They said, 'Yes, we agree.'" (Narrated by Abdullah ibn Abbas; collected by Al-Bukhari; Source: Sahih al-Bukhari).

- **Jibril washing the Prophet›s chest with ZamZam:** «The roof of my house in Makkah was opened, and Jibril came down. He opened my chest and then washed it with **ZamZam** water. Then, he brought a golden basin full of wisdom and faith and poured it into my chest. Then he closed it, took me by the hand, and ascended with me to the heavens...». (Narrated by Abu Dharr; collected by Muslim; Source: Sahih Muslim).

- **The Prophet›s heart being washed with ZamZam:** «The Prophet of Allah was playing with the young boys when Jibril came to him, took him down, and split open his chest. He took out his heart and removed a clot from it, saying, ‹This is Satan›s Share from you.› Then he washed it in a golden basin with **ZamZam** water, sewed it up, and returned it to its place. The boys ran to their mother, meaning their nurse, and said, ‹Muhammad has been killed.› They welcomed him, noticing his color had changed. Anas said: ‹I used to see the mark of that stitching on his chest.». (Narrated by Anas ibn Malik; collected by Muslim; Source: Sahih Muslim).

- **ZamZam as food and healing:**

«The Prophet of Allah said about the water of **ZamZam**: ‹Indeed, it is a food with a taste and a healing for sickness.›» (Narrated by Abu Dharr Al-Ghifari; authenticated by Shu›ayb Al-Arna›oot; Source: Takhreej Mushkil Al-Athar).

- **Blessing of ZamZam water from Abu Dharr›s fasting experience:**

- «Then he raised his head and said: ‹How long have you been here?› I said, ‹I have been here for thirty days and nights.› He asked, ‹Who was feeding you?› I replied, ‹I had no food except the water of **ZamZam**.» I grew fat until my belly split open, yet I felt no pangs of hunger in my liver.› He said, ‹It is indeed blessed; it is a nourishing food.» (Narrated by Abu Dharr Al-Ghifari; authenticated by Muslim; Source: Sahih Muslim).

- **The best and worst water on earth:**

- «From Ibn Abbas, it is reported that the Prophet of Allah **(PBUH)** said: ‹The best water on the face of the earth is the water of **ZamZam**; in it is food for the taste and healing for sickness. And the worst water on the face of the earth is the water of a valley called Barhut, in a dome in Hadramout, like a swarm of locusts — it flows in the morning and at night is bitter and salty». (Graded Hasan by Al-Albani; Source: Sahih Al-Targhib, Al-Durar Al-Sunniyah).

Knowledge of Non-Muslims Regarding ZamZam Water

Al-Azraqi recounts that Kaʿb al-Aḥbar, a Jewish scholar who converted to Islam following the death of the Prophet, habitually transported **ZamZam** water when returning to al-Sham. According to al-Waqidi, relayed through al-Thawri, from Mughirah ibn Ziyad, and ʿAṭa: "Kaʿb al-Aḥbar carried twelve water-skins of **ZamZam** to al-Sham." Additionally, as noted by al-Waqidi, through Thawr ibn Yazid, from Makḥul, and Kaʿb al-Aḥbar: "He used to carry **ZamZam** water as provision to al-Sham." (Al-Azraqi, 1969).

Ibn Jurayj reported, with information received from Yazid ibn Abi Ziyad, from a shaykh among the inhabitants of al-Sham: "I heard Kaʿb state: 'Indeed, I find in the revealed Book of Allah that **ZamZam** is nourishing food and a cure for illness." He referred to the Torah as the "Book of Allah."

The Historical Duration of the Existence of ZamZam Water

ZamZam water did not appear until the incident involving Prophet Ismail and his mother, Hagar, when the Angel Jibril **(PBUH)** dug the spot, and water gushed forth. Imam al-Ṭabari mentioned in his Tarikh (History) several durations between the prophets:

- The time between Abraham and Moses **(PBUT)** is approximately 1,000 years.
- The time between Moses and Jesus is about 1,900 years.
- The time between Jesus and Muhammad **(PBUH)** is 600 years.

Thus, the total duration between Abraham and Muhammad **(PBUT both)** is around **3,500** years. Adding the **1,446** years since the Hijrah until today, the approximate age of **ZamZam** water on the earth's surface is about **4,946** years. This is an approximation, with variations in reported durations among scholars. Allah knows best. (Al-Ṭabari, Vol. 2, 1967).

ZamZam Water is Recognized as One of the Clear Signs

Allah addressed the Quraysh and honored them in the Qur'an, saying **(SWT)** ﴿*For the accustomed security of the Quraysh. Their accustomed security [in] the caravan of winter and summer*﴾, interpreted by scholars as referring to their trade journeys to Yemen in winter and to Syria in summer, followed by ﴿*So let them worship the Lord of this House, Who has fed them.* [saving them] from ﴿*hunger and made them safe from fear*﴾ [Quraysh 106:14]. Allah (SWT) also reminded them by saying ﴿*Have We not established for them a haven*﴾ [in Makkah], ﴿*to which fruits of all kinds are brought as a provision from Us?*﴾ [Al-Qasas 28:57].

Among these clear signs is **ZamZam** water, a pure and blessed source, surrounded by significant events that demonstrate its high status and importance. It has virtues and merits unmatched by any other water and has consistently drawn the attention of prophets and followers throughout the ages. The Prophet **(PBUH)** clarified its virtue, prescribed drinking from it, and included it in the rites of Hajj and ʿUmrah. This reverence continues among Muslims and will endure until the end of the world by Allah's will.

Sharia (Islamic) Rulings Concerning ZamZam Water

Several Islamic Shari›a rulings pertain to **ZamZam** water, specifically regarding ablution, cleansing, transportation, and sale.

First: Ruling on Using ZamZam Water for Ablution and Cleansing for a Living Person

The fuqahāʾ (Islamic jurists) unanimously agree that purification using **ZamZam** water is valid. However, they emphasize that it should not be used in contexts deemed disrespectful, such as removing impurities. Al-ʿAllāmah al-Buhūtī stated in his book Kashshāf al-Qināʿ: "It is disliked to use **ZamZam** water to remove impurity out of reverence for it. However, it is not disliked to use it for purification from a state of ritual impurity."

Al-Nuʿaymī said: "The four Imams (Abū Ḥanīfah, Mālik, al-Shāfiʿī, and Aḥmad) agreed that it is permissible to perform cleansing with **ZamZam** water to remove a state of ritual impurity, except for one narration from Imam Aḥmad indicating dislike. However, the position most commonly issued in fatwas among the Ḥanbalīs is permissibility." Shaykh Mullā ʿAlī al-Qārī, a Ḥanafī scholar, stated in his manual on Manāsik: "It is not appropriate for one in a state of major ritual impurity to perform cleansing with **ZamZam** water," possibly intending to avoid what he viewed as improper due to the sanctity and high status of **ZamZam** water. And Allah knows best.

Permissibility is supported by general texts that permit purification with any pure water, without distinction between **ZamZam** and other types of water. There is no authentic prohibition against using **ZamZam** water for cleansing. Regarding the narration from al-ʿAbbās—the Prophet's uncle and overseer of the **ZamZam** well—where he said: "I do not permit it for bathing; it is permissible and a cure for drinking and ablution only."

His statement and prohibition likely stemmed from witnessing individuals exposing their private parts at **ZamZam** while bathing, thereby engaging in inappropriate behavior. His prohibition was administrative, intended to prevent such misconduct. Sufyān ibn ʿUyaynah, who transmitted the report, clarified: "He meant bathing in it."

Al-ʿAbbās had witnessed a man from Banī Makhzūm remove his clothes and bathe naked in the **ZamZam** basin. He thus forbade the act to maintain the sanctity of the Ḥaram Mosque and prevent public indecency. Similar incidents continue to occur today among the uninformed public.

Some Ḥanafīs believe that **ZamZam** water should not be used in contexts involving disrespect, such as washing impure clothes or disposing of it in unclean places. It is considered extremely unhygienic to use it for cleansing oneself after using the bathroom or for removing actual impurities. Some scholars, including Mālikīs and Shāfiʿīs, even consider such usage ḥarām. However, the general stance among the Mālikīs, Shāfiʿīs, and Ḥanbalīs is that such use is makrūh (discouraged but not sinful), particularly when it comes to cleansing private parts. This opinion is based on hadiths and traditions that emphasize the sacred nature and significant virtue of **ZamZam** water. It is the water with which angels washed the Prophet's **(PBUH)** heart. The Prophet **(PBUH)** used **ZamZam** for drinking, ablution, healing, and anointing the mouths of al-Ḥasan and al-Ḥusayn, actions that highlight its honor and uniqueness. His Companions and subsequent generations followed this tradition, affirming that **ZamZam** water is distinct from regular water.

Therefore, numerous scholars have advised against employing it in inappropriate manners, although their opinions varied regarding whether this represented a prohibition or merely discouragement. Nonetheless, there was a consensus that the use of **ZamZam** water for purification purposes is indeed valid. These rulings are applicable only in circumstances where alternative water sources are accessible. If **ZamZam** is the sole source of water available, its utilization, even for the removal of impurities, is a permissible necessity.

Ruling on Ablution and Dry Ablution When ZamZam Is Available

The Mālikīs, Ibn al-Zaghnūnī from the Ḥanbalīs, and various scholars from the Ḥanafī, Shāfiʿī, and Ḥanbalī schools stated that performing ablution with **ZamZam** is recommended and not disliked. They cited the following narration: In the description of the Prophet's **(PBUH)** pilgrimage, ʿAlī **(RA)** said: "Then the Prophet of Allah **(PBUH)** came down from ʿArafah, and he asked for a bucket of **ZamZam** water. He drank from it, then performed ablution with it. Then he said: 'Draw water, O sons of ʿAbd al-Muṭṭalib. Were it not that people would overpower you, I would draw it myself.'" (Narrated by Aḥmad [532], graded ḥasan by al-Albānī in Irwāʾ al-Ghalīl).

Al-Ḥumaydī also narrated from trustworthy transmitters that Wāil ibn Ḥujr said: "The Prophet of Allah **(PBUH)** was brought a bucket of **ZamZam** water. He drank from it, then performed ablution, then spat some water back into the bucket (which had been perfumed with musk), and then rinsed his nose outside the bucket." Since pouring **ZamZam** water over the head and body for blessing is *Sunnah*, using it for ablution as a form of blessing is even more appropriate.

Use by Travelers

Travelers sometimes carry **ZamZam** water with them. If they run out of other water but have **ZamZam**, and they are not in danger of thirst, then using **ZamZam** for ablution is permissible. Dry ablution (tayammum) is not permitted in this case because water is available. Imam Walī al-Dīn Abū Zurʿah al-ʿIrāqī was asked about someone carrying a small amount of **ZamZam**, whether he must use it or perform tayammum. He replied: "There is no difference between **ZamZam** and other pure water regarding purification. If the time of prayer arrives and the person has water available but does not need it for drinking, they must use it for prayer. If the water is insufficient,

scholars disagree—but the stronger opinion is that it must be used. Therefore, if he performs tayammum while usable water is available, it is invalid."

If the person says, "I brought **ZamZam** for healing," we respond: If the need is **immediate**, healing takes precedence. Nevertheless, if it is anticipated in the future, purification may not be delayed for the possibility. In contrast, thirst is certain and has no substitute.

Shaykh Ibn Bāz: "There is no harm in using **ZamZam** for ablution, washing clothes, cleansing after relieving oneself, or major ritual purification if needed. The Prophet used it for ablution. Though blessed, it is pure and good, and using it for such acts is permissible." He likened it to the water that flowed from the Prophet's fingers—blessed and used for ablution by his Companions.

Shaykh Ibn ʿUthaymīn: "Performing ablution with **ZamZam** is permissible and falls under the general ruling in [al-Māʾidah: 6]. Therefore, it must be used for purification if present; tayammum is not valid while it is available." (al-ʿAbdalī, 2012)

ʿAṭāʾ (as narrated by Ibn Jurayj): "There is no harm in performing ablution with **ZamZam**. If someone needs to relieve himself, let him do so, then perform ablution with it. The religion is accommodating and easy." (Narrated by ʿAbd al-Razzāq in al-Muṣannaf [1636]).

Ibn al-Qayyim: "It is permissible to perform ablution with blessed water, and its blessedness does not make it disliked. Thus, it is not disliked to perform ablution with **ZamZam**."

Ibn ʿĀbidīn: "Ritual impurity is removed absolutely by **ZamZam** water, without any dislike." (Ibn ʿĀbidīn, 1966).

Al-Muwaqq recommended drinking, performing ablution with, and washing with **ZamZam** while staying in Makkah, as did **Fadl ibn Muslim** and **al-Lakhmī**.

Al-Nawawī stated in *Sharḥ al-Muhadhdhab*: "The majority—including our school—hold that ablution or bathing with **ZamZam** is not disliked. The narration from Aḥmad, expressing dislike, is weak and based on an unverified attribution to al-ʿAbbās. Even if it were authentic, established legal texts take precedence.".

Second: The Ruling on Washing the Deceased with ZamZam Water

Washing the deceased with **ZamZam** water seems to be permissible. Al-Fākihī mentioned: "Al-ʿAbbās ibn Muḥammad al-Dūrī told us: Saʿīd ibn ʿĀmir told us: Ṣāliḥ ibn Rustum Abū ʿĀmir al-Khazzāz narrated from Ibn Abī Mulaykah, who said: I was the first to bring the glad tidings to Asmāʾ of the permission to bury ʿAbdullāh ibn al-Zubayr. He said, ‹So we went to him, and she followed us immediately.› He said: Asmāʾ had prepared a basin filled with **ZamZam** water and some Yemeni incense wood. We began handing her his limbs one by one so she could wash them, then we would take the washed limb and pass her the next. When she had completed washing him, we wrapped him in his shroud, and she then stood and prayed over him. She used to supplicate: 'O Allah, do not let me die until You cause me to enter Your Paradise.' And not even a week passed before she died. To this day, the people of Makkah continue to wash their deceased with **ZamZam** water. After completing the washing and purification of the body, they perform the final rinse with **ZamZam** water, seeking its blessing." (Al-Fākihī, 1994).

It seems that what the author intended in the chapter on funerals, when he said «even with **ZamZam** water,» was. Allah knows best, to clarify that

washing the deceased with **ZamZam** water is valid and **not prohibited**, as stated by Ibn Shubān and interpreted by both the author and Ibn ʿAbd al-Salām. Likewise, Ibn ʿAbd al-Salām said: "There is no doubt that it is a blessed water, yet that does not prevent it from being used for the same purposes as any other water.".

Ibn al-Ḥājib also said: "According to the opinion that the deceased is pure and not impure, it is permissible to wash the deceased with **ZamZam** water; in fact, it is preferable due to the expected blessing from it."

A Muslim is not impure whether alive or dead. In an authentic ḥadīth: "There is no need for you to bathe your dead after having washed him, for your deceased is not impure. It is sufficient for you to wash your hands." Reported by al-Ḥākim (1/386) and al-Bayhaqī (3/398) from the narration of Ibn ʿAbbās. Al-Ḥākim stated that it is authentic according to the conditions of al-Bukhārī, and al-Dhahabī concurred. Al-Albānī also authenticated it in Ṣaḥīḥ al-Jāmiʿ (no. 854) (al-Ḥaṭṭāb al-Raʿīnī, 1992).

Conclusion: Washing the deceased with **ZamZam** water is **permissible and not disliked**.

Third: The Ruling on Selling ZamZam Water

Shaykh Ibn Bāz said: "There is no harm in selling **ZamZam** water.".

Shaykh Ibn Jibreen stated: "There is no objection to it, as is currently practiced, because those who sell it exert effort to obtain it, package it, transport it, and guard it. They deserve compensation for their effort and labor.".

Shaykh Yaḥyā ibn ʿAlī **al-Ḥajūrī** said: "It is permissible, as proven by the statement of the mother of Ismāʿīl **(PBUH)** to the tribe of Jurhum:

‘You have no right to the water,’ and she gathered it for herself. It was in her possession, so it is permissible to sell **ZamZam** water and other types of water.”

Shaykh ʿAbd al-Muḥsin al-ʿAbbād stated: “If a person owns water, he has the right to sell it. If he brings it in his vehicle or stores it in his tank or reservoir, he may sell it.”

According to **Islam Q&A**: “Originally, it is not permissible to sell water as long as it is still at its source or flowing in its natural channel. But if someone collects it and stores it in his container, he may sell it—and this is agreed upon among scholars.”

Ibn Qudāmah wrote in al-Mughnī: “As for water that one collects in his container, he owns it by that action and may sell it, with no disagreement among scholars. This has been the normal practice in cities where people sell water carried in containers without objection. No one is allowed to drink, perform ablution, or take from it without the owner’s permission. Likewise, if someone draws water from a well, even a public one, using his bucket or device, the water he extracts becomes his property, and he may sell it. Aḥmad said: The prohibition is only regarding selling surplus water still at the source. However, the well or spring itself may be sold, and the buyer is more entitled to its water.”

Shaykh al-Fawzān was asked: “Is it permissible to sell water? And when?” He answered: “There are details: If someone collects the water in his container or pond, he owns it and it is permissible for him to sell it since he has taken possession of it and exerted effort in collecting it—so it becomes his property. However, if the water remains in the well, river, or channel running through his land, there is a difference of opinion among the scholars. The correct view is that he may not sell it, but he has the right to benefit from it himself. He may not prevent others from using it as long as their use does not harm him.”

The Prophet **(PBUH)** forbade the sale of **surplus water**, and this applies equally to **ZamZam** water and other types. However, **Shaykh Ibn Bāz** said: "There is no harm in selling **ZamZam** water, nor in transporting it outside of Makkah." (al-ʿAbdalī, 2012 CE).

Fourth: The Ruling on Transporting ZamZam Water across Countries

Shaykh Ibn Baz stated: "**ZamZam** water retains its blessing and the goodness within it, even if transported to places like Al-Sham, Yemen, or America. **ZamZam** remains blessed water, whether drunk in Makkah or carried to other locations, such as America, Najd, Al-Sham, or elsewhere. Its virtue and benefit remain present even when it is moved.".

Shaykh Muhammad ibn ʿUthaymeen also said: "There is no harm in taking the soil of Makkah outside the Ḥaram, and likewise no harm in transporting **ZamZam** water outside the Ḥaram.".

Some of the pious predecessors (ṣalaf) would instruct those visiting Makkah to bring **ZamZam** water back for them to drink. Others among the ṣalaf would travel with a supply of **ZamZam** water back to their home countries.

According to Islam Q&A: "The blessing of **ZamZam** water is a blessing that Allah the Almighty placed in the water itself, wherever it may be. It is not limited to the place of **ZamZam** or to the time of Ḥajj and ʿUmrah. The Prophet **(PBUH)** described the water itself as: 'Indeed it is blessed, it is a food that nourishes'" (Reported by Muslim), and in other narrations, such as those of Al-Bazzār, At-Ṭabarānī, and Al-Bayhaqī, it adds: "and a healing for illness.".

The apparent meaning of the evidence is that this blessing applies to all **ZamZam** water, whether it remains in Makkah or is transported elsewhere. Accordingly, many scholars have affirmed the permissibility and

recommendation of transporting **ZamZam** water outside of Makkah, and that its blessed properties remain even after transportation.

Shaykh al-Islām Ibn Taymiyyah said: "Whoever carries some **ZamZam** water with him, it is permissible; the ṣalaf used to do so." Al-Sāwī al-Mālikī said: "It is recommended to transport it—i.e., **ZamZam** water—and its special quality remains, contrary to those who claim it vanishes.".

Ibn Ḥajar al-Ḥaytāmī said: "One may transport it to his homeland for healing and seeking blessings—for himself and others." Al-Sakhāwī stated: "It is said by some that its virtue only exists while it is in its original place, and that it changes when transported—this has no basis. For example, it was written to Suhayl ibn ʿAmr: 'If my letter reaches you by night, do not wait for the morning; if by day, do not wait for night, send me **ZamZam** water.' He sent him two water skins of it. At that time, Suhayl was in Madinah before the conquest of Makkah. This is a sound narration based on its corroborating reports.".

Likewise, **ʿĀ'ishah (RA)** used to carry **ZamZam** water and reported that the Prophet **(PBUH)** did the same. He would carry it in small flasks and leather bags, pouring it over the sick and giving it to them to drink (Al-Jurjānī, n.d.). ʿAṭā' was asked about transporting **ZamZam** water, and he replied: "The Prophet **(PBUH)** carried it, as did Al-Ḥasan and Al-Ḥusayn." Al-Mulla ʿAlī al-Qārī said: "Transporting **ZamZam** water for the sake of blessing is unanimously recommended.".

Shaykh Ibn ʿUthaymeen was asked: "Is it required to drink **ZamZam** water in Makkah for its blessing to be realized?" He replied: "No, it is not a condition." This is why some of the ṣalaf would request it to be brought to

them in their lands so they could drink it. This also aligns with the apparent meaning of the hadith: "**ZamZam** water is for whatever purpose it is drunk for," without the Prophet **(PBUH)** restricting it to drinking it only in Makkah. He also said: "The evidence indicates that **ZamZam** water is beneficial whether in Makkah or elsewhere." The Prophet's **(PBUH)** saying "**ZamZam** water is for whatever purpose it is drunk for" includes both drinking it in Makkah and outside of it.

In **The Kuwaiti Fiqh Encyclopedia**, there is no disagreement regarding the permissibility of transporting **ZamZam** water outside the Sacred Area (al-ḥill), as it is replenished like fruit. The fuqahāʾ unanimously agree that it is permissible to take provisions of **ZamZam** water and transport them since it is replenished like fruit and does not diminish or disappear. The Ḥanafīs, Mālikīs, and Shāfiʿīs believe it is recommended to take **ZamZam** water and carry it to other lands, as it serves as a healing for those seeking relief.

Al-Ṭirmidhī narrated from ʿĀ'ishah (RA) that she used to carry **ZamZam** water and reported that the Prophet of Allah **(PBUH)** also carried it. He would pour it over the sick and give it to them to drink, and use it to perform taḥnīk (rubbing the palate) for Al-Ḥasan and Al-Ḥusayn (may Allah be pleased with them).

Ibn ʿAbbās (may Allah be pleased with them both) narrated that the Prophet of Allah **(PBUH)** requested Suhayl ibn ʿAmr to send him **ZamZam** water. In al-Azraqī's historical account, it is mentioned that the Prophet **(PBUH)** urged Suhayl to hasten in sending it to him, and that Suhayl sent him two large containers.

In **al-Majmūʿ Sharḥ al-Muḥaḍḍhab**, it states: "The texts of al-Shāfiʿī and his companions unanimously agreed on the permissibility of transporting **ZamZam** water to all lands, and the recommendation of taking it for blessing." (al-ʿAbdalī, 2012)

Fifth: Ruling on Washing the Kaaba with ZamZam Water

ʿ**Abdullāh ibn** ʿ**Ubaydah** narrated the events of the Prophet's **(PBUH)** entry into the Sacred Mosque on the Day of the Conquest (of Makkah): "He **(PBUH)** went to a side of the mosque and a bucket of **ZamZam** water was brought to him. He washed his face with it, and not a drop would fall except that it landed in someone's hand. If it was enough to drink, they drank it; otherwise, they wiped it over themselves. The polytheists were watching and said: 'We have never seen a king greater than this day, nor a people more foolish than today!' Then the Prophet **(PBUH)** ordered Bilāl to ascend the Sacred House and give the call to prayer (adhān). The Muslims gathered, clothed in their waist wrappers, took up buckets, and began washing the inside and outside of the Kaaba with **ZamZam**. They did not leave a trace of the polytheists without washing or removing it." Narrated by Ibn Abī Shaybah in his Muṣannaf (8/537), and recorded in Jamʿ al-Jawāmīʿ, al-Jāmiʿ al-Kabīr, and al-Jāmiʿ al-Ṣaghīr with its supplements, vol. 15. Until this day, the Kaaba is washed with **ZamZam** water as part of an established ritual and tradition.

Sixth: Ruling on Reciting Over ZamZam Water for Healing

It has been narrated that the Prophet **(PBUH)** drank from **ZamZam** water, carried it, and encouraged others to do the same. Ibn ʿAbbās **(RA)** said: "The Prophet of Allah **(PBUH)** came to the water station and requested a drink. Al-ʿAbbās said to him: 'O Fadl, go to your mother and bring some water for the Prophet of Allah **(PBUH)** from her.' The Prophet said: 'Give me water (from here).' Al-ʿAbbās said: 'O Messenger of Allah, their hands are in it.' He replied: 'Give me to drink.' So he drank. Then he went to the **ZamZam** well, where people were drawing and working. He said: 'Carry on; you are doing a good deed.' Then he added: 'Were it not that you would overwhelm me, I would have gone down to the well and put the rope on my shoulder,' and he gestured toward his shoulder." Narrated by al-Bukhārī. (Al-ʿAsqalānī, 1959 CE).

It has not been established by the Prophet **(PBUH)** that he recited over **ZamZam** water for any of his companions to drink or to wipe themselves for a specific request or in hopes of healing from illness—despite the great blessing of **ZamZam**, its high status, its widespread benefits, and the Prophet's keen desire for good for his nation. This is despite his frequent visits to **ZamZam** before the Hijrah, during his multiple ʿUmrahs, and his Ḥajj to the Sacred House after the Hijrah. Furthermore, it has not been proven that he instructed his companions to recite it, even though he was obligated to convey and clarify guidance to the ummah.

If this were a prescribed practice, he would have done it and made it clear to his nation, for there is no good except that he would guide them to it, nor any evil except that he would warn them against it. However, reciting over **ZamZam** water for healing poses no objection, just as one might do with other types of water. This approach is even more suitable due to the blessings and healing mentioned in the hadiths. (Permanent Committee for Scholarly Research and Ifta, Fatwa no. 1545).

How to Drink and Perform Tadallu‘ with ZamZam Water

Tadallu ‹ from ZamZam water refers to drinking to the point of satisfaction—drinking abundantly until one is completely quenched. The origin of the term implies drinking until one’s stomach is full and the water reaches the ribs. In terminology, tadallu means to drink to such an extent that one feels entirely satiated and the water reaches the ribcage. In the hadith, “So he drank until he was full (tadalla‘),” it means he drank abundantly until his stomach and ribs expanded.

What Has Been Reported About Tadallu?

While certain scholars have expressed skepticism regarding the authenticity of this hadith, others have affirmed its validity and acted accordingly. Jurists from the four Sunni schools of thought have underscored the recommendation to consume **ZamZam** water extensively and to perform tadallu‘, referencing the following narrations: From Ibn ‘Abbas, the Prophet of Allah **(PBUH)** stated: “The sign between us and the hypocrites is that they do not perform tadallu‘ from **ZamZam**.” This is reported by Ibn Majah in his Sunan.

Ibn ‘Abbas also narrated that the Prophet **(PBUH)** said: “Tadallu‘ from **ZamZam** is a sign of innocence from hypocrisy.” (Akhbar Makkah by Al-Azraqi 2/52; referenced by Al-Suyuti in Al-Jami‘ al-Saghir, no. 3/283). Ibn Majah narrated from Muhammad ibn ‘Abd al-Rahman ibn Abi Bakr that he was sitting with Ibn ‘Abbas when a man approached and asked, “Where have you come from?” Ibn ‘Abbas replied, “From **ZamZam**.” The man then asked, “Did you drink from it properly?” Ibn ‘Abbas asked, “And how is that?” He answered: “When you drink from it, face the Qiblah, say the name of Allah, breathe three times, and drink to fullness (tadallu‘). When you finish, praise Allah.”.

The Prophet **(PBUH)** said: "The sign between us and the hypocrites is that they do not perform *tadallu'* from **ZamZam**." (*Sunan Ibn Majah*, Book of Hajj Rituals, 2/1017; Sunan al-Daraqutni 2/288; Al-Mustadrak 1/472). Al-Hakim stated: "This hadith is authentic according to the conditions of al-Bukhari and Muslim, although they did not include it—provided that 'Uthman ibn al-Aswad heard it from Ibn 'Abbas." Al-Azraqi and Al-Hafiz Al-Sakhawi also affirmed its authenticity in Al-Maqasid al-Hasanah (p. 360).

My grandfather narrated to me from Sa'id ibn 'Uthman that Sa'id, a man from the Ansar, reported from his father, who reported from his grandfather, that the Prophet of Allah **(PBUH)** said: "The sign that distinguishes us from the hypocrites is that they do not drink deeply from **ZamZam** water, whereas we drink abundantly from it as much as we can. No hypocrite ever drinks deeply from **ZamZam**." Al-Azraqi (1969) also reported, through several narrators, that: "Drinking deeply (*tadallu'*) from **ZamZam** water is a sign of innocence from hypocrisy. It is water that cures headaches, and drinking deeply improves vision. A time will come when it will be sweeter than the Nile and the Euphrates."

Al-Fakihi recorded that Hadiyyah ibn 'Abd al-Wahhab al-Kalbi narrated from Al-Fadl ibn Musa, who narrated from 'Uthman ibn al-Aswad, from Ibn Abi Mulaykah, from Ibn 'Abbas: He saw a man drinking from **ZamZam** and said, "Do you know how to drink **ZamZam** water?" The man replied, "How should I drink it, O Abu 'Abbas?" He said, "When you want to drink **ZamZam** water, draw a bucket of it, then face the Qiblah, say: Bismillah (In the name of Allah), breathe three times, drink deeply (tadallu'), and say: 'O Allah, I ask You for beneficial knowledge, abundant provision, and healing from every disease.'"

Accordingly, **Ibn 'Abbas** taught the following etiquette when drinking **ZamZam** water:

- **Face the Qiblah.**
- **Mention the name of Allah.**
- **Breathe in three times (meaning to pause and inhale three times).**
- **Drink deeply *(tadallu‘)*.**
- **Praise Allah upon finishing.**

The phrase “breathe three times” refers to separating the container from the mouth between sips, drinking in three rounds.

Generally speaking, it is recommended to drink **ZamZam** water abundantly and to perform tadallu‘—meaning to fill oneself until the water reaches the ribs. This practice is based on various narrations, including that reported by Al-Daraqutni and Al-Bayhaqi, in which the Prophet **(PBUH)** said: “The sign that distinguishes us from the hypocrites is that they do not drink deeply from **ZamZam**.”

Al-Manawi explained: “This sign refers to the distinction between believers and hypocrites—those who outwardly claim belief but inwardly disbelieve. A hypocrite appears to be Muslim but conceals disbelief. They do not drink deeply (tadallu‘) from **ZamZam** water—meaning they refrain from drinking abundantly.”

Although excessive drinking is generally discouraged, when it comes to **ZamZam** water, the Shari‘ah encourages drinking it abundantly as a sign of spiritual longing. The desire to drink deeply from **ZamZam** reflects love for what the Prophet **(PBUH)** loved. It is a source of mercy and blessings. Thus, the one who drinks deeply from it fulfills a symbolic covenant of love and sincerity.

Imam An-Nawawi said in *Al-Majmoo'*: Al-Shafi'i and his companions, as well as others, recommended drinking **ZamZam** water abundantly and with intention. It is preferable to drink it while making supplication for one's needs in this world and the Hereafter. For example, if one seeks forgiveness or healing, they should face the Qiblah, say the name of Allah, and make a supplication such as: "O Allah, I have heard that Your Prophet said: **ZamZam** water is for whatever it is drunk for. O Allah, I drink it seeking Your forgiveness, so forgive me." Alternatively, "O Allah, I drink it seeking healing from my illness, so grant me healing."

It is also recommended to breathe three times during the drinking, and to praise Allah after finishing. Numerous hadiths support this etiquette. Al-Hakim narrated in Al-Mustadrak that a man came to Ibn 'Abbas and said: "Where have you come from?" He replied, "From the water of **ZamZam**." Ibn 'Abbas asked, "Did you drink from it as it should be?" The man said, "How is that?" He said: "When you drink from it, face the Qiblah, mention the name of Allah, breathe three times, and drink deeply (tadallu'). When you finish, praise Allah."

Al-Azraqi recorded a narration in which the Prophet **(PBUH)**, while at the **ZamZam** well, ordered a bucket to be drawn. He said, "In the name of Allah," and drank deeply three times, each time drinking less than the previous, and praised Allah after each sip. He then said: "The sign that distinguishes us from the hypocrites is that they never drink deeply (tadallu') from **ZamZam**."

It was also reported from the father of Al-Hakim At-Tirmidhi: "I entered the Tawaf at night, and I was overcome with an urgent need to urinate, which caused me pain. I feared being trampled if I left the mosque, as it was during the Hajj. I then remembered the hadith: '**ZamZam** water is for whatever it is drunk for.' I drank deeply from **ZamZam**, and the pain disappeared until morning." (Al-Qurtubi, 1964).

Scholars—may Allah have mercy on them—have said that whoever wishes to drink **ZamZam** should do so with their right hand, face the Sacred House, and say: "O Allah, I have been informed by Your Prophet **(PBUH)** that **ZamZam** water is for whatever it is drunk for. O Allah, I drink it for [mention your intention]." Then they should drink, pausing three times, mentioning Allah's name at the beginning of each sip, and praising Him upon completion. (Kawshak, 1983). If you can drink **ZamZam** before going to Safa, do so and say: "O Allah, grant me beneficial knowledge, abundant provision, and healing from every disease and sickness. Indeed, You are capable, O Lord of the Worlds." (Ibn Babawayh Al-Qummi, 1986).

The Advantages of ZamZam Water

ZamZam water is renowned for its numerous virtues and significant benefits, attributed to its pure and sacred nature. Several prophetic hadiths highlight the virtues of **ZamZam** water, although some have raised questions about their authenticity. Nonetheless, several scholars have authenticated key hadiths and acted upon them, a practice that continues to this day. One famous hadith states:

ZamZam water is for whatever it is drunk for.

Ibn Majah narrated from Hisham ibn ‘Ammar, who reported that Al-Walid ibn Muslim said: Abdullah ibn Al-Mu’ammal heard Abu Al-Zubayr say that Jabir ibn Abdullah reported the Prophet **(PBUH)** said, “**ZamZam** water is for whatever it is drunk for.” (Ibn Majah, undated). Similarly, Sahih Muslim reports from Abu Dharr: “**ZamZam** water is a food with a taste,” and Al-Tayalisi added, “and a cure for sickness.” In Al-Mustadrak, Ibn Abbas is reported to have said—attributed to the Prophet **(PBUH)**—“**ZamZam** water is for whatever it is drunk for.” Al-Bayhaqi authenticated this hadith in Al-Sha‘b, Ibn ‘Aynah, and Ibn Hibban, and it appears in the Musnad of Ahmad ibn Hanbal. Its narrators were deemed trustworthy by Al-Hafiz Al-Dimyati and Al-Hafiz Al-‘Asqalani, who noted in Al-Fath that, although there is debate about whether the narration is mursal (disconnected) or musnad (connected), the mursal version is considered stronger.

Al-Qastallani, commenting on the hadith in Al-Mustadrak, affirmed: «In sum, the authenticity of this hadith has been established—that is, the hadith ‹**ZamZam** water is for whatever it is drunk for.› Its meaning is that if you drink it seeking healing, Allah will heal you; if you drink it to satisfy your

hunger, Allah will satisfy you; if you drink it to quench your thirst, Allah will quench it, and so forth.»

It was reported that **Abu Hanifa**—may Allah have mercy on him—drank **ZamZam** water in pursuit of knowledge and jurisprudence, and subsequently became the most learned among his contemporaries. Al-Bakri—may Allah have mercy on him—said: «I have tried that myself and found it to be true, although I only drank it with firm belief and trust in the hadith.» (Al-Bakri, 1992). Imam Al-Shafi'i—may Allah have mercy on him—stated: «I drank from **ZamZam** water for three purposes: knowledge, archery (in which I would hit nine out of ten targets), and for Paradise, which I hope to attain.»

The most important intention in drinking **ZamZam** water is to affirm true monotheism (Tawhid), to die upon it, and to gain honor through obedience to Allah. Ibn Al-Munir reflected: «This is a sign of a good covenant and perfect longing, for the Arabs have a habit of yearning for the springs of beloved ones and the sources of those with affection. **ZamZam** is the spring of the family of the Prophet (Ahl al-Bayt), so whoever thirsts for it has raised the banner of love and fulfilled the covenant with the beloved.»

Al-Bakri (1992) described the taste of **ZamZam** water: «When it first emerges from the well, it resembles water mixed with warm, fresh milk—soft and without bitterness. If it cools, a slight bitterness may develop. I used to have my breakfast with it and seek blessings from it, witnessing its blessings.».

Al-Manawi said: **ZamZam** water, the chief of waters, the noblest and most honored in status, and the most beloved to the hearts, was carried by Jibril and given to Ismail **(PBUH)** to drink for ‹whatever it is drunk for› — because it was the water provided by Allah, the aid for the son of His friend Ibrahim (Abraham). It has remained a source of help for those after him. Whoever drinks it sincerely will find that help».

Al-Hakim remarked: «This is divine grace to the servants according to their intentions and sincerity. For a monotheist facing a matter, turning to his Lord in desperation brings aid. A servant attains benefit according to his intention. Sufyan al-Thawri said: ‹Ruqyah (spiritual healing) and supplication are by intention, because intention connects the servant to the essence of things.› Intentions correspond to the purity of hearts and their striving towards their Lord, and to the mind and knowledge that enable the heart to ascend to Allah. Thus, the drinker of **ZamZam** is upon that.» (Al-Manawi, 1938).

ZamZam Water: A Spring from the Springs of Paradise

Ibn Abbas (RA) narrated that a black man fell into **ZamZam** and died. When someone was sent to retrieve him, he said, «Remove the water from it,» and then instructed the man in the well, «Place your bucket near the spring adjacent to the House or the corner, for it is one of the springs of Paradise.» This indicates that **ZamZam** water originates from Paradise. Although this is a mawquf (compounded from a companion) statement rather than marfu‘ (directly from the Prophet), its clear and uncontested nature gives it equivalent significance.

It was also narrated from ‘Abdah bint Khalid ibn Ma‘dan, from her father, that the **ZamZam** water and the Sulwan spring in the Holy House (Jerusalem) are from Paradise. From Abdullah ibn Amr, it was said: «There is a spring in **ZamZam** from Paradise near the corner.» This establishes that Allah revealed **ZamZam** as a source of relief for Ismail.

Regarding the scholars’ views on this hadith, Abu Huraira **(RA)** reported that the Prophet **(PBUH)** said: «Sihaan, Wajihan, the Euphrates, and the Nile are all rivers of Paradise.»

Imam Nawawi explained, «These rivers are from the water of Paradise in a real sense, containing some substance from Paradise that exists today

according to the people of the Sunnah.» Imam Muslim narrated that when the Prophet was taken to Sidrat al-Muntaha (the Lote Tree of the Utmost Boundary), he saw four rivers originating from it—two visible and two hidden. The Prophet asked the Angel Jibril **(PBUH)** about them, who replied: «The two hidden rivers are rivers in Paradise; the two visible ones are the Nile and the Euphrates.»

In **Sahih al-Bukhari**, the Prophet **(PBUH)** saw in the lowest heaven two flowing rivers, which Jibril said were the Nile and the Euphrates. The phrase "flowing" refers to a continuous flow. From these hadiths, we understand that the origin of the Nile and the Euphrates is Paradise, emanating from the base of Sidrat al-Muntaha, which descends to Earth and flows through it.

Al-Hafiz Ibn Hajar commented: «The Prophet saw these rivers at Sidrat al-Muntaha alongside the rivers of Paradise in the lowest heaven. Their origin is in Paradise; they emerge from its root, flow to the earth, and spring forth. So their source is beneath the Sidrah, descending to Earth.»

Based on this, the meaning of **ZamZam** water being from Paradise is understood literally: it descends from Paradise by Allah's power, in a manner known only to Him. This connection between **ZamZam** water and the four rivers primarily revolves around understanding the phrase *"***ZamZam** water is from Paradise.*"* **ZamZam** also possesses unique virtues and qualities not found in any other rivers.

Some interpretations propose that **ZamZam's** extraordinary attributes are conveyed through figurative language, underscoring its immense virtue and abundant blessings. According to these views, **ZamZam** embodies the qualities of paradisiacal waters, as if it originates from the heavens. This is reflected in its unique properties: it sustains, heals, remains eternally fresh, and flows ceaselessly, a testament to its remarkable nature.

Others believe that after the world ends, **ZamZam** will be transferred to Paradise as an honor, or that **ZamZam** surpasses all other waters as Paradise surpasses the Earth. This aligns with the Prophet's statement: «The best water on the face of the Earth is **ZamZam** *water*». (Al-'Abdali, 2012).

The Emergence of ZamZam Through the Angel Jibril (PBUH) (PBUH)

The water of **ZamZam** emerged by the command of Allah through the Angel Jibril **(PBUH) (PBUH)**. Although Allah could have caused the water to spring forth directly by His will, He chose to manifest the honor and significance of this water through the agency of Jibril. By striking the ground with his wing, Jibril caused the blessed water to gush forth—at a sacred location, for a blessed person, and by the act of a trusted and noble angel. This divine intervention serves as a sign of the water's exalted status and the special honor bestowed upon Ismail **(PBUH)** for whom the water was provided: Allah, the Highest, honors whomever He wills from among His creation.

Al-Suhayli (2000) elucidates that the significance of the water emerging from beneath Ismail's heel, rather than from his hand or another limb, indicates that **ZamZam** was intended for his descendants and heirs—specifically, the Prophet Muhammad **(PBUH)** and his Ummah—as stated by Allah: "And He made it a lasting word in his descendants" (Az-Zukhruf: 28). The term "and the drink of Ismail" alludes to the well-documented narrative in which Ibrahim **(PBUH)** left his son Ismail and his mother in the desert when Ismail was a young child.

Al-Manawi clarifies in Al-Taysir that it was 'Abd al-Muttalib, rather than Abu Talib, who reinstated the well of **ZamZam** (Al-Manawi, 1938). Mujahid Abu al-Hajjaj recounts: "We have always heard that the heel strike of Jibril opened **ZamZam** and that it was Allah's provision for Ismail." He further

states, "**ZamZam** is blessed; it was caused by a strike from Jibril's heel and provided by Allah for Ismail." The name **ZamZam** derives from the Arabic root hizma, denoting a stomp or press with the heel into the ground. 'Uthman ibn Saj also narrates that **ZamZam** was formerly known as Sabiq and was revealed through Jibril's strike as a provision for Ismail and his mother during a period of intense thirst (Al-Fakihi, 1994).

ZamZam Water Was Used to Wash the Blessed Heart of the Prophet (PBUH)

Allah granted **ZamZam** a unique honor that remains unparalleled by any other water: it was utilized to purify the noble heart of the Prophet Muhammad **(PBUH)** on numerous occasions. Imam Muslim narrates through Anas ibn Malik **(RA)** that the Prophet was engaging in play with children when Jibril arrived, took hold of him, laid him down, and opened his chest to extract a blood clot referred to as "the portion of Satan in you." He then cleansed the Prophet's heart in a basin of gold filled with **ZamZam** water before meticulously sewing it back together. Anas recalled observing the stitch marks on the Prophet's chest.

Similarly, **Imam al-Bukhari** recounts that Jibril visited the Prophet's residence, opened his chest, washed it with **ZamZam** water, and subsequently filled it with wisdom and faith from a golden basin, sealing it thereafter. This sacred event transpired on multiple occasions, notably during the Prophet's childhood at the ages of four and ten, and again when Jibril first revealed himself, highlighting the profound spiritual purification and wisdom conferred upon him.

In Musnad Ahmad, it is documented that the Prophet stated: "The roof of my house was opened while I was in Makkah. Jibril descended, opened my chest, washed it with **ZamZam** water, poured wisdom and faith into it, and then sealed it." (Ibn Hanbal, 2001).

Moreover, **Al-Bukhari and Muslim** narrate that on the occasion of the Night Journey (Isra and Mi'raj), the Prophet's chest was opened, and Jibril thoroughly washed his chest and abdomen with **ZamZam** water, underscoring its unmatched spiritual purity and blessing (Al-Bukhari, 1980; Muslim, 1991).

ZamZam Blessed by the Pure Saliva of the Prophet (PBUH)

Ibn 'Abbas (RA) narrates that the Prophet **(PBUH)** came to **ZamZam**, drank from it, rinsed his mouth, and spat some of the water back into the well. He remarked: "If it were not that people might overwhelm it, I would have drawn water from it with my hand." (Authentic chain per Imam Muslim)

In another narration, '**Abd al-Jabbar ibn Wa'il** reports that the Prophet rinsed his mouth with **ZamZam** water and spat into it, and that his saliva was more fragrant than musk. This act imbued **ZamZam** water with additional blessings, enhancing its sweetness, healing properties, and purity. The Prophet's noble saliva poured back into the well symbolizes his mercy and care for the entire Ummah, extending the blessing of **ZamZam** water to all followers until the Day of Judgment.

ZamZam Water: A Nourishing Food

Among the virtues of **ZamZam** water is its ability to nourish the body, serving as a substitute for food and drink. This remarkable quality was experienced by Hajar, the mother of Ismail **(PBUH)**, when Prophet Ibrahim **(PBUH)** left her and her infant son with only a bag of dates and a waterskin. She would nurse her child and drink from the water until it ran out, both becoming thirsty thereafter. As she watched her son squirm in agony, she saw an angel at the site of **ZamZam**, who dug into the ground with his heel—or wing—until the water gushed forth. She drank, and her milk was restored for her child. Thus, Allah made **ZamZam** a source of sustenance for both Hajar and her son. (Al-Fakihi, 1994).

The Recommendation to Carry ZamZam Water

It is a sunnah (recommended practice) to carry **ZamZam** water from the Haram (sacred precinct) when departing from Makkah, following the practice of the Prophet Muhammad **(PBUH)** and subsequent generations. Contrary to a common misconception, there is no evidence to suggest that **ZamZam's** blessings are limited to within the Haram's boundaries. In fact, the sunnah encourages bringing it home to benefit from its virtues.

Al-Tirmidhi reported: «Abu Kurayb narrated to us, Khalad ibn Yazid al-Ju'fi narrated to us, Zuhayr ibn Mu'awiyah narrated from Hisham ibn 'Urwah, from his father, from 'A'ishah **(RA)**, who said: She used to carry **ZamZam** water and reported that the Prophet **(PBUH)** used to carry it as well.» Abu 'Isa (al-Tirmidhi) commented: «This is a sound and rare hadith; we do not know it except through this chain.» (Al-Tirmidhi, 1962–1978).

Al-Hafiz al-Sakhawi (may Allah have mercy on him) stated: «It is mentioned by some that **ZamZam** loses its virtue if taken out of its original place, but this has no basis. The Prophet **(PBUH)** wrote to Suhayl ibn 'Amr: 'If my letter reaches you by night, do not wait until morning; and if it reaches you by day, do not wait until evening before sending me **ZamZam** water.' He sent two water skins while the Prophet was still in Madinah, before the conquest of Makkah. This hadith is considered sound due to supporting narrations.» Similarly, 'A'ishah **(RA)** used to carry **ZamZam** water, stating that the Prophet **(PBUH)** did so too. He would carry it in flasks and leather containers, pour it over the sick, and give it to them to drink. (Al-Sakhawi, 1985).

The Presence of ZamZam in the Blessed Location

ZamZam is located adjacent to the Sacred House of Allah, near the Black Stone (al-Rukn), the Maqam (station) of Ibrahim, and the hills of Safa and Marwah. Millions of pilgrims visit this sacred site annually seeking divine reward, forgiveness, and mercy from the Lord of all worlds. This place is blessed continuously and experiences angelic descent day and night. Worshippers are constantly engaged in prayer, reciting the Qur'an, performing tawaf around the Ka'bah, making sa'y between Safa and Marwah, and drinking or purifying themselves with **ZamZam** water.

This entire area is imbued with immense grace, mercy, and divine favor. The presence of **ZamZam** in this holy and honored location enhances its significance, virtue, and status. It is the purest and most beneficial water on earth, created by Allah in the best land on earth—the holy city of Makkah—and in the most honored part of that land, the Sacred Mosque. However, scholars note that the most blessed water ever is that which flowed from the fingers of the Prophet **(PBUH)** during his miracles, superior even to **ZamZam**. After that, **ZamZam** ranks highest in virtue. The most honored place on earth is where the Prophet **(PBUH)** is buried; next in rank is the Sacred House in Makkah.

ZamZam: The Drink of the Righteous (al-abrar)

The righteous (al-abrar) are those devout worshippers of Allah—believers who act righteously, follow the Prophet **(PBUH)** in his actions and sayings, adhere to his sunnah, and walk in his guidance. **ZamZam** water was caused to emerge through the agency of the righteous:

It was the strike of Jibril (Jibril), and it appeared for the sake of a noble Prophet, Ismail, son of another noble Prophet, Ibrahim. It also flowed for the sake of his mother, the noble lady Hajar, the great-grandmother of our Prophet **(PBUT all)**.

Allah Almighty concealed **ZamZam** water when people indulged in sins and persisted in misguidance. Later, He caused it to reappear through the hand of ‘Abd al-Muttalib, the grandfather of the Prophet **(PBUH)**, as a sign and prelude to the coming of the Prophet **(PBUH)**

Thus, **ZamZam** was revealed through the hands of the righteous and for the sake of the righteous, the most righteous and pious of all creation. It was said to Ibn ‘Abbas: “Where is the prayer place of the righteous?” He replied: “Beneath the water spout (mizab) of the Ka‘bah.” When asked: “And what is the drink of the righteous?” he said: “**ZamZam** water.” (Al-Basri, 1980).

Ibn ‘Abbas (RA) narrated: ‘Abd al-Muttalib saw in a dream that he should dig a well called Barrah. He woke up worried. On the second night, it was repeated to him: ‘Dig Barrah, the drink of the righteous.» (Al-Fakihi, 1994).

Tibi‘ **al-Himyari** narrated: “When Ka‘b entered **ZamZam**, he came on his camel, drank from it, and poured the water over his clothes. People said, ‘Why are you soaking your clothes, O Bedouin?’ He replied: ‘You do not understand, it is in the Book of Allah as Barrah—the drink of the righteous. **ZamZam**—it is neither exhausted nor despised.’” (Al-Azraqi, 1969).

ZamZam Water: Among the Greatest Blessings at the Sacred House

Drinking **ZamZam** is a sunnah during Hajj and ‘Umrah. Allah says: ﴿*And proclaim the pilgrimage among the people: they will come to you on foot and every lean camel; they will come from every distant pass. That they may witness benefits for themselves and mention the name of Allah on known days over what He has provided them...*﴾ [Al-Hajj: 27–28].

Among the most incredible blessings experienced by pilgrims of the Sacred House is drinking **ZamZam** water, due to its immense goodness,

blessings, acceptance of supplications, and healing properties. One of its greatest virtues is that Allah made it the drink of pilgrims and ‘umrah performers throughout all eras. The Arabs, past and present, hold the task of providing **ZamZam** water in high esteem, believing it grants honor and leadership to those entrusted with it. (Al-Azraqi, 1969).

Gaining Strength Through ZamZam

The people of Makkah—and Muslims in general—drink **ZamZam** to gain strength in hardship, considering it a source of health, power, and vitality. They relied on it to endure the hardships of battle and strive for the Cause of Allah. This connection aligns naturally with **ZamZam's** virtues as a nourishing drink and a cure for illness.

Ibn ‘Abbas (RA) said: “The people of Makkah used to have no complaints in their joints and would defeat anyone in racing or wrestling. However, when they turned away from **ZamZam**, their condition changed.” Abu ‘Awn said: ‹We were so hungry that a man could not carry his weapon, so I would go to **ZamZam** with my companions, drink from it, and find in its strength and sustenance.” (Al-Fakihi, 1994).

Recommended: Drinking ZamZam Water When Bidding Farewell to the Sacred House

Al-Fuḍayl ibn ʿIyaḍ narrated from Manṣur who said: «I asked Mujahid, ‹What should I do when I want to bid farewell to the House (Ka‘bah)?› He said: ‹You perform ṭawāf (ritual circumambulation) around the House seven times, then go to the Station of Abraham (Maqām Ibrāhīm) and pray two rak‘ahs (units of prayer), then go to **ZamZam** and drink from it, and proceed to the Multazam (the area between the Black Stone and the door of the Ka‘bah) and supplicate to Allah and ask Him for your needs, then touch the Black Stone and depart». (Al-Fākihī, 1994).

Manṣur also said**:** «I asked Mujahid: 'What should I do when I want to leave?' He replied: 'Make **ṭawāf** around the House seven times, then pray two **rak'ahs** behind the Station of Abraham, then go to **ZamZam** and drink its water, then go to the **Multazam**—between the Stone and the Door—touch it, supplicate, and ask Allah for your needs. Then touch the Black Stone and depart.».

Manṣur ibn Yūnus al-Ḥanbalī added: «Then he should drink from **ZamZam** water—Shaykh **Taqī al-Dīn** stated this—and he should touch the Black Stone and kiss it, and then exit.»

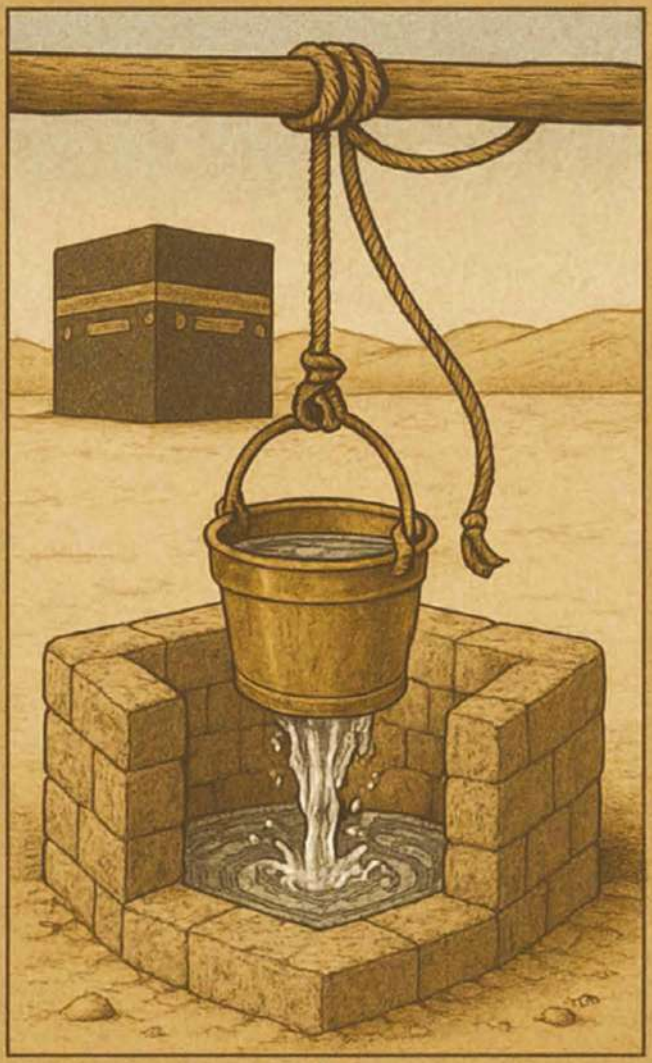
Ibn ʿĀbidīn asserted: «When one concludes the farewell **ṭawāf** (ṭawāf al-wadāʿ), he is advised to proceed to the Station [of Abraham], to pray two **rak'ahs** there. Following this, he should approach **ZamZam** and drink its water while standing, and apply some of it to his face and head.» (Ibn ʿĀbidīn, 1966).

Chapter Three

ZamZam Across Eras

Milestones in the Custodianship of the Blessed Water

The Era of Prophets Ibrahim and Ismail, (PBUT)



The Era of Abdulmutallab (480 – 570 CE)

The Umayyad Era (661 - 750 CE)

The Abbasid Era (750 - 1258 CE)

The Mamluk Era (1250 - 1517 CE)

The Ottoman Era (1299 - 1924 CE)

The Saudi State Era (1744 CE – Present)

Development Programs of the Zamzam Well

Introduction

ZamZam water emerged in the blessed area adjacent to the Sacred House of Allah, preceding the construction of the Kaaba's foundations. Due to this early appearance, **ZamZam** water has held a distinguished status in the Qur'an and the Sunnah. It played a pivotal role in the settlement of the Arabs in the surrounding area, in direct response to the supplication of Prophet Ibrahim **(PBUH)**. This elevated status was reflected in the Arabs' linguistic and cultural regard for **ZamZam**—both in the pre-Islamic era and after the advent of Islam—as evidenced by the many names attributed to it, which reflect its esteemed significance.

Throughout the ages, the **ZamZam** Well has received great attention from caliphs, kings, and rulers who have worked to restore and improve it in ways befitting its religious and historical significance. Historians have documented the remarkable care given to the well, particularly during the Abbasid era, when the descendants of al-ʿAbbās ibn ʿAbd al-Muṭṭalib assumed the responsibility of providing water to the pilgrims. However, the peak of this care and development was reached during the era of the Saudi State, which marked a transformative period in the management, maintenance, and modernization of the well.

This chapter explores the historical dimension of the **ZamZam** Well across different periods—beginning with the time of Prophet Ibrahim and his son Ismaʿil **(PBUT)**, when the water first gushed forth in its blessed location. It then moves through the successive Islamic eras, each of which witnessed important developments in the maintenance and management of the well. The chapter includes a detailed study of the era of ʿAbd al-Muṭṭalib, the grandfather of Prophet Muhammad ﷺ, followed by the eras of the Rightly

Guided Caliphs, the Umayyads, and the Abbasids—all of whom contributed to the preservation and development of **ZamZam**.

The chapter also examines the efforts of the Mamluks and Ottomans in renovating and safeguarding the well, before turning to the modern Saudi era, characterized by advanced programs for **ZamZam** water management. These programs include technological innovations and high-level services to ensure sustainability and quality for the millions who visit the holy sanctuary.

Additionally, the chapter sheds light on the historical role of the **Al-Zamazimah**—the group entrusted with maintaining and distributing **ZamZam** water—presenting a comprehensive view of the well's journey through time, and highlighting the key historical and administrative milestones that have contributed to preserving this sacred resource across the centuries.

The Era of Ibrahim and Ismail (PBUT)

Historical accounts indicate that the **ZamZam** Well did not exist on the earth's surface until Allah commanded its emergence during the time of the Prophet Ibrahim **(PBUH)**. According to Islamic tradition, the Angel Jibril (Gabriel) **(PBUH)** was the first to uncover the source of **ZamZam**, striking the earth to produce water for the infant Ismail **(PBUH)**, who was suffering from severe thirst.

Subsequently, Ibrahim—referred to in Islamic tradition as *Al-Khalīl* (the Friend of Allah)—re-excavated the well after its temporary disappearance. Later, it was rediscovered and reopened by ʿAbd al-Muṭṭalib, the grandfather of the Prophet Muhammad **(PBUH)**, after the tribe of Jurhum had buried it.

The story of **ZamZam** begins with Allah's divine command to Ibrahim to journey from the Levant to the sacred land of Makkah, with his wife Hājar and infant son Ismail, who was reportedly two years old according to some narrations. Divinely guided by the Angel Jibril, Ibrahim arrived at the future site of Kaʿbah, where he settled his family under a large tree situated above the **ZamZam** location, within what would later become the grand mosque.

At that time, Makkah was a desolate valley devoid of water, vegetation, and human settlement. Ibrahim instructed Hājar to remain there and constructed a temporary shelter for her and their son. As he departed toward the Levant, Hājar—startled by his departure in such harsh conditions—followed after him, asking, "O Ibrahim! To whom are you leaving us?" He remained silent until he reached the valley of *Thaniyyat Adākhir*, the very place from which the Prophet Muhammad **(PBUH)** would later enter Makkah.

There, Ibrahim responded, "I leave you in the care of Allah".
She then asked, "Did Allah command you to do this?".
He replied, "Yes".

She said, “Then I am content. You have left us in the care of the All-Sufficient”.

Ibrahim continued his journey until he reached *Kudāʿ*, a barren and uninhabited area with no structures, shelter, or sources of shade. Overcome by paternal compassion, he looked back at his son. He raised his hands in supplication, praying: *“Our Lord, I have settled some of my descendants in an uncultivated valley near Your sacred House, ﴿our Lord, that they may establish prayer. So, make hearts among the people incline toward them and provide for them from the fruits that they might be grateful.﴾* [Ibrahim 37]

Hājar, returning to her infant, constructed a basic shelter in an area known as *al-Ḥijr* using branches from *Samar* trees (a type of acacia) and sealed the gaps using *Thumām*, a long plant traditionally used for insulation in desert architecture.

According to narrations, Ibrahim left his wife and son with a small supply of dates and a water skin. When the water ran out, Hājar and her child became extremely thirsty, and her milk ceased to flow. As Ismail weakened and neared death, Hājar, unable to bear the sight of his suffering, walked away in anguish. She reportedly said, “It is easier for me if he dies while I am not looking at him”.

At that moment, the Angel Jibril appeared and struck the earth—either with his heel or, according to another narration, with his wing—causing water to burst forth from the ground.

Hājar rushed to contain the water, fearing it would escape. She filled her container and brought water to her son. Ibn ʿAbbās reported that the Prophet Muhammad **(PBUH)** said: *“May Allah have mercy on Hājar. If she had left the water as it was,* **ZamZam** *would have become a flowing stream”. (Al-Bukhārī, 1980).*

In a narration reported by al-Tabari from ʿAli ibn Abi Talib, with a sound chain of transmission, it is said that Jibril called out to Hājar, asking, "Who are you?" She replied, "I am Hājar, the mother of Ibrahim's child". He then asked, "To whom has he entrusted you?" She responded, "To Allah". Jibril replied, "He has entrusted you to the All-Sufficient".

At that time, the Kaʿbah was located on a raised platform, and floodwaters would flow past it on both its right and left sides. Hājar remained in this condition, sustained only by the water of **ZamZam**, which served as both her food and drink. A caravan from the tribe of Jurhum, coming from the direction of Kudaʿ, saw a bird flying overhead—a species known not to hover unless water is nearby. They remarked, "This bird is circling over water, yet we have never known of any water in this valley". They sent out one or more scouts who found the spring and told their people. The entire tribe then gathered at the site.

At that time, Hājar was seated beside the water. They asked, "May we settle near you?" She replied, "Yes, but you shall have no claim to the water". They agreed. Ibn ʿAbbas reported that the Prophet Muhammad **(PBUH)** said: "They found the mother of Ismail there. She loved companionship, so they settled and invited their families to join them, who also took up residence there. Eventually, the area became inhabited. Ismail grew up, learned Arabic from them, and adopted it as his native tongue, indicating that the language of his parents was not originally Arabic" (al-Shafiʿi, 2001).

Historians agree that the water of **ZamZam** was provided by divine intervention for Ismail and his mother. However, there are slight variations in the accounts concerning its origin. Al-Fakihi narrated that Ibrahim later dug the well after the spring gushed forth through Jibril's action. Dhul-Qarnayn also visited the site. The well continued flowing until it eventually dried up during a great flood (al-Fakihi, 1994).

From these narrations, we learn that **ZamZam** was originally a surface spring. Hājar was the first to construct a boundary of stones and clay to contain the water and prevent its waste. This marks the first construction around the **ZamZam** Well, serving as the earliest reservoir. The tribes that succeeded Jurhum later built a second reservoir within the well itself, located deeper underground.

The Burial and Rediscovery of ZamZam Well

It is believed that **ZamZam** ceased to flow not due to natural causes but as a result of the many sins committed by the Jurhum tribe. Al-Azraqi recorded that Jurhum consumed **ZamZam** water and remained in Makkah as long as Allah willed. However, when they violated the sanctity of the Haram, looted the offerings dedicated to the Kaʿbah, and committed other serious transgressions, the spring dried up and disappeared. Over time, its location was lost, and floods continued to obscure it (al-Azraqi, 1969).

When ʿAmr ibn al-Harith and his people committed further desecrations, Allah caused them to be expelled from Makkah. Before fleeing to Yemen, ʿAmr placed treasures—including two golden gazelles and seven swords gifted by the Persian king—into the **ZamZam** Well and buried them, sealing and concealing them thoroughly. **ZamZam** remained hidden for over five centuries until ʿAbd al-Muttalib, the grandfather of the Prophet Muhammad **(PBUH)**, was shown its location through recurring dreams. Recognizing the signs, he excavated the well and restored its flow. Since then, by Allah's grace, it has remained active (al-Shafiʿi, 2001).

Al-Masʿudi documented that upon settling Ismail and Hājar in Makkah, Ibrahim entrusted them to Allah's care, as described in the Qur'an. The area was barren, with the Kaʿbah site merely a reddish hill. Ibrahim instructed Hājar to construct a shelter. In response to Ismail's thirst, God caused the

ZamZam Spring to emerge. This occurred around the time when the ʿAmaliq and Jurhum tribes migrated due to the severe drought afflicting the regions of al-Shihr and Yemen. Led by the Yemeni king al-Sumaydʿ ibn Hubar, they searched for water and pasture. Scouts traveling ahead spotted birds circling above the valley, signaling the presence of water. Upon descending, they found Hājar and Ismail near a spring, which was encircled by stones to prevent the water from dispersing.

The Prophet Muhammad **(PBUH)** reportedly said: "May Allah have mercy on our mother Hājar. Had she not enclosed the water, **ZamZam** would have become a freely flowing river". The newcomers sought permission from Hājar to settle and access the water. She permitted them, and they eventually brought their families with them. The valley flourished, and Ismail adopted Arabic as his language, replacing that of his parents (al-Masʿudi, 1973).

Historical accounts note that as Jurhum's dominance grew, they committed further violations within the sacred precincts. When Mudad ibn ʿAmr witnessed their misdeeds, including theft and abuse of outsiders, he attempted to advise them, but they ignored his warnings. In response, he took the golden gazelles and finely crafted swords from the Kaʿbah and buried them in the **ZamZam** site. By then, the spring had already dried up due to their collective sins. Meanwhile, the prophecy of the collapse of the Maʾrib Dam by the soothsayer Tarifah to ʿAmr ibn ʿAmir (also known as Muzaiqiyaʾ ibn Maʾ al-Samaʾ) came true. Consequently, ʿAmr sold his property and migrated with his tribe. Eventually, they reached Makkah, where Jurhum had already abandoned the area, allowing Khuzaʿah to settle there (al-Azraqi, 1969).

The Era of Abd al-Muttalib, grandfather of the Prophet (PBUH) (480 – 570 CE)

ZamZam remained buried and forgotten until the time of ʿAbd al-Muttalib. Ibn Ishaq, al-Bayhaqi, and Ibn Kathir recount that ʿAbd al-Muttalib received divine guidance in a series of dreams. In the Hijr area near the Kaʿbah, he dreamt of an unseen voice instructing him to dig. The voice mentioned various names—"Tayyibah," "Barrah," and finally, "al-Mudnunah," the last.

Being accompanied by a detailed sign. Upon awakening, ʿAbd al-Muttalib recognized the sign and excavated the site, thus rediscovering the **ZamZam** Well, which continues to bless the sacred sanctuary to this day.

ʿAbd al-Muṭṭalib asked, "What is al-Mudnūnah?" Then he left me. On the fourth day, he came and said, "Dig **ZamZam**". I said, "What is **ZamZam**?" He said, "It is water that never dries up nor is ever scorned. It quenches the thirst of great pilgrims, flowing from between excretions and blood, near the pecking place of the spotted crow (where the crow shall peck tomorrow), beside the ant nest".

When he was shown its description, and its location was clarified, he was certain of the vision's truth. So, he went out in the morning with his pickaxe, along with his son al-Ḥārith ibn ʿAbd al-Muṭṭalib—his only son at the time. They found the ant colony and the place where the crow was pecking, near the idols Isāf and Nāʾilah.

Quraysh used to offer their sacrifices there. He then came with his pickaxe and stood ready to dig where he had been commanded. But when Quraysh saw his determination, they rose against him and said, "By God, we will not let you dig near our two idols by whom we slaughter our offerings". But ʿAbd al-Muṭṭalib said to his son al-Ḥārith, "Defend me while I dig. By Allāh, I will carry out what I have been commanded". When Quraysh realized he would not back down, they left him alone and refrained from interfering.

He had barely dug a little when the stone lining of the well appeared, so he exclaimed, "Allāhu Akbar!" and Quraysh knew that his vision had been true. As he continued digging, he found two golden gazelles—the very same that the Jurhum tribe had buried in **ZamZam** when they were forced out of Makkah. He also found swords forged in Qaliʿah and shields. Quraysh then said to him, "ʿAbd al-Muṭṭalib, we have a share and a right in this matter with you".

In one narration, He began to dig where he had been directed. The People of Quraysh said to him, "What is this, O ʿAbd al-Muṭṭalib?" He said, "I have been commanded to dig **ZamZam**". When ʿAbd al-Muṭṭalib saw the stone tiles, he exclaimed, "Allāhu Akbar," and the Quraysh knew that he had achieved his goal.

In another narration: When he uncovered it, and they saw the gazelle statues, they came to him and said, "O ʿAbd al-Muṭṭalib, this is the well of our forefather Ismāʿīl, and we have a right in it. So let us share it with you". He replied, "I will not do that. This matter has been specifically granted to me over you, and I alone have been given it". They said, "Then deal with us justly, for we will not leave you until we take this to judgment". He said, "Then appoint between me and you whoever you wish, and I will take the matter to them for judgment". They said, "The soothsayer of Banū Saʿd ibn Hudhaym". He said, "Agreed".

She was in the highlands of the Levant. So ʿAbd al-Muṭṭalib set out, accompanied by a number of his relatives from Banū ʿAbd Manaf, and several men from each tribe of Quraysh also set out. At that time, the land was a barren desert. They set out until, when they reached one of the deserts between al-Ḥijāz and al-Shām, the water supply of ʿAbd al-Muṭṭalib and his companions ran out, and they were overcome by thirst to the point they were certain they would perish. They asked the other Quraysh tribes for water, but

they refused, saying, "We are in a desert, and we fear the same fate may befall us as has befallen you". When ʿAbd al-Muṭṭalib saw what they had done and feared for himself and his companions, he said, "What do you think?" They said, "We see no opinion but to follow yours. So, command us as you wish". He said, "I think each man among you should dig a hole for himself with what strength he has left. Then, whenever one of us dies, his companions can place him in his hole and bury him. That way, the last man will be only one, and the loss of one man is lighter than the loss of the whole group". They said, "You have commanded well".

So, each of them dug his own grave and then sat down, waiting for death from thirst. Then ʿAbd al-Muṭṭalib said to his companions, "By Allāh, throwing us into death like this—making no effort on the earth and not seeking anything for ourselves—is sheer helplessness. Perhaps Allāh will provide us with water somewhere in the desert. Set out!" and so they set out, where the tribes of Quraysh who were with them stood watching what they would do.

ʿAbd al-Muṭṭalib stepped forward to his mount and rode it. As soon as he sat on it and it moved beneath him, water burst forth from beneath its hoof—fresh, sweet water. ʿAbd al-Muṭṭalib exclaimed, "Allāhu Akbar!", and so did his companions. Then he dismounted and drank, and so did his companions. They drew water until they had filled their containers.

Then he called out to the Quraysh tribes, saying, "Come to the water—for Allāh has given us drink. Drink and take water". So, they came, drank, and filled their containers. Then they said, "By Allāh, O ʿAbd al-Muṭṭalib, the case is settled in your favor. By Allāh, we will never dispute with you about **ZamZam** again. The one who gave you this water in this desert is surely the one who gave you **ZamZam**. So, return to your responsibility for giving water (to the pilgrims), rightly guided". So, he returned, and they returned with him. They did not consult the soothsayer and left the matter entirely to him.

Ibn Isḥāq said that ʿAbd al-Muṭṭalib found swords alongside the gazelle statues. So, Quraysh said, "We have a share and a right in this with you, O ʿAbd al-Muṭṭalib".

He replied, "No—but come, let us settle this matter fairly between me and you: we will cast lots over it". They said, "How shall we do that?" He said, "Assign lots for the Kaʿbah, and lots for you, and lots for me. Whoever's lot is drawn receives what is assigned". They said, "You have judged fairly, and we are content".

So, he assigned two yellow lots for the Kaʿbah, two black lots for ʿAbd al-Muṭṭalib, and two white lots for Quraysh, and they handed them over to the one who casts the lots.

ʿAbd al-Muṭṭalib stood and supplicated, saying: "O Allāh, You are the praised King, my Lord. You are the Originator and the Restorer, the One who holds firm the massive rock. From you comes both the newly acquired and the long-inherited. If You will, You inspire what You wish—even the rightful place of ornaments and iron. So, fulfill today what You will. I have made a vow, a binding pledge—so make it mine, O Lord, and I shall never return to dispute again".

Then, the one who cast the lots struck the divining arrows, and the two yellow arrows came out for the gazelle statues, assigning them to the Kaʿbah. ʿAbd al-Muṭṭalib affixed them to the door of the Kaʿbah, and they were the first gold ornaments ever placed upon it. The two black arrows came out for the swords and armor, assigning them to ʿAbd al-Muṭṭalib.

After ʿAbd al-Muṭṭalib took the swords and armor, it was said that Quraysh and other pre-Islamic Arabs would often compose their earnest supplications in rhymed prose, crafting eloquent expressions that they believed would rarely go unanswered.

Ibn Isḥāq reported that when ʿAbd al-Muṭṭalib dug the well of **ZamZam** and Allāh guided him to it and granted him exclusive possession, Allāh increased his honor and status among his people. All other water supplies in Makkah were abandoned after **ZamZam** appeared, and people flocked to it in search of its blessings and recognition of its virtue due to its location beside the Kaʿbah and its being the provision of Allāh for Ismāʿīl (al-Hamawī, vol. 3, 1995).

ʿAbd al-Muṭṭalib died when the Prophet Muhammad **(PBUH)** was eight years old, and the responsibility for **ZamZam** and the service of water (al-siqāyah) passed to his son al-ʿAbbās ibn ʿAbd al-Muṭṭalib. It remained with him until the coming of Islam, and the Prophet **(PBUH)** affirmed al-ʿAbbās in this duty, allowing it to continue as it had.

Ibn Kathīr (1998 CE) mentions in his Tafsīr (Qur'anic exegesis) that ʿUbayd Allāh ibn Muḥammad al-ʿUtbi — a descendant of ʿUtbah ibn Abī Sufyān — reported from his father, from ʿAbd Allāh ibn Saʿīd, from al-Ṣunabihī: "We were with Muʿāwiyah ibn Abī Sufyān when the matter of the 'sacrificed son' was mentioned—whether it was Ismāʿīl or Isḥāq. Muʿāwiyah said, 'You've asked someone who knows. We were once with the Prophet of Allāh **(PBUH)** when a man came to him and said, 'O Messenger of Allāh, give me from what Allāh has granted you, O son of the two who were to be sacrificed.' The Prophet **(PBUH)** laughed. He was asked, 'O Commander of the Believers, who are the two sacrificial sons?' He replied, 'When ʿAbd al-Muṭṭalib was digging ZamZam, he vowed that if Allāh made it easy for him, he would sacrifice one of his sons. The lot fell on ʿAbd Allāh (the Prophet's father), but his maternal uncles intervened and said, "Ransom your son with a hundred camels," so he ransomed him accordingly. And Ismāʿīl is the second one". This is a very unusual narration, also mentioned by al-Umawī in his Maghāzī.

The Era of the Rightly Guided Caliphs (Al-Khulafāʾ al-Rāshidūn) (632 - 661 CE)

During the era of the Rightly Guided Caliphs (11–40 AH / 632–661 CE), the **ZamZam** well received significant attention due to its sanctity and importance for pilgrims. ʿUmar ibn al-Khaṭṭāb (may Allāh be pleased with him) oversaw Makkah's affairs with great care, expanding the water basin for easier access, supervising the pilgrimage arrangements, including the siqayah (water service), regularly cleaning the well, and supplying water buckets and containers, assigning staff dedicated to these services.

ʿUthman ibn ʿAffan (may Allāh be pleased with him) also maintained a strong interest in the Two Holy Sanctuaries, expanded the Sacred Mosque, personally supervised the distribution of **ZamZam** water during the pilgrimage seasons, and made improvements to the well and its surroundings to facilitate easier access and stronger infrastructure.

The Umayyad Era (661 - 750 CE)

The status of the **ZamZam** well has undergone significant evolution following the spread of Islam and the prophetic mission of Muhammad **(PBUH)**. Muslims worldwide aspired to visit the well as part of the Hajj rites, eager to drink from its pure waters, which are believed to possess healing properties for various ailments. The Umayyad rulers, acknowledging its sanctity, generally refrained from interfering with the well's management, which remained under the stewardship of ʿAlī ibn ʿAbbas ibn ʿAbd al-Muttalib (may Allāh be pleased with him) and his descendants.

Abū al-Walīd reported that his grandfather was informed by Muslim ibn Khalid, who narrated from Ibn Jurayj, who in turn related that ʿAtāʾ said:

The water service provided to pilgrims during the early period of **ZamZam** included two basins—one located between the well and the corner of the Kaʿbah for drinking and another behind it designated for ablution. The ablution basin had a drainage system directing water toward what is now known as the Gate of Ablution (the Gate of Safa). Water drawn from the well was poured into both basins by individuals standing close to the well, which at the time lacked any protective lattice.

Muʿāwiyah ibn Abī Sufyān intended to supply water from the Dar al-Nadwah (Council House), but Ibn ʿAbbas sent a message asserting, "This is not your right". Muʿāwiyah acknowledged the correctness of this claim and instead provided water from al-Muhaṣṣab and later from Mina. Muslim ibn Khalid indicated that the distribution point for drinks—meaning any infused beverage—was situated between the Kaʿbah's corner and **ZamZam**, near the direction of al-Ṣafā. Subsequently, Ibn al-Zubayr relocated the water service station to its current site.

Several Makkahn scholars reported that Ibn ʿAbbas's seat was located in the **ZamZam** corner, facing Ṣafā and the valley, to the left of anyone entering the **ZamZam**. Sulaymān ibn ʿAlī ibn ʿAbd Allāh ibn ʿAbbas was the first to construct a dome over this seat during the governorship of Khalid ibn ʿAbd Allāh al-Qasrī, under the reign of Sulaymān ibn ʿAbd al-Malik. Later, Caliph Abū Jaʿfar al-Manṣūr expanded the structure and added a lattice (shubbak) over **ZamZam**. Caliph al-Mahdī subsequently erected a similar lattice and added two more. A kanīsāt saj—a wooden domed canopy for shade—was installed on a platform in the corner adjacent to Ibn ʿAbbas's seat. Some Makkahns also credit Khālid ibn ʿAbd Allāh with being the first to place a lamp at **ZamZam**, illuminating the area for those performing Ṭawāf. The lamp was positioned opposite the Black Stone during the caliphate of Abd al-Malik ibn Marwān.

The Abbasid Era (750 - 1258 CE)

The Abbasids demonstrated profound reverence for the **ZamZam** well, as its water service (al-siqāyah) had belonged to their ancestor, ʿAbbas ibn ʿAbd al-Muttalib, a source of considerable pride. Many Abbasid caliphs contributed to the well's maintenance and development. The first significant renovation was undertaken by Caliph Abū Jaʿfar al-Manṣūr, who paved the well's floor with marble. His successor, Caliph al-Mahdī, continued this work. During the reign of al-Muʿtaṣim bi-llāh, the well was roofed internally with gilded teakwood and externally adorned with mosaics. Also, during the time of the Abbasids, the depth of the well was increased by several meters, and lamps were added to columns to illuminate the area.

The dome over the platform between **ZamZam** and the House of Drinks was constructed during the reign of Caliph al-Mahdī. It was built by Abū Bahr, a Magian carpenter brought from Iraq by ʿĪsā ibn ʿAlī ibn ʿAbd Allāh ibn ʿAbbas, who had previously worked on roofs and doors near al-Marwah in 161 AH (770 CE). Abū Muḥammad al-Khuzāʿī recounted that the dome was intentionally erected on the site traditionally believed to be where Abraham settled his son Ishmael and Hajar, situating the dome over the location of that tree (Al-Azraqī, 1969).

In early Abbasid times, the **ZamZam** lamp was placed on a tall pillar opposite the Black Stone, following the original placement by Khalid ibn ʿAbd Allāh. When Muḥammad ibn Sulaymān became governor of Makkah in 216 AH (831 CE), he erected a second pillar aligned with the Western Corner of the Kaʿbah. These pillars stood until 222 AH (837 CE) when Muḥammad ibn Dawūd replaced them with two taller pillars at the Right Corner and opposite the Western Corner.

The 12th-century traveler Ibn Jubayr described the **ZamZam** dome as follows: It faced the Black Stone at a distance of twenty-four steps, with ten steps separating one of its corners from the Maqām Ibrāhīm. The interior was paved with white marble, with the well's opening located near the center, slightly inclined toward the Kaʿbah-facing wall—the well measured eleven qamāḥ (arm spans) in depth, with water reaching seven qamāḥ. The marble rim of the well was sealed with lead, supported by lead pillars and metal beams gripping the circular edge tightly.

The dome's interior housed a continuous basin approximately one span wide and two spans deep, elevated five spans above the ground, for ablution purposes. Surrounding this basin was a circular platform for pilgrims to perform wudu'. The dome featured a staircase leading to a wooden loft overlooking the Safa Gate. This loft, crafted from fine wood, included a mashrabiyyah (wooden lattice window) and a platform from which the **ZamZam** muezzin issued the call to prayer.

Al-Taqī al-Fāsī described **ZamZam's** location as a square building with nine basins embedded in its walls, supplied by the well for ablution. The wall facing the Kaʿbah contained windows, and the building was roofed with teakwood except above the well, where a wooden lattice covered the opening. This reconstruction postdated al-Azraqī's account, reflecting Abbasid architectural contributions (al-Fāsī, 1996).

According to al-Azraqī (1969), the Abbasids:

- Increased the well's depth by several meters.
- Paved its floor with marble.
- Constructed a gilded teakwood-covered dome.
- Installed lamps on columns to illuminate the area.

Caliph Harūn al-Rashīd further enhanced the sacred precincts during his reign, commissioning structures and lighting for the pilgrimage season (al-Fakīhī, 1994).

The Mamluk Era (1250 - 1517 CE)

During the Mamluk period (1250–1517 CE), the **ZamZam** well underwent multiple restorations and architectural enhancements. The Mamluks established waqf endowments dedicated to its upkeep, underscoring its continued importance.

Sultan al-Ẓāhir Baybars al-Bunduqdārī (1260–1277 CE) was among the earliest Mamluk rulers to prioritize the maintenance of the Two Holy Sanctuaries, including the **ZamZam** well. Sultan al-Nāṣir Muḥammad ibn Qalāwūn (1293–1341 CE) repaired the well's roof and renovated its surroundings. Sultan Qaytbay (1468–1496 CE) notably improved the water quality and distribution, renovating the **ZamZam** dome and introducing copper and ceramic vessels to better serve pilgrims.

In 1489 CE, the Fayyat al-ʿAbbās—a large drinking fountain complex featuring a grand yellow-stone gate, central fountain, and three iron windows—was rebuilt. This complex included two metal fountains dedicated specifically to pilgrims, all housed beneath a spacious dome.

The 14th-century traveler Ibn Baṭṭūṭa described **ZamZam** as facing the Black Stone, separated by twenty-four steps. The Noble Maqām Ibrāhīm lay ten paces from one corner. The dome's interior was paved with white marble; the well's opening was centered and slightly inclined toward the Kaʿbah wall. The well's marble lining was tightly sealed with lead. It measured forty shiraʿs in circumference and four and a half shiraʿs in height. The accessible water depth was eleven qāmas (approximately 1.8 meters). The dome door faced east. A surrounding cistern about one shiraʿ wide and deep, raised five shibrs above ground, held ablution water, bordered by a circular platform where pilgrims performed wudu' (Ibn Baṭṭūṭa, 1996).

The Ottoman Era (1299 - 1924 CE)

During the Ottoman era, the Ottoman state devoted considerable attention to maintaining and developing the **ZamZam** well. Routine cleaning, structural repairs, and architectural improvements were systematically carried out. Imam Al-Fasi provides a detailed account of the architectural works executed on the **ZamZam** house, noting that the canopy above the structure housing the **ZamZam** well, used by the muezzins, had suffered severe termite damage. These termites, small insects approximately half the size of a lentil, significantly compromised the wooden pillars supporting the canopy. To prevent collapse, the canopy was reinforced with additional timber in 1418 AH (circa 1997 CE).

On 7th Rabi' al-Awwal 819 AH (1419 CE), the deteriorated canopy was dismantled, and the wooden muqarnas beneath it, along with the surrounding railing, were removed for restoration. Inspection revealed that termites had extensively damaged the muqarnas, requiring replacement. New, finely crafted brick pillars were constructed along the wall adjoining the prayer chamber adjacent to the **ZamZam** house to support the muezzin's canopy and reinforce the northern wall by approximately one handspan. The foundation was lowered about one cubit into the ground and rebuilt alongside the original foundation.

The foundation near the Shafi'i shrine was found to be broad and well-constructed, enabling the extension of the building. Three brickwork arches were built on each of the two walls, supported by slender marble columns set in lead placed between the arches on the wall facing the Kaaba. These marble columns created openings within the wall, and the windows flanking the water basins inside the house were widened to match the walls' width. The upper portions of the walls were built using uncut stones incorporated into brickwork.

The eastern upper wall of the **ZamZam** house was rebuilt above the upper lintel with bricks and stones. Two brick columns were erected on this eastern wall to support a wooden railing surrounding the well, which had not previously been in place. The roof was stripped of damaged wood and replaced with high-quality timber. On the western wall, three slender brick pillars were installed, accompanied by two wooden columns on the northern and southern walls, respectively. A wooden column was placed between these to align with the central brick pillar, and wood panels were fitted between all six pillars, covered by painted wooden boards.

A painted wooden roof spanned the pillars, leaving an open space only between the central brick pillar and the opposing wooden column, where an intricately painted wooden dome was installed. Above this dome, a layered covering of wood, palm fronds, and reeds was constructed, surmounted by a painted wooden lattice that matched the roof, serving as a canopy for the muezzins. The ceiling, dome, and lattice were securely fastened with nails and iron clamps. Above the painted roof, an additional unpainted wooden roof was visible. Installed, compacted with brickwork, and the dome's surface was plastered with gypsum. The entire roof surface was finished using brickwork and stone.

A conical wooden railing encircled the **ZamZam** house on all sides except the southern side. Additional railings were built around the eastern and southern sides of the muezzins' canopy, where none had previously existed. A metal mesh was placed over the **ZamZam** well to prevent accidental falls, and the opening beside the well was narrowed using nailed wooden panels surrounded by a conical wooden railing that enclosed the windows. Prior to these improvements, tall wooden pillars painted with plaster surrounded the water basin on all four sides. Several windows on the western wall of the **ZamZam** house have been reinforced with metal. The steps leading to the roof—where **ZamZam** is accessed—and to the muezzins' canopy were widened and reconstructed.

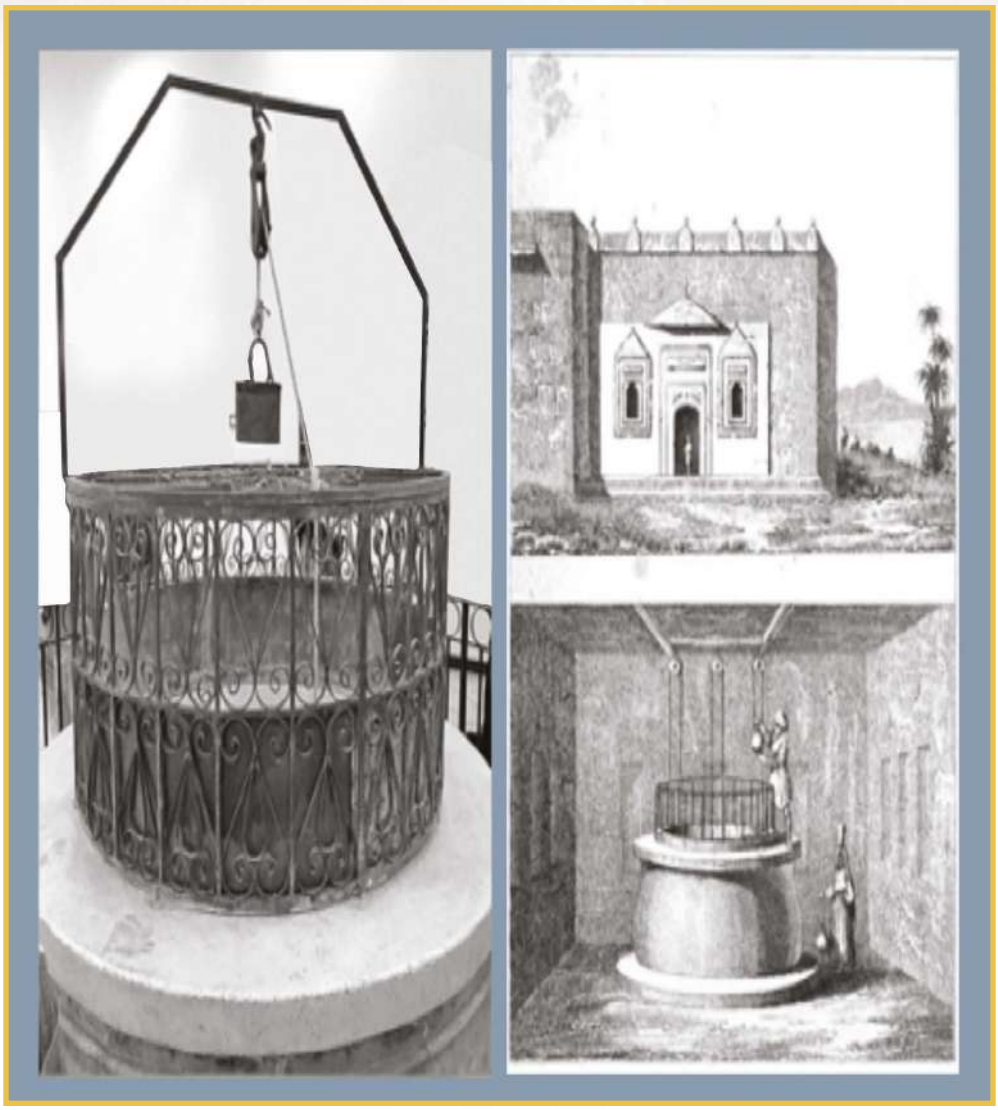
The narrow stairway was rebuilt in 1415 CE during renovations of the adjacent prayer chamber, which was converted into a public fountain with wooden railings that were not conical in shape. The expanded stairway and the walls constructed between the **ZamZam** house and its roof structures, including the muezzins' canopy, were widely praised. This construction was completed in Rajab 819 AH (1419 CE) under the supervision of Khawaja Sheikh Ali ibn Muhammad ibn Abd al-Karim al-Jilani, a senior Makkah official responsible for managing construction expenditures.

Adjacent to the **ZamZam** house was a prayer chamber containing a pool filled with **ZamZam** water, accessible for drinking. This chamber had a door facing Safa Hill, which was later closed and replaced by a domed pool. On the wall adjoining Safa, faucets with stone bases were installed for ablution. Above the domed pool was a khalwa (secluded prayer room) with windows facing north (al-Qimmah) and Safa, as well as a small floor above the pool. These structures were constructed in 1405 CE but were later demolished and leveled during the first ten days of Dhu al-Hijjah 815 AH (1414 CE) after reports indicated misuse by individuals relieving themselves there. Subsequently, a public drinking fountain was erected in honor of Sultan al-Mu'ayyad Abu al-Nasr Sheikh al-Mahmudi to provide clean water for public consumption.

The public fountain was a rectangular building with three large iron windows; each topped with an intricately carved wooden panel—one facing north (al-Qimmah) and two facing Safa. Beneath each window, inside, were basins holding water reservoirs. The fountain had a painted roof visible to visitors, a door facing Safa, and an exterior wooden lattice adorned with colorful stone corbels. Construction was completed in Rajab 816 AH (1415 CE) to accommodate the increasing number of pilgrims. Historically, this location

corresponded to the council site of Abdullah ibn Abbas, as noted by historians Al-Azraqī and Al-Fākihī. The distance between the Black Stone and the midpoint of the **ZamZam** house wall measured thirty-one and one-sixth cubits.

During the reign of Sultan Suleiman, the Magnificent (1520–1566 CE), the dome over the **ZamZam** basin was reconstructed in a distinct Islamic architectural style. The surrounding area, including the Grand Mosque courtyard, was reorganized to facilitate easier access for pilgrims. Sultan Suleiman dispatched engineers and specialists from Istanbul to oversee maintenance and ensure the well's safety. He also ordered the distribution of copper and ceramic drinking vessels and regulated water distribution during the Hajj seasons. Sultan Abdul Hamid II (r. 1909–1918 CE) was also notable for supporting extensive restoration projects in the Two Holy Mosques, including the **ZamZam** well.



The illustration on the left shows a copper bucket from the year 1299 AH (1881 AD), which was used in the well. The illustration at the lower right shows the copper neck of the well, which dates back to the late 14th century CE.

In 1526 CE, a calligraphic, gilded inscription bearing the name of Sultan Suleiman was installed on the **ZamZam** house. In 1541 CE, under the patronage of Prince Khushqaldī Farukhmat Ardah, Sultan Suleiman renewed the **ZamZam** house by adding a wooden roof covered with a decorated wooden canopy featuring a triangular gable roof (jamālūn) and a centrally lead-covered dome. The well was cleaned following an incident involving a drowning (Ghabashi, 1990).

A copper bucket, dated to 1299 AH (1881 CE), which was historically used in the well, is illustrated alongside the copper neck of the well, dating back to the late 14th century CE. The Kurdish historian of the period describes the **ZamZam** well structure as follows: from the water level upwards, the well was lined with lime mortar and gypsum; upright marble extended from the foundation to the water drawer's platform; a circular lead band topped the structure; delicate lead pillars protected smaller marble pieces from falling; from the architect's standing point to mid-height, delicate copper pillars spaced about one cubit apart with lead-cast rings were installed. This construction was attributed to the ruler Khushqaldi during the reign of Sultan Suleiman, around 1566 CE.

Sultan Murad Khan, Suleiman's son, oversaw repairs of the **ZamZam** building while completing the Grand Mosque in 1577 CE. Later, during Sultan Ahmed Khan's reign in 1616 CE, Hasan Pasha, the architect, was instructed to install a copper mesh over the **ZamZam** well's opening to prevent accidents and contamination. The mesh fits the well's circumference, was positioned about one meter below the highest water level and was suspended by iron chains. However, Muhammad ibn Mustafa al-Qanawi removed the mesh two years later due to operational issues, including bucket entrapment and rust-induced changes to the taste of **ZamZam** water.

In Ramadan 1027 AH (1618 CE), Al-Agha Hussein al-Habashi, custodian of the Makkahn shrine, supervised repairs to the **ZamZam** well's northern and western sides, including stonework above and below the water line. At that time, the **ZamZam** water's taste had deteriorated due to increased salinity, making it unpleasant for consumption.

In 1661 CE, Suleiman, the governor of the Sanjak of Jeddah, renovated the **ZamZam** well and its superstructure, except for the qibla (western) side. The dome entrance was relocated to the southern side. The Kurdish historian describes the **ZamZam** house as a square building with eight windows—three facing the Kaaba, three facing the stairs, and two adjacent to the door, which was centrally located. Behind two of these windows were triangular basins for **ZamZam** water. Above the dome stood an elevated structure supported by pillars, known as the "Sheikh of **ZamZam**," the chief of the muezzins. This was accessed via stairs near the Hanbali maqam (shrine), where the chief muezzin would ascend to call to prayer, followed by other muezzins throughout the day.

By 1700 CE, Ibrahim Bek, governor of the Sanjak of Jeddah, undertook renewal efforts of the **ZamZam** complex**.**

Following its formal presentation to the Ottoman authorities, the **ZamZam** Well underwent substantial renovations under state patronage. Restoration efforts included plastering the structure both internally and externally, refurbishing the external shelving near the Hanbali Maqam, renewing deteriorated wooden elements, sheathing them with lead, and adorning the structure with decorative paintwork.

The Kurdish historian Ibrahim Bek documented additional interventions, including the renewal of the maqams (shrines) and the Abbasid-era water trough (saqaya), which had suffered degradation over time due to extensive usage. The original dome was dismantled down to its base and reconstructed

using sun-dried bricks. The structure was then whitewashed with multiple finishes, and two reservoirs were installed. Furthermore, an archway was opened on the eastern side of the structure, within which a basin was constructed to accommodate the water channel.

In 1713 CE, further renovations included plastering the well's walls (tiles/tranquil) and resurfacing the port area with gypsum. The treated surface extended 5 meters in length, 13 cm in height, and 4.5 meters in width. This application followed the traditional "Tabata" technique, whereby a mixture of cement, soil, and gravel was spread evenly. Over the ground and compacted using a wooden plank.

During the reign of Sultan Abdul Hamid I in 1786 CE, a comprehensive restoration initiative was implemented in the Masjid al-Haram. This included the realignment of structural columns, dome repairs, and major refurbishments of the **ZamZam** Well and surrounding infrastructure. According to the Kurdish historian, these efforts also encompassed the replacement of windows, marble flooring, the well's mouth, and its protective railing under the supervision of Abdullah bin Al-Sharif Muhammad bin Awn and Al-Hajj Izzat Pasha during the rule of Sultan Abdul Aziz Khan in 1862 CE.

At the dawn of the 20th century, the **ZamZam** Well was described as having a circular mouth capped with a marble slab that corresponds to its diameter. The height from the healthy mouth to the tiled floor inside the dome was approximately 2.5 cubits. The floor of the **ZamZam** House was paved in white marble and enclosed by a substantial iron railing. In 1913, a fine iron mesh was added above the railing for additional safety.

The architectural design of the **ZamZam** House featured a square interior, with each side measuring eleven cubits in length. The well's upper surface was coated with a durable layer of mortar and stone. A prominent eastern arch, adorned with a substantial window, was present, formerly housing a

now-defunct water fountain. On the western façade, three windowed openings faced the Kaaba. Half of the west roof—opposite the Kaaba—was shaded by a canopy supported by four slender pillars: two on the front wall and two aligned on the eastern side. The eastern half remained uncovered. A gabled structure adorned with lead sheeting rose above the canopy. The roof included five windows—three facing west, one north, and one south—constructed of fine iron mesh. The canopy, painted green, served as the designated space for the "Rais al-Waqtin" (Chief of the Muezzins), who oversaw calls to prayer and coordinated with other muezzins during Friday and Eid services. He also summoned the imams who led the five daily prayers at Maqam Ibrahim.

Ibrahim Rifaat Pasha described the **ZamZam** Well during his time in the early 13th century AH (approximately the 19th century AD), stating: "This well is located to the south of Maqam Ibrahim, with the northwest corner of its building positioned 18 meters from the Black Stone. Its water is sweet. The structure above it is square-shaped inside, with each side measuring 5.25 meters, and the floor is paved with marble. The building consists of two levels: the lower level is designated for servicing the well, while the upper level is used by the **Aghawat** (the individuals who serve in the holy mosques in Makkah and Madinah)".

The Saudi State Era (1744 CE – Present)

A transformative era for the **ZamZam** Well began with the unification of the Kingdom of Saudi Arabia. For over a century, the Saudi government has provided exceptional care to the well, focusing on modernization, preservation, and accessibility. Key interventions included the installation of water pumps, relocation of the well beneath the Mataf, and the addition of a secondary underground level to accommodate increased pilgrim traffic.

As part of the Second Saudi Expansion Project, a comprehensive water distribution and drainage system was introduced, featuring two large storage units, a series of taps, and pumping mechanisms. Under King Abdullah bin Abdulaziz, the **ZamZam** Water Project was launched, encompassing a purification plant, automated filling facilities, and centralized distribution centers. Sub-projects were also initiated for the automated cleaning and ergonomic redesign of **ZamZam** water containers.

The Era of King Abdulaziz Al Saud

Until the early 20th century, **ZamZam** water was manually extracted using buckets and stored in open basins. In 1372 AH (1953 CE), King Abdulaziz authorized the installation of mechanical pumps connected to overhead zinc tanks, each with twelve taps. These modern taps complement traditional buckets, offering pilgrims multiple access options.

The King also financed the construction of two new fountains (drinking fountains): one near the southern door of the **ZamZam** dome and another adjacent to the Aghawat chamber. He ordered the restoration of an older Ottoman sabil to harmonize its design with the new installations. Built with marble and alabaster, the three sails facilitated broad public access to **ZamZam** water.

The Era of King Saud bin Abdulaziz

In 1383 AH (1963 AD), King Saud—may Allah have mercy on him—ordered the expansion of the Mataf area and the development of the **ZamZam** Well. The old structure above the well was removed, and the well's opening was relocated below the Mataf level into a basement 2.7 meters deep. Access to the cellar was facilitated by a staircase divided into two separate sections—one for men and one for women. This marked the end of the traditional bucket era, as water extraction transitioned to taps. Additionally, a plant was established to produce ice from **ZamZam** water, which was distributed across designated drinking stations throughout the Grand Mosque before the advent of electric water coolers.

The Era of King Faisal bin Abdulaziz

In 1393 AH (1973 AD), King Faisal—may Allah have mercy on him—ordered the construction of a second basement level for the **ZamZam** Well and the installation of a glass cover over the well to protect it from exposure. This development allowed for increased capacity to accommodate pilgrims and visitors, significantly enhancing their comfort. Furthermore, he issued the General Mutawwif System to improve the efficiency and professionalism of pilgrimage service providers, ensuring the delivery of high-quality services to the guests of Allah. The process of **ZamZam** water distribution was also improved through the use of portable water containers.

The Era of King Khalid bin Abdulaziz

In 1400 AH (1979 CE), King Khalid established the **ZamZam** Water Supply Administration to oversee the healthy management of the water supply. The basement entrance was repositioned near the eastern colonnade, and a

royal decree mandated comprehensive cleaning of the well using specialized divers and modern techniques. This operation significantly increased water output.

Subsequently, a sterilization facility was constructed near the Grand Mosque. Ultraviolet light was used to purify the water, eliminating bacteria without altering its taste, color, or composition. Mobile dispensers and fixed fountains distributed this treated water throughout the mosque.

The Era of King Fahd bin Abdulaziz

In 1403 AH (1982 CE), King Fahd launched the Unified Zamazemah Office, consolidating water distribution under a single administrative body. The office provided daily water services to over two million pilgrims and developed strategic plans for future Hajj seasons.

A cooling station was established opposite Bab al-Fath in 1404 AH (1983 CE), replacing ice-based cooling systems. The King also renovated and relocated King Abdulaziz Sabil to the Kuday area. In 1415 AH (1994 CE), a reinforced concrete reservoir with a capacity of 15,000 m^3 was constructed, accompanied by two additional distribution hubs. Consequently, daily **ZamZam** water supplies to the Prophet's Mosque in Medina also commenced.

In **1424 AH (2003 CE),** the Mataf area was expanded by 400 square meters. Entrances to the **ZamZam** basement were roofed over, and drinking fountains were relocated to the perimeter. A 47-meter-long maintenance tunnel was constructed, and fountains were installed under the new arcades—the Siqayah and Rifadah Committee. The text was also established.to ensure service quality.

The Era of King Abdullah bin Abdulaziz

In Ramadan 1431 AH (2010 CE), King Abdullah inaugurated the King Abdullah **ZamZam** Water Project, marking a new era in the technological management of this sacred resource. Covering over 100,000 m², the project included two major hubs: a primary site in Kuday (4.5 km from the Grand Mosque) and a secondary site in Al-Kakiyyah (7 km away).

The project focused on sustainability, hygiene, and accessibility. It integrated state-of-the-art systems for extraction, sterilization, and bottling. Continuous quality monitoring ensured that the water remained free of impurities while retaining its unique characteristics. Automated systems streamlined all stages from purification to final distribution, fulfilling the increasing global demand for **ZamZam** water.

King Abdullah bin Abdulaziz initiated the establishment of a state-of-the-art purification facility for **ZamZam** water, which included an integrated plant for bottling and distribution of the purified water. This advanced station is operated through a fully automated system encompassing control, monitoring, and storage functions. In addition to these infrastructure developments, two major sub-projects were launched: the first involved the automated cleaning of **ZamZam** water containers, while the second focused on redesigning the containers to ensure enhanced water protection, smoother flow, and improved accessibility.

The facility is capable of producing up to 200,000 containers per day, operating continuously 24 hours a day. Annual extraction from the **ZamZam** well was regulated and capped at 700,000 cubic meters, allocated as follows:

- **60%** for the Two Holy Mosques (al-Masjid al-Haram and al-Masjid al-Nabawi),
- **40%** for the production of bottled **ZamZam** water.

The bottling process utilizes advanced, integrated automation technologies that cover all stages, from purification to storage, transportation, and distribution. Notably, the purification process preserves the unique composition and taste of **ZamZam** water, utilizing cutting-edge global technologies, including the BioTin method —a biological water purification system.

To support large-scale operations, the project also includes a highly efficient warehouse system designed for the storage and distribution of bottled containers. The warehouse is equipped with air conditioning, fire suppression, and alarm systems and can manage up to 1.5 million 10-liter containers. The facility also provides dedicated areas for the hygienic packaging of containers, ensuring safe and efficient delivery during peak pilgrimage seasons.

King Abdullah bin Abdulaziz ZamZam Water Supply Project. The project consists of several buildings, including the air compressors building and the raw water container warehouse, in addition to the production lines building, which operates using the SCADA system. This system relies on automated control and monitoring, including the transport line. The total area of the plant is 13,405 square meters, and it contains four production lines with a maximum output of 200,000 containers per day, according to the plant's design capacity (Hammou & Shaaban, 2011).

The Era of King Salman bin Abdulaziz

In **1439 AH (2018 CE),** King Salman bin Abdulaziz launched a significant initiative titled the **ZamZam** Well Rehabilitation Project, continuing the modernization efforts initiated under King Abdullah. The project encompassed the following key objectives:

- Finalizing the removal of impurities and the sterilization of the geological environment surrounding the well.
- Demolishing the old foundations of nearby structures and replacing them with geologically compatible backfill to restore natural water flow and increase yield.
- Constructing five service passageways on the eastern side of the Mataf, with a total width of 8 meters and a length of 120 meters.
- Cleaning the interior of the well for the first time using modern, non-invasive methods.
- Removing sediment and obstructions to improve flow efficiency.
- Expanding the innerspring zone and enhancing the well's pumping capacity.
- Installing high-performance pumps to transport **ZamZam** water to the Grand Mosque and various distribution points.
- Cooling and delivering the water via thermally insulated containers and specialized faucets.
- Advancing King Abdullah's vision by launching the Technology and Innovation Program for modern **ZamZam** water management.
- Implementing innovative distribution technologies, including online ordering systems and robotic distribution units, marks a transformative advancement in the history of **ZamZam** water services.
- Establishing rigorous daily testing, documentation, and monitoring protocols to maintain the water's purity, safety, and compliance with international health standards.

An image from the "ZamZam Well Rehabilitation Project" showing the mechanism of cleaning the well, expanding the spring area, and improving the water supply and distribution system.

Al-Zamazimah

The **Al-Zamazimah** are a distinguished group of families that have historically been entrusted with the honorable task of distributing water from the sacred **ZamZam** Well to pilgrims visiting the Holy Mosque (*al-Masjid al-Haram*). Their service extended from within the Grand Mosque to the private accommodations of pilgrims. In addition to water distribution, they were also traditionally involved in the ceremonial washing of the Kaaba. This profession is among the oldest known trades in the city of Makkah, with documented continuity dating back to the mid-14th century AH (circa 1950 CE).

The origins of this profession can be traced back to the emergence of two foundational Islamic institutions: Saqqāyah (provision of water) and Rifādah (provision of food and hospitality), established by *'Abd al-Muṭṭalib ibn Hāshim*, the grandfather of the Prophet Muhammad **(PBUH)**. Initially confined to his descendants, the right to serve **ZamZam** water eventually expanded to include other noble families in Makkah, especially as the number of pilgrims increased. The significance of this service was affirmed by the Prophet Muhammad **(PBUH)** during the Conquest of Makkah when he declared:

"Indeed, every act of pride or claim regarding blood or wealth from the pre-Islamic era is abolished beneath my feet—except for the service of the pilgrim and the custodianship of the Sacred House". (*Sahih Hadith*).

Over time, the **Zamazimah** profession evolved into a structured and inherited craft passed from one generation to the next. It developed its own identity, complete with standardized tools, clothing, and procedures. The **Zamazimah** traditionally served **ZamZam** water in duwarq (earthen pots) and tays (drinking vessels made of copper) while wearing attire specific to their role. Each family maintained a ḥelwah—a designated storage space

inside the Grand Mosque for their vessels and equipment. To distinguish their service, each family marked their pots with a unique symbol known as the nishān, serving both as a sign of authenticity and a marker of family identity.

In 1403 AH (1983 CE), the Unified **Zamazimah** Office was established to coordinate the work of various families under a collective institutional framework. Its objective was to improve and standardize services provided to pilgrims of all nationalities. This marked a significant organizational shift, ensuring efficiency and inclusiveness in water provision.

Later, in Ramadan 1440 AH (2018 CE), the **Zamazimah** Company was founded to modernize and further professionalize these services, particularly by delivering **ZamZam** water directly to the residences of pilgrims in Makkah. The company now oversees a comprehensive set of services, including:

- Supplying **ZamZam** water at the reception centers for international pilgrims.
- Distributing chilled **ZamZam** water at orientation and departure centers.
- Delivering **ZamZam** water to pilgrims' accommodations throughout Makkah.
- Facilitating access to **ZamZam** water with minimal logistical obstacles.
- Reducing congestion around the **ZamZam** Well.
- Utilizing advanced technologies to enhance service quality and efficiency.

Scientific Management and Disinfection of ZamZam Water

Ultraviolet (UV) Disinfection Technology

ZamZam water undergoes rigorous disinfection via ultraviolet **(UV)** radiation, a scientifically validated method that effectively inactivates microorganisms by disrupting their DNA structure. This process achieves a remarkable sterilization rate of 99.77% for both bacteria and viruses without the need for chemical additives.

UV disinfection employs low-pressure mercury vapor lamps encased in special quartz glass that allows **UV** light to penetrate microbial cell walls. The water passes through a cylindrical reactor housing these **UV** lamps, where irradiation neutralizes pathogens by damaging their genetic material.

The disinfection process includes the following critical steps:

- Closed-circuit extraction of water directly from the **ZamZam** Well.
- Pre-filtration using high-grade purifiers to remove suspended solids, sand, and impurities.
- Transfer through stainless steel pipelines to avoid contamination and rust.
- Storage in sealed tanks, followed by exposure to primary **UV** disinfection units.
- Continuous supervision by a specialized technical team ensuring compliance with international water safety standards.

Advantages of UV-Based Disinfection

- A chemical-free process that eliminates the need for chlorination or the addition of chemical agents.
- Thermal neutrality: avoids heating or cooling, preserving the natural properties of **ZamZam** water.
- pH stability: maintains the water's inherent mineral balance.
- High energy efficiency: one kilowatt of electricity can disinfect approximately 12,000 gallons of water.
- Simplified infrastructure: facilitates integration into existing electrical and plumbing systems.

This scientifically advanced approach ensures that **ZamZam** water remains microbiologically safe while preserving its natural composition, flavor, and spiritual significance for millions of pilgrims each year.

Production and Distribution

ZamZam well pumps water at a minimum rate of 11 liters per second and a maximum of 18.5 liters per second, with an average rate of 15 liters per second. Two giant pumps, each with a capacity of 360 cubic meters per hour, work alternately to draw **ZamZam** water from the well and pump it to the King Abdullah **ZamZam** Water Project via stainless steel pipes extending 4.5 km, designed to preserve its purity.

The **ZamZam** water distribution network consists of centrifugal pumps, strategically mounted on the well and powered by electricity, with each pump having a capacity of 20 horsepower (14.9kW). This network connects to the

Bab Al-Salam reservoir and supplies it with water through a galvanized iron pipe with a precise diameter of 7.5 cm. On regular days, the pumps typically operate for six to seven hours daily, with an average pumping rate of 750 liters per minute.

The **ZamZam** Well supplies water to the corridors of the Grand Mosque, and it sends 150,000 liters of water daily to the Prophet's Mosque on regular days and 400,000 liters during religious seasons. The extraction and pumping operations are monitored through fiber-optic-controlled systems, which are managed by the SCADA system—a centralized system for automated monitoring and control of pumping, storage, and distribution operations. Its computerized system relies on fiber optics for remote monitoring and management of industrial processes.

Distribution of ZamZam Water in Sterilized Bottles and Dispensers

Storage

The **ZamZam** Water Supply Administration at the Grand Mosque provides both chilled and unchilled **ZamZam** water through dispensers distributed across the prayer areas and corridors of the Grand Mosque. It also oversees the **ZamZam** Water Analysis Laboratory and monitors the tankers transporting **ZamZam** from Makkah to the Prophet's Mosque in Madinah. **ZamZam** water is stored in a reinforced concrete reservoir with a capacity of 5,000 cubic meters, divided into two sections. After storage, the water is transferred to the purification station, where it is filtered and treated to achieve an elevated level of purity and sterilization. The purified water is then transferred to the Kuday reservoir, which has a capacity of 10,000 cubic meters. This reservoir supplies the Grand Mosque and the King Abdulaziz Sabil (fountain), from which the tankers carrying **ZamZam** to the Prophet's Mosque are filled. It also supplies the production plant that produces 5-liter **ZamZam** water bottles. Finally, the treated water from the Kuday reservoir is pumped to **ZamZam** cooling stations surrounding the Grand Mosque, where it is distributed to dispenser refilling points and drinking stations within the mosque.

ZamZam water can be stored under suitable conditions for up to one year, maintaining its purity and quality if the following precautions are observed:

- Use clean, pre-sterilized bottles for filling, ensuring thorough sanitation to prevent bacterial growth.
- Store the water in a cool, dark place, avoiding direct sunlight exposure to the bottles.
- Preferably use glass containers. If plastic bottles are used, they must be kept at temperatures below 25°C, as higher temperatures may cause the plastic to break down and release particles into the water, altering its taste and quality.

- Designated storage rooms have been established on the ground floors to facilitate access for pilgrims. These rooms are connected to the ZamZam water network and equipped with containers, mostly made of metal or clay.

Quality and Sustainability

ZamZam water is naturally pure, and its quality is continuously monitored. It contains balanced mineral levels, giving it a unique taste and potential health benefits. The **ZamZam** Studies and Research Center of the Saudi Geological Survey conducts regular testing. Daily analyses using advanced equipment help detect any biological contaminants or changes in chemical composition. The water is also sterilized using ultraviolet light, and purification and sterilization stations in both Makkah and Madinah are closely monitored. Additionally, the deep foundations, rock excavation works in the Wadi Ibrahim basin, and the protected zones are being closely monitored. The quantity and quality of the groundwater are regularly assessed, along with climate and rainfall data in the Wadi Ibrahim basin.

Despite millions of liters being pumped annually, studies show that the water level in **ZamZam** Well remains relatively stable due to continuous natural groundwater replenishment. The amount of extracted water is measured with advanced digital sensors, and intelligent systems regulate pumping and consumption to ensure safe withdrawal limits are not exceeded. Regular distribution points have been established in Makkah and Madinah to allocate a specific quantity of water per person, thereby conserving water resources. Furthermore, the impact of urban expansion on groundwater recharge is periodically studied to mitigate any adverse effects on water sources.

ZamZam Water Quality and Sustainability Programs

The rocky and sedimentary outcrop of Wadi Ibrahim covers an area of approximately 42 square kilometers. Groundwater recharge in the area occurs primarily through limited infiltration of rainwater into the valley's sedimentary layers. However, the increasing urbanization of the valley floor in Makkah has significantly reduced the volume of infiltrating rainfall due to the proliferation of impervious surfaces, thereby constraining natural groundwater replenishment.

Given the inherently low annual rainfall and the limited percolation reaching the deeper aquifer zones, artificial and natural recharge mechanisms—such as direct rainfall infiltration and floodwater runoff—are essential to sustaining the **ZamZam** groundwater reservoir. Therefore, the hydrogeological modeling of recharge processes is vital for maintaining a sustainable balance between aquifer supply and **ZamZam** water demand.

With the annual increase in pilgrims and Umrah performers, demand for **ZamZam** water continues to grow. In response, the **ZamZam** Studies and Research Center regularly evaluates the well's safe yield capacity and enacts measures to align consumption levels with sustainable recharge thresholds. This is accomplished through real-time monitoring of extraction volumes using advanced digital flow sensors installed on the outlet pipes of the **ZamZam** Well. These instruments ensure accurate quantification of water withdrawal and facilitate ongoing assessment of the aquifer's water balance.

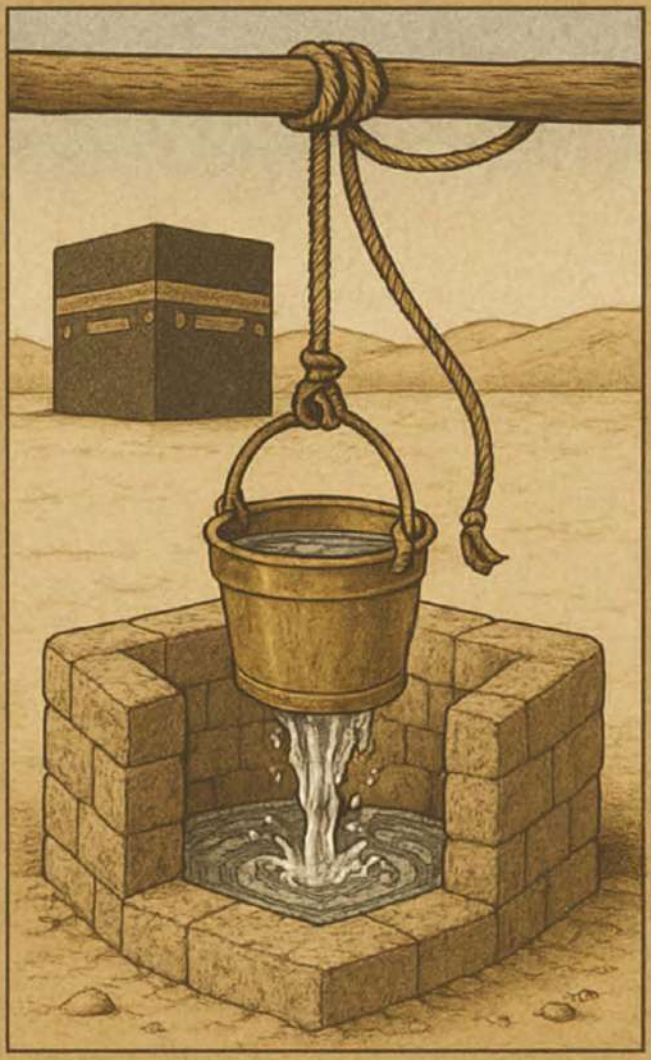
To optimize sustainability, a dedicated groundwater management program needs to be implemented. This program should regulate pumping schedules, assess hydraulic performance, and monitor fluctuations in static and dynamic water levels within the well. Such a system ensures that water extraction remains within safe operational limits, preventing aquifer depletion or structural degradation of the well.

Moreover, strict urban planning regulations must be enforced to protect the Wadi Ibrahim basin from hydrogeological disruption. The construction of high-rise structures and deep foundations poses a serious risk, as such developments may penetrate aquifer layers, increasing the risk of contamination and altering the natural subsurface flow patterns. Non-compliant construction projects that threaten the integrity of the basin should be halted immediately to preserve the aquifer's long-term viability and hydrological equilibrium.

Chapter Four

ZamZam Well
in the Context of Makkah's Natural Phenomena

Mountains of Makkah



Valleys & Mountain Passes of Makkah

Water Springs of Makkah

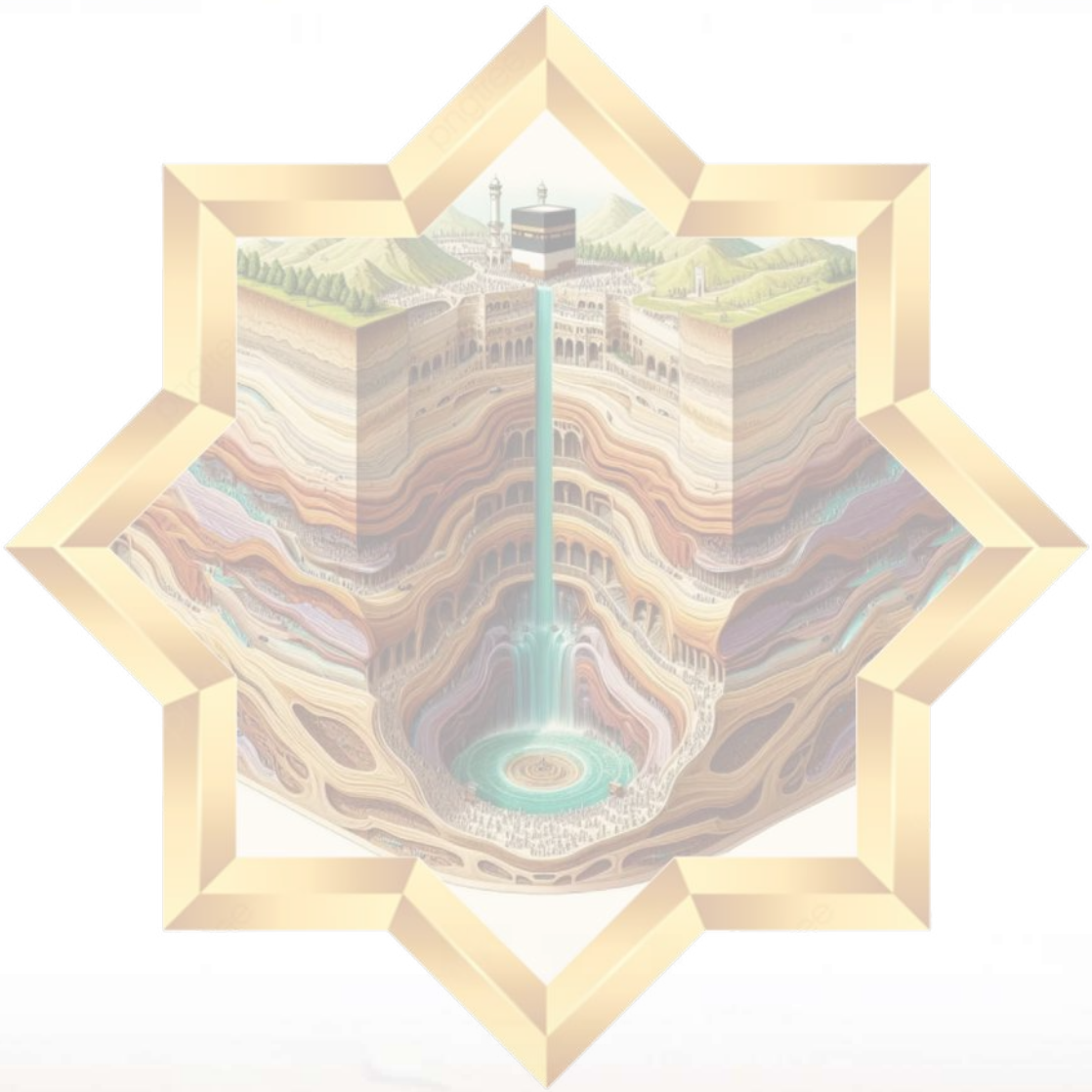
Geology of Makkah Region

Seismicity of Makkah Region

Volcanic Activity of Makkah Region

Impact of Foundations on ZamZam Well

Seismic Hazard Assessment



INTRODUCTION

The city of Makkah is situated at a latitude of 21.42° N and a longitude of 39.83° E. Its elevation ranges from 250 to 350 meters above sea level, gradually increasing from west to east, encompassing the sacred sites ***(Al-Mashā'ir Al-Muqaddasah)***. This location is considered one of the most geologically complex in the region, characterized by rugged terrain primarily composed of hard granite rocks, reflecting the area's intricate geological structure. The Valley of Ibrahim (*Wadi Ibrahim*) lies between two closely aligned mountain ranges to the east, west, and south. The northern range consists of Jabal Al-Falaq and Jabal Qa'qī'ān, while the southern range includes Jabal Abī Ḥadīdah to the southwest of Makkah, Jabal Kuday to the south, Jabal Abī Qubays to the southeast, and Jabal Khandamah. Makkah has three main entry points: Al-Ma'lāh (also known as Al-Ḥujūn), Al-Masfalah, and Al-Shabīkah.

Makkah's topography is characterized by notable diversity and can be divided into three sections extending from north to south. The western section has an elevation ranging from 200 to 250 meters and includes some peaks that reach up to 400 meters above sea level. The central section rises above 300 meters and features several historically significant mountains, such as Jabal Khandamah, Jabal Abī Qubays, Jabal Thawr, and Jabal Qa'qī'ān. The eastern section exceeds 400 meters in elevation, with peaks reaching over 800 meters, most notably Jabal Al-Ṭāriqī, located east of Mina, which is considered the highest peak in the mountains of Makkah and the sacred sites. Makkah is known for its numerous valleys and ravines, the most prominent of which is *Wadi Ibrahim*, the main valley surrounding the Holy Mosque and the primary source feeding the **ZamZam** Well. Other significant valleys include 'Urnah, Nu'mān, Al-Tan'īm, Bakkah, Muḥassir, Baldah, Ḥunayn, Sarf, Fakhkh, and Baṭn Dhū Ṭuwā, along with many tributary ravines. Makkah's climate is arid and desert-like, characterized by infrequent rainfall, with annual precipitation ranging between 25 and 100 mm, mainly resulting from northwesterly or

southwesterly monsoonal winds. Despite the general dryness, the region occasionally experiences brief episodes of heavy rain that may lead to flash floods and natural disasters, including several instances where floodwaters inundated the Holy Mosque. The climate is also marked by low humidity levels, with recorded maximum humidity at 57% and minimum at 32%, according to local climatological studies.

This chapter explores the diverse natural phenomena of the Makkah region, reviewing the key geological and geographical features that define this sacred area. It begins with a discussion of Makkah's mountainous terrain and deep ravines that shape its unique landscape, followed by an examination of its valleys, which serve as natural channels for water, and the subterranean springs that emerge from beneath the surface. From a geological perspective, the chapter also addresses the faults and structural zones of Makkah, as well as the impact of high-rise construction and deep foundations on the water table of the **ZamZam** Well. Historically and in modern times, the region has experienced significant seismic activity, particularly between Makkah and Ṭā'if, with notable concentrations around the Damm Fault and the Eastern Fault. Additionally, earthquakes have occurred in the volcanic fields (*ḥarāt*) north of Makkah, associated with the major fault system of the Red Sea.

In order to evaluate the seismic hazard level in the Makkah region, advanced computational models were employed. These models incorporated seismic intensity mapping based on ground motion parameters and peak ground acceleration. The results provide an enhanced understanding of regional seismic risks and contribute to the protection of critical infrastructure and facilities in the area.

Finally, this chapter examines the volcanic activity that affected the Makkah region in earlier geological periods. The area witnessed significant eruptions that gave rise to several prominent volcanic fields (ḥarāt), including Ḥarrat Rahat, Ḥarrat Kishb, Ḥarrat Ḥaḍn, and Ḥarrat Nawāsif (al-Baqūm). These eruptions generated extensive lava flows and resulted in the formation of volcanic plateaus and cones, which are closely linked to the rifting phases of the Red Sea.

Mountains of Makkah al-Mukarramah

Most of the mountains surrounding Makkah al-Mukarramah are characterized by their dark color, as they are composed of black basaltic igneous rocks. Among the most prominent of these mountains—witnesses to major religious and historical events—are:

Mount Al-Noor

One of the most well-known mountains of Makkah al-Mukarramah, Mount Al-Noor (literally "The Mountain of Light") was named for the light of prophethood believed to have emanated from it. It houses the famous Cave of Ḥirāʾ (*Ghar Ḥirāʾ*), where the Prophet Muhammad **(PBUH)** used to retreat in worship before the beginning of revelation. Mount Al-Noor is located to the northeast of the Holy Mosque. Its summit resembles a dome or the hump of a camel. The mountain stands at 642 meters in height and slopes steeply at a right angle down to 500 meters, after which it continues descending sharply to around 380 meters.

Al-Akhshabān

It is well known that Makkah al-Mukarramah is flanked by two prominent mountains referred to as Al-Akhshabayn. These are the two mountains between which the Ifāḍah route passes—from ʻArafah to Muzdalifah. They form the eastern boundary of Muzdalifah. The northern of the two is known as Al-Akhsab Al-Kabīr (the Greater Akhsab), while the southern is called Al-Akhsab Al-Ṣaghīr (the Lesser Akhsab). The path between them is known as the Route of Al-Maʻzamayn or the Route of Al-Akhshabayn.

These two mountains are sometimes attributed to Makkah, and at other times to Mina, though they are considered one geographical feature. Some sources identify them as Mount Abū Qubays and Mount Qaiqān, while others say they are Abū Qubays and Al-Jabal Al-Aḥmar (the Red Mountain).

Mount ‘Umar

Located to the southwest of the Grand Mosque, in the Al-Misfalah neighborhood near the edge of Ash-Shubaikah, Mount ‘Umar lies at the junction of Ri‘ Al-Ḥafā’ir and Ash-Shubaikah. It overlooks Ibrahim Al-Khalīl Street from one of its slopes, and the mountain reaches an elevation of 394 meters. In pre-Islamic times, this mountain was known as *Dhā* Āṣir (of Hurricanes), and it was also referred to as *Jabal Al-Nūbī* before being renamed Mount ‘Umar.

Mount Thawr

Mount Thawr is one of the most famous mountains in Makkah al-Mukarramah. It is located to the south of the city and reaches an elevation of 728 meters. The mountain stretches approximately 4,123 meters from north to south, and around 4,000 meters from east to west. It is said that Mount Thawr was formerly known as Mount Athal, but after Thawr ibn ‘Abd Manāf settled there, it became known as Mount Thawr in reference to him. The Cave of Thawr (*Ghar Thawr*) in the mountain is a hollowed rock measuring about 1.25 meters in length. It has two openings: one facing east and the other facing west.

Mount Abū Qubays

Mount Abū Qubays gained prominence during the Quraysh era and is considered one of the two Akhshabayn. It is located to the east of the Holy Mosque and holds great significance due to its close proximity to it, making it one of the nearest mountains to the Holy Mosque. Mount Abū Qubays rises to an elevation of approximately 420 meters above ground level. The lower part of the mountain is known as Al-Ṣafā. It is believed—and God knows best—that Mount Abū Qubays is the first mountain placed by Allah on Earth. It is also said that during the time of the Flood, the Black Stone (*Al-Ḥajar Al-Aswad*) was entrusted and safeguarded within the depths of this mountain.

Mount Khindamah

Mount Khindamah is classified among the mountains surrounding Makkah al-Mukarramah. According to the map of Makkah's mountain ranges, it is located in the southeastern part of the Holy Mosque. Certain areas of Mount Khindamah reach elevations of up to 615 meters. The region is known for its rugged and mountainous terrain. It is reported—and Allah knows best—that the graves of ninety prophets are located within Mount Khindamah. The mountain's slopes descend sharply to both the east and west, with inclinations reaching up to 80%, especially in the area stretching from north to south.

Mount Al-Ka'bah

Mount Al-Ka'bah is located to the northwest of the Holy Mosque, in the Ḥārat Al-Bāb district. It is also known as Mount Maqla' Al-Ka'bah (The Quarry of the Ka'bah), so named because the stones used to rebuild the Ka'bah after it was damaged by a flood in 1039 AH (1630 AD) were quarried from this mountain.

Mount Fārān of Makkah

Mount Fārān is one of the mountains of Makkah al-Mukarramah, situated in the Ḥijāz region. It holds historical and religious significance as the place where Hājar and her son Ismāʻīl sought refuge, and where the **ZamZam** spring gushed forth from beneath his feet.

Mount Al-Ṭāriqī

Mount Al-Ṭāriqī is notable for having the highest summit among the mountains of Makkah and the Holy Sites, reaching approximately 900 meters in elevation. It lies to the east of the Mina ritual site, with Mount Salaʻ to its east, and to the west lies Thaqbah, one of the peaks of Thabir Al-Aʻẓam.

Mount Thābir

Mount Thābir is located to the east of the Holy Mosque, at a distance of approximately four kilometers. It forms the northeastern boundary of Mina, directly opposite Mount Ḥirā'. The mountain overlooks Jamrat Al- ʻAqabah and Al-Khayf Mosque, extending to the far end of Mina near Muzdalifah. Mount Thābir reaches an elevation of approximately 856 meters.

Mount ʿArafāt and Mount Al-Raḥmah

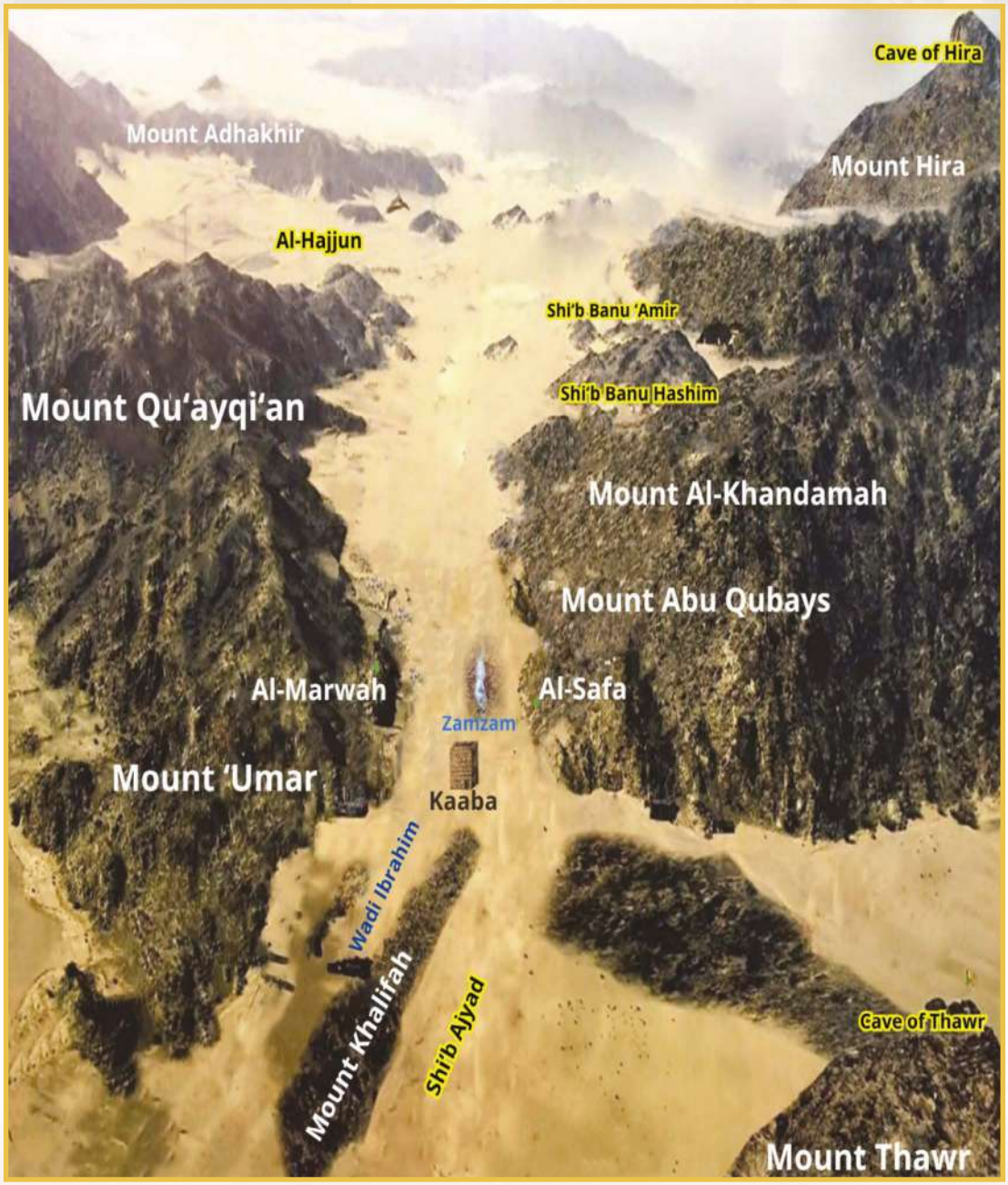
Mount ʿArafāt and Mount Al-Raḥmah are among the most renowned mountains of Makkah al-Mukarramah. They are situated along the road between Makkah and Ṭā'if. Mount Al-Raḥmah, in particular, is a central site during Ḥajj, as pilgrims stand upon it on the Day of ʿArafah, emulating the Prophet (**PBUH**). Mount Al-Raḥmah is composed of smooth, black, large stones. It lies to the east of Mount ʿArafāt, measuring approximately 300 meters in length, with a circumference of 640 meters, and a base that rises about 65 meters above the surrounding land.

Mount Al-Sayyidah

Mount Al-Sayyidah ("The Lady's Mountain") is located to the northeast of the Holy Mosque, in the Al-Ḥujūn district. At its base lies the Maʿlā Cemetery, which contains the grave of Lady Khadījah bint Khuwaylid, the wife of the Prophet (**PBUH**). The mountain was named in her honor. It rises to an elevation of approximately 400 meters and overlooks the neighborhoods of Al-Jumayzah, Al-ʿUtaybiyyah, and Al-Ḥujūn. There is also another mountain bearing the same name located in Al-Misfalah, at the edge of Ash-Shubaikah, near the bridge connecting Al-Ḥafā'ir to Ash-Shubaikah.

Mount Al-Ṣabīḥ (Cave of Al-Mursalāt)

The Cave of Al-Mursalāt (literally meaning "the gushing winds") is situated within the ritual site of Mina, between Al-Khayf Mosque and Mount Al-Ṣabīḥ, which overlooks the mosque from the southwest. It is narrated by ʿAbdullah ibn Masʿūd (may Allah be pleased with him): "We were with the Prophet (**PBUH**) in a cave when the verse 'By those [winds – Al-Mursalāt] sent forth in gusts...' was revealed to him".



An approximate figure showing the most famous mountains, valleys and ravines surrounding the Grand Mosque area.

Valleys of Makkah al-Mukarramah

Makkah al-Mukarramah is renowned for its abundance of valleys and mountain passes, to the extent that it is said: *"The people of Makkah know best its mountain paths."* These mountain passes consist of small watercourses—essentially branches of larger valleys—and are generally narrow, short, and small in comparison to the main valleys.

The Valley of Ibrāhīm

This is the principal valley supplying the **ZamZam** Well in the Holy Mosque area, and it is what is meant in the saying of Allah the Almighty:

﴿*O our Lord! I have made some of my offspring to dwell in an uncultivable valley by Your Sacred House (the Kaʿbah at Makkah); in order, O our Lord, that they may perform the prayer (Ṣalāh), so fill some hearts among men with love toward them, and (O Allah) provide them with fruits so that they may give thanks*﴾. [Ibrāhīm: 37].

It is sometimes called the Valley of Bakkah. Al-Azraqī (1996) stated: *"And Bakkah is the valley in which the Kaʿbah is located."* Allah the Almighty also said:

﴿*Indeed, the first House [of worship] established for mankind was that at Makkah—blessed and a guidance for the worlds*﴾. [Āl ʿImrān: 96].

Al-Fākihī (1994) made a similar assertion, adding: *"And the belly of Makkah and the rest of the valley is Makkah, among them Al-Murabbaʿ and the wall of Ibn Barmak"*.

The Valley of Ibrāhīm is considered one of the largest valleys, occupying most of Makkah's land and neighborhoods. Its basin area is approximately

42 km². The first human settlement in this valley was established by the descendants of Prophet Ibrāhīm (**PBUH**), which is why it was named after him. Subsequently, the tribe of Jurhum settled there as well. The valley extends from Ash-Sharā'i in the east to Al-Kaʿkiyyah in the south, passing through the Grand Mosque. It begins in the north of Makkah, where it is wide at its source in Ash-Sharā'i, then becomes very narrow between Mount Al-Nūr and Mount Thābir, before widening again in Al-Abṭaḥ, Al-ʿAdl, Al-Rawḍah, and Al-Maʿābidah. It narrows once more from Al-Jumaizah through the Grand Mosque and Al-Misfalah, and finally widens again in the plains of Al-Shumaysī and ʿUrnah.

The Valley of ʿUrnah

Al-Azharī (2001) noted that *Baṭn* ʿUrnah is a valley opposite ʿArafāt. Others have described Baṭn ʿUrnah as including the area of the ʿArafah Mosque and the surrounding surface runoff area. Al-Muḥibb al-Ṭabarī (1967) stated: *"*ʿUrnah *is what lies beyond the Valley of* ʿArafāt*; neither the valley nor the mosque is considered part of it. It extends toward the facing mountains, the walls of Ibn* ʿĀmir*, and the al-Ḥudn road. What lies beyond that is not part of* ʿUrnah*".*

Al-Bilādī (1985) explained that ʿUrnah is one of the major valleys of Makkah. Its head forms from two branches: the southern one, called Al-Bujaydī, is adjacent to Mount Kabkab from the north, and the northern branch is the Valley of Ḥunayn. The valley is also known as the Valley of Ash-Sharā'i. When the two branches merge, the eastern portion becomes known as ʿUrnah. The entire valley lies within the territory of the Quraysh.

Baṭn Dhū Ṭuwā

This valley runs between Al-Ḥujūn and Raʾy al-Kahl, passing through Jarwal and joining the Valley of Ibrāhīm in Al-Misfalah. In its upper part lies a region formerly called Raʾy al-Luṣūṣ, later renamed Raʾy al-Sadd. In the middle section of the valley is the neighborhood of Al-ʿUtaybiyyah, and at the lower end are Jarwal and then Al-Tandabāwī (also pronounced Al-Tantabāwī by some locals). This entire area comprises the geographic scope of the Valley of Ṭuwā, one of the three main valleys forming Makkah's present-day urban layout.

Al-Bilādī (1985) noted that what is referred to today as Ṭuwā denotes *Bir Ṭuwā* (Ṭuwā Well), located in Jarwal between the Qubbah and Raʾy Abī Lahab. It is a stone-lined well with a built structure above it. This is the place where the Messenger of Allah (**PBUH**) spent the night before the Opening (Conquest) of Makkah, as unanimously recorded by the historians of Makkah and the authors of the Prophet's biography.

The Valley of Baldah (The Valley of Makkah)

Al-Bilādī (1985) identified Baldah as the second main valley of Makkah, encompassing areas such as Al-Shuhadāʾ and Umm al-Dūd (now called Umm al-Jūd). Al-Azraqī reported that *Baṭn Makkah*, on the side of Dhū Ṭuwā, extends from *Al-Thanīyyah Al-Bayḍā*ʾ—the pass leading to Al-Tanʿīm—to *Thanīyyat al-Ḥashaḥā*s, which lies between Dhū Ṭuwā and Al-Ḥashaḥās. Al-Ḥamawī (1995) stated that Baldah is a valley west of Makkah. Al-Bakrī (1992) mentioned that it is near Al-Jarāḥiyyah, on the road from Al-Tanʿīm to Makkah, and that Al-Azraqī referred to it as *"The Valley of Makkah",*

Al-Azraqī further noted that, in his time, each section of Baldah bore a distinct name: the area near Ḥirāʾ was known as *Makkah al-Sidr*, and the

area near Al-Shuhadāʾ was called *Fakhkh*. It appears that the name "Baldah" originally referred only to the area beyond Al-Zāhir toward Al-Ḥudaybiyyah (Al-Shumaysī).

The Valley of Al-Tanʿīm

Al-Ḥamawī (1995) reported that Tanʿīm is a location in Makkah within the boundary of *Al-Ḥill*. It is situated between Makkah and Sārīf, at a distance of about two parasangs (*farsakhs*) from Makkah, though some state it is four. Al-Bakrī (1992) noted that those intending to perform ʿumrah enter into *iḥrām* from Tanʿīm. This is the place from which the Messenger of Allah (**PBUH**) instructed ʿAbd al-Raḥmān ibn Abī Bakr to help ʿĀʾishah (may Allah be pleased with her) begin her ʿumrah.

The location was named Tanʿīm because the mountain on its right is called *Naʿīm*, and the one on its left bears the same name. The valley itself is known as *Nuʿmān*. Al-Fākihī (1994) narrated from ʿAbdullah ibn ʿUthmān that the name Tanʿīm was derived from the valley's name. Some have erroneously believed that the *Nuʿmān* mentioned here refers to *Nuʿmān al-Arāk*, but this is incorrect, as pilgrims heading toward the Mosque for ʿumrah are not in proximity to *Nuʿmān al-Arāk*. Today, Tanʿīm is considered the closest district to the Holy Mosque.

The Valley of Ḥunayn

Al-Bakrī (1992) stated that Ḥunayn is a valley near Ṭāʾif, located about a dozen miles from Makkah. It is generally treated as masculine, as it refers to a water source. The valley is the site where the Messenger of Allah (**PBUH**) defeated the tribe of Hawāzin. Some sources report that it was named after Ḥunayn ibn Qaynah ibn Mahlāʾil. Al-Bilādī (1985) described it as one of

Makkah's valleys. It flows from the Sarat Mountains, from the area around Tād and Tandabah, then descends westward, passing between the well-known Mount Kanthil on its right and the two mountains known as Laban on its left. Today, it is referred to as the Valley of Ash-Sharāʾiʿ, and the name "Ḥunayn" is no longer in use.

The water source of Ḥunayn lies 36 *dhirāʿ* (measures) east of the Holy Mosque. During her time, Umm Jaʿfar **Zubaydah**, wife of Caliph Hārūn al-Rashīd, attempted to channel water from Ḥunayn to Makkah by carving a path through the Khul mountain pass. However, due to the project's inefficiency, she abandoned it and instead redirected the water from ʿAyn Nuʿmān, which later became known as ʿAyn Zubaydah.

The Valley of Sārif

According to Al-Bakrī (1992), Sārif is located approximately six miles from Makkah on the route to Marr, although other accounts suggest it was seven, nine, or even twelve miles away. Today, it is no longer a populated settlement. The Prophet Muhammad (**PBUH**) married Maymūnah in Sārif upon his return from Makkah after completing his pilgrimage rites and she later passed away there. Maymūnah had fallen ill in Makkah and said: *"Take me out of Makkah, for the Messenger of Allah told me I would not die there."* She was thus carried to Sārif, to the tree beneath which the Prophet used to sit, and she passed away there in 659 AD.

Al-Bilādī (1985) described Sārif as a large valley and one of the tributaries of Marr al-Zahrān. It originates from Mount Azlam and the surrounding areas. The valley continues through Al-Jiʿrānah and then descends into the Valley of

Al-Zāwiyah, followed by the Valley of Al-Wusayʿah. It is intersected by the Makkah–Madinah road, approximately twelve kilometers north of Makkah, before joining Marr al-Zahrān at Daff Khuzaʿah. Along this route lies the Al-Nawariyyah water station.

The Valley of Fakhkh

Al-Azraqī (1969) reported that Fakhkh is the valley that begins at the base of Al-Thanīyyah Al-Bayḍāʾ and extends to the Valley of Baldah. It is the valley crossed on the road to Jeddah, to the left of Dhū Ṭuwā. Al-Ḥamawī (1995) identified it as a valley in Makkah, and some scholars equate it with the Valley of Al-Zāhir. According to Al-Bilādī (1985), Fakhkh is a valley whose upper watersheds originate from Mount Al-Sittār toward the Najd Road and from Mount Ḥirāʾ and its surrounding areas.

Today, it is known by several names: its upper part is referred to as *ʿAshar Road*, the middle section includes Al-Zāhir and Al-Shuhadāʾ, and the lower portion is known as Umm al-Jūd.

The Valley of Muḥassir

Al-Ḥamawī (1995) described the Valley of Muḥassir as a location between Makkah and ʿArafāt. Some said it lies between Minā and ʿArafāt, while others placed it between Minā and Muzdalifah. However, it is considered distinct from both Minā and Muzdalifah. Al-Muḥibb al-Ṭabarī (1967) stated that the valley begins from the eastern side of the mountain to the left of the road to Minā. According to Islamic scholars, it is a separate watercourse lying between the two sites.

Al-Bilādī (1985) described it as a small valley emerging from the eastern side of Al-Ṭabir Al-Aʿẓam near the edge of Naqbah. It flows into the Valley of ʿArah. When passing between Minā and Muzdalifah, it marks the boundary

between them before turning southward. Its stream runs near the ʿAyn Al-Ḥusaynīyyah spring before flowing into ʿUrnah. Before reaching that point, it merges with three valleys known as Al-Mafājir, forming a single stream. There is no agriculture or construction in Muḥassir.

Among the public, Muḥassir is commonly known as the stretch traversed by pilgrims between Muzdalifah and Minā, where signage has been installed. It is named "Muḥassir" because the elephant of Abraha al-Ḥabashī halted there, unable to proceed. Therefore, it is Sunnah for pilgrims to hasten their pace while crossing it, whether on foot or mounted. It was narrated by the Companion Jābir ibn ʿAbdullāh that the Prophet (**PBUH**), during his Ḥajj, slightly increased his pace upon reaching Muḥassir. It was also reported that ʿUmar ibn al-Khaṭṭāb **(RA)** did the same.

The Valley of Nuʿmān (Nuʿmān al-Arāk)

Al-Bakrī (1992) stated that this valley lies between ʿArafāt and Minā and is known for its abundance of *arak* (Salvadora persica) trees. Al-Ḥamawī (1995) mentioned that it is situated between Makkah and Ṭāʾif and that the distance from its lower end to Makkah is approximately half a night's journey. The valley eventually flows into Waddān.

According to Al-Bilādī (1985), Nuʿmān is among the largest valleys in the Makkah region. Its upper tributaries originate from the highlands of the Ḥijāz, such as the mountains of Karā, ʿAfar, and Tafṭafān. Its major branches include Al-Dāʾiqah, Al-Kurr, and Al-Sharā, while its upper channels are called Al-Ṣudūr. As it flows, the valley is joined by tributaries such as ʿArʿar, Sar, and Rahjān, receiving water from prominent mountains like Kabkab and Yalam (also known as Al-Khashaʿ). The valley runs almost in a straight path, passing south of ʿArafāt in full view. After it passes ʿArafāt, it merges with the Valley of ʿUrnah, at which point the name "Nuʿmān" ceases to be used.

Al-Bilādī (1985) also noted that the valley contains springs such as ʿAyn **Zubaydah**, ʿAyn Sammar, and ʿAyn Al-ʿĀbidiyyah, and that the surrounding mountains are renowned for producing high-quality honey.

The Valley of Yaʾjīj

Al-Bakrī (1992) reported that this valley descends from the east toward Makkah and lies nearby. Al-Bilādī noted that it is known today as "Yaj" and passes north of ʿUmrah at Al-Tanʿīm. It flows into Marr al-Zahrān at Daff Khuzaʿah, between that site and Al-Maqwaʿ. Among the public of Makkah, it is commonly referred to as the Valley of Bir Muqīt, named after a well located there.

The section through which the Makkah–Madinah road passes has become urbanized and features modest gardens. It was once a residence of Ibn al-Zubayr. At its northern edge lies the location where the martyred Companion Ḥabīb ibn ʿAdiyy Allāh was killed—a captive from the Day of Al-Rajīʿ.

The Valley of Fāṭimah

This is a seasonal watercourse situated within the boundaries of the Makkah region. The valley extends for 210 kilometers, spanning the governorates of Ṭāʾif, Al-Jumūm, and Jeddah. It flows from east to west, originating in the highlands of Al-Sarawāt near Ṭāʾif and eventually emptying into the Red Sea near the Al-Khumrah district south of Jeddah, with an average gradient of 7 m/km.

The Valley of Fāṭimah is fed by two main tributaries: the Valley of Al-Shāmiyyah and the Valley of Al-Yamāniyyah. Its geological composition

includes ortho- and para-gneiss, basaltic and andesitic rocks (Jeddah Group), clastic volcanic to metamorphosed sediments (Fāṭimah Group), gabbro, diorite, and a variety of granites ranging from tonalite to alkali granite, typically gray or pink. These formations are partially covered by flood basalts. Several valleys have dissected these rocks and deposited Quaternary sediments, including aeolian sands.

The simplified geological map categorizes the area as follows (Abdelkareem et al., 2023):

- Alluvium: 9.65%.
- Jeddah–Fāṭimah Gneiss: 25.68%.
- Flood Basalt: 16.42%.
- Granite–Gabbro: 48.25%.

The Valley of Al-Mughammis

Al-Mughammis—literally meaning "immersed"—derives from the verb *ghamasa* ("to immerse"). It is believed to refer to a low-lying area where feet or water might become immersed. The valley is located to the east of Makkah, along the Makkah–Ṭāʾif road, near Al-Sayl Al-Kabīr and the Miqāt of Qarn Al-Manāzil.

It holds religious and historical significance, particularly in relation to the Prophet Muhammad's (**PBUH**) biography and the events of the Battle of Ṭāʾif. It is narrated that Al-Mughammis is the location where Allah sent the *Abābīl* birds to pelt Abraha's army with stones of baked clay, as mentioned in Sūrah Al-Fīl, when Abraha attempted to destroy the Kaʿbah.

The Valley of Al-Ḥaramayn

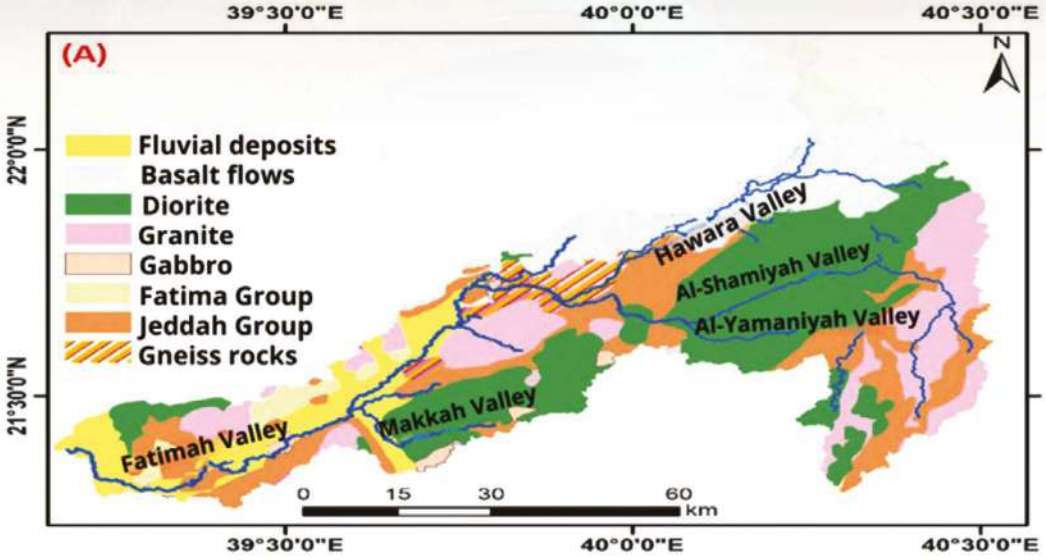
This valley is situated to the east or southeast of Makkah, adjacent to ʿArafāt from the eastern side. It comprises a series of plateaus featuring early Islamic inscriptions carved into the rocks. While the origin of its name remains unclear due to a lack of definitive documentation, it may be linked to the area's aridity or harsh topography.

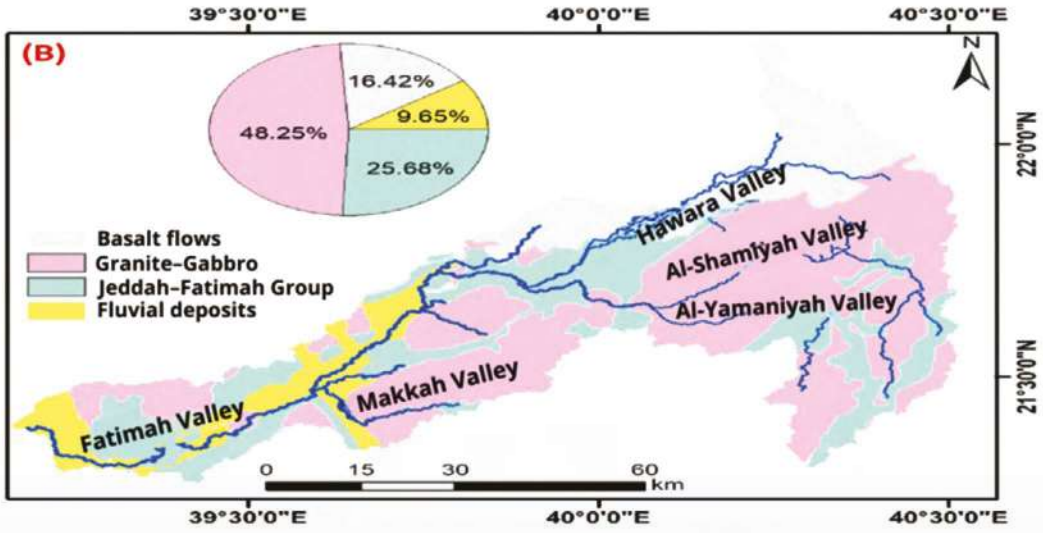
The Valley of Al-ʿAzīziyyah

The Valley of Al-ʿAzīziyyah is one of the valleys within the Sacred Mosque area, nestled among rocky mountains and plateaus with natural slopes that facilitate the collection of rainwater and flow through the valley. It receives its water from Jabal Al-Khandāmah, where the mountain range acts as a watershed divide between the Valleys of Al-ʿAzīziyyah and Ibrāhīm. The water continues its course toward the Al-ʿAwālī area and ultimately ends in the Al-Ḥusainiyyah region.

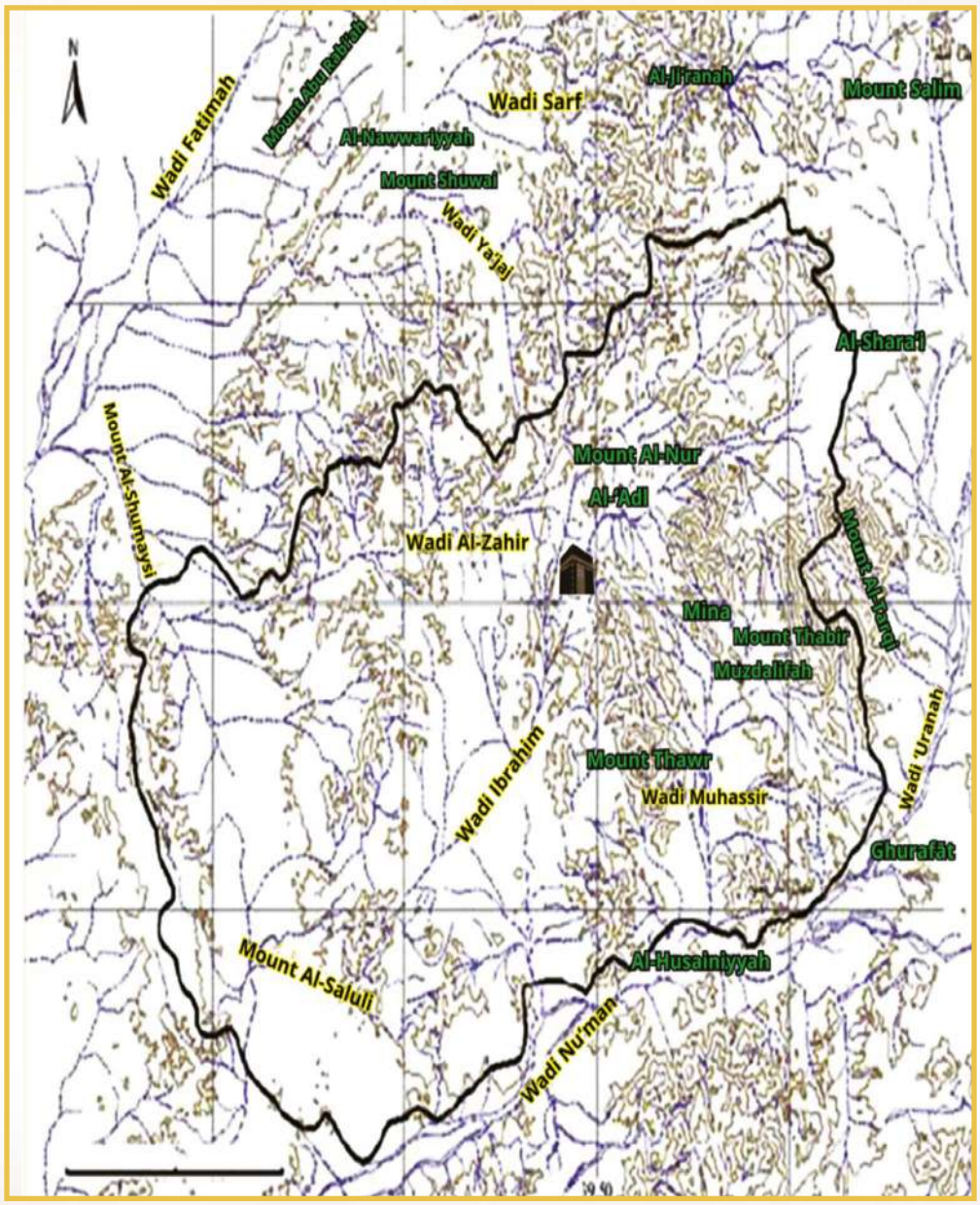
The Valley of Minā

The Valley of Minā is located to the east of Makkah, specifically to the northeast of the Sacred Mosque, approximately 7 kilometers away. It lies between Mount Thābir on one side and Mount Al-Nūr on the other. The valley stretches from the area of the Jamarāt in the west and terminates at the Valley of Muḥassir in the east.





In the upper figure (A), a geological map of Fatimah Valley is shown, indicating the rock units and flow basins. In the lower figure (B), a map illustrates the classification of rock and valley sediments proportions (modified from Abdelkareem et al., 2023).



Map showing the mountains and valleys of the Sacred Mosque area
(modified from Mirza & Al-Baroudi, 2005)

The Mountain Passes of Makkah

A mountain pass refers to a gap or opening between two mountains, often describing a valley or area situated between two mountain formations. The mountain passes of Makkah are more than just geographical features; they are integral to the city's historical and cultural identity. These passes have played a pivotal role in the formation of neighborhoods and in shaping key events throughout Islamic history. Their enduring names and landmarks serve as testaments to Makkah's deeply rooted heritage and its rich geographical and social diversity. These mountain passes also hold substantial social, economic, and religious significance.

Historically, the passes were natural locations where Makkah's early inhabitants settled. They offered shelter from harsh climatic conditions such as sand-laden winds and the intense heat of the sun due to the protective presence of surrounding mountains. These gaps also served as natural borders between tribal territories and provided defense against invasions due to the rugged terrain that hindered rapid movement. Furthermore, they functioned as natural routes connecting Makkah to surrounding areas, contributing to its emergence as a significant religious and commercial hub.

Makkah lies in a long, narrow valley within the Sarawāt Mountain range, known as the Valley of Ibrāhīm. It is surrounded by mountains, barren hills, and solid rock formations, making mountain passes a natural component of the city's topography. The homes of Makkah are distributed throughout the valley and these mountain passes, with both old and new neighborhoods developing within their gaps. Among the most renowned of these passes are:

- **Abī Ṭālib Mountain Pass**: Located between Mount Abū Qubays and Mount Al-Khandāmah, this pass was once owned by ʿAbd al-Muṭṭalib and later inherited by Banū Hāshim. Historically, it is known as the

location where Quraysh imposed a three-year siege on the Muslims during the early years of the Prophet Muhammad's (**PBUH**) mission. Today, a significant part of it has been incorporated into the expansions of the Holy Mosque, with only a small area remaining, known as *Sūq al-Layl* ("The Night Market").

- **Āmir Mountain Pass**: A historically significant pass located to the north of the present-day Ajyād area.
- **ʿAlī Mountain Pass**: A well-known pass associated with several of Makkah's historical neighborhoods.
- **Banī Hāshim Mountain Pass**: Sometimes identified with the Abī Ṭālib Mountain Pass, named after the Banū Hāshim tribe who lived there.
- **Al-Khawz Mountain Pass**, **ʿAmr (al-Malāwī) Mountain Pass**, and **ʿUthmān (al-Rawḍah) Mountain Pass**: These are adjacent mountain passes situated in the Al-Rawḍah and Al-Maʿābidah areas today.
- **Banī Makhzūm Mountain Pass**: Named after the Banū Makhzūm tribe, located in the present-day Al-Maʿābidah area.
- **Al-Maʿābidah Mountain Pass**: One of Makkah's northeastern extensions, near the Al-Maʿābidah neighborhood.
- **Banī Jumah Mountain Pass**: Located to the west of the Holy Mosque, named after the Banū Jumah tribe.
- **Banī Sahm Mountain Pass**: Located to the southwest of the Holy Mosque.
- **Al-Naqqāsah Mountain Pass**: Located southwest of Makkah, this pass has been inhabited since ancient times.
- **Al-ʿUtaybiyyah Mountain Pass**: A mountain pass that has evolved into a well-known residential neighborhood of Makkah.
- **Al-Murabbaʿ Mountain Pass (Al-Zāhir neighborhood)**: Once included Mount Al-Barūd and several wells.
- **Al-Mughsh Mountain Pass**: Stretches from Al-Manṣūr Street to the edge of Al-Misfalah.

Water Springs of Makkah

The water springs of Makkah emerged through a complex network of natural springs and man-made canals developed by Muslim rulers beginning in the early Islamic period. The most prominent of these is the **Spring of Zubaydah**, an engineering marvel of its time, constructed to provide a continuous water supply to pilgrims and residents of Makkah. These springs were more than just sources of drinking water—they formed an integral part of the city's social, religious, and economic fabric and are today recognized as part of Makkah's heritage tourism assets.

Contemporary efforts are underway to revive these historic springs and promote them as tourist attractions. Their remnants still testify to the city's deep historical roots (Rally, 2009). Historians agree that the first to bring spring water to Makkah was Muʿāwiyah ibn Abī Sufyān, who, during his caliphate, connected ten channels to the Sacred Mosque. He constructed protective channels for these sources, complete with walls and basins.

The water springs of Makkah represent some of the most prominent historical and engineering achievements, playing a vital role in supplying water to the city's inhabitants and pilgrims over the centuries. They were essential for daily life, providing water for drinking, agriculture, and ritual purification.

- **Zubaydah Spring** originates from the Valley of Nuʿmān.
- **Al-Ḥumaijah Spring** originates from the Valley of Al-ʿAshar.
- **Zaʿfarān Spring** originates from the northeast and north of Makkah.

Some of these springs have since dried up due to rainfall scarcity or seasonal flooding. Their sources lie within the groundwater layers of igneous

and metamorphic rocks, where geological fractures facilitate water flow. In addition to the springs, there were several significant wells—**ZamZam Well**, **Tanʿīm Well**, and **Shurakāʾ Well**—which played a crucial role in providing water, especially during periods when spring flow ceased.

Zubaydah Spring

Zubaydah Spring is a significant and abundant water source named in honor of **Zubaydah** bint Jaʿfar ibn Abī Jaʿfar al-Manṣūr, the wife of Caliph Hārūn al-Rashīd. The spring originates from a towering mountain called Tād, located among the Thaqbah mountains along the Ṭāʾif–Makkah road. **Zubaydah** ordered the construction of canals to transport water to Makkah and established seven reservoirs to collect rainfall from surrounding mountains. These reservoirs later transformed into independent springs, each known as a ʿAyn (spring). The seven reservoirs/springs include: Mishāsh, Maymūnah, Al-Zaʿfarān, Al-Barūd, Al-Ṭarfī, Thaqbah, and Al-Khuraybāt. All these converge into the course of the Hunayn Spring, considered the primary source of Zubaydah Spring (Sharif, 2020).

Zubaydah also ordered the diversion of spring water from the Valley of Nuʿmān to ʿArafāt. These waters originate from the tail of Mount Karā in the Ṭāʾif region, flowing toward a place called *Al-Awjar* in the Valley of Nuʿmān. From there, they were conveyed through underground canals to ʿArafāt, reaching Mount Al-Raḥmah. The canal encircled the sacred site, branching into multiple reservoirs within ʿArafāt to provide drinking water for pilgrims on the Day of ʿArafah. Beautifully crafted stone taps were installed to facilitate access. Additional channels were built around Mount Al-Raḥmah to collect ablution water and divert it toward surrounding farms in the ʿArafāt area.

According to Al-Sharif, the *Hunayn* Spring feeds into **Zubaydah** Spring, originating from below Mount Karā at the upper end of the Valley

of Nuʿmān. The canal continues toward *Muzdalifah*, where a water station was constructed near *Al-Mashʿar Al-Ḥarām*. The spring then flows into multiple reservoirs—some reserved for pilgrims and others for animals. From Muzdalifah, the canal flows above ground toward the ʿ**Azīziyyah** area near Minā, crossing a mountain range to supply it with water. It then continues underground, reemerging at a large stone-lined well known as **Bir Zubaydah** (**Zubaydah** Well), located in the area today called *Maḥbas al-Jinn*. This marks the endpoint of the **Zubaydah** Spring canal system.

The spring remained functional for over 1,200 years. In 1946 AD, during the reign of King ʿAbd al-ʿAzīz, a dedicated department was established to oversee the restoration of the spring, which subsequently resumed supplying water. However, it was later determined that the spring's capacity no longer met the needs of the growing population of residents and pilgrims. As a result, a new agreement was made between the royal authority and the owners of the springs in the Valley of Fāṭimah, leading to the establishment of a new source known as Al-ʿAzīziyyah Spring.

Hunayn Spring (Al-Sharāʾiʿ Spring)

The **Hunayn** Spring, also known today as the Al-Sharāʾiʿ Spring, dates back to the 2nd century AH. It is situated northeast of Makkah, approximately 26 kilometers from the Sacred Mosque, within the Valley of Hunayn (now Al-Sharāʾiʿ). The spring was established by order of Lady **Zubaydah** and is considered the earliest major infrastructure project intended to provide water for pilgrims. Water channels were excavated through the valleys of Al-Ṣadr and Al-Nuʿmān to supply it. The spring stands as a testament to the advanced hydraulic engineering of its time, with some remnants still visible today, and it remains one of Makkah's significant historical landmarks.

Al-Mishāsh Spring

Al-Mishāsh Spring was part of the expansive **Zubaydah** Spring system that extended 26 kilometers from the heights of Mount Al-Kurr in the Valley of Nuʿmān near Ṭāʾif to the city of Makkah. It passed through the sacred sites of Minā, ʿArafāt, and Muzdalifah. Located on Mount Azlam in Al-Jiʿrānah, northeast of Makkah, Al-Mishāsh Spring is distinguished by numerous mountain passes feeding into the Valley of Saraf (Al-Ṣaḥwah), from where the water flows toward Al-Mishāsh.

The spring contributes water to the **Zubaydah** Spring network. Its waters merge with those of the Hunayn Spring in a region called Al-Ṣifah and continue under the same name. After passing through Thanīyat Khall Al-Ṣifah—where the boundary markers of the sanctuary are located—they merge with the spring from Mount Al-Ṭāriqī.

Al-Rashā Spring

Al-Rashā Spring is one of Makkah's historical water sources, dating back to the reign of Caliph Hārūn al-Rashīd (786–809 AD). He ordered the restoration of several earlier springs, originally constructed under Muʿāwiyah ibn Abī Sufyān, and combined their flow into a unified canal known as Al-Rashā Spring.

ZamZam Spring

The **ZamZam** Well is located at what is considered a divinely ordained site, situated at the lowest point in the sacred area (Sazred) within the basin of the Valley of Ibrāhīm. It is believed to be connected to three underground water sources: one beneath the Black Stone Corner of the Kaʿbah, a second

beneath Mount Abū Qubays and Al-Ṣafā, and a third beneath Al-Marwah. The well's origin dates back approximately 5,000 years, and it has continuously served as a primary water source for Makkah throughout recorded history.

Other Springs in Makkah

Several other springs were part of the expansive water supply network established by Lady **Zubaydah**. These include:

- **Maymūn Spring.**
- **Al-Zaʿfarān Spring.**
- **Al-Barūd Spring.**
- **Al-Ṭāriqī Spring.**

These springs and their associated canals were vital in supplying fresh water to Makkah and the sacred sites. Though many of them are no longer active, their historical significance and infrastructural legacy continue to reflect the ingenuity and devotion with which water provision was ensured for the Holy City.

Zubaydah's water system represents the oldest water network in Makkah, and for over 1,200 years, it continued to supply water to the pilgrims of the Holy Mosque, the ʿUmrah performers, and the residents of Makkah.

Geology of Makkah Region

Geologically, the Makkah region lies in the central-western part of the Arabian Shield, comprising five complex geological units and several igneous intrusions dating back to the Precambrian era. Most of the area is composed of diorite and tonalite rocks, along with younger formations found in the Valley of Nuʿmān. These geologic bodies are intersected by lava flows and pyroclastic volcanic rocks of basaltic and rhyolitic origin, which are more recent and generally belong to the Cenozoic era.

Additionally, the plains and valleys throughout the region are filled with Quaternary clastic sediments, composed of varying proportions of gravel, sand, silt, and clay. Overall, the rock formations in the Holy Sanctuary area of Makkah are geologically interwoven and structurally complex (Hamimi, 2010), and may be categorized as follows:

Main Rock Types

- **Tonalite Rocks** Hornblende-rich tonalite to granodiorite, found in Mount Thawr, Mount Al-Nūr, and the Minā area.
- **Amphibolite Rocks** It contains calcium silicates, occurring in Mount Thawr and partially in the Ajyād area.
- **Monzonite and Granite Rocks**
- **Diorite and Gabbro Rocks** Found in the regions of Muzdalifah and ʿArafāt.
- **Diorite, Gabbro, and Quartz** Present in Minā and ʿArafāt.
- **Metamorphosed Gabbro Rocks and Migmatitic Gneiss** Found in ʿArafāt, especially at Mount Al-Raḥmah.

Rocks are classified by Age, Formation, and Structure (Al-Amri, 2006), Into Five major intrusive complexes of Precambrian rocks:

Sharqah Complex

Composed of massive, somewhat layered gabbro and diorite. Outcrops appear at Mount Azlam, spanning about 2 km in width. The rock types are primarily fine- to medium-grained gabbro, along with metamorphosed gabbro containing coarse-grained pyroxene lenses.

Malḥ Complex

This complex occupies roughly half of the Makkah Batholith, comprising mainly diorite and quartz diorite. The rocks have undergone minor metamorphism, classified within the greenschist facies.

Jaʿrānah Complex (Minā Tonalite)

Covers mountainous terrain and elevated provinces across the Makkah region. It represents the northwestern portion of the Makkah Batholith, consisting mostly of tonalite with minor granodiorite. Limited metamorphism is observed, and the most widespread lithology is hornblende-bearing tonalite, ranging from medium- to coarse-grained.

Ḥashfān Complex

Comprising monzonite and granite, this complex forms the largest part of a deep, composite batholith. It intrudes the Sharqah, Malḥ, and Jaʿrānah complexes and is unconformably overlain by Tertiary formations. The rock units also contain intrusions of metamorphosed volcanic rocks and granodiorite, and are intersected by numerous mafic dikes, aplite, pegmatite, and quartz veins. The joint systems trend north-northwest, northwest, and north (Al-Amri, 2006).

Nuʿmān Complex

This complex is composed of monzonite and biotite granite, notable for their light crimson coloration and coarse grain size. Outcrops occur to the east and southeast of Makkah.

Precambrian Stratified Rocks

This group comprises volcanic and sedimentary rocks that have undergone metamorphism. The volcanic units are predominantly basalt and rhyolite, while the sedimentary rocks are enriched with carbonates, quartz, and feldspar. These stratified formations are further subdivided into several distinct groups:

Zubarah Group

Comprised of metamorphosed schist and amphibolite. This group has experienced significant tectonic deformation, including folding of its strata.

Samrān Group

Consists of feldspathic volcanic lava flows, pyroclastic volcanic rocks, and minor sedimentary deposits. It unconformably overlies the rocks of the Fāṭimah Group.

Fāṭimah Group

The Fāṭimah Group is divided into three stratigraphic sequences:

- Lower Sequence: Dominated by basaltic flows.
- Middle Sequence: Composed of carbonate rocks interbedded with shale.

- Upper Sequence: Consists of clastic sediments capped with volcanic rocks.

These rocks have undergone mild metamorphism and structural deformation, notably intense folding in a northeastward direction.

Tertiary Rocks

The Tertiary formations in the Makkah region are predominantly volcanic and sedimentary, and representing a younger phase compared to the surrounding Precambrian units. These formations include:

- **Basaltic lava flows**
- **Rhyolitic volcanic rocks**
- **Tuffaceous and pyroclastic deposits**
- **Silicified ash beds**
- **Interbedded alluvial and lacustrine sediments**

These formations are associated with the early tectonic rifting of the Red Sea, which initiated the Cenozoic volcanism observed in the region. They unconformably overlie older basement rocks and contribute to the formation of regional volcanic fields known as ḥarāt, such as:

- **Ḥarrat Rahāṭ**
- **Ḥarrat Kishb**
- **Ḥarrat Ḥaḍn**

These volcanic fields contain basalt plateaus, spatter cones, and lava tunnels, and are important in understanding the geomorphology and hydrology of the Makkah region.

Tertiary Sediments

Tertiary sediments are found beneath a cover of volcanic lava flows and recent alluvial deposits. These sedimentary units occur in three main basins that extend in a north–northwest direction: Al-Shām, Sūqah, and Al-Shumaysī. The sediments are significantly disrupted by numerous faults and are associated with several volcanic lava flows (Al-Amri, 2006).

Ghumaighah Complex

The Ghumaighah Complex appears as thick segments of gabbro intrusions trending northwest to north. The complex consists of mafic rocks, ranging from medium-grained diabase to fine-grained basalt, which have not undergone metamorphism or deformation. These dikes can be traced over long distances, reaching up to 60 km.

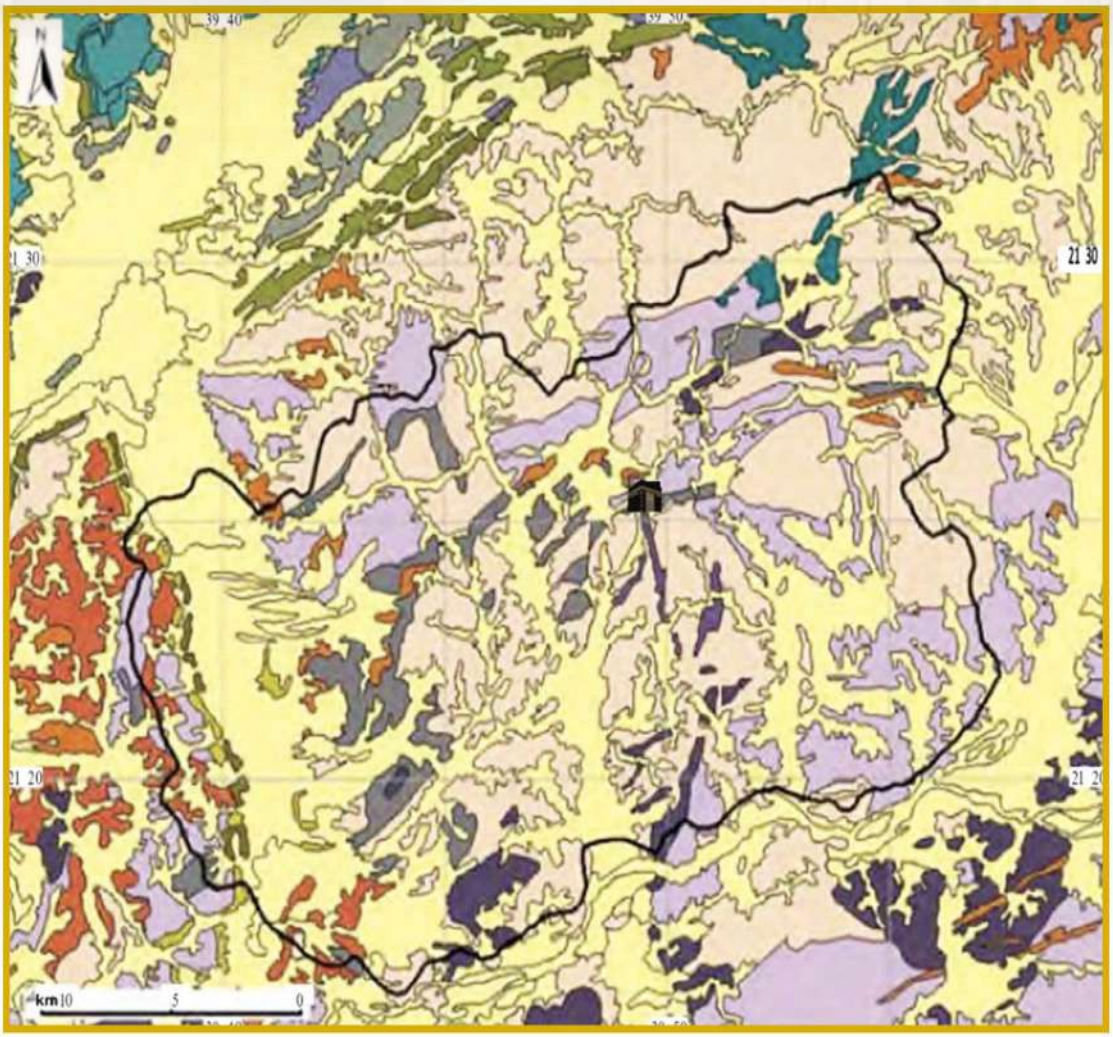
Quaternary Rocks

Quaternary Talus (QT)

Quaternary talus forms smooth desert surfaces characterized by distinctive dark shadows. These deposits typically consist of poorly sorted angular rock fragments of various sizes, forming in fan-shaped arrangements. They are common across the region's lower slopes and foothills (Al-Amri, 2006).

Alluvial Fan Sediments

These are characterized by a shallow dendritic drainage system overlaying terrace sediments. The terrace topography rises 3 to 4 meters, comprising deposits of coarse, poorly sorted gravel atop a sandy matrix. The layers often include a significant proportion of boulders and large rock fragments. As alluvial fans reach the base of a slope, they transition into slope deposits. These fans also feature smooth desert pavements with dark-stained surfaces.



Geological Map of the Sacred Mosque Area Showing the Geological Formations and Complexes (Modified from Mirza & Al-Baroudi, 2005).

Faults and Structural Zones

The Precambrian rocks of the Makkah region have undergone multiple deformation phases, including folding, faulting, and varying degrees of metamorphism, along with volcanic intrusions and eruptions. By contrast, the Tertiary rocks show signs of only faulting and tilting.

The most significant fault systems in the region extend in two dominant orientations:

- **North–northeast**
- **North–northwest**

Based on Al-Amri (2006), the structural features—including faults and structural zones—can be categorized as follows:

Fault Systems

• Thrust Faults

Primarily concentrated between the Ad-Damm Fault and Ṭāʾif. Key examples include:

- The Valley of Muḥarram Fault: Extends 11 km with a width of 200 meters.
- The Valley of Al-Ḥawrah Thrust Fault: Runs discontinuously over 65 km in a northeast direction. It lies roughly parallel to the Valley of Al-Shāmiyyah Fault, approximately 8 km to the northwest, forming the southeastern boundary of the Fāṭimah Structural Zone. Some seismic activity has been recorded near this fault in the Valley of Fāṭimah, especially adjacent to Ḥarrat Rahāṭ.

Red Sea Faults

These represent a major structural component of the Red Sea Rift System. They trend north–northwest and originated during the opening of the Red Sea at the start of the Cenozoic era. These are primarily normal faults, dipping steeply to the northeast, and are older than the regional thrust faults.

- **Subcategories:**

- Group of Faults Trending Northwest These faults are relatively old and play a key role in defining the coastal sedimentary basins. Most are normal faults with steep dips toward the southwest. According to Moore and Al-Rehaili (1989), they bound basins such as the Levant Basin.
- Group of Faults Trending Northeast These faults cross-cut the northwest-trending group and define the second structural system of the Quaternary sedimentary basins. A prominent example is the Valley of Fāṭimah Fault, which has disrupted the Fāṭimah Group. Magnetic surveys (Gettings and Anderson, 1983) show that this fault extends beneath the coastal plain.
- Faults Trending North–South These are dextral strike-slip (right-lateral) shear and tear faults. They have displaced earlier structures such as the Fāṭimah Fault. The Shaibah Fault, the youngest among them, has caused uplift of coral reefs in the Al-Līth quadrant, south of Makkah, and is considered seismically sensitive due to its proximity to Jeddah.
- Northwest-Trending Faults These faults, such as the one bounding the Levant Depression, are regional in scale.
- West–Northwest-Trending Faults These are smaller faults, extending for 5 to 10 kilometers.

Transform Faults

Transform faults in the region trend from north–northeast to northeast, forming structural components perpendicular to the general direction of the Red Sea Rift. Major examples include:

- **Al-Damm Fault**

Considered one of the most critical transform faults, representing the onshore extension of a Red Sea transform zone. It trends northeast to east-northeast, extending 85 km from south of Al-Līth to north of Ḥarrat Kishb, approximately 44 km SSE of Al-Sharāʾiʿ. It is a right-lateral strike-slip fault dipping 65° to 80° eastward. The fault is segmented into deformation zones up to 1 km wide, possibly formed in Precambrian times, but has shown recent seismic activity, with magnitudes between 0.11 to 3.43 on the Richter scale.

- **The Valley of Al-Shāmiyyah Fault**

Extends over 45 km, trending northeast, visible on geological maps. It traverses the Valley of Al-Shāmiyyah, continues southwestward from south of Jaʿrānah toward Masjid Al-Tanʿīm, and then disappears in the Valley of Al-Shumaysī (Moore and Al-Rehaili, 1989).

- **Al-Shafā Fault**

Located southeast of the Al-Damm Fault, it extends 30 km northeastward, dipping 70° to 80° northward.

Structural Zones

Makkah Structural Zone

Trending east–northeast, this zone is considered contemporaneous with or older than the Jaʿrānah Complex. It does not cut through the intrusions of the Jaʿrānah Complex but instead wraps around them. The zone primarily consists of fractured amphibolite with pronounced jointing.

Nuʿmān Structural Zone

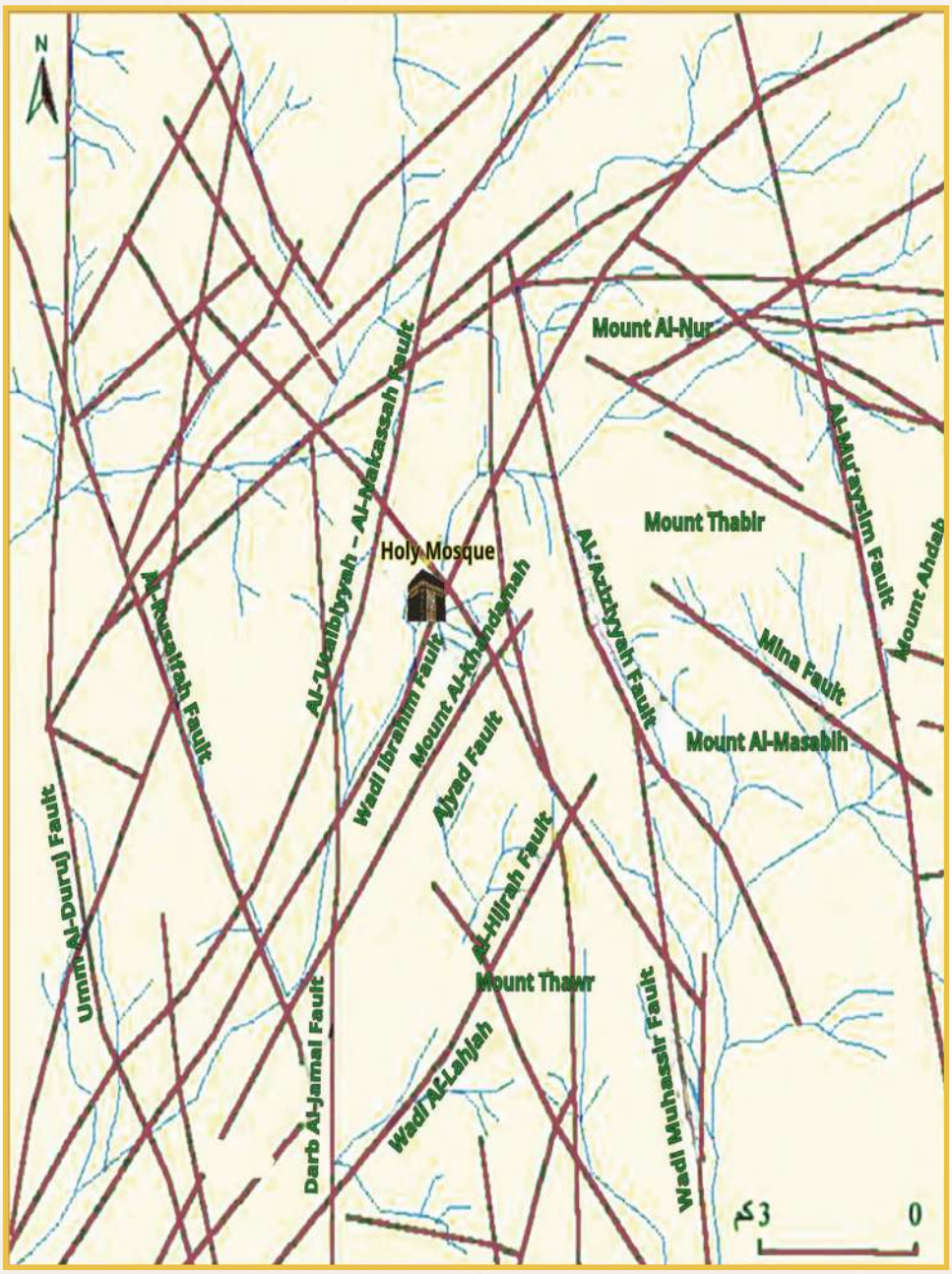
Approximately 55 km in length, also trending east–northeast, this zone lies south of the Makkah Structural Zone and is younger. It developed during the formation of the Nuʿmān Complex.

Fāṭimah Structural Zone

Among the longest and most active structural zones in the Makkah region, the Fāṭimah Zone lies about 23 km north of Al-Sharāʾiʿ. It is regarded as the onshore continuation of a Red Sea transverse fault. The rocks within this zone have undergone intense shearing, folding, and thrusting, suggesting current tectonic activity and a significant impact on the surrounding geological features.

Al-Ḥayd Structural Zone

This zone trends northeast, running adjacent to the Makkah Structural Zone. Evidence indicates that this zone was active during the formation of the Nuʿmān intrusion and played a role in shaping local geological complexity.



Map showing the relationship between fault directions (brown) and the valleys of Makkah (blue). Modified from (Sahl, 1987).

Impact of Foundations and Buildings on the Water Level of the ZamZam Well

The underground channels that supply the **ZamZam** Well originate from the Valley of Ibrahim and lie at a depth not exceeding 13 meters below the well's mouth. However, the foundations of major construction projects—such as the Mount Omar Project and the Clock Tower Project—reach depths of approximately 30 meters. These projects involved extensive excavation and groundwater dewatering during their execution phases, which functioned effectively as hydraulic barriers against the natural flow of **ZamZam** water. This disruption led to a rise in the surface water level and increased vulnerability to contamination.

A particularly critical case is the Jabal Omar Project, which is hydrologically connected to the **ZamZam** aquifer. Due to continuous pumping of water from the **ZamZam** Well, the water level within the well drops below the level of the surrounding groundwater in the project area. As a result, the natural flow of groundwater reverses, moving from the construction site toward the **ZamZam** Well. To address this issue, in April 2018, the old basement foundations adjacent to the **ZamZam** Well were removed, and the site was backfilled with engineered gravel layers possessing specific hydraulic and mineral properties similar to the well's geological composition. This intervention aimed to enhance the hydraulic conductivity, increase storage capacity, and improve flow rates, ultimately resulting in higher water production rates.

According to Salam (2015), the proposed foundation level of 306 meters at the Kuday Station site is considered geotechnically safe. Additionally, construction activities in the southern zone of the Holy Mosque area contribute to a rise in the **ZamZam** water level. Hydrogeological contour maps indicate that the primary recharge of the **ZamZam** Well comes from the Valley of Ibrahim, flowing northeast to southwest, north of the mosque. In this valley, the aquifer thickness reaches 28 meters. In contrast, water from the Valley

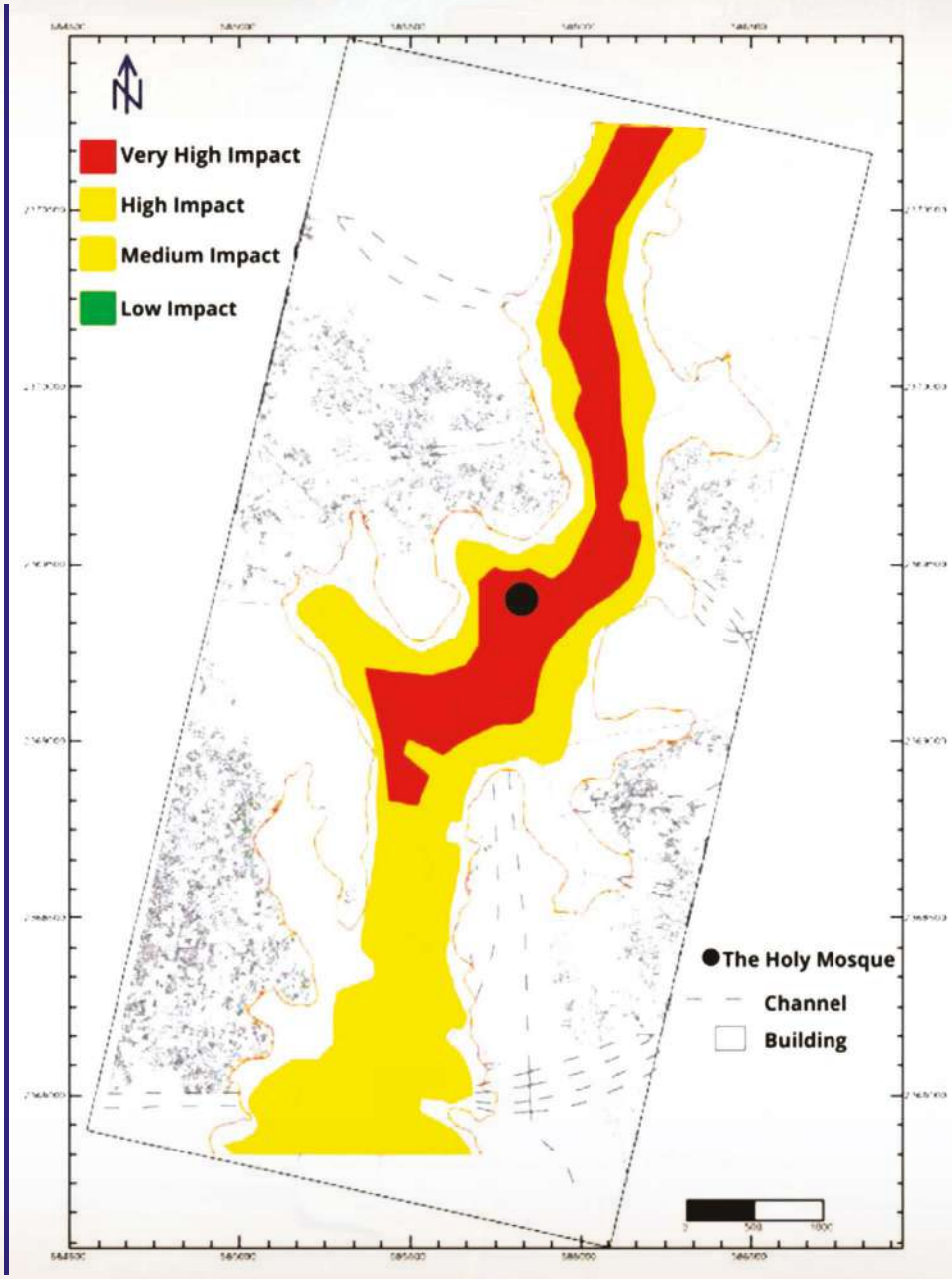
of Kuday, located south of the mosque, flows away from the well. As for the Ajyad branch, it has a very small recharge basin, with minimal recharge volume and an aquifer thickness of less than 4 meters. Although connected to the Valley of Ibrahim and contributing to the **ZamZam** recharge, Ajyad and Kuday branches are not hydrologically connected, and the mountainous zone between them exhibits no inter-basin flow or leakage.

Hydrogeological modeling demonstrates that:

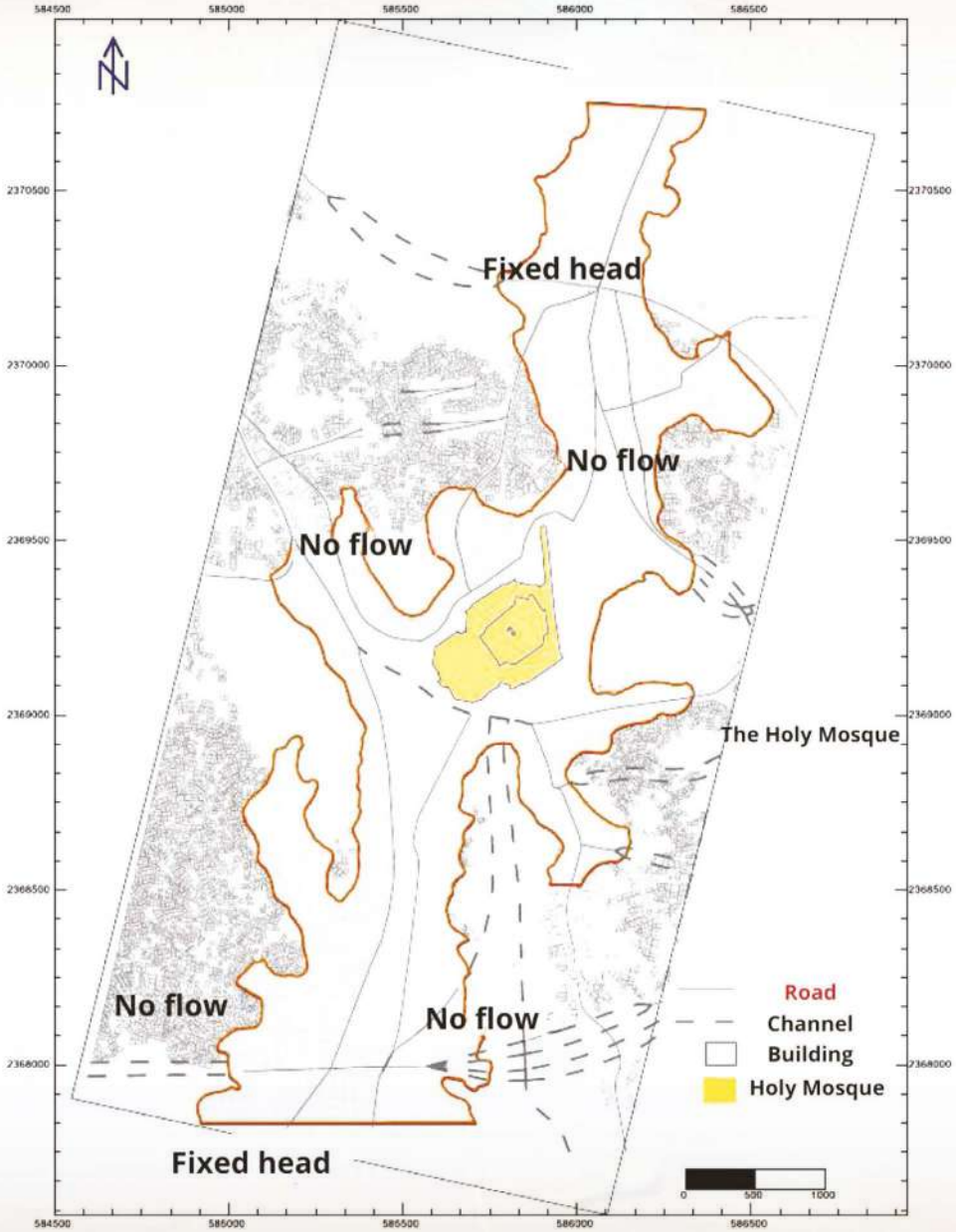
- Deeper foundations in the northern zone (Valley of Ibrahim) lead to a drop in groundwater levels.
- Conversely, deeper foundations in the southern zone (Ajyad and Kuday) correlate with a rise in the groundwater level. The following findings were recorded at a building foundation depth of 12 meters:
- In the northern zone, the water level in the **ZamZam** Well drops to 7.6 meters.
- In the southern zone, the water level rises to 4.4 meters.

Changes in groundwater levels caused by building foundations

Foundation depth (meters)	Changes caused by buildings located North of the Holy Mosque (meters)	Changes caused by buildings located North of the Holy Mosque (meters)
4	-1.4	0.5
6	-1.9	0.75
8	-3.1	1.9
12	-7.6	4.4



Map Illustrating the Impact of High-Rise Buildings and Foundations on the Water Level of the ZamZam Well (Modified from Salam, 2015)



Map showing groundwater levels and flow direction (modified from Salam, 2015)

Seismic Activity in the Makkah Region

Most earthquakes in the region occur between Makkah and Ṭāʾif, particularly around the Al-Damm Fault and the Eastern Fault. Additional epicenters are found around Ḥarrat Al-Damm and northern Makkah. These locations lie within a tectonically active zone that extends from the Red Sea inland, especially near the Al-Damm Fault, Shaʿib Fault, and Ḥarrat Al-Damm, trending in a northeast direction.

The tectonic dynamics of the Red Sea play a central role in shaping seismicity across western Arabia. The rifting process responsible for the formation of the Red Sea remains active, influencing regional fault systems. The main Red Sea fault, trending northwest, is intersected by a network of transverse faults trending northeast, extending into the Arabian and Nubian Shields. These faults result in both horizontal and vertical displacements and are subject to intermittent seismic movement.

Historically, at least twelve major earthquakes occurred in the Makkah region between 801 AD and 1963 AD. Most were felt in the Makkah or Ṭāʾif areas, except for the 1121 AD event, which was particularly destructive, damaging the Yemeni Corner (al-Rukn al-Yamānī) of the Kaaba. Some reports suggest it also affected Madīnah, causing partial collapse of the Prophet's Mosque. In general, historical seismicity in the region has been infrequent and characterized by moderate to low intensity (Al-Amri, 2025).

The table illustrates the historical seismic events that occurred in the Makkah region during the period 801–1963 CE (Al-Amri, 2022).

Location	Gregorian Year			Hijri Year		
	Year	Month	Day	Year	Month	Day
Makkah / Thunderbolt in Holy Mosque	801	1	20	185	1	1
Yemen / Impact on Hijaz (Ayn Mishash spring in Makkah)	859	4	8	245	1	1
Earthquake occurred in many regions including Makkah	859	12	1	515	9	1
Hijaz / Affected both Makkah and Madinah / Impact on the Yamani Corner of the Kaaba and partial destruction near the Prophet PBUH Mosque	1121	3	23	587	1	1
Makkah	1191	1	29	592	1	1
Black Wind / Impact on Holy Mosque and the Yamani Corner	1195	12	6	668	1	1
Ta'if	1269	8	31	811	1	1
Makkah	1408	12	30	885	8	10
Makkah and Hijaz	1481	3	18	1039	1	17
Makkah	1630	7	1	1122	11	19
Makkah	1710	3	2	1122	1	1
Makkah	1710	8	27	1122	7	2

Significant recent events include:

- In **1408 AH (1987–88 CE),** a strong Red Sea tremor destroyed one of the arches on Mount Marwah.
- In **1269 AH (1853 CE),** residents of Ṭāʾif felt an earthquake, likely along the Al-Damm Fault.

Between **1964 and 2025 CE**, more than 1,330 earthquakes were recorded, with magnitudes ranging from less than 2.0 to above 5.5. Most events occurred near the main Red Sea fault, approximately 150 km west and southwest of Makkah. The majority had shallow focal depths (~10 km).

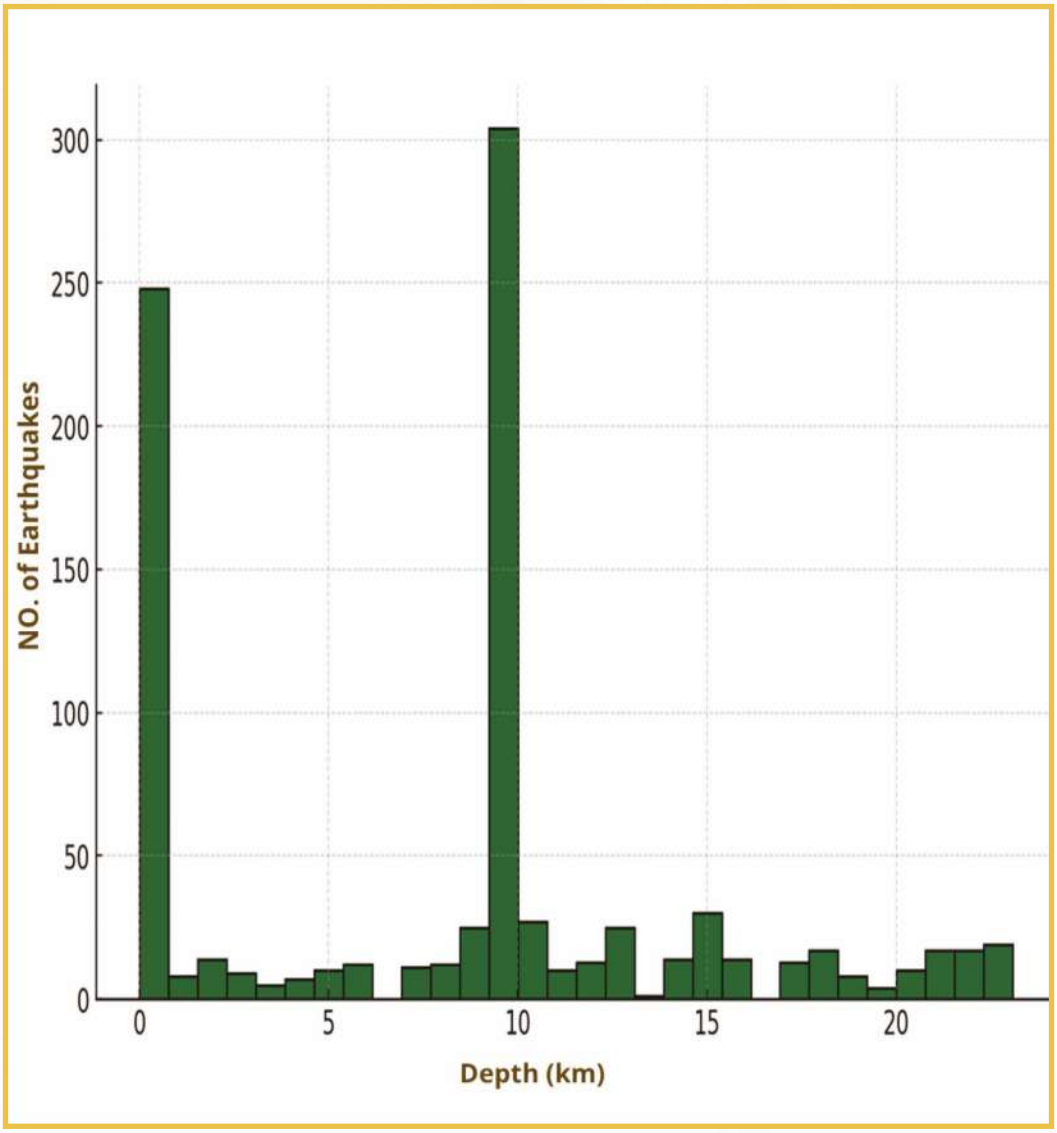
Key observations:

- Over **75%** of earthquakes had focal depths deeper than 10 km, typical of tectonic activity.
- Less than **20%** occurred at depths shallower than 5 km, possibly induced by human activities such as foundation drilling and tunneling, particularly in the Mount Omar area.

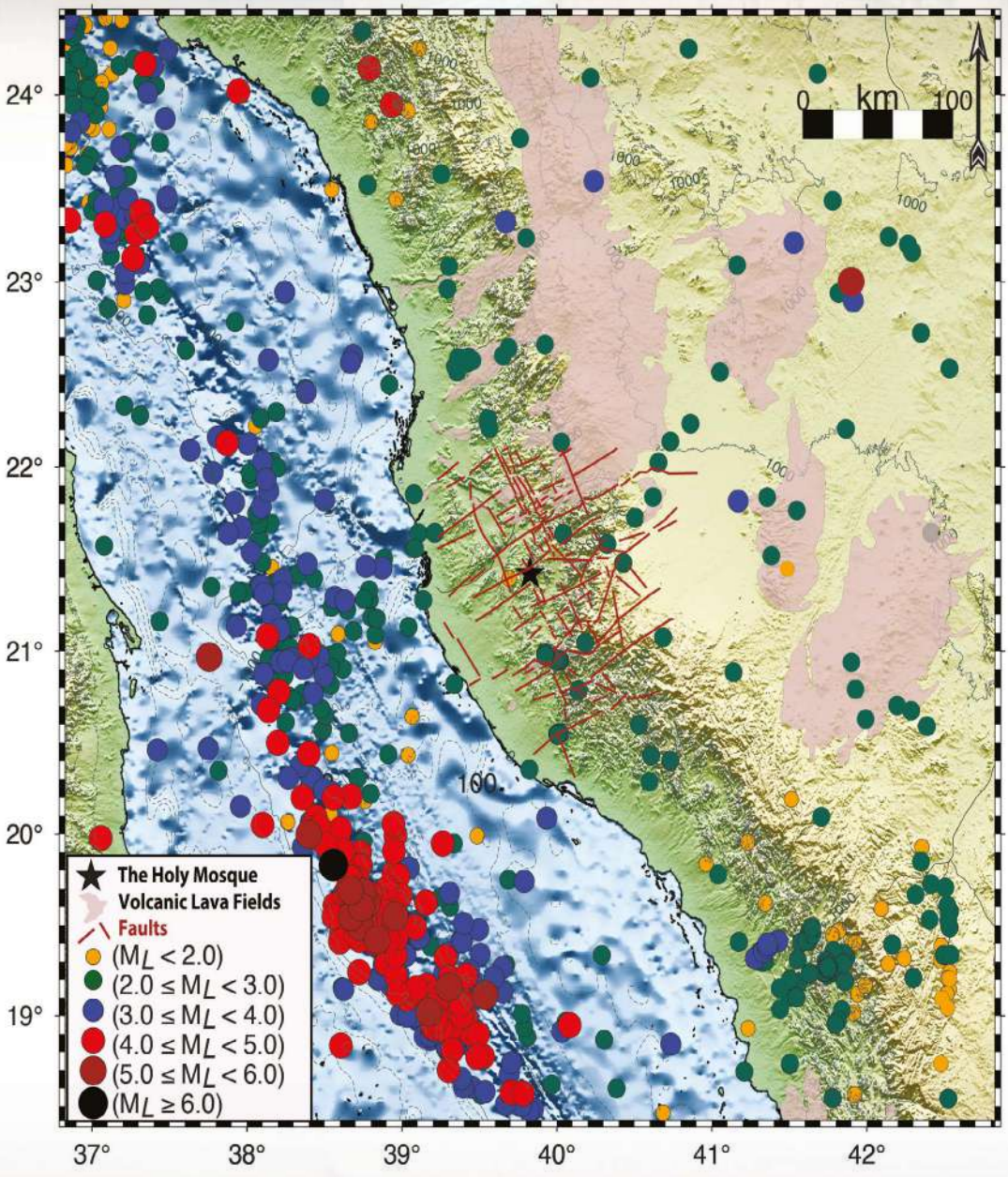
The shallow seismic events—with low b-values, indicating a high recurrence of small to moderate earthquakes—suggest a tectonic origin related to active fault systems. In regions with ongoing fault activity, such earthquakes often result from the accumulation and release of tectonic stress in the brittle upper crust.

Though some deeper events may reflect magmatic activity in the lower crust or upper mantle, current data support a primarily tectonic origin, especially associated with the Red Sea rift system.

A particularly notable sequence occurred from March 10 to May 17, 1967, along the main Red Sea fault. During this period, 68 tremors were recorded, ranging from magnitude 3.0 to 6.7, including five earthquakes above magnitude 6. The strongest, at magnitude 6.7, remains the most powerful event recorded in both historical and modern times for the region.



Depths distribution of the 1,330 seismic events recorded during the period from 1964 - 2025 CE.



A recent seismic map for the city of Makkah Al-Mukarramah and its surroundings covering the period from 1964-2025 CE, which numbered 1330 events, its destiny ranged from less than 2.0 to greater than 5.5 on the Richter scale, which gives a clear indication of the distribution and intensity of seismic activity.

Despite the strength of these earthquakes, no significant impact was recorded in the nearby cities of Makkah, Jeddah, and Ṭāʾif, located approximately 100–270 km from the epicenter.

On March 13, 1993, the Makkah region experienced a similar seismic swarm, with dozens of tremors occurring along the main Red Sea fault, approximately 133 km west of Makkah. The main event registered a magnitude of 5.8 on the Richter scale. Remarkably, neither this nor earlier seismic swarms were felt by the population, despite their relatively high magnitudes. This phenomenon is attributed to the Tertiary-period volcanic rocks along the Red Sea coast, which dampen, absorb, and obscure shear waves, effectively neutralizing their surface impact.

On Sunday, October 3, 1993, a local earthquake occurred in the Al-Sharaʿi area of Makkah, registering a magnitude of 4.1 on the Richter scale. It was widely felt in surrounding areas, including Sharāʿ al-Mujāhidīn, Sharāʿ al-Nakhl, Al-Jumūm, Lihyān, Mount al-Muʿayṣim, and Mount al-Nūr. Over the following three months, 45 aftershocks were recorded, the strongest of which reached 3.4 in magnitude.

Another significant event occurred on Saturday, June 18, 1994, in the Madrakah area, approximately 40 km north of Makkah. The epicenter was precisely determined, and the earthquake registered 4.1 on the Richter scale. Although the tremor was brief, it was accompanied by a loud booming sound. The quake's effects extended over an area of approximately 35 × 35 km², covering Madrakah, Mashā, Rahat, and the al-Barzah junction. The village of Rahat reported the strongest shaking. No casualties occurred, though rockfalls were reported from a roadside cliff about 1 km north of Madrakah.

Later, between January 5 and 10, 2019, the Valley of al-Markh area, located approximately 60 km southeast of Makkah, experienced a seismic swarm of 16 minor earthquakes, with magnitudes ranging from 0.8 to 2.2.

The study of uplifted coral reefs along the Red Sea coast is of particular geological importance. Three coral terraces have been discovered, the oldest reaching an elevation of 30 meters above sea level. A displacement of 0.5 meters was measured along a fault near Jeddah. When assessing tectonic activity and fault mechanisms in the region, it is crucial to distinguish between:

- Tectonic faults, which extend deeply, store significant stress and produce widespread displacement and seismic energy.
- Salt dome faults, which are confined to stratigraphic sections and produce localized deformation without earthquake-generating capability, yet may pose risks to structures in their vicinity.

Researcher Al-Saud (2008) presented a detailed analysis of the tectonic and seismic features of the Jeddah–Makkah region. Two key local earthquake source zones were identified:

- The Al-Damm Fault Zone, a northeast-southwest trending fault system with relatively high seismicity.
- The Nuʿmān–Makkah–Fatimah Zone, a northwest-trending region with dense faulting and moderate seismic activity, is primarily influenced by Red Sea tectonics.

Statistical seismic analyses of the Makkah region and the central Red Sea zone suggest that:

- Magnitude 7 earthquakes may recur twice every 100 years.
- Magnitude 6.5 earthquakes may recur four times per century.
- Smaller earthquakes occur more frequently, following the well-known inverse relationship between magnitude and frequency.

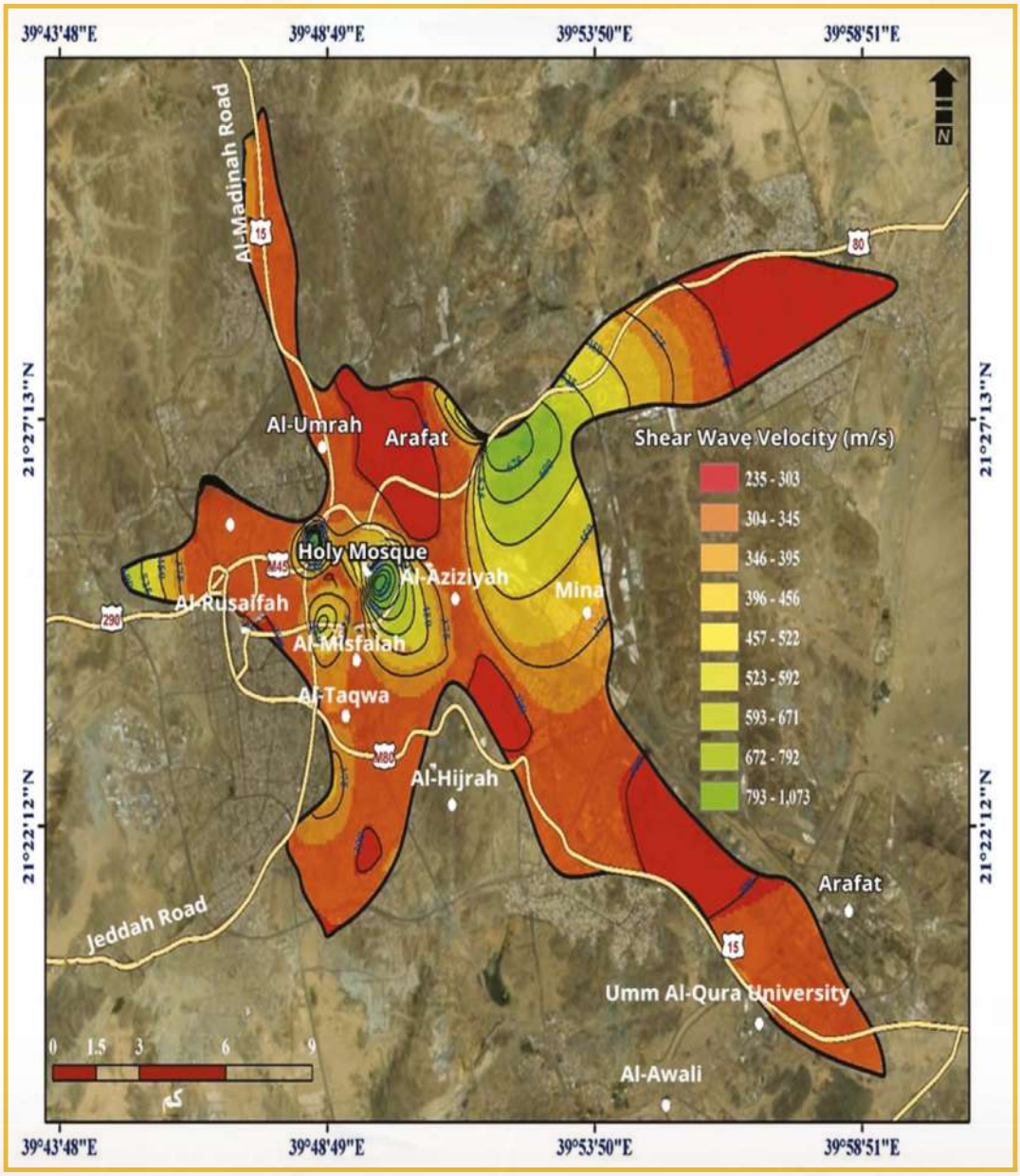
Recent seismic studies predict that the maximum expected earthquake magnitude in the region—by the will of God—will not exceed 7.0 on the Richter scale. *And God knows best.*

Seismic Hazard Assessment

Studying seismic hazards and mitigating their impacts in the Makkah region is crucial due to the area's profound religious, economic, and historical significance, as well as its high population density. Moreover, Makkah's proximity to active seismic sources, which have generated earthquakes in the past and present, underscores the need for a thorough seismic hazard assessment. This requires identifying and characterizing these seismic sources, understanding the properties and structures of the Earth's crust, and examining surface geological formations that influence seismic wave behavior, including amplification and attenuation effects.

Numerous near-surface geotechnical parameters were collected, tested, and evaluated in the city of Makkah and subsequently mapped. Soil materials vary from fine to very coarse, based on international standards, ranging from 4 to less than 50. The average shear wave velocity in the city of Makkah was measured down to a depth of 30 meters, with values ranging from 235 to 1073 m/s. The calculated rock quality designation ranged from very poor to good between 0 and 25%, indicating the presence of very poor granodiorite, while the granite rock quality varies from poor to good, with an increase in the quality index from 25 to 80% as depth increases (Abdelrahman et al., 2020).

The soils in the city of Makkah were classified into three categories: B, C, and D. Type "B" is concentrated in the western part of Makkah (e.g., Al-Nuzhah, Al-Hindawiyyah, Al-Rusaifah, and Al-Khalidiyyah), while type "C" is found in the northern, eastern, and central urban areas of the city. Shear wave velocities in category "D" soils were less than 760 m/s, whereas they exceeded 760 m/s in category "B" soils. These results are of utmost importance for seismic hazard assessment and mitigation in Makkah. Furthermore, they provide clear guidance for improving the Saudi Building Code in terms of shear wave velocity down to a depth of 30 meters (Al-Amri et al., 2022).



Shear-Wave Velocity Distribution Map in the City of Makkah to a Depth of 30 m

Seismic hazard analysis and mitigation are crucial components, particularly in regions with complex geological settings like Makkah. To achieve this, a comprehensive and meticulously documented seismic database was compiled and corrected, spanning the period from November 11, 1962, to September 7, 2024. The recorded magnitudes ranged from 0.25 to 5.2, with an average magnitude of 3.0, and depths ranged from 5 km to 50 km, with an average depth of 20.4 km. The latest computational models were utilized by integrating earthquake catalog data and fault proximity, resulting in the production of three main seismic intensity maps.

Seismic intensity maps were developed based on the following measures:

- Seismic Intensity Map based on the Modified Mercalli Intensity (**MMI**) Scale
- Seismic Intensity Map based on ground shaking intensity (ShakeMap)
- Seismic Intensity Map based on Peak Ground Acceleration (**PGA**)

The generated seismic intensity maps provide two different spatial resolutions: ±2 degrees covering an area of 222 × 222 km², and ±0.75 degrees covering an area of 83 × 83 km² around the Holy Mosque, offering a closer and more detailed view.

The area directly surrounding Makkah is included in the analysis, which incorporates not only core data from recorded seismic events but also considers the impact of fault proximity on seismic hazard, particularly where earthquake data intersects with structural fault systems. However, it is important to note that structural information from faults and fractures alone may not be sufficient or directly applicable in such calculations, as the fundamental basis for these hazard assessments is the historical seismic database, which provides direct evidence of the level of seismic activity. While this approach enhances our understanding of earthquake-related hazards, it

is equally important to acknowledge existing limitations: gaps in historical seismic records—particularly prior to the onset of modern monitoring—create a degree of uncertainty in long-term hazard estimations. Nevertheless, the advent of continuous seismic monitoring has significantly mitigated this uncertainty, ensuring that future hazard assessments are grounded in more comprehensive and reliable data.

By integrating updated earthquake catalog data, fault proximity analysis, and advanced computational models, the three generated seismic intensity maps highlight areas of varying seismic vulnerability. These maps serve as essential—yet preliminary—tools for understanding the seismic landscape and guiding future urban planning and construction practices. The maps clearly identify areas near active faults, particularly in the southern and southeastern parts of Makkah, as zones of higher seismic risk. These areas are more likely to experience moderate ground shaking, which could result in relative structural damage, especially in older or insufficiently reinforced buildings. This is evident when comparing across different result versions.

Infrastructure Risk

Moreover, these maps indicate that the infrastructure in Makkah and its surrounding areas—particularly high-rise buildings—may be vulnerable to significant risk during a major earthquake, God forbid. This underscores the importance of continuous seismic monitoring, ongoing research, and strict adherence to earthquake-resistant building codes.

Seismic hazard is also evaluated through the measurement of Peak Ground Acceleration (**PGA**), as the level of seismic risk in the region is influenced by the potential magnitude of earthquakes occurring at the intersection of

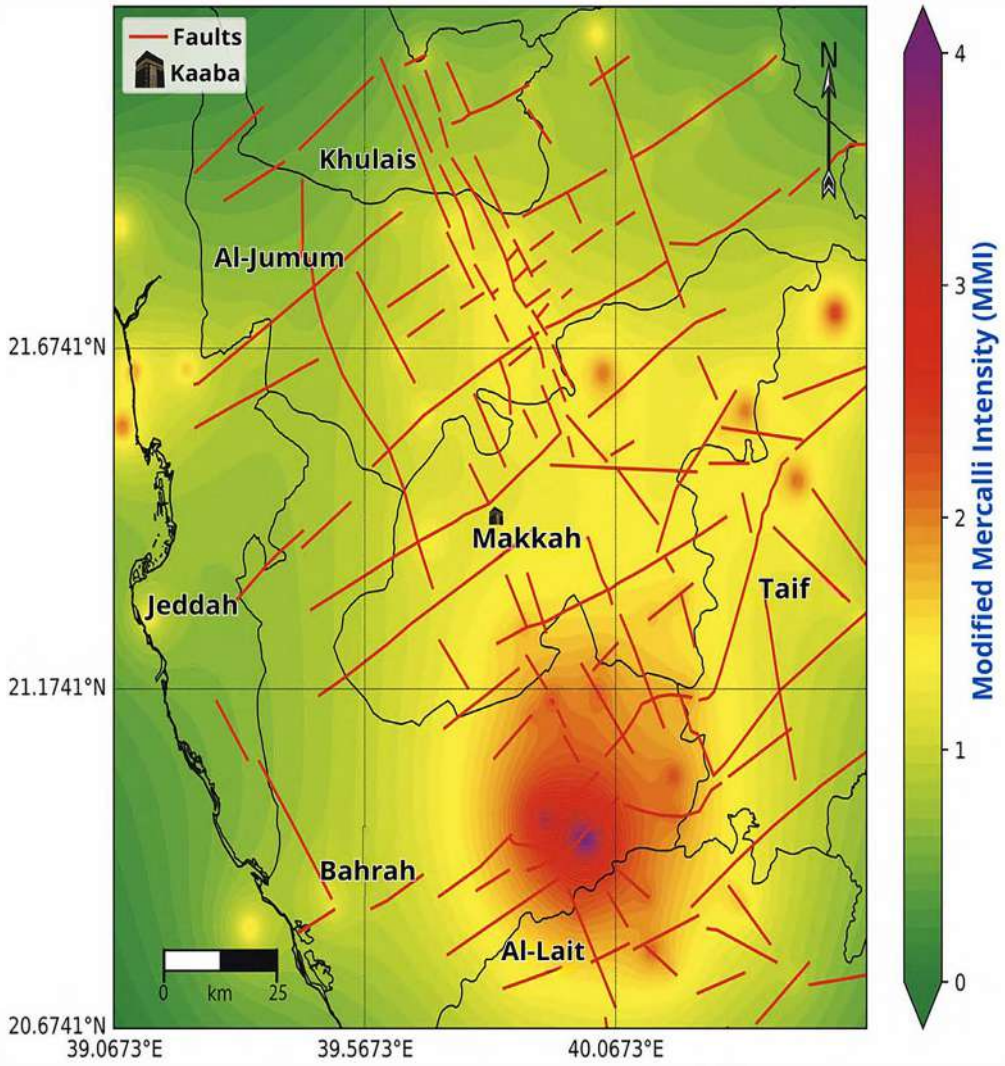
northeast–southwest-trending faults (such as the Ad-Damm Fault Zone and the shear zone in The Valley of Fatimah) and the northwest-trending faults that run parallel to the Red Sea coast. Therefore, it is crucial to produce accurate fault maps using geological, geophysical, and seismic data, and to assess whether these faults are currently active. In addition, special attention should be given to accurately estimating the maximum potential magnitude of earthquakes that could occur along an active fault. A comprehensive perspective that incorporates uncertainties in earthquake source characteristics and seismic wave propagation should be integrated into every seismic hazard assessment study.

The **PGA** map also provides a preliminary technical assessment of the strongest expected ground shaking, which may be vital for engineers and urban planners focused on designing earthquake-resistant infrastructure. Areas closest to certain fault lines exhibit higher **PGA** values, underscoring the importance of integrating and reinforcing this data into building codes and construction practices to reduce the risk of seismic damage.

It is evident from the above that the Makkah region is characterized by low to moderate seismic activity, with Spectral Acceleration (SA) ranging between 13 and 124 cm/s². Moderate seismic events that could pose a threat to the area may occur. Specifically, the **PGA** was calculated at 0.16g, indicating that buildings in this region should be designed for Zone A2 in accordance with the 1997 **UBC**.

The seismic intensity map, centered on the Holy Kaaba and constructed using the Modified Mercalli Intensity **(MMI)** scale, offers a detailed spatial representation of estimated ground motions throughout the region. This visualization illustrates the distribution of seismic intensities across Makkah and its environs, depicting the range of shaking levels perceptible during an earthquake, from light tremors to moderate ground motions. The **MMI** values delineate areas where seismic shaking is expected to produce observable impacts.

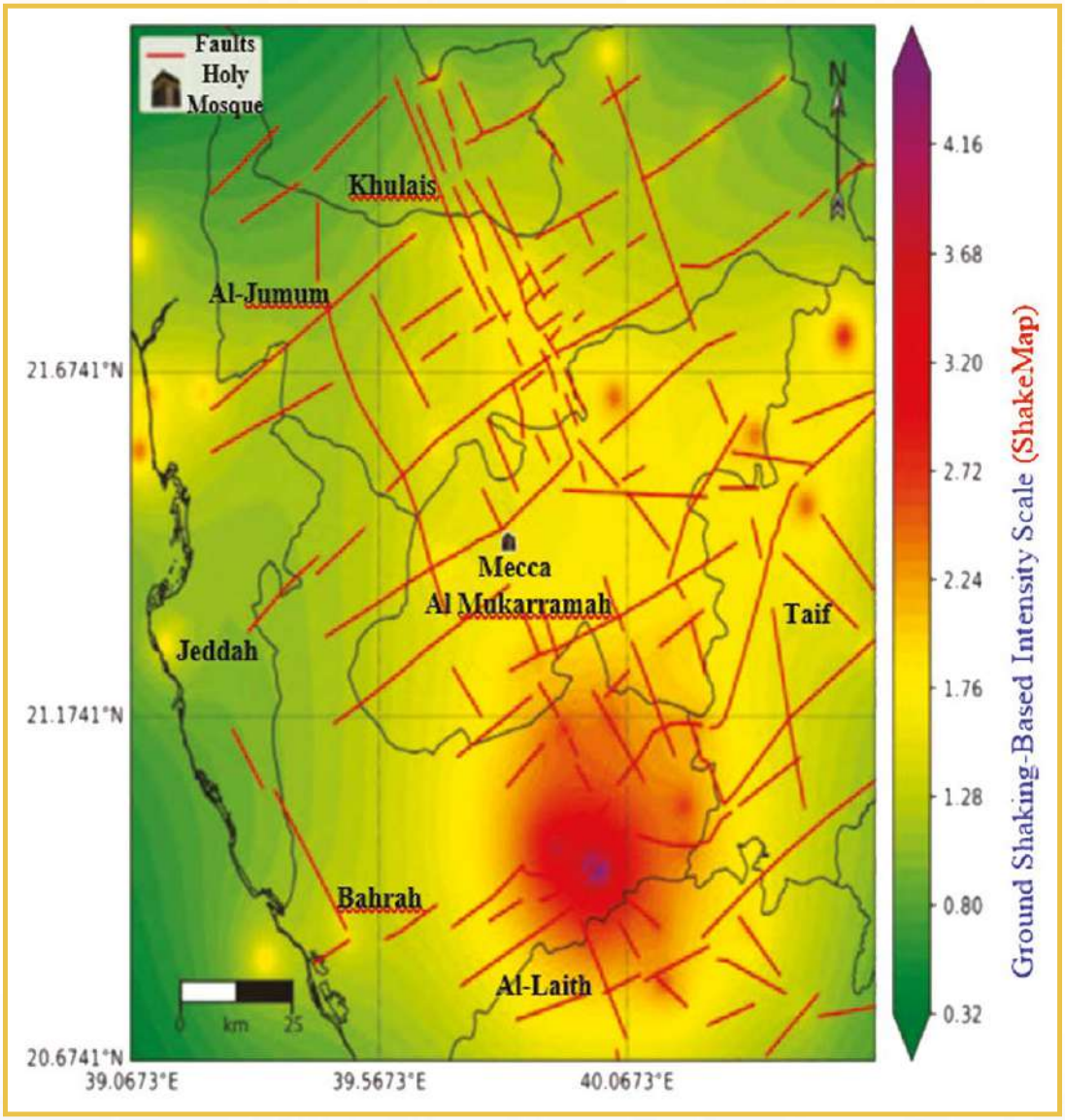
The map reveals pronounced spatial variations in intensity, with elevated **MMI** values recorded in proximity to active fault zones—particularly within the southern and southeastern sectors—represented by the warmer color spectrum (red to orange). These values indicate an increased likelihood of moderate shaking in the event of seismic activity. Furthermore, the map underscores the potential for structural damage to buildings and critical infrastructure. Zones exceeding an **MMI** value of 3.0 are identified as potential hotspots for infrastructure vulnerability, especially for older constructions or those characterized by limited structural resilience. In these areas, high-rise buildings and unreinforced masonry structures are especially susceptible to heightened seismic risk.



Seismic Intensity Map Based on the Modified Mercalli Intensity (MMI) Scale

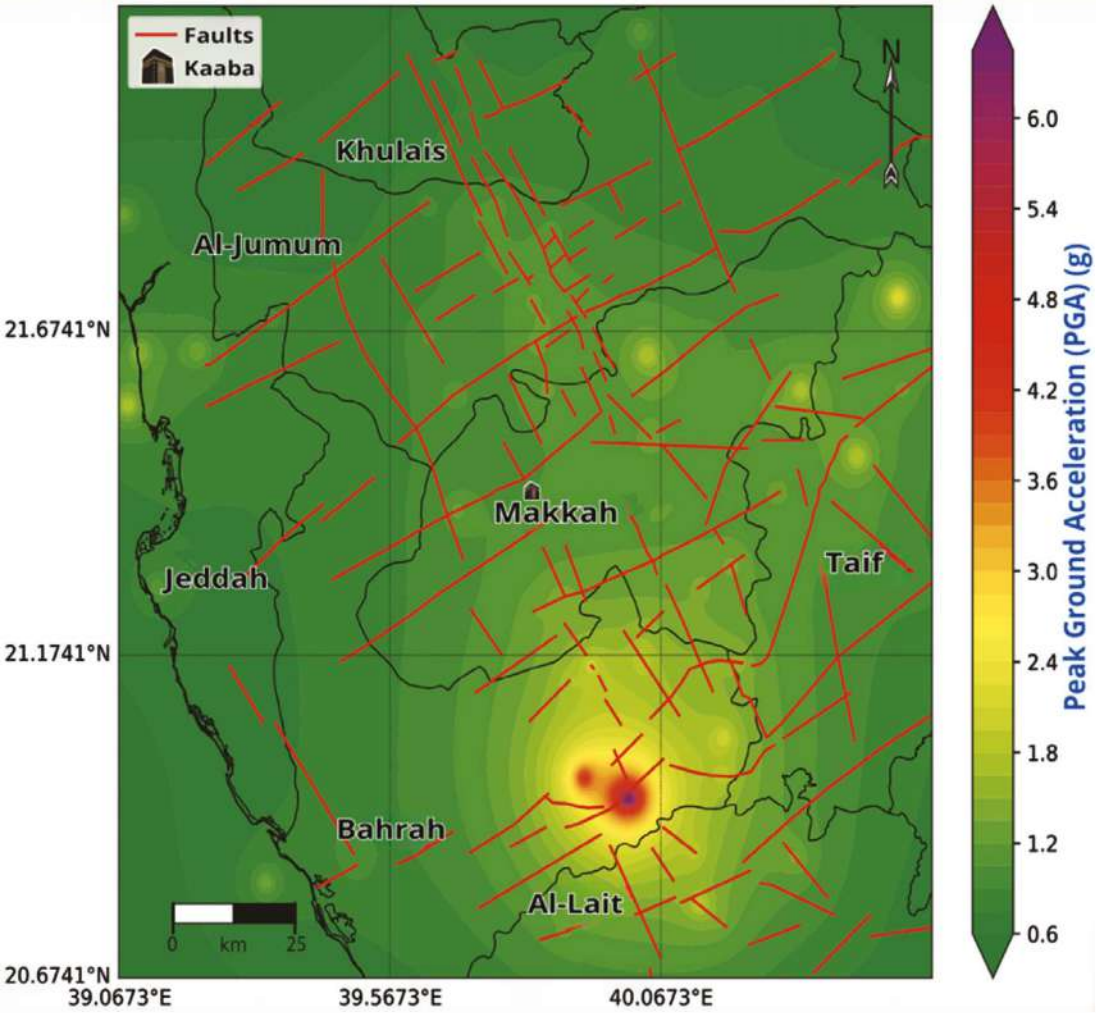
The ShakeMap Intensity Map, centered on the Holy Mosque, provides an accurate empirical measurement of ground shaking intensity. By integrating real-time seismic monitoring data alongside fault system modeling, the map is designed to reflect the potential structural damage that may occur immediately following an earthquake. It offers greater detail in areas near fault lines and captures a broader range of seismic intensity to better guide emergency response efforts and risk assessment.

The ShakeMap intensity closely mirrors and aligns with the results shown by the **MMI**. The ShakeMap intensity reflects a more precise correlation between strong shaking and proximity to active faults, particularly in the southwestern and southeastern parts of the region. Darker shades on the map indicate higher likelihoods of intense shaking, and these areas are at a greater risk of structural damage, especially to unreinforced buildings and high-rise structures. Zones with higher intensity—marked in dark orange to red—represent locations where buildings are more likely to sustain damage. The closer a structure is to an active fault, the more likely it is to experience strong ground motion. Even high-rise buildings designed for seismic resistance may still be vulnerable to long-period seismic waves, particularly in the areas highlighted in dark orange to red on the map.



Ground Shaking-Based Intensity Scale (ShakeMap)

This map illustrates the Peak Ground Acceleration (**PGA**) centered on the Holy Mosque, updated with higher resolution and expanded datasets. It provides a vital tool for understanding the maximum expected ground shaking during seismic events. **PGA**, a direct measure of the strongest ground motion during an earthquake—expressed as a fraction of gravity (g)—is critically important for engineering purposes, particularly in designing earthquake-resistant structures. The map integrates recent seismic data, with a special emphasis on how proximity to fault lines influences ground acceleration dynamics. While the **PGA** map may be less intuitive for non-specialists compared to the **MMI** and ShakeMap, it offers essential insights into the maximum expected shaking across the region. Higher **PGA** values correspond to stronger, more destructive ground motion. The map clearly shows elevated acceleration levels near some, though not all, fault lines—reflecting the absence of long-term seismic records in certain areas. These zones indicate where stronger ground shaking may be expected in the event of an earthquake. Engineers and urban planners can use this data to prioritize seismic-resilient design, particularly in areas with high **PGA** values near active faults.



Seismic Intensity Map Based on Peak Ground Acceleration (PGA)

Volcanic Activity in the Makkah Region

Volcanic fields occupy extensive areas of the Makkah region, represented by several lava fields (ḥarāt), including:

- The southern third of Ḥarrat Rahāṭ
- Most of Ḥarrat Kishb
- Ḥarrat Ḥaḍan
- Major portions of Ḥarrat al-Baqūm and al-Nawāsif

These lava fields range in age from the Tertiary to Quaternary periods, aligning with the two rifting phases of the Red Sea. The volcanic flows are composed primarily of:

- Alkaline and transitional olivine basalt
- Hawaiite
- Basanite

These are often topped by numerous volcanic cones and ash fields, imparting a distinct dark coloration to the terrain.

Ḥarrat Rahāṭ Lava Field

Located between Al-Madīnah and Makkah, Ḥarrat Rahāṭ is the largest lava field in Saudi Arabia, covering an area of approximately 20,000 km². The lava flows emerged through northward-trending fissures, forming part of the Makkah–Madīnah volcanic alignment. The central volcanoes developed along this axis, dominating the surface features. Some cones, however, have deviated north-northwest from the main axis.

The southern sector of Ḥarrat Rahāṭ contains approximately 14 shield volcanoes, alongside remnants of volcanic cone slag, most of which have eroded due to prolonged exposure. The craters of the shield volcanoes—more resistant than the cone slag—have also eroded.

The field hosts more than 700 volcanic craters, including Mount Munawwar, which rises to 1,783 meters. The last recorded eruption in this field occurred in 1256 AD (654 AH) near Al-Madīnah.

Ḥarrat Kishb Lava Field

Situated northeast of Makkah, near al-Khurmah Governorate and east of Ḥarrat Rahāṭ, Ḥarrat Kishb is lower in elevation, with margins not exceeding 1,000 meters above sea level. However, the central area rises to 1,120 meters, and volcanic cones such as Mount Hil reach up to 1,475 meters—the highest point in the field.

This lava field contains over 188 volcanic cones, though many are heavily eroded. The terrain is rugged, blanketed in basaltic flows. It spans about 6,000 km², stretching 110 km in length and up to 70 km in width. The volcanic activity dates from 2.5 million years ago to the present.

The field showcases diverse volcanic landforms, including:

- **Volcanic domes**
- **Scoria cones**
- **Shield volcanoes**
- **Sabkhat al-Ashʿariyyah**
- Al-Wahbah Crater (Maqlaʿ Tamiyyah): The deepest volcanic crater in Saudi Arabia, at 220 meters deep and 2 km wide, making it the largest of its kind in the Middle East. It was formed by a phreatomagmatic

explosion, where groundwater interacted violently with rising magma.

Among the younger volcanic remnants:

- Mount Hil and Mount ʿAsalj, with Stone Age and historic-period lava flows, are prominently visible.
- Mount Shalman Dome, in the south-central field, is the youngest volcanic dome.
- In contrast, Mount Abū Ḥārith Dome is among the most eroded features in the field.

Hadhan Lava Field

Located east of the city of Taif, the Hadhan Lava Field lies between the Nawasif Lava Field (Al-Baqum) to the south, the Kishb Lava Field to the north, and the Rahat Lava Field to the northwest. It covers an area of approximately 3,700 square kilometers and is considered one of the oldest lava fields in the region, with an estimated geological age of over 16 million years.

Although the Hadhan Lava Field is smaller in area and extent than the Kishb Lava Field, its basaltic layer can reach a thickness of up to 150 meters. However, the surface elevation does not rise significantly above the surrounding terrain. Due to its considerable age, erosion has obliterated most of its volcanic cones. Remnants of these cones are visible along the western, southern, and northern edges of the lava field, where they appear as small isolated hills rising above the general surface. These remnants mark the original sites of the volcanic cones from which the lava field once erupted.

Al-Nawasif Lava Field (Al-Baqum)

Located in the central part of the Arabian Shield within the Makkah Region, the Al-Nawasif Lava Field (also known as Al-Baqum) sits atop Precambrian rocks of the Hijaz Mountains and the Najd Plateau. It spans an area of approximately 10,800 square kilometers, with a maximum width of about 100 km. This volcanic field is one of the oldest in the region, with a geological age estimated at more than 16 million years. Due to its age, weathering and erosion have significantly altered its volcanic cones, which number around 350 small cones. The lava field also contains volcanic fissures through which most of the lava and magma once flowed, in addition to the presence of shield volcanoes.

Located directly south of the Hadhan Lava Field, the Al-Nawasif Lava Field extends from the northeast to the southwest and covers a larger area than Hadhan. Although some of the lava flows and volcanic ejecta in the region date back to the Neolithic period, the surface of the volcanic field is largely flat, except for a few more recent volcanic cones.

The lava field is notable for two prominent basaltic tongues: one extending about 40 km toward the city and valley of Ranyah, and the other stretching approximately 65 km toward the Valley of Turabah. Several volcanic cone slags are found in the central part of the lava field, along with tuff and maar rings aligned with the general direction of the field's extension (ksaency.com).

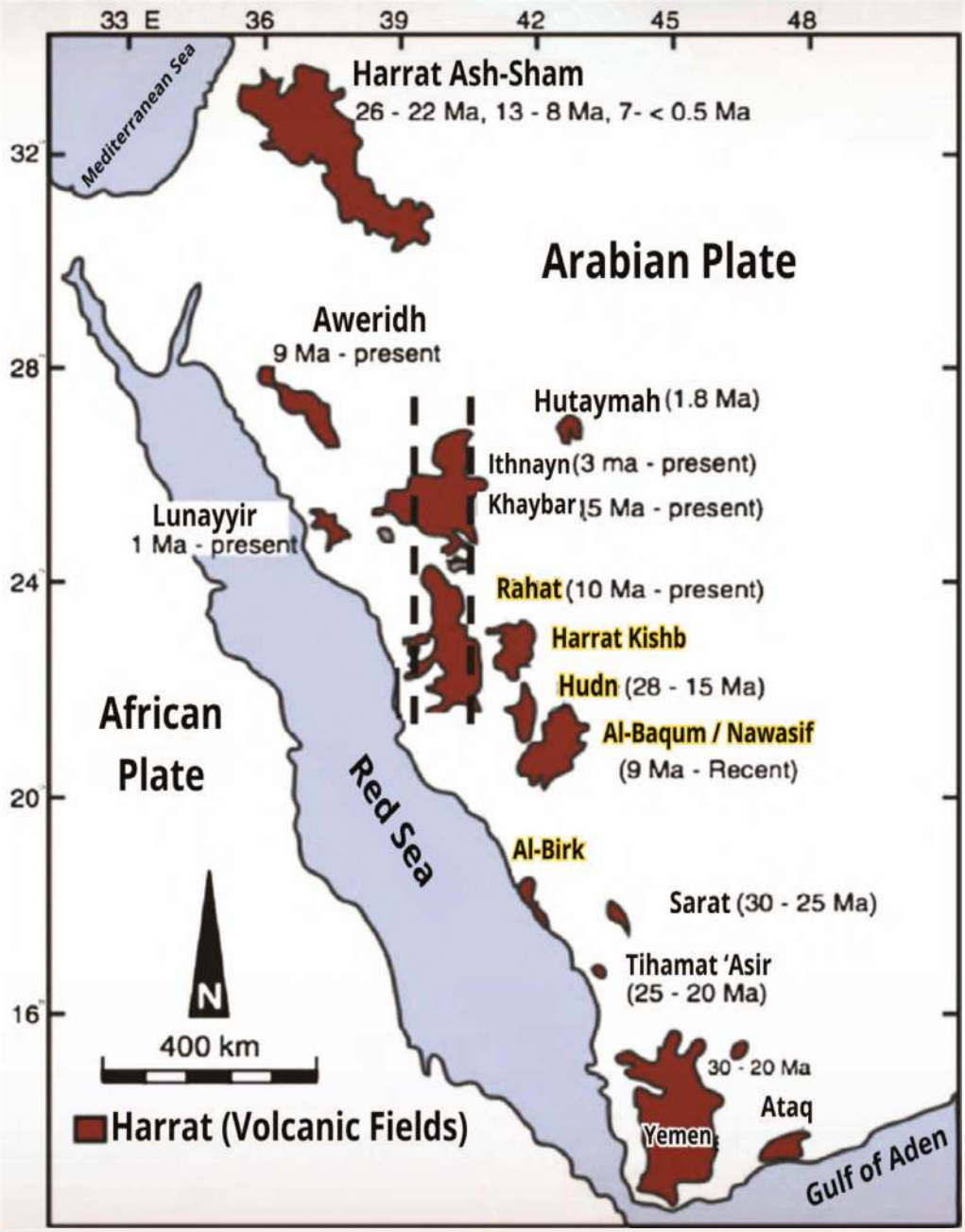
In addition to the aforementioned lava fields, there are several smaller lava fields located south of the city of Jeddah, the most notable of which are the Idam Lava Field and the Shama Lava Field (Tufail). Both fields flowed toward the coastal Tihama plain and rose approximately 110 meters above the coastal plain's surface.

A table shows major Volcanic Harrats of Makkah Region

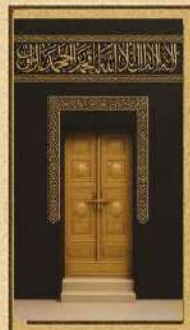
Harrat (Lava Field)	Area (km²)	Dominant Rock Type	Estimated Age
Harrat Rahat	**~20,000**	Basaltic lava (alkali olivine basalt)	Pleistocene–Holocene
Harrat Kishb	**~6,000**	Basaltic lava, cinder cones	0.5–2 million years
Harrat Nawasif–Al-Buqum	**~3,500**	Basaltic lava	~5 million years
Harrat Hadan	**~900**	Basaltic lava flows	Quaternary
Harrat al-Birkah	**~1,200**	Alkali basalt	Quaternary
Harrat al-Sharqiyah (Eastern Harrat)	**~1,000**	Vesicular basalt	Quaternary

A table indicates hazards associated with Makkah's Volcanic Fields

Harrat	Primary Volcanic Hazards	Secondary Hazards	Historical/Modeled Risk to Makkah
Rahat	Lava flows, fire fountains, ash fall (if explosive)	Ground fissures, volcanic gases	Moderate risk; closest historic eruption in 1256 CE (north of Makkah)
Kishb	Maar explosions, ash plumes	Base surges	Low–moderate; maar hazards significant but distant
Nawasif–Buqum	Lava flows	Structural damage to wadis, floods	Low risk; direction of flows away from Makkah
Hadan	Basaltic fissure eruptions	Ground cracks	Potential influence on eastern wadis draining toward Makkah
Eastern Harrat	Cinder cone eruptions	Gases, minor ash	Localized hazards; low risk



Map Showing the Locations of Volcanic Fields (Ḥarrāt) in the Makkah Region (Kishb, Hadan, and Nawasif), Corresponding to the Two Stages of Red Sea Rifting.

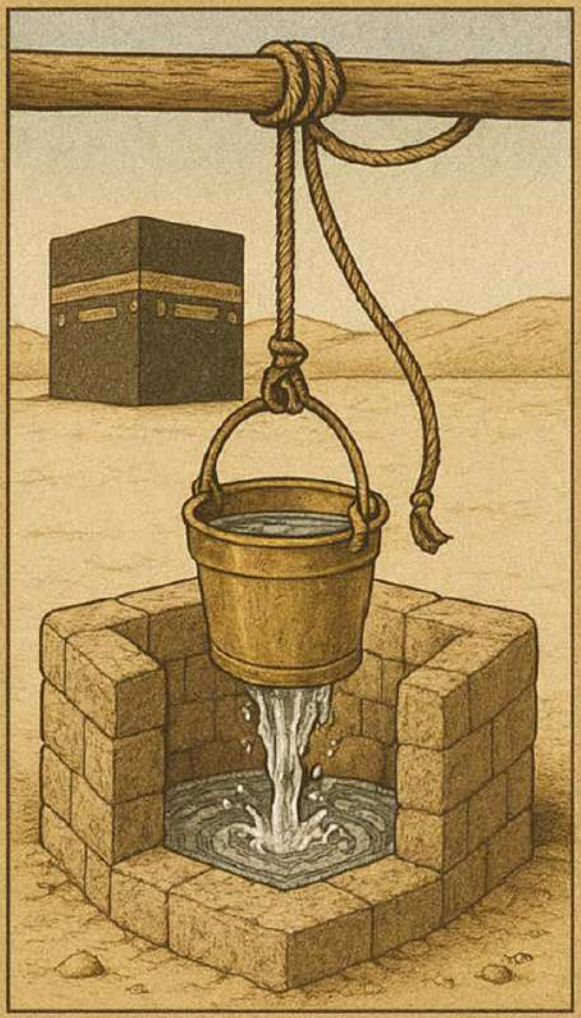


Chapter Five

The Secrets of ZamZam Miracle

Between Inexhaustible Water Sources and Unchanging Properties

Secrets behind the Miracle of ZamZam



Geometry behind ZamZam Well

ZamZam Well Surface Water Sources

ZamZam Well Groundwater Sources

Tributaries Feeding ZamZam Well

Physical and Chemical Properties

Radiative and Optical Properties

Bacterial Properties

Introduction

ZamZam water is one of the most remarkable and uncommon water resources in the world. It combines a unique scientific composition with deep religious roots, tying it to the Islamic faith and the sanctity of the Holy Mosque in Makkah. Since it gushed forth beneath the feet of Prophet Ismail **(PBUH),** this blessed water has continued to flow uninterrupted for over five thousand years in a clear defiance of the laws of nature and hydrology. It has long fascinated scientists and specialists in the fields of geology, chemistry, medicine, and hydrology.

In this chapter, we delve into the depths of the miracle of **ZamZam**, an inexhaustible source and enduring mystery. We explore the origins of this blessed water, both from the earth and the sky, and reflect on the consistency of its properties across time, as attested by the latest scientific studies and spiritual facts. **ZamZam** is not merely a traditional well, but a fully integrated water system that remarkably balances stable water levels, chemical purity, and continuous replenishment, despite being consumed by millions of pilgrims and visitors continuously throughout the year. This miracle becomes even more evident when we consider that, throughout its long history, the **ZamZam** well has never recorded a single case of environmental or microbial contamination. Its taste, color, and characteristics have remained unchanged, even after transport and storage. Such resilience reflects an intricate natural system not subject to coincidence, but rather a manifestation of extraordinary divine care.

The **ZamZam** well is located approximately 21.5 meters from the Holy Kaaba, in one of the lowest points inside the Grand Mosque in Makkah. It penetrates two distinct geological layers: the first consists of loose alluvial

sediments, and the second is made up of fractured igneous rocks. **ZamZam** receives water from two primary sources: the first is rainfall and floods captured from nearby mountains, which infiltrate through valleys and fractures. The second source is a deep aquifer that constantly supplies water to the well via a natural network of faults and permeable layers. This system helps maintain a steady water level and preserve its properties year-round, eliminating the need for artificial support or external treatment.

Recent studies have revealed a distinctive composition of **ZamZam** water, which contains minerals and natural elements at concentrations higher than those found in ordinary water, such as calcium, magnesium, bicarbonates, and fluoride, all within internationally recognized safe limits. This unique composition gives the water a distinct taste and a specific chemical signature unlike any other. Those who have tasted **ZamZam** water often describe it as "water unlike any other."

ZamZam water also exhibits relative thermal stability, transparency, and the absence of any color or odor, reflecting an exceptional level of purity. Remarkably, despite undergoing no chemical treatment, **ZamZam** water is completely free from bacteria, algae, and microorganisms, indicating its unique biological properties. Furthermore, radiological tests using advanced techniques have shown that **ZamZam** water contains no harmful radioactive activity, with its natural radiation levels falling well within safe limits.

This chapter tackles the main properties of **ZamZam** water, beginning with its taste and chemical composition, moving through its physical characteristics such as density, electrical conductivity, and transparency, and detailing biological and radiological analyses. This chapter also discusses the findings related to the optical properties of this water, including light refraction and spectral transparency, supported by the latest laboratory measurements. It further includes scientific comparisons between **ZamZam** water and various

types of groundwater and bottled water from around the world, highlighting the unique aspects of this sacred resource. Illustrative tables and graphical representations are provided to support and clarify the data.

This chapter aims to bridge scientific knowledge with profound faith, while explaining water in terms of composition and properties, yet remaining open to a deeper question: How does this spring continue to flow without running dry, and without losing any of its properties? It is water not merely meant to be drunk, but to be contemplated and interpreted as an evident manifestation of divine greatness, in which a secret was placed that still defies the tools of science and continues to inspire hearts.

The Secrets behind the Miracle of ZamZam Water

From a barren highland, in an untilled valley, burst forth the miraculous imperishable divine water that is **ZamZam**. It was a testimony to Allah's boundless might and to His ever-watchful care over His prophets and subjects. This miracle was not merely the gushing of water, but the answer to a prayer, an honoring of a prophet's mother, and a mercy to a helpless infant. From that moment to this very day, **ZamZam** water continues to flow, defying all natural and geological norms, preserved in its purity, unique in its properties, and surrounded by an aura of sanctity and miraculousness. What is astonishing about **ZamZam** is not just its components, but its story, its continuity, and its spiritual and physical impact on those who drink from it. It is the only water in the world that is consumed with intention, through which prayers are answered, healing is sought, and for which people travel from all corners of the earth. With the advancement of science, along with the analysis of the components of this blessed water, scientific findings have confirmed its unique chemical and physical properties compared to other types of water. This has prompted many scientists to study its properties with both astonishment and admiration. So, are we merely looking at blessed water? Or is this a natural phenomenon that continues to defy science and its instruments? Or are we, rather, witnessing a renewed divine miracle, one that speaks, through water, of the Creator's wisdom and His care for His creation? Below are the most notable miracles of this water:

- The Prophet of Allah **(PBUH)** said: "The best water on the face of the earth is **ZamZam** water. In it is nourishment in place of food and healing from illness." Some of the Companions lived on it for many days without the need for food. **ZamZam** water is regarded as pure and blessed, incomparable to any other water. Pilgrims and performers of Umrah are keen to drink from **ZamZam** water, bathe with it, and take some of it with them when they depart.

- Any water that flows into this spring takes on the purity and clarity of **ZamZam**. **ZamZam** is a spring that will continue to flow without end until the Day of Judgment. Even if all other wells dry up before that day, **ZamZam** water shall remain inexhaustible.

- Its source is a relatively small well (about 30 meters deep), yet it produces enormous quantities of water daily, without interruption. This in itself is one of the most astonishing features ever observed in natural water sources. It has been overflowing for thousands of years without drying or decreasing; whatever volume is drawn from it is constantly replenished by flowing water, as if it were waves of the sea.

- Scientifically, **ZamZam** is classified as alkaline water based on the acidity scale, or what is known as the potential of hydrogen scale (pH). Its alkalinity is attributed to the geological nature of the granodiorite and diorite rocks through which it flows. The water's alkalinity is also associated with its relatively low Total Dissolved Solids (TDS) index, which measures the amount of organic and inorganic substances dissolved in water.

- **ZamZam** is also notable for its significant mineral content (particularly potassium, calcium, magnesium, and zinc), which gives it unique nutritional value due to the importance of these elements for vital functions of the central nervous system, muscles, and the body's fluid balance. This may scientifically explain its nutritional value as described in the hadith: "nourishment in place of food". Though **ZamZam** does not contain any calories, it nonetheless contributes to maintaining the body's balance through the aforementioned nutrients.

- It has been scientifically proven that **ZamZam** water differs from all other types of water in the world. **ZamZam** water possesses divine properties granted by Allah, setting it apart from all other types of water.

These properties remain unknown, despite complete knowledge of its components. **ZamZam** water possesses unique characteristics found in its electrical conductivity, levels of dissolved oxygen, concentration of nitrate, and pH level.

- In any other yielding well around the world, algae growth eventually develops, making the water unpleasant and causing issues with taste and odor. Yet **ZamZam** well has functioned for over fourteen centuries without any biological growth, i.e., without any algae or microbial contamination. To this day, **ZamZam** water continues to be consumed without any form of treatment due to the presence of fluoride compounds in the water, which eliminate all types of biological organisms.

- One of the most astonishing qualities of **ZamZam** water is that it tastes sweet despite its high total salinity. Those who drink it do not perceive the saltiness, although if the same mineral concentration were present in any other water, it would be undrinkable! This is one of the mysteries of **ZamZam**, and may be the very reason why this water refreshes exhausted pilgrims.

- There is no water on the face of the earth purer than **ZamZam** water. For the frightened, **ZamZam** is a source of safety, for as the saying goes, "**ZamZam** water is for whatever it is drunk for," offering healing to the sick and nourishment to the hungry. **ZamZam** contains 366 mg/L of bicarbonates, making it the best water on earth, even surpassing the waters of the French Alps, which contain 357 mg/L.

- The spring of **ZamZam** was brought forth by the angel Gabriel. Though Allah, the Almighty, is fully capable of causing **ZamZam** water to gush forth without the need for Gabriel, He chose such means as an honor and a blessing for the water, and to magnify its status. He also chose Makkah, a barren, lifeless valley, for this miracle to unfold, as a sign of

His immense power, and to make it a source of water for the pilgrims to His sacred House and for all of humanity.

- The gushing forth of **ZamZam** is a miracle in itself, for it appeared in a dry, barren land after Prophet Ibrahim left behind his wife Hagar and their infant son Ismail there. When their provisions ran out, Hagar desperately searched for water, running between Safa and Marwa. Then the angel Gabriel struck the earth, and from it sprang this blessed source.

- Research indicates that **ZamZam** water increases energy levels and strengthens the body's cellular systems. Its bio-energetic power has been measured at 200 units, surpassing all other substances on Earth, whose energy does not exceed 130 units. Furthermore, the electromagnetic energy in **ZamZam** water is twice that of ordinary water.

- The four toxins arsenic, lead, cadmium, and selenium are present in **ZamZam** water at levels well below harmful thresholds for human consumption. Moreover, ultraviolet analysis has shown that **ZamZam** water is free of germs. The selenium found in **ZamZam** is particularly important, as it is a mineral that boosts the immune system due to its antioxidant properties.

- It is also worth noting that during exposure to extreme heat, the body loses both sodium and potassium through increased sweating. This explains why the sodium level in **ZamZam** water is higher than the commonly allowed limit, reaching up to 60 mg/L, to help compensate for such loss.

- Over the centuries, there have been numerous attempts to find similar water sources in the hills of Safa and Marwa, but all have failed. For example, the Dawudiyyah well, located in the southern part of the Grand Mosque and only about 130 meters from **ZamZam**, is known for its extremely salty taste and poor water quality.

- **ZamZam** water is renowned for its remarkable stability in physical and chemical properties over thousands of years. Its taste, smell, and color have remained unchanged, setting it apart from other natural waters. The water contains a balanced proportion of minerals and elements, including calcium, magnesium, fluoride, and sodium, which contribute to its therapeutic properties. These properties make it beneficial for alleviating fatigue, digestive disorders, and some chronic illnesses.

- Laboratory experiments have confirmed that **ZamZam** water has antibacterial properties and can accelerate wound healing. Some studies have also suggested a positive effect in certain cancer cases, although these findings still require further scientific validation.

The Geometry behind ZamZam Well

The **ZamZam** well is located at the lowest point of the valley of Makkah, specifically in the area known as "Al-Batha", which is also referred to in some sources as "Al-Jawf" (the Low-Lying Area) or "Batn Makkah) (the Belly of Makkah), due to its low-lying topography resembling a natural basin. This geographical depression has, throughout history, made the well vulnerable to flooding, especially during seasons of heavy rain, when water would reach the door of the Kaaba or even rise above it at times. The effects of this topography remain visible today, as the Holy Mosque is surrounded by two low areas from the north and south, which converge behind the Mosque. This causes rainwater to flow downhill toward the Al-Misfalah area, where the **ZamZam** well is located, making it prone to water accumulation.

The well is situated within the Mataf (the area where pilgrims circumambulate the Kaaba) of the Grand Mosque, approximately 22 meters east of the Kaaba. It is about 18 meters away from Maqam Ibrahim (the Station of Ibrahim), lies parallel to the Multazam area, and is adjacent to Bab (Door of) Bani Shaybah, one of the historical gates of the Sacred Mosque. The elevation of the well's location is about 286.4 meters above sea level.

Historical sources have provided detailed descriptions of the **ZamZam** well. Al-Azraqi, writing in the 3rd century AH, recorded that the depth of the well from top to bottom was sixty cubits. At its base, there were three water springs: one facing the Black Stone, another facing Mount Abu Qubais and Safa, and a third facing Mount Marwah. (*Al-Azraqi, 1969*)

The **ZamZam** well is considered one of the oldest known manually-dug wells. It has a total depth of approximately 30.5 meters, with a diameter ranging between 1.08 and 2.66 meters, giving it an irregular shape. The water surface is approximately 4 meters below the top opening of the well. The

upper part of the well, down to a depth of 13.5 meters, consists of Quaternary alluvial silt and sand deposits from the Valley of Ibrahim. This section has been lined with stones to prevent horizontal seepage of groundwater at that level. The lower section, extending to a depth of 17 meters, is carved into hard diorite and granodiorite rock. Between these two layers is a highly permeable transitional zone about 0.5 meters thick, composed of weathered and transversely fractured rock. This zone is considered the main source of groundwater feeding the well.

The structural design of the well displays meticulous engineering gradation. The alluvial section is stone-lined, except for the top meter, which is reinforced with a concrete ring. The weathered rock section at the bottom is also stone-lined. This part serves as the primary entry point for water into the well, due to its intersection with a network of subsurface cracks and channels.

The **ZamZam** well is distinguished by its unique geometric form, which is shaped like a truncated cone, unlike the typical cylindrical shape of most wells. This formation plays an important role in precise hydrological modeling, as it helps determine flow characteristics and calculate recharge and discharge rates.

Pumping tests have shown that the **ZamZam** well can discharge between 11 and 18.5 liters per second, equivalent to approximately 660 liters per minute or nearly 40,000 liters per hour, demonstrating the abundance of its water and the continuity of its flow, despite high consumption levels.

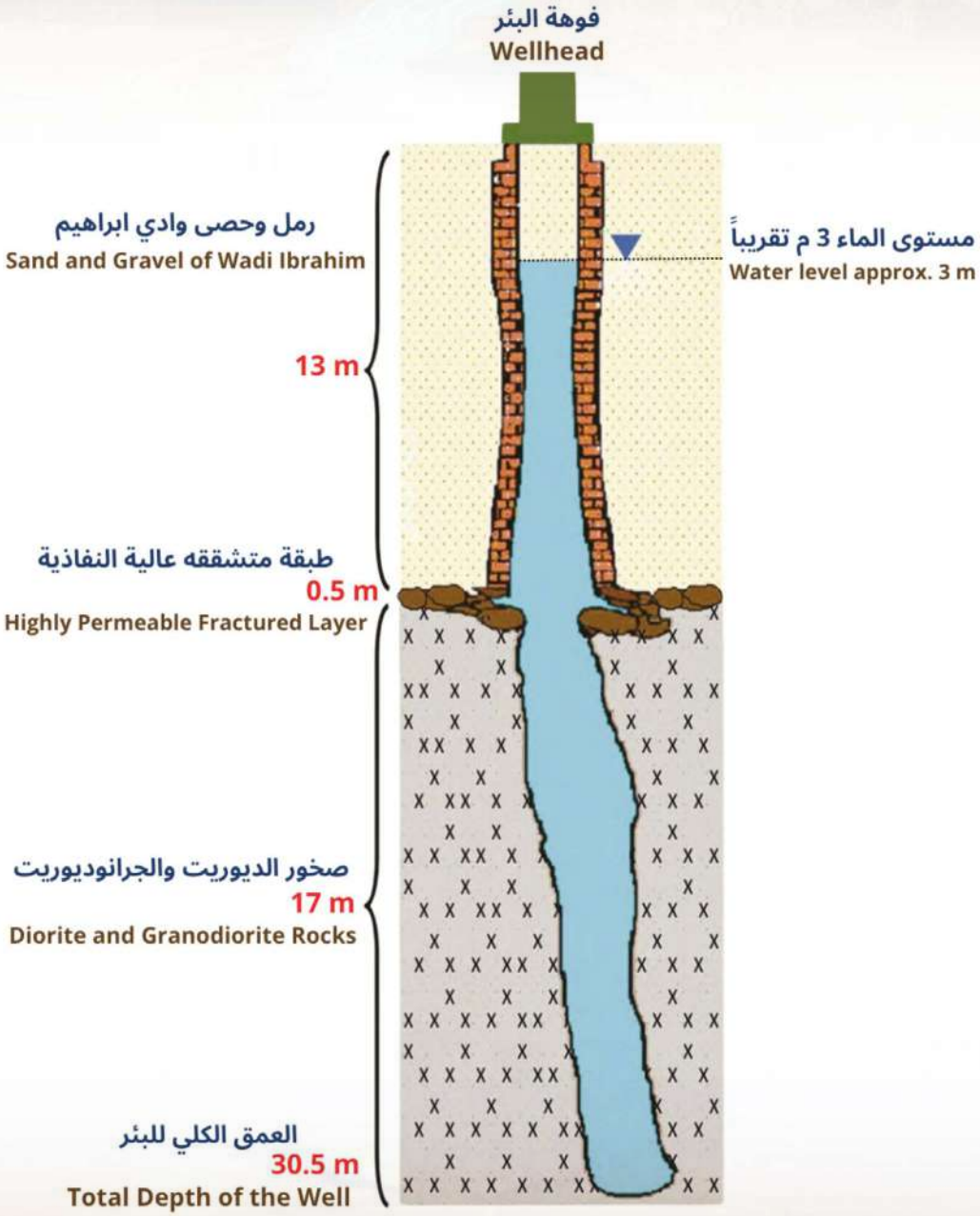
ZamZam well is fed from three main directions: the northwest, the east, and the south, which gives it distinctive hydrological properties. The water source originates from underground accumulations in surface deposits, as well as from the surrounding rock fractures and fissures across different geological layers.

Scientific opinions have varied regarding the nature of **ZamZam**'s water recharge. In 1980, the Hajj Research Center proposed that water reaches the well through horizontally extending fractures within the rock layer, suggesting the possibility of distant recharge sources. However, this view was contradicted by the findings of Sin (2008), whose study indicated that the fractures play only a limited role in water transmission and are not the main source of recharge. He instead concluded that the primary source is the local groundwater stored in the nearby alluvial deposits surrounding the well.

These findings were supported by the results of the Water Resources Studies Center (RSMC) in 1986, which confirmed that Ibrahim Valley constitutes the main geographical and hydrological source feeding the **ZamZam** well, due to its proximity and direct connection to the surrounding groundwater basin.

Historically, the methods used to extract water from the well have evolved over the ages. In earlier times, the water was drawn manually using ropes and buckets. With the advent of the modern era, these methods were replaced by advanced electric pumps, ensuring continuous and efficient water delivery to pilgrims and visitors.

During the reign of the Abbasid Caliph Al-Muatasim Billah, specifically between the years 223 and 224 AH (838–839 CE), the Hijaz region experienced a severe drought, which caused a significant drop in the water level of the well to the point where it nearly dried up. This exceptional situation was used as an opportunity to deepen the well by nine cubits (approximately 5.06 meters), in addition to expanding and reinforcing its structure. These engineering interventions helped restore the water level to normal, and by the year 225 AH (840 CE), the water began flowing abundantly once again.



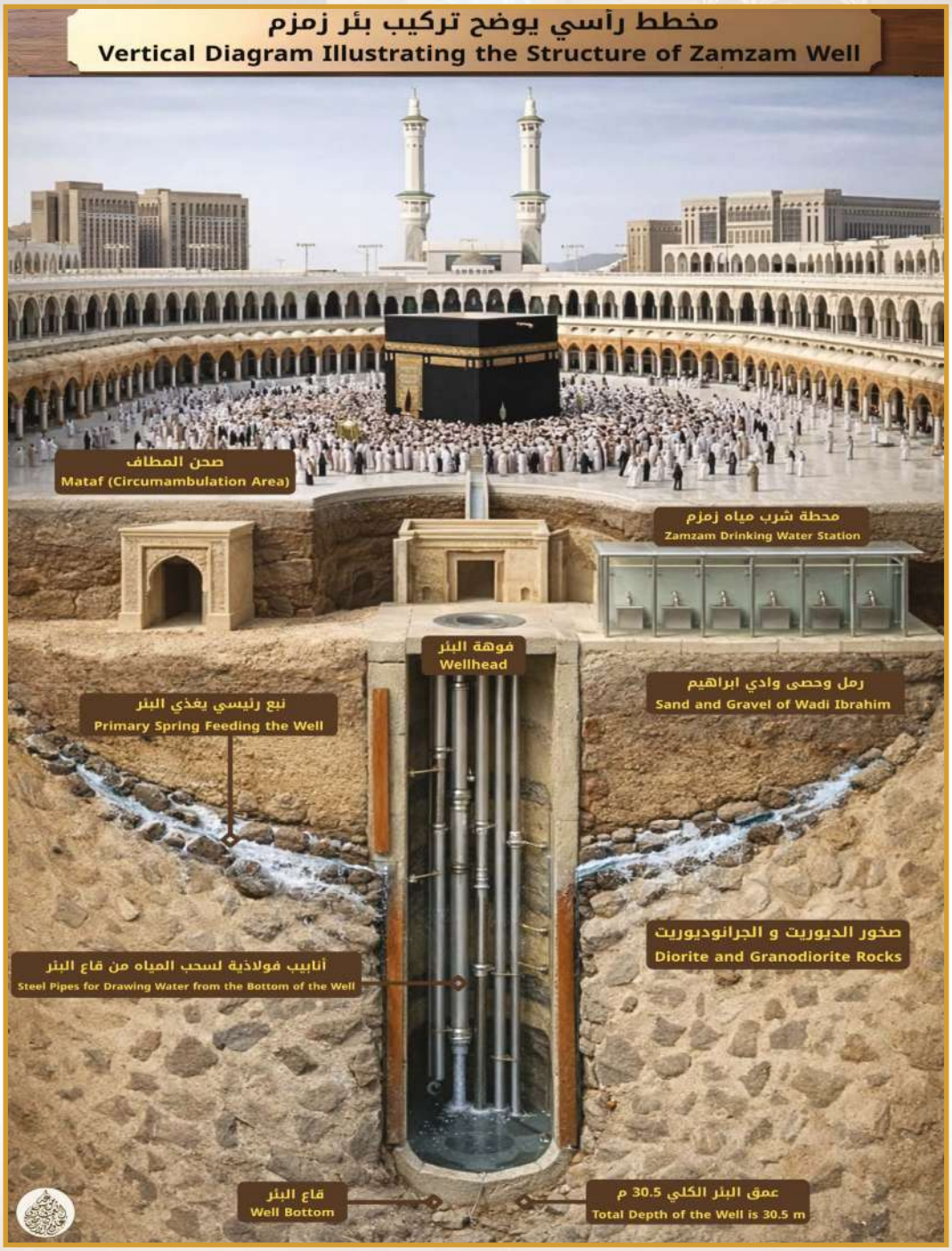
Geometric Configuration and Lithological Composition of the ZamZam Well to a Depth of 30.5 m

Generally speaking, **ZamZam** Well is one of the most significant water sources in the world, not only for its religious importance but also for its unique engineering structure that combines natural formation with modern technological development. Over time, it has undergone several engineering improvements to maintain sustainability, water purity, and meet increasing demand. From an engineering perspective, it is a manually excavated vertical well with a non-uniform cylindrical shape, featuring a variable diameter along its depth, making it an irregular vertical shaft rather than a perfect cylinder. The well is naturally fed through fractures and fissures in surrounding rock formations, allowing continuous inflow of groundwater. This makes **ZamZam** not a static reservoir but a renewable groundwater system, which explains its uninterrupted flow over centuries due to constant natural recharge.

With technological advancement, traditional water extraction methods have been replaced by a modern pumping system using high-efficiency electric pumps, such as submersible or vertical turbine pumps. These pumps operate at a rate of approximately 300–360 cubic meters per hour (around 100 liters per second), enabling large-scale water supply. The process involves water entering through rock fractures, collecting at the bottom, and then being pumped directly into a closed pipeline network.

The water is transported to the King Abdullah **ZamZam** Project in Kudai through a pipeline system extending 4–5 kilometers. The pipes are made of high-grade stainless steel, typically 316L, chosen for its corrosion resistance and non-reactivity, ensuring the water's chemical properties remain unchanged. With a diameter of about 200 mm, the system allows efficient high-volume flow with minimal pressure loss. It is fully enclosed and digitally monitored to ensure maximum purity and safety.

As mentioned earlier, Upon reaching the Kudai facility, the water undergoes precise treatment using ultraviolet (UV) sterilization without chemicals, preserving its natural characteristics. It is then stored in large-capacity tanks and distributed to the Grand Mosque or bottled for consumption. Overall, this system represents a seamless integration of natural hydrology and advanced engineering, making **ZamZam** Well a unique and sustainable water system serving millions daily with high efficiency.



Vertical Section of the ZamZam Well Showing Its Rock Structure, Water Sources, and Extraction System

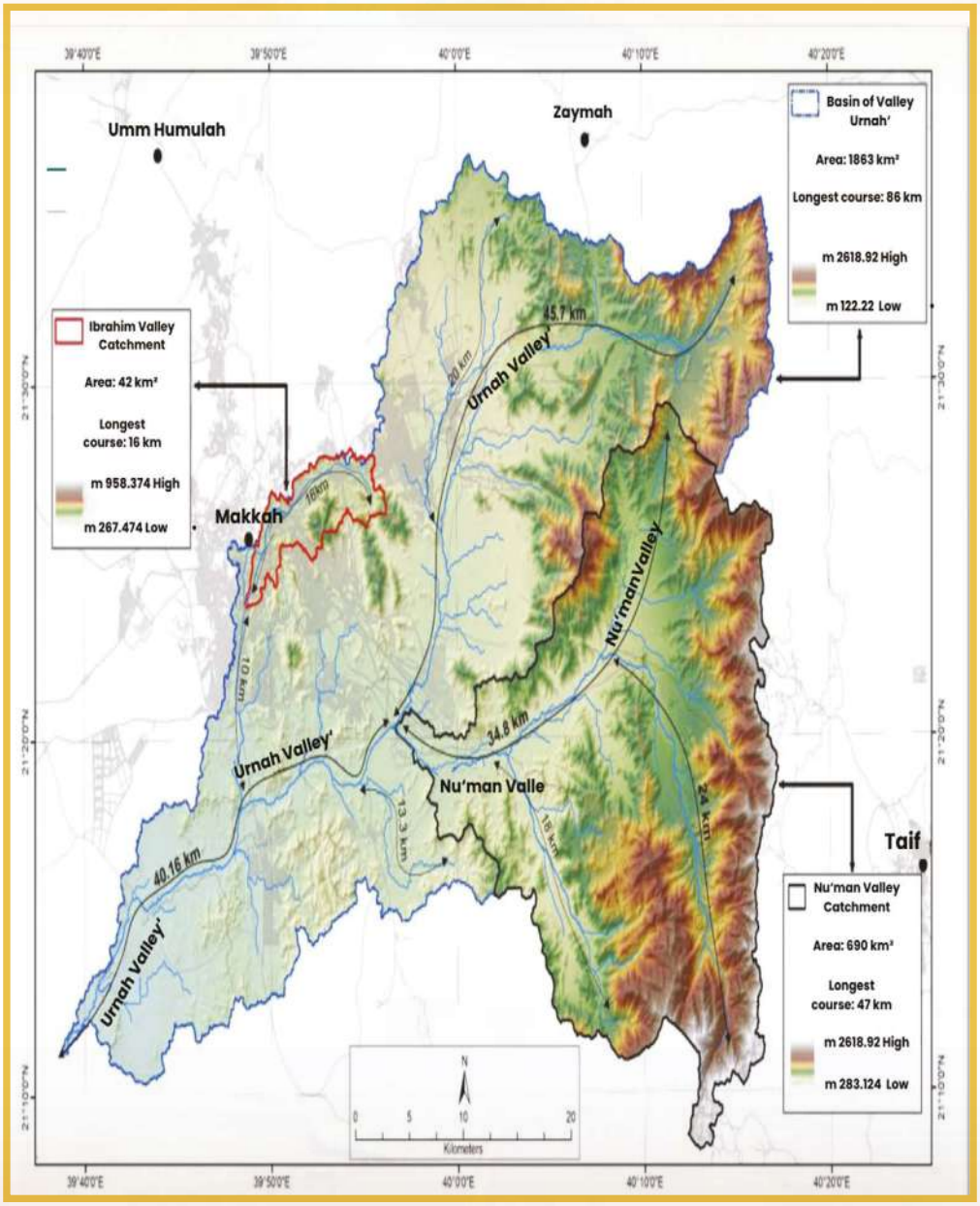
ZamZam Well Surface Water Sources

The **ZamZam** well is directly influenced by the surrounding surface and groundwater systems. Although rainfall and flash floods are uncommon in Makkah, they play a fundamental role in sustaining this unique water resource. Recent studies highlight the importance of adopting an integrated water resources management approach in the area of the Holy Mosque to ensure the continued preservation of the **ZamZam** Well as a vital water source of great religious and environmental significance.

Hydrological system analyses of Makkah indicate that the **ZamZam** Well is fed by a natural, integrated, and complex network that includes seasonal rainfall, surface runoff from flash floods, as well as deep groundwater reserves. What sets this system apart is its high efficiency and ability to function without external intervention, allowing it to remain stable over the centuries despite harsh climate conditions and extreme environmental changes. **ZamZam** well is renowned as an enduring "water miracle" founded on a unique balance of science and spirituality.

In this context, surface water sources play a vital complementary role in supporting the hydrological system that feeds the **ZamZam** Well. Makkah is situated within the Arabian Shield formations, a geological zone primarily composed of igneous and metamorphic rocks dating back to the Precambrian era. This region is characterized by the widespread presence of natural faults and fractures, which serve as key pathways for water infiltration and groundwater recharge.

The area's topographical features, including steep valleys and rugged mountains, significantly contribute to the rapid and concentrated collection of rainwater during the limited rainy seasons. Through these valleys, water flows toward the low-lying areas surrounding the Holy Mosque, where it infiltrates the permeable soil and highly permeable rock formations, especially basaltic and metamorphic rocks, thus enhancing the natural recharge processes of the **ZamZam** Well.



Map Showing the Drainage Basins of the ʿUrnah, Nuʿmān, and Ibrāhīm Valleys (modified from Saudi Geological Survey, 2024 CE).

Surface Recharge

Hydrology research has shown that one of the most prominent sources feeding the **ZamZam** Well is surface recharge. Surface recharge is a natural process that occurs when rainwater and floodwater seep into the ground through pores and fractures in geological layers. This process contributes to the replenishment of the groundwater reservoir that continuously feeds the well, ensuring a sustainable flow of water despite the region's harsh climatic conditions. The **ZamZam** Well is part of a complex hydrological and hydrogeological system that is directly connected to Ibrahim Valley, which constitutes the main water basin feeding the well. This valley recharges from several prominent topographical areas, most notably the western slopes of Mount Al-Tariqi, which rises to about 987 meters above sea level and forms the dividing ridge between the basins of Ibrahim Valley and Uranah Valley.

From the northern side, the valley recharges from the mountain peaks that separate it from Al-Zaher Valley—the most prominent of which include Mount Al-Wadiah, Mount Al-Dhiba, Mount Al-Nour, and Mount Dhakhir. Meanwhile, from the south, the recharge comes from Mount Thubayr and Mount Khindimah, which act as natural barriers separating the valley from Muhassir Valley, in addition to Mount Kuda, which serves as a geomorphological divide between Ibrahim Valley and the basin of Al-Lahahjah Valley. Koshak (1983) pointed out that rainfall over the city of Makkah alone causes only a slight rise in the water level of **ZamZam**. In contrast, rainfall over the surrounding mountain highlands—such as the Taif region—has a much greater impact on recharge rates. Thus, the primary source of groundwater feeding the well is situated within those mountains, through an extensive network of

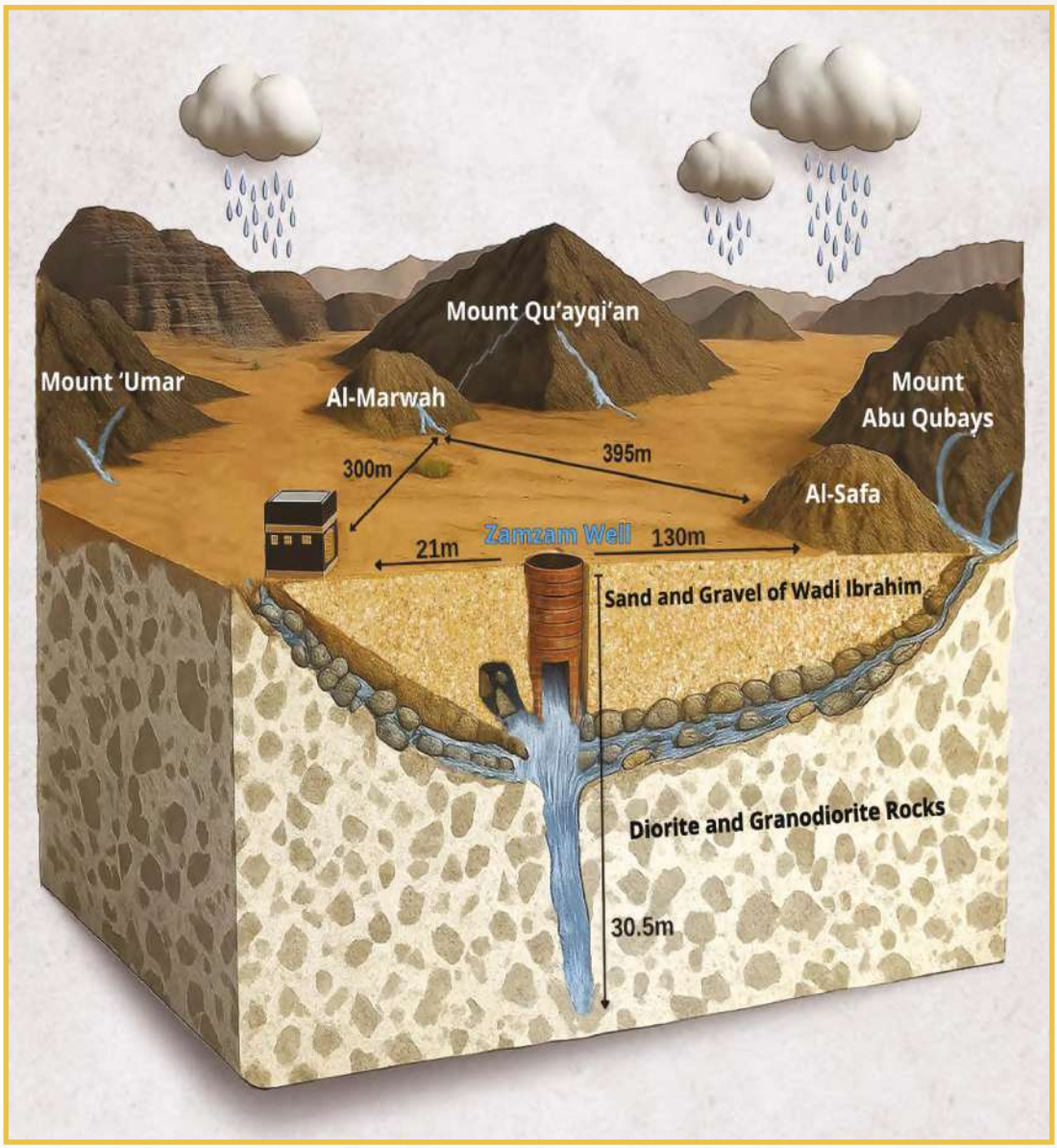
fractures and rock fissures. Ibrahim Valley is distinguished by its branching into numerous tributaries and channels, which enhance its effectiveness as a water source. Among its most important tributaries are: Shab Al-Ghusalah, Al-Malawi, Al-Khansa, Ri Dhakhir, Shab Amir, Shab Ali, Ajyad Al-Sadd, Ajyad Al-Masafi, and Tuwa Valley, which is considered the largest and most significant tributary. The valley is also fed by runoff from Rubu‘ Al-Hajun, Al-Rassam, Al-Hafayer, Al-Kuhl, and Abi Lahab—all of which reflect the dense surface drainage network that converges into the Wadi Ibrahim basin, as noted by Mirza and Al-Baroudi (2005).

Ibrahim Valley is considered one of the small hydrological basins in the western region of the Saudi Kingdom, with an estimated area of approximately 42 square kilometers. Within this basin, the upper sector, which drains into the area of the Holy Mosque, covers about 31 square kilometers, with an average topographic slope of 0.145 meters per meter. Recent estimates indicate that the annual surface runoff volume in the basin reaches around 6 million cubic meters, while the peak hydrological discharge is approximately 616.4 cubic meters per second. This reflects the significance of the basin as an effective water source supporting the groundwater reservoir that feeds the **ZamZam** Well (Al-Qaidi, 2024), making it the direct source of surface water flowing toward the Kaaba.

This part of the Arabian Shield is characterized by a dry, semi-arid climate, with an average annual rainfall of about 100–105 mm. Based on these rates, the total annual rainfall volume over the entire basin of Ibrahim Valley is estimated at approximately 4.34×10^6 cubic meters, while rainfall over the upper sector leading toward Al-Masjid Al-Haram is around 3.1×10^6 cubic

meters (Sen, 2008). Using a surface runoff coefficient of 0.35, the maximum surface runoff volume at the basin's outlet in the Al-Misfalah area is estimated at 1.5×10^6 cubic meters, and approximately 1.08×10^6 cubic meters at the Holy Mosque area. These values indicate a relatively limited amount of surface water that can infiltrate into the subsurface layers, confirming the constraints of natural recharge under the current climatic conditions.

Hydrogeological studies indicate that the alluvial aquifer in Ibrahim Valley has a hydraulic conductivity of approximately 0.001 square meters per second, a value consistent with the results of pumping tests conducted on these sediments (Sen, 2008). Based on the assumption that the actual infiltration rate into the groundwater reservoir represents about 10% of the total rainfall, the estimated annual recharge of the aquifer in the upper areas of Ibrahim Valley, particularly in the vicinity of the Holy Mosque, is approximately 310,000 cubic meters per year.



An approximate 3-D model of the subsurface water system in Ibrahim Valley, which shows the three recharge sources of ZamZam well from under the black stone, Safa and Marwa.

Climate and Rainfall

Climatic data indicate that the average annual rainfall in Makkah ranges between 100 and 105 mm, which is higher than in the neighboring city of Jeddah, where the annual average is around 50 mm. Rainfall in Makkah is characterized by its sudden intensity and rapid downpour, increasing the likelihood of frequent flash floods. Makkah experiences a desert climate, with temperatures ranging from 20°C to 45°C, and may exceed 50°C during summer. Over the past five decades, the city has witnessed noticeable variability in rainfall patterns (Mashat and Abdel Basset, 2011), including:

- Severe droughts in years such as 1986 and 1990
- Exceptionally high rainfall throughout the years, such as in 1992 (≈ 253.7 mm) and 1996 (247 mm)
- A notable dry period between 1985 and 1995
- An upward trend in rainfall amounts during the 1990s and early 2000s
- A relative decline from 2012 to 2016

Despite this fluctuation, the overall trend shows a gradual increase in rainfall, estimated at around 36 mm over the last three decades. Most of the rainfall in Makkah occurs between November and February, following a climatic pattern of rainy winters and dry summers. The city has experienced heavy downpours and sudden floods, notably in November 2009 and December 2022, reflecting a rise in extreme weather phenomena in the region. https://ar.wikipedia.org

Floods of Makkah

Floods are a recurring seasonal climatic phenomenon in Makkah due to its mountainous terrain and low-lying topography in several areas. Floods present a dual challenge: on one hand, they pose a direct threat to infrastructure and public safety; on the other hand, they serve as a vital natural source for recharging groundwater reservoirs. Floods in Makkah are typically sudden and intense (flash floods), a characteristic attributed to the interaction of several environmental and geomorphological factors, the most notable of which are:

- Heavy rainfall occurs over short periods, especially during transitional seasons.
- The rugged mountainous landscape accelerates water flow toward valleys and low-lying areas.
- The presence of relatively impermeable soils, which reduces the land's ability to absorb water and increases surface runoff volume
- Steep slopes in Makkah significantly increase water flow velocity and intensify flood severity.

Throughout history, the city has experienced a number of devastating floods that impacted its urban structure and population. However, these floods also played a crucial role in replenishing groundwater resources, especially in recharging the **ZamZam** Well. The valleys of Ibrahim, Numan, and Uranah serve as natural drainage channels into the heart of Makkah. When rainfall intensifies over the city's outskirts, flash floods form in the upper valleys—particularly near Mina—causing powerful flows of water to rush toward the

Makkah's Sanctuary, often resulting in severe damage to the Holy Mosque and its surroundings. This recurring threat prompted Makkah's residents, since the earliest centuries of the Islamic calendar, to implement engineering and protective measures, such as the construction of dams and canals to divert floodwaters away from the Holy Mosque.

One of the most notable of these projects was the Dam of Umar ibn Al-Khattab, built in 17 AH (638 CE). It was followed by landfilling works in the Al-Mada area, an elevated location from which the Kaaba was once visible. These interventions succeeded in redirecting the flood path to Ibrahim Valley, whereas previously, floodwaters had flowed toward Al-Masa from the direction of Al-Marwah.

Historical records, as cited by historians such as Mirza (1418 AH) and Al-Qaidi et al. (2012), show that more than one hundred floods have struck Makkah since the beginning of the Hijri calendar. Some of the earliest and most notable floods include:

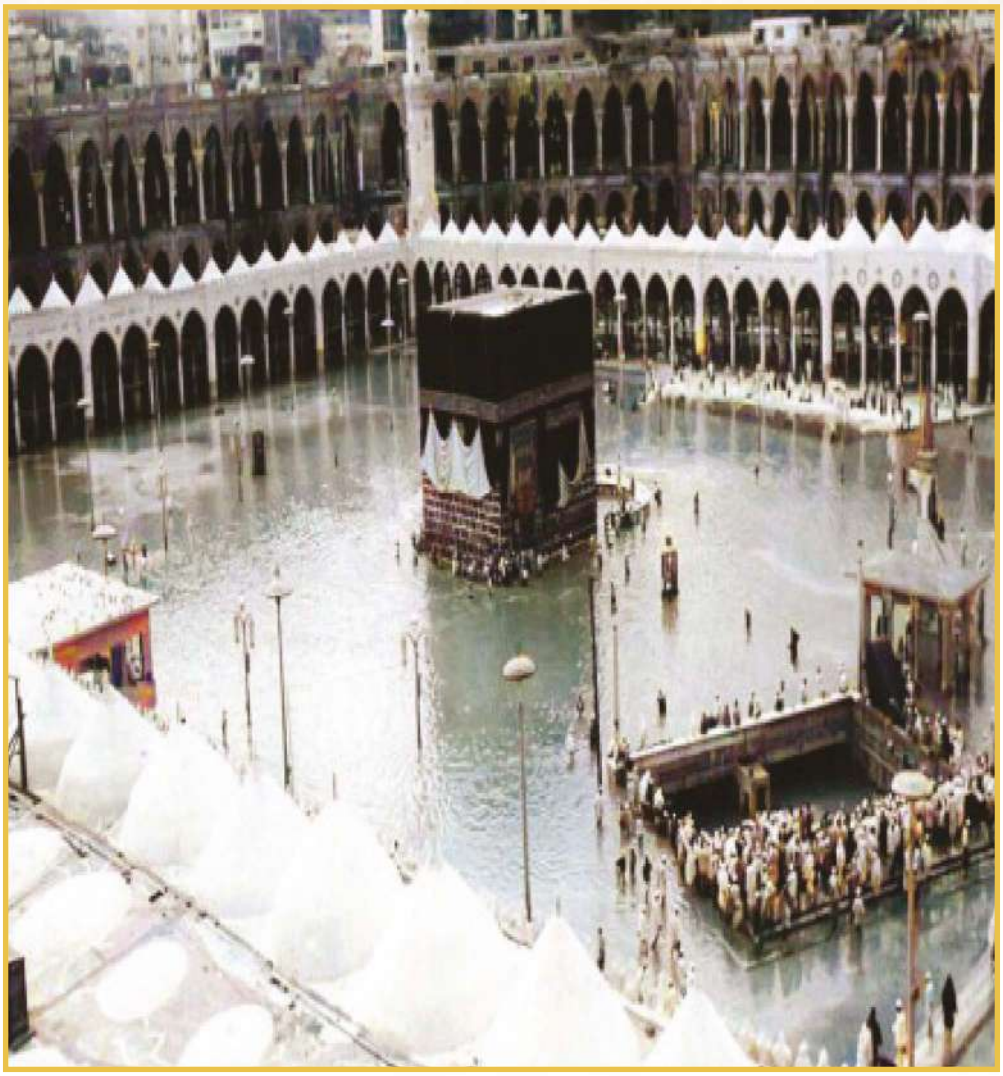
- Flood of Umm Nahshal.
- Flood of Al-Juhaf, 80 AH (699 CE).
- Flood of Al-Mukhbil, 84 AH (703 CE).
- Flood of 88 AH (706 CE).
- Flood of Abu Shakir, 120 AH (737 CE).
- Floods of the years 160 AH (776 CE), 184 AH (800 CE), 202 AH (817 CE - Flood of Ibn Hanzalah), 208 AH (824 CE), 253 AH (867 CE), 262 AH (875 CE), 279–281 AH (892–894 CE), 297 AH (909 CE), 528 AH (1133 CE), 549 AH (1154 CE), 569 AH (1173 CE), and 579 AH (1183 CE).

In modern times, Makkah has witnessed at least 27 major floods during the past Hijri century (i.e., over the past 100 years). Among the most notable of these are the floods of the years 1325 AH (1907 CE), 1327 AH (1909 CE), 1328 AH (1910 CE), 1330 AH (1911 CE), 1335 AH (1916 CE), 1344 AH (1925 CE), 1350 AH (1931 CE), 1376 AH (1956 CE), 1382 AH (1962 CE), and 1384 AH (1964 CE).

On Wednesday, the 4th of Dhu al-Qadah, 1388 AH (1969 CE), Makkah witnessed one of the most devastating floods of its modern history, locally known as "Sil Al-Rubu'" (The Wednesday Flood). Rain began falling around 9:00 a.m. and lasted for one to three hours.

The first hour of rainfall was characterized by an unusually intense downpour, typical of locally generated thunderstorms, with large volumes of water falling in a short time. This intense rainfall triggered a flash flood that rapidly inundated low-lying areas, including the Holy Mosque. The floodwaters surged into the Mosque's courtyard and rose to reach the door of the Kaaba, in a scene rarely witnessed. The flood also swept away a large number of vehicles in its path, and the Tawaf area was flooded, completely disrupting the performance of rituals. It is also noted that **ZamZam** Well, located beneath the Tawaf area, was filled with floodwater due to the heavy rain and surface runoff seeping into it, an indication of the flood's strength and magnitude on that day. This incident remains etched in the memory of Makkah's residents as one of the most significant natural disasters linked to floods and marked a turning point in flood risk management within the Sacred Mosque. It prompted the relevant authorities at the time to reassess the design of drainage systems and protective infrastructure around the Haram.

Climatic and geographical characteristics play a critical role in accelerating the transformation of rainwater into surface runoff, which then contributes to the formation of torrential floods. The floods originating in the Uranah Valley, Numan Valley, and Ibrahim Valley basins are of great hydrological importance, making their study essential to avoid potential risks and, at the same time, capitalize on them in water storage and surface water sustainability projects. It is crucial to understand the hydrological behavior of Makkah's valleys for effective flood risk management and to guide policies toward utilizing surface runoff in water harvesting and strategic storage projects, contributing to the enhancement of water security in the region.



The Al-Rubu flood occurred on Wednesday, 4/11/1388 AH (1969 CE), when rain began falling at around nine o'clock and continued for a period ranging from one to three hours. The first hour of rainfall was extremely heavy, and as a result of it, the flood entered the Holy Mosque, reached the door of the Kaaba, swept away many vehicles, and filled the circumambulation courtyard with rainwater. The ZamZam well was seen filled with floodwater.

ZamZam Well Groundwater Sources

The **ZamZam** Well represents a unique hydrogeological system, fed by a natural multilayered aquifer with a complex geological and hydrological structure. The well is located in a topographic depression in the heart of Ibrahim Valley, at the junction where surface sedimentary layers meet hard igneous rocks—creating an ideal geological environment for collecting and channeling groundwater toward the well. The aquifer system feeding the **ZamZam** Well is characterized by several key features:

- **Geological Structure**: The well is surrounded by rock formations consisting of sandy silt layers that belong to the deposits of Ibrahim Valley, underlain by metamorphosed igneous rocks such as diorite and granodiorite. These rocks are penetrated by cracks and fractures, which act as natural channels for groundwater movement.
- **Recharge Mechanism**: The well is recharged by surface water from rainfall and flash floods, which infiltrate through the valley network, especially Ibrahim Valley, percolating through the soil and geological formations until reaching the aquifer via rock pores and fractures.
- **Porosity and Permeability**: Water is stored in rocks with partial porosity and limited permeability, and the system includes two main zones: an unsaturated zone that retains moisture, and a saturated zone that serves as the direct source of water for the well.
- **Water Movement**: Water flows into the well by natural hydraulic pressure without the need for mechanical intervention, indicating a stable dynamic balance in the aquifer system that has persisted since ancient times.
- **Chemical Properties**: **ZamZam** water contains natural concentrations of minerals, such as calcium, magnesium, and fluoride, in proportions that do not affect its potability or require artificial treatment. This hydrological system stands as a remarkable example of the interaction between the unique geological nature of Makkah and the physical properties of water, ensuring the sustainability of this sacred resource under challenging climatic and geological conditions.

Hydraulics of ZamZam Well System

Research in Hydrology indicates that the recharge of the **ZamZam** Well follows a regular water flow pattern influenced by distinct Hydraulic Gradients, which flow from the southeast toward the northwest—directly toward the location of the well. Water travels along this slope from the surrounding highlands through a complex network of geological fractures and fissures to the junction point where sedimentary formations meet fractured igneous rocks, forming a highly efficient water collection zone.

Field observations reveal a dynamic equilibrium between recharge and discharge rates, as the water level returns to its natural state shortly after heavy extraction. This demonstrates the efficiency and stability of the system. Three-dimensional digital simulation models confirm that the aquifer feeding the well relies primarily on seasonal rainfall, supplemented by continuous recharge from deep aquifers, providing a sustainable source of water.

Ibrahim Valley, filled with sandy and alluvial deposits from the Quaternary period, serves as the main stream for groundwater movement in the area. The Kaaba and **ZamZam** Well are situated at the lower part of this hydrological channel, between the two hills of Safa and Marwah, where the geological formations converge to create a narrow basin conducive to water accumulation. These deposits gradually extend eastward and westward from the basin, enhancing the layers' water storage capacity.

The Ibrahim Valley channel extends for about 3 kilometers before reaching the Grand Mosque, and its narrow cross-sections contribute to the concentration of water flow. Natural recharge occurs as rainwater seeps deep into the soil, particularly in upstream areas. Evidence also supports the presence of subsurface fractures, which act as effective channels transferring water from neighboring valleys into the aquifer basin.

Factors Affecting the Groundwater of ZamZam Well

The quality of groundwater is influenced by a number of natural factors, including climatic conditions and chemical interactions between rainwater and rocks. The high concentration of bicarbonate ions (HCO_3^-) in the recharge areas is attributed to the reaction between rainwater and the basic minerals in rocks, forming alkaline compounds that contribute to the water components.

Despite the high volume of water extraction from the well, there is no significant impact on the water level due to the distinctive physical properties of the alluvial deposits in the Ibrahim Valley. These deposits are characterized by high permeability, which allows for rapid water regeneration and reduces drawdown levels.

The aquifer layers consist of various igneous and metamorphic rocks, including quartz diorite, migmatite, amphibolite, diorite, dolerite, and hornblendite (RSMC, 1986). The primary formation penetrated by the well is marked by dense fracturing in its upper section, creating a favorable environment for water transmission despite limited storage capacity. The alluvial and fluvial infills in Ibrahim Valley have good porosity and moderate permeability, making them an ideal medium for storage.

In deeper layers, permeability decreases due to the density of crystalline rocks such as diorite and granite, which reduces their contribution to recharge compared to the upper layers affected by weathering. The hydraulic conductivity of the water-bearing layer is estimated at approximately 10^{-3} m^2/s, a rate consistent with the results of pumping tests, indicating high efficiency of the alluvial sediments.

Hydrogeological Units Beneath ZamZam Well

The stratigraphy system responsible for the movement and storage of water in the well area consists of the following:

- **Upper Unit – Alluvial Deposits of Ibrahim Valley:**

This is the most hydrologically significant layer, with an approximate thickness of 13 meters. It has high porosity and effective storage capacity, holding more than 95% of the usable groundwater. It consists of a mixture of gravel (20–30%), sand (50–70%), and alluvion (~ 5%), providing an ideal environment for both water transmission and storage.

- **Middle Unit – Transitional Rock Horizon:**

Located at a depth of about 13 meters with an estimated thickness of 0.5 meters, this layer plays a critical role in horizontally transferring water from the aquifer layers into the well. It is considered the main source of direct recharge.

- **Lower Unit – Fractured Crystalline Rocks:**

Composed of igneous and metamorphic rocks such as quartz diorite, pegmatite, amphibolite, and dolerite, this unit is about 17 meters thick. Despite its low porosity, it contributes to the well's recharge through a network of fractures that facilitate water movement toward the well shaft.

Sources of ZamZam Well Recharge

Historical sources indicate that the well is fed by at least three main springs:

- The first spring is located beneath the Black Stone in the Holy Kaaba.
- The second spring extends from the direction of Mount Abu Qubais toward the area of Al-Safa.
- The third spring is situated near the area of Mount Al-Marwah.

In 1400 AH (1980 CE), Koshak and his team conducted a scientific research project to verify the aforementioned accounts. They employed drilling, geological surveys, and hydrogeological property analysis to classify the sources of recharge into three main components based on water flow into the well, locations of active fissures, and comparative water chemistry from various directions.

The Primary Source of ZamZam Water Recharge

The main source is an opening located directly beneath the Black Stone, extending toward the Kaaba in the direction of the corner opposite the Hijr Ismail. The opening measures approximately 45 cm in length and 30 cm in height, and it is the channel through which the majority of **ZamZam** water flows, making it the most significant in terms of both quantity and quality (Koshak, 1983). This spring has garnered increasing scientific interest due to its unique physical and chemical properties. Studies show that its water composition differs significantly from nearby wells, despite their proximity. Analyses indicate a change in water composition as it passes through the underground channel, suggesting the presence of special geological processes that influence water quality. Despite extensive research to understand this phenomenon, researchers have not been able to fully explain its characteristics. Some have therefore considered the source of **ZamZam** water to be a complex geological mystery shaped by natural, structural, and geomorphological factors that are not yet fully understood (Hussain, 1997).

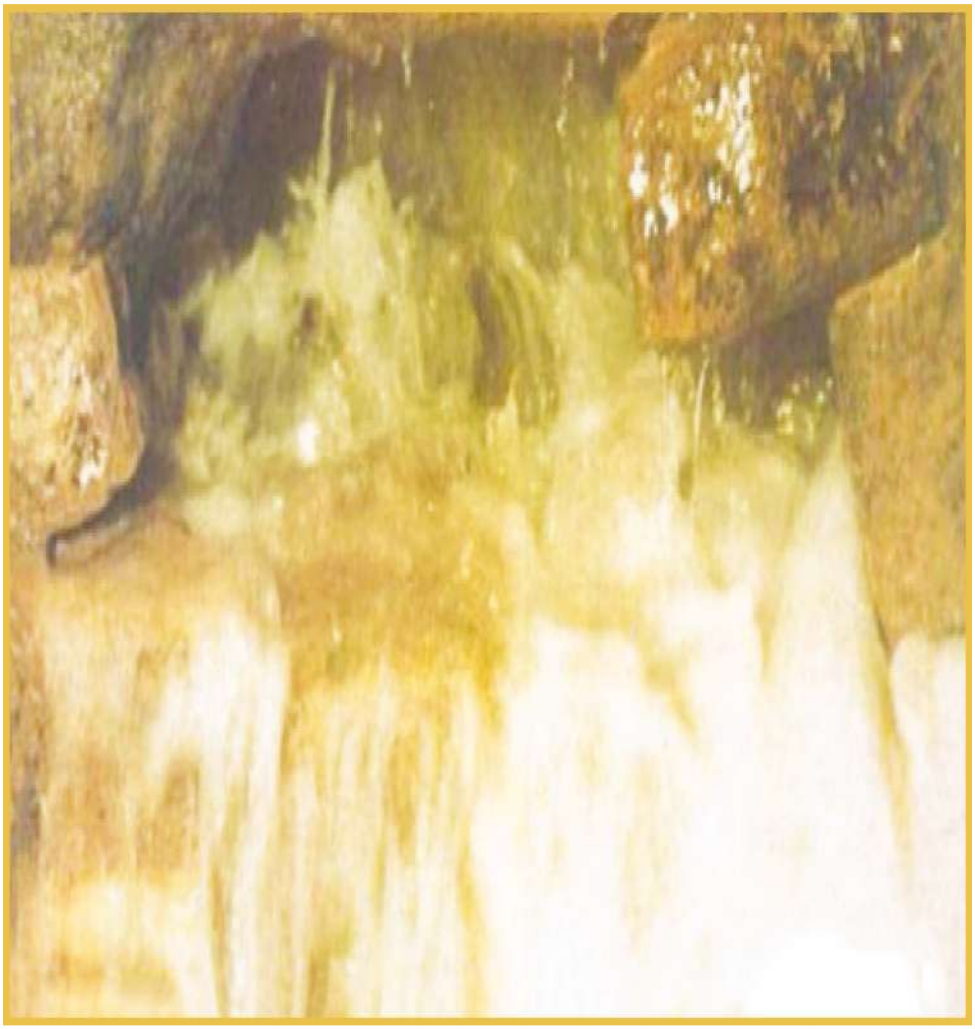


Photo taken inside ZamZam well of the well's recharge source from the direction of the Kaaba. (Al Abdely, 2012).

The Secondary Source of ZamZam Well Recharge

The secondary source consists of another main opening located near the Muqabbariyah—the structure designated for the call to prayer that overlooks the Tawaf area. This opening is approximately 70 cm long and 30 cm high and is internally divided into two smaller sub-openings. Although the water flow rate from this source is lower than that of the primary source, it remains a significant contributor to the overall recharge of the well (Koshak, 1983).

Between these two main openings, separated by a distance of about one meter, there are five additional small openings embedded within the stone structure, which continuously contribute to the well's recharge. In addition, a network comprising 21 openings has been identified, starting near the second main opening and extending toward Mount Abu Qubais on the Safa side and also toward Marwah. This indicates the presence of a complex subsurface channel system that connects different geological layers and facilitates water movement toward the well.

The Subsidiary Sources of ZamZam Well Recharge

The **ZamZam** area contains a network of small fissures and limited openings scattered along its defined boundaries. These vary in size, depth, and direction, and discharge undefined quantities of water, suggesting a diversity of sources. Some of these openings are likely connected to secondary aquifers or independent faults that are not directly linked to the main aquifer.

Most geological and hydrogeological studies have indicated that these waters emerge from fissures penetrating Precambrian rocks—ancient metamorphic igneous rocks—overlain by layers of sand, gravel, and alluvial deposits. The thickness of these overlying layers varies depending on their location within the subsurface strata of Ibrahim Valley.

This perspective reinforces the notion of multiple viable water sources and the continuity of the hydrological system that sustains and feeds the **ZamZam** well, granting it a distinctive hydro-property (Hussain, 1997).

A schematic diagram of the ZamZam Well showing the directions of the feeding water flows (modified from Şen, 2008).

The Physical Properties of ZamZam Water

The physical properties of **ZamZam** water have received special attention from researchers due to their importance in assessing the quality of this blessed water, its suitability for drinking, and its long-term sustainability. One of **ZamZam**'s most distinctive features is that its properties have remained relatively stable over the years despite surrounding climatic or environmental changes. Among its most notable physical traits is the consistency of its taste and properties, even after long periods of storage, provided it is kept under appropriate conditions. Below is an overview of its key physical properties:

• Color

ZamZam water is clear and colorless, free from turbidity under natural conditions. Recent tests have confirmed that it doesn't contain any organic matter or algae that could affect its appearance.

• Taste

ZamZam water has a unique, slightly saline taste that is unlike other fresh or saline waters. This distinctive flavor is due to its unique mineral composition, particularly the concentration of bicarbonates.

• Odor

ZamZam water is completely odorless unless stored in unclean containers or exposed to external contaminants.

• Temperature

ZamZam water's temperature ranges between 30°C to 34°C, which is slightly higher than the temperature of other groundwater in the region due to the relatively shallow depth of the well and the heat of the surrounding rocks.

• Transparency

ZamZam water is highly transparent compared to laboratory-distilled water. This clarity indicates a scarcity of impurities and suspended particles.

• Density

ZamZam water's density is close to that of pure water but is slightly influenced by the total dissolved mineral content. The specific gravity ranges between 0.995 and 1.015 g/cm³ at room temperature, reflecting its natural balance and rare composition.

• Electrical Conductivity

ZamZam water's electrical conductivity ranges from 600 to 850 µS/cm, indicating a moderate concentration of dissolved minerals higher than that of most commercial bottled waters, yet still within globally accepted limits. It contains a relatively high proportion of dissolved minerals such as sodium, calcium, and magnesium.

This makes **ZamZam** water more conductive than regular drinking water or even some mineral waters, reflecting its high ionic content and deep geological origin.

• pH Level (Acidity/Alkalinity)

ZamZam water has a pH level ranging from 7.5 to 8.0, making it moderately alkaline. This alkalinity helps maintain acid-base balance in the human body and reflects its basic mineral components (especially the bicarbonates), distinguishing it from many other types of water.

• Appearance

No living microorganisms or suspended impurities are present in **ZamZam** water. Electron microscope analyses have shown no biological or algal deposits.

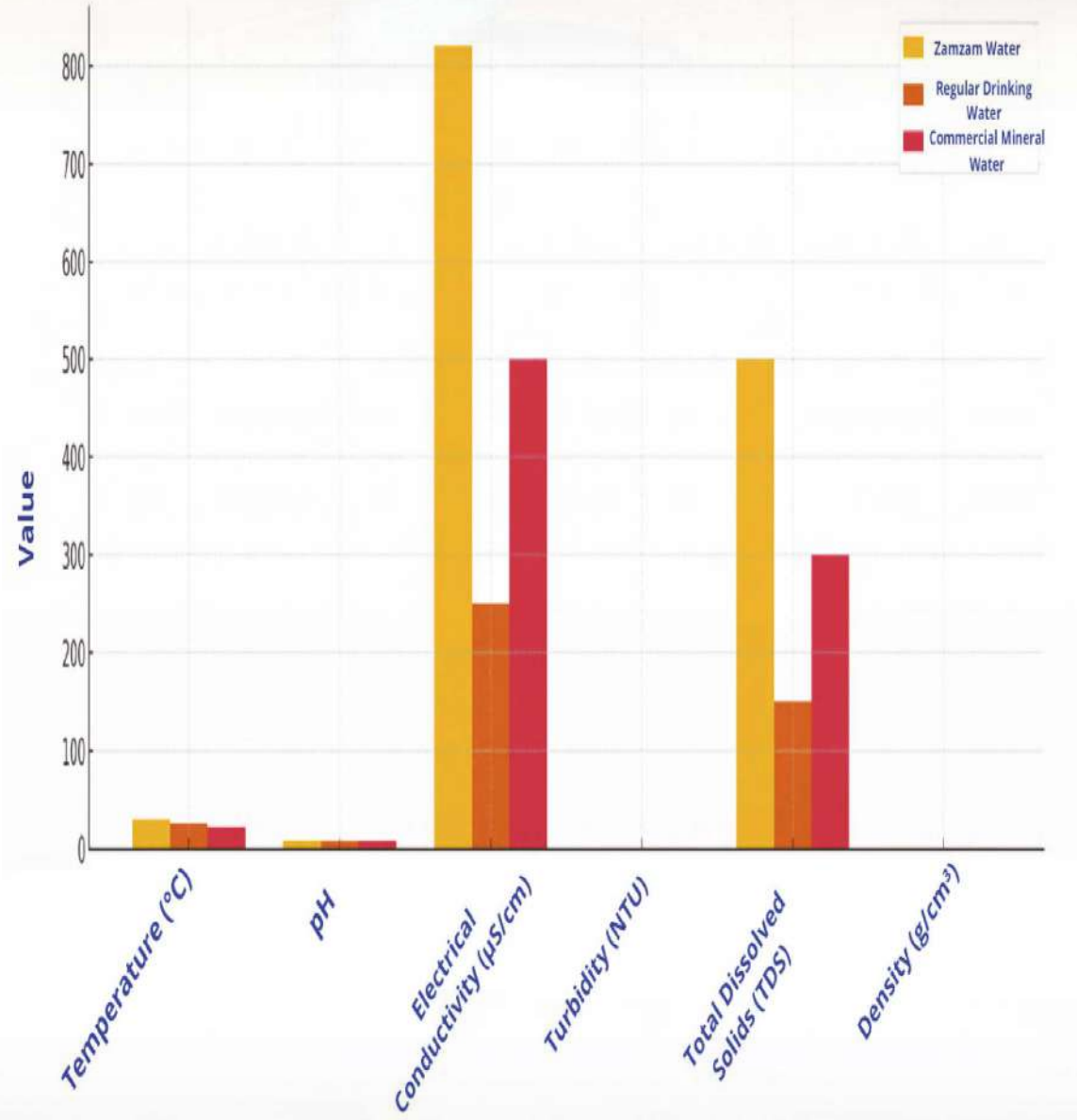
• Total Dissolved Solids (TDS)

ZamZam water contains approximately 500–800 mg/L of dissolved minerals, a concentration higher than that of ordinary drinking water (which typically ranges between 100–300 mg/L). These minerals give it its unique taste.

• Turbidity

Despite its high mineral content, **ZamZam** water is completely free of turbidity. It is known for its visual clarity, with extremely low turbidity (less than 1 NTU), indicating a high level of physical purity.

The accompanying chart compares the physical properties of **ZamZam** water with those of ordinary drinking water and commercial mineral water. It is evident that **ZamZam** water contains the highest levels of total dissolved solids (TDS) and electrical conductivity, indicating its superior mineral richness. In contrast, commercial mineral waters typically occupy a middle ground between **ZamZam** and ordinary drinking water in most physical properties. Ordinary drinking water tends to be lower in turbidity, electrical conductivity, and dissolved substances. (Halim et al., 2016).



Comparison of the Physical Properties of ZamZam Water, Regular Drinking Water, and Commercial Mineral Water.

Comparison of the Physical Properties of **ZamZam** Water with Those of Ordinary Drinking Water and Commercial Mineral Water.

Physical Property	ZamZam Water	Commercial Mineral Water	Ordinary Drinking Water
Natural Temperature	34–30 °C (relatively stable)	Varies by source (often 12–25 °C)	Varies depending on climate and distribution source
Color	Colorless or slightly bluish	Usually, colorless	Colorless
Taste	**Distinct and slightly saline**	**Varies depending on mineral composition**	**Plain or may have a chlorine taste**
Odor	Odorless or has a faint metallic scent	May sometimes have a chlorine odor	Odorless
pH (Hydrogen Ion Concentration)	7.8–8.0, slightly alkaline	6.5–8.5, varies by source	6.5–8.5, varies depending on treatment
Electrical Conductivity	670–720 µS/cm, relatively high	200–600 µS/cm	100–800 µS/cm
Turbidity	0.1–0.2 NTU, very clear	NTU often > 0.5	NTU may reach 100–1000
Total Dissolved Solids (TDS)	500–600 mg/L	100–500 mg/L	100–1000 mg/L

The Chemical Properties of ZamZam Water

ZamZam water is distinguished by its unique chemical composition, which sets it apart from other natural waters and confers its exceptional properties in both.

structure and effect. Chemical analyses have shown that **ZamZam** water contains balanced and significant levels of essential elements that contribute to its distinctive characteristics, high quality, and suitability for drinking. Among the most prominent of these elements, measured in mg/L, are:

Calcium (Ca): 38.71, Magnesium (Mg): 9.10, Sodium (Na): 64.44, Potassium (K): 30.34, Chloride (Cl^-): 73.45, Sulfate (SO_4^{2-}): 57.19, Bicarbonate (HCO_3^-): 167.5, Nitrate (NO_3^-): 6.76, Fluoride (F^-): 47.04 (Al-Omari, 2025). These values indicate that **ZamZam** water is relatively rich in minerals compared to ordinary drinking water, which explains its distinct taste and physiological effects.

Studies have shown that the concentrations of heavy metals in **ZamZam** water fall within safe limits: Chromium (Cr): 0.011, Copper (Cu): 0.00012, Arsenic (As): 0.00139, Lead (Pb): 0.161, Zinc (Zn): 0.017, Cobalt (Co): 0.007 (Al-Amri, 2025).

Some studies by Shomar (2012) using tools like ICP-MS, IC, and ICP-OES demonstrated that **ZamZam** water maintained stable chemical properties for 24 months without any noticeable change, which confirms its chemical stability. A research team led by Vikthar and others (2019) used inductively coupled plasma techniques to analyze 34 elements in **ZamZam** water, and the results showed the following:

- elevated concentrations of essential elements (Na, Ca, Mg, Cl) compared to natural waters;

- extremely low concentrations of elements such as Sb, Be, Bi, Br, Co, I, and Mo (less than 0.01 ppm); and trace amounts of chromium, manganese, titanium, arsenic, selenium, and cadmium, all within safe drinking limits. Some scientific hypotheses attribute the unique properties of **ZamZam** to:

- The nature of the surrounding rocks (igneous rocks that may be naturally magnetized), which contributes to altering the energy and charge of the water.

- Some of its characteristics resemble those of magnetized water, which may explain the body's strong absorption of it and its rapid biological effects.

- Another factor is its distinctive molecular structure: the angle between the hydrogen and oxygen atoms in the water molecule reaches 104.5°, and this molecular arrangement may grant **ZamZam** different physical properties than ordinary water.

Due to **ZamZam's** alkalinity and mineral components, some evidence suggests that drinking **ZamZam** water:

- may support the body's immune system and help prevent any viral activity;

- does accumulate a harmful amount of heavy metals with moderate consumption;

- does it lead to any adverse health effects for pilgrims who drink it extensively during pilgrimage seasons?

The Multiple Mineral Elements in ZamZam Water

Advanced scientific research has been conducted to precisely analyze the components of **ZamZam** water, using highly sensitive analytical techniques, the most notable of which include:

- Neutron Activation Analysis (NAA): This technique is used to detect trace elements with high precision without any complex chemical preparation.
- Inductively Coupled Plasma (ICP): A technique that generates plasma using electric current induced by electromagnetic induction in a varying magnetic field. It is used to measure the concentrations of multiple mineral elements in fluids with high precision.

In addition to other conventional techniques, such as optical and emission spectroscopy, these studies revealed that **ZamZam** water contains 34 chemical elements. They also showed the distinct concentrations of certain elements as follows:

- Essential elements with concentrations higher than those found in natural waters: calcium (Ca^{+2}), magnesium (Mg^{+2}), sodium (Na^{+}), and chloride (Cl^{-}). These elements are important for promoting bone health, regulating blood pressure, and maintaining fluid balance in the body.
- Trace elements in very low concentrations (less than 0.01 ppm): antimony (Sb), beryllium (Be), bismuth (Bi), bromine (Br), cobalt (Co), iodine (I), and molybdenum (Mo). These elements are safe at such low levels and do not pose a health risk to humans.
- Limited elements: Slight traces of elements such as chromium (Cr), manganese (Mn), and titanium (Ti) were detected, all within internationally permitted limits for drinking water.

Hydrochemical studies conducted on **ZamZam** water, most notably the study by Khalid et al. (2014), revealed a number of significant scientific indicators that reinforce the water's reliability in terms of chemical safety and health quality. The findings confirmed that **ZamZam** water enjoys a pure and safe chemical composition, free of toxic elements, and contains beneficial elements in naturally balanced proportions. This enhances **ZamZam**'s status as an uncommon water resource that combines purity, safety, and ionic balance, without the need for any artificial treatment.

A study has shown that the concentrations of certain heavy and toxic elements in **ZamZam** water, such as arsenic (As), cadmium (Cd), lead (Pb), and selenium (Se), all fall below the maximum limits permitted for drinking water according to the guidelines of the World Health Organization (WHO). This is a crucial indicator of the lack of chemical toxicity in **ZamZam** water, making it safe for continuous human consumption even over the long term.

The study indicated that part of the sodium chloride (NaCl) content in **ZamZam** water may have an atmospheric origin, likely resulting from interactions with water vapor or atmospheric deposits that occur naturally within the water cycle, rather than from terrestrial pollution or geological salinity. This supports the hypothesis that the salinity of **ZamZam** water is not a sign of declining quality, but rather part of a naturally balanced composition reflecting environmentally safe surface interactions.

Another notable result is that the concentration of calcium (Ca^{2+}) in **ZamZam** water is higher than in most ordinary drinking waters. From a hydrochemical perspective, this makes **ZamZam** water a rich source of elements that support general health, particularly in conditions requiring enhanced electrochemical balance in the body.

Trace Metallic Elements in ZamZam Water

Trace metallic elements (TME) are a highly important component in drinking water, as they have dual biological properties. On the one hand, they play an essential role in supporting metabolic processes, and on the other, their presence in high concentrations can lead to severe toxic effects on public health (Lu et al., 2022).

This category includes transitional elements such as iron (Fe), zinc (Zn), copper (Cu), and selenium (Se). All are known for their key role in vital cellular processes, including enzyme activation, energy production within mitochondria, immune support, and oxidative balance within cells (Mohammadifard et al., 2019).

When collecting and analyzing **ZamZam** water samples, researchers used containers made of high-density polyethylene (HDPE) for several reasons: to reduce metal absorption or interaction with the container walls, to prevent clogging of fine analytical instrument nozzles, to lower the level of dissolved carbon dioxide, and to improve the accuracy of element analysis using inductively coupled plasma mass spectrometry (ICP-MS).

❖ Classification of Elements According to the Periodic Table

In a recent study (Zergui et al., 2022), 52 elements were quantitatively analyzed using precise analytical techniques (measured in mg/L). These elements were classified into 8 periodic categories as follows:

Periodic Category	No. of Elements	Examples
Alkali Metals	5	Na, k
Alkaline Earths	5	Ca, Mg
Transition Elements	14	Fe, Zn, Cu, Mn
Poor Metals	7	Sn, Pb
Metalloids	4	As, Sb
REE	13	Ce, La, Nd
Chalcogens	1	Se
Halogens	3 (semi-quantitative)	Cl, Br, I

❖ General Analysis Results

- The study confirmed that **ZamZam** water is rich in essential minerals such as magnesium, calcium, and sodium, in addition to a number of vital trace elements. The trace elements were mostly within internationally permissible limits, with extremely low levels of toxic elements.

- **ZamZam** water also contained rare earth elements in trace amounts, which is an uncommon phenomenon to be found in natural groundwater.

- Overall, this diversity in the composition of trace metallic elements in **ZamZam** water reflects a unique natural balance between biological efficacy and health safety. It demonstrates the water's ability to supply the body with necessary minerals without exceeding critical thresholds, thus enhancing its natural and nutritional value alike.

- High-precision chemical analysis results indicate that **ZamZam** water contains ideal concentrations of essential minerals, while the levels of toxic or hazardous trace elements remain below the laboratory detection limit, reflecting its natural balance and environmental safety.

- **Elements Below the Limit of Detection (Below LOD):** Some elements were not detected due to their very low concentrations, falling below the technical detection limit of the instruments used in the analysis. These include: lithium (Li), beryllium (Be), barium (Ba), cesium (Cs), aluminum (Al), cadmium (Cd), mercury (Hg), lead (Pb), antimony (Sb), chromium (Cr), manganese (Mn), cobalt (Co), nickel (Ni), copper (Cu), bromine (Br), and iodine (I). This result indicates a very high degree of purity and is a strong indicator that **ZamZam** water is free from contamination by toxic heavy metals. Advanced research was conducted to improve the accuracy of magnesium concentration measurement in **ZamZam** water using visible spectrophotometry. By forming chemical complexes that depend on the pH level, at pH 10, magnesium forms stable complexes that can be accurately detected. At pH > 12, magnesium becomes more prone to precipitation, reducing measurement efficiency. This analysis is used to understand the stability of mineral compounds and their role in the quality of mineral water.

Cation and Anion Chemistry in ZamZam Water

Geochemical studies indicate that the aquifer layer feeding the **ZamZam** well is mainly composed of igneous rocks, specifically diorite and granodiorite. These rocks are believed to be the primary geological source of the mineral elements that characterize **ZamZam** water, especially iron (Fe), magnesium (Mg), and calcium (Ca). Naturally rich in these elements, the rocks transfer them into the water through long-term interaction between groundwater and rocks. This process explains the water's relatively rich and distinctive mineral composition.

Interestingly, **ZamZam** water exhibits remarkable chemical stability, with a clear balance between cations and anions, suggesting that it is fed by a closed and protected geological and hydrological system. This stability is one of the main factors that has helped **ZamZam** retain its distinctive properties over the centuries without any change in its nature or quality.

❖ Cations (Positive Ions)

Cations in **ZamZam** water are essential components that contribute to its unique mineral properties. Among the most notable are: **Calcium (Ca^{2+}):** The primary divalent cation in **ZamZam** water, calcium often reacts with bicarbonates and carbonates to form compounds that contribute to alkaline balance and enhance the benefits of **ZamZam** water for bones and teeth. **Magnesium (Mg^{2+}):** Magnesium is typically present in the form of bicarbonates or sulfates and plays an important role in supporting cellular functions and regulating vital enzymes in the body. **Sodium (Na^{+}) and Potassium (K^{+}):** These ions together form part of the total dissolved salts, such as sodium chloride (NaCl) and potassium chloride (KCl), contributing to osmotic pressure balance and fluid regulation in the body, as well as supporting nerve signaling.

❖ Anions (Negative Ions)

Anions in **ZamZam** water play a central role in determining its chemical nature and ionic balance. The most notable include:

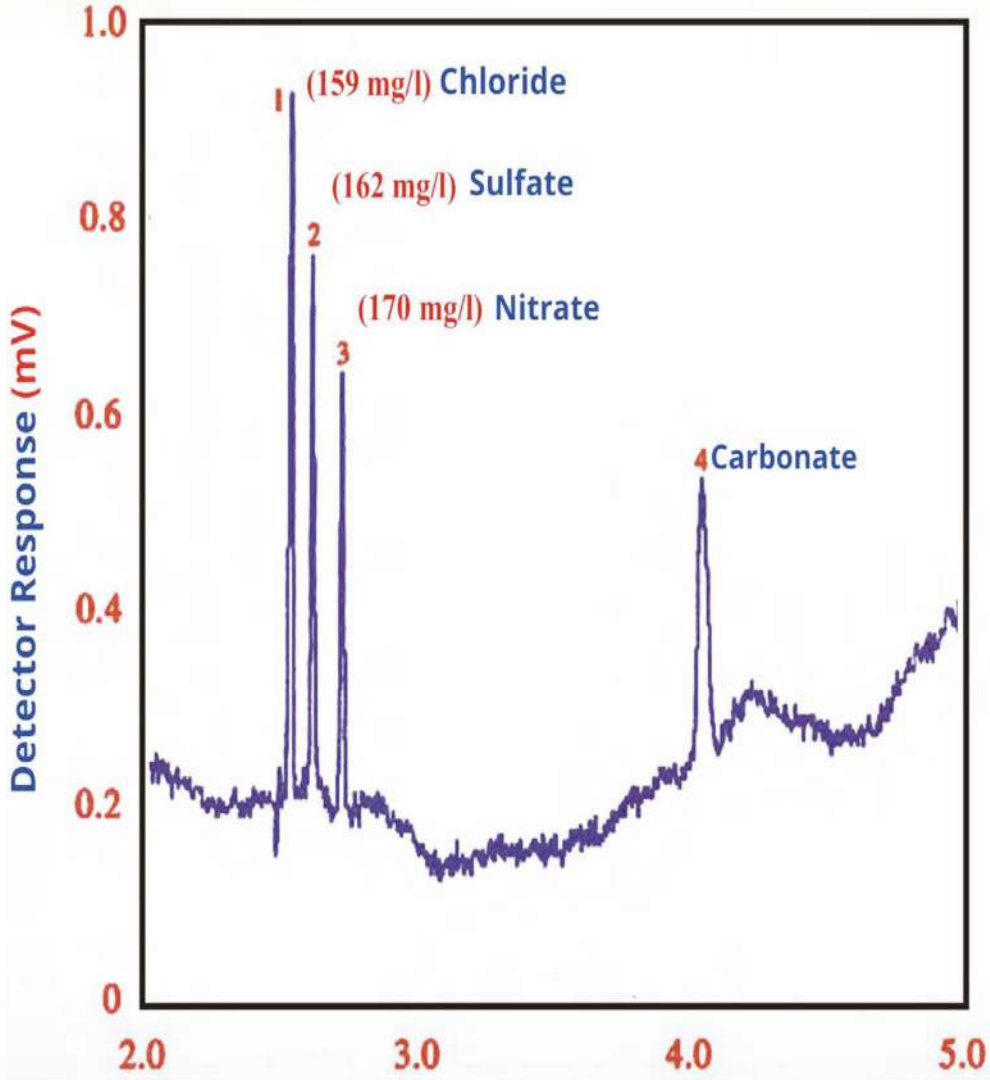
Bicarbonate (HCO_3^-): This is the element responsible for the water's alkalinity, contributing to its chemical stability and preventing the formation of harmful acids.

Sulfate (SO_4^{2-}): Often associated with magnesium or sodium, sulfate participates in natural reactions that enhance the stability of the water's components without affecting its taste or properties.

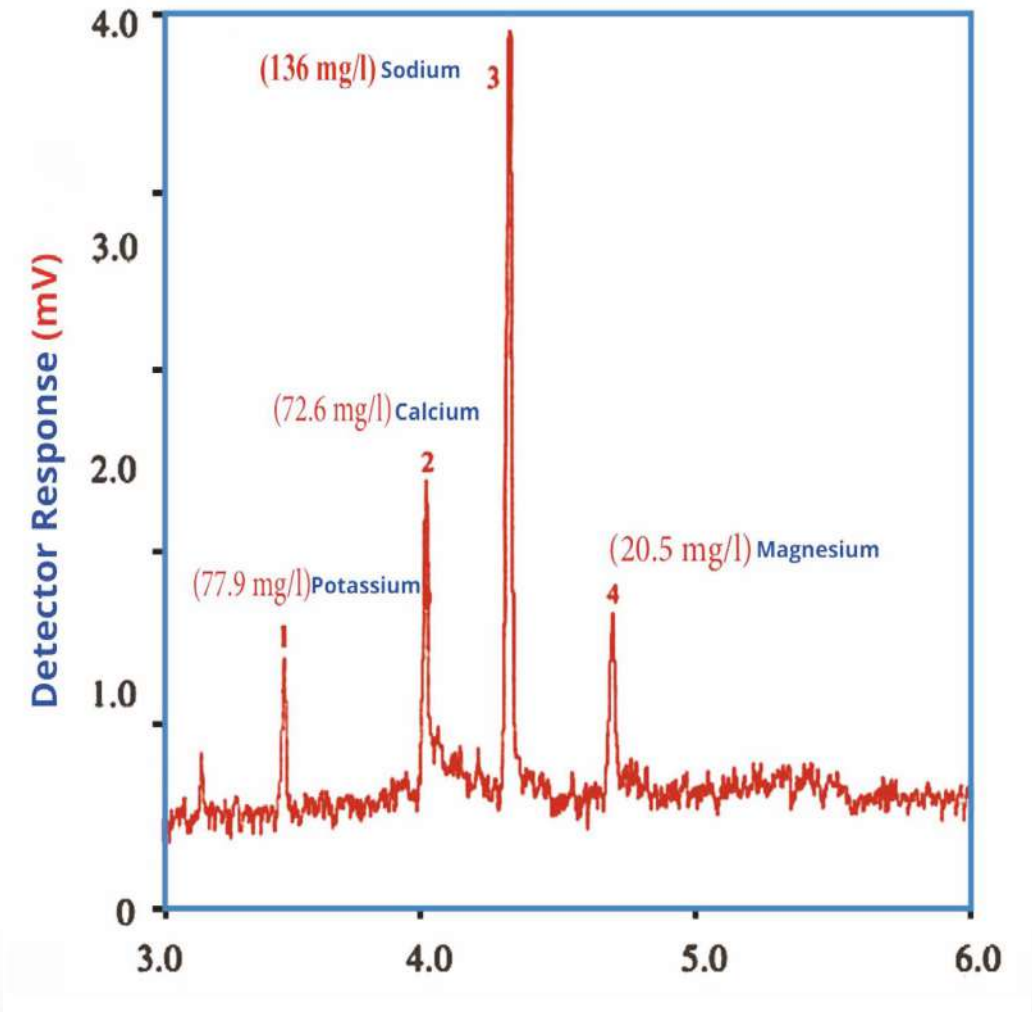
Chloride (Cl^-): One of the main ions in **ZamZam** water, chloride plays a vital role in balancing flavor and the composition of dissolved salts, as well as contributing to the overall electrochemical balance of the water.

Samples of **ZamZam** water were analyzed using capillary electrophoresis, one of the most precise techniques for measuring the concentrations of dissolved cations and anions. The results of these analyses revealed relatively high levels of ions in **ZamZam** water compared to tap water and commercially bottled water. Despite these elevated concentrations, they remain within the globally accepted health limits as set by the World Health Organization (WHO) and the United States Environmental Protection Agency (EPA), except for nitrate (NO_3^-), which in some cases exceeded the maximum permissible limit, necessitating continuous periodic monitoring (Khalid et al., 2014).

Comparative analyses show that the chemical standards of **ZamZam** water differ fundamentally from those applied to treated or commercially bottled water. This is attributed to the deep underground origin of **ZamZam** and the prolonged residence time of the water within igneous rocks, which allows it to become saturated with beneficial mineral elements and grants it its unique chemical composition.



Electrical diagram of ZamZam water sample showing anion analysis: (1) Chloride, (2) Sulfate, (3) Nitrate, (4) Carbonate. (Modified from Khalid et al., 2014).



Electrical diagram of ZamZam water sample showing cation analysis: (1) Potassium, (2) Calcium, (3) Sodium, (4) Magnesium. (Modified from Khalid et al., 2014).

The table presents the physical and chemical analyses of the components of **ZamZam** water, totaling 38 elements, of which 9 were analyzed within the Kingdom of Saudi Arabia and accredited by the Saudi Accreditation Committee (SAC). The remaining 29 elements were analyzed in international laboratories and accredited by both the International Accreditation Service (IAS) and the Saudi Accreditation Committee (SAC) (Al-Amri, 2025).

Item	Element	Result	Unit	LOQ	Approved Testing Method
1	pH	7.86	---	---	IAS+SAC
2	Total Dissolved Solids (TDS)	448	ppm	1.0	IAS+SAC
3	Total Hardness	134.13	Mg/L	1.0	IAS+SAC
4	Electrical Conductivity	0.66	mS/cm	0.01	IAS+SAC
5	Turbidity	0.30	NTU	0.10	IAS+SAC
6	Ammonium	<LOQ	ppm	---	IAS+SAC
7	Antimony	0.00506	mg/L	0.00004	IAS+SAC
8	Arsenic	0.00139	mg/L	0.00004	IAS+SAC
9	Barium	0.00800	mg/L	0.00004	IAS+SAC
10	Bicarbonate	167.5	mg/L	5.00	SAC
11	Boron	0.70000	mg/L	0.00004	IAS+SAC
12	Bromide	236.44	ppm	5.00	SAC
13	Cadmium	<LOQ	mg/L	0.00004	IAS+SAC
14	Calcium	38.71	mg/L	0.02	IAS+SAC
15	Chloride	73.45	mg/L	0.1	IAS+SAC
16	Chromium	0.00012	mg/L	0.00004	IAS+SAC

Item	Element	Result	Unit	LOQ	Approved Testing Method
17	Cobalt	0.007	mg/L	0.00004	SAC
18	Copper	0.011	mg/L	0.0	IAS+SAC
19	Fluoride	0.47	mg/L	0.0	SAC
20	Iron	0.07	mg/L	0.036	IAS+SAC
21	Lead	0.161	mg/L	0.00004	IAS+SAC
22	Lithium	<LOQ	ppm	---	IAS+SAC
23	Magnesium	9.10	mg/L	0.04	IAS+SAC
24	Manganese	<LOQ	mg/L	0.027	IAS+SAC
25	Molybdenum	0.02466	mg/L	0.00004	IAS+SAC
26	Nickel	0.00059	mg/L	0.00004	IAS+SAC
27	Nitrate	6.76	mg/L	0.35	SAC
28	Nitrites	<LOQ	mg/L	0.15	SAC
29	Phosphate	<LOQ	mg/L	0.05	SAC
30	Potassium	30.34	mg/L	0.02	IAS+SAC
31	Selenium	0.00223	mg/L	0.00004	SAC
32	Silica	17.00	mg/L	1.00	IAS+SAC
33	Sodium	64.44	mg/L	0.04	IAS+SAC
34	Strontium	0.34	mg/L	0.00004	SAC
35	Sulphate	57.19	mg/L	0.4	IAS+SAC
36	Thallium	<LOQ	mg/L	0.00004	IAS+SAC
37	Titanium	0.03	ppm	---	IAS+SAC
38	Zinc	0.017	mg/L	0.02	IAS+SAC

Bacterial Characteristics of ZamZam Water

ZamZam water has garnered growing global scientific interest for centuries due to its exceptional purity and complete absence of microbial contamination-an exceedingly rare phenomenon among untreated groundwater sources. Unlike most conventional drinking water supplies, which undergo chemical treatment or chlorination, **ZamZam** water is consumed directly without any such processing. Multiple studies employing advanced microbiological analyses have confirmed that **ZamZam** water is entirely free from harmful microorganisms, including the total absence of Escherichia coli (E. coli) - a key indicator of fecal contamination from human or animal waste. Moreover, no aerobic or anaerobic pathogenic bacteria have been detected.

These findings are particularly striking given the high and direct consumption of **ZamZam** water by millions of pilgrims and visitors annually. To date, no documented infections have been linked to its use, reflecting an extraordinary level of natural microbial safety.

Recent bacterial analyses further support these results. The total bacterial count in **ZamZam** water has consistently remained within globally accepted limits for safe drinking water—even in samples stored for extended periods. In a study by Vikhar et al. (2019), over 30 samples were analyzed using sealed systems and highly sensitive bacterial culture techniques, and no microbial growth was observed in any of the samples, including those stored for over six months. This suggests a remarkable stability in purity over time.

Similarly, a study by Al-Barakah (2017) analyzed more than 100 samples using direct bacterial count methods. The results further confirmed that **ZamZam** water is free from any microbial contaminants.

All samples were free from Escherichia coli and Enterococci, as well as any signs of fungal presence, which reinforces confidence in **ZamZam** water as a pure and completely safe source for human consumption, without the need for sterilization or chemical treatment. This unique level of microbial purity is attributed to a number of natural geological and hydrochemical factors surrounding the **ZamZam** well. The deep rock layers, particularly those composed of granodiorite, play a dual role in isolating the water from any surface contamination while also providing an effective natural filtration process as the water passes through their fine fractures. Moreover, the absence of biodegradable organic compounds in **ZamZam** water is a crucial factor in preventing the formation of algae or bacterial growth, even during long periods of storage. To verify these vital characteristics, advanced microbiological analysis techniques are used, including:

- **Electron microscope**: to examine micro-particles and microscopic contaminants.
- **Traditional microbial culture**: to detect any bacterial growth in the samples.
- **Polymerase chain reaction (PCR)**: to detect bacterial DNA in the water with high precision.
- **Nano-analytical techniques**: to monitor contamination at the atomic and subatomic levels.

Despite the inherently unique purity of **ZamZam** water, some external environmental factors, such as direct human contact or the possibility of mixing **ZamZam** water with adjacent groundwater sources during transport or distribution, may occasionally lead to incidental contamination at certain points. For this reason, modern systems are employed in **ZamZam** water filling and distribution stations, using ultraviolet (UV) light to disinfect the

water. This is an effective method for eliminating any potential microbial contaminants without affecting the water's chemical composition or natural taste, thereby preserving its unique properties.

From a preventive perspective, **ZamZam** water naturally contains fluoride **(F^-)** within the safe and recommended limits set by the World Health Organization **(WHO)**. Studies confirm that this natural concentration of fluoride helps reduce the risk of tooth decay and supports oral health, without the need for artificial additives, as is the case with some treated drinking waters.

Systematic scientific documentation of **ZamZam** water analysis began in the 1970s, in response to questions and claims raised at the time about the safety of its water. In 1971, a doctor claimed that the relatively low geographical location of the **ZamZam** well might make it susceptible to water infiltration from nearby sewage.

Based on this, King Faisal **(RIP)** ordered that official samples of **ZamZam** water be sent to advanced European laboratories for testing. The scientific results decisively refuted such claims and confirmed that:

- **ZamZam** water is entirely suitable for drinking and biologically safe.
- It has a relatively higher concentration of calcium and magnesium salts compared to other wells in Makkah, which gives it a distinct taste.

In 1976, the American Water Resources Association (AWRA) published the first documented international scientific report on the components of **ZamZam** water, which later became a primary reference for researchers in this field. This was followed by the report by Abu Saman (1982), who conducted a comparative study between **ZamZam** and several neighboring

wells, such as the Dawoodiyyah and Al-Misfalah wells. The results of the chemical analysis showed that **ZamZam** water contains a lower percentage of total dissolved solids (TDS), reflecting its relatively higher purity.

In the late 1970s, during comprehensive cleaning and maintenance operations of the **ZamZam** well, specialized divers were assigned to descend into the well and take direct samples from its feeding sources, especially those directed toward the Holy Kaaba. These samples underwent precise chemical analyses in advanced national laboratories within the Kingdom, and the results were consistent with international standards, further reinforcing the credibility of the sustained natural purity of this revered water source.

A table showing the results of the chemical analysis of the main source beneath the Black Stone.

Date	Calcium	Magnesium	Iron	Manganese	Sulphate	Copper
1979	198	43.7	0.15	0.15	370	0.12

Although the bacteriological properties of **ZamZam** water are well-documented in a large number of laboratory studies, the precise components of its microbial ecology remain a relatively underexplored topic in specialized scientific literature, as noted by Donia & Mortada (2021). This research gap is of particular importance due to the sacredness of the well and its unique environmental nature, which calls for deeper investigations using metagenomic techniques and microbial DNA analysis.

Some studies have shown that the water source closest to the Holy Kaaba is the purest in terms of microbial content, suggesting that water movement toward this location undergoes a more effective geological filtration process.

The minimal presence of microorganisms observed in other directions of the well is most likely due to incidental human activity or temporary surface environmental factors, rather than contamination resulting from a water source or permanent geological structure.

This unique microbial stability in **ZamZam** water is attributed to a combination of interrelated natural factors, most notably:

- The geological depth of the well, which ranges between 30 to 33 meters, makes it isolated from surface influences such as rainwater or floods and prevents the infiltration of external pollutants.
- Its distinctive mineral composition, which includes elements such as fluoride, bicarbonates, and magnesium, is known for its inhibitory effects on microbial growth, either by altering pH levels or by affecting the bacterial cell membrane.

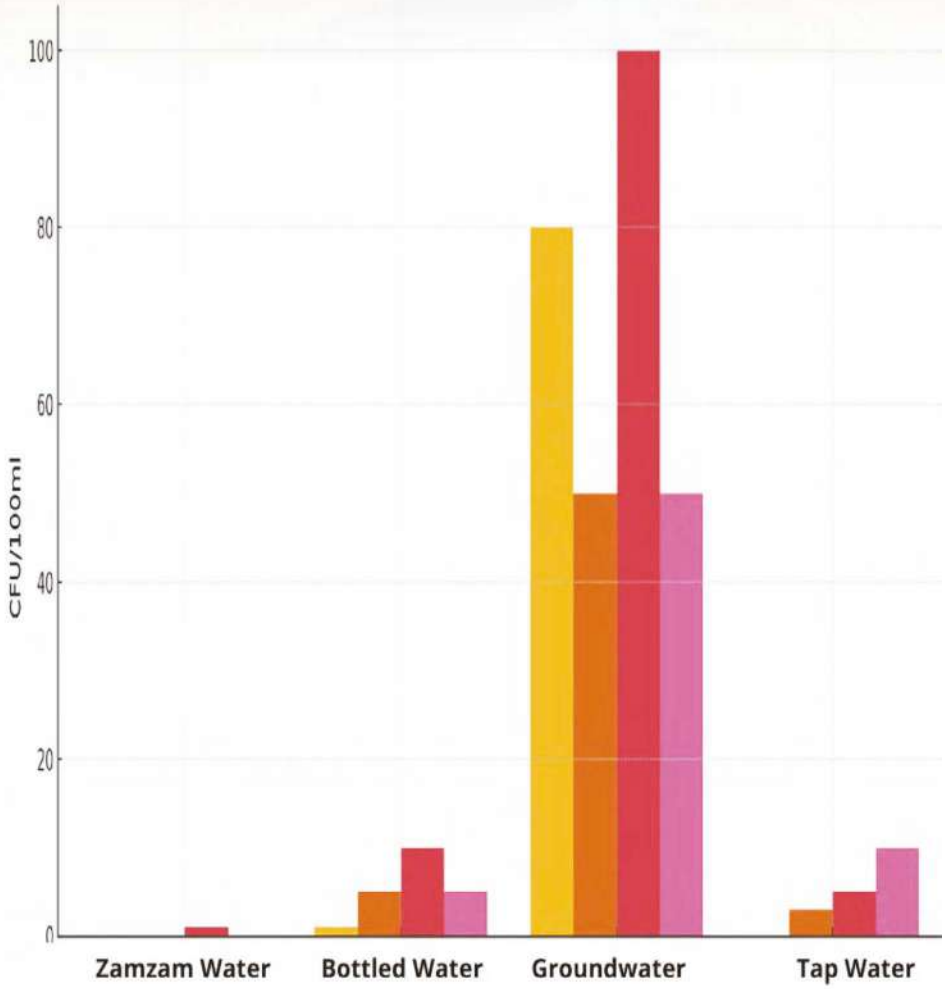
These combined properties enhance **ZamZam** water's ability to maintain its microbiological stability over time, making it a rare model of groundwater that achieves both biological safety and natural stability without any artificial intervention.

Where the samples were taken	Coliform count per 100 cm^3	Confirming tests for the Coliform group per 100 cm^3
Al Marwa	180	20
The Holy Mosque	40	0
Al Safa	340	60

A table comparing the bacterial properties of **ZamZam** water with those of mineral water and tap water, based on data from the World Health Organization (WHO, 2017), the Saudi Food and Drug Authority, and published scientific studies on the microbial characteristics of **ZamZam** water (modified from Al-Barakah, 2017; Donia & Mortada, 2021).

Tap Water	Mineral Water	ZamZam Water	Property
Absent (0 CFU/100 mL)	Should be absent (sometimes found in old samples)	May appear in trace amounts in some deteriorated networks	**Total Coliforms**
May appear in non-sterilized or old water	Should be absent (rarely appears in contaminated water)	Completely absent (0 CFU/100 mL)	**Escherichia coli (E. coli)**
May reach 100–500 CFU/mL depending on the source	10–100 CFU/mL	<10 CFU/mL, very low	**Aerobic Bacteria at 22 °C**
10–50 CFU/mL	Up to 200 CFU/mL	<5 CFU/mL	**Aerobic Bacteria at 37 °C**
May appear in mixed sewage water	Usually absent	Absent	**Fecal Streptococci**
Variable depending on network cleanliness and treatment plants	Generally compliant with standards with minor variations	Fully compliant with standards	**General Microbiological Analysis**
Common in old pipes or uncovered tanks	May be present during storage	Not detected	**Fungi and Mold Count**
May be present during storage	Possible growth in bottled water or tanks	No growth in ZamZam well at all	**Algae or Microorganism Growth at Source**
Medium	Relatively good	Excellent	**Storage Stability**

CFU is short for Colony Forming Unit



The graph illustrates a comparison between ZamZam water and other types of water in terms of the presence of Escherichia coli (E. coli), total coliform count (TCC), aerobic bacteria, and fungi and mold. As is evident, ZamZam water excels in its microbiological purity, recording the lowest values across all indicators compared to the other types. The graph is based on published data on the quality of ZamZam water from the World Health Organization (WHO, 2017), the Saudi Food and Drug Authority (SFDA), and field studies by Al-Barakah (2017), Donia, and Mortada (2021) on the microbiological properties of ZamZam water.

ZamZam Water Radiological Properties

ZamZam water is characterized by unique radiological and optical properties that serve as precise scientific indicators of water quality and physical safety. These properties also help determine the purity of the source and the stability of the geological formation that feeds it. Laboratory analyses have revealed that **ZamZam** water possesses a high degree of optical clarity along with notable radiological stability. No significant changes in these properties have been recorded, even after bottling and extended storage periods. This consistency is considered one of the important scientific proofs of **ZamZam** water's natural quality and resistance to physical or chemical degradation over time.

Detailed radiological analyses show that **ZamZam** water has a high level of radiological stability—an uncommon feature among groundwater sources globally. No noticeable changes have been observed in the levels of natural radiation, whether during extraction from the well or after bottling and storage for many months.

The **ZamZam** well is located in rock formations primarily composed of diorite and granodiorite, which are types of deep igneous rocks known for their low natural content of radioactive materials, especially compared to volcanic environments or sedimentary rocks rich in uranium and thorium. This unique geological feature significantly contributes to the purity of **ZamZam** water from harmful radiation. Recent studies—most notably Al-Amri (2025) - have shown that the concentrations of naturally occurring radioactive elements in **ZamZam** water, such as:

- Radium: Ra-226
- Thorium: Th-232
- Uranium: U-238

All fall within the safe limits set by the World Health Organization **(WHO)** for drinking water. This clearly indicates that **ZamZam** water is completely free from radioactive contamination and is entirely safe for human consumption—even with frequent and widespread use.

These results have been confirmed through high-precision spectrometric analyses conducted using advanced mass and radiological spectrometry equipment in prestigious international laboratories such as Eurofins. These analyses are scientifically credible and enhance confidence in their results, affirming that no harmful radioactive activity has been recorded in any of the tests conducted on **ZamZam** water.

Despite being consumed by millions of pilgrims and visitors annually, **ZamZam** water has an impeccable safety record, with no reported cases of radiation exposure or waterborne illnesses. On the contrary, it enjoys an excellent health reputation and is widely consumed without any documented scientific concerns. This further strengthens its status as a safe, natural, and exceptional water source.

The table presents the radiological analyses of 11 elements in ZamZam water, which were tested in international laboratories and accredited by both the International Accreditation Service (IAS) and the Saudi Accreditation Committee (SAC) (Al-Amri, 2025).

Item	Element	Result	Unit	LOQ	Approved Testing Method
1	Thorium – 230	<LOQ	Bq/L	400	ISO17294-2
2	Thorium – 232	<LOQ	Bq/L	400	ISO17294-2
3	134CS	0.00	Bq/L	---	ORTEC-SAC
4	137CS	0.00	Bq/L	---	ORTEC-SAC
5	K-40	0.00	Bq/L	---	ORTEC-SAC
6	1-131	0.00	Bq/L	---	ORTEC-SAC
7	RU-103	0.00	Bq/L	---	ORTEC-SAC
8	Uranium 234	0.00	Bq/L	---	ORTEC-SAC
9	Uranium 235	0.7	Bq/L	---	ORTEC-SAC
10	Uranium 238	0.00	Bq/L	---	ORTEC-SAC
11	Total Uranium (Metal)	<LOQ	mg/L	0.0005	ISO17294-2

All values are below the permissible limits, indicating that ZamZam water contains no harmful or hazardous radioactive activity. The comparison is based on modified results from scientific studies examining the radioactive activity in ZamZam water and other groundwater sources (Halim et al., 2007; El-Zaiat, 2016), in addition to the recommended radioactive limits from the World Health Organization (WHO, 2017). Activity is measured in becquerels per liter (Bq/L).

Radiological Property	ZamZam Water	Other Groundwater	Scientific Interpretation / Notes	WHO Permissible Limit (Bq/L)
Radium-226 Concentration	<0.1	0.3–1.0	ZamZam occurs in a granitic environment, but it is radiologically stable; other waters may be elevated in volcanic or uranium-rich regions.	0.5
Gross Alpha Activity	Very low, <0.1	Variable, occasionally exceeds limits in some regions	Indicates exceptional geological purity for ZamZam; other waters may vary depending on geology	0.5
Gross Beta Activity	Very low, <0.01	Sometimes elevated in volcanic or uranium-rich areas	ZamZam shows unique radiological stability	1.0
Uranium-238 Concentration	Very low	Variable	ZamZam is in a radiologically stable granitic environment	0.05

ZamZam Water Optical Properties

ZamZam water is characterized by exceptional clarity and transparency. Even after being bottled and stored for extended periods, no changes have been recorded in its clarity or in any of its physical properties related to appearance, taste, or smell. Analyses indicate that **ZamZam** water is:

- Free from turbidity and suspended particles.
- Its color remains stable and does not tend to change, even under different lighting or storage conditions.
- It is odorless and carries no sharp metallic taste despite containing a high concentration of beneficial elements such as calcium and magnesium. These features are linked to the low levels of organic and inorganic compounds that typically affect the optical properties of water, causing light scattering, discoloration, or loss of clarity. Laboratory experiments conducted in European labs have proven that **ZamZam** water retains its optical properties over months of storage and under various conditions, confirming its chemical consistency and natural stability.

ZamZam water displays exceptional optical characteristics that make it unique when compared to various types of water, such as regular water, distilled water, and magnetically treated water. Advanced studies have shown that this uniqueness extends to several precise optical indicators directly related to the molecular composition and physical structure of the water.

Optical Absorbance

Measurements show that the optical absorbance of **ZamZam** water is the highest among the compared samples, especially at the wavelength of 500 nanometers—a range commonly used in visible light measurements.

These high values indicate a distinct ability of **ZamZam** water to absorb light in this range, reflecting a molecular composition rich in optically active elements and ions.

Optical Transmittance

In contrast, the optical transmittance of **ZamZam** water was the lowest when compared to other types of water, indicating a dense molecular structure that reduces the passage of light through the water, often a characteristic associated with compositional purity and the absence of scattering or floating substances.

Refractive Index

The refractive index was measured at a wavelength of 8.589 nm, reaching a value of 1.3345 in **ZamZam** water, which is the highest compared to samples of drinking water and other purified waters. This indicates a higher optical density and a greater ability to compress light waves than is typical in ordinary water, reflecting a high degree of visual stability.

Optical Reflectance

ZamZam water recorded the highest optical reflectivity within the same spectrum used to compare various water samples. This demonstrates that **ZamZam** water reflects light accurately and uniformly, which is an indicator of the homogeneous distribution of molecules within the water.

Delicacy Factor

One of the most notable optical results is that **ZamZam** water achieved the highest delicacy factor among the compared samples. This indicates exceptional optical balance and the ability of the water to respond precisely and uniformly to light, translating into highly precise optical behavior.

Abbe Number:

The Abbe number, a measure of light dispersion within a transparent medium, was found to be significantly higher in **ZamZam** water, approximately 2.4 times higher than in commercial water. This indicates low light dispersion, which is an important marker of optical purity and stability in spectral behavior.

Single Oscillator Constants

According to Ahmed (2023), the single oscillator constants in **ZamZam** water were **1.5 times higher** than in ordinary water, reflecting a high spectral response and a unique ability of the water molecules to interact with light waves.

Advanced studies have revealed precise and unique optical properties in **ZamZam** water, enhancing its status as exceptional in terms of optical and physical composition. Measurements of the refractive index were conducted at six different wavelengths within the visible light range to evaluate spectral stability and uniformity in light dispersion.

Refractive Index Stability and Light Dispersion:

Results showed that the dispersion of refractive indices at a wavelength of 550 nm was 0.4 times lower than in bottled and distilled water, indicating low dispersion. This behavior reflects precise spectral uniformity and the stability of optical properties in **ZamZam** water across a wide range of wavelengths, demonstrating internal molecular balance and the absence of visually disruptive components.

Geological Interpretation of the Optical Properties

These atypical properties of **ZamZam** water are most likely attributed to the geological composition of the rocks surrounding the well. The igneous rocks, primarily diorite and granodiorite, which are rich in alkaline elements and rare minerals, contribute to forming a precise chemical composition that directly affects the optical and electrical behavior of the water. This geological–optical correlation was highlighted by El-Zaiat (2007), who demonstrated the relationship between rock composition and the optical properties of groundwater.

Electrical Conductivity and Optical Correlation

ZamZam water exhibits relatively high electrical conductivity, approximately **0.66 mS/cm**, reflecting a moderate concentration of dissolved salts. This value explains the water's balanced electrical behavior and is also linked to its high optical capabilities, as ions influence the behavior of light waves in the aqueous medium.

Long-Term Optical Stability

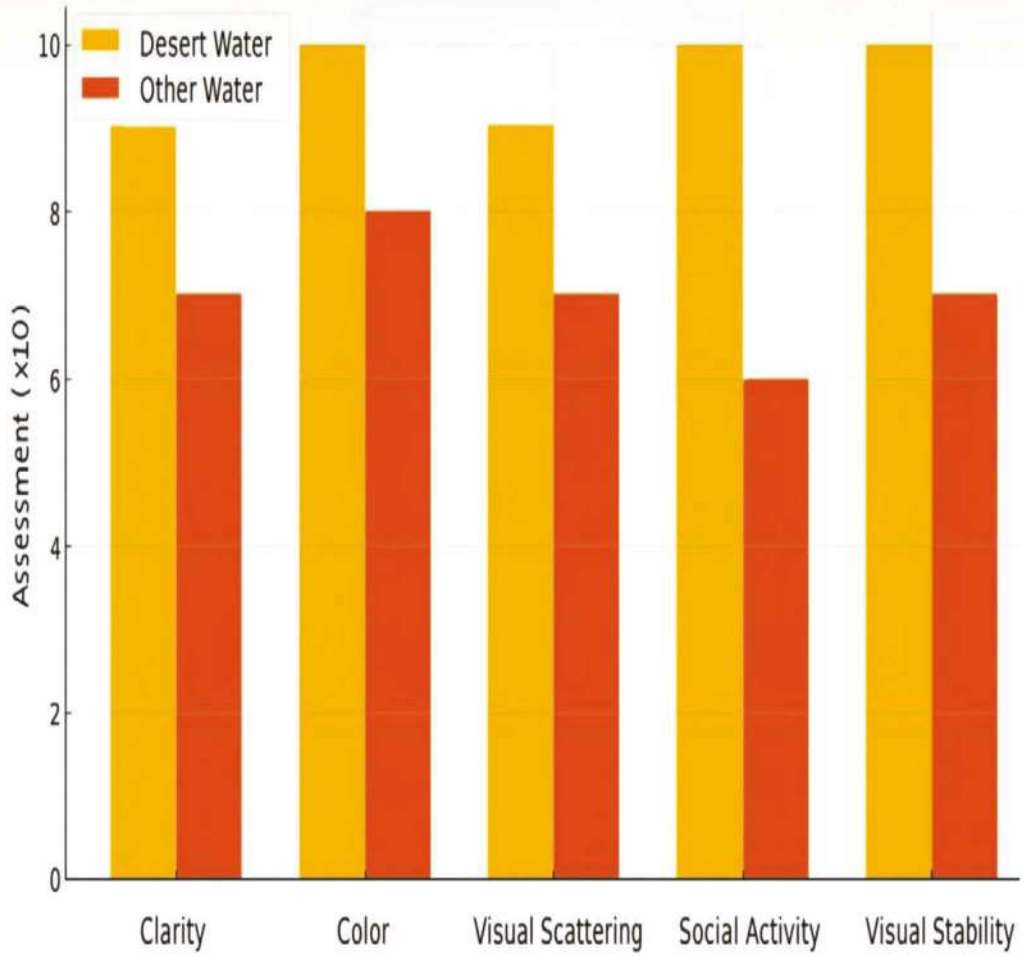
Multiple studies have shown that the optical properties of **ZamZam** water remain stable even after long-term storage in plastic containers, with no significant changes in transparency, color, or overall clarity. This was verified using ultraviolet-visible (UV-Vis) spectroscopy, which indicated a clean spectrum free of abnormal absorption peaks, demonstrating:

- Absence of harmful organic compounds
- Lack of fine impurities or absorption spots
- Exceptional optical and spectral stability

In summary, these findings collectively indicate that **ZamZam** water not only exhibits microbiological purity but also rare optical, spectral, and electrical stability. This behavior serves as a scientific indicator of the safety of its groundwater source and the stability of its geological environment. It also reinforces its reliability as pure water suitable for long-term storage without losing its physical or chemical properties.

Comparison of the Radiological and Optical Properties of **ZamZam** Water with Other Waters. The comparison relied on published results and data from the World Health Organization (WHO, 2017) and analytical studies (Modified from Halim et al., 2007; El-Zaint, 2016).

Property	ZamZam Water	Other Waters (Regular or Mineral)	Scientific Observations
Color	Completely transparent, colorless	Colorless or sometimes slightly yellowish	**ZamZam** retains its color even after long-term storage.
Transparency	Very high	Could contain visible particles or any changes sometimes	Contains no visible particles or impurities.
Refractive index (n)	Similar to pure water, ~1.3334 refractive index	May vary slightly depending on salts	**ZamZam** contains no components that affect its visual appearance.
Fluorescence	No fluorescence under UV	Some waters show a light glow	Indicates the presence of complex organic compounds
Natural radiation	Almost none of the harmful radiation activity	Natural radiation varies by geological region	**ZamZam** contains no harmful radiation
Optical Dispersion	Close to distilled water	Could get dispersed by salts and minerals	**ZamZam** does not get affected by minerals and salts
Optical Stability	Retains optical stability even after long storage	May change in color or fluorescence	**ZamZam** remains stable even after long storage



The chart illustrates a comparison between the radiological and optical properties of ZamZam water and other waters. As observed, ZamZam water excels in almost all aspects in terms of optical purity and radiological stability. The comparison is based on scientific studies addressing the radiological and optical properties of ZamZam water (Modified from El-Zaiat, 2016; Halim et al., 2007), in addition to the World Health Organization's specifications regarding levels of radiological activity in drinking water (WHO, 2017).

Optical features of ZamZam water compared to bottled water

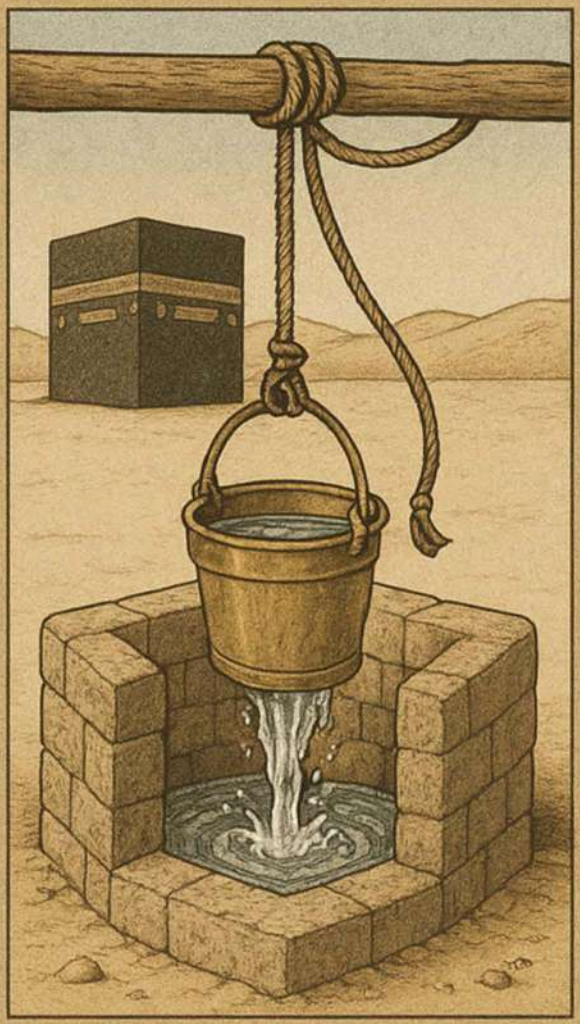
(El-Zaiat, 2007)

Water dispersion in bottles	ZamZam water dispersion	factors
-3.1907×10^{-5}	-1.2954×10^{-5}	refractive index
-9.5721×10^{-5}	-38863×10^{-5}	Group parameter
-8.5059×10^{-5}	-3.4492×10^{-5}	Allowability
-8.5059×10^{-5}	-36573×10^{-5}	Specific refraction
-2.1507×10^{-5}	-8.7312×10^{-5}	Polarity
-3.3464×10^{-5}	-1.3549×10^{-6}	Reflection
7.807×10^{-6}	-3.1587×10^{-6}	Exhaustibility

Chapter Six

Everlasting Legacy of ZamZam Water: The Secret behind its Suitability in the Age of Artificial Intelligence

Distinct Taste of ZamZam



Quality of ZamZam and its Sustainability

Scientific Fingerprint of ZamZam

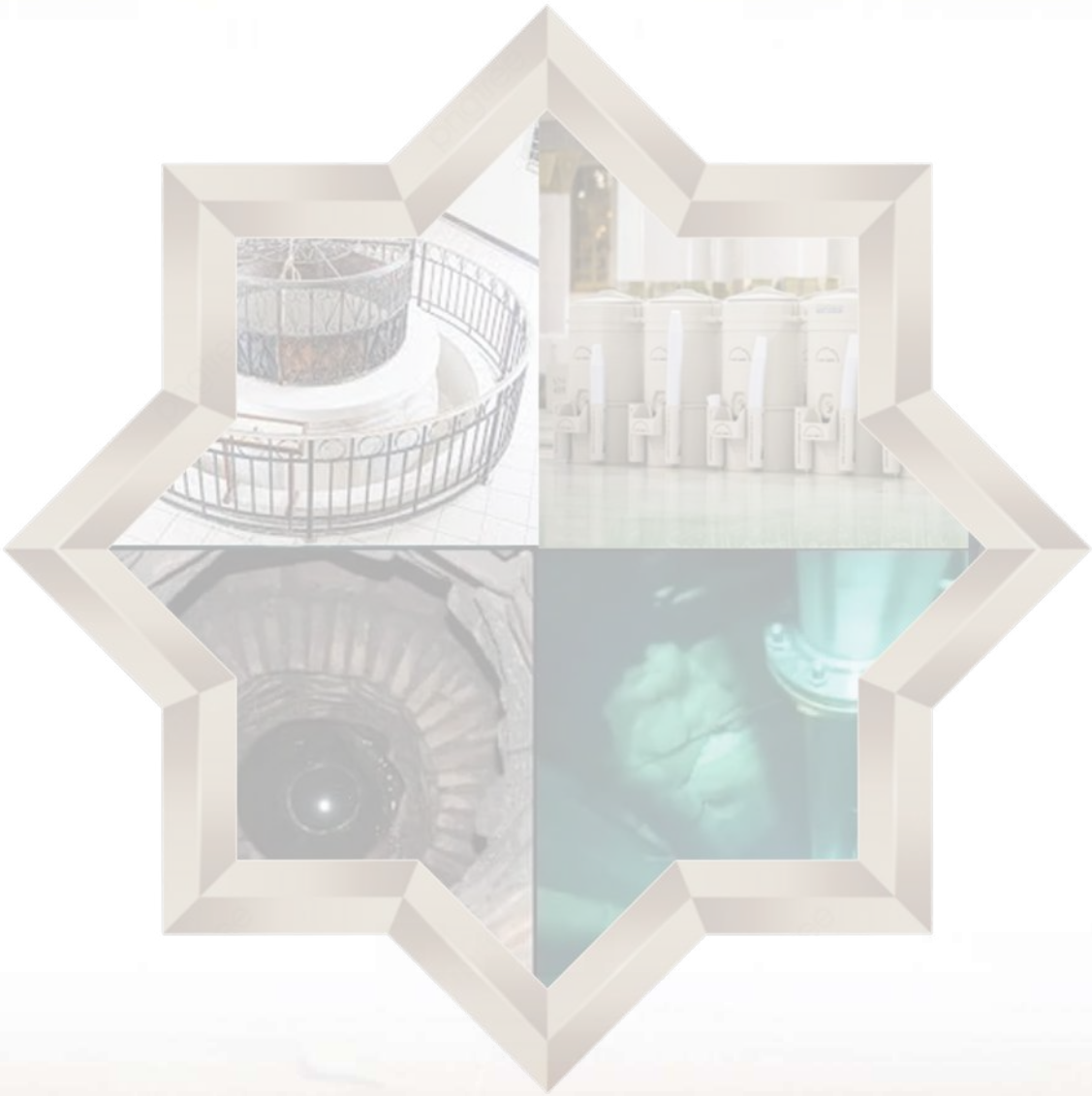
Age of ZamZam Water Using Isotopes

Scientific Research in Improving ZamZam

AI Role in the Development of ZamZam

AI and ML in Modeling ZamZam Water

Cases of AI and Internet of Things (IoT)



Introduction

With the increasing number of visitors, pilgrims, and Hajj performers each year, alongside the expanding urban development around the Holy Mosque and the evident impacts of regional climate change, managing **ZamZam** water has become a pressing imperative. This requires a smart, modern approach that effectively addresses these growing challenges while preserving the miraculous nature of this blessed water, which has flowed uninterrupted for thousands of years.

In this context, this chapter explores one of the key aspects of understanding **ZamZam** water: its distinctive taste, which has been a hallmark of its quality and purity throughout the ages. The discussion then turns to a deeper issue, the sustainability of **ZamZam** water, whose uninterrupted flow is not a mere geological coincidence but the product of a complex and unique natural system.

One of the most prominent modern scientific concepts addressed in this chapter is the "fingerprint" of **ZamZam** water, its unique geochemical identity that distinguishes it from other waters around the world. This "fingerprint" is composed of a set of precise physical, chemical, and radiological indicators that make it possible to identify **ZamZam** water even if transported or stored far from its source. Such property has enabled researchers to verify the authenticity of the water with remarkable precision and has contributed to the development of effective scientific tools for monitoring its quality and analyzing its properties.

Scientific efforts have not stopped there; they have extended to attempts to determine the age of **ZamZam** water using advanced techniques such as radiocarbon analysis (^{14}C) and isotope geochemistry studies. These have

revealed precise chronological estimates that deepen our understanding of the water's origin and the reasons for its continuous renewal over thousands of years. Such studies show that **ZamZam** is not a temporary spring fed by a shallow, passing source, but rather part of a deep and stable geological system. It is one of the most complex known hydrological systems, which grants it exceptional characteristics of continuity, purity, and regeneration, making it a living testimony to a divine miracle that transcends the boundaries of time and place.

Finally, this chapter highlights the crucial role of scientific research and collaboration between both national and international laboratories in continually studying **ZamZam** water, evaluating its microbiological and chemical characteristics, and ensuring its ongoing compliance with global health and environmental standards. By integrating smart technologies and advanced laboratory analysis, these efforts form the foundation of sustainable development of **ZamZam's** resources, ensuring its quality, and preserving its everlasting fingerprint that makes it an unparalleled water resource.

Artificial intelligence (AI), the Internet of Things (IoT), and Artificial Neural Networks (ANN) have emerged as revolutionary tools capable of understanding human behavior, analyzing its sources, and predicting future changes, thereby contributing to its sustainability without altering the water's unique natural essence. Through the use of Machine Learning (ML), Big Data analytics, and long short-term memory (LSTM) time-series models, it is now possible to monitor every aspect of the well with unprecedented precision, from water recharge and quality to seasonal and environmental variations. This provides a solid scientific foundation for developing predictive and proactive models that safeguard the **ZamZam** resource and guarantee its long-term continuity and high quality.

Artificial intelligence (AI) is used to analyze consumption patterns, predict seasonal changes, and design smart solutions for managing pumping and distribution operations, relying on vast amounts of environmental and hydrological data collected around the clock. Meanwhile, the Internet of Things (IoT) provides precise, real-time monitoring through sensors that measure water levels, quality, and flow, alongside the climatic conditions surrounding the well. AI is also supplied with accurate, real-time data used to build early warning systems for any sudden changes. As for Artificial Neural Networks (ANN), their role focuses on modeling the complex relationships between geological, climatic, and human factors, and predicting water levels and future impacts on **ZamZam**'s hydrological system.

The importance of these technologies lies not only in monitoring **ZamZam** water, but also in developing its resources both hydrologically and environmentally, by supporting engineering and administrative decision-making, and achieving the highest levels of quality and safety, without affecting its original components or miraculous properties. These intelligent systems also contribute to preserving the unique fingerprint of **ZamZam** water and maintaining its chemical and qualitative balance, which has long fascinated researchers.

Thus, the purpose of this chapter is not only to present technical information, but it also takes the reader on a journey between scientific miraculousness and faith, where the most advanced tools of artificial intelligence meet the greatest well-known to mankind. To this day, the **ZamZam** well continues to flow with mercy, its secret continually renewed, now interpreted through the language of algorithms without losing its blessing or altering its identity.

The Distinct Taste of ZamZam Water

ZamZam water has a unique taste that Allah Almighty has made its special mark, recognizable to those accustomed to drinking it, even if many long years pass without tasting it again. This distinctive flavor makes **ZamZam** different from all other types of water. Sincere believers taste its sweetness and pleasantness, and the more they drink it, the greater their love and attachment to it grow. It is reported that many of the righteous predecessors **(Al-Salaf Al-Salih)**, during their stay in Makkah, would drink only **ZamZam** water and use no other water for ablution, because of its blessing, goodness, and deep spiritual connection to the holy place.

Despite **ZamZam**'s fame for its sweetness, its taste has never been permanently fixed. The well-known traveler al-Muqaddasi (d. 990 CE) mentioned that when he performed Hajj in the year 356 AH (967 CE), he found the taste of **ZamZam** water unpleasant. But when he returned in 367 AH (978 CE), he found it had regained its good flavor. His contemporary Ibn Babawayh al-Qummi (d. 992 CE) explained: "**ZamZam** water becomes sweet at certain times but not at others because a spring from beneath the Stone (of the Kaaba) flows into it. When the water of that spring predominates, **ZamZam** becomes sweet." (Ibn Babawayh al-Qummi, 1986). This interpretation means that **ZamZam**'s taste may be influenced by other underground springs that mix with it; when its source predominates, the water returns to its true flavor.

Al-Azraqi (1969) recorded astonishing reports about the taste of **ZamZam**, narrated by his grandfather from Said ibn Salim, from Uthman ibn Saj, from Abd al-Aziz ibn Abi Rawad, from Ribaḥ, from al-Aswad, who said: "I was living with my family in the desert, then I arrived in Makkah and was freed (from bondage). I spent three days without finding anything to eat. I had nothing but **ZamZam** water to drink. Then I went to the well and knelt

from exhaustion and hunger. I was afraid that if I asked for water, I might not be able to take it. I began to draw the water little by little until I brought up the bucket and drank from it. Suddenly, I heard the sound of milk between my teeth as if I were drinking milk! I thought I was asleep or imagining it, so I splashed water on my face to make sure, but I was fully conscious. I could feel the strength and satiation of milk in my stomach." Al-Azraqi continues, quoting Abd al-Aziz ibn Abi Rawad, who told him about a pious shepherd: when he was thirsty and drank **ZamZam**, he found it to be milk, but when he intended to perform ablution, he found it to be water (al-Azraqi, 1969). These accounts show how, by Allah's will, the taste of **ZamZam** can change for one who drinks it with pure intention, so that it feels as if they are drinking food, not just water.

Al-Azraqi also transmitted from Said ibn Salim, from 'Uthman ibn Saj, from Muqatil, from al-Dahhak ibn Muzaḥim, who said: "It has reached me that drinking one's fill of **ZamZam** water is protection from hypocrisy, that its water removes headaches, that looking at it clears the eyesight, and that a time will come when it will be sweeter than the water of the Nile and the Euphrates." Abu Muḥammad al-Khuzai confirmed this, saying: "We indeed saw this in the year 281 AH (895 CE), when heavy rains fell upon Makkah, and great floods flowed, until the **ZamZam** well filled and its water level rose greatly, leaving only about seven cubits between the water and the mouth of the well. I had never seen it in that state before, nor had I ever heard anyone say they had."

He added, "At that time, the taste of **ZamZam** water was so sweet that even the people of Makkah themselves preferred it over all other water. I, along with others, chose to drink from it rather than from any other source, for it was better even than spring water. I never heard any of the elders say that they had tasted it with such sweetness before. Then, about two years later, in the year 283 AH (approximately 897 CE), the water began to return to its

usual heaviness, even though its quantity had not changed. People would say that if **ZamZam** were located in the valley floor of Makkah, its water would overflow onto the surface of the land, because the Sacred Mosque is higher than the valley, and the **ZamZam** well is higher than the Mosque." He also described how, during those heavy rains, water gushed from the mountain passes, ravines, and houses of Makkah, as if the whole city had turned into a network of springs.

Al-Fakihi (1994) narrated from Aḥmad ibn Yaḥya al-Ṣufi, who said: "I heard Yaḥya al-Ḥammani say: I heard Abu Bakr ibn Ayyash say: I drank from **ZamZam** water and found it to be milk and honey." This reflects what many scholars and devout worshippers believe: that when **ZamZam** water is drunk with sincerity and pure intention, Allah may grant the drinker from its blessing a form of nourishment beyond expectation. Thus, **ZamZam** Water may taste like milk or honey.

Al-Azraqi tells us about the taste of **ZamZam** in the time of Abd al-Muṭṭalib, the grandfather of the Prophet **(PBUH)**, saying that the water was thick and heavy for drinkers, especially in the summer. Therefore, Abd al-Muṭṭalib would try to lighten its taste by adding other substances to it.

Al-Azraqi (1969) reported: "Abd al-Muṭṭalib had many camels. When the Hajj season came, he would gather them and offer the pilgrims their milk mixed with honey in a leather basin, which he would place beside the **ZamZam** well. He would also buy raisins, soak them in **ZamZam** water, and offer this to the pilgrims to drink. He did this to soften the heaviness of **ZamZam** water, which at that time was very dense."

The people of Makkah, when fetching water from the city's wells to their homes, would often add handfuls of raisins or dates into their water skins to

improve the water's taste. Since fresh, sweet water was scarce, and the well water in Makkah was typically heavy and dense, residents relied on these simple methods to make it more palatable.

In conclusion, the taste of **ZamZam** water has not remained constant throughout the ages; it has sometimes changed due to natural conditions or underground water inflows, and at times perhaps for a wisdom known only to Allah. Nevertheless, its distinctiveness and special flavor remained evident to those accustomed to it. Indeed, some of the righteous felt that **ZamZam** water transformed in their hands into milk, honey, or complete sustenance. Such accounts have been recorded with credible chains of narration. This confirms the spiritual and doctrinal dimension of this blessed water, which gushed forth from the earth by Allah's command, served as sustenance for Hagar and her son Ismail, and has remained a source of blessing, healing, and nourishment for all who drink it with sincere intention until this very day.

ZamZam Water Quality

The **ZamZam** well stands as a unique example among the world's wells, owing to its ability to keep its water pure and potable for more than fourteen centuries, without any recorded harmful biological activity—such as bacteria or algae, despite the common occurrence of such phenomena in humid environments. This hydrological stability, despite exposure to harsh climatic conditions and continued excessive consumption, reflects a distinct hydrological and geological environment that prevents the growth of microorganisms and preserves water quality, as confirmed by recent studies (Bhardwaj, 2023).

Studies indicate that the aquifer supplying the **ZamZam** well, located in the Ibrahim Valley, is partially impacted by urban activities, which explains the elevated concentrations of certain elements, such as nitrates and potassium. However, the historically stable concentration of potassium suggests that its source is not solely anthropogenic, but also linked to the area's constant geological and environmental characteristics.

Urban expansion, particularly in the areas surrounding the Haram, has reduced the natural infiltration of rainwater into underground layers due to the paving of ground surfaces and the diversion of floodwaters into closed drainage networks. This change weakens natural groundwater recharge processes, highlighting the need to develop accurate hydrological models to analyze future recharge and assess the impact of urbanization on the aquifer balance of the **ZamZam** well.

Studies have revealed that the Ibrahim Valley exhibits higher potassium concentrations compared to the Fatimah and Numan valleys, despite the geological similarity between these valleys. This disparity is attributed to differences in land use: urban activities dominate in the Ibrahim Valley, while agricultural activities are more prevalent in the other two valleys. This finding clearly demonstrates the direct impact of human activities on groundwater quality, especially in urban environments.

Chemical analysis of the groundwater reveals unusual behavior: contrary to the general rule that ion concentrations increase along the water flow path, in the Ibrahim Valley, the concentration of total dissolved solids (TDS) locally decreases as one approaches the Haram area. This suggests the possibility of new localized recharge in that area—perhaps caused by surface leakage or human intervention in the infrastructure. Although most ions follow this declining pattern, potassium concentration remains conspicuously high, reinforcing the hypothesis that some modern recharge sources may carry unusual impurities. Potassium is an exception in this context, with its concentration continuing to rise, which supports the theory of its direct influence by human activities.

The uniqueness of **ZamZam** water becomes especially evident when compared to other groundwater sources in the region, such as the Dawoodiyyah well south of the Grand Mosque, which is characterized by a salty taste and low quality, limiting its use to service purposes. Scientific and historical attempts have failed to find an alternative water source matching **ZamZam's** physical and chemical properties, cementing its status as an exceptional water resource.

Despite some slight variations that may occasionally be noticed in its taste, **ZamZam** water has remained consistently safe to drink. The experiences of millions of pilgrims and visitors attest to its high quality, with no credible reports of adverse health effects from its consumption—in fact, drinking it is often associated with a general feeling of comfort.

Research Findings on ZamZam Water Quality

One of the most notable scientific studies analyzing the chemical and biological quality of **ZamZam** water was conducted by Al-Fadul & Khan (2011). The results showed no presence of coliform bacteria (E. cfor oli) and a complete absence of Salmonella, Shigella, fungi, and yeasts. The total bacterial count at 37°C was zero or nearly undetectable. Furthermore, the study concluded that **ZamZam** water possesses extremely high microbiological purity and well-balanced mineral components, with all its elements falling within the permissible limits set by the World Health Organization (WHO) and the United States Environmental Protection Agency (EPA). It is recommended for its safe consumption over long periods without adverse effects.

A study by Halim et al. (2016) also confirmed that **ZamZam** water is of exceptionally high quality, both chemically and microbiologically, and is completely safe for direct drinking without treatment. Moreover, it surpasses many commercially bottled waters in terms of essential mineral content and purity. Similarly, Koshak et al. (2015), in a study of 50 **ZamZam** water samples collected from different areas in Makkah, found that **ZamZam** water is free from harmful bacteria and microorganisms, even after long-term storage. The study noted that **ZamZam** water retains high quality at its source, while emphasizing the importance of monitoring storage and transportation methods outside Makkah.

Reports from the Saudi Food and Drug Authority state that all samples undergo regular testing and consistently exhibit very high purity levels. Geochemical studies (Al-Amri, RSMC: 1986–2008; 2025) indicated that **ZamZam** water has a balanced composition of dissolved elements, the most notable of which are:

- Potassium (^{+}K) is at a relatively high concentration.
- Bicarbonates (HCO_3^-) and silica (SiO_2), indicators of superior water quality.
- Sodium (^{+}Na) and nitrates (NO_3^-) within safe limits.
- A moderately alkaline pH (7.5-8), which gives the water its distinctive taste and enhances its chemical stability.

Decades of research have shown that **ZamZam** water exhibits an unusually high degree of physical stability, documented through extensive field and laboratory analyses over long periods. One of its most distinctive features is its balanced fluoride content, a mineral known for its health benefits, particularly in:

- Combating harmful bacteria: Fluoride is effective in inhibiting bacterial activity.
- Preventing natural bacterial contamination: The presence of fluoride creates an environment unsuitable for microbial growth, protecting **ZamZam** water from changes in taste or microbial proliferation even after bottling.
- Maintaining biological stability: Thanks to its antibacterial properties, **ZamZam** water remains pure for long periods without spoilage, unlike many other water sources.

The chemical analysis conducted by the Saudi Food and Drug Authority (2020 CE) showed that the fluoride concentration in **ZamZam** water ranges between 0.6 and 0.75 parts per million. Such an amount is considered completely safe according to World Health Organization standards, and even beneficial for health. A study by the Saudi Standards, Metrology, and Quality Organization (SASO, 2005), repeated in 2011 and 2018 CE, found no statistically significant differences in the water's physical properties.

The Water Research Center at King Abdulaziz University has conducted periodic tests from the 1990s to the present, concluding that pH, turbidity, and electrical conductivity of **ZamZam** water have remained remarkably stable despite changing climatic factors and expanding infrastructure around the well. This stability is attributed to the aquifer's natural geological isolation, located within an ancient rock layer protected by impermeable strata, which minimizes surface influences and interaction with organic materials. Additionally, the water's balanced mineral content and lack of biological growth contribute to its stability, even as it emerges at moderate temperatures. Examples of this stability include:

- **pH** remained within the alkaline range (7.5–8.0) despite variations in temperature and seasons.
- **Total salinity** did not change by more than ±3% between 1985 and 2020 CE, indicating aquifer stability and no significant seasonal depletion.
- **Isotope Analysis** of oxygen and hydrogen isotopes (such as $\delta^{18}O$ and $\delta^{2}H$) suggests that **ZamZam** water carries a distinctive fingerprint pointing to an ancient origin (*fossil water*) with partial modern recharge:

  $\delta^{18}O = -4.5\%$

  $\delta^{2}H = -23.4\%$

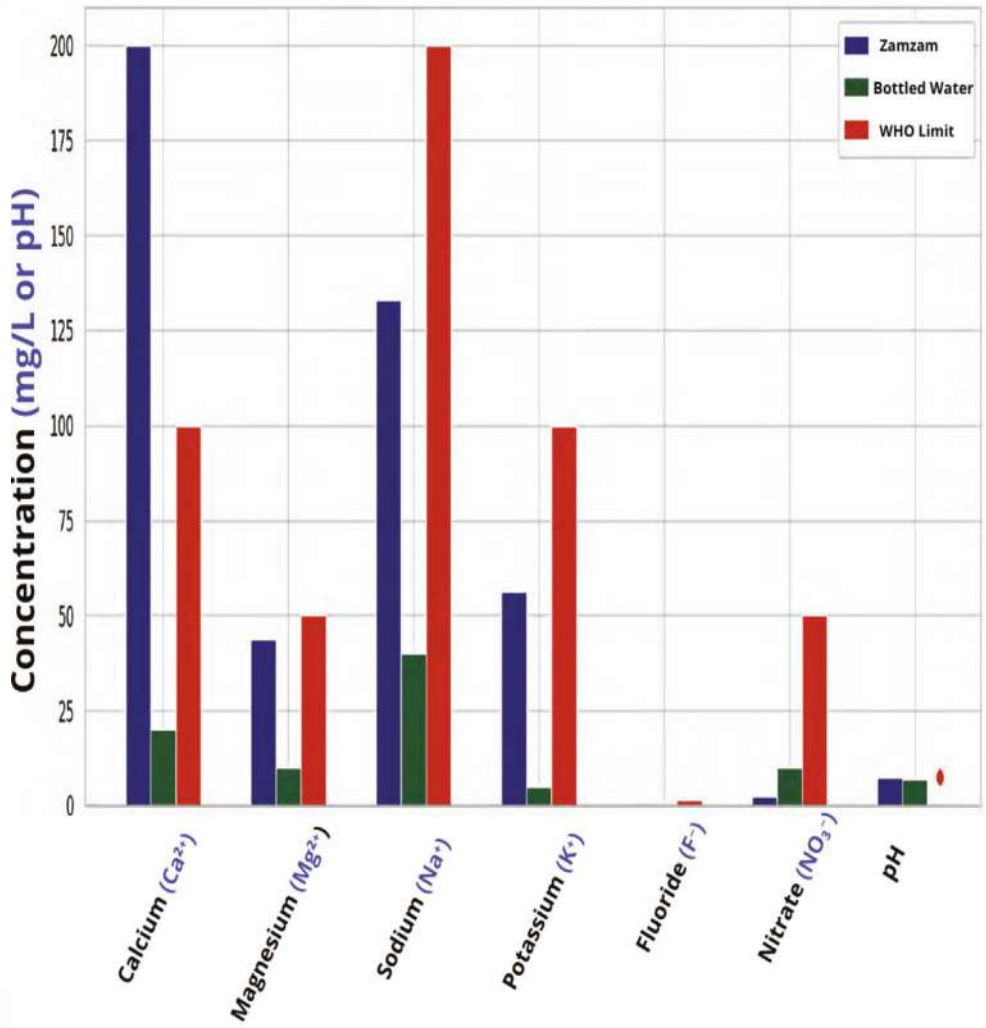
These values are lower than those recorded in local rainwater, indicating a recharge source that is not entirely surface-based. Recent studies (such as Damayanti et al. 2023) have demonstrated that **ZamZam** water has higher antioxidant capacity than some types of commercial water, with a high content of active mineral ions (such as Zn, Se). **DPPH** test results showed antioxidant activity rates exceeding 70%.

Models based on Artificial Neural Network (ANN) have been implemented to analyze visitor consumption rates during peak periods, estimate weekly withdrawals from the well, and issue automatic alerts when pumping rates exceed targeted levels.

Preserving the quality of **ZamZam** water in the face of growing urban challenges requires more than just monitoring and purification. Such a feat demands a deep understanding of groundwater behavior, precise analysis of urbanization's effects on the quality and quantity of this unique resource, and reliance on digital modeling, chemical analysis, and informed urban planning as essential pillars for safeguarding this enduring miracle.

Qualitative Comparison of ZamZam Water and Other Water Types

Property	ZamZam Water	Groundwater Wells	Bottled Drinking Water
Alkalinity	Moderate (pH 7.5–8)	Neutral to acidic	Mostly neutral (pH 7)
Mineral Content	Relatively high	Variable	Usually, low
Fluoride Presence	Natural and safe	Low or absent	Added artificially
Biological Activity	Uncontaminated	May contain bacteria	Sterilized



Parameters indicating the quality of ZamZam water compared to bottled water

Sustainability of ZamZam Water

Water sustainability means ensuring the continuous availability of water in sufficient quality and quantity to meet present needs without compromising the ability of future generations to meet their own, while preserving the natural environment of the water system. In the context of **ZamZam**, sustainability takes on a unique dimension that goes beyond environmental or engineering definitions. The **ZamZam** well is a revered religious symbol and a unique water resource distinguished by its exceptional physical and chemical properties and continuous availability. Ensuring the sustainability of **ZamZam** is both a religious and scientific obligation, requiring a delicate balance between rightful use and safeguarding from misuse or depletion. This collective responsibility necessitates the integration of modern technology, scientific research, environmental management, and public awareness to preserve this precious resource.

Pillars of ZamZam Water Sustainability

- **Hydrological Sustainability**
  - ❖ Ensuring continuous recharge of the well from the Ibrahim Valley aquifer.
  - ❖ Monitoring the balance between withdrawal and recharge to prevent depletion.
- **Environmental Sustainability**
  - ❖ Protecting the groundwater recharge area from excessive urban expansion.
  - ❖ Reducing contamination resulting from nearby human activities.

- **Quality Sustainability**
  - ❖ Preserving the water's unique attributes (taste, purity, and mineral components).
  - ❖ Closely monitoring chemical and biological changes.
- **Technical and Administrative Sustainability**
  - ❖ Using AI and the IoT to monitor water consumption and analyze recharge data.
  - ❖ Managing bottling, transportation, and distribution in line with global standards without altering the original composition.
- **Religious and Social Sustainability**
  - ❖ Ensuring fair distribution to pilgrims and visitors.
  - ❖ Preventing tampering or fraud in **ZamZam** water sold outside the Haram.

Importance of Sustainability for ZamZam Water

- ❖ Ensuring the permanent availability of this blessed water without harming the well.
- ❖ Supporting fairness in distribution within the Umrah and Hajj (pilgrimage) system.
- ❖ Strengthening public and global trust in **ZamZam**'s purity and safety.
- ❖ Avoiding over-reliance on artificial treatment and preserving the water's natural properties.
- ❖ Responding to the challenges of climate change, civilization, and the growing demand during pilgrimage seasons.

ZamZam: Between Adversity and Continuity

First: ZamZam in the Face of the Modern Era

ZamZam water, this blessed spring that has never run dry for thousands of years, now faces growing challenges due to climate change, urban expansion, and increasing human pressures. Despite its miraculous stability in purity and composition, today's reality imposes a dual scientific and moral responsibility to safeguard this unique resource, not only for its religious symbolism but also as a rare global water treasure.

Second: Contemporary Challenges Threatening the Sustainability of ZamZam Water

- **Environmental and Natural Demands**
  - ❖ Declining rainfall rates in the Makkah affect aquifer recharge.
  - ❖ Urban expansion around the Holy Mosque hinders floodwater infiltration into areas of natural recharge.
  - ❖ Significant seasonal demand during the Hajj and Umrah (pilgrimage) seasons leads to intensive consumption in short periods.
- **Human and Administrative Threats**
  - ❖ Marketing and selling water falsely attributed to **ZamZam** tarnishes its reputation and affects consumer trust.
  - ❖ Attempts to smuggle the water or refill it unofficially pose safety and quality risks.
  - ❖ Unregulated distribution outside official channels undermines the principle of fair access.

Third: National Efforts to Protect ZamZam Water

- **Infrastructure Projects and Smart Management**

  - ❖ Since 2013, the Kingdom has launched an integrated technological project to enhance the quality of **ZamZam** water, including upgrades to bottling, storage, and transportation systems.
  - ❖ Linking the system to digital monitoring networks according to the WHO and APHA standards to prevent contamination.
  - ❖ Using closed systems to transport water from the well to the Kudai bottling plant, with digital tracking for each container to ensure sterilization and prevent counterfeiting.

- **Strict Official Regulations (Since 2010)**

  - ❖ Prohibiting the smuggling of **ZamZam** outside official channels.
  - ❖ Criminalizing the refilling or selling of **ZamZam** without a license.
  - ❖ Adopting advanced technologies to detect counterfeiting, such as:
  - ❖ Fourier Transform Infrared Spectroscopy (FTIR) to distinguish **ZamZam** from other types of water with high levels of accuracy.

Fourth: Smart and Technological Solutions for Protecting ZamZam

- **Modern Monitoring and Analysis Technologies**
  - ❖ Installing deep sensors to monitor water levels in real time.
  - ❖ Utilizing artificial intelligence to analyze consumption patterns and predict peak periods.
  - ❖ Connecting all bottling and distribution stages to the Internet of Things (IoT) network to ensure monitoring and control of consumption.

- **Continuous Analysis and Quality Control**
  - ❖ Conducting periodic tests covering chemical and physical indicators using accredited laboratories.
  - ❖ Developing real-time monitoring systems linking **ZamZam** storage facilities with distribution points to ensure transparency and consumer safety.

Fifth: The Role of Scientific Research in Ensuring ZamZam Water Sustainability

- Supporting isotope analysis studies to determine the source of **ZamZam** water and understand its recharge dynamics.
- Updating groundwater maps in cooperation with research centers in Makkah.
- Studying the spectral fingerprint of **ZamZam** water to document its authenticity and combat counterfeiting.
- Developing digital simulation models to analyze the balance between future withdrawals and recharge.

Sixth: Comprehensive Management and Institutional Integration

- Managing seasonal demand through smart distribution systems that ensure fairness and prevent waste.
- Integrating digital systems inside and outside the Haram to regulate distribution and monitor consumption.
- Comprehensive maintenance of the surrounding sewage networks to protect groundwater layers.
- Prohibiting construction over the alluvial valley outcrops that naturally recharge the well.

Seventh: Raising Community Awareness and Promoting Shared Responsibility

- Raising awareness of the importance of respecting official measures and avoiding the random redistribution or sale of the water.
- Stressing the importance of **ZamZam** water as a spiritual and scientific resource that demands respect and integrity.
- Encouraging individuals and institutions to support research and respect the official channels through which they can get **ZamZam** water.

Challenges and proposed technical solutions for the sustainability of ZamZam water. The table is compiled from published technical reports of the ZamZam Project, the standards of the General Water Authority and the Saudi Geological Survey, and relevant scientific and technical studies addressing water resource sustainability in desert environments, including ZamZam water (WHO, 2017; Al-Amri, 2022; Al-Ghamdi et al., 2020).

Proposed Technical Solutions	Explanation	Challenge
• Smart distribution systems based on the Internet of Things (**IoT**) • Using **AI** techniques to predict demand and manage supplies	The increase in water consumption is due to the increasing number of pilgrims and Umrah performers annually.	Increased demand due to expansion and a large number of visitors.
• Digital Hydrological Modeling • Analyzing well data continuously through a smart underground sensor.	The possibility of the nutritional content of the water being affected by frequent well drilling.	Pressure on the groundwater reservoir.
• Using Geographic Information Systems **(GIS)** to determine risk areas and apply groundwater flow simulation techniques.	Urban infrastructure projects affect the groundwater flow paths.	Urban sprawl and its effect on the well-drilling areas.
• Smart water quality monitoring stations using devices that track water composition with infrared rays without changing the building's infrastructure.	The chemical composition of the water changes due to over-pumping or the transport and movement of the water.	Maintaining the quality of water.
• Using **Blockchain** to document the source of water and prevent manipulation by using barcodes or a dedicated blockchain to protect the source.	The spread of alarming rumors that ZamZam water is a contaminated source.	Detecting fraud and tampering with ZamZam water during the Hajj season.
• Integrated Solar Energy Adoption • Using smart pumps that consume less energy.	The need for more sustainable and energy-efficient technologies.	Energy consumption in pumping, cooling, and transportation operations.
• Establishing a unified digital platform **(Dashboard)** to monitor and analyze ZamZam data • using sensors connected to a smart control network.	The delay in interacting with any change in the level or quality of the water.	Limited access to ZamZam well data in real time.

The Role of Scientific Research in Improving ZamZam Water

Amid rapid scientific advancement, **ZamZam** water has emerged as a unique research field that combines spiritual significance with environmental and engineering interest. Over the past decades, particularly the last one, research centers and universities have shown great scientific attention, seeking to understand the distinctive properties of this blessed water and to ensure its safety, quality, and sustainability for future generations.

Laboratory studies and precise analyses have revealed fine physical, chemical, and biological characteristics that make **ZamZam** water an exception among the world's groundwater sources. These studies confirm its freedom from bacterial contaminants, its chemical stability, and its balanced, safe levels of mineral elements. Other research has shown that its properties remain unaffected even after long periods of storage, whether in plastic or glass containers—reflecting its structural stability and the absence of microbial activity.

Scientific research has also contributed to developing methods for monitoring the quality of **ZamZam** water using modern technologies such as UV-Visible Spectroscopy, hydrological modeling, and smart monitoring systems, enabling continuous quality control from its main source to distribution points in the Grand Mosque and elsewhere.

Research findings have become a key foundation in designing safe methods for sterilizing, storing, and transporting the water without altering its original composition. Some studies have even focused on understanding the "water fingerprint" of **ZamZam** by analyzing stable isotopes to identify its recharge source and the stages of its formation over time.

This section reviews the most notable findings from scientific research and field experiments over the past ten years, highlighting the latest developments in analytical techniques and their impact on improving the management of this unique resource and ensuring its sustainability amid increasing climatic and urban challenges.

ZamZam Water's Purity from Microorganisms

The results of testing three **ZamZam** water samples, collected from drinking tanks in the Prophet's Mosque, showed a complete absence of bacteria. No deposits or microbial growth were observed when the samples were cultured on **CLED** Agar plates and incubated for 48 hours at 37°C. These results confirm the findings of Mahmoud et al. (2020), who reported that **ZamZam** water is exceptionally free from any microorganism.

Health Safety on Long-Term

Comparative studies have proven that regular consumption of **ZamZam** water causes no harm to liver or kidney function. On the contrary, some of its components, such as calcium, magnesium, and selenium, help support bodily functions, while its nitrates have a positive role in dilating blood vessels and boosting immunity, thereby enhancing its long-term safety. Research has confirmed that **ZamZam** water is fit for drinking and safe for human use. These findings have served as a scientific response to certain media claims suggesting possible contamination. The study by Mahmoud et al. (2020) refuted such allegations, confirming their inaccuracy and urging reliance on laboratory data rather than general impressions.

Animal Experiments and Their Role in Assessing ZamZam Water

An experimental study was conducted on 18 white rats, divided into three groups that drank different types of water: tap water, distilled water, and **ZamZam** water. After three months, the group that consumed **ZamZam** water showed:

- A decrease in uric acid levels ($p < 0.05$).
- Improvement in cholesterol and triglyceride levels ($p < 0.05$).
- A protective effect on body tissues, with no signs of toxicity or bacterial growth in the **ZamZam** water.

The results suggest that these positive effects are related to the relative alkalinity and mineral content in **ZamZam** water.

Debate on Arsenic Concentration

Media reports have raised concerns about the possibility of **ZamZam** water containing high levels of arsenic (As), especially when bottled outside the Kingdom of Saudi Arabia. However, multiple studies, including those by Al-Amri (2025) and Fazal & Khan (2011), have shown that recorded concentrations fall within the safe limits set by the World Health Organization and Saudi standards (Khalid et al. 2014).

Purification and Quality Control Systems

ZamZam water undergoes strict monitoring using ultraviolet sterilization units with an efficiency of up to 12,000 gallons per kilowatt, without affecting taste, color, or odor. **ZamZam** samples, including bottled ones, have been subjected to chemical analyses according to APHA standards, covering indicators such as:

- pH (acidity/alkalinity)
- Total Dissolved Solids (TDS)
- Mineral elements (Na, K, Mg, Ca, Fe, Cu, Zn, Pb, Mn, Al)
- Ions (Cl^-, SO_4^{-2}, HCO_3^-, PO_4^{-3})

The results matched WHO and EPA standards, except for TDS, which recorded slightly higher values, though it does not pose any health risk (Al-Amri, 2025).

Effect of Packaging Type on Water Quality

A comparative study using Ion Chromatography (IC) was conducted to measure anion and cation concentrations in **ZamZam** water stored in glass and plastic bottles (Halim et al., 2016). The findings showed:

- **ZamZam** water in glass bottles retained its alkalinity (pH 8.31) compared to plastic bottles (pH 7.91).
- Minor differences in ion concentrations were not statistically significant. The variation was attributed to the permeability of plastic materials to air and light, which can cause slight changes in composition.
- Using the MIT test, the cytotoxicity of **ZamZam** water was measured on human glioblastoma cells (U-87). The results confirmed that:

❖ There are no toxic effects, regardless of the type of container.

❖ Ion concentrations are stable with no significant changes. Moreover, researchers concluded that **ZamZam** water is non-toxic and safe for storage, whether in glass or plastic containers. (Halim et al., 2016)

Careful Monitoring of Pumping and Consumption Rates

With the annual increase in visitors and pilgrims, studies have been conducted to determine the safe production capacity of the **ZamZam** well. Measures include:

- Installing high-precision digital meters to monitor pumping.
- Implementing strict operational programs to maintain water levels.
- Conducting regular reviews to maintain a balance between supply and consumption.

Risks of Urban Expansion on the Aquifer

The Saudi Geological Survey (2024) recommended halting all unauthorized urban projects within the boundaries of Ibrahim Valley to preserve the integrity of the **ZamZam** aquifer and its hydrogeological balance.

Al-Amri (2025) explained, based on geophysical and seismic study results, that high-rise buildings with deep foundations could penetrate the aquifer, potentially contaminating or disrupting water flow.

Types of containers and cation concentration analysis of ZamZam water (Modified from Halim et al., 2016)

Mg (mg/L)	Ca (mg/L)	K (mg/L)	NH_4 (mg/L)	Na (mg/L)	Li (mg/L)	pH	Type of container
12.93	65.85	41.16	0.12	4.43	0.059	7.91	Plastic
12.67	65.73	41.16	0.11	1.73	0.059	8.31	Glass

Types of containers and anion concentration analysis of ZamZam water (modified from Halim et al., 2016).

Type of container	pH	F (mg/L)	Cl (mg/L)	NO_2 (mg/L)	NO_3 (mg/L)	Br (mg/L)	PO_4^{-2} (mg/L)	SO_4^{-2} (mg/L)
Plastic	7.91	0.41	76.08	0.23	36.23	0.77	0.62	88.28
Glass	8.31	8.31	0.059	1.73	0.11	41.16	65.73	12.67

The Scientific Fingerprint of ZamZam Water

Just as human fingerprints differ, every underground water source has its own unparalleled "fingerprint." In environmental and hydrological research, this water fingerprint is defined as a combination of chemical, isotopic, physical, optical, and radiological properties that form a precise scientific fingerprint. Such a feature enables researchers to distinguish each water source from others, even if they are only a few meters apart.

While many groundwater sources share similar characteristics, the fingerprint of **ZamZam** water stands out as entirely unique. Its scientific composition—especially its isotope—has enabled scientists to identify it clearly and precisely among all other water types worldwide, proving the uniqueness of its source and its independence from any external water interference. **ZamZam** water has thus become not only a sacred religious symbol, but also a distinctive scientific icon that speaks to researchers in the languages of chemistry, spectroscopy, isotopes, and light. Every property tells a story of uniqueness, and every drop carries an unmatched mark of excellence. It is not only "the best water on the face of the earth," as the Prophet **PBUH** described, but also a water that speaks in the language of faith and has been validated by science.

First: The Isotopic Fingerprint

The isotopic fingerprint is specifically represented by the ratios of stable isotopes of hydrogen (^{2}H) and oxygen (^{18}O) in water molecules. These ratios are influenced by fine factors such as the water source, climatic characteristics, precipitation type, evaporation levels, or mixing with water from other sources. Because of its ancient source and desert climate, **ZamZam** water possesses a distinctive isotopic signature that appears when analyzed below the **Global Meteoric Water Line** (GMWL), indicating its meteoric origin and showing that it underwent limited evaporation before recharging the well.

The isotopic fingerprint of **ZamZam** water is determined by comparing its isotope ratios with what is known as the Meteoric Water Line (MWL). MWL is a reference line representing the relationship between $\delta^{2}H$ and $\delta^{18}O$ in natural rainwater. The basic equation for this line is:

$$\delta^{2}H = 8 \times \delta^{18}O + 10 \qquad \text{(Craig, 1961)}$$

This relation, known as the Global Meteoric Water Line (GMWL), is widely used to determine water sources and to study evaporation and recharge processes in hydrological systems.

In Saudi Arabia, however, data from the International Atomic Energy Agency (IAEA) show that the regional meteoric water line takes the form:

$$\delta^{2}H = 6.15 \times \delta^{18}O + 13.09$$

The lower slope (6.15 compared to the global slope of 8) indicates the effect of evaporation on rainwater in the region due to the arid climate and high temperatures. This lower gradient is evidence that the region's waters are influenced by harsh climatic conditions, often accompanied by high evaporation rates.

One important value in this context is the deuterium excess (d-excess), calculated by the equation:

$$\text{d-excess} = \delta^{2}H - 8 \cdot \delta^{18}O$$

The value 13.09 in the case of Saudi Arabia represents the intercept of the regional meteoric water line and reflects the humidity conditions and atmospheric temperatures during raindrop formation. High values of d-excess indicate that the rain formed in cold, dry air, whereas low values suggest warmer and more humid conditions.

Analytical values indicate that **ZamZam** water's primary recharge source is local rainfall over Makkah and its surrounding highlands. However, the clearly lower d-excess compared to the global average (approximately 10%) suggests that the water underwent partial evaporation prior to infiltration, implying that the water was exposed to surface conditions before recharging the aquifer.

This isotopic pattern typically matches what is observed in shallow or near-surface groundwater in arid or semi-arid regions, where evaporation causes selective loss of lighter isotopes, altering the ratios of $\delta^{18}O$ and $\delta^{2}H$ and reducing the d-excess value.

Based on these indicators, it can be concluded that **ZamZam** water formed from local rainwater that was relatively affected by evaporation in an open system before settling in its current aquifer, granting it a unique isotopic fingerprint that can be traced and distinguished from any other water source.

Second: The Chemical Fingerprint

ZamZam water contains a balanced ionic composition, showing high levels of calcium and magnesium, unique proportions of sodium and bicarbonate, and an uncommon natural concentration of fluoride. This mixture not only gives it its distinctive taste but also maintains its stability even after long storage or transport over great distances.

Third: The Radiological Fingerprint

At a time when concerns about radioactive contamination are increasing, **ZamZam** water proves its purity once again. There is no trace of radium, thorium, or uranium in **ZamZam** water, and all measurements of its components fall within the limits set by the World Health Organization, even after bottling and storage.

Fourth: The Optical Fingerprint

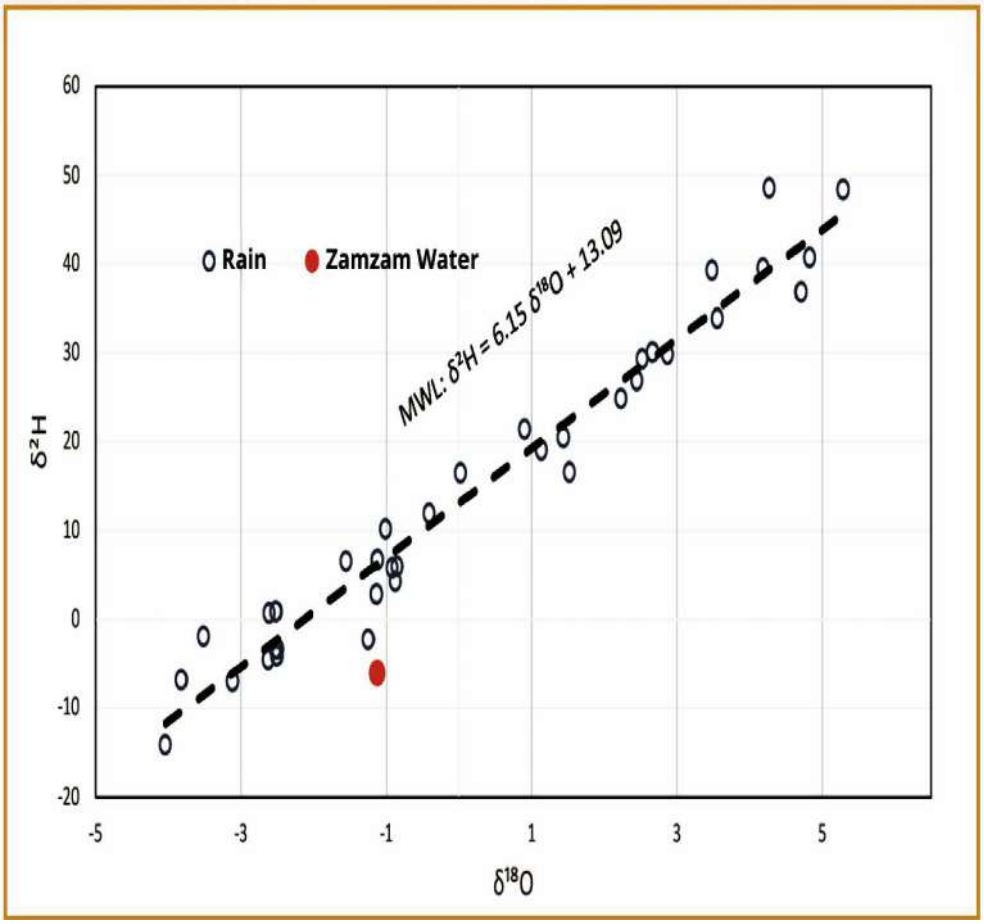
Visually, **ZamZam** water reveals astonishing properties: it has a higher refractive index than ordinary water and specific light absorption at precise wavelengths. **ZamZam** water exhibits a high Abbe number, meaning low light dispersion and a purer, more stable spectral image, as if every drop reflects a rare optical clarity.

Fifth: The Microbial Fingerprint

ZamZam water is completely free of pathogenic bacteria, with no trace of fecal coliform, harmful bacteria, algae, or fungi. Such purity requires no chlorine, ozone, or sterilization and naturally maintains its cleanliness at all times and places.

Sixth: The Temporal Fingerprint

Radiocarbon (^{14}C) analysis has revealed that **ZamZam** water has been positioned in its aquifer for over 6,175 years, dating back to a wet climatic period in the Quaternary era. It is one of the oldest known groundwater resources still in continuous use since the dawn of history.



The Meteoric Water Line (MWL) serves as a reference line to trace water and factors affecting it, such as evaporation. The MWL for Saudi Arabia $\delta^2H = 6.15 \times \delta^{18}O + 13.09$ indicates that rainfall during this period was influenced by drought conditions and high temperatures, which affected isotope ratios. The deuterium excess (d-excess) value of 13.09 represents the intersection point reflecting the humidity and temperature conditions at the time of precipitation formation.

The table shows data from the International Atomic Energy Agency (https://nucleus.iaea.org/wiser) related to the Meteoric Water Line of the Kingdom, represented by the stable isotope values of hydrogen and oxygen over various time periods.

Hydrogen $\delta^{2}H$	Oxygen $\delta^{18}H$	Water Type
10.12	-1.00	Rainfall
4.19	-0.87	
11.90	-0.41	
-4.61	-2.62	
26.84	2.45	
-2.27	-1.24	
-1.94	-3.51	
-6.88	-3.82	
48.50	4.27	
29.77	2.87	
2.80	-1.13	
29.27	2.53	
5.69	-0.92	
6.51	-1.55	
24.80	2.23	
5.85	-0.85	
6.64	-1.12	
48.32	5.29	

Hydrogen $\delta^{2}H$	Oxygen $\delta^{18}H$	Water Type
-14.16	-4.03	Rainfall
16.41	0.03	
-7.00	-3.11	
16.49	1.52	
20.43	1.44	
33.81	3.56	
39.19	3.48	
36.82	4.71	
-3.37	-2.49	
-4.17	-2.50	
-3.41	-2.52	
18.98	1.14	
30.04	2.67	
0.62	-2.60	
0.81	-2.51	
40.66	4.83	
39.49	4.19	
21.32	0.90	
ZamZam	-1.12	-6.06

Comparing the Fingerprint of ZamZam Water with Bottled Drinking Water

A series of laboratory analyses was conducted from an objective experimental perspective on selected samples of **ZamZam** water. The study aimed to verify certain circulating claims and provide reliable results grounded in scientific evidence.

Among the experiments that drew researchers' attention in this context was the work of Japanese researcher Masaru Emoto, who claimed that **ZamZam** water possesses exceptional physical properties not found in other waters. Relying on water analysis techniques at the nanoscale, he stated that **ZamZam** water exhibits a unique stability unaffected by the analytical techniques used. Moreover, Emoto stated that **ZamZam** water has an extraordinary influence, such that adding a single drop of it to one thousand drops of ordinary water would alter the latter's properties to resemble those of **ZamZam** water.

To verify the accuracy of these claims, we conducted repeated laboratory experiments using high-precision analytical tools and standardized measurement methodologies. The test results showed that samples resulting from mixing **ZamZam** water with other waters did not exhibit complete conformity with the properties of the original **ZamZam** water. Instead, they appeared closer to commercially bottled water, both chemically and physically. A slight difference in taste was also noted between the mixed samples and those of commercial water.

Nevertheless, the intriguing result emerged when **ZamZam** water was mixed with bottled drinking water at a 50% ratio, yielding a sample that exhibited a pronounced alkaline tendency, characteristic of **ZamZam** water.

This phenomenon may be attributed to a specific chemical reaction or ionic balance triggered by the mixing, warranting further investigation to elucidate the underlying mechanisms and interactions.

Multidimensional statistical analyses reveal the uniqueness of **ZamZam** water's chemical composition and its potential health benefits, clearly affirming its exceptional characteristics compared with other water types, including commercially bottled water. Using advanced analytical tools such as radar charts, chemical fingerprinting, principal component analysis (PCA), and heat mapping, it becomes evident that **ZamZam** water maintains a distinct and unique geochemical pattern—supporting the widespread claims about its therapeutic benefits.

The extracted data indicate that **ZamZam** water has significantly higher concentrations of total dissolved solids (TDS), sodium, and bicarbonates (which influence water alkalinity), in addition to nitrates, compared with regular bottled water, even when highly diluted (such as mixing 50% with ordinary water). This high mineral concentration is attributed to the original alkaline nature of **ZamZam** water, which is likely one of the key factors behind its historical reputation as a source of natural hydration and associated health benefits.

Previous studies have shown that higher alkalinity enhances water's efficiency in hydration and contributes to maintaining the body's acid-base balance. This property has also been linked to potential medical effects, such as improving digestion and aiding detoxification. For this reason, many global companies have adopted techniques to produce naturally or artificially alkaline water and market it as a health-conscious choice backed by the growing global demand for "functional" water.

From a practical standpoint, the present study revealed that mixing **ZamZam** water with bottled drinking water results in a gradual shift in the resulting sample's properties toward the distinctive characteristics of **ZamZam** water, particularly its pH level and mineral content. The heat map, based on a logarithmic scale, shows that certain chemical compounds, such as nitrates, sodium, and TDS, not only display a slight increase but also appear at concentrations tens or even hundreds of times higher compared to reference water. This sharp contrast represents a clear geochemical fingerprint that facilitates distinguishing **ZamZam** water from other waters.

The use of the logarithmic scale in statistical data analysis enhances the accuracy of interpretation, as it enables the detection of both minor deviations and large variations, providing a comprehensive visual model of the water's chemical structure. Through this approach, subtle differences that might not be visible using traditional methods become apparent, adding an extra dimension to the analytical distinction of **ZamZam** water. Ultimately, the results of this multi-level analysis reinforce the conclusion that **ZamZam** water maintains a strong and consistent mineral identity, even under various dilution conditions, and that its chemical and physical properties remain unique compared with any other commercially available drinking water.

The attached table presents a detailed comparison between **ZamZam** water and bottled drinking water in terms of physical and chemical characteristics, to clarify similarities and differences between them. The data have been organized in a systematic design that allows analysis of the transformations occurring in water composition when the two are mixed in different ratios. The horizontal axis represents fifteen key physical and chemical parameters, including but not limited to: pH, total dissolved solids (TDS), electrical conductivity, and ion concentrations such as:

Sodium, potassium, calcium, magnesium, bicarbonates, and nitrates. As for the vertical axis, it represents different mixing ratios between **ZamZam** water and bottled drinking water, starting from 100% pure **ZamZam** water, followed by gradual dilutions (of 75% **ZamZam** - 25% bottled water, 50%–50%, 25%–75%), and finally 100% pure bottled drinking water. This gradient-based analysis enables a precise study of how chemical and physical properties change depending on mixing ratios, contributing to scientifically grounded conclusions on the extent of **ZamZam** water's influence on other waters when mixed, and deepening the understanding of the geochemical mechanisms underlying the stability of its distinctive properties.

The table presents a detailed comparison between ZamZam water and bottled drinking water in terms of physical and chemical characteristics.

Component	Unit	ZamZam Water 100%	Bottled Drinking Water 100%	Drop of ZamZam Water mixed with 1 Liter of Bottled Water	330 ml of ZamZam mixed with 1 Liter of Bottled Water	660 ml of ZamZam mixed with 1 Liter of Bottled Water	1 Liter of ZamZam mixed with 1 Liter of Bottled Water
pH	---	8.28	7.14	6.98	7.75	7.96	7.99
TDS	mg/L	386	110	114	185	225	256
Total Alkalinity	mg/L	139	11	8	41	60.0	74.0
Total Hardness	mg/L	149	81.2	82.3	95.8	105	105
Nitrate (NO_3^-)	mg/L	2.67	<0.01	<0.01	0.66	0.95	1.38
Sodium (Na^+)	mg/L	59.7	5.4	6.8	19.0	27.4	33.4
Potassium (K^+)	mg/L	43.0	<0.01	<0.01	11.6	18.2	23.1
Calcium (Ca^{+2})	mg/L	43.7	25.6	26.2	29.3	31.7	30.6
Magnesium (Mg^{+2})	mg/L	9.6	4.2	4.1	5.5	6.3	7.0
Chloride (Cl^-)	mg/L	73	42.0	49.0	50.0	55.0	54.0
Sulphate (SO_4^{-2})	mg/L	57.8	15.7	16.5	25.9	31.9	36.7
Fluoride (F^-)	mg/L	0.5	1.1	1.0	0.9	0.8	0.8
Iron (Fe^-)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phosphate (PO_4^{-3})	ppm	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromate (Br^-)	µg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0

Distinct Differences Between ZamZam Water and Bottled Drinking Water

Statistical data presented in the previous table reveal a set of distinct differences between **ZamZam** water and bottled drinking water, particularly when they are mixed in varying proportions. The results showed notable changes as follows:

- Changes in taste when **ZamZam** water is mixed with bottled water, the resulting water acquires taste characteristics different from both sources, indicating a compositional interaction that influences the sensory perception of the water.
- Changes in odor where the smell of the mixed water was found to be relatively less pleasant compared to the natural aroma of pure **ZamZam** water, which may be linked to changes in ionic balance or interactions between trace organic compounds.
- Changes in turbidity where no significant differences were recorded in turbidity between samples before and after mixing, suggesting that the optical clarity of the water remains stable and unaffected by blending.
- Changes in electrical conductivity where conductivity increased gradually with higher proportions of **ZamZam** water in the mixture. However, it remained below the conductivity level of pure **ZamZam** water in all cases, yet higher than that of bottled drinking water, reflecting a partial transfer of ionic properties with progressive composition changes.
- Changes in phosphate concentration where measurements showed clear stability at all mixing stages, with values consistently below 0.002 ppm (Parts per Million), indicating that this parameter is unaffected by dilution or blending.

- Changes in pH level rose progressively with increasing **ZamZam** content, though it did not reach the alkaline levels of pure **ZamZam** water. However, it clearly exceeded the pH of bottled water, indicating that **ZamZam** water raises alkalinity when mixed, albeit without achieving its full level.

- Changes in total dissolved solids **(TDS)** where its levels increased gradually with the proportion of **ZamZam** water in the mixture, remaining higher than those recorded for bottled drinking water but still below the distinctive values of pure **ZamZam** water.

- Changes in total alkalinity (associated with Bicarbonate Concentration) where a gradual rise was recorded with higher **ZamZam** content in the mixed samples. While the values stayed well below those of pure **ZamZam**, they clearly surpassed those of bottled water.

- Similarly, total hardness (calcium carbonate) showed a comparable pattern, with a gradual increase.

- Bromate concentration analyses - a compound resulting from water treatment with ozone—showed stable values before and after mixing, remaining below 5 µg/L, indicating a high safety level.

- Other mineral elements exhibited a similar pattern, gradually increasing with higher proportions of **ZamZam** water, although not reaching their original values. Nonetheless, these values remained higher than those found in bottled water. These included nitrates, sodium, magnesium, potassium, calcium, and chloride. The increases in nitrate, sodium, and potassium concentrations were relatively prominent and higher, while the increases in magnesium, calcium, and chloride were more moderate.

- Interestingly, unlike the other elements, fluoride concentration decreased gradually after mixing, remaining below bottled water levels while still above the original values of **ZamZam** water. Likewise, sulfate concentration stayed far lower than that of pure **ZamZam** water, though it rose noticeably compared with the reference bottled water.

- Finally, iron maintained a low and stable concentration in all samples before and after blending, staying below 0.01 mg/L, enhancing the quality of the resulting water in terms of heavy metal content. Taken together, these results indicate that **ZamZam** water retains its distinctive chemical properties to varying degrees even when diluted, and its balanced chemical behavior grants it a unique level of stability and health standards, supporting earlier conclusions about its distinction from all other commercially available bottled waters.

Physical and Chemical Interpretation of the Changes Resulting from Mixing ZamZam Water

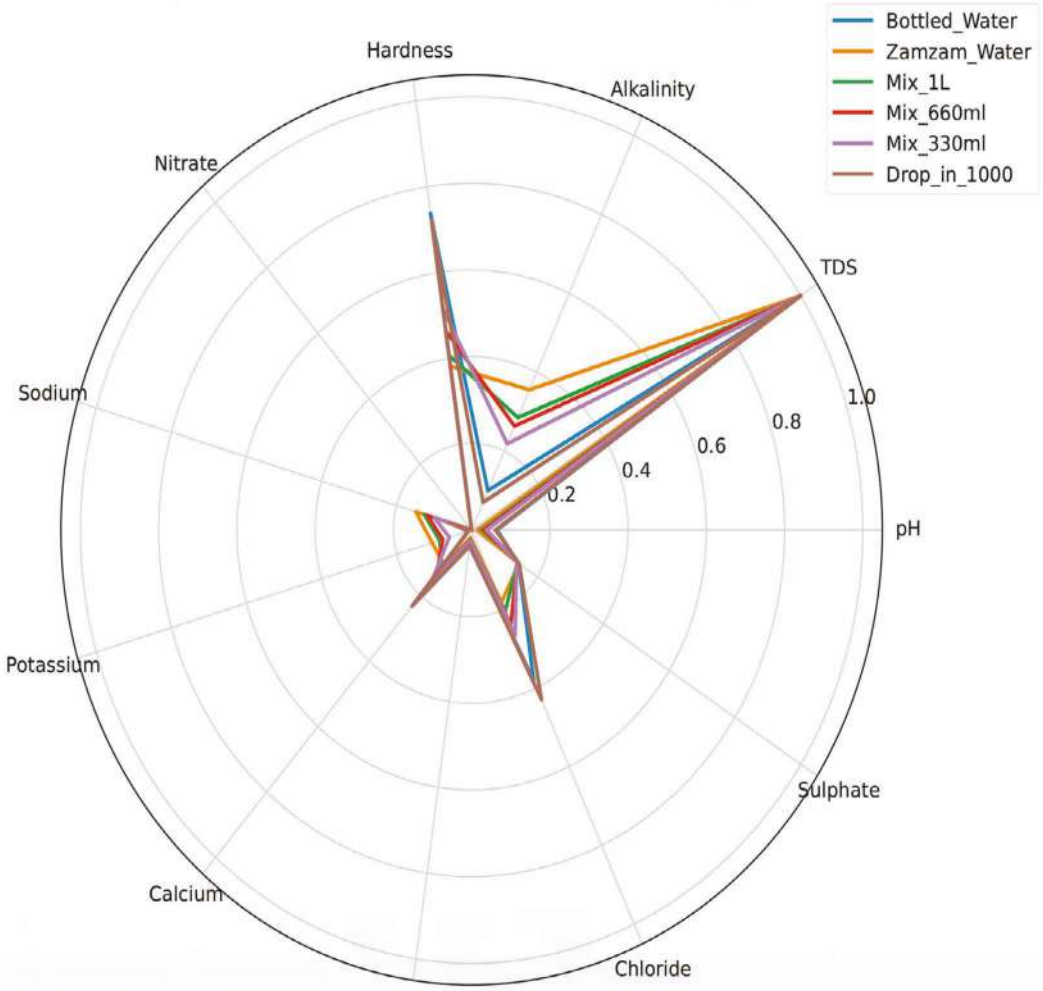
The preceding analyses show that mixing **ZamZam** water with bottled drinking water in varying proportions produces gradual and noticeable changes in the physical and chemical characteristics of the resulting water, highlighting the profound influence of **ZamZam** water even at high dilution levels.

- Physically speaking, a consistent increase in electrical conductivity was observed with a higher proportion of **ZamZam** water in the mixture. This increase is attributed to the high concentration of dissolved ions in **ZamZam** water, including sodium, chloride, bicarbonates, and sulfates. Although the total conductivity did not reach its original level in pure **ZamZam** water, it exceeded the values recorded in bottled drinking water. This behavior is interpreted as the result of ions transferring and gradually integrating into a lower-concentration aqueous medium, in a dynamic process that reflects the rich geochemical balance of **ZamZam** water.

- Chemically speaking, most chemical compounds, such as total dissolved solids (TDS), nitrates, alkaline bicarbonates, sodium, magnesium, calcium, and others, showed an upward trend in concentration proportional to the percentage of **ZamZam** water added, without reaching the original levels of pure **ZamZam** water. This pattern indicates that **ZamZam** water retains its distinct mineral influence even when heavily diluted with other waters, reflecting its cohesive and stable chemical nature.

- In contrast, some compounds, such as phosphates and iron, remained at consistently low and stable levels before and after mixing, indicating a high degree of chemical stability for these elements and their resistance to change through blending. Conversely, fluoride exhibited a different pattern, with its concentration gradually decreasing after mixing, although it remained higher than its original level in **ZamZam** water—suggesting a unique interaction with this element in the mixing process. This behavior calls for more detailed future studies to understand its reaction mechanism. In simple scientific terms, **ZamZam** water imparts its distinctive mineral fingerprint to the resulting mixture, gradually transferring its geochemical characteristics even at high dilution ratios. These results support the study's conclusion that **ZamZam** water maintains its physical and chemical uniqueness at all dilution levels, making its properties difficult to mask or eliminate when blended with other waters. However, the detailed quantitative analyses conducted in this study do not support Japanese researcher Masaru Emoto's claim that a single drop of **ZamZam** water is enough to alter the properties of a thousand drops of ordinary water—an assertion previously disproved by experimental data and precise analytical methods.

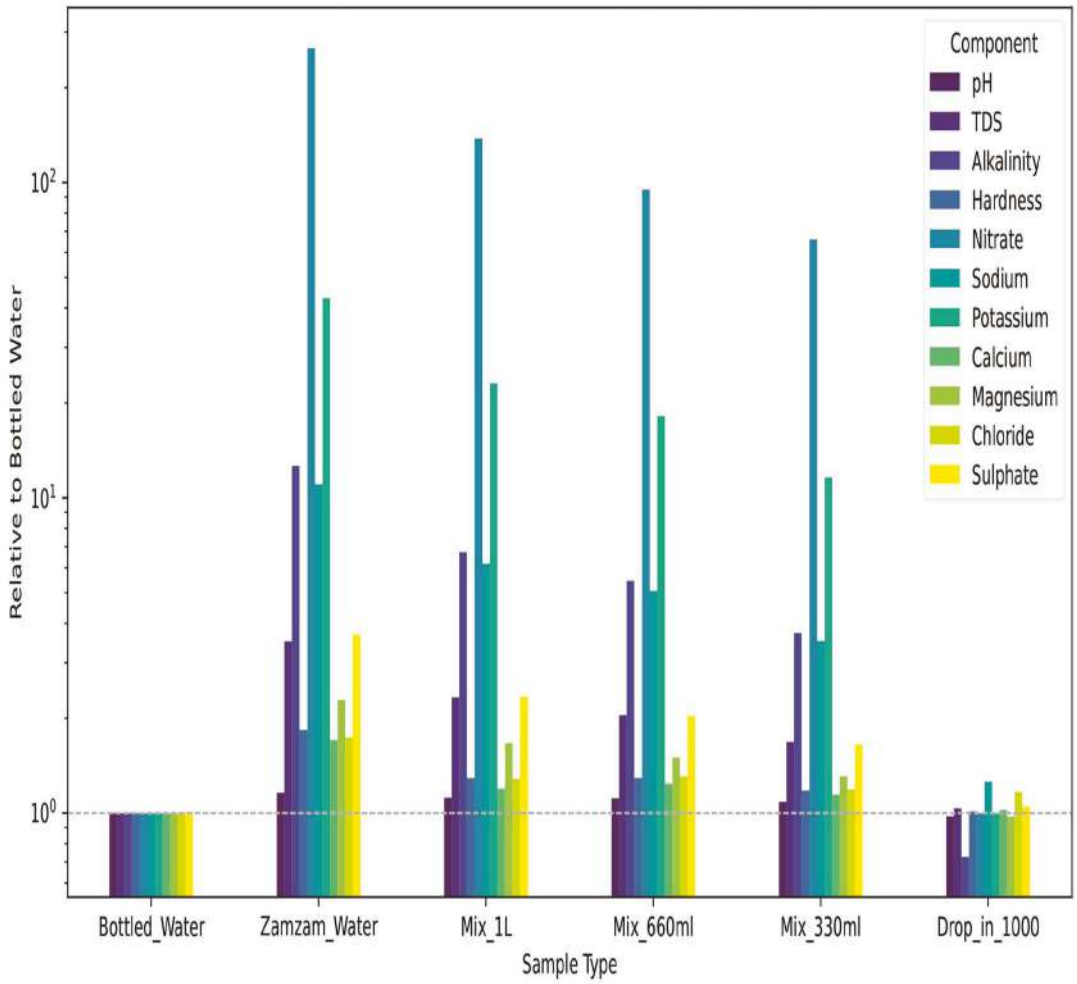
The normalized radar chart illustrates **ZamZam** water's calibrated chemical fingerprint compared with bottled water and the various mixture ratios between them, starting from pure **ZamZam** water (100%) down to the highest studied dilution level, represented by a single drop of **ZamZam** water added to 1,000 drops of bottled water. The standard min-max normalization technique was applied to all chemical values, enabling direct and objective comparison of the main chemical compounds across all samples. This analysis clearly highlights the distinctive chemical characteristics of **ZamZam** water, particularly its high levels of total dissolved solids (TDS), sodium, and alkalinity (bicarbonates), which remain distinguishable even at very low concentrations. These results reflect the high compositional stability of **ZamZam** water and its ability to retain its unique fingerprint within a mixture of other waters, further reinforcing the credibility of its exceptional nature as demonstrated by other analytical indicators in this study.



The radar graph shows the normalized chemical fingerprint of ZamZam water.

The bar chart illustrates the relative chemical fingerprint of **ZamZam** water and its mixtures compared with bottled water, using a logarithmic scale. This approach enables the detection of both subtle and large differences in chemical composition among the samples. Bottled water was adopted as the baseline reference (baseline = 1), with each relative value calculated by normalizing the concentration of each chemical component in the sample against its corresponding value in bottled water.

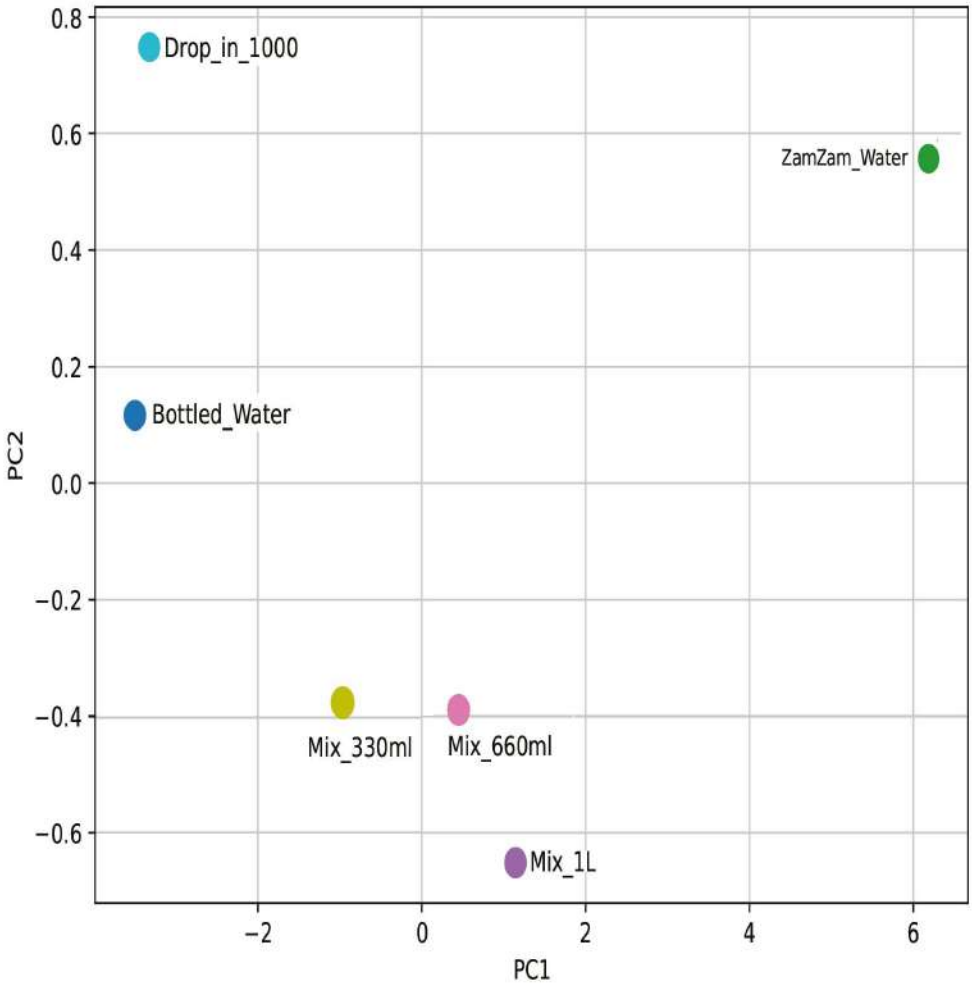
This scale allows for a precise understanding of the degree of variation: a value of 2 indicates that the component's concentration in **ZamZam** water is twice that in bottled water, while a value of 10 means the concentration is ten times higher. According to this methodology, the analysis results showed that **ZamZam** water contains significantly higher concentrations of several key elements, most notably sodium (about five times higher), nitrates (around 12 times higher), and total dissolved solids **(TDS)** (three times higher), compared with bottled water. These results quantitatively and clearly highlight the unique chemical fingerprint of **ZamZam** water, demonstrating its distinctiveness in terms of mineral and geochemical composition, even when compared with the most common bottled drinking waters. Moreover, the use of the logarithmic scale has proven effective in revealing subtle differences that may not be as apparent in traditional linear representations, adding further credibility to the analysis of fine chemical variations among the studied samples.



The bar chart illustrates the relative chemical fingerprint of ZamZam water and its mixtures compared with bottled water, using a logarithmic scale.

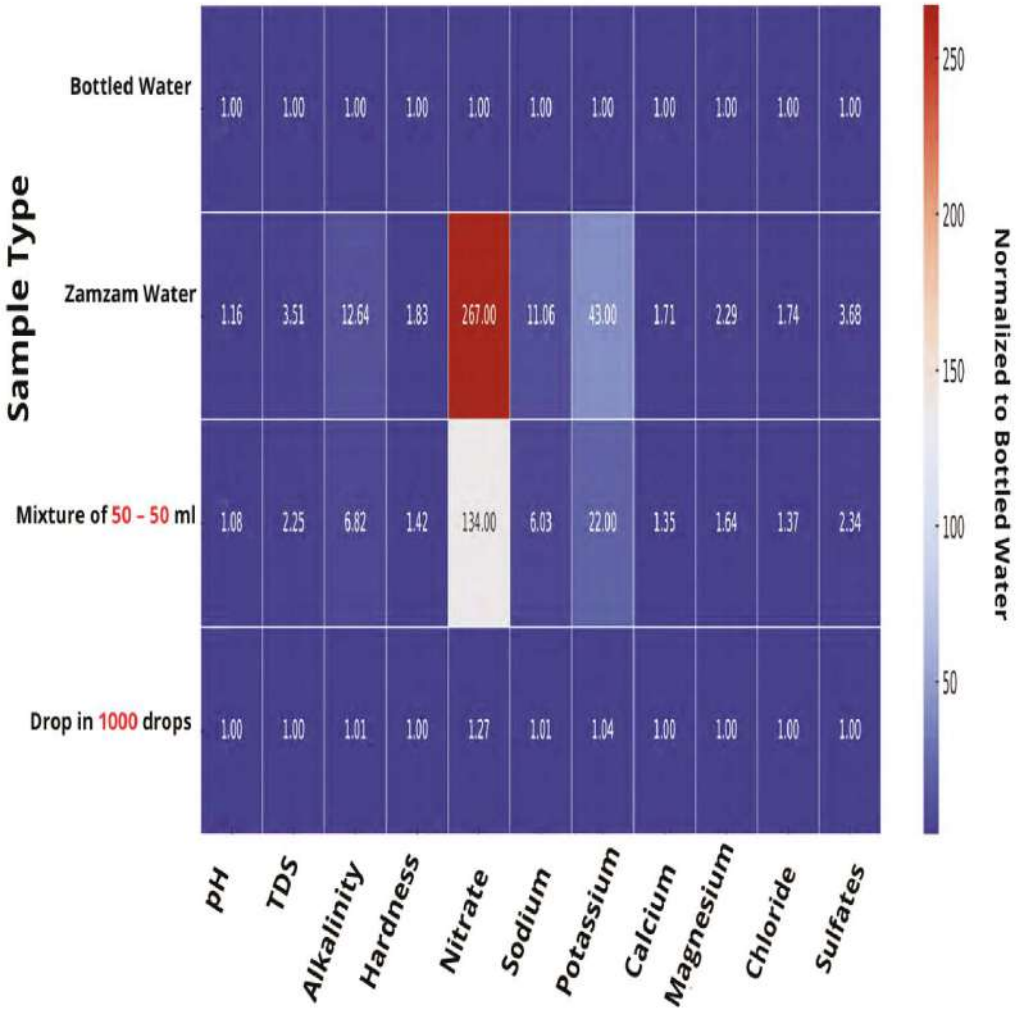
Principal Component Analysis (PCA) is used to simplify the underlying variations in a multivariate chemical dataset by reducing them to two principal components (Component 1 and Component 2) that account for the largest proportion of the total variance in the data. This analysis helps highlight hidden patterns and distinguish between the studied samples based on their chemical characteristics.

As shown in the graph, the **ZamZam** water sample stands out clearly from the other samples—particularly from bottled water and mixtures resulting from dilution, indicating a distinct and unique chemical identity for **ZamZam** water compared to the other samples. The intermediate positions of the sample mixed at a 50% ratio (**ZamZam**/bottled) and the sample diluted at the ratio of one drop of **ZamZam** water in 1,000 drops of bottled drinking water show a gradual shift toward the bottled water axis. This reflects a logical behavior for the composition of mixed samples and aligns with progressive chemical regression models associated with the dilution ratio. This clear separation in the PCA space confirms the unique geochemical nature of **ZamZam** water and supports other analytical results, such as logarithmic and radar analyses, which likewise demonstrated the stability and distinctiveness of its chemical composition even under high dilution. From a scientific standpoint, this pattern serves as additional evidence of the structural stability and compositional uniqueness of **ZamZam** water, explaining its ability to retain its chemical fingerprint even when mixed with large amounts of other water sources.



Principal Component Analysis (PCA) is employed as a statistical technique to reduce and interpret the underlying variations within multivariate chemical datasets, thereby facilitating a more comprehensive understanding of complex data structures.

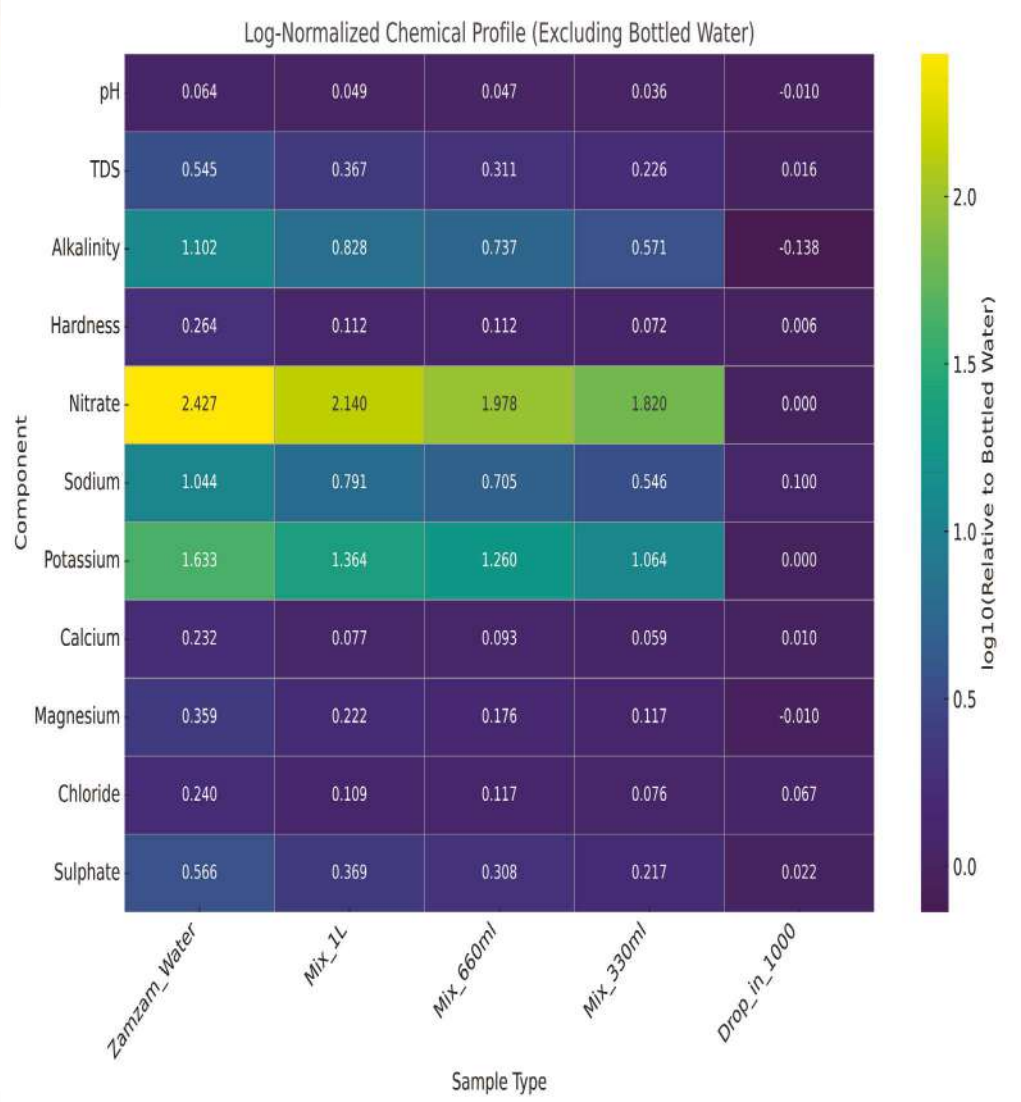
The simplified heat map provides a visual analysis of the concentrations of eleven major chemical components in various water samples, comparing these values to the reference level for bottled drinking water, which is set at the normalized value of 1. The map is based on the assumption of a linear relationship between chemical concentrations, making it easier to directly and clearly interpret the relative differences among the samples. The design ensures complete clarity in distinguishing concentration levels, with special focus on components showing high variability, such as sodium, nitrates, and alkalinity (bicarbonates). These components appear prominently in the darker color pattern for **ZamZam** water, reflecting its rich mineral content and distinctive geochemical composition. Visually, this heat map underscores the fundamental differences between **ZamZam** water and bottled water and clearly demonstrates the preservation of **ZamZam** water's unique characteristics even in mixed or diluted samples, thereby enhancing the scientific understanding of its unique chemical identity.



The simplified heat map provides a clear visual interpretation of the spatial and comparative variations in the concentrations of eleven principal chemical constituents across multiple water samples.

This heat map presents a logarithmic display of the concentrations of the main chemical components in **ZamZam** water and its mixtures, compared to bottled drinking water, which was excluded from the chart to avoid complicating the visualization and to highlight differences more clearly. The values shown are based on the logarithm with base 10 of the ratio between the concentration of each component in the sample and its corresponding concentration in bottled water. This approach makes it intuitive and straightforward to interpret differences of an exponential nature. The logarithmic transformation here serves as an effective tool for enhancing contrast and improving data interpretability, particularly for components that show large disparities, such as nitrates and sodium, whose concentration differences range from 10 to 100 times those in bottled water. Positive logarithmic values indicate a concentration higher than the reference ($\log(1) = 0$), while negative values indicate dilution compared to bottled water.

For example, the nitrate concentration in pure **ZamZam** water shows a logarithmic value exceeding 2.4, indicating a concentration more than 250 times higher than that in bottled water, underscoring the mineral richness of **ZamZam** water. This heat map captures both subtle and extreme deviations in concentrations, allowing for the creation of a precise and well-defined geochemical fingerprint of **ZamZam** water mixtures, thereby enhancing the understanding of the unique chemical characteristics of this water source.



This heat map provides a logarithmic visualization of the concentrations of the key chemical constituents in ZamZam water and its blended samples, while explicitly excluding bottled drinking water for comparative clarity.

Estimating the Age of ZamZam Water Using Radioactive and Stable Isotopes

Determining the age of groundwater, such as **ZamZam** water, relies on analyzing the composition of naturally occurring isotopes in the water, which include stable isotopes such as deuterium (^{2}H) and oxygen -18 (^{18}O), and radioactive isotopes such as tritium (^{3}H) and carbon -14 (^{14}C). Tritium, deuterium, and oxygen -18 are among the primary isotopes in the water molecule; hence, they are widely used in studying the sources and history of water.

In the case of modern water that is still influenced by the atmosphere, tritium can be used to estimate the water's age. Tritium is a radioactive isotope of hydrogen that decays over time into helium -3 (^{3}He). It has a half-life of about 12.4 years. By measuring the remaining tritium content alongside the amount of helium -3 produced, the original tritium concentration at the time the water entered the aquifer can be calculated, allowing for age estimation with an accuracy of ± one year or less.

For old or fossil water, carbon -14 is used to determine the age with high precision. The accumulation of helium -4 (^{4}He), produced by the natural radioactive decay of uranium and thorium within the Earth's crust, can also serve as an additional indicator of age. In studies dealing with the oldest groundwater, isotopes with longer half-lives, such as chlorine -36 (^{36}Cl) and iodine -129 (^{129}I), are used to help understand water movement in deep and complex aquifer systems.

Determining the Age of ZamZam Water Using Radiocarbon

Radiocarbon dating (^{14}C) is a recognized scientific method for estimating the age of groundwater. This technique relies on the properties of the radioactive isotope carbon -14, an unstable isotope consisting of six protons and eight neutrons, which undergoes natural radioactive decay over time.

In the case of **ZamZam** water, analysis of the stable carbon isotope -13 ($^{13}C = -20.6$) indicated that the carbon source in the water may originate from biologically derived organic material, such as decomposed plant matter in the soil, suggesting a link to the photosynthetic cycles of plants. This serves as an important indicator for understanding the carbon pathways in the human-related hydrological system.

Radiocarbon (^{14}C) is used directly to determine the water's absolute age, based on the decay rate of this isotope. According to international conventions, the reference used for calibrating radiocarbon results is the standard approved by the U.S. National Institute of Standards and Technology (NIST), known as the Oxalic Acid Standard (SRM 4990C-11).

According to the Libby Method, which uses the radiocarbon half-life of 5,730 years, and based on ISO/IEC 17025:2017 quality and accreditation standards, analysis of a **ZamZam** water sample showed that its age is approximately **6,175 years**. This finding reinforces the belief in the antiquity of this blessed source and its unique geological characteristics.

Confirmation of the Ancient Origin of ZamZam Water from Radiocarbon Isotopes Analysis

An analysis of a groundwater sample from **ZamZam** water showed a significant decrease in radiocarbon (^{14}C) concentration, clearly indicating that this water belongs to the category of ancient waters. Based on this decline, together with an analysis of the stable carbon isotope (^{13}C) ratio in the sample, the age of the water was calculated to be approximately 6,175 years.

Although radiocarbon dating is highly accurate, relying on it alone may not be sufficient in all cases, as results can be influenced by "hydrological mixing" processes. For example, a sample may contain a mixture of very old water, possibly tens of thousands of years old, and recent water from rainfall, floods, or fresh surface sources. In such cases, the calculated age may not necessarily reflect the true age of the original water, but rather the average age resulting from this mixing.

Therefore, to achieve more accurate and reliable results, additional independent methods are used. One of the most prominent and widely applied is the measurement of the concentration of the radioactive isotope tritium (^{3}H), an isotope of hydrogen. Tritium is a powerful tool for tracing recent water, particularly because its atmospheric concentrations rose sharply during the period of nuclear testing in the 20th century, making it an excellent time marker for studying the renewal and history of groundwater.

Limitations of Radiocarbon Dating and the Importance of Tritium Measurement

The atmosphere in the 1950s and 1960s experienced a substantial increase in tritium concentrations (^{3}H) as a result of nuclear testing carried out during that period. Because tritium has a relatively short half-life (about 12.4 years), its concentration in the atmosphere, and therefore in rainwater,

has decreased over time, although it remains much higher than its levels in ancient groundwater. Consequently, tritium measurements can distinguish between recent and ancient water: modern rain-derived water records tritium concentrations between 50 and 100 Tritium Units (TU), while concentrations in ancient water are below the detection limits of modern instruments.

This distinction is crucial because some groundwater samples may yield very old ages when dated using radiocarbon, suggesting prolonged isolation. However, when the same sample is examined using tritium measurements, elevated concentrations may be found, indicating that the water is not entirely ancient, but rather a mixture of old and recently infiltrated water from rain or floods. This means that the radiocarbon-calculated age does not accurately represent the true age of the water, but instead reflects the average age of a blend from different sources.

A global study confirmed this conclusion: researchers used radiocarbon dating to analyze 6,455 datasets worldwide from aquifers described as ancient and not receiving modern recharge. Nevertheless, the results showed that nearly half of these wells contained relatively high tritium concentrations, indicating that the groundwater in these wells was not entirely old, but the result of mixing between ancient and more recent waters.

Confirmation on the Ancient Origin of ZamZam Water Based on Tritium and Radiocarbon Results

To address the potential issue of mixing old and recent waters, which could affect the accuracy of age estimation using radiocarbon (^{14}C), a direct measurement of tritium isotope (^{3}H) concentration was conducted on a sample of **ZamZam** water. The results showed that the tritium concentration in the sample was below the detection limit of modern instruments, meaning the levels were extremely low and could not be precisely quantified. This sharp

depletion of tritium indicates that **ZamZam** water belongs to the category of "ancient fossil water", with only a very small possible proportion of recent water mixed in.

This finding reinforced the results obtained from radiocarbon (^{14}C) analysis, which also showed a marked decline in this isotope's concentration, serving as a strong indicator of the ancient nature of the groundwater in the **ZamZam** well. To ensure the accuracy and quality of the results, a dedicated quality assurance report was prepared for the radiocarbon analyses. This report included data from certified reference materials with known values, analyzed alongside the studied sample. The radiocarbon results were reported as a comparison between the measured and expected values, with corrections applied based on the reference standards of the U.S. National Institute of Standards and Technology (NIST) using the SRM-4990C reference sample. Additional corrections for isotope fractionation were also made to ensure the highest possible precision and reliability.

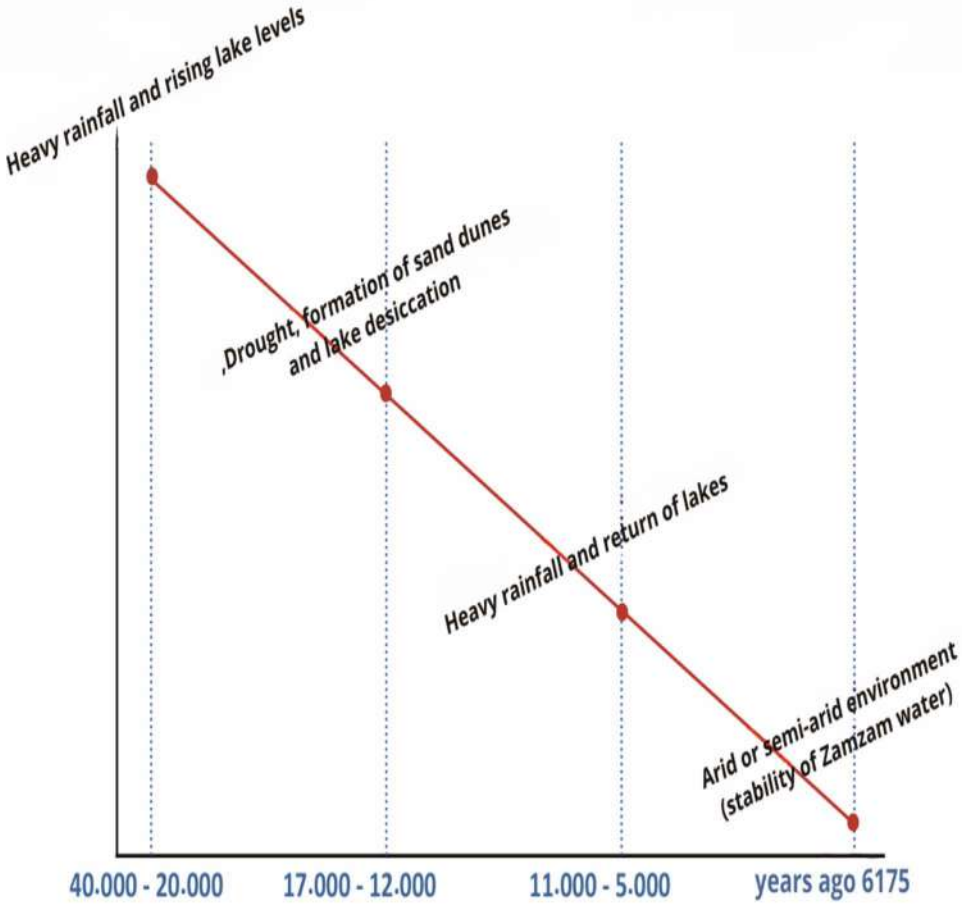
Linking the Age of ZamZam Water to Ancient Climatic Changes

These scientific findings are consistent with the conclusions of Khalid et al. (2014) in their study of groundwater in the Arabian Peninsula, which indicated that the source of **ZamZam** water is linked to the ancient climatic conditions of the late Quaternary period, when rainfall was more abundant, enabling natural recharge of deep groundwater.

Global paleoclimate studies based on sediment and environmental isotope analyses indicate that regions lying between 20° and 25° North latitude, including Makkah, situated at latitude 21° North, have experienced several major climatic fluctuations over the past 40,000 years, summarized as follows:

- **40,000–20,000 years ago**: A humid period prevailed, characterized by heavy rainfall and higher lake levels.
- **17,000–12,000 years ago**: Tropical regions experienced prolonged droughts accompanied by the formation of dunes and a notable drop in lake levels.
- **11,000–5,000 years ago**: Rainfall returned in abundance, and lake levels rose sharply. This is the most likely period during which the aquifer feeding the **ZamZam** well was recharged.
- Based on the results of the radiocarbon analysis, which determined the age of **ZamZam** water to be approximately 6,175 years, it can be said that the final emplacement of the water at the current location of the well occurred under climatic conditions similar to the arid or semi-arid climate that characterizes the region today. This scientific conclusion is consistent with the description stated in the Quran regarding the environment in Makkah in the words of Prophet Ibrahim **PBUH**: ﴿*Our Lord, I have settled some of my descendants in an uncultivated valley near Your sacred House*﴾ [Ibrahim: 37].

- This connection between modern scientific data and the Qur'anic text offers an integrated perspective that brings together science and faith, affirming the unique geological and religious significance of **ZamZam** water as a distinctive water resource formed under exceptional natural conditions.



A chart illustrating the chronological sequence of climatic conditions and their impact on the formation of ZamZam water. The chart is based on scientific studies that examined the evolution of climatic conditions during the Holocene and pluvial periods, and their influence on the formation and recharge of the ZamZam aquifer, drawing on data from geological and climatic research (Al-Amri, 2025 ; Khaled et al., 2014)**.**

Artificial Intelligence Role in the Development of ZamZam Water Resources

Introduction

Artificial Intelligence (AI) and the Internet of Things (IoT) are among the most prominent modern technologies that professionals need to understand thoroughly, given their significant role in enhancing performance and improving work environments. The Internet of Things involves connecting everyday devices and tools to the internet, enabling them to collect, exchange, and analyze data intelligently and automatically. When these two technologies combine, they create smart systems capable of improving the efficiency of water resource utilization. AI and IoT have demonstrated their effectiveness in optimizing the use of water resources, which has driven scientists and specialists worldwide to focus more on developing and implementing these technologies in water-related projects.

The global water sector is facing accelerating challenges amid increasing climate change and the depletion of natural resources that were once considered abundant and sustainable. Extreme weather events, such as sudden droughts and severe flash floods, have become recurring realities that complicate the ability to predict water availability and exacerbate problems of scarcity and contamination. These challenges not only affect the quantity of available water but also extend to affect its quality, the efficiency of infrastructure, and the sustainability of treatment and distribution systems.

Amid this crisis, Artificial Intelligence stands out as one of the most advanced and effective technological solutions. Its use contributes to achieving sustainability goals related to providing clean and safe water, in alignment with Saudi Arabia's Vision 2030. AI applications in this field are diverse, encompassing rule-based intelligence, machine learning, neural networks, and generative AI such as ChatGPT.

Moreover, AI has the potential to bring about a qualitative transformation in the way water resources are managed, not only by improving operational efficiency but also by providing intelligent predictive tools that enable a major leap toward long-term sustainability. AI offers a range of advanced applications that address major challenges in the sector, including:

- **Smart monitoring of water quality** through sensor systems connected to analytical algorithms that continuously track chemical and physical parameters such as pH, turbidity levels, chlorine concentration, and the presence of microbial contaminants, ensuring that changes are detected as soon as they occur.

- **Early leak detection** using machine learning techniques to analyze data flows from water networks and identify abnormal patterns that may indicate leaks in underground reservoirs or transmission pipelines, enabling rapid intervention and reducing losses.

- **Intelligent infrastructure maintenance management** with predictive algorithms that determine optimal maintenance schedules and identify critical points in the network requiring urgent attention, lowering costs and improving service continuity.

- **Flood prediction and proactive management** by integrating meteorological data, hydrological surveys, and rainfall simulation models to create early warning systems that help prepare for extreme weather conditions and minimize potential damage.

- Enhancing water resource efficiency through smart systems that monitor and analyze consumption patterns, propose improvements, reduce waste, and promote principles of sound management and sustainable water governance.

AI's role is not limited to crisis management. It extends to becoming a strategic partner in building a secure water future where data, knowledge, and technology form the three pillars of water security in an ever-changing world.

Smart Water Systems: the integration between Technology and Artificial Intelligence

Smart Water Management Systems (SWMS) are a vivid example of how artificial intelligence and data analytics can bring about a transformative shift in the water sector. These systems integrate precision sensors, cloud computing services, and real-time data analytics to monitor water quality, improve distribution efficiency, and optimize usage based on accurate, continuously collected and analyzed information.

SWMS operate by combining and analyzing live data to enhance water distribution and conservation. With the rapid pace of digital transformation, the integration of AI technologies with cloud-based analytics platforms has become a practical model showcasing the tremendous potential of smart technology to support authorities in monitoring water operations instantly and with high precision. This integration empowers decision-makers with reliable real-time data, strengthening their ability to take prompt, well-informed actions and improving the efficiency of water resource management.

Key potential applications of this model include:

- Real-time monitoring of **ZamZam** water quality through the deployment of smart sensors connected to cloud computing platforms to measure salinity, mineral levels, and contaminants, with automatic alerts when deviations from standards are detected.
- Optimizing **ZamZam** water distribution by analyzing demand data from pilgrims and visitors, linking it with machine learning algorithms to determine optimal quantities at distribution points, reducing waste, and ensuring swift responses to actual needs.

- Forecasting future water demand using AI models based on seasonal data, pilgrim numbers, and climatic conditions to aid in storage and supply planning.
- Detecting leaks or faults in transport and distribution systems with advanced algorithms that track flow patterns and identify anomalies, speeding up preventive maintenance.
- Integrating Geographic Information Systems **(GIS)** with AI to create heat maps that pinpoint areas of high consumption, guiding investment toward the most in-need locations.

Best practices for maximizing AI benefits in water management include:

❖ Comprehensive data collection and analysis on water usage patterns. Smart water management depends on precise data on daily, seasonal, and sector-specific consumption (residential, agricultural, industrial). In major cities such as Singapore, consumption data is used to identify neighborhoods with high wastage and direct targeted awareness campaigns or infrastructure upgrades.

In Saudi Arabia, agricultural consumption in arid regions can be monitored via satellites and sensors to estimate losses and provide targeted technical support.

❖ Applying Machine Learning Models to Forecast Future Water Demand. AI leverages techniques such as **predictive analytics** to estimate future water demand based on factors like weather data, population growth, and economic activity. In Australia, such models are used to forecast drought seasons and provide early recommendations for water rationing or increased storage. A similar model could be trained in Makkah to predict consumption during the Hajj season based on historical pilgrimage data and the expected number of pilgrims.

- Deploying Smart Meters and Real-Time Monitoring Sensors. Smart meters can measure water consumption with high precision, every hour or even every minute, and transmit the data directly to a control center. In California, smart meters have enabled the detection of household leaks within minutes of their occurrence. Sensors could be installed in the **ZamZam** reservoir to measure water levels, quality, and flow toward distribution points within the Haram.

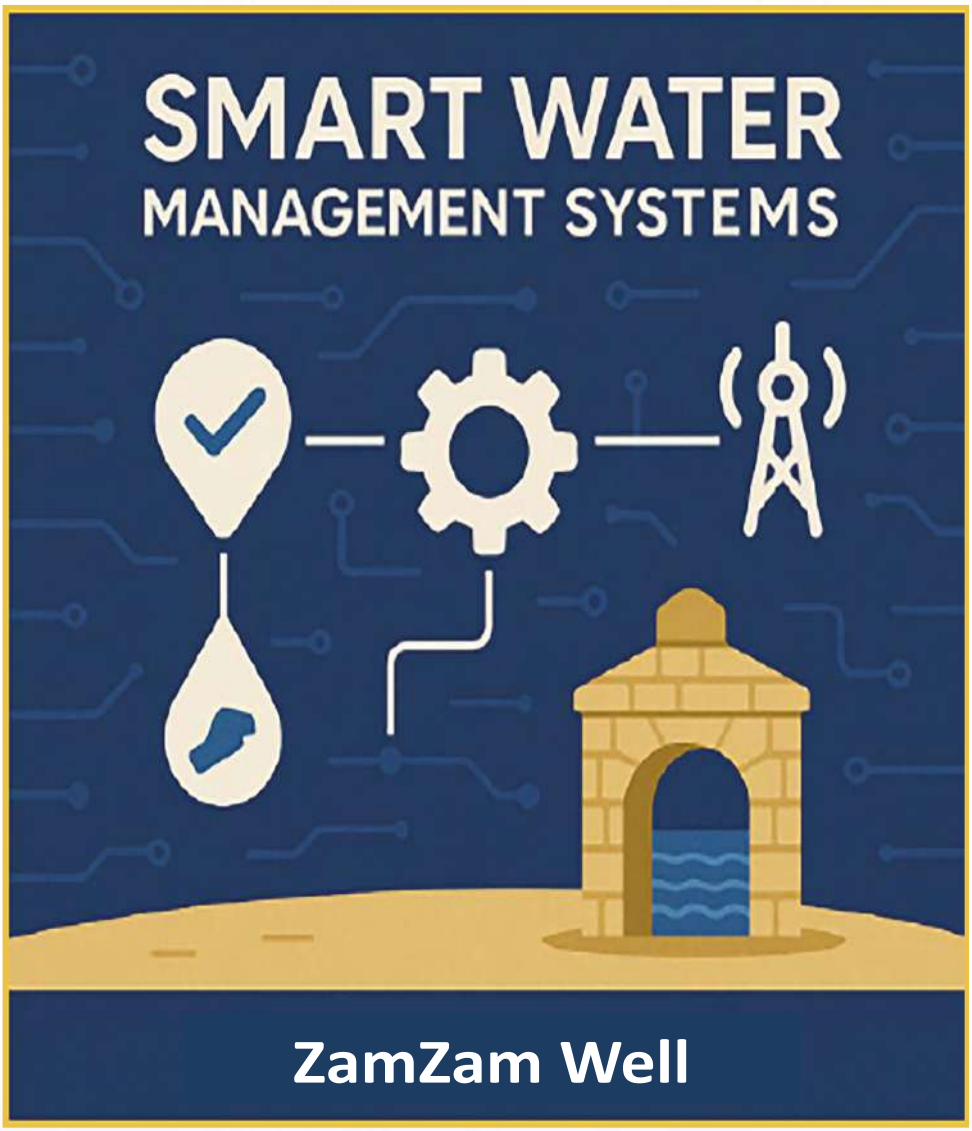
- Developing Robust Water Data Processing Infrastructure. Data has no value unless it can be stored and analyzed quickly. Strong data centers and communication networks are essential.

  Dubai, for example, uses a "smart dashboard" that displays real-time water status to decision-makers. Cloud platforms (such as AWS or Azure) could host data from thousands of water sensors, enabling AI-powered analysis.

- Strengthening Cybersecurity to Protect Water Infrastructure Data Water infrastructure is considered a critical target, making protection from hacking and cyberattacks essential. In the United States, strict security standards were enforced after an attempted hack of a Florida water system in 2021. **ZamZam** water storage and distribution data should be rigorously encrypted to prevent tampering or the leakage of sensitive information on storage volumes and distribution patterns.

- Raising Public Awareness on Water Use and Technology Alone is not enough. Citizens must understand their role and use water mindfully, supported by data. Apps like "Dropcountr" send users monthly consumption alerts and compare them with neighborhood averages to encourage responsible behavior. A dedicated app for the Haram could display daily **ZamZam** water consumption to pilgrims, fostering appreciation for this valuable resource.

- Designing Flexible Solutions That Consider Geographical and Social Differences One model cannot be applied everywhere; solutions must be tailored to local conditions. In mountainous areas, drones can monitor waterways and natural recharge sources.



Smart Water Management Systems (SWMS) monitor water quality, enhance distribution efficiency, and promote its rational use.

Artificial Intelligence: Opportunities and Challenges in Water Management

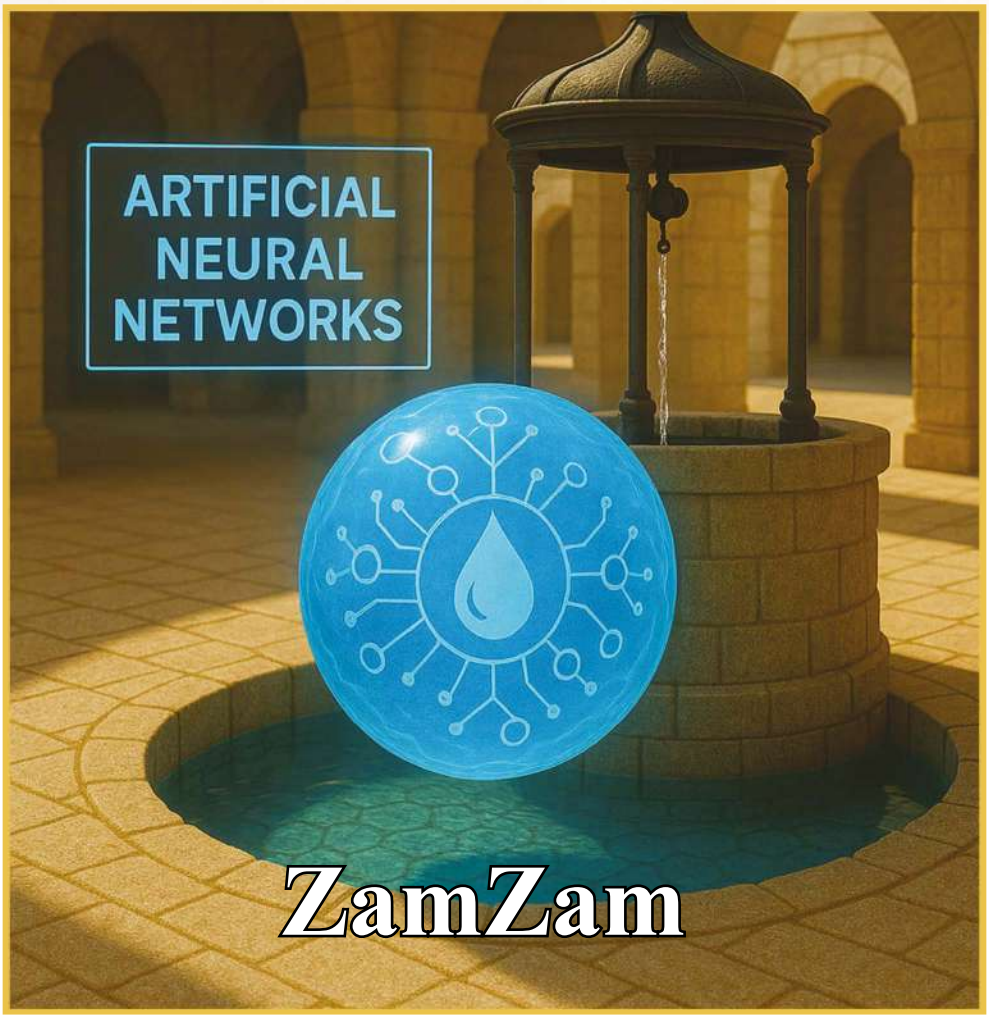
With the increasing complexity of challenges related to groundwater management, from data scarcity and changing climatic conditions to the difficulty of predicting pumping and recharge, artificial intelligence has emerged as a golden opportunity to reshape the way we understand and manage this vital resource. But how, in practice, can AI truly make a difference?

Here, artificial neural networks (ANNs) emerge as a model that mimics the way the human brain thinks, making it adept at recognizing complex patterns in hydrological data, such as water level fluctuations or long-term rainfall impacts. Picture this: using an ANN to analyze **ZamZam** water data over the years to forecast peak periods or seasonal variations.

On the other hand, the ANFIS system, a hybrid of artificial intelligence and fuzzy logic, steps in to fill the gaps that many traditional models suffer from, especially when dealing with incomplete data or complex geological settings. This system not only predicts but also provides intelligent recommendations even under uncertainty, making it an ideal choice for managing groundwater resources in regions like Makkah, where natural, religious, and tourism factors intersect.

But alongside all these opportunities, it is necessary to pause and consider the challenges.

- Do we have sufficient data to train these models?
- How can these technologies be localized to fit the geological and cultural uniqueness of water sources such as the **ZamZam** well?
- What is the real cost compared to the expected benefit?



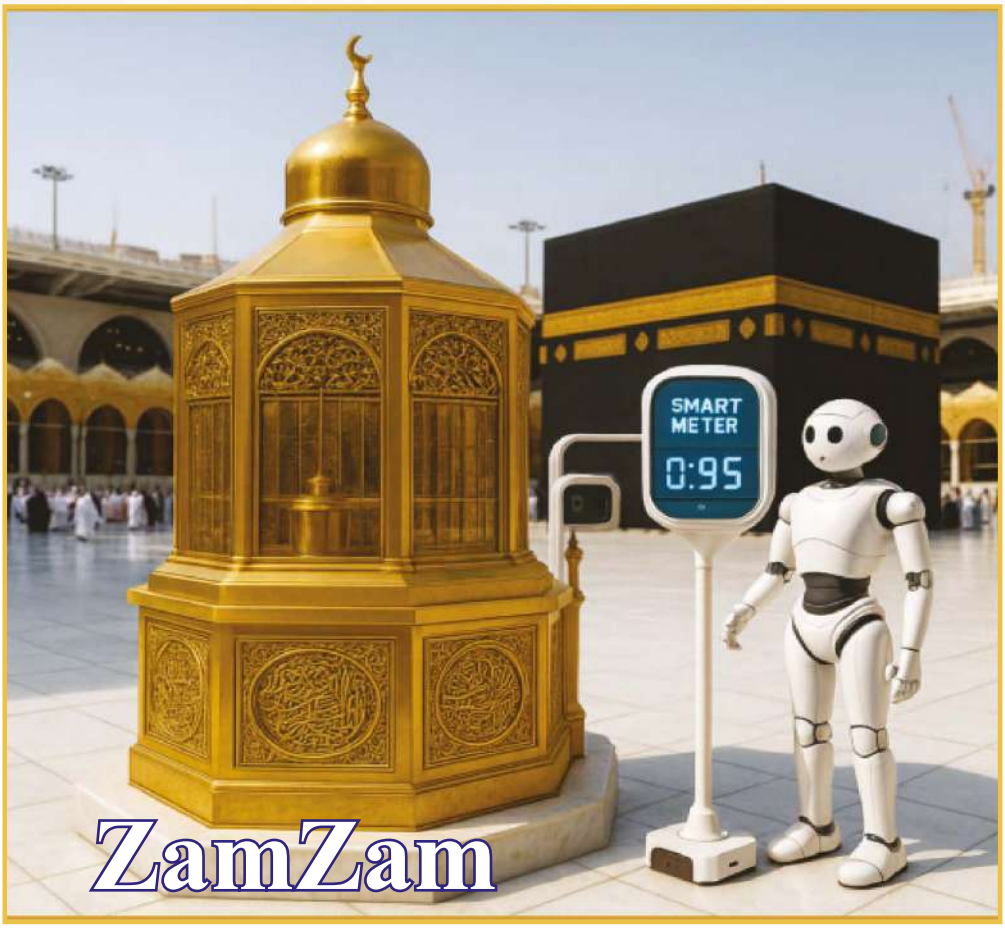
The image represents the concept of Artificial Neural Networks (ANN) in analyzing ZamZam water data. These networks simulate the human brain's way of processing vast amounts of water-related data, such as mineral levels, subtle pollution patterns, seasonal quality variations, and consumption forecasting. This approach is considered revolutionary for the sustainable management and monitoring of the ZamZam well without direct human intervention.

Success in employing artificial intelligence depends not only on the model's accuracy, but also on a profound understanding of the hydrological context and effective collaboration among engineers, geologists, and technical planners.

Employing AI in groundwater management represents a modern strategic direction, opening broad horizons for developing precise models capable of predicting the behavior of these vital resources, with the possibility of real-time monitoring and the analysis of incoming data from multiple, diverse sources.

Many countries, especially the United States and European Union members, have already begun adopting AI technologies within their water systems. Among the most notable are smart meters, used to accurately monitor water consumption, and early contamination forecasting systems, which rely on machine learning algorithms to analyze water quality in real time. These systems reduce water loss rates and enhance the ability of the relevant authorities to respond swiftly to environmental and health risks.

Additionally, technology solutions based on Cloud AI have proven highly effective in processing and analyzing big data in real time. These systems produce precise, interactive reports that support decision-makers and facilitate highly efficient water management.



The image illustrates an advanced use of smart technologies within the Grand Mosque in Makkah, through the integration of interactive robots and smart meters (Smart Meters) to monitor and analyze the environment surrounding the Maqam Ibrahim and the Kaaba. The meters may track air quality, humidity, visitor movement, crowd density, or even directly measure water or energy indicators at the nearby ZamZam drinking site. This integration of artificial intelligence and smart environmental systems helps improve the efficiency of services provided to pilgrims and visitors, and reinforces the concept of a "smart mosque," where technology is used to preserve sanctity rather than violate it, and to facilitate rituals rather than complicate them.

In this context, the Kingdom of Saudi Arabia—particularly Makkah and the holy sites—stands out as a prime candidate for the phased implementation of these smart solutions through the following measures:

- Installing smart consumption meters in government facilities and vital infrastructure to ensure accurate monitoring of usage.
- Establishing a central AI-powered system to monitor water levels and quality in real time, in line with the nature of the **ZamZam** well and its surrounding areas.
- Leveraging open-source models used worldwide and adapting them to train local models that account for the region's unique environmental, geographical, and cultural characteristics.

Some AI-based water management projects in the Kingdom have already achieved tangible success, such as water demand forecasting systems in major cities. This reinforces the feasibility of applying similar tools to sensitive sources like the **ZamZam** well, especially given the presence of sensitive and variable data linked to religious seasons and rituals. However, despite the vast opportunities these technologies offer, they are not without challenges. Some AI models are known as black box models, whose internal workings and decision-making processes are difficult to interpret or understand, reducing transparency and trust in their results. For this reason, implementing such technologies requires specialized human expertise alongside high-quality and sufficiently abundant data, something that may be limited in certain contexts, potentially affecting prediction accuracy and model quality.

Therefore, success in this field depends on several critical factors, most notably:

- Ensuring data quality through the adoption of precise, standardized criteria for its collection and documentation.

- Providing ongoing training and capacity building for professionals in the water sector to ensure their full understanding of AI technologies and their ability to operate and maintain them.
- Developing clear regulatory and legislative policies to govern data use, ensure its security, and safeguard its privacy.

Harnessing artificial intelligence for groundwater management is a necessary step toward achieving prudent and sustainable stewardship of this vital resource, particularly in sensitive environments with special religious and spiritual significance, such as the **ZamZam** well in Makkah. The success of this technological transformation requires a combination of technical competence, institutional commitment, and community awareness to ensure water security for future generations.

The Role of Artificial Intelligence in the Development Stages of ZamZam Water

ZamZam water is one of the most revered water sources with a special status in Islam. It is not just a source of drinking water. **ZamZam** water holds immense spiritual significance, deeply rooted in Islamic history, and is highly regarded by Muslims. Every year, millions of pilgrims and visitors come to it, making its management extremely important. With increasing environmental challenges and pressures from the growing number of visitors, there is an urgent need to adopt modern, sustainable technologies that can ensure the preservation of this unique resource. In this context, artificial intelligence presents a powerful tool, offering promising opportunities for the management and development of **ZamZam** water resources through its predictive, analytical, and decision-making capabilities.

Relying on AI is no longer a technological luxury or a future option. It has become an urgent necessity for achieving water sustainability, enhancing resource management efficiency, and balancing growing demand with available supply. With its ability to learn from data, adapt to changes, and make intelligent decisions, AI has become a central element in reshaping the future of water management worldwide.

First: Why Should We Prioritize AI in Managing ZamZam Water?

In a world witnessing rapid advances in smart technologies, managing water resources through traditional methods is no longer sufficient. **ZamZam** water, this blessed and exceptional spring, deserves to be managed using the most advanced scientific methods to ensure its sustainability, purity, and quality, especially in light of increasing challenges related to seasonal consumption and climate change.

To achieve this, AI and machine learning (ML) technologies emerge as indispensable tools. They can understand the complexities of **ZamZam**'s water system, process massive amounts of data with accuracy and speed, and make intelligent decisions that enhance management quality and improve performance. Below are the most prominent of these technologies and the reasons for their importance:

- **Artificial Neural Networks (ANN):** Functioning as an electronic brain, ANNs can predict complex behaviors of **ZamZam** water, such as changes in water level or quality due to environmental factors. For example, they can forecast a drop in water level during peak seasons or detect changes in water composition caused by geological formations.

- **Intelligent Time Series Models (such as LSTM):** These models "understand" time, analyzing daily and yearly consumption data to predict demand rates during Hajj and Umrah seasons, and detecting sudden seasonal changes in water composition.

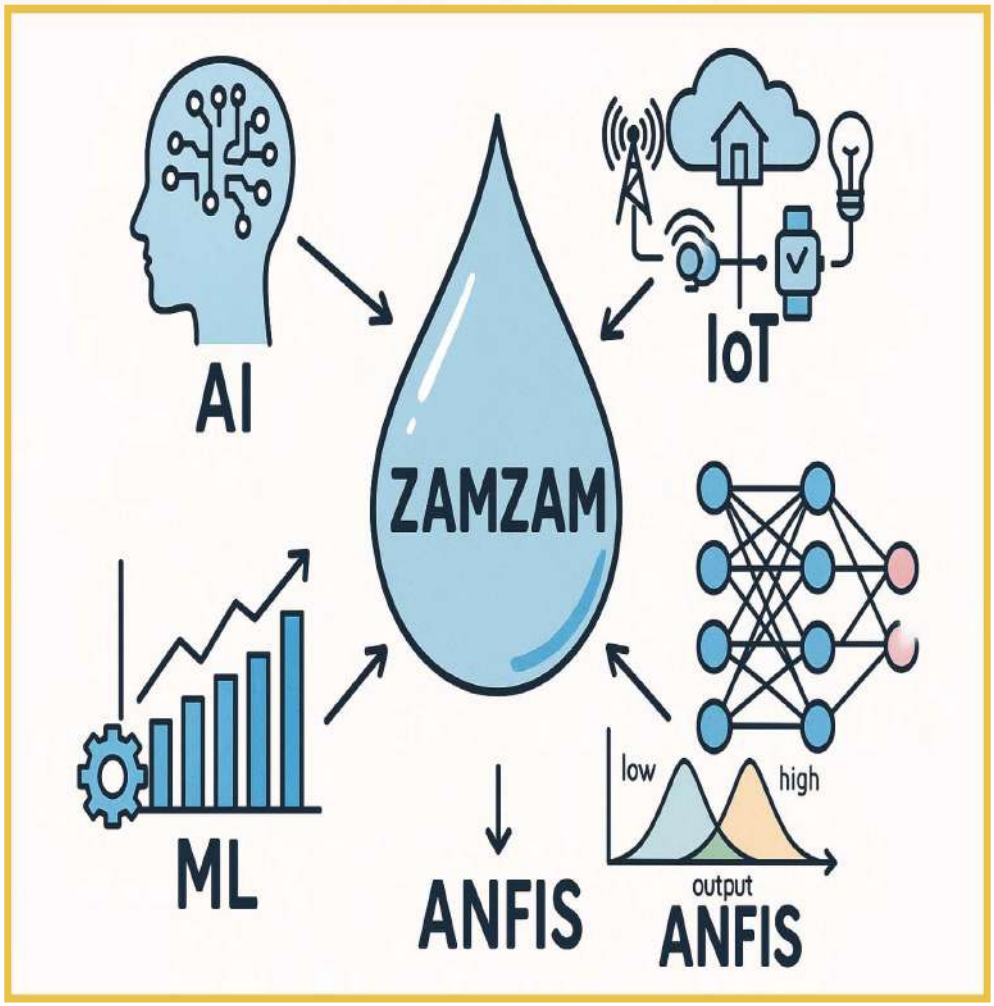
- **Adaptive Neuro-Fuzzy Inference System (ANFIS):** When data is incomplete or conflicting, this system combines AI with fuzzy logic to provide accurate decisions. It is ideal for assessing water quality with partial data or monitoring unclear leaks.

- **Reinforcement Learning:** This approach enables systems to self-learn and adapt. For example, it can develop intelligent strategies for distributing **ZamZam** water based on visitor density and optimize the performance of bottling and storage stations over time.

- **Anomaly Detection Algorithms:** This type of Algorithm works as a watchful eye. It detects any abnormal changes in quality or quantity, such as hidden leaks or a surprising increase in mineral percentage. It warns of malfunctions promptly.

- **Computer Vision + AI:** this adds a smart dimension in monitoring **ZamZam**, for example, inspecting bottles, visually detecting impurities, and automatically tracking filling lines to ensure the highest levels of cleanliness and quality.

- **Big Data + ML:** when we're talking about millions of visitors and billions of data points (time, location, temperatures, individual consumption, …), the importance of big-data analysis becomes clear: to forecast demand, determine the effects of weather or earthquakes on the well's flow, and plan water volumes in a scientific, well-studied way.



The image embodies an integrated vision for applying artificial intelligence and smart technologies in analyzing and managing ZamZam water. By combining the Internet of Things (IoT), Machine Learning (ML), Artificial Neural Networks (ANN), and Adaptive Neuro-Fuzzy Inference Systems (ANFIS), a smart system can be developed capable of monitoring water quality, predicting future changes, and making precise and effective decisions to ensure the long-term sustainability of the ZamZam well.

Second: The Role of the Internet of Things (IoT) in Managing ZamZam Water and Ensuring Its Quality

The Internet of Things (IoT) plays a pivotal and advanced role in managing and ensuring the quality of **ZamZam** water by deploying a network of smart, internet-connected devices and sensors to collect and analyze real-time data. The main roles include:

- **Real-time water level monitoring**

Sensors are installed in **ZamZam** storage tanks and along the well line to monitor water levels instantly, ensuring a continuous supply and preventing sudden drops in reserves.

- **Continuous water quality measurement**

Smart sensors are placed at **ZamZam**'s sources and storage facilities to measure indicators such as pH level, salinity, temperature, mineral content, and water purity. These readings are transmitted in real time to central analysis systems, enabling immediate detection of any quality changes.

- **Managing water consumption and improving efficiency**

Smart water meters track the quantities consumed at distribution points inside the Haram and related facilities, allowing for better allocation and reduced wastage. Cooling units and storage tanks are connected to IoT-based control systems that adjust temperature and humidity according to surrounding conditions and consumer needs.

- **Early detection of faults and leaks**

Using pressure and flow sensors, any issues in **ZamZam**'s transportation or bottling network—such as leaks or pipe blockages—can be identified and addressed before they escalate.

- **Integration with artificial intelligence technologies**

By combining IoT data with machine learning algorithms, future water demand during the Hajj and Umrah seasons can be predicted, enabling distribution planning accordingly.

- **Tracking the water cycle from source to distribution**

Tracking devices are installed along the supply chain (from the well to distribution points) to ensure full transparency in managing **ZamZam**, guaranteeing fair and safe distribution. Automated periodic reports on water quality and system performance can be generated, enhancing oversight and ensuring compliance with health and religious standards.

- **Central Dashboards**

All collected data is displayed on digital dashboards, enabling officials to monitor network status and make informed, real-time decisions.

The image presents a practical vision for applying the Internet of Things (IoT) in monitoring and managing the distribution of ZamZam water. The system involves the use of digital sensors to measure quality indicators such as pH, with the data automatically sent to cloud platforms for analysis and display on smart dashboards. Through these technologies, immediate decisions can be made regarding water distribution or alerts can be issued in case of any irregularities. These systems also enable the generation of periodic, data-supported reports to ensure transparency and sustainability in the management of ZamZam water.

Third: Using Artificial Intelligence to Monitor and Analyze Hydrological Data

Smart management of the **ZamZam** well is a complex process that requires a precise understanding of groundwater behavior within the Haram area. Artificial intelligence provides powerful tools to analyze large volumes of complex hydrological data, such as:

- Groundwater levels in the well and surrounding areas.
- Natural recharge rates and daily extraction rates across different seasons.
- Climatic data, such as rainfall amounts, temperature, and humidity, and their impact on the aquifer. Machine learning algorithms, such as Artificial Neural Networks, and linear and nonlinear regression, are used to build accurate predictive models capable of anticipating changes in water levels and chemical composition, especially during peak periods such as the Hajj season and Ramadan. This helps optimize pumping operations and water distribution to achieve efficiency and reduce loss. One of the most promising applications is integrating AI techniques with seasonal crowd data to predict pressure on **ZamZam** resources during Umrah and Hajj seasons, an approach made possible by machine learning tools already used in managing some urban water networks within the Kingdom.

Fourth: Improving Pumping and Distribution Systems with Smart Monitoring and Control Technologies

Artificial intelligence contributes to developing an intelligent system for managing **ZamZam** water pumping and distribution operations, based on real-time data provided by smart sensors deployed in pumping stations and distribution networks. This can be achieved by:

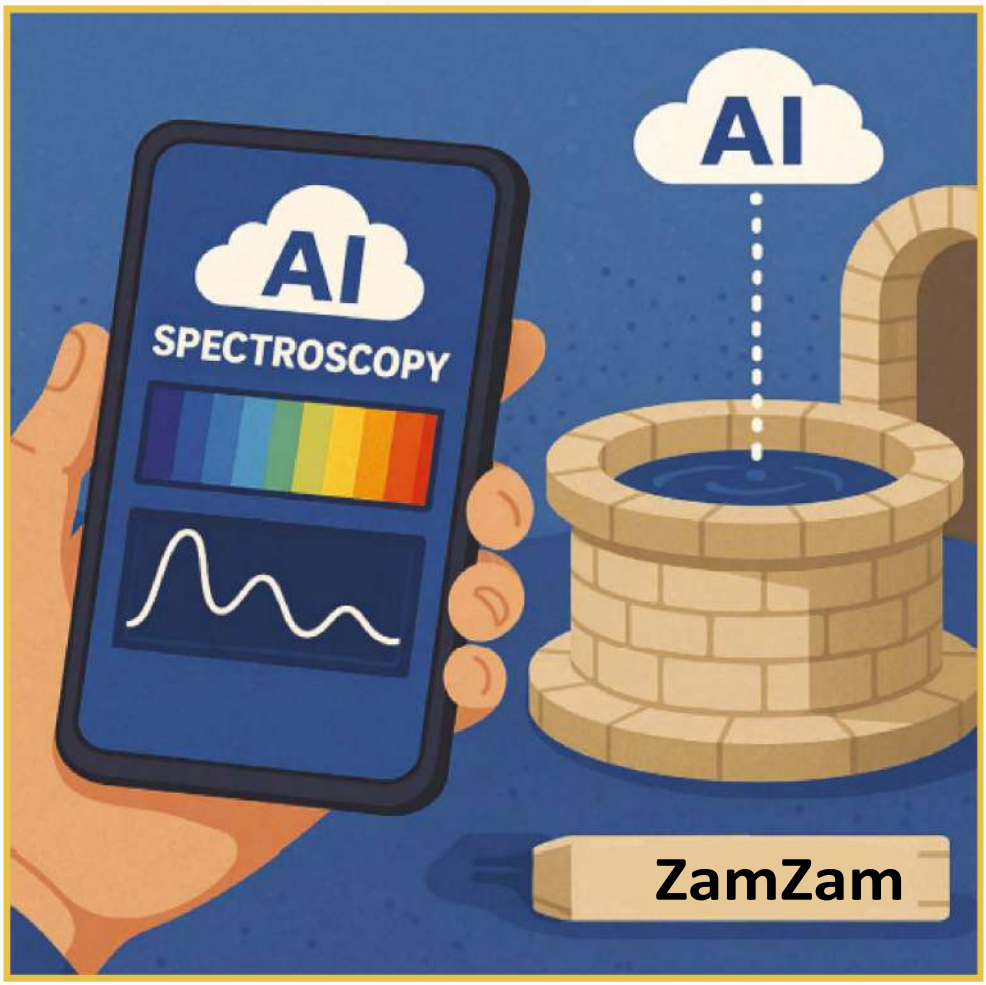
- Analyzing consumption data to identify peak times and select optimal pumping schedules, reducing waste and improving supply efficiency.

- Enhancing the performance of pumping stations and water tanks by monitoring their operational efficiency and recommending continuous improvement measures.
- Applying predictive maintenance by anticipating potential failures in mechanical devices and systems before they occur, pinpointing fault locations accurately, thus minimizing downtime and improving operational efficiency.
- Proven solutions from other water projects in the Kingdom can be leveraged, such as smart sensors in the capital and AI-integrated monitoring systems. These enable real-time performance optimization and quality control, both essential when managing a sacred and vital water source like the **ZamZam** well.

Fifth: Monitoring Water Quality and Predicting Contamination

Monitoring the quality of **ZamZam** water is one of the cornerstones of smart management of this blessed resource. Artificial intelligence offers advanced tools that enhance the efficiency of this process, including:

- Using automated recognition techniques and image processing to analyze chemical and laboratory samples, ensuring highly accurate assessment of their contents and components.
- Periodic monitoring of the physical and chemical properties of the water, such as pH level, turbidity, and salt and mineral concentrations, is instant and continuous.
- Recent studies have shown the effectiveness of AI-powered spectroscopy techniques in analyzing the water's spectral absorption, enabling the detection of minute contaminants that may not be identified by traditional methods.
- Predicting potential contamination, whether microbial or chemical, through advanced algorithms that analyze historical patterns, issue early warnings, and propose immediate corrective actions to mitigate risks.



Spectroscopy and Artificial Intelligence (AI) are applied in studying the chemical and physical properties of ZamZam water. This system relies on analyzing light spectra reflected from the water to detect mineral concentrations, impurities, and fine optical characteristics, then uses AI to interpret the results, compare patterns, and generate accurate instant reports. This technique represents an advanced step in non-invasive verification of ZamZam water quality, enhancing the reliability and speed of monitoring.

Sixth: Predictive Modeling of Climate Change and Its Impact on the ZamZam Well

Artificial intelligence contributes to building future simulation models that help understand the effects of climate change on **ZamZam**'s water resources as follows:

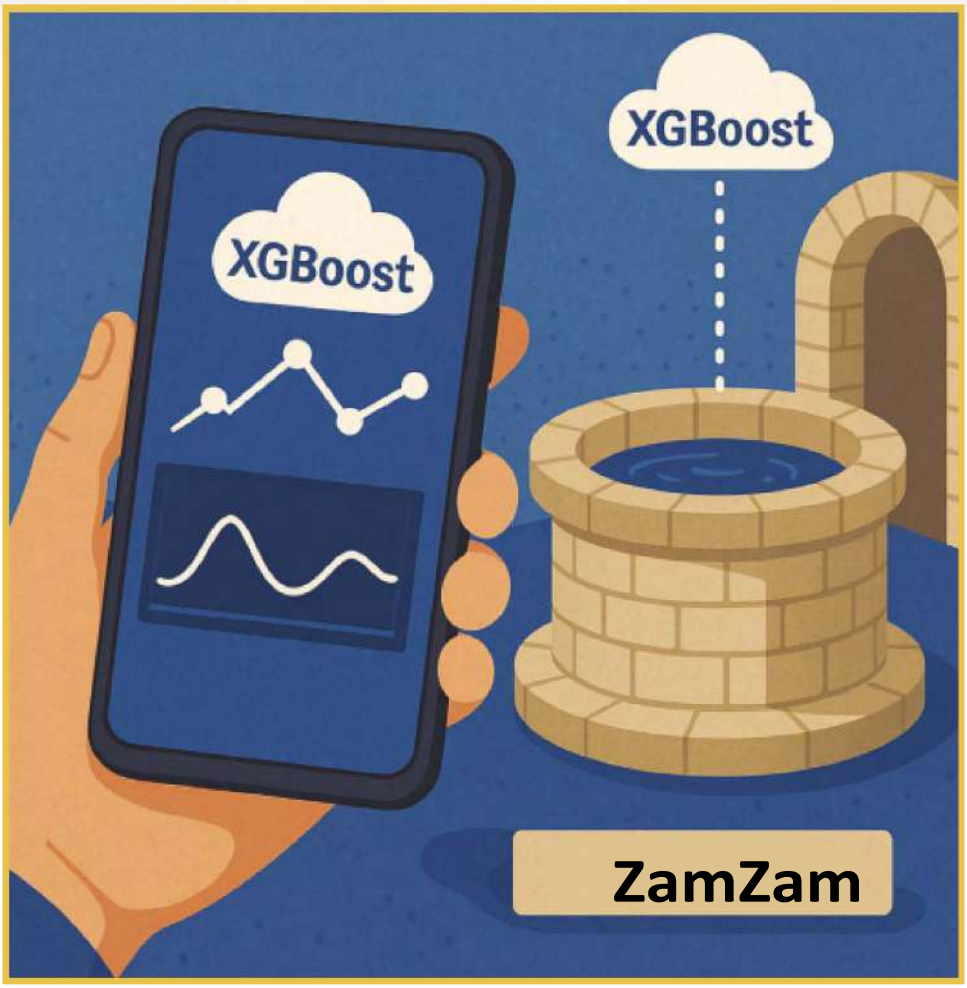
- Analyzing time series of historical and current meteorological data.
- Predicting the likelihood of floods or drought periods and their impact on the recharge of the aquifer feeding the well.
- Integrating environmental data with visitor consumption patterns to generate forecast scenarios that support planning and decision-making under changing climate conditions.

Advanced machine learning tools such as **XGBoost** and nonlinear regression have shown high accuracy in predicting groundwater fluctuations. One study applied these tools to semi-arid aquifers in India, with results published in Nature Scientific Reports in 2022, opening the door for similar applications to the **ZamZam** well.

Seventh: Supporting Decision-Making and Water Policy Formulation

Artificial intelligence has a strong capacity to support decision-makers in managing **ZamZam** water, as follows:

- Integrating big data with predictive analytics algorithms to provide accurate and up-to-date insights.
- Developing effective water policies based on data and intelligent analysis, enhancing the efficiency of demand and supply management.
- Improving coordination among operating and concerned entities for water distribution and maintenance.
- Preparing interactive periodic reports that enable rapid response to emergencies and potential risks.



The image illustrates the use of the XGBoost algorithm, one of the most powerful machine learning techniques for big data analysis, to accurately assess the properties of ZamZam water. XGBoost can be employed to predict quality changes over time or classify samples based on precise physical and chemical indicators. When integrated with smartphone applications, these analyses become available in real time, contributing to immediate monitoring, early warning, and proactive planning for intelligent and efficient management of ZamZam water.

Eighth: Practical Application of Artificial Intelligence in the ZamZam Project

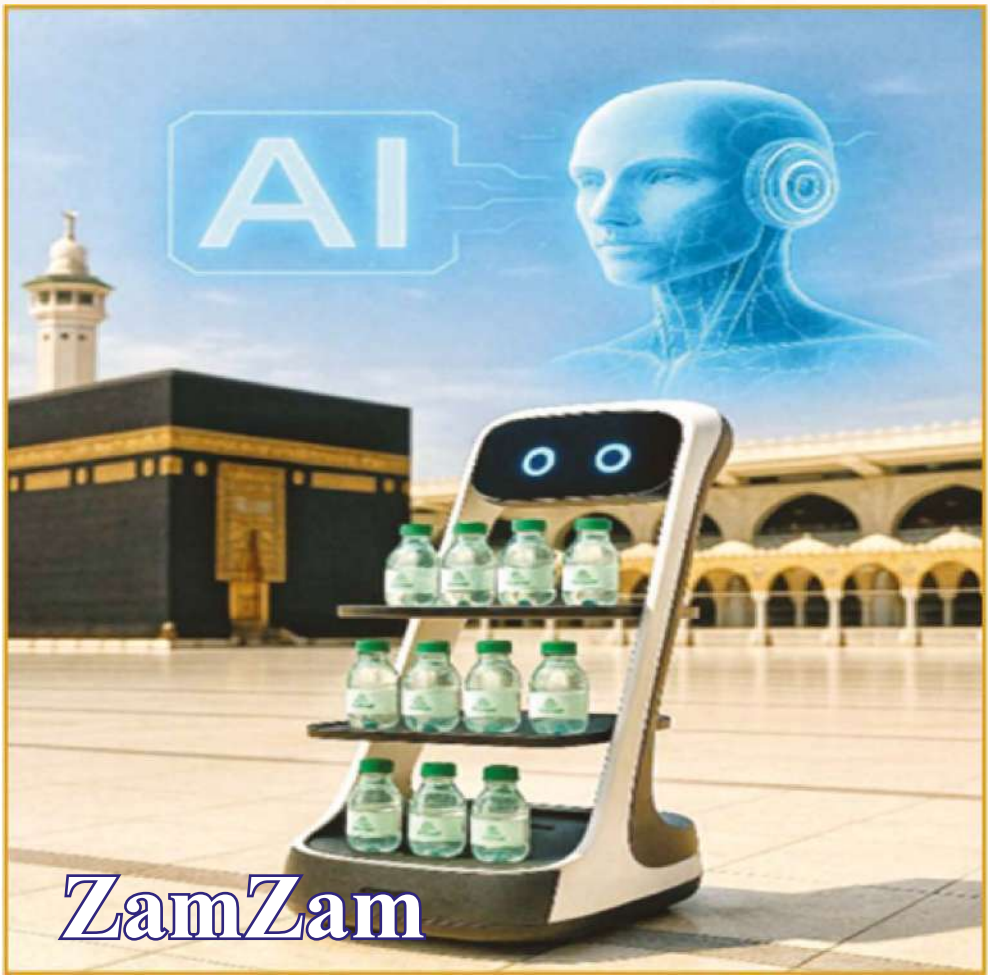
In an advanced field trial, smart robots were recently deployed to distribute **ZamZam** water inside the Holy Mosque in Makkah and the Prophet's Mosque in Madinah. These robots feature several advanced capabilities, including:

- The ability to distribute 30 bottles of water per operating cycle.
- Acquiring SLAM technology (Simultaneous Localization and Mapping) to accurately determine their location and map the surrounding environment.
- Containing A smart misting unit equipped with both audio and visual alert systems.
- The ability to operate autonomously for 5 to 8 continuous hours without human intervention.
- Fast battery charging and high energy efficiency.
- Equipped with cameras and laser sensors that allow flexible movement and obstacle avoidance.

Authorities plan to further develop this system as follows:

- Installing automated **ZamZam** water refilling stations in the Holy Mosque.
- Using smart devices to measure water levels and temperature in the well.
- Exploring advanced methods to enhance the efficiency and smoothness of water distribution through robots and AI.

The integration of artificial intelligence into the management and development of **ZamZam** water resources is a strategic step toward ensuring the sustainability of this blessed resource. Through the use of intelligent analytics, advanced monitoring, predictive modeling, and decision support, the quality and efficiency of **ZamZam** water can be preserved, ensuring it continues to meet the needs of pilgrims and visitors while safeguarding its religious and historical values. In this way, a blessed partnership between faith and science emerges, with modern technology harnessed in the service of humanity and the sacred. https://arab.news/jr8e7



The image depicts a real-world application of artificial intelligence in distributing ZamZam water within the Grand Mosque in Makkah, where interactive smart robots equipped with autonomous navigation systems and computer vision are used to deliver ZamZam bottles to pilgrims and visitors in a safe, efficient, and sustainable manner. This technology is part of the digital transformation initiative in the Two Holy Mosques, aimed at achieving the highest standards of health quality, reducing reliance on human labor, and ensuring fair and rapid distribution.

The Role of Artificial Intelligence and Machine Learning in Modeling and Simulating ZamZam Water

ZamZam water is a rare water resource distinguished by a unique composition of both religious and scientific significance. With technological advancement, it has become possible to employ artificial intelligence techniques, particularly deep learning algorithms, to analyze subtle changes in the water's chemical composition. This contributes to the early detection of any undesirable variations and supports the implementation of preventive measures to preserve the natural and spiritual characteristics of this blessed water. AI models can also propose intelligent strategies for drawing water from the well in a way that maintains its hydrological balance without affecting its religious or symbolic aspects.

Modeling Groundwater Behavior Using Machine Learning

Machine learning techniques such as:

- Artificial Neural Networks (ANN)
- Multiple Regression
- Classification & Clustering algorithms

are used to simulate the behavior of the aquifer under different climatic conditions, such as drought or heavy rainfall. These tools help uncover hidden patterns in the data that may indicate new recharge sources for the well or signal gradual changes in the aquifer. When combined with Geographic Information Systems (GIS), these analyses can produce accurate maps that highlight recharge areas and potential environmental risk zones, enabling proactive management based on integrated spatial and temporal analysis.

Practical Proposals for Employing Artificial Intelligence in the ZamZam Well

With full consideration of the site's religious and cultural sanctity, several suitable practical applications are proposed, including:

- Real-time water level prediction system: Based on sensor arrays that transmit live data to predictive algorithms, enhancing monitoring and regulation efficiency.
- Interactive monitoring dashboard: Displays temporal changes in chemical element concentrations to track quality and ensure compliance with standards.
- Intelligent withdrawal control system: Maintains a dynamic balance between consumption volumes and natural recharge rates.
- Dynamic cloud-based database: Utilizes cloud computing technologies to allow continuous updates and support decision-making based on current, real-time data.

Challenges regarding Using Artificial Intelligence in ZamZam Water Management

Despite the advanced technical capabilities, several challenges remain, including:

- Lack of precise historical data results from the site's special nature and the difficulty of conducting long-term field studies.

- The unique groundwater composition of **ZamZam** calls for the development of specialized algorithms that account for its distinctive geological and hydrological characteristics.

- Religious and cultural considerations: Any technical intervention must respect the well's sacred symbolism and ensure that modern applications do not conflict with religious beliefs.

- Shortage of specialized technical expertise: The project requires skills that combine AI, environmental engineering, and hydrology, expertise that may not currently be available to all stakeholders.

Applied Cases of Artificial Intelligence and the Internet of Things (IoT)

The application of AI and IoT in water management within the Kingdom has become an advanced reality, reflecting the country's commitment to preserving this strategic resource and ensuring its sustainability and quality through the latest smart technologies.

Advanced Digital Tools

With the advancement of digital simulation technologies, it is now possible to support the modeling of **ZamZam** water behavior using sophisticated methods. A range of advanced digital tools can contribute to accurately modeling the underground distribution of **ZamZam** water and its compositional changes over time. Examples include:

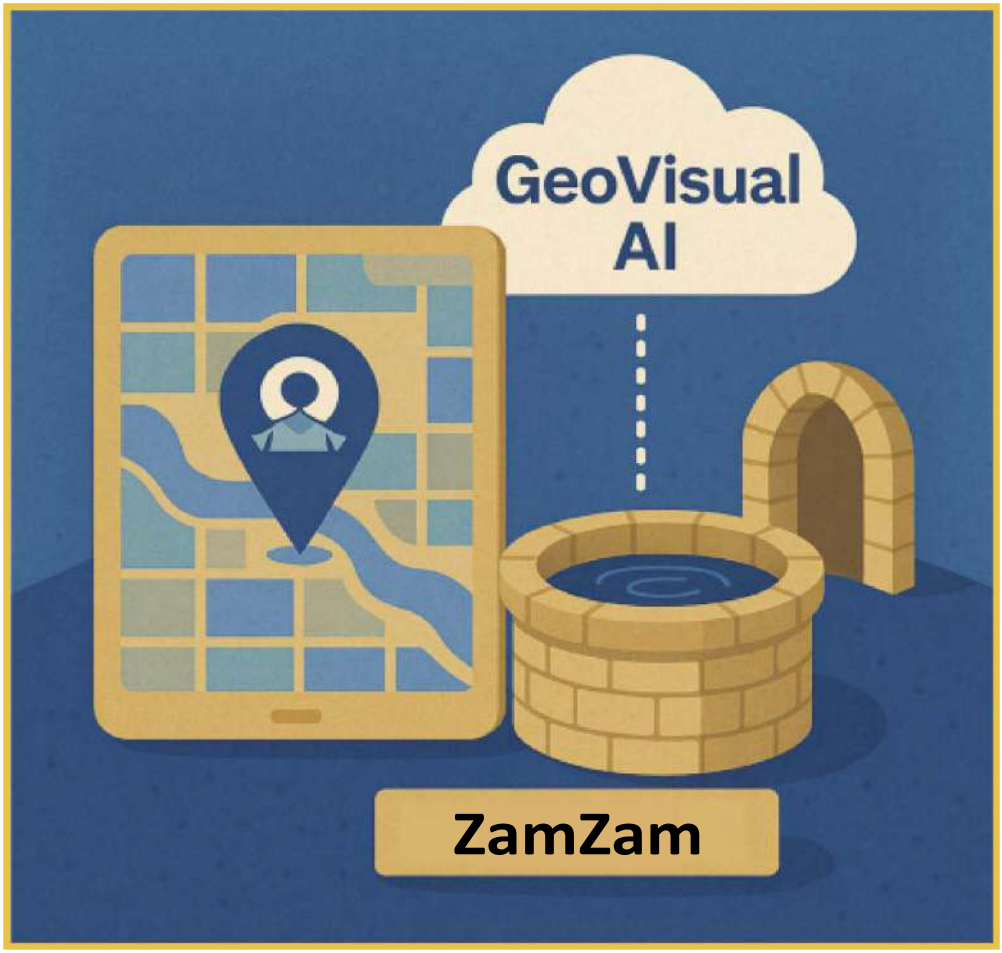
- Microsoft Azure Digital Twins: Used to build an integrated digital model of the well that combines historical and current data.
- Smart dashboards with early warning systems: Capable of analyzing data and providing predictive alerts.
- Edge AI systems: Enable real-time monitoring at the water source, as applied in certain European stations for pollution monitoring.
- Geovisual AI: Processes images from subsurface sensors to visually analyze geological structures and the aquifer.

These tools are used to monitor interactions between **ZamZam** water and environmental or climatic factors, providing accurate long-term forecasts of its chemical properties.

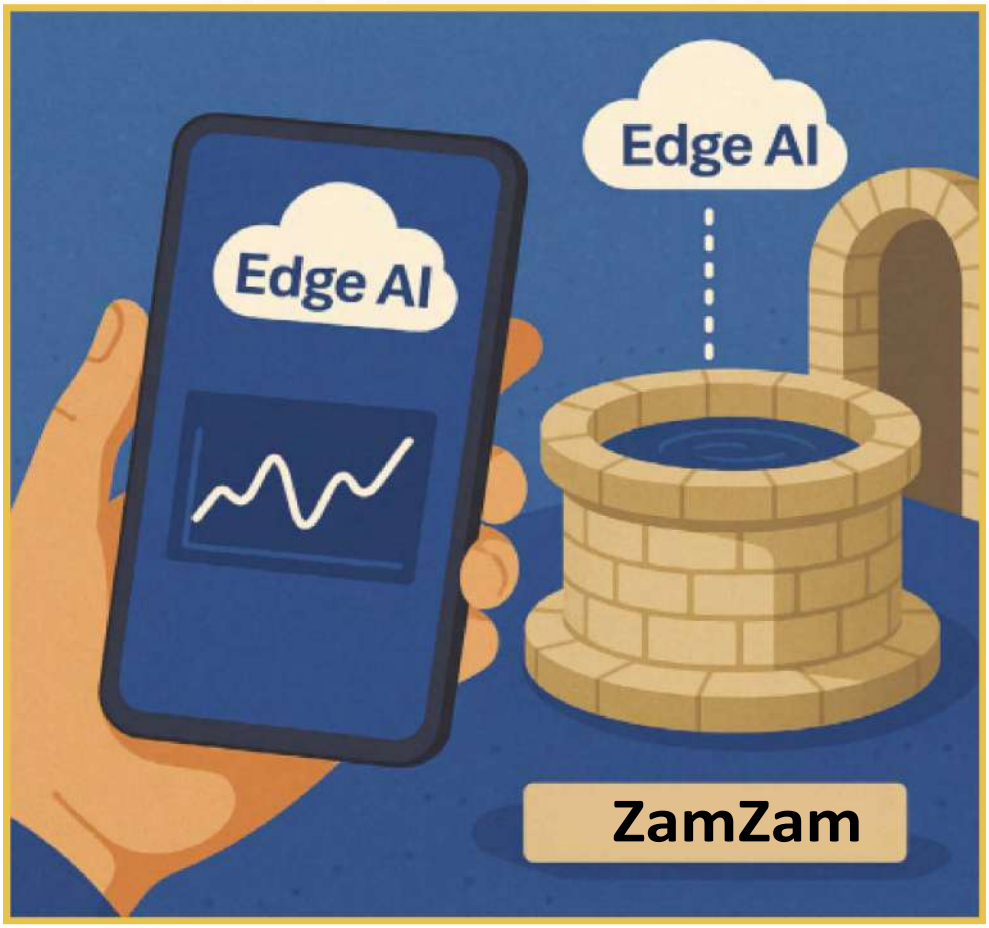
Table showing the most prominent artificial intelligence techniques and their benefits and applications on ZamZam

Technique	Application on ZamZam	Benefit
Machine Learning	Forecasting demand and consumption in all seasons of Hajj and Umrah.	Pre-planning for distribution, avoiding shortages or waste.
Large data analysis	Analyzing consumer data, flights, timestamps, and real-time location.	Improving operational management and decision accuracy.
Artificial Neural Networks (ANN)	Detecting minor or non-natural changes in water properties over time.	Early detection and rapid treatment.
Computer Vision	Devices for inspection and detection of unwanted objects and abnormalities from cameras.	Enhancing monitoring and safety.
Robotics	Using clean and safe robots to serve ZamZam water in the Grand Mosque and its surroundings, and to reduce waste.	Providing a unique experience for pilgrims and Umrah performers and reducing waste.
Internet of Things (IoT)	Connecting smart meters and reservoirs and measuring consumption through a unified network.	Following up on the water distribution network and limiting consumption.
Natural Language Programming (NLP)	Providing a smart customer service that improves the visitor's experience and gives quick access to the information they are looking for.	Improving the visitor experience and providing quick access to information for companies.

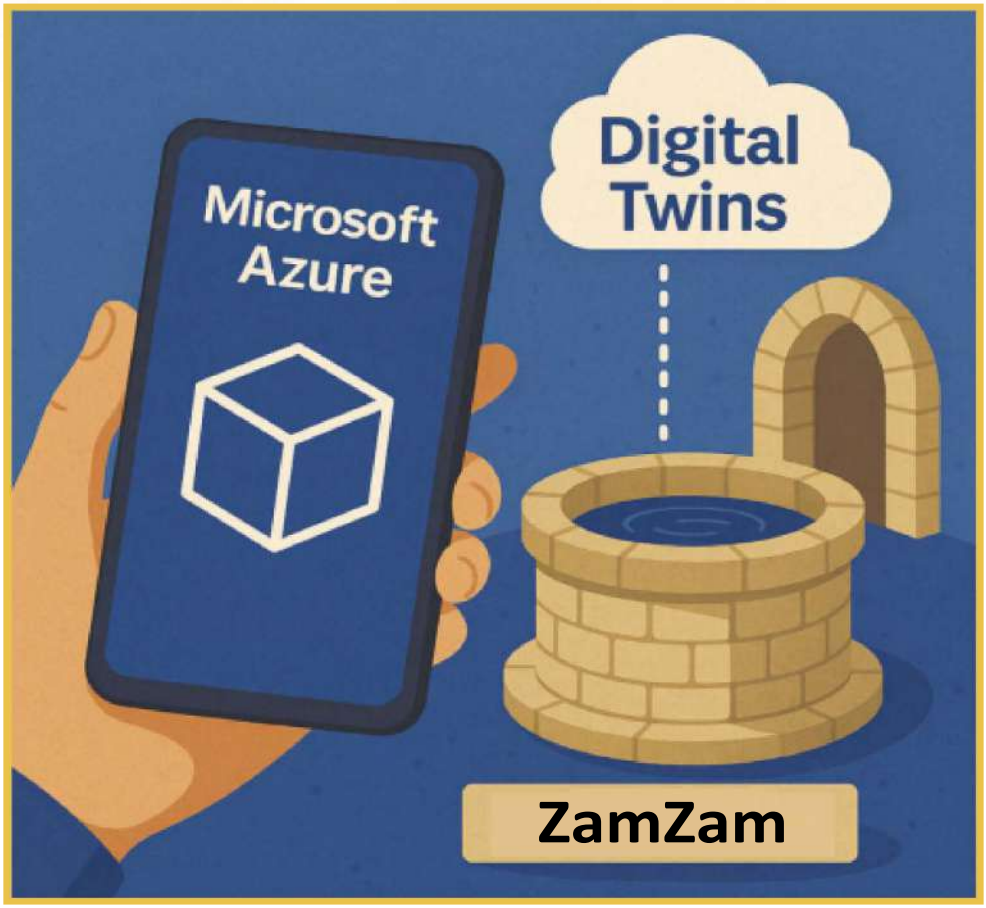
Technique	Application on ZamZam	Benefit
Generative AI	Simulating scenarios to design new reservoirs for water, or to design and develop new pump models.	Modeling and simulating to design new reservoirs and improve the pumping system.
Decision Support Systems	Providing (for example) a decision schedule or human regulation based on advanced data analysis.	Data-driven decision-making.
Digital Twin	Creating a highly detailed digital model of the well and its facilities, with real-time monitoring and simulation capabilities.	Simulating potential scenarios and monitoring the system in real time.
Sensors and Learning	Using high-accuracy sensors to measure water quality, density, and flow rates, and to process any change.	Monitoring water quality and swift response to any change.
Predictive Analytics	Predicting the most important maintenance outages for consumption planning, and outages and pollution probabilities.	Planning for consumption and potential breakdowns, and pollution.
AI and Internet of Things (IoT)	Measuring levels + water quality	Monitoring levels and water quality for better planning.
Hydrological AI Modeling	Adapting to the dynamics	Modeling the well dynamics and forecasting changes.



The image illustrates how GeoVisual AI technologies can be employed to monitor the movement of groundwater around the ZamZam well and analyze the impact of modern infrastructure on its sustainability. This technology integrates artificial intelligence with geographical data, such as satellite imagery and digital maps, to understand patterns of environmental and geographical changes surrounding the well. GeoVisual AI also contributes to building predictive models for future impacts of climate or seismic changes on the well, thereby enhancing the ability of relevant authorities to make well-informed strategic decisions.



The image reflects the advanced potential of Edge Artificial Intelligence (Edge AI) in supporting the sustainability of the ZamZam well through on-site analysis of data received from smart sensors connected to the well. Unlike cloud-based AI, Edge AI enables processing directly at the source, providing faster interaction and response, reduced bandwidth consumption, better protection of sensitive data, and greater operational autonomy within the Grand Mosque. This technology can monitor vital quality parameters such as pH, conductivity, and water levels, and trigger instant alerts without the need for continuous connection to external networks, making it ideal for sensitive applications in sacred sites.



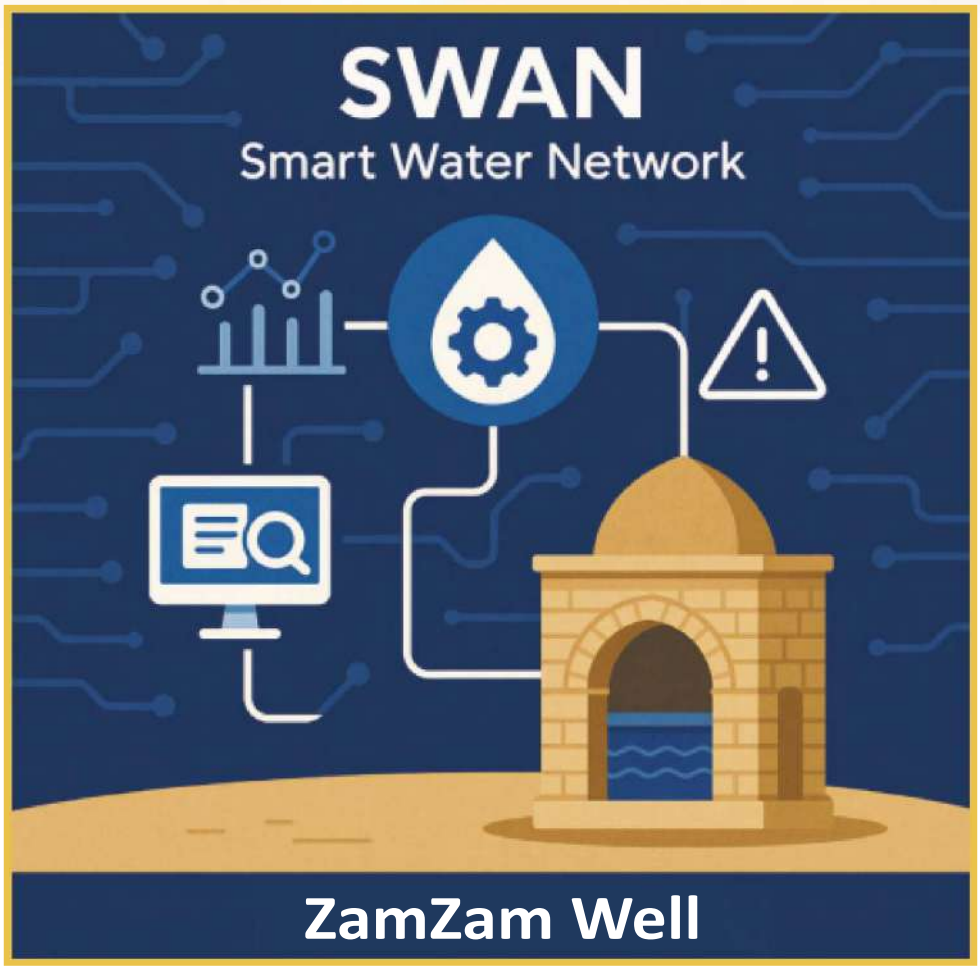
The image shows the application of the Digital Twin concept to the ZamZam well through the Microsoft Azure platform. A digital twin is a live virtual model that mirrors the actual operations taking place in the well and is updated in real time based on data from smart sensors. This concept provides a dynamic visualization of changes in water depth, flow, and quality; simulates future scenarios such as water stress or contamination; and improves operation and maintenance strategies through predictive analytics. Using Digital Twins in managing the ZamZam well represents a transformative step in preserving this sacred resource through the tools of the Fourth Industrial Revolution, ensuring its safety and sustainability for future generations.

Real-World Cases

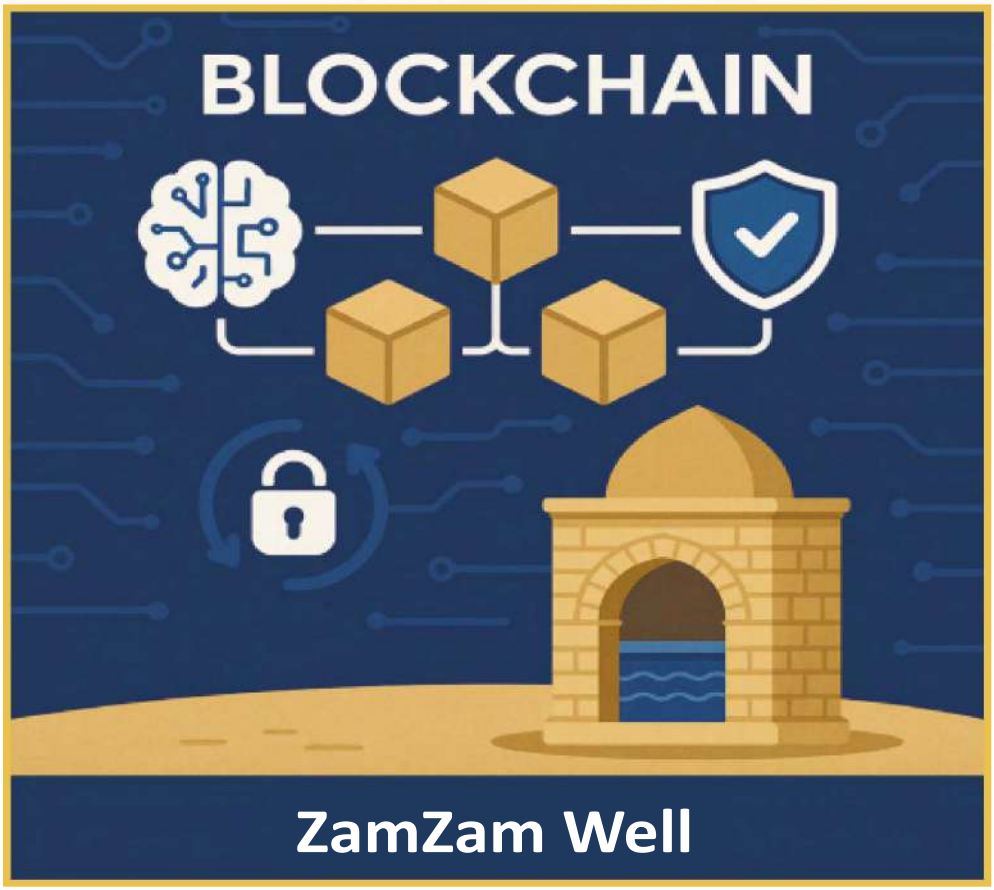
- Cloud-based platforms are used for real-time water quality monitoring. Published studies in leading scientific journals have demonstrated the effectiveness of artificial intelligence algorithms in predicting contamination or changes in water properties in similar environments.

- One of the most notable global success stories is the United Kingdom's SWAN system, an intelligent platform that uses AI algorithms to predict water demand and detect leaks in infrastructure networks. This system has helped improve water management and reduce losses. Such successes promise a bright future for expanding the use of AI and IoT in the water sector—particularly through smart sensing systems like SCADA, which enable officials to monitor and analyze data in real time, facilitating timely and accurate decision-making. These applications not only improve water quantity management but also enhance quality control, as AI can measure water quality with high precision and speed, boosting the efficiency of monitoring and safety systems.

- In addition to AI, Blockchain technology has emerged as an advanced solution for storing and sharing large volumes of electronic data securely and transparently. With the rapid growth in big data usage, employing blockchain has become essential for strengthening global collaboration. The integration of blockchain with IoT forms a cornerstone for building modern intelligent systems based on transparency and accuracy in data collection and analysis. This partnership helps overcome the limitations of traditional systems, which often suffer from centralization and a limited ability to process big data efficiently and quickly.



The image shows the integration of the ZamZam well into the SWAN (Smart Water Network) system—a smart network that collects and analyzes water data in real time through sensors and advanced analytics technology. This system includes automatic water quality monitoring, early detection of changes or faults, consumption prediction, and assessment of distribution efficiency. Incorporating the ZamZam well into this smart framework is a proactive step toward achieving the highest levels of sustainability and safety for ZamZam water, enabling supervising authorities to conduct predictive analysis and intelligent maintenance to ensure uninterrupted flow while preserving its quality.



The image shows the potential of employing blockchain technology in managing ZamZam water operations within a secure and transparent system. By recording all data related to water quality, bottling, storage, transport, and distribution on a blockchain platform, relevant authorities can ensure that sensitive data is protected from tampering or loss. Every ZamZam bottle can be tracked from its source (the well) to the distribution point, enhancing trust among users through absolute transparency and facilitating both religious and scientific audits of automated and documented operations. When blockchain is combined with artificial intelligence, the system gains the ability to make smart, real-time, and secure decisions—such as issuing instant alerts in the event of sudden changes in water quality or supply routes.

One of the most notable recent innovations in water management is the "Smart Ball", an advanced system designed to detect invisible underground leaks. This technology serves as an effective alternative to traditional devices, helping to reduce waste, costs, and effort, while improving the efficiency of using this vital resource. The technology relies on a small ball equipped with a high-precision acoustic sensor that monitors the water's flow speed inside pipelines and detects any abnormal sounds that may indicate a leak. The smart ball can travel at speeds of up to 3 kilometers per hour and cover as much as 35 kilometers per day. This technology was first implemented in Dubai in 2021, achieving remarkable results by reducing water loss to less than 4.5%, one of the lowest rates recorded worldwide. It also helped cut operational costs by detecting and addressing small cracks early on.

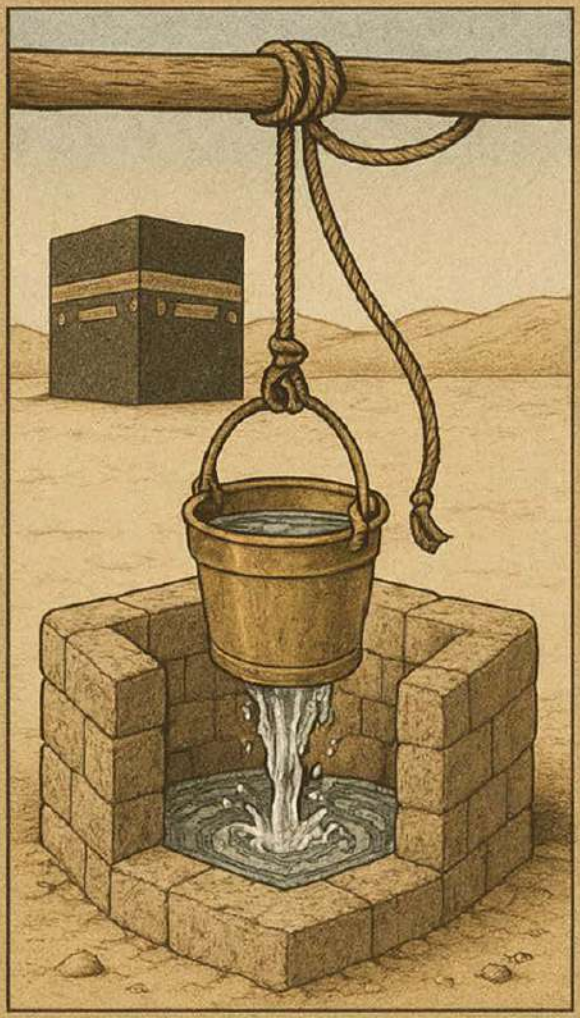
The image highlights the Smart Ball technology, one of the modern methods used to monitor water quality inside enclosed sources such as wells. In the proposed context for the ZamZam well, this technology is used to detect changes in water quality in real time without the need for large equipment or direct human intervention. The Smart Ball's capabilities include: measuring pressure, temperature, electrical conductivity, and magnetism; detecting micro-leaks and internal corrosion; and continuously recording data as it moves inside the well. Integrating this technology into the ZamZam system represents a step toward smart transformation in monitoring the well from within and preserving its high quality through proactive and precise tools.

AI
AI

Chapter Seven

ZamZam on the Medical Scale: Water with Benefits that Surpassed even the Boundaries of Science

Healing with ZamZam the Past



Scientific Evidence of ZamZam's Benefits

Treating Oral and Dental Diseases with ZamZam

Modern Medical Benefits of ZamZam

ZamZam in Treating Kidney and Liver Diseases

Effect of ZamZam Cancer and Tumors

ZamZam Water's Activity Against Fungi and Bacteria

Treating Other Diseases with ZamZam

Introduction

ZamZam water is one of the greatest water treasures that Allah has bestowed upon Muslims, not only for its profound spiritual significance deeply rooted in the hearts of Muslims, but also for its historical, health, and scientific symbolism. Since the dawn of Islam, this blessed water has been associated with concepts of healing, blessing, and purity, remaining throughout the ages a source of inspiration and faith, supported by the noble Prophetic hadiths and repeated human experiences across the world. However, with modern scientific advancements, critical questions have arisen: Does **ZamZam** water truly possess verifiable healing properties? And is there evidence from laboratory results or clinical studies to substantiate this historical belief?

To date, global medical authorities do not officially recognize **ZamZam** water as a definitive cure for any disease, nor have its properties been incorporated into established protocols in modern clinical practice. Nevertheless, its unique chemical composition, distinctive physical properties, and remarkable microbiological profile have prompted a growing number of researchers to conduct experimental and laboratory studies, which have revealed a potential role for this water in supporting public health, particularly in cases of chronic diseases, inflammation, and certain types of cancer, as well as kidney and liver conditions, among others. They indicate that **ZamZam** water contains balanced concentrations of bioactive elements such as calcium, magnesium, fluoride, selenium, zinc, and lithium, along with a moderate alkalinity that helps support the body's internal environment. Laboratory results also demonstrated its ability to inhibit the growth of certain cancer cells, reduce inflammatory markers, improve kidney function indicators, and exhibit antibacterial activity.

Despite the significance of these findings, it is crucial to acknowledge that most available studies remain in their early stages, with some conducted on animals or in controlled laboratory environments (in vitro), making them insufficient to draw definitive therapeutic recommendations for humans. Nonetheless, these preliminary indicators open promising horizons for future scientific research and call for extensive clinical trials to evaluate the effects of **ZamZam** water with rigorous scientific precision.

Accordingly, drinking **ZamZam** water can be considered a supportive factor for general health as part of a balanced lifestyle, without replacing modern medical care or specialist consultations. The distinction between faith and scientific inquiry does not imply conflict; rather, it paves the way for a complementary understanding between belief and research, leading to more mindful use of this unique divine gift.

From the moment the Angel Gabriel (**PBUH**) caused **ZamZam** water to spring forth beneath the feet of Ismail, this source was not merely a means of irrigation in a barren desert, but a divine promise of care and mercy, a renewed beacon of hope in the heart of everyone who drinks it with certainty. Through the passing ages, **ZamZam** water has transcended its sacred significance to become a symbol of healing, a refuge for the sick, a beacon of hope for the troubled, and a profound longing for every pilgrim and visitor to the Sacred Mosque.

In the books of history and prophetic medicine, references to its health benefits are frequently repeated. Ibn al-Qayyim al-Jawziyya, recounting his personal experience, stated that he drank **ZamZam** water many times and sought healing through it, finding in it “something wondrous” of cure by Allah’s permission. Imam al-Nawawi also affirmed that seeking healing has been “tried” before. This indicates that health awareness in Islam was not separate from this blessed spring; rather, these convictions went beyond

theoretical belief into lived reality, as people regularly recommended drinking it in times of illness. Some of Al-Salihun (The Righteous) even advised it for healing the soul before the body. Over time, this belief did not vanish; instead, modern laboratories have provided new tools to verify it or at least to understand it in modern language. Recent medical studies have begun to illuminate the properties of **ZamZam** water from a scientific perspective, complementing traditional understanding with empirical evidence. In 2023, a study was conducted demonstrating **ZamZam** water's ability to inhibit the growth of pathogenic bacteria, such as Staphylococcus aureus, outperforming three types of commercially available mineral water in purity (Ahmed, 2023). Additionally, a clinical study at King Saud University (2021) found that drinking **ZamZam** water improved certain vital indicators in kidney patients without adverse effects on kidney function; rather, it contributed to balanced hydration and stimulated certain cellular functions.

In psychology, attention has been drawn to the naturally occurring lithium in **ZamZam** water, an element used in treating depression and mood disorders. This has led to suggestions for including **ZamZam** water in addiction recovery and psychological support programs, not only for its chemical composition but also for its spiritual impact.

In a 2014 clinical study by Al-Hanri et al., the results revealed significant improvement in the health indicators of patients with type 2 diabetes after drinking **ZamZam** water, including reduced oxidative stress levels and improved cumulative sugar HbA1c, compared to ordinary drinking water. This was attributed to its rich composition of antioxidant elements.

Other research has suggested that the relatively high concentrations of lithium, calcium, magnesium, and zinc may support the central nervous system and improve mood, strengthening the hypothesis of using **ZamZam** as a low-cost supportive factor in psychological rehabilitation programs (Almad, 2023).

On the optical side, spectroscopic studies have shown that **ZamZam** water possesses higher optical absorption and reflectivity than other waters, as well as a higher refractive index, reflecting a unique molecular structure (El-Zaiat & Elshamy, 2015). From a chemical perspective, analyses have shown that **ZamZam** water contains ideal levels of calcium, magnesium, sodium, and fluoride, elements that enhance bone and immune health and regulate muscle and heart performance.

Nevertheless, **ZamZam** water cannot be regarded as a pharmaceutical drug in the modern sense, yet it remains a unique spring that combines "the intention of healing" with the "effectiveness of its components", uniting the spiritual with the scientific. In this chapter, we will take the reader on an engaging journey that blends ancient healing stories with modern laboratory findings, revealing how **ZamZam** water has remained, throughout the ages, unlike any other.

Scientific Evidence of the Benefits of ZamZam Water

ZamZam water has long been a symbol of faith and healing in Islamic culture, with its benefits closely linked to deeply rooted religious beliefs over the centuries. However, modern scientific advancements prompt us to investigate these benefits within the framework of the experimental method, placing this blessed water at a unique intersection between religious certainty and scientific evidence.

● Religious and Doctrinal Dimension

The noble hadith of the Prophet **(PBUH)** : "**ZamZam** water is for whatever purpose it is drunk", narrated by Ibn Majah and al-Bayhaqi and authenticated by hadith scholars such as al-Suyuti and al-Nawawi, reflects the comprehensive scope of **ZamZam** water's benefits, encompassing the intention of the drinker, whether for healing, relief, or spiritual well-being. The books of Seerah and Hadith have documented numerous accounts of Companions and scholars who drank **ZamZam** water with the intention of recovery, seeking knowledge, or provision, and witnessed tangible outcomes. Another hadith says: "Fever is from the heat of Hell, so cool it with **ZamZam** water," opening the door to the possibility of lowering body temperature through the consumption of water with special distinctive properties, and supporting the idea of tangible biological effects.

● Distinctive Chemical Properties

Modern chemical analyses indicate that **ZamZam** water possesses a balanced composition of cations and anions:

Cations: calcium, sodium, potassium, and magnesium.

Anions: bicarbonate, sulfate, nitrate, and chloride.

This composition resembles that of table mineral waters in terms of ionic balance and is considered beneficial for: supporting muscular and nervous function, regulating blood pressure, strengthening bones and teeth, and enhancing the body's acid–base balance (Aini et al., 2022).

● Antibacterial and Antioxidant Effects

Some preliminary studies have shown that **ZamZam** water exhibits antibacterial activity against certain pathogenic bacteria, such as Escherichia coli (E. coli) and Staphylococcus aureus. This effect is thought to be linked to its high mineral concentration and relatively alkaline pH (7.9–8.0), which creates a hostile environment for the growth of certain microbes (Damayanti et al., 2023; Al-Zuhair & Khounganian, 2006).

Laboratory experiments have also demonstrated that **ZamZam** water has antioxidant capacity, which theoretically enables it to combat harmful free radicals in cells, an important mechanism in the prevention of chronic inflammation and cancer.

● Psychological Effect and Placebo

In faith-based settings, the symbolism of **ZamZam** water itself may contribute to enhanced healing through the placebo effect, where belief and intention play a significant role in boosting immunity and improving a patient's psychological and physiological indicators. This phenomenon does not diminish the value of **ZamZam** water; rather, it affirms that its benefits are holistic, encompassing both spiritual and physical dimensions, which are inseparable components of overall well-being (Murfat et al., 2023).

A Call for Conducting Rigorous Clinical Research

Despite the promises of science, most current studies remain confined to laboratory settings or limited clinical trials, highlighting the need for rigorous clinical research to measure the effects of **ZamZam** water on major health parameters, such as:

- Blood pressure and sugar levels in blood sugar;
- Markers of chronic inflammation;
- Digestive system health;
- Kidney and liver function.

Researchers have called for the establishment of **"**ethical protocols**"** to ensure respect for the religious dimension of **ZamZam** water, while providing rigorous research tools that can lead to accurate and universally recognized results (Nurhapsari & Kamila, 2023; Abdillah & Kusyowo, 2021). Overall, the scientific exploration of **ZamZam** water's benefits is still in its early stages, with preliminary findings proving encouraging and calling for further studies, not only to verify its physiological effects but also to understand the relationship between water, faith, and healing. Respecting the sanctity of this water does not conflict with subjecting it to research; rather, it makes it a unique model for discovering the intersection between religion and science.

Healing with ZamZam Water in the Past

ZamZam water is among the greatest spiritual and natural resources that Allah has granted the Muslims. Since the dawn of Islam, it has been associated with the concept of healing, whether through direct drinking or washing, supported by authentic Prophetic traditions and the repeated practices of the Companions, the Followers, scholars, and the general Muslim public throughout the ages.

• Drinking to Fullness (Tadallu) from ZamZam Water

Among the Prophetic hadiths that established the concept of healing through **ZamZam** water is what al-Azraqi narrated with his chain of transmission from Ibn Abbas, that the Prophet (**PBUH)** said: "Drinking to fullness from **ZamZam** water is protection from hypocrisy…"He also said: "The sign between us and the hypocrites is that they draw a bucket from **ZamZam** water and drink it to fullness." (Al-Azraqi, 1969).

Tadallu refers to drinking **ZamZam** water until the stomach is full. It is recommended to be done on an empty stomach, preferably drinking with an odd number of doses (3, 5, 7, 9,...) and repeated at intervals according to one's capacity. Some people may notice a change in urine color or experience vomiting, seen as a sign of bodily cleansing.

• The Prophet's Method in Healing

It is narrated from Aishah that the Prophet (**PBUH)** used to carry **ZamZam** water in small containers and waterskins, and he would pour it over the sick and give it to them to drink (narrated by al-Bukhari in al-Tarikh al-Kabir, 21/173; al-Bayhaqi, 5/202; authenticated by al-Albani in al-Silsilah al-Sahihah, 883). This hadith establishes a Prophetic method for using **ZamZam** water in treatment, whether by drinking it or pouring it over the body, conditional upon sincerity of intention and proper reliance on Allah.

Abu Jamrah al-Dubi said, "I used to sit with Ibn Abbas, and I was struck by a fever. He said: 'Cool it off with **ZamZam** water, for the Prophet **PBUH** said: "Fever is from the heat of Hell, so cool it with **ZamZam** water."'" (narrated

by al-Bukhari, no. 3261; Ahmad, 2517; al-Nasa'i, 6147; Ibn Hibban, 6068). It is notable that **ZamZam** water was used for lowering body temperature, which aligns with modern therapeutic principles (Ahmad, 2023).

The Prophet **(PBUH)** said: "The best water on the face of the earth is **ZamZam** water; in it is food to satisfy and a cure for illness." (al-Tabarani; al-Albani, Sahih al-Jami', 3322). He also said: "**ZamZam** is food to satisfy and a cure for illness." (al-Bazzar; Sahih al-Jami', 3572; al-Matalib al-'Aliyah, 1357). These hadiths indicate that **ZamZam** water provides healing for both physical and spiritual ailments (Ibn Hajar al-Haytami, Tuhfat al-Muhtaj, 4/134).

In another hadith: "**ZamZam** water is for whatever purpose it is drunk; if you drink it seeking healing, Allah will heal you." (al-Daraqutni; al-Hakim, 1693; Fath al-Bari, 3/493; al-Targhib, 1164). From this, **ZamZam** water became associated with the intention of the drinker: whoever drinks it seeking healing will be healed; whoever drinks it seeking knowledge will be granted understanding.

• Documented Historical Testimonies on Healing

Historical and empirical accounts indicate a deep-rooted conviction among early scholars and devout worshippers regarding the therapeutic and spiritual values of **ZamZam** water. Among the most notable testimonies in this regard is what Ibn Hajar al-Asqalani reported from Ibn Khuthaym, who said:

Wahb ibn Munabbih once came to us while he was ill, so we visited him. We found him drinking **ZamZam** water, and we said to him, "Why not drink sweeter water, for **ZamZam** water has a certain heaviness to it?" He replied, "I do not wish to drink anything else until I leave Makkah. By Him in Whose hand is my soul, it is mentioned in the Book of Allah the Almighty: '**ZamZam**, never exhausted, never diminished,' and also in His saying: 'Pure and drink of the righteous.' It is precious, and it is food that nourishes and a cure for illness. By Him in Whose hand is Wahb's soul, no one drinks it to

the point of filling himself except that any disease within him is removed and healing is granted to him." (Ibn Hajar al-'Asqalani, 1959)

- Kab al-Ahbar said: "It is food that nourishes and a cure for illness, granted exclusively to this nation and not to others." (al-Azraqi, 1969)
- Muawiyah ibn Abi Sufyan drank **ZamZam** water and poured it over his head and face while saying: "**ZamZam** is healing. It is for whatever it is drunk for." (al-Fakihi, 1042; al-Ajluni, *Kashf al-Khafa*, 1421)
- Ibn al-Qayyim al-Jawziyyah said: "I, along with others, have experienced healing with **ZamZam** water, and I recovered by Allah's permission." (*Zad al-Maad*, 1994, 11/212)
- Imam Ahmad ibn Hanbal used to drink **ZamZam** water and wipe his face and hands with it (*Siyar Alam al-Nubala*).
- In another narration showing the tangible effects of neglecting this blessed water, al-Fakihi reported from Ibn Abbas: "The people of Mecca never suffered from knee pains, no one could outrun them in races, and no one wrestled them except that they threw him down—until they lost interest in **ZamZam** water, and Allah changed their state." (al-Fakihi, 1994)
- Ahmad ibn Abd Allah al-Sharifi was cured of blindness after drinking **ZamZam** to the point of filling himself (al-Fasi, 1996).
- The scholar al-Shanīnī was cured of severe dropsy in Makkah after drinking **ZamZam** with sincere intention (al-Fāsī).
- Al-Jahiz mentioned that whoever persisted in drinking **ZamZam** after conventional medicine failed, attained healing through it (al-Bayan wa al-Tabyin, 1965).
- Ibn Hajar al-Haytami said: "**ZamZam** does not benefit except one who drinks it with certainty, not as a mere experiment." (al-Fatawa al-Fiqhiyyah al-Kubra, 9/443)
- As for Imam al-Shaybani, he presented practical, on-the-ground observations documenting multiple uses of **ZamZam** water in therapeutic and spiritual contexts. He mentioned that he saw his father writing

talismans for those afflicted with fever or whose wives experienced delayed childbirth, then reciting over water, giving it to the patient to drink, and washing the patient's head with it. He also saw his father seeking healing through a hair of the Prophet (**PBUH**). Upon receiving it, he washed it in a cistern of water and then drank from that water, believing in its blessing. Among his other habits was drinking **ZamZam** water and wiping his hands and face with it, seeking healing (al-Shaybani, 1981). Al-Shawkani said in Nayl al-Awtar: "**ZamZam** water is for whatever it is drunk for," which indicates generality, meaning that what one intends with **ZamZam**, whether worldly or otherworldly, is hoped to be realized (al-Shawkani, 1993). Scholars affirmed that **ZamZam** benefits only those who drink it with certainty, not as an experiment. Kab and Wahb, both People of the Book who embraced Islam, mentioned that **ZamZam** is referenced in the Torah as: "A food that satisfies, a cure for illness, and a blessed water that is never diminished nor disapproved." Imam Zakariya al-Qazwini said: "**ZamZam** water is suitable for all ailments, and if one were to gather together all whom physicians have healed, they would not amount to half of those whom God has healed with it".

From the sum of the reports and statements, it is clear that **ZamZam** water is not merely ordinary water, but rather a complete faith-based experience, contingent upon intention, reliance on God, and sincerity. It combines prophetic blessing with an unbroken tradition of practice throughout the centuries of Islam, making it a central element of Islamic spiritual healing to this day.

Modern Medical Benefits of ZamZam Water

With advancements in biomedical sciences and water analysis technologies, research efforts have intensified to scientifically evaluate the physical and functional properties of **ZamZam** water. Findings have revealed a unique composition, making this water a focal point of numerous studies that confirm its distinctiveness compared to other water sources.

Unique Chemical Composition

Intricate chemical analyses indicate that **ZamZam** water is rich in essential minerals necessary for general health, most notably:

- **Sodium, potassium, calcium, and magnesium.**
- **Chloride, bicarbonate, sulfate, and nitrate.**

Studies (such as Harahap 2018 and Jannah 2003) have shown that these elements are distributed in **ZamZam** water in balanced proportions that require no industrial treatment prior to consumption. **ZamZam** water also naturally maintains an alkaline pH (7.9–8.0), a property that helps combat free radicals and enhances cells' functions, granting **ZamZam** water antioxidant characteristics at the cellular level.

Biological Purity and Immune Effects

Laboratory studies have confirmed the absence of microbial activity in **ZamZam** water, even under intricate microscopic examination (Nuaman, 2013), indicating antimicrobial properties stemming from its chemical nature.

A qualitative study further found that regular consumption of **ZamZam** water stimulates the expression of aquaporin (AQP) proteins, protein channels

that regulate water transport within cells and play a critical role in kidney, brain, and eye functions, as well as reproductive health (Are, 2009; Ali et al., 2006). This mechanism is considered a cornerstone in modern molecular medicine for understanding the efficiency of water regulation within the human body.

Anti-Tumor Effects

Multiple studies suggest that **ZamZam** water possesses bioactivity that inhibits the growth of cancer cells, thanks to three main factors:

- Its richness in natural antioxidants.
- The abundance of calcium and magnesium in physiological proportions.
- Its ability to modulate the gene expression of targeted cells.

In a clinical trial conducted by Ali et al. (2009), 100 women were divided into two groups, one of which consumed **ZamZam** water (500–750 ml/day) for 30 days. The results showed a marked improvement in the levels of tumor-suppressor proteins such as:

- Bowman-Birk Inhibitor.
- Lunsain.
- Pectin.

Research by Pitcher & Van Oers (2003) and Ansari et al. (2018) in animal subjects has shown that **ZamZam** water can reduce the effects of carcinogenic substances such as AOM and decrease the size of colon tumors. This suggests its potential use as an adjunct in chemotherapy or preventive treatment protocols.

• Radiation and Cancer Protection

Laboratory experiments have demonstrated that drinking **ZamZam** water mitigates bone marrow damage caused by gamma-ray exposure, reduces oxidative stress–induced genetic damage, activates protective genes, and suppresses oncogenes (Oktaviani & Fakhruddin, 2021). These findings indicate the possibility of using **ZamZam** water in bioprotective programs for individuals exposed to radiation or as a balancing agent in radiotherapy.

• Use of ZamZam in Herbal Therapeutics

A recent study revealed that **ZamZam** water can enhance the efficacy of date seed extract (Phoenix dactylifera) against seven different cancer cell lines, including Hep-2, MCF-7, and A549, among others. **ZamZam** water facilitated greater absorption of active compounds and improved their cellular bioactivity, highlighting its role as a natural bio-enhancer for drug delivery.

Similarly, white turmeric (Curcuma zedoaria) extract dissolved in **ZamZam** water showed increased anti-tumor activity and boosted the effectiveness of phenolic and flavonoid compounds. Results also indicated a reduction in the proliferation rate of cancer cells, supporting the hypothesis that **ZamZam** water enhances the bioactivity of active compounds.

Although clinical studies in humans remain limited, the available experimental and laboratory data support expanding research in the following areas:

- **Integrative Medicine.**
- **Supportive cancer therapies.**
- **Community prevention programs in high-radiation environments.**
- **Investigation of bio-interactions between ZamZam water and pharmacologically active compounds.**

Table summarizing the potential effects of ZamZam water in treating certain diseases, based on peer-reviewed studies. The reference for each study is listed. It should be noted that these findings are from controlled scientific studies published in peer-reviewed journals. Some effects are drawn from non-clinical studies and need to be further validated in a comprehensive clinical study. We suggest not using ZamZam water as an alternative treatment, but as a complementary one, part of an integrative treatment plan after medical consultation.

Reference	Study Type	Effect of ZamZam Water	Health Condition or Disease
Albar et al., 2016	Experimental laboratory (in vitro)	Reduces the growth of harmful bacteria like Streptococcus mutans	Oral and dental inflammation
Khan et al., 2013	Cellular (in vitro)	Reduces the proliferation of some cancer cells (like HeLa)	Cancer (in a scientific and medical context)
Halim et al., 2016	Observational and experimental	Improves the body's resistance to harmful bacteria	Digestive system diseases
Al Meheithif et al., 2012	Experimental animal (in vivo)	Reduces blood sugar levels in mice	Diabetes mellitus
Rizwan et al., 2019	Experimental on animals	Reduces the formation of kidney stones and improves kidney function	Kidney and urinary tract diseases
Donia & Morta-da, 2021	Experimental laboratory	Reduces the toxic effects of some heavy metals	General cellular and toxic poisoning
Narratives and documented traditional experiences	Traditional experimental	Soothes eye inflammation/ swelling when used as a compress	Eyes (inflammation/ swelling)
Bhardwaj, 2023	Physicochemical analysis	Contributes to electrical and alkaline balance	Heart health and blood pressure
Al-Barakah, 2017	Experimental on animals	Accelerates wound healing and prevents infection	Skin diseases and wounds
Multiple chemical and bacteriological analyses	Deducing from the water composition	Enhances resistance to inflammation and bacterial infections	Respiratory system inflammation

Treatment of Oral and Dental Diseases with ZamZam Water

In recent years, there has been growing scientific interest in studying the effects of **ZamZam** water on oral and dental health, owing to its unique biochemical composition, immune-boosting properties, and alkalinity, which qualify it to be a promising preventive and therapeutic agent in modern dentistry. Studies have demonstrated that **ZamZam** water helps strengthen tooth enamel, reduce the incidence of cavities, adjust oral acidity, and limit the growth of harmful bacteria, without negatively affecting the natural oral flora.

The Role of ZamZam Water in Treating Dental Caries

Dental caries is one of the most common oral diseases, primarily caused by bacterial activity in an acidic oral environment that weakens enamel and leads to demineralization. Recent research has shown that **ZamZam** water has multiple properties that make it effective in preventing cavities and even helping to remineralize damaged enamel, which is an important step in the non-invasive treatment of early-stage caries.

Chemical analyses indicate that **ZamZam** water contains high levels of essential minerals for dental health, such as:

- **Fluoride:** 0.75 parts per million (ppm) directly from the well, and 0.68 ppm from the tap, both within the safe limit recommended by the World Health Organization (1.5 ppm).
- **Calcium, phosphorus, and magnesium:** Vital minerals involved in the remineralization process and in strengthening enamel hardness.

A clinical study using the **Vickers enamel hardness test** revealed that **ZamZam** water was more effective than several conventional medical solutions in strengthening enamel, highlighting its potential role in preventive dentistry applications (Al-Khalifah et al., 2022).

Antibacterial Effect and Role in Microbial Balance

Laboratory studies have confirmed **ZamZam** water's ability to inhibit the growth of cavity-causing bacteria, particularly:

- Streptococcus mutans.
- Lactobacillus sp.

In an experiment conducted by Muhlisin et al. (2019), a 100% reduction in the growth of these bacteria was observed when using **ZamZam** water at a concentration of 0.68 ppm. Moreover, direct analysis shows that **ZamZam** water is free from pathogenic microbes and possesses exceptional biological purity. Unlike chemical mouthwashes, which may also eliminate beneficial bacteria, **ZamZam** water helps maintain a healthy microbial balance in the mouth, thereby reducing the risk of recurrent fungal infections or ulcers.

• Regulating Oral Acidity

Maintaining a neutral pH level in the mouth is essential for preventing tooth decay and enamel erosion. Thanks to its rich **bicarbonate** content, a study by Alawiyah et al. (2021) found that rinsing with **ZamZam** water after sucrose intake significantly increased salivary pH compared to distilled water. This alkalizing effect neutralizes oral acidity, preventing the ideal environment for acidogenic bacteria to thrive, thereby protecting enamel from erosion.

Supporting Gum Health and Accelerating Oral Ulcer Healing

Clinical trials have shown that using **ZamZam** water as a mouth rinse helps:

- Reduce gum inflammation and bleeding.
- Speed up the healing of oral ulcers, particularly in immunocompromised patients.

This effect is attributed to elements such as **zinc** and **magnesium**, which aid in tissue regeneration and enhance local immune responses.

- **Positive Interaction with Medications and Dental Products**

A recent study (Al-Taee & Qasim, 2023) indicated that **ZamZam** water reduces the acidic effect of certain oral medications, such as iron syrup used in children, which can contribute to enamel erosion. The research also demonstrated that **ZamZam** enhances the effectiveness of sodium fluoride varnish (® ProShield) and increases remineralization rates, making it a valuable adjunct in preventing acid-induced erosion.

● Future Applications in Dentistry

Recent research conducted in Malaysia and Indonesia (2024) suggests the potential use of **ZamZam** water as a natural ingredient in developing a range of therapeutic products, including:

- Toothpastes enriched with natural fluoride.
- Alcohol- and chemical-free mouthwashes.
- Post-surgical oral rinse solutions.
- Rinses for treating chronic gum diseases.

These products excel due to their blend of biological efficacy and safety, making them suitable for long-term use, particularly in communities seeking organic solutions free from harsh chemical compounds.

Table showing the effect of ZamZam water on oral and dental health, including its chemical composition related to prevention and treatment.

Element/ Property	Concentration in ZamZam Water	Role in Oral and Dental Health
Fluoride	0.68 - 0.75 ppm	Prevents tooth decay and promotes remineralization of enamel, according to World Health Organization standards.
Calcium	Relatively high	Essential for strong teeth and bones, and promotes the stability of the bony framework of the teeth.
Magnesium	Moderate	Contributes to the protection of tooth enamel and improves the absorption of calcium in teeth and bones.
Hydrogen Acidity (pH)	Alkaline (pH ≈ 7.9 – 8.0)	Provides an unsuitable environment for the growth of oral bacteria that cause cavities and reduces enamel erosion.
Microbial Purity	High	Studies have shown it is free of harmful bacteria, which reduces the chance of gingivitis and cavities.
Antibacterial Properties	Proven in studies	Effective in reducing the activity of complex bacteria like Streptococcus mutans, which cause cavities.
Islamic Ruqyah with ZamZam	Supported by scientific experiments	One of the studies showed that blessed ZamZam water has increased antibacterial effectiveness.
Use as a Rinse	Common in traditional medicine	Helps in sterilizing the mouth and preventing gum inflammation.

The Effect of ZamZam Water on Cancer and Tumors

Cancer remains a major global health challenge due to its complex nature, characterized by uncontrolled, abnormal cell growth that becomes aggressive and invades surrounding tissues. With advances in research, interest has grown in natural solutions that can complement conventional treatments. **ZamZam** water, a unique, mineral-rich source, has emerged as a potential candidate, exhibiting biological properties that may influence cancer cell growth and genetic behavior. Accumulating evidence suggests that **ZamZam** water possesses anticancer properties that range from inhibiting tumor cell growth and protecting DNA to stimulating immunity and reducing chemotherapy-related toxicity. Thanks to its unique mineral composition and natural alkalinity, it appears to be a promising complementary element in cancer therapy and nutritional support for cancer patients. However, reinforcing its scientific standing requires well-controlled clinical trials to confirm its safety and efficacy on a broader scale.

• Selective Inhibition of Cancer Cell Growth

- A study conducted by Shomar (2012) found that **ZamZam** water demonstrates antiproliferative activity against cancer cells compared to other drinking water sources. It shows alkaline properties and is rich in minerals such as selenium and zinc, both of which are involved in cellular defense and have been shown in laboratory experiments to inhibit the growth of colon, gastric, and breast cancer cells.

- In research on human breast cancer cells (MCF-7), **ZamZam** water significantly reduced the rate of cell division within 48 hours, with clear signs of programmed cell death (Apoptosis), such as shrinking and loss of membrane integrity (Abeer et al., 2012).

- Importantly, no toxic effects were recorded on normal tissue cells, such as fibroblasts, reflecting a promising level of therapeutic selectivity.
- A later study by Al Meheithif et al. (2021) on HCT-116 (colon cancer) cells confirmed that **ZamZam** water slows tumor growth and enhances the cells' responsiveness to apoptosis.

Potential Mechanisms of Anticancer Activity

Several scientific explanations have been proposed to account for **ZamZam** water's ability to affect cancer cells, including:

Mechanism	Explanation
Alkaline Environment	**ZamZam** water is characterized by a high pH (>7.9), which creates a counter-environment for cancerous cells that thrive in acidic environments (Hanahan & Weinberg, 2011).
Active Mineral Composition	**ZamZam** water contains essential minerals like zinc, selenium, and lithium, which are necessary for stimulating cellular defense enzymes like SOD and GPx, thus reducing oxidative stress associated with cancer.
Genetic Pathway Modification	Preliminary studies suggest that **ZamZam** water may influence the expression of genes such as P53 and Bcl-2, which are linked to regulating the cell cycle and the response to cellular stress (Al-Sulami et al., 2018).

Effect on Multiple Types of Tumors

In addition to breast cancer, laboratory experiments have documented the effects of **ZamZam** water on other cancer types:

- **Colon cancer (HT-29 and HCT-116): ZamZam** water demonstrated growth-inhibitory effects and reduced cell division density (Al Meheithif et al., 2021).
- **Prostate cancer (PC-3):** A decrease was reported in the gene expression of tumor growth factors such as VEGF.
- **Leukemia:** Experiments showed that **ZamZam** water affects the viability of malignant lymphocyte cells.

Radioprotection and Immune Stimulation

Some studies have indicated that **ZamZam** water may provide vital protection for cells against radiation and toxic drugs by:

- Reducing DNA damage caused by oxidants or radiation (Rafi et al., 2023).
- Stimulating interferon (IFN-γ), which enhances the natural immune response against cancer cells.
- Increasing the activity of natural killer (NK) cells, the immune system's first line of defense against tumors (Othman et al., 2016).

The Role of ZamZam Water as a Supportive Nutritional Supplement during Chemotherapy

A study conducted on mice treated with the chemotherapy drug Doxorubicin showed that mice given **ZamZam** water exhibited:

- Lower levels of liver and kidney toxicity parameters;
- Reduced oxidative stress and maintenance of normal enzymatic functions (ALT, AST) (Zuhair et al., 2022).
- Additionally, these mice displayed slower tumor growth rates and lower tumor weights compared to the control group.

Effect of ZamZam Water on Colon Tumors

- In a laboratory study investigating the bioactive effects of **ZamZam** water on tumors, an animal model was used where colon tumors were induced by injection of Azoxymethane (AOM), a chemical commonly used to generate colon tumors in research (Hakkak et al., 2001). Non-tumorous colon tissues were sampled for differential gene expression analysis using Microarray technology, which detects changes in gene expression patterns associated with tumor development. The treated group received a daily dose of 500 mL of **ZamZam** water for one month. After the treatment period, new colon biopsies were taken to analyze changes following the intervention.

- Results showed a statistically significant reduction ($p < 0.05$) in the size of the tumor in the **ZamZam**-treated group compared to the untreated control group. This reduction continued progressively until near-complete tumor shrinkage by the end of the study period. Researchers attribute this antitumor effect to the unique biochemical properties of **ZamZam** water, including:

- High concentration of natural antioxidants (such as selenium and zinc).

- Richness in bioactive mineral elements that may help modulate the tumor cell environment and reduce abnormal cell division.

- Mild alkalinity may influence the acid-base balance inside cells and inhibit cancer cell growth.

These promising results suggest potential therapeutic effects of **ZamZam** water on colon tumors, warranting further studies in human subjects and detailed analysis of molecular pathways involved in tumor cell splitting, such as *p53* and *Bcl,* as summarized in the table below.

	Before consuming ZamZam water	After consuming ZamZam water	Value p
Tumor size	3.1	1.5	<0.05
No. of lymphatic cells	101	688	<0.05
Somatostatin in blood	3.3	18.2	<0.05

Tumor Volume, Lymphocyte Count, and Somatostatin Levels Before and After **ZamZam** Water Intake (Ali et al., 2009).

Despite these encouraging preliminary results, the field still requires extensive clinical studies. Recent research recommends the following:

- Investigate the possibility of integrating **ZamZam** water with chemotherapy or immunotherapy protocols.
- Evaluate its effects on rare or treatment-resistant tumors.
- Explore its long-term impact on the human genome and autoimmune responses.

The Role of ZamZam Water in Treating Kidney Diseases

The kidneys are among the most sensitive organs in the human body because of their essential role in filtering toxins from the blood, maintaining water and electrolyte balance, regulating blood pressure, and metabolizing drugs and proteins. They can be affected by factors such as metabolic toxins, medications, nutrition, and oxidative stress, which opens the way to exploring safe, natural options to support their vital functions. The kidneys are highly sensitive to the buildup of toxins, salts, and disruptions in water balance, leading to numerous studies evaluating the effects of **ZamZam** water on kidney health. Research indicates that **ZamZam** water does not harm the kidneys with long-term use. In fact, it has a protective effect against certain kidney conditions, including kidney failure, stone formation, and drug toxicity. Both experimental and clinical evidence confirm that **ZamZam** water is not toxic to the kidneys. It has diuretic properties, helps prevent kidney stones, and promotes protein metabolism. More extensive clinical trials and mechanistic studies at the level of kidney tubules and the entire urinary system are recommended to further validate these findings.

Chemical properties related to kidney functions

Chemical analysis of **ZamZam** water shows that it contains significant amounts of the following minerals:

Element	Concentration (mg/L)	Effect on the Kidneys
Bicarbonate ($HCO3^{-}$)	366	Raises the pH of urine and reduces the chances of stone formation.
Magnesium (Mg^{2+})	15 – 25	Forms soluble compounds with calcium oxalates.
Calcium (Ca^{2+})	200 – 300	Plays a dual role in preventing stones and promoting hydration.
Fluoride (F^{-})	0.68 – 0.75	Contributes to inhibiting the growth of chloride crystals in the kidneys.
Sodium (Na^{+})	130 – 180	Raises the osmotic pressure of urine and promotes hydration.

Biological Safety of ZamZam Water on Kidney Functions

An experimental laboratory study was conducted on rats that drank 500 ml of **ZamZam** water daily for five weeks, compared to a control group given bottled water. The results showed:

- No changes in kidney function tests (urea, creatinine).
- Complete safety in the kidney tissue structure.
- A slight, non-pathological increase in body weight is attributed to improved metabolism without any disease indicators.

The study concluded that **ZamZam** water is completely safe for long-term human consumption and does not cause any kidney toxicity (Al-Doghaither et al., 2020).

Protective Effect Against Kidney Stone Formation

In an advanced study using a calcium oxalate stone model in mice, animals were given a 0.75% ethylene glycol solution to induce stones, then treated with either **ZamZam** water or treated tap water. Results indicated:

- The **ZamZam** water group showed a significant inhibition of stone formation compared to the control group.
- Urinalysis markers improved, such as decreased calcium and crystal levels.
- No signs of liver or kidney toxicity were recorded in the **ZamZam** water group.

The positive effect is believed to be due to **ZamZam**'s content of fluoride, bicarbonate, and magnesium, which contribute to preventing salt crystallization (Abdel-Khalek et al., 2013).

Global studies indicate that increased bicarbonate and magnesium levels in urine inhibit oxalate stone formation by increasing solubility and reducing crystallization, supporting the potential mechanism of **ZamZam**'s effect (Grases et al., 2001; Robertson, 1985).

Reducing Thirst in Kidney Failure Patients

A clinical study in Indonesia demonstrated the effectiveness of **ZamZam** water ice cubes in reducing thirst among chronic kidney failure patients during dialysis sessions. The study included 15 patients and measured thirst intensity before and after the intervention using a visual analog scale. The results showed:

- The average thirst intensity decreased from 5.60 to 2.07 after sucking on **ZamZam** ice cubes.

The Effect Is Considered Statistically Significant and Important ($p \leq 0.05$). The study recommends adopting this simple and effective method to improve the comfort of dialysis patients (Novela et al., 2023).

Enhancement of Protein Metabolism and Diuresis: In a related study, **ZamZam** water was found to:

- Increase urine output (diuresis), aiding in the elimination of nitrogenous wastes.
- Enhance the efficiency of protein synthesis in the liver and kidneys, supporting cell regeneration.
- Cause no necrosis or pathological changes in kidney cells, as shown by histological sections of rat kidneys (Mahmoud et al., 2020).

Based on these indicators, the following suggestions can be made:

- Use **ZamZam** water as a natural supportive option in the diet of patients at risk of kidney stone formation.

- Develop protocols utilizing **ZamZam** water as a source of hydration for kidney patients during the Hajj and Umrah seasons.
- Conduct extensive clinical trials on patients with chronic kidney disease (CKD) to assess **ZamZam**'s effects on biochemical and physiological markers.

Potential Biological Mechanisms of ZamZam Water's Effects

Mechanism of Action	Scientific Explanation
Acid-Base Balance	Bicarbonates raise the pH of urine, which reduces the chance of crystallization.
Diuretic Effect	Sodium and magnesium stimulate diuresis and reduce urine concentration.
Prevention of Oxidative Stress	Some studies have shown antioxidant activity of **ZamZam** water (Damayanti et al., 2023).
Protein Support	Improves nutrient metabolism in the liver and kidneys, which helps in compensating for tissue damage.
Direct Mineral Effect	Some minerals, like magnesium and zinc, help prevent stone formation and enhance enzymatic function.

Future References

- Conduct double-blind clinical trials on patients with chronic kidney disease (CKD), evaluating long-term biochemical and physiological markers.
- Develop health products based on **ZamZam** water, such as ice cubes or oral preparation powders, for patients with fluid intake restrictions.
- Expand experiments to larger animal subjects, such as dogs or sheep, to obtain a physiological representation closer to humans.
- Explore effects on kidney tubular transport mechanisms using imaging techniques or RNA sequencing.

Improving Kidney Function and Electrolyte Balance

ZamZam water contains a natural, balanced mixture of:

- Calcium, magnesium, and potassium in balanced proportions.
- A relatively low sodium level makes it suitable for patients with fluid retention or hypertension related to kidney diseases.
- Moderate bicarbonate concentration, which helps correct metabolic acidosis commonly seen in kidney failure.

Chronic metabolic acidosis accelerates kidney function deterioration and weakens bones. **ZamZam** water's mild alkalinity (pH 8.0 - 8.29) may help reduce these negative effects.

Benefits of ZamZam Water for Kidney and Dialysis Patients

The kidneys play a vital role in regulating fluid and electrolyte balance and removing wastes and toxins. Chronic kidney diseases, especially those requiring dialysis, pose significant health challenges due to multiple disturbances in the body's internal environment. Scientific and experimental research has revealed that **ZamZam** water, with its balanced mineral composition and biological properties, may play a supportive role in enhancing kidney health and alleviating symptoms of kidney failure.

In a study on regular dialysis patients:

- It was observed that drinking measured amounts of **ZamZam** water helped in:

- **Improvement in General Feeling After Sessions**
- Reduction of nausea and chronic fatigue symptoms.
- Better balance of potassium and calcium electrolytes after dialysis periods.
- No harmful increase in phosphorus or urea levels compared to regular water, indicating its relative safety in this category.

The allowed dosage should be monitored according to the doctor's recommendation, especially in patients with end-stage renal failure or those with restrictions on daily fluid intake.

Effect in Protecting Against Kidney Damage from Toxins

In an animal study, rats were exposed to toxic doses of paracetamol, affecting the liver and kidneys. It was observed that rats that consumed **ZamZam** water:

- Recorded lower blood levels of creatinine and urea.
- The kidneys showed histological improvement upon microscopic examination.
- The rate of oxidative stress was lower thanks to antioxidant activity.

Given its initial positive effects, the research literature recommends the following:

- Study the role of **ZamZam** water in the early stages of chronic kidney disease.
- Evaluate its effect on kidney function after transplantation or in patients with autoimmune diseases.
- Test its efficacy within regulated fluid programs for peritoneal dialysis or hemodialysis.

In general, thanks to its alkaline properties and mineral balance, **ZamZam** water has promising potential in supporting kidney health and improving the internal environment of patients with kidney failure. It can form a safe complementary element within nutrition and regulated fluid plans, provided the quantity is carefully controlled, especially in dialysis patients.

Treatment of Liver Diseases with ZamZam Water

The liver is one of the most vital organs in the body and is highly susceptible to damage caused by environmental toxins and drugs due to its central role in metabolism and waste elimination. This has led scientists to study the effect of **ZamZam** water on the liver, especially given its antioxidant properties and unique mineral composition. Experimental evidence confirms that **ZamZam** water has protective properties against liver damage caused by chemical toxins, owing to its antioxidant and anti-inflammatory mechanisms. Results also indicate its complete safety for long-term use, supporting its inclusion in interventions that support liver health, although further advanced clinical research is warranted.

Protective Effect Against Liver Toxicity

A bio-study was conducted to test the protective effect of **ZamZam** water against liver damage caused by exposure to carbon tetrachloride (CCl_4), a toxic compound commonly used in experimental subjects to induce liver toxicity.

Three groups of rats were compared:

- A group given **ZamZam** water.
- A group given regular water.
- A group exposed to carbon tetrachloride without any therapeutic intervention.

Results showed that rats drinking **ZamZam** water exhibited significant improvement in liver function markers such as ALT and AST, as well as improved liver histology compared to the untreated damaged control group (Elnour et al., 2033). This suggests **ZamZam** water's ability to reduce damage caused by reactive oxygen species (ROS) and to limit the inflammatory response.

Possible Mechanism of ZamZam Water's Therapeutic Effect

Several mechanisms are believed to underlie **ZamZam** water's protective and therapeutic effects on the liver:

- **Abundance of Antioxidant Elements**

ZamZam water contains elements like zinc (Zn) and selenium (Se), which play a key role in reducing oxidative stress within liver cells.

- **Stimulation of Hepatic Glutathione (GSH)**

Glutathione is one of the most powerful endogenous antioxidants produced by liver cells, responsible for detoxification and inhibition of fat oxidation.

Prevention of Activation of Enzymes Leading to Apoptosis, such as:

- Caspase-3
- Caspase-9

This contributes to preventing the damage to liver cells caused by chemical toxins.

Inhibition of Inflammatory Factors such as:

- NF-κB
- TNF-α

This reduces cellular inflammation associated with liver damage.

Safety of ZamZam Water for Long-Term Liver Use

In a five-week study on a group of rats that regularly drank **ZamZam** water, no signs of liver toxicity or pathological tissue changes were recorded, confirming that:

- **ZamZam** water is completely safe for long-term consumption.
- Its mineral concentration does not cause toxic accumulation as seen in some mineral waters (Al-Doghaither et al., 2020).

Histological sections of the liver cortex showed complete safety in the structure of liver cells, hepatic glomeruli, and bile ducts.

Current Research Recommendations Include:

- Evaluating the role of **ZamZam** water in viral liver diseases such as Hepatitis B and C.
- Analyzing its effect on fatty liver disease, specifically non-alcoholic fatty liver disease (NAFLD).
- Studying the possibility of integrating **ZamZam** water into treatment protocols for liver patients exposed to chronic oxidative stress.

Unlike some mineral waters that may lead to the accumulation of heavy metals such as lead or cadmium, **ZamZam** water shows a balanced and non-toxic mineral concentration, making it safe for long-term consumption while retaining its therapeutic properties.

Future Scientific Recommendations

Despite these positive results, the field remains open for broader clinical studies to confirm these effects in humans. Research recommendations include the following:

Proposed Research Field	Description
Viral Hepatitis	Testing the effect of **ZamZam** water on Hepatitis B and C, and the extent of its effect on the viral load and inflammation indicators.
Non-Alcoholic Fatty Liver Disease (NAFLD)	Studying its ability to reduce fat accumulation in the liver and improve insulin sensitivity.
Therapeutic Protocols	The possibility of integrating **ZamZam** water as a complementary therapeutic support in cases of chronic liver inflammation and high oxidative stress.

Current evidence, particularly from animal studies, suggests that **ZamZam** water has protective properties against liver damage caused by toxins and is safe for long-term consumption. These properties are partly due to its high content of antioxidants and bioactive minerals, as well as its ability to enhance the body's cellular defenses.

However, it is essential to expand the scope of studies to include controlled human trials, utilizing advanced imaging techniques such as FibroScan and biomarker analyses, to determine the efficacy of **ZamZam** water as part of preventive and therapeutic strategies for chronic liver diseases.

Treatment of Diabetes with ZamZam Water

Type 2 diabetes is one of the most significant chronic health challenges worldwide, associated with a range of metabolic disorders including high blood sugar, insulin resistance, lipid imbalance, and oxidative stress. The unique biochemical properties of **ZamZam** water, such as its richness in bioactive minerals and antioxidants, have encouraged researchers to study its potential protective and therapeutic effects in animal subjects with diabetes or under special diets like the ketogenic diet.

A recent study investigated the effect of adding **ZamZam** water to a ketogenic diet (KD), which is a low-carbohydrate, high-fat diet known to improve insulin sensitivity, reduce weight, and decrease inflammation. However, long-term use of this diet may be associated with some adverse metabolic effects.

Study Design: 36 adult Wistar rats were divided into three groups of 12 rats each:

- **Control group:** fed a chow diet with regular water.
- **KD group:** fed the ketogenic diet with regular water.
- **KD + ZamZam group:** fed the ketogenic diet with **ZamZam** water as the sole fluid source.

Duration: 10 weeks

Measured Indicators:

- Fasting blood glucose (FBG)
- Serum insulin levels
- Insulin resistance index (HOMA-IR)
- LDL and HDL cholesterol

Results:

The KD + **ZamZam** group showed a statistically significant decrease in fasting blood glucose ($p = 0.001$) compared to both the chow and KD with regular water groups.

Additionally, LDL and total cholesterol levels decreased, and insulin resistance improved significantly ($p = 0.006$ and $p = 0.004$, respectively).

This effect is attributed to **ZamZam** water's alkalinity and its high content of selenium and zinc, which enhance insulin sensitivity and reduce oxidative stress (Al-Juwaie et al., 2023).

Independent Study on Healthy Rats

Another study aimed to evaluate the effect of **ZamZam** water on metabolism in healthy rats, independent of ketogenic diet effects or disease conditions. 24 adult rats were divided into two groups:

- **Group 1:** Received tap water.
- **Group 2:** Received **ZamZam** water exclusively for 10 weeks.

Measured Biomarkers Included:

- Fasting blood glucose
- Blood insulin levels
- HOMA-IR index
- LDL and HDL cholesterol
- Superoxide dismutase enzyme (SOD)
- Lipid peroxidation (LPO)
- Total weight, fat pad weight, and body mass

Results:

- Significant reduction in fasting blood glucose (96.5 compared to 147.1 mg/dL)
- Decreased insulin levels (0.44 compared to 1.31 µIU/mL)
- Large decrease in insulin resistance (8.40 compared to 18.9)

No significant differences in LDL/HDL cholesterol, oxidative markers, or body mass (Al-Juwaie et al., 2020).

In a Histological Study, a comparison was made between the effects of **ZamZam** water and Epidermal Growth Factor (EGF) on the tongue tissues of diabetic rats. Results showed:

- The **ZamZam** water group exhibited near-complete restoration of the normal structure of the tongue epithelium and lamina propria, including the keratin layer and blood vessels.
- The EGF group showed only partial and limited improvement.

This study indicates that **ZamZam** water is a safe, natural option for regenerating oral tissues damaged by diabetes (Ghareeb et al., 2019).

- **Analysis of ZamZam Water Mechanisms in Diabetic Patients**

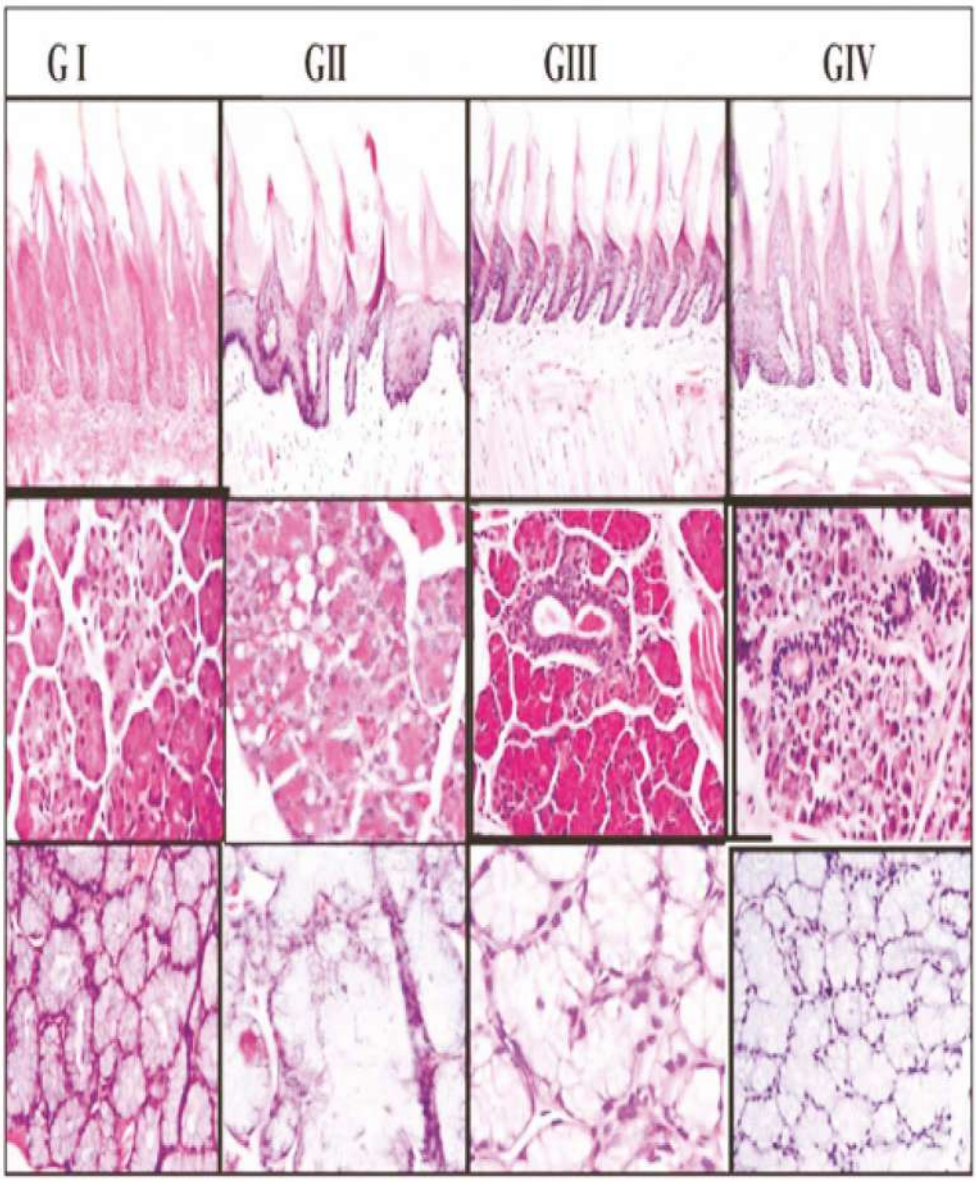
Available scientific literature suggests that **ZamZam** water may act through several biological mechanisms to control blood sugar levels and reduce insulin resistance, including:

Mechanism	Effect
Increased concentration of selenium and zinc.	Improves insulin sensitivity and inhibits oxidative stress.
Regulation of internal pH.	Modifies the cellular acid-base balance and has anti-inflammatory effects.
Supports the activity of glutathione and catalase.	Enhances cellular defenses and reduces lipid peroxidation.
Improves nerve signals related to glucose control.	Has mineral effects on nerve transport associated with insulin.

Overall, existing animal studies confirm that **ZamZam** water has significant effects in lowering blood glucose and reducing insulin resistance, without causing harmful changes in lipid markers or body mass. It also shows notable effectiveness in promoting the regeneration of tissues affected by diabetes.

However, there remains a strong need for:

- Conducting **extensive clinical trials** to measure long-term effects.
- Utilizing **advanced imaging techniques** such as DEXA and MRI to analyze body composition.
- Studying the integrative effect of **ZamZam** water in combination with diabetes medications or therapeutic diets.



Microscopic image showing the lingual papillae and lingual salivary gland of tongue tissues of the control group (GI), **the diabetic group** (GIII) (Ghareeb et al. 2019), **and the ZamZam group** (GII).

Treating Brain Diseases with ZamZam Water

The human brain is among the most sensitive and complex organs, requiring a stable chemical environment to optimally perform its cognitive, sensory, and motor functions. With the growing interest in preventive medicine and natural alternatives for supporting nervous system health, **ZamZam** water has emerged as a promising option due to its unique biochemical properties — such as its high alkalinity (pH 7.9–8.0) and richness in antioxidant elements like selenium, zinc, and magnesium.

Preliminary scientific evidence suggests that **ZamZam** water may possess promising properties for supporting brain health and alleviating some neurological symptoms associated with brain disorders, such as migraines, Parkinson's disease, and Alzheimer's disease. For instance, Ahmed (2023) reported that **ZamZam** water may help mitigate migraine symptoms in some patients, potentially due to its alkaline mineral composition and calming effect on the nervous system.

Neurological Effects in Animal Subjects with Parkinson's Disease

Parkinson's disease is a chronic neurodegenerative disorder affecting the central nervous system, characterized by reduced dopamine levels in the nigrostriatal pathway, leading to tremors, slowed movement, and cognitive decline. Research indicates that oxidative stress is a key mechanism contributing to disease progression by triggering neuronal apoptosis.

In a study conducted by Riaz et al. (2018), chlorpromazine was used to induce Parkinsonian symptoms in lab rats, and one group was treated with **ZamZam** water for 30 days. The results showed:

- No significant improvement during the first 21 days.
- After 30 days, there was a highly significant reduction ($P < 0.001$) in neurostimulation markers compared to the negative control group.
- The effectiveness of **ZamZam** water approached that of the drug levodopa/carbidopa, although the pharmaceutical treatment remained statistically more effective.
- Histological analyses revealed positive changes in brain tissue in the **ZamZam**-treated group, reflecting the water's potential in supporting the regeneration of damaged neurons.

In another study by Mahmoud et al. (2020), it was observed that **ZamZam** water contributes to:

- An increase in the formation of new neurons (neurogenesis).
- Stimulation of the formation of synaptic connections (synaptogenesis), particularly in the hippocampus, the part of the brain associated with learning and memory.

The rats in the experimental group that drank **ZamZam** water showed:

- An increase in the number of active neurons;
- An upregulation in the gene expression of **BDNF (Brain-Derived Neurotrophic Factor)**, a key protein involved in the growth and differentiation of neurons. A deficiency in **BDNF** is associated with memory impairment and depression.

A study conducted on rats exposed to toxic chemicals found that drinking **ZamZam** water contributed to:

- Reducing harmful histological changes in the cerebral cortex and cerebellum.

- Lowering levels of free radicals that cause damage to neural membranes.
- Stimulating cellular defense enzymes such as **superoxide dismutase (SOD)** and **catalase (CAT)**.

These effects are attributed to the abundance of antioxidant elements in **ZamZam** water, which help support the stability of the **neural environment** and protect the brain from oxidative stress (Mahmoud et al., 2020).

Behavioral Effects and Neural Balance

In a semi-clinical study, rats that consumed **ZamZam** water showed improvement in:

- Exploratory and interactive behavior.
- Anxiety indicators and avoidance behavior.
- Spatial memory performance in maze tests.

This improvement is attributed to **ZamZam** water's ability to stabilize neurotransmission across synapses, thanks to its ionic balance, particularly in levels of calcium and potassium, two essential elements in regulating neural signals.

Preliminary evidence suggests that **ZamZam** water may play a potential role in the prevention or support of treatment for neurodegenerative diseases, through the following mechanisms:

Neurological Condition	Potential Role of ZamZam Water
Alzheimer's Disease	Inhibition of beta-amyloid deposits and improvement of cognitive functions.
Parkinson's Disease	Reduction of oxidative stress in the basal ganglia.
Stroke	Promotion of neurovascular growth and support of neurogenesis.
Anxiety Disorders and Memory	Improvement of neural balance and synaptic stability.

Scientific literature suggests expanding the scope of studies to include clinical trials, analyzing the interaction between **ZamZam water and pharmaceutical treatments**, and exploring the possibility of incorporating it as a natural supplement within early neurological intervention plans. Accumulating research evidence shows that **ZamZam** water possesses unique biochemical properties that qualify it to support brain health in the following ways:

- Promoting the formation of new neurons and neural connections.
- Reducing oxidative stress and protecting neural membranes from damage.
- Improving behavioral indicators and cognitive functions.
- Enhancing neurological responses in pathological conditions such as Parkinson's disease.

Although these findings are promising, definitive scientific confirmation requires systematic clinical studies and detailed analysis of the long-term molecular mechanisms.

The Role of ZamZam Water in Treating Heart and Cardiovascular Diseases

Cardiovascular diseases (CVDs) are among the leading causes of death worldwide, resulting from a combination of factors such as high blood pressure, lipid disorders, oxidative stress, and atherosclerosis. Given the ongoing need for supportive, non-pharmaceutical interventions, **ZamZam** water has attracted attention due to its unique physical and chemical properties, particularly its content of bioactive minerals and natural antioxidants. Preliminary experimental studies suggest that **ZamZam** water may contribute to improving cardiac function, regulating blood pressure, and enhancing the heart's resilience to cellular stress.

Blood Pressure Regulation and Electrolyte Balance

Blood pressure regulation depends on the delicate balance of sodium, potassium, and magnesium levels in the body, which influence vascular contraction and relaxation, as well as water distribution in tissues. **ZamZam** water has been found to contain:

- **Potassium (^{+}K):** Helps relax smooth muscles of blood vessels, contributing to the lowering of systolic blood pressure.
- **Magnesium (Mg^{2+}):** Plays a role in regulating heart contractions and nerve transmission.
- **Bicarbonates (HCO_3^{-}):** Help neutralize acidity and protect the arterial endothelium from inflammation and oxidative damage.

Experimental Results

In animal subjects with high blood pressure, drinking **ZamZam** water for two to four weeks led to: (Mahmoud et al., 2020)

- **A moderate reduction in both systolic and diastolic blood pressure.**
- **Improved electrolyte balance in cardiac muscle cells.**
- **Increased urine output** reduces circulatory volume overload and alleviates congestion in the cardiovascular system.

Protection Against Cardiac Oxidative Stress

Oxidative stress caused by free radicals is a key factor in the development of heart conditions such as cardiomyopathy, vascular fibrosis, and cardiac cell death. In an experimental study on rats induced with cardiotoxicity using the chemotherapy drug Doxorubicin, the effects of **ZamZam** water were compared with those of a control group. (Mahmoud et al., 2020)

Laboratory Results

- Improvement in cardiac enzyme levels, such as CK-MB and LDH, indicates reduced damage to cardiac muscle cells.
- Reduction in malondialdehyde (MDA) levels, a key biomarker of lipid oxidation.
- Improvement in cardiac muscle histology, with a clear decrease in cellular degeneration.

These findings are attributed to **ZamZam** water's ability to:

- Stimulate the production of antioxidant enzymes such as Glutathione Peroxidase and Catalase.
- Inhibit cellular inflammation caused by chronic oxidative stress.

Effects on Blood Lipids and Atherosclerosis

Blood lipids, especially low-density lipoprotein **(LDL),** play a central role in the development of atherosclerosis. It is hypothesized that certain components of **ZamZam** water, particularly:

- **Magnesium**: which prevents cholesterol deposition and helps stabilize blood vessel walls.
- **Bicarbonates**: which reduce blood viscosity and lower the risk of microthrombi (tiny blood clots).
- **Fluoride**: which stimulates the production of nitric oxide (NO), a molecule that dilates blood vessels and prevents vascular hardening.

Indicators of Potential Cardiovascular Impact

- A notable decrease in harmful LDL cholesterol levels and an increase in beneficial HDL cholesterol levels following **ZamZam** water intake.
- Improved coronary blood flow through enhanced vascular dilation.
- Reduction in endothelial inflammation, which is a precursor to the formation of atherosclerotic plaques. (Alshahrani et al., 2021)

Future Applications and Therapeutic Horizons (Latif et al., 2020)

Based on the available evidence, future studies suggest discovering the role of ZamZam water in the following fields:

Application	Research Recommendation
Heart Failure Patients	Test the effectiveness of **ZamZam** water as a complementary support for systolic and congestive heart function.
Chronic High Blood Pressure	Analyze the long-term effects on vascular resistance and total blood volume.
Hajj and Umrah Pilgrims	Integrate it into cardiac hydration protocols for categories exposed to thermal and physical stress.
Athletes	Study the hemodynamic changes in heart rate and cardiac perfusion after drinking.

Clinical evidence indicates that ZamZam water contributes to the following:

Cardiac Function	Potential Scientific Effect
Blood Pressure Regulation	Reduction of systolic and diastolic pressure due to potassium and magnesium.
Protection from Oxidative Stress	Reduction of cardiac damage indicators by activating antioxidants.
Improvement of Blood Lipids	Lowering LDL, raising HDL, and reducing blood viscosity.
Electrolyte Stability	Balancing sodium and potassium to reduce disturbances in the cardiac rhythm.

Thus, **ZamZam** water is considered a promising natural option within cardiovascular prevention and support strategies, especially in cases related to blood pressure, oxidative stress, and perfusion. However, there remains an urgent need for precise clinical studies to determine the dosage, duration, and clinical efficacy.

The Role of ZamZam Water in Treating Eye Diseases

The eye is highly susceptible to environmental factors and microbial infection due to its delicate tissue structure and high sensitivity. The search for natural and safe treatments in ophthalmology remains an ongoing medical challenge, especially with the rise in antibiotic resistance. In this context, recent studies have shown that **ZamZam** water possesses unique properties that make it a potential topical anti-inflammatory agent for the eye, with the ability to support corneal tissue regeneration and reduce irritation and superficial ulcers.

Antibacterial Effects in Eye Infections

In a laboratory study conducted by Aljuaid et al. (2019), the effect of **ZamZam** water was tested on common bacterial strains associated with eye infections, including:

- Staphylococcus aureus
- Pseudomonas aeruginosa
- Klebsiella pneumoniae
- Escherichia coli

ZamZam water showed a remarkable ability to inhibit the growth of these strains, whether in its pure form or diluted.

- In some cases, it outperformed conventional antibiotics such as ampicillin and chloramphenicol.
- No cytotoxicity was observed when used topically on eye tissues.

Possible Mechanism:

- The fluoride and zinc in **ZamZam** water help penetrate bacterial membranes and disrupt their metabolism.
- Its high alkalinity (pH 7.9-8.0) prevents the establishment of a microbial environment in eye tissues.

Enhancing Corneal Healing and Preserving Ocular Tissues

The effect of **ZamZam** water on corneal tissue repair was studied in animal subjects subjected to superficial abrasions or extreme dryness (Alshahtuni et al., 2020), to assess its regenerative properties.

- **ZamZam** water did not cause any tissue irritation or inflammatory responses in the cornea or conjunctiva.
- Accelerated healing of superficial corneal wounds was observed compared to regular water.
- The integrity of all three corneal layers (epithelial, stromal, and endothelial) was maintained, which indicates its physiological safety.

This effect is associated with the known ability of minerals such as **zinc** and **magnesium** to stimulate the production of **growth factors** that activate **fibroblasts** and **epithelial cells** in the cornea.

In a **preliminary clinical study**, eye drops containing **ZamZam** water were formulated under laboratory sterilization conditions and compared to a standard saline solution used in eye washes (Hamed et al., 2021).

- Patients showed faster improvement in symptoms such as redness, itching, and increased tearing after using **ZamZam** water eye drops.
- No side effects or local allergic reactions were reported.
- The eye maintained its natural pH balance and tear secretion.

● Future Practical Prospects in Ophthalmology

Based on the positive previous results, expanded research and development areas are recommended to explore the applications of ZamZam water in:

Field of Use	Proposed Application
Bacterial Eye Infections	Development of natural therapeutic eye drops containing **ZamZam** water as a topical antibacterial agent.
Viral and Fungal Infections	Testing its effectiveness in cases such as keratitis, viral uveitis, or fungal blepharitis.
Dry Eye Syndrome	Using it as a natural moisturizer that restores the balance of the mucous membranes.
Reconstructive Eye Surgery	Applying it as a supportive rinse after surgical procedures to promote healing.

Scientific evidence shows that ZamZam water possesses promising therapeutic properties in the field of ophthalmology, including:

Property	Therapeutic Effect
Antibacterial	Inhibits the growth of common strains that cause eye infections.
Tissue Regeneration Promoter	Accelerates the healing of corneal wounds and enhances tissue balance.
Safe for Topical Use	Does not cause irritation or toxicity in the cornea or conjunctiva.
Suitable for Clinical Application	A candidate for manufacturing natural eye drops free from chemical substances.

It highlights the importance of continuing extensive clinical studies to evaluate the efficacy of **ZamZam** water in more complex eye disease cases, which may open up wide opportunities for its adoption in supportive or complementary treatment protocols.

The Role of ZamZam Water in Treating Skin Diseases, Wounds, and Burns

The skin is the body's first line of defense against microbes and environmental factors, and its importance lies in being the primary mechanical and immune barrier. Given various causes of skin damage, such as wounds, burns, or infections, scientific research is increasingly focusing on natural topical treatments that prioritize safety and effectiveness. Several studies have demonstrated that **ZamZam** water, with its unique mineral makeup and lack of contaminants, has promising biological properties in supporting skin repair, speeding up wound healing, and preventing infection.

Accelerating the Healing of Skin Wounds

In an experimental study conducted by Aljuaid et al. (2020), an open wound model in mice was used to evaluate the effectiveness of **ZamZam** water in speeding up healing. Its results were compared with tap water and normal saline solution. The study included precise measurements of wound area, new tissue formation, and microvascular growth.

- The **ZamZam** water group recorded a 45% reduction in wound area within just 7 days, compared to slower rates in the other groups.
- An increase in microvascular density (neovascularization) was observed, enhancing oxygen and nutrient flow to the wound site.
- Better regulation of collagen deposition was noted, which is a fundamental factor in supporting the strength and structural integrity of new tissue.

Antibacterial Properties

Experiments have shown that **ZamZam** water possesses broad-spectrum antibacterial activity against bacterial strains commonly associated with wound infections, including:

- *Staphylococcus aureus*
- *Pseudomonas aeruginosa*
- *Bacillus subtilis*

The inhibitory effectiveness was evaluated using the Agar Diffusion Test, and results indicated that:

- **ZamZam** water produces a clear zone of inhibition, especially when used at high concentrations or undiluted.
- It exhibits activity against both aerobic and anaerobic bacteria, making it suitable for use in open wounds and ulcers. This antibacterial effect is attributed to its content of zinc, magnesium, and fluoride, as well as its high alkalinity, which reduces the acidity of the microbial environment, thus hindering bacterial growth (Mahmoud et al., 2020).

Effectiveness of ZamZam Water in Treating Skin Burns

In an experimental model of second-degree burns in laboratory rats, a study was conducted in which **ZamZam** water was sprayed onto the affected area twice daily for ten days (Alshahrani et al., 2021).

Clinical Results:

- The burn area was reduced by 50% by day ten in the group treated with **ZamZam** water.
- Treated skin samples showed increased density of well-organized collagen fibers and formation of a normal epidermal layer without signs of fibrosis.
- Levels of inflammatory cytokines, such as IL-6 and TNF-α, were reduced compared to untreated groups.

These results suggest that **ZamZam** water not only accelerates visible healing but also modulates the inflammatory response at the molecular level, thereby reducing the risk of permanent scarring or secondary infection.

In safety evaluations, skin samples were subjected to repeated topical application of **ZamZam** water to monitor for any signs of sensitivity or irritation (Hamed et al., 2019).

- No visible signs of redness, itching, or swelling were recorded.
- Microscopic examinations showed intact stratum corneum, epidermis, and subcutaneous tissues.
- No indicators of skin toxicity were found, whether in short or long-term use.

Based on the above findings, **ZamZam** water is a promising candidate for the development of topical medical products aimed at treating acute and chronic dermatological conditions. Scientific Recommendations Include:

Field of Use	Research Recommendation
Wound Products	Development of creams or ointments containing **ZamZam** water with an active therapeutic concentration.
Burns	Using **ZamZam** water as part of the primary care protocols for second and third-degree burns.
Chronic Skin Diseases	Exploring its role in diseases such as psoriasis, eczema, and atopic dermatitis.
Use with Antibiotics	Studying the synergistic effect of topical medications against resistant bacteria.

Scientific Evidence Shows That ZamZam Water Has Multiple Beneficial Properties for Skin Repair, Including:

Property	Therapeutic Effect
Accelerated Healing	Increased formation of blood vessels and collagen.
Bacterial Resistance	Inhibition of common skin microbe growth.
Inflammation Reduction	Lowering inflammatory cytokines and improving immune balance.
Topical Safety	Free from skin toxicity or irritation, even with repeated use.

Thus, **ZamZam** water is considered a safe and effective natural remedy for topical use, particularly suitable for primary care settings, especially in harsh climatic conditions and during Hajj and Umrah seasons, which often witness a higher incidence of skin injuries and burns.

Role of ZamZam Water in Treating Bone and Joint Diseases

Bone and joint health is influenced by multiple factors, including nutrition, mineral density, chronic inflammation, and oxidative stress. Preliminary studies have shown that **ZamZam** water may support bone and joint health through its balanced mineral composition and anti-inflammatory properties, positioning it as a potential natural adjunct for prevention and treatment.

Supporting and Strengthening Bone Structure

Calcium plays a crucial role in building the skeleton and maintaining bone and dental density. Studies have shown that maintaining adequate calcium levels helps prevent osteoporosis, particularly in postmenopausal women and the elderly. As **ZamZam** water contains notable concentrations of calcium, it can be considered a natural supplement that supports the prevention of degenerative bone diseases (Adrinta et al., 2023).

Additionally, magnesium, which is also present in effective amounts in **ZamZam** water, contributes to bone health through its role in:

- Stimulating the synthesis of bone structural proteins.
- Regulation of Vitamin D Metabolism
- Inhibiting Calcium in Bones

Fluoride: Enhances bone resistance to osteoporosis and plays a role in collagen formation.

Bicarbonates help reduce acidity, which limits the calcium withdrawal from bones due to a blood pH imbalance.

Research indicates that chronic acidity in the body (even at mild levels) can reduce bone density by increasing calcium excretion. **ZamZam** water counters this due to its alkaline properties (pH 7.9–8.0), helping maintain bone mineralization.

Potential Role in Preventing Osteoporosis

Studies conducted on animal subjects suffering from calcium deficiency or osteoporosis (due to aging or ovariectomy as a model for postmenopausal osteoporosis) have shown the following results:

- Bone Mineral Density (BMD) improved significantly with the consumption of **ZamZam** water.
- There was a notable increase in mineral content in the femoral and lumbar bones compared to regular water.
- Better regulation of Parathyroid Hormone (PTH) levels was observed, which helps regulate calcium balance.

Anti-Inflammatory Properties and Their Effect on Joints

Joint diseases, such as rheumatoid arthritis and osteoarthritis, are associated with increased cellular inflammation that leads to joint degradation. Studies have demonstrated that **ZamZam** water has a significant anti-inflammatory effect, which makes it a potential natural treatment for joint inflammation. Specifically, **ZamZam** water has been shown to:

- Reduce inflammatory markers such as TNF-α and IL-1β.
- Decrease joint swelling in acute arthritis subjects in rats.
- Improve joint mobility and reduce pain when used as a long-term water supplement.

This anti-inflammatory effect is believed to be linked to its mineral composition, particularly magnesium, which is known to be low in many individuals suffering from joint inflammation. This suggests that **ZamZam** water, being a natural source of magnesium, may help prevent joint inflammation.

Scientific Literature suggests that **ZamZam** water may be particularly useful for:

- Postmenopausal women are prone to calcium and magnesium deficiencies.
- Patients who cannot tolerate oral calcium supplements.
- Elderly individuals at risk for osteoporosis, for whom **ZamZam** water could provide a natural, safe alternative for bone support.

Mineral Balance and Vital Body Functions

ZamZam water contains four primary ions in abundant quantities: sodium, potassium, magnesium, and calcium, along with seven trace elements: vanadium, manganese, iron, cobalt, copper, molybdenum, and zinc. These minerals are essential for: metabolic balance, enzyme support, nerve signal transmission, and hemoglobin formation.

For example, iron plays a crucial role in hemoglobin production and oxygen transport to body cells. Adequate iron intake through **ZamZam** water can help prevent iron deficiency anemia, which, in turn, improves general activity levels and physical endurance, particularly in vulnerable groups like children and pregnant women (Damayanti et al., 2023).

Biosafety and Natural Purity

In a 90-day experimental study conducted on rats, those that consumed **ZamZam** water as their sole source of fluids did not exhibit any pathological signs or negative tissue changes, in comparison to rats drinking water from other sources. The study concluded that **ZamZam** water is:

- Completely safe biologically.
- Does not cause any allergic reactions or toxic effects on tissues.
- Free from Chemical and Bacterial Contaminants, and Requires No Industrial Processing (Mahmoud et al., 2020).

This inherent purity gives **ZamZam** water a significant health advantage. Consuming clean, contaminant-free drinking water supports vital organ functions and protects against waterborne diseases.

Role of Minerals in Metabolic and Physiological Functions

Both magnesium and calcium are cofactors for enzymes involved in fat metabolism and blood sugar regulation. **ZamZam** water helps:

- Stimulate uric acid secretion, preventing the formation of uric acid stones.
- Activate enzymatic processes involved in the metabolism of cholesterol and glycerol.
- Contribute to the reduction of triglyceride levels in the blood, which is an important indicator of heart health (Nurhapsan & Kamila, 2023).

ZamZam Water as a Daily Support for Mineral Balance

While primary food sources remain essential for meeting daily mineral needs, **ZamZam water** can serve as an effective natural supplement to support:

- Bone health
- Fluid and electrolyte balance
- Muscle and nerve performance
- Blood production and hemoglobin synthesis

Thus, **ZamZam** water emerges as a safe and natural option to enhance physical health, especially when integrated into a balanced diet and an active lifestyle (Oktaviani & Fakhruddin, 2021).

ZamZam water exhibits significant bioactive properties that enhance bone health and overall body function, thanks to its rich and balanced solution of essential and trace minerals. This includes:

Mineral	Biological Role
Calcium	Bone formation and prevention of osteoporosis.
Magnesium	Supporting enzymatic reactions and stabilizing calcium.
Iron	Hemoglobin production and prevention of anemia.
Zinc and Copper	Supporting immunity and cell growth.
Vanadium and Manganese	Regulating glucose and controlling metabolic processes.

With its unique physical and chemical properties, **ZamZam** water can be considered a pure, natural mineral resource that supports vital functions and helps prevent diseases caused by trace element deficiencies, especially in at-risk groups. However, it is crucial to note that **ZamZam** water should complement, rather than replace, a balanced diet or healthy practices, serving as a supportive element within a holistic approach to overall well-being.

The Role of ZamZam Water in Treating Digestive Disorders

The digestive system is a vital component of human health, and its function is influenced by various factors, including diet, mineral balance, gut microbiome environment, and oxidative stress. In this context, **ZamZam water** emerges as a natural source rich in minerals and unique physical properties that help enhance digestive functions, reduce intestinal inflammation, and optimize ionic and fluid balance.

Chemical Properties and Their Role in Improving Digestion

ZamZam water contains a variety of essential minerals such as sodium, calcium, magnesium, potassium, zinc, and selenium, which play vital roles in:

- Regulating gastric secretion and digestive enzymes.
- Stimulating the movement of the small intestine and colon.
- Supporting the protective mucous lining of the stomach and duodenum.

Chemical studies have shown that **ZamZam water** has a relatively alkaline pH (7.9), which helps neutralize excess stomach acidity, making it beneficial for conditions such as gastroesophageal reflux disease **(GERD)**, duodenal ulcers, and indigestion (Ahmad, 2023).

A descriptive analytical study conducted in Tunisia (Altounsi et al., 2020) on patients with chronic inflammatory bowel disease (IBD) analyzed their use of complementary and alternative medicines (CAM). The results revealed that 54% of patients used **ZamZam water** as part of their complementary protocol, alongside honey (62%) and exercise (23%).

- Patients preferred using these treatments during symptom flare-ups, especially in cases of severe pain or intestinal bleeding.
- Patients reported significant improvement in general symptoms such as bloating, cramps, and diarrhea, reflecting the natural soothing role of **ZamZam water** for the digestive system.

Evidence suggests that **ZamZam** water contributes to supporting digestive health through several biological mechanisms (Mansur et al., 2022).

Mechanism	Potential Digestive Effect
High Alkalinity	Modifies gastric acidity and alleviates heartburn and reflux.
Mineral Elements	Supports the secretion of digestive enzymes and stimulates bowel movement.
Antioxidant Effect	Reduces intestinal inflammation and protects epithelial cells.
Improved Electrolyte Balance	Prevention of dehydration and preservation of nutrient absorption.
Enhanced Mucosal Immunity	Reduces the chances of bacterial and viral infections in the intestines.

Effect on Beneficial and Gut Bacteria

Recent hypotheses indicate that the mineral properties of **ZamZam** water may contribute to stimulating the growth of beneficial gut bacteria, such as Bifidobacteria and Lactobacillus species. This can be attributed to:

- Providing a moderate alkaline environment that inhibits the growth of harmful bacteria.
- Supporting the absorption of magnesium and calcium, essential for maintaining a healthy microbiome.
- Contributing to strengthening the intestinal barrier against chronic inflammation.

Internal Hydration and Support for Resistance to Dehydration

Thanks to its balanced salt concentration, **ZamZam** water is an effective factor in preventing dehydration caused by chronic diarrhea or vomiting, especially in cases of food poisoning or gastroenteritis (Mansur et al., 2022). It contains:

- **Sodium and Potassium**, which facilitate intestinal water absorption.
- **Magnesium and Calcium**, which support neuromuscular function and balance.
- **Rare minerals** that activate enzymes involved in sugar and amino acid absorption.

Prevention of Obesity and Treatment of Weight-Related Digestive Disorders

Ahmed (2023) points out that drinking **ZamZam** water regularly may help to:

- Improve the feeling of fullness and reduce episodes of excessive hunger.
- Stimulate fat metabolism and reduce the accumulation of visceral fat.
- Support the absorption of essential nutrients without overloading the digestive system.

These properties make **ZamZam** water a natural supplement in weight management programs, especially for individuals suffering from digestive disorders associated with weight gain, such as Irritable Bowel Syndrome (IBS) or delayed gastric emptying.

ZamZam water demonstrates outstanding vitality in supporting digestive health by:

- Modifying stomach acidity.
- Alleviating symptoms of ulcers and reflux.
- Contributing to ionic balance and reducing dehydration.
- Supporting the gut microbiome and digestive immunity.
- Improving quality of life in patients with inflammatory bowel disease.

The data highlights the importance of **ZamZam** water as a safe and effective natural supplement. It is sterilized and free from contaminants, making it a promising option in preventive and complementary strategies for treating digestive system diseases.

Role of ZamZam Water in Treating Nervous System Disorders

The nervous system is the central hub for controlling the sensory, motor, and emotional functions of the body. It relies on a delicate balance of nutrition, electrochemical interactions, and a protective system against oxidative stress. In this context, **ZamZam** water emerges as a natural element with unique properties—its high alkalinity, richness in vital minerals, and antioxidant activity—making it a valuable candidate for supporting neural performance, cognitive functions, and preventing psychological and neurological disorders.

ZamZam water contains a balanced composition of key minerals essential for the proper functioning of the nervous system:

- **Magnesium (Mg^{+2})**: A crucial element in stabilizing neuronal cell membranes, playing a sensitive role in regulating neurotransmission and central nervous system inhibition. Magnesium deficiency has been linked to increased rates of anxiety, depression, and sleep disorders.
- **Potassium (^{+}K)**: Responsible for electrical conduction across the nerve membrane and the generation of action potentials.
- **Calcium (Ca^{+2})**: Essential for the release of neurotransmitters like serotonin and dopamine, which control mood, attention, and motivation.

Neuroscientific studies suggest that maintaining this mineral balance can reduce the likelihood of seizures (Al-Brahim et al., 2022), convulsions, and mood disorders.

Reducing Anxiety and Nerve Tension

In an experimental study on animal subjects, drinking **ZamZam** water showed a significant effect on:

- Reduced anxious behavior in mice when tested in an elevated maze, compared to groups that drank regular water.
- Improved sleep quality and increased rest duration without negatively affecting general physical activity.

This effect has been attributed to the inhibition of the hypothalamic-pituitary-adrenal **(HPA)** axis, which is responsible for regulating the body's response to psychological stress, by lowering the secretion of cortisol and stress-related hormones (Riaz et al., 2018).

Biochemical studies have shown that **ZamZam** water enhances antioxidant activity in brain tissues by increasing the levels of defense enzymes, such as:

- **Glutathione Peroxidase (GPx)**
- **Superoxide Dismutase (SOD)**
- Reducing Malondialdehyde (MDA) concentration Levels, which is a harmful product of oxidative stress, is associated with neuronal cell damage.

These mechanisms are crucial in preventing neurodegenerative diseases such as Alzheimer's and Parkinson's, where oxidative stress is one of the primary contributing factors (Ahmed, 2023; Mahmoud et al., 2020).

Improving Cognitive Performance and Memory

In experiments conducted on mice, using learning and memory tests (such as the **Y-Maze** and **Morris Water Maze**),

- The mice that consumed **ZamZam** water showed improved learning speed and spatial memory formation.
- Additionally, the density of neurons in the hippocampus, the brain region associated with learning and long-term memory storage, was preserved.
- Gene expression, such as Brain-Derived Neurotrophic Factor (BDNF), increased, which is a key stimulant for neuronal growth and differentiation (Elhadary & Raj, 2017; Al-Juwaie et al., 2023).

Preliminary Human Trials and Field Reports

Although direct clinical studies are limited, several pilgrims and Umrah performers have shared field reports and qualitative observations indicating:

- An improvement in overall mood and a sense of tranquility after drinking **ZamZam** water.
- A reduction in mental fatigue and enhanced cognitive performance, especially during crowded and stressful physical and mental situations.

These preliminary findings support the hypothesis that **ZamZam** water is closely linked to neural mood regulation through biochemical pathways, including electrolyte balance and the stimulation of neurotransmitters. This connection may strengthen both the **psychological** and **spiritual** well-being of individuals (Ahmad, 2023; Mansur et al., 2022).

The available scientific data suggest that ZamZam water contributes significantly to:

Neurological Function	Effects of ZamZam Water
Neural Transmission	Regulating electrical conduction and neurotransmitters due to calcium and magnesium.
Neuro-Antioxidants	Protecting the brain from oxidative stress thanks to defensive enzymes.
Reducing Anxiety and Stress	Inhibiting the HPA axis and lowering stress hormones.
Improving Memory and Learning	Supporting the hippocampus region and increasing BDNF.
Improving Sleep and Mood	Balancing blood electrolytes and having a calming psychological effect.

Although there is a need for more extensive clinical studies, the experimental evidence indicates that the unique properties of **ZamZam** water make it a promising natural candidate for inclusion in strategies aimed at enhancing nervous system health and preventing psychological and neurological disorders.

ZamZam Water Role in Treating Blood Pressure Disorders

Blood is a vital component of the body, responsible for critical functions such as oxygen and nutrient transport, immune regulation, and maintaining internal balance. The regulation of blood pressure within the cardiovascular system is a delicate physiological mechanism closely linked to mineral balance and the integrity of the autonomic nervous system. Recent studies have shown that **ZamZam** water possesses distinctive properties that support blood health, increase hemoglobin levels, and regulate blood pressure without any toxic or oxidative side effects.

Supporting Blood Formation and Hemoglobin Integrity

Laboratory evidence indicates that **ZamZam** water has a positive impact on blood components, particularly regarding hemoglobin concentration and the protection of heme from oxidation. In an experimental study conducted by Badar et al. (2019) on 52 Wistar rats, the animals were divided into four groups, each consuming a different type of water: regular water, mineral water, new **ZamZam** water, and **ZamZam** water stored since 2008.

Key Results:

- No signs of toxicity or methemoglobinemia were observed in any of the groups.
- There was no significant difference in **methemoglobin** levels (MetHb), a marker of hemoglobin oxidation by nitrates.
- The two **ZamZam** water groups showed a significant increase in total hemoglobin concentration:
  - 22% increase in the new **ZamZam** water group.
  - 9% increase in the regular water group.
  - 5% increase in the mineral water group.

These results strengthen the hypothesis that **ZamZam** water is safe for blood cells and can enhance hemoglobin formation without causing cellular oxidation.

Supporting Iron Balance and Preventing Anemia

ZamZam water is rich in trace elements, including a **notable concentration of iron**, which is essential for building hemoglobin and red blood cells. According to Okraviani & Fakhruddin (2021), regular consumption of **ZamZam** water may contribute to:

- Preventing **anemia resulting from iron deficiency**, especially in children and pregnant women;
- Enhancing the production of red blood cells;
- Improving oxygen distribution in the body and enhancing its endurance.

Regulating Blood Pressure Through Mineral and Physiological Effects

Hypertension is one of the most prevalent chronic diseases, and it is linked to serious complications affecting the heart, brain, and kidneys. Studies have highlighted that the rich mineral composition of **ZamZam** water has direct effects on circulatory dynamics and blood pressure regulation.

In a clinical study by Latif et al. (2020), it was found that drinking **ZamZam** water led to:

- A slight increase in both systolic and diastolic blood pressure and an increase in heart rate.
- A clear activation of the **sympathetic nervous system**, which plays a role in regulating blood pressure during stress.
- This physiological response was moderate when compared to carbonated water and did not lead to excessive stimulation of the cardiovascular system.

ZamZam water contains balanced concentrations of essential minerals that influence blood pressure regulation (Tama & Sagiran, 2019), including:

Mineral	Physiological Role in Blood Pressure Regulation
Calcium	Contributes to the contraction of the smooth muscles of blood vessels and reduces vascular resistance.
Magnesium	Regulates vasodilation and reduces the stimulation of the sympathetic nervous system.
Sodium	The balance of calcium and magnesium in ZamZam water reduces the risk of sodium despite its association with high blood pressure.

In a subsequent study conducted by Munir et al. (2015) on 20 patients with hypertension, the participants were divided into two groups, one of which consumed only **ZamZam** water for a month. This group showed an average reduction in blood pressure readings, supporting the hypothesis that **ZamZam** water may help promote dynamic blood pressure balance.

Research in nutritional science indicates that mineral absorption from natural water is higher than from food, due to:

- **Complete ionic dissolution** of minerals in water.
- **Absence of dietary inhibitors** such as phytates or fibers that impede absorption.
- **Direct absorption through the digestive system** without chemical breakdown.

ZamZam water is an excellent example of what is known as "Functional Waters," i.e., waters that provide health benefits beyond hydration by supporting the body's electrical and physiological balance.

Scientific evidence suggests that **ZamZam** water acts on the following:

Function	Scientifically Supported Effect
Supporting Blood Formation	Increased hemoglobin concentration without oxidation or toxicity in the blood.
Blood Pressure Regulation	A balanced effect on the autonomic nervous system and improved vascular response.
Strengthening Blood Immunity	Reduction of oxidative stress and promotion of blood cell integrity.
Mineral Absorption Efficiency	Facilitating the absorption of iron, magnesium, and calcium to support the health of the heart and circulatory system.

Thus, **ZamZam** water is considered a safe and functional natural supplement for promoting healthy blood and pressure balance, especially in groups more prone to pressure-related disorders, such as pregnant women, chronically ill patients, and the elderly.

The Role of ZamZam Water in Reducing Cholesterol

Disorders of blood lipids are among the leading factors contributing to coronary heart disease and strokes, which remain the primary cause of death worldwide. The World Health Organization estimates more than 5 million people lose their lives each year due to cardiovascular diseases associated with hypercholesterolemia (WHO, 2023).

As the world shifts toward natural and functional alternatives for managing these conditions, **ZamZam** water emerges as a promising bioactive substance worthy of study and analysis. Preliminary data indicate that **ZamZam** water may help reduce cholesterol and triglycerides due to its unique composition of bioactive elements. This positions it as a potentially safe and effective therapeutic option, particularly for populations seeking natural alternatives free from side effects. However, further rigorous scientific validation through controlled clinical trials is necessary to confirm these preliminary findings.

Chemical Basis of ZamZam Water and Its Role in Lipid Regulation

ZamZam water contains a distinctive mix of essential minerals, including **magnesium, zinc, bicarbonate, fluoride, and calcium,** all of which have demonstrated physiological effects on lipid metabolism. Previous studies have shown that magnesium improves insulin sensitivity and reduces cholesterol absorption in the small intestine (Huby et al., 2012), while zinc plays a key role in inhibiting the enzyme HMG-CoA reductase, responsible for cholesterol synthesis in the liver (Prasad, 2014). Bicarbonate helps neutralize pH, thereby enhancing the cellular environment for metabolic processes.

Experimental Study on the Effect of ZamZam Water on Cholesterol

In a laboratory experiment conducted by Mahmoud et al. (2023), the effect of **ZamZam** water on the lipid profile was tested in animal subjects with hypercholesterolemia. The results showed:

- A significant reduction in total cholesterol levels compared to the negative control group ($p < 0.05$).
- Noticeable improvement in triglyceride levels.
- An increase in HDL levels compared to LDL, one of the most important indicators of cardiac protection.

These potential effects are attributed to the interaction of the minerals in **ZamZam** water with lipid oxidation pathways, stimulating enzymes responsible for fat breakdown and reducing the oxidation of low-density lipoproteins, the fundamental process in the development of atherosclerosis.

The study also confirmed that **ZamZam** water outperformed both mineral and home-filtered water in its lipid-lowering effect, as commercial bottled water showed no significant changes in lipid levels. This further emphasizes **ZamZam**'s uniqueness as a functional therapeutic resource.

Proposed Biochemical Mechanisms

- **Magnesium** improves the balance of calcium and potassium within cells, enhancing cardiac performance and reducing fat accumulation (Hruby et al., 2014.
- **Zinc** strengthens blood vessel walls by inhibiting oxidative processes and promotes the formation of HDL proteins, which transport cholesterol that is good for the body. (Prasad, 2014);
- **Bicarbonates** help reduce oxidative stress within cells, thereby alleviating LDL oxidation, the main contributor to atherosclerosis.

Proposed Clinical Applications

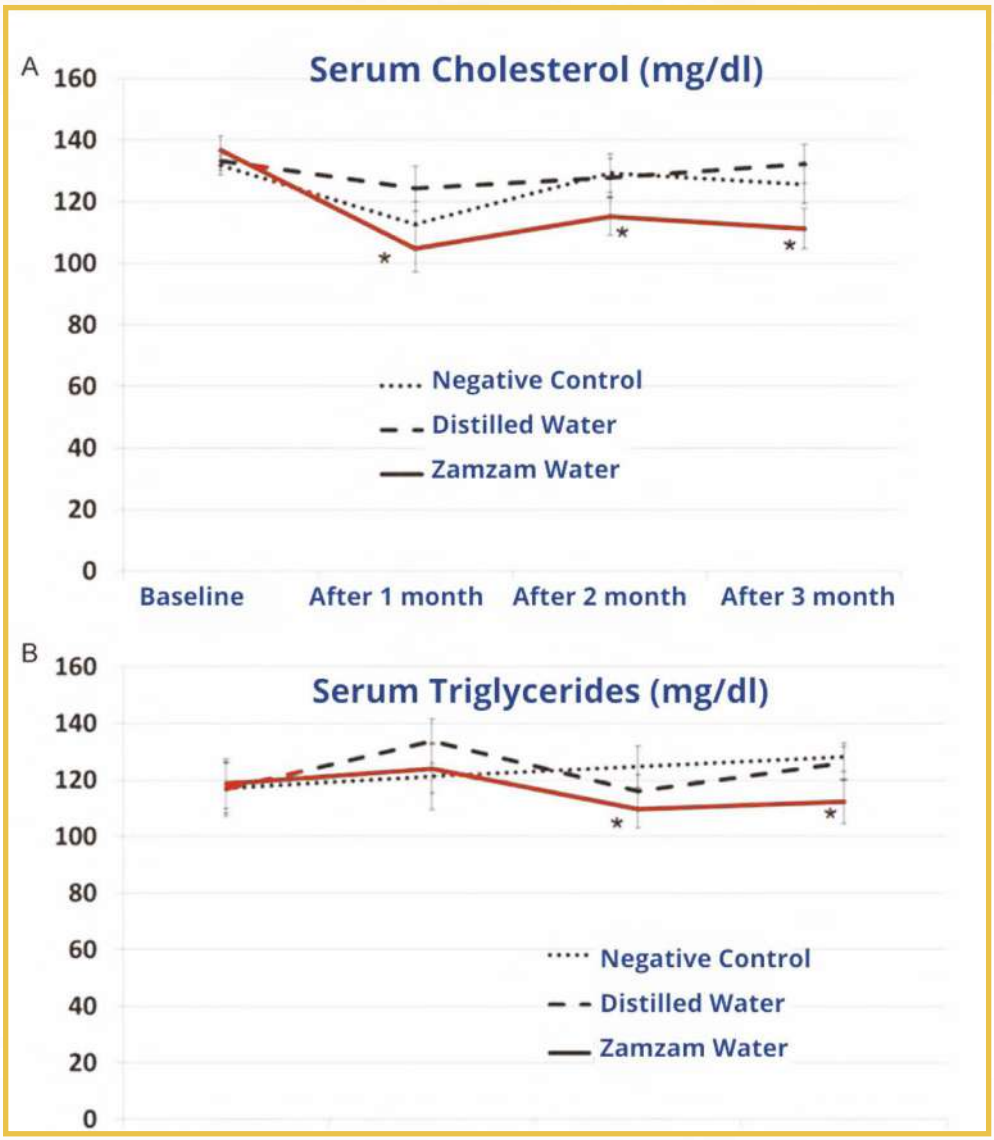
These findings suggest the potential integration of **ZamZam** water into preventive and therapeutic dietary programs for patients at risk of hyperlipidemia, particularly in the following groups:

- Patients with type 2 diabetes.
- Patients who are intolerant to statins or other lipid-lowering medications.
- Pilgrims and Umrah performers with chronic cardiac disorders.

Future Recommendations

Although laboratory and experimental data appear promising, further research is required:

- Conduct **large-scale human clinical trials** to evaluate the effectiveness of **ZamZam** water in lowering cholesterol.
- Compare its effects with other therapeutic waters.
- Investigate differences in mineral bioavailability when consuming **ZamZam** water versus separate dietary supplements.



ZamZam water demonstrates lipid-lowering effects. Specifically, (A) a significant reduction in cholesterol levels and (B) a decrease in blood triglyceride levels were observed. *p < 0.05 indicates a statistically significant difference compared with the negative control (Mahmoud et al., 2020).

ZamZam Water and Ruqiah Al-Shariah

The combination of **ZamZam** water and Ruqiah, which involves reciting verses from the Quran seeking a cure for oneself or others, holds deep spiritual significance in

Islamic culture. This integration has attracted researchers to study it from a scientific perspective, particularly regarding its potential antimicrobial effects. In this context, a recent analytical study was conducted to evaluate the antibacterial properties of three types of water:

- **ZamZam** water alone;
- **ZamZam** water over which Ruqiah (Qur'anic verses) had been recited;
- Three different types of commercial mineral water.

These waters were tested against five common pathogenic microbial strains:

- *Escherichia coli*
- *Staphylococcus aureus*
- *Pseudomonas aeruginosa*
- *Bacillus spp.*
- *Candida albicans*

Study Results (El-Desoukey et al., 2000)

- All water types, including **ZamZam** water and **ZamZam** with Ruqiah, were free of microbial contamination when tested using nutrient agar.
- After exposure to air, varying degrees of microbial growth appeared:

❖ The highest growth was observed in commercial mineral water.

❖ **ZamZam** water showed less growth than mineral water.

❖ **ZamZam** water with Ruqiah exhibited the least microbial growth, indicating the highest antimicrobial resistance.

In terms of antimicrobial effectiveness:

❖ **ZamZam** water with Ruqiah outperformed all other types.

❖ Regular **ZamZam** water followed.

❖ Commercial mineral waters showed no antimicrobial activity.

Significance of the Results

- The findings support the hypothesis that combining Ruqiah with **ZamZam** water enhances its effectiveness against bacteria and fungi.
- These properties make **ZamZam** water a promising candidate for safe health and preventive uses in environments that require natural sterilization and antimicrobial activity, such as crowded areas during Hajj.
- This effect may be attributed to the vibrational frequencies of the Quranic verses, which influence the molecular structure of water, as suggested by Emoto (2005). These frequencies help regulate the hydrogen bonds within water, thereby affecting its biological properties.
- Additionally, the minerals present in **ZamZam** water, such as calcium, magnesium, and zinc, contribute to its antimicrobial effect (Al-Juaid et al., 2019; Elhadary & Raj, 2017).

The Role of ZamZam Water in Promoting Addiction Treatment

Addiction to drugs represents a complex medical and psychological challenge, associated with intricate changes in brain chemistry, neurotransmitter dysfunction, and disruptions in psychological balance, in addition to environmental and social factors. In the search for natural adjuncts to conventional pharmacological and psychological therapies, the potential integration of **ZamZam** water into supportive treatment models has emerged, based on its balanced mineral composition and active biological properties.

Scientific literature indicates that the minerals present in **ZamZam** water, such as lithium, calcium, magnesium, and zinc, have proven effects on neurological functions and mood regulation (Ahmad, 2023). Other studies have highlighted the role of these minerals in alleviating withdrawal symptoms, improving psychological stability, and reducing relapse rates.

Lithium (Li): Mood Stabilization and Relapse Reduction

Lithium is a classical treatment used in mood disorders and has been shown to stabilize mood and reduce episodes of depression and mania in patients with bipolar disorder. Lithium modulates neurotransmitter signaling, particularly serotonin and dopamine, which are key mediators in addiction and impulsivity circuits (Malhi et al., 2017).

Multiple studies have demonstrated that taking lithium in precise doses can reduce intense drug cravings and lower relapse rates following cessation (Young, 2013).

Calcium (Ca): Regulating Neural Signaling and Emotional Fluctuations

Calcium is a key element in transmitting electrical signals between neurons and regulating neurotransmitter release at synapses. Disturbances in calcium balance have been linked to increased anxiety, sleep disorders, and heightened neural excitability, all common symptoms during drug withdrawal (Haghighi et al., 2015). From this perspective, consuming **ZamZam** water as a calcium-rich source may help alleviate these symptoms.

Magnesium (Mg): Reducing Neural Stress and Irritability

Magnesium plays a central role in over 300 enzymatic reactions and is essential for calming the central nervous system. Studies indicate that magnesium deficiency can exacerbate stress, anxiety, and depression (Serefko et al., 2016). Additionally, magnesium helps regulate NMDA receptors, which are involved in addiction to alcohol and stimulants.

Zinc (Zn): Supporting Neural Stability and Recovery

Zinc is crucial for neuronal metabolism and plays a significant role in regulating dopamine receptors, the neurotransmitter associated with addictive behaviors. Zinc also promotes neural tissue recovery and reduces neuroinflammation caused by chronic exposure to chemical toxins (Grabrucker, 2014). Studies have shown that zinc deficiency may be associated with increased addiction severity and difficulty in achieving cessation.

ZamZam Water as a Natural Supplement in Addiction Treatment Programs

ZamZam water is a natural and safe source of the minerals mentioned above, without any known side effects, which enhances its acceptability in therapeutic contexts. Its electrochemical balance facilitates absorption at the neuronal level, making it an effective supplement within psychological rehabilitation programs.

Compared to synthetic supplements, using **ZamZam** water offers:

- High biological safety without toxic accumulation.
- Low cost, especially in regions where it is readily available.
- Broad religious and psychological acceptance, which boosts confidence among Muslim patients.

Future Recommendations

- Conduct controlled clinical trials on patients with addiction to study the effects of **ZamZam** water on brain chemistry and withdrawal symptoms.
- Evaluate its effectiveness when combined with psychotropic medications in comprehensive treatment programs.
- Examine its role in mood stabilization, sleep improvement, and reduction of neural irritability in recovering individuals.

Antifungal and Antibacterial Activity of ZamZam Water

Microorganisms, such as viruses, bacteria, and parasites, are among the most significant challenges to public health, particularly in crowded and open environments, as is the case during the Hajj and Umrah seasons, where the likelihood of disease transmission increases due to close physical contact and pressure on healthcare resources. Multiple studies have revealed the unique bioactive properties of **ZamZam** water in combating a wide spectrum of these microorganisms, a feature attributed to its alkaline ionic composition and richness in bioactive minerals.

When comparing **ZamZam** water with bottled drinking water or tap water in terms of antibacterial activity, the results showed:

- A broader spectrum of microbial growth inhibition: **ZamZam** water outperformed other types of water in preventing the growth of pathogenic bacteria and fungi.
- Long-term stability: It maintained its antibacterial effectiveness even after storage for more than six months, without the need for refrigeration.
- Absence of contamination: No signs of bacterial or fungal growth were recorded in **ZamZam** water samples during storage, indicating its biological stability.

These findings support the fact that **ZamZam** water possesses antibacterial and antifungal properties, especially when combined with natural substances such as black seed, honey, and certain medicinal plants. This is attributed to several key factors:

- Complete absence of microorganisms even after environmental exposure.

- High content of bioactive minerals such as calcium, magnesium, and fluoride, which have direct antibacterial and antifungal effects.
- Role as an effective botanical solvent: Studies have shown that using **ZamZam** water to extract active plant compounds enhances their bioactivity compared to conventional solvents, making it an ideal choice for developing natural and safe pharmaceutical preparations.

While **ZamZam** water's standalone antimicrobial effect may be relatively limited, its integration into a comprehensive therapeutic system alongside natural compounds holds promise in complementary and preventive medicine. This synergistic approach may be particularly beneficial for developing natural, topical, or oral formulations.

Despite the limited published research on the effects of **ZamZam** water on viruses, some preliminary studies and unpublished clinical trials have provided encouraging indications, suggesting:

- Improvement in upper respiratory tract infection symptoms among some patients who regularly consumed **ZamZam** water.
- Indirect reports linking **ZamZam** water to immune system support, potentially reducing the severity of symptoms.
- Viral infections such as the novel coronavirus (SARS-CoV-2)
- Some bio-research supports the hypothesis that alkaline water, such as **ZamZam** water, may help create an internal environment unfavorable for viral replication, particularly for viruses that thrive in acidic conditions.
- It may also stimulate the innate immune response by enhancing the function of phagocytic cells and helper T cells (T-helper cells), which serve as the first line of defense against viral infections.

- Overall, **ZamZam** water has promising potential as a natural antimicrobial agent against microorganisms, including bacteria, fungi, and possibly viruses. This potential is reinforced by its:
- Biological stability even under long-term storage conditions.
- Complete absence of microorganisms and mycotoxins.
- Enhanced microbiological activity when combined with natural ingredients.

These properties make **ZamZam** water a distinctive natural option for preventive and therapeutic strategies—particularly in crowded environments and in situations requiring safe, sustainable alternatives for infection control.

First: Antifungal Activity

Pathogenic fungi, especially Candida albicans, are among the most common causes of vaginal, skin, and immune-related fungal infections. In recent years, these organisms have shown an increasing ability to resist synthetic antifungal agents. Therefore, the search for safer, more effective natural alternatives has become urgent in medical circles.

In this context, a study was conducted at Umaru Musa Yar'adua University in Katsina State, Nigeria, to evaluate the synergistic activity of ethanolic black seed extract (ISE), honey (TIN), and **ZamZam** water against isolates of C. albicans using the agar well diffusion method, along with determination of the minimum inhibitory concentration (MIC) and minimum fungicidal concentration (MFC). The results showed that black seed extract recorded the highest inhibition zone at 14 mm, followed by honey at 12 mm, while **ZamZam** water alone had a relatively limited effect at around 6 mm. The best

MIC and MFC values were 30 mg/mL and 60 mg/mL, respectively, indicating the potential use of **ZamZam** water as an adjuvant in synergistic antifungal formulations (Saulawa & Hamisu, 2019).

Second: Antibacterial Activity

Bacterial infections pose a global health challenge due to increasing antibiotic resistance. Common pathogenic strains include Pseudomonas aeruginosa, Escherichia coli, Salmonella spp., and Staphylococcus aureus, in addition to recurrent fungal infections caused by Candida albicans. In a comparative analytical experiment, **ZamZam** water was found to inhibit the growth of these strains when used pure or in diluted concentrations. In some cases, it even surpassed the effectiveness of conventional antibiotics such as ampicillin and chloramphenicol (Aljuaid et al., 2019). Other studies have also shown that **ZamZam** water remains completely free of bacterial contamination even after several months of storage without refrigeration (El-Desoukey et al., 2020). This microbial stability is attributed to its unique composition, which contains high concentrations of calcium, magnesium, and fluoride, elements known for their ability to inhibit bacterial growth and prevent algal formation. Additionally, the alkalinity (pH = approx. 7.9-8.0) of **ZamZam** water (Khalid, 2010; Viklur, 2017, 2019) creates a hostile environment for bacterial and microbial proliferation, further enhancing its properties as a natural antioxidant and antimicrobial agent.

Third: ZamZam Water as an Effective Solvent for Extracting Plant Compounds

In an additional scientific experiment, **ZamZam** water was used as a chemical solvent to extract bioactive compounds from the leaves of *Moringa oleifera* within a comparative study that included six different solvents, among them **ZamZam** water and its mixtures with ethanol or acetone. The antibacterial and antifungal activity of these extracts was evaluated against a group of pathogenic strains, including *S. aureus, B. cereus, B. subtilis, P. aeruginosa, E. coli, P. mirabilis, and C. albicans.* The lowest MIC value (6.25 mg/mL) was recorded for extracts obtained using the **ZamZam** water/acetone mixture, particularly against *Bacillus subtilis*. Acetone extracts, especially when combined with **ZamZam** water, showed the highest levels of bioactivity against most of the tested strains. These findings indicate that **ZamZam** water is not only pure drinking water but also plays an active role in enhancing the bioefficacy of medicinal plants when used in extraction processes (Puchooa & Jahally, 2017).

General Summary of the Key Health Benefits of ZamZam Water

In light of the presented scientific data, laboratory analyses, clinical trials, and medical observations, it can be concluded that **ZamZam** water is an extraordinary natural water, distinguished by its unique mineral composition, distinctive physical and nanometric properties, and multiple evidence-based health effects. Additionally, its deep-rooted religious significance in Islamic consciousness adds to its significancessignificance.

First: Physical and Structural Properties

- Possesses a balanced mineral profile, including calcium, magnesium, fluoride, and bicarbonates within healthy limits.
- Has a moderately alkaline pH (7.9–8.0), giving it anti-acidic properties and aiding biological balance.
- Demonstrates remarkable stability in chemical composition even after years of storage, indicating its unique natural stability.

Second: Biological and Functional Benefits

- Proven safe for living cells, with no signs of toxicity even at high concentrations.
- Contributes to strengthening the immune system, increasing natural antioxidants, and reducing inflammation markers.
- Supports kidney and liver function, and helps reduce the accumulation of toxins and heavy metals.
- Shows antibacterial, antiviral, and antiparasitic activity without harming beneficial gut bacteria.
- Enhances metabolic balance and improves blood sugar, lipid profile, and blood pressure indicators.

Third: Organ-Specific Benefits

- **Digestive system:** Improves digestion, relieves gastric ulcers and constipation, and enhances nutrient absorption.
- **Urinary system:** Reduces kidney stone formation and improves kidney performance in dialysis patients.
- **Nervous system:** Calms neural activity, improves mood and sleep quality, and reduces anxiety markers.
- **Oral health:** Reduces bacteria that cause tooth decay, promotes gum health, and aids in enamel remineralization.
- **Skin and wound healing:** Speeds up wound healing, reduces skin inflammation, and promotes cell regeneration.

Four: Medical and Nanotechnology Applications

- Used in the production of bioactive nanoparticles (such as silver, zinc, and gold nanoparticles).
- Exhibits distinctive nanoscale structural and molecular bonding properties, leading some researchers to describe it as a "natural nanostructured water."
- Contributes to precision drug delivery technologies and is proposed for use in medical and cosmetic formulations.

Fifth: Optical and Dynamic Properties

- Forms symmetrical hexagonal water crystals upon freezing, unlike regular water.
- Shows stability in spectral refractive indices and optical purity in laser imaging techniques.
- It can be used as a digital optical "fingerprint" to verify its authenticity.

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موسوعة زمزم العالمية
Global ZamZam Encyclopedia

Conclusion and Final Thoughts

This book has shown that the study of **ZamZam** extends far beyond the scientific analysis of water. It is, at once, a subject of history, faith, culture, and science. **ZamZam** is not an ordinary well, but a phenomenon of extraordinary significance—religious, historical, and scientific. Flowing continuously for millennia, it embodies the memory of revelation and the testimony of divine providence, remaining a living link between the sacred past and the ever-evolving present.

Our objective has been to present the many dimensions of **ZamZam** within a coherent and integrated framework:

- **Religious Significance** – firmly established in Qurʾānic verses and Prophetic traditions, affirming **ZamZam** as a source of blessing and guidance.
- **Historical Presence** – its central role in the trajectory of Islamic civilization, enriching the lives of generations of pilgrims, scholars, and rulers.
- **Scientific Uniqueness** – confirmed by geological, hydrological, chemical, and medical studies that highlight its distinctive and enduring properties.
- **Contemporary Relevance** – its protection, monitoring, and sustainable management through the tools of modern science, including artificial intelligence and digital water technologies.

By bringing these interwoven dimensions together, this book has sought to demonstrate that revelation and scientific inquiry are not opposing forces but complementary perspectives. Together, they provide a holistic understanding of **ZamZam** as both a sacred trust and a unique scientific phenomenon.

The findings presented here emphasize that **ZamZam** cannot be confined to a single field of study. It demands a multidisciplinary approach that unites geoscientists, hydrologists, medical researchers, historians, religious scholars, and experts in digital and artificial intelligence technologies. The study of **ZamZam** is not merely about preserving a past miracle—it is about ensuring that this legacy continues to benefit the present and the future.

Thus, the conclusion of this work is not an ending but an open invitation: to establish interdisciplinary research centers dedicated to **ZamZam**, to strengthen hydrological and environmental studies, to expand medical and digital analyses, and to safeguard this well as both sacred heritage and scientific resource.

A water source that has never run dry carries mysteries that demand continued exploration. Let this exploration reach not only the depths of the earth's substrata but also the expanding horizons of human knowledge. In this way, **ZamZam** will remain—just as it has since its miraculous origin—an eternal testimony that what descends from heaven never loses its value on earth.

Multilingual Glossary of Terms

Arabic	Urdu	Persian	Malay	English	French	Spanish	Turkish	Bengali	Hindi	Russian	Chinese	Japanese	Swahili	Hebrew
مكة المكرمة	مکہ مکرمہ	مکه مکرمه	Mekah al-Mukarra-mah	Makkah	La Mec-que	La Meca	Mekke	মক্কা	मक्का	Мекка	麦加	メッカ	Makka	מכה
الحرم المكي	حرم مکی	حرم مکی	Tanah Ha-ram Mekah	Sacred Precinct	Sanc-tuaire de La Mecque	Santuario de La Meca	Mekke Harem	মক্কার পবিত্র মসজিদ এলাকা	मक्का का पवित्र हरम क्षेत्र	Священная территория Мекки	麦加禁寺圣区	メッカの聖域	Eneo Takatifu la Msikiti wa Mak-ka	מתחם המ־סגד הקדוש במכה
المسجد الحرام	مسجد الحرام	مسجد الحرام	Masjid al-Haram	Grand Mosque	Grande Mosquée	Gran Mezquita	Mescid-i Haram	মসজিদুল হারাম	मस्जिद अल-हरम	Аль-Масджид аль-Харам	禁寺（麦加大清真寺）	マスジド・ハラーム	Msikiti Mkuu wa Makka	מסגד אל־חראם
الكعبة المشرفة	خانہ کعبہ	کعبه مشرفه	Kaabah	Holy Kaaba	Kaaba sacrée	Kaaba sagrada	Kâbe	পবিত্র কাবা	पवित्र काबा	Священная Кааба	神圣的天房	神聖なカアバ	Kaaba Tukufu	הכעבה הקדושה
أركان الكعبة	ارکان کعبہ	ارکان کعبه	Rukun Kaabah	Corners of the Kaaba	Coins de la Kaaba	Esquinas de la Kaaba	Kâbe köşeleri	কাবার কোণসমূহ	काबा के कोने	Углы Каабы	克尔白的角	カアバの四隅	Pembe za Kaaba	פינות הכעבה
الركن اليماني	رکن یمانی	رکن یمانی	Rukun Yamani	Yemeni Corner	Coin yéménite	Rincón yemení	Yemeni Köşesi	ইয়েমেনি কোণ	यमनी कोना	Йеменский угол	也门角	イエメンの角	Pembe ya Ye-meni	הפינה התימנית
الحجر الأسود	حجر اسود	حجر الاسود	Hajar Aswad	Black Stone	Pierre Noire	Piedra Negra	Hacerü'l-Es-ved	হাজরে আসওয়াদ	हजरे अस्वद	Чёрный камень	黑石	黒石	Jiwe Jeusi	האבן השׁ־חורה
مقام إبراهيم	مقام ابراہیم	مقام ابراهیم	Maqam Ibrahim	Station of Abraham	Station d'Abra-ham	Estación de Abra-ham	Makam-ı İbrahim	মাকামে ইব-রাহিম	मकाम-ए-इब्राहीम	Макам Ибрахима	易卜拉欣立足	イブラーヒームの	Maqam Ibrahim	מקאם אברהם

Multilingual Glossary of Terms

Arabic	Urdu	Persian	Malay	English	French	Spanish	Turkish	Bengali	Hindi	Russian	Chinese	Japanese	Swahili	Hebrew
حجر إسماعيل (الحطيم)	حجر اسماعیل	حجر اسماعیل	Hijr Ismail	Hijr Ismail	Hijr d'Ismaël	Hijr de Ismael	Hicr-i İsmail	হাজরে ইসমাইল (হাতিম)	हि-जु-ए-इस्मा-ईल (हतीम)	Хиджр Исмаила (Хатим)	伊斯梅尔 حجر (哈提姆)	イスマーイールの	Hijr Ismail (Hateem)	حجر ישמעאל
الملتزم	ملتزم	ملتزم	Multazam	Multazam	Multa-zam	Multa-zam	Mül-tezem	মুলতাজিম	मुल्तज़िम	Мультазам	ملتزم	ムルタザム	Multa-zam	מולתזם
المطاف	مطاف	مطاف	Mataf	Tawaf Area	Aire du Tawaf	Área del Tawaf	Metaf	তাওয়াফের স্থান	तवाफ का क्षेत्र	Зона тавафа	区域	タワーフ区域	Eneo la Tawaf	אזור הטוואף
المسعى	مسعیٰ	مسعی	Mas'a	Sa'i corri-dor	Couloir du Sa'i	Pasillo del Sa'i	Mes'a	সাঈ পথ	सई का मार्ग	Са'й коридор	伊通道	サイの通路	Njia ya Sa'i	מסלול הסעי
الصفا	صفا	صفا	Safa	Safa	Safa	Safa	Safa	সাফা	सफा	Сафа	法	サファー	Safa	ספא
المروة	مروہ	مروه	Marwah	Marwah	Marwah	Marwa	Merve	মারওয়া	मरवा	Марва	尔瓦	マルワ	Marwa	מרווה
المشاعر المقدسة	مشاعر مقدسہ	مشاعر مقدسه	Tanah Suci Haji	Holy Sites	Lieux saints	Lugares sagrados	Kutsal Mekânlar	পবিত্র স্থান-সমূহ	पवित्र स्थल	Священные места	地	聖なる巡礼地	Maeneo Matakat-ifu	האתרים הקדושים
منى	منیٰ	منا	Mina	Mina	Mina	Mina	Mina	মিনা	मिना	Мина	米	ミナー	Mina	מינא
عرفات	عرفات	عرفات	Arafah	Arafat	Arafat	Arafat	Arafat	আরাফাত	अराफात	Арафат	阿拉法特	アラファト	Arafat	ערפאת
جبل عرفات	جبل عرفات	کوه عرفات	Jabal Arafah	Mount Arafat	Mont Arafat	Monte Arafat	Arafat Dağı	আরাফাত পর্বত	अराफात पर्वत	Гора Арафат	阿拉法特山	アラファト山	Mlima Arafat	הר ערפאת
مزدلفة	مزدلفہ	مزدلفه	Muzdalifah	Muzdalifah	Mou-zdalifa	Muzdal-ifa	Müzdelife	মুজদালিফা	मुज़दलिफ़ा	Муздалифа	穆兹里法	ムズダリファ	Muzdal-ifa	מוזדליפה
الجمرات	جمرات	جمرات	Jamrah	Jamarat	Jamarat	Jamarat	Cemarat	জামারাত	जमारात	Джамарат	石柱（投石）	ジャマラート	Jamarat	ג'מראט

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Arabic	Urdu	Persian	Malay	English	French	Spanish	Turkish	Bengali	Hindi	Russian	Chinese	Japanese	Swahili	Hebrew
جمرة العقبة	جمرہ عقب	جمره عقبه	Jamrah Aqabah	Jamrat al-Aqabah	Jamra d'Aqa-bah	Jamra de Aqaba	Akabe Cemresi	জামরাতুল আকাবা	जमरतुल अक़बा	Джамрат аль-Акаба	阿卡巴石柱	ジャムラト・アル・アカバ	Jamrat al-Aqaba	ג'מרת אל-עקבה
مسجد نمرة	مسجد نمرہ	مسجد نمره	Masjid Namirah	Namirah Mosque	Mosquée Namirah	Mezquita Namira	Nemire Mescidi	মসজিদে নামিরা	मस्जिद नमिरा	Мечеть Намира	米拉清真寺	ナミラモスク	Msiki-ti wa Namira	מסגד נמירה
بئر زمزم	کنواں زمزم	چاه زمزم	Telaga Zamzam	Zamzam Well	Puits de Zamzam	Pozo de Zamzam	Zemzem Kuyusu	জমজম কূপ	ज़मज़म कुआँ	Колодец Замзам	泉	ザムザムの井戸	Kisima cha Zam-zam	באר זמזם
ماء زمزم	آب زمزم	آب زمزم	Air Zamzam	Zamzam Water	Eau de Zamzam	Agua de Zamzam	Zemzem Suyu	জমজমের পানি	ज़मज़म का पानी	Вода Замзам	水	ザムザムの水	Maji ya Zamzam	מי זמזם
سقيا زمزم	سقیا زمزم	سقای زمزم	Pemberian air Zamzam	Zamzam Distribu-tion	Distri-bution de Zam-zam	Distribu-ción de Zamzam	Zemzem dağıtımı	জমজম পানি পান করানো	ज़मज़म पिलाना	Поение Замзамом	提供水	ザムザムの給水	Kuwapa maji ya Zamzam	השקיית זמזם
بصمة زمزم	بصمت زمزم	اثر زمزم	Jejak Zam-zam	Zamzam Signature	Empre-inte de Zamzam	Huella de Zamzam	Zemzem izi	জমজমের বৈশিষ্ট্য	ज़मज़म की विशेषता	Особенность Замзама	水特性	ザムザムの特性	Sifa ya Zamzam	מאפיין זמזם
عمر ماء زمزم	عمر آب زمزم	عمر آب زمزم	Usia air Zamzam	Age of Zamzam Water	Âge de l'eau de Zamzam	Edad del agua de Zamzam	Zemzem suyunun yaşı	জমজম পানির বয়স	ज़मज़म के पानी की आयु	Возраст воды Замзам	水的年代	ザムザムの水の年代	Umri wa maji ya Zamzam	גיל מי זמזם
التضلع من زمزم	زمزم سے سیر ہو کر پینا	سیراب شدن از زمزم	Minum Zam-zam hingga kenyang	Drinking Zamzam abundantly	Boire Zamzam abondam-ment	Beber Zamzam abundan-temente	Zemzemle doyasıya içmek	পেট ভরে জমজম পান করা	ज़मज़म से तृप्त होना	Полное насыщение Замзамом	用至足	ザムザムで満たされること	Kushi-ba kwa Zamzam	רוויה מזמזם

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Arabic	Urdu	Persian	Malay	English	French	Spanish	Turkish	Bengali	Hindi	Russian	Chinese	Japanese	Swahili	Hebrew
الزمزمة	زمزم	زمزمه	Zamzamah	Zamzamah	Zam-zamah	Zamza-ma	Zemzeme	জমজম শব্দ	ज़मज़म की ध्वनि	Журчание Замзама	水声	ザムザムの音	Sauti ya Zamzam	קול זמזם
الزمازمة	زمزم والے	زمزمه کنندگان	Zamazimah	Zamazimah	Zamaz-imah	Zamaz-imah	Zemzem görevli-leri	জমজম পরিবেশন-কারীরা	ज़मज़म पिलाने वाले	Раздатчики Замзама	水供者	ザムザム配布者	Wahudu-mu wa Zamzam	מחלקי זמזם
الاستشفاء بزمزم	زمزم سے شفا لینا	شفا با زمزم	Penyembu-han Zamzam	Healing with Zam-zam	Guérison avec Zamzam	Curación con Zam-zam	Zemzemle şifa	জমজম দ্বারা আরোগ্য লাভ	ज़मज़म से उपचार	Исцеление Замзамом	用水治愈	ザムザムによる治癒	Upony-aji kwa Zamzam	ריפוי בזמזם
التبرك بزمزم	زمزم سے برکت لینا	تبرک با زمزم	Berkat Zamzam	Blessing with Zam-zam	Béné-diction avec Zamzam	Bendi-ción con Zamzam	Zemzem-le bere-ket	জমজম দ্বারা বরকত লাভ	ज़मज़म से बरकत लेना	Благословение Замзамом	以水求福	ザムザムによる祝福	Baraka kwa Zamzam	ברכה מזמזם
هاجر	ہاجرہ	هاجر	Hajar	Hagar	Agar	Agar	Hacer	হাজেরা	हाजरा	Хаджар	夏甲	ハージャル	Hajar	הגר
إسماعيل عليه السلام	حضرت اسماعیل	اسماعیل پیامبر	Nabi Ismail	Prophet Ishmael	Prophète Ismaël	Profeta Ismael	Peyg-amber İsmail	ইসমাইল (আ.)	इस्माईल (अ.स.)	Исмаил (мир ему)	以利(愿他平安)	イスマーイール（彼に平安あれ）	Ismail (A.S)	ישמעאל עליו השלום
عبد المطلب	عبدالمطلب	عبدالمطلب	Abdul Mut-talib	Abdul Muttalib	Abd al-Mut-talib	Abdul Muttalib	Ab-dülmut-talib	আব্দুল মুত্তালিব	अब्दुल मुत्तलिब	Абд аль-Мутталиб	阿卜杜勒·穆塔利布	アブドゥル・ムッタリブ	Abdul Muttalib	עבד אל-מוטליב
غار حراء	غار حرا	غار حرا	Gua Hira	Cave of Hira	Grotte de Hira	Cueva de Hira	Hira Mağarası	হেরা গুহা	गार-ए-हिरा	Пещера Хира	希拉山洞	ヒラー洞窟	Pango la Hira	מערת חירא

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Arabic	Urdu	Persian	Malay	English	French	Spanish	Turkish	Bengali	Hindi	Russian	Chinese	Japanese	Swahili	Hebrew
غار ثور	غار ثور	غار ثور	Gua Thawr	Cave of Thawr	Grotte de Thawr	Cueva de Thawr	Sevr Mağarası	সওর গুহা	ग़ार-ए-सौर	Пещера Саур	索尔山洞	サウル洞窟	Pango la Thawr	מערת ת'ור
وادي إبراهيم	وادی ابراہیم	دره ابراهيم	Lembah Ibrahim	Valley of Ibrahim	Vallée d'Ibrahim	Valle de Ibrahim	İbrahim Vadisi	ইবরাহিম উপত্যকা	वादी इब्राहीम	Долина Ибрахима	易卜拉欣山谷	イブラーヒームの谷	Bonde la Ibrahim	עמק אברהם
مسجد البيعة	مسجد بیعت	مسجد بیعت	Masjid Bai'ah	Mosque of Allegiance	Mosquée de l'Allégeance	Mezquita del Juramento	Biat Mescidi	মসজিদে বাইআত	मस्जिद अल-बैअत	Мечеть Бай'а	拜阿特清真寺	バイアトモスク	Msikiti wa Bai'ah	מסגד ביעה
مسجد عائشة	مسجد عائشہ	مسجد عایشه	Masjid Aisyah	Aisha Mosque	Mosquée Aïcha	Mezquita Aisha	Aişe Mescidi	মসজিদে আয়েশা	मस्जिद आयशा	Мечеть Айши	阿伊莎清真寺	アイシャモスク	Msikiti wa Aisha	מסגד עאישה
شعب أبي طالب	شعب ابی طالب	دره ابوطالب	Syi'b Abi Talib	Valley of Abu Talib	Vallée d'Abou Talib	Valle de Abu Talib	Ebu Talib Vadisi	শিয়াবে আবি তালিব	शिब-ए-अबी तालिब	Шиб Аби Талиб	阿比塔利卜山谷	アビータ一リブの谷	Shib Abi Talib	עמק אבי טאלב
بئر طوى	کنواں طوی	چاه طوی	Telaga Tuwa	Well of Tuwa	Puits de Tuwa	Pozo de Tuwa	Tuva Kuyusu	তুওয়া কূপ	तुवा कुआँ	Колодец Тува	瓦井	トゥワの井戸	Kisima cha Tuwa	באר תוא
عين زبيدة	عین زبیدہ	چشمه زبیده	Mata air Zubaidah	Zubaidah Spring	Source Zubaida	Manantial Zubaida	Zübeyde Kaynağı	আইন জুবাইদা	ऐन ज़ुबैदा	Источник Зубайда	祖拜 水渠	ズバイダの泉	Chemchemi ya Zubaida	עין זובידה
الحج	حج	حج	Haji	Hajj	Hajj	Hach	Hac	হজ	हज	Хадж	朝	ハッジ	Hajj	חג'
العمرة	عمرہ	عمره	Umrah	Umrah	Omra	Umrah	Umre	উমরা	उमरा	Умра	副朝	ウムラ	Umra	עומרה
الميقات	میقات	میقات	Miqat	Miqat	Miqat	Miqat	Mikât	মীকাত	मीक़ात	Микат	受戒界	ミーカート	Miqat	מיקאת
الإحرام	احرام	احرام	Ihram	Ihram	Ihram	Ihram	İhram	ইহরাম	इहराम	Ихрам	受戒状	イフラーム	Ihram	איהראם
المحرم	محرم	محرم	Muhrim	Muhrim	Muhrim	Muhrim	Muhrim	মাহরাম	महरम	Махрам	直系属(禁婚)	マフラム	Mahram	מחרם

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Link https//alamrigeo.com/zamzam/

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Definition of Terms with Transliteration

Term	Transliteration	Definition
Abdul-Muttalib	ʿAbd al-Muṭṭalib	The grandfather of Prophet Muhammad (PBUH) who rediscovered and re-excavated the ZamZam well after it had disappeared over time.
Age of ZamZam Water	ʿUmr Māʾ ZamZam	The estimated age of ZamZam water determined to be about 6,175 years using radiocarbon dating.
Arafat	ʿArafāt	A vast plain east of Makkah where pilgrims stand on the ninth day of Dhul-Hijjah; standing at Arafat is the greatest pillar of Hajj.
Ayn Zubaydah	ʿAyn Zubaydah	A historic water canal constructed by Zubaydah, the wife of Caliph Hārūn al-Rashīd, to supply water to Makkah and pilgrims.
Black Stone	al-Ḥajar al-Aswad	The sacred stone fixed in the eastern corner of the Kaaba where Tawaf begins and ends.
Boundary Markers of the Haram	Anṣāb al-Ḥaram	Stone markers that define the boundaries of the Sacred Precinct of Makkah.
Cave of Hira	Ghār Ḥirāʾ	A cave on Jabal al-Nūr where the Prophet (PBUH) received the first revelation.
Cave of Thawr	Ghār Thawr	A cave on Jabal Thawr where the Prophet (PBUH) and Abu Bakr stayed during the migration to Madinah.
Characteristics of ZamZam Water	Khaṣāʾiṣ Māʾ ZamZam	The chemical and physical properties that distinguish ZamZam water from other types of water.
Corners of the Kaaba	Arkān al-Kaʿbah	The four corners of the Kaaba: the Black Corner, the Iraqi Corner, the Levantine Corner, and the Yemeni Corner.
Door of the Kaaba	Bāb al-Kaʿbah	The door located on the eastern side of the Kaaba used for entering its interior.
Drinking ZamZam Abundantly	al-Taḍallu‘ min ZamZam	Drinking ZamZam water until one becomes completely satisfied and hydrated.
Grand Mosque	al-Masjid al-Ḥarām	The largest and holiest mosque in Islam located in Makkah surrounding the Kaaba.
Hajar	Hājar	The wife of Prophet Ibrahim and mother of Ismail who ran between Safa and Marwah searching for water.

Term	Transliteration	Definition
Hajj	al-Ḥajj	One of the five pillars of Islam performed by visiting Makkah and completing specific rituals at a designated time.
Hajj al-Ifrad	Ḥajj al-Ifrād	Performing Hajj alone without performing Umrah.
Hajj al-Qiran	Ḥajj al-Qirān	Performing Hajj and Umrah together in a single state of Ihram.
Hajj al-Tamattuʿ	Ḥajj al-Tamattuʿ	Performing Umrah first and then Hajj in the same year with a break between the two rituals.
Haram of Makkah	al-Ḥaram al-Makkī	The sacred area surrounding the Grand Mosque established since the time of Prophet Ibrahim.
Healing with ZamZam	al-Istishfāʾ bi-ZamZam	Drinking ZamZam water with the intention of seeking healing.
Hijr Ismail (Al-Hatim)	Ḥijr Ismāʿīl	A semicircular area adjacent to the Kaaba believed to have originally been part of the Kaaba structure.
Holy Kaaba	al-Kaʿbah al-Musharrafah	A cube-shaped structure at the center of the Grand Mosque and the direction toward which Muslims pray.
Hudaybiyah	al-Ḥudaybiyah	An area west of Makkah where the Treaty of Hudaybiyah took place.
Ihram	al-Iḥrām	The state of ritual consecration for Hajj or Umrah with specific prohibitions.
Ismail (peace be upon him)	Ismāʿīl	The son of Prophet Ibrahim whose childhood is associated with the emergence of ZamZam water.
Jamaraat	al-Jamarāt	Three pillars in Mina where pilgrims throw pebbles during Hajj.
Jamrat al-Aqabah	Jamrat al-ʿAqabah	The largest Jamrah and closest to Makkah where pilgrims throw pebbles on the Day of Sacrifice.
Jabal Abu Qubais	Jabal Abī Qubays	A mountain overlooking the Grand Mosque from the eastern side.
Jabal al-Nur	Jabal al-Nūr	A mountain northeast of Makkah containing the Cave of Hira.
Jabal Arafat (Mount of Mercy)	Jabal ʿArafāt	A small mountain located in the plain of Arafat.
Jabal Qaiqaan	Jabal Qayqaʿān	A mountain west of the Grand Mosque that historically surrounded Makkah.
Jabal Thawr	Jabal Thawr	A mountain south of Makkah containing the Cave of Thawr.
Kaaba Covering (Kiswah)	Kiswat al-Kaʿbah	A black cloth embroidered with Qur'anic verses covering the Kaaba.

Term	Transliteration	Definition
Kaaba Gutter	Mīzāb al-Kaʿbah	A golden spout that drains rainwater from the roof of the Kaaba.
Maqam Ibrahim	Maqām Ibrāhīm	The stone on which Prophet Ibrahim stood while building the Kaaba.
Makkah al-Mukarramah	Makkah al-Mukarramah	The holy city in western Saudi Arabia containing the Grand Mosque and the Kaaba.
Marwah	al-Marwah	The hill where the ritual of Saʿi ends.
Masʿa (Saʿi Corridor)	al-Masʿā	The walkway between Safa and Marwah where pilgrims perform Saʿi.
Mashʿar al-Haram	al-Mashʿar al-Ḥarām	A sacred place in Muzdalifah where pilgrims remember Allah after leaving Arafat.
Masjid Aisha (Al-Tanʿim Mosque)	Masjid ʿĀʾishah	A mosque north of Makkah used as a Miqat for Umrah.
Masjid al-Khayf	Masjid al-Khayf	A historic mosque in Mina where the Prophet (PBUH) prayed.
Masjid Namirah	Masjid Namirah	A mosque in Arafat where the sermon of the Day of Arafah is delivered.
Mataf	al-Maṭāf	The open area around the Kaaba where pilgrims perform Tawaf.
Mineral Composition of ZamZam Water	al-Tarkīb al-Maʿdanī li-Māʾ ZamZam	The distribution of minerals and chemical elements in ZamZam water.
Mina	Minā	An area east of Makkah where pilgrims stay during the Days of Tashreeq.
Muhrim	al-Muḥrim	A person who has entered the state of Ihram for Hajj or Umrah.
Multazam	al-Multazam	The area between the Black Stone and the door of the Kaaba where supplication is recommended.
Muzdalifah	Muzdalifah	An area between Arafat and Mina where pilgrims spend the night during Hajj.
Qiblah of Muslims	Qiblat al-Muslimīn	The direction Muslims face during prayer toward the Kaaba.
Re-excavation of ZamZam	Iʿādat Ḥafr ZamZam	The rediscovery of ZamZam well during the time of Abdul-Muttalib.
Release from Ihram	al-Taḥallul min al-Iḥrām	The stage in which some restrictions of Ihram are lifted after performing certain Hajj rituals.

Term	Transliteration	Definition
Safa	al-Ṣafā	One of the two hills between which pilgrims perform Saʿi.
Sacred Sites	al-Mashāʿir al-Muqaddasah	The holy sites of Hajj: Mina, Arafat, and Muzdalifah.
Seeking Blessings through ZamZam	al-Tabarruk bi-Zam-Zam	Seeking blessings from ZamZam water because of its religious significance.
Shiʿb Abi Talib	Shiʿb Abī Ṭālib	A valley in Makkah where the Prophet (PBUH) and Banu Hashim were boycotted for three years.
Source of ZamZam Water	Maṣdar Miyāh Zam-Zam	The geological system supplying groundwater to the ZamZam well.
Story of ZamZam	Qiṣṣat ZamZam	The historical story associated with the emergence of ZamZam water beneath the feet of Ismail.
Tanʿim	al-Tanʿīm	A location north of Makkah serving as a Miqat for residents performing Umrah.
Tuwa Well	Biʾr Ṭuwā	A historic well near Makkah where the Prophet (PBUH) bathed before entering the city.
Umrah	al-ʿUmrah	A pilgrimage that includes Tawaf and Saʿi and can be performed at any time of the year.
Wadi Ibrahim	Wādī Ibrāhīm	The valley in which the city of Makkah is located.
Wadi Mina	Wādī Minā	The valley where Mina is located.
Wadi Muhassir	Wādī Muḥassir	A valley between Muzdalifah and Mina where pilgrims move quickly.
Yemeni Corner	al-Rukn al-Yamānī	The corner of the Kaaba preceding the Black Stone.
Zamazimah	Zamāzimah	The people responsible for distributing ZamZam water to pilgrims.
ZamZam Fingerprint	Baṣmat ZamZam	The unique physical and chemical characteristics distinguishing ZamZam water from other water sources.
ZamZamah	ZamZamah	A soft murmuring sound similar to flowing water.
ZamZam Water	Māʾ ZamZam	The blessed water drawn from the ZamZam well.
ZamZam Water Service	Siqyā ZamZam	The service of providing ZamZam water to pilgrims in the Grand Mosque.

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The End

Professor Abdullah Al-Amri has had a distinguished scientific career spanning over 45 years. He has served as Professor of Seismology and Chairman of the Department of Geology and Geophysics at King Saud University, Riyadh. He also held the positions of Director of the Seismic Studies Center, President of the Saudi Society for Geosciences, and Principal Investigator in 15 American and German research collaborations. In addition, he has acted as a national and international consultant to numerous scientific societies and institutions within and beyond the Kingdom. He founded and served as Editor-in-Chief of the first Arabic geosciences journal (AJGS) in partnership with Springer. His research focuses on modelling and simulation of earthquake mechanics, seismic hazard mitigation, deep groundwater exploration, and identification of geothermal energy reservoirs. Beyond research, Al-Amri has made substantial contributions to scientific dissemination through the authorship of encyclopedias, academic textbooks, and specialized publications that enrich the Arabic scientific library. Among his most significant achievements is the establishment of the first Digital Geological Encyclopedia of the Kingdom. He has published more than 250 peer- reviewed papers, completed over 65 research projects and 80 scientific reports, and authored a 36-volume educational encyclopedia, 5 specialized scientific encyclopedias, the Global Zamzam Encyclopedia in 15 languages, and 3 academic textbooks. He has received numerous national and international awards and honorary distinctions in recognition of his outstanding scientific contributions.

Professor
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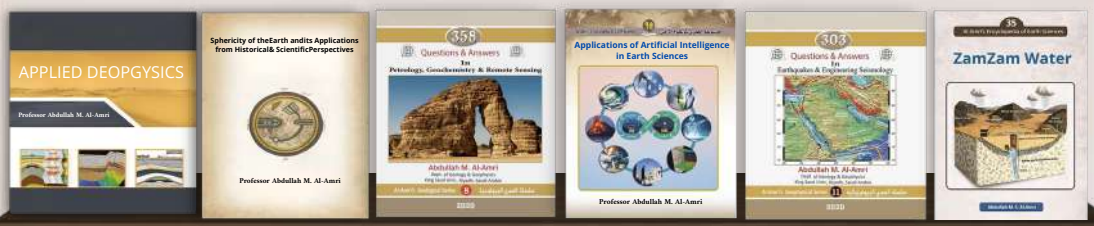

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