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358

Questions & Answers

In

Petrology, Geochemistry & Remote Sensing

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PREFACE

انطلاقاً من أهداف الجمعية السعودية لعلوم الأرض الرامية إلى نشر المعرفة والثقافة العلمية لخدمة المجتمع عامة والمهتمين بعلوم الأرض خاصة فقد أصدر المؤلف سلسلة علمية من **١٢** كتاب : **٦** كتب ثقافية و**٤** كتب جيولوجية و**٢** جيوفيزيائية. في مرحلة ما من حياتنا ، قد يُطلب من كل واحد منا إجراء اختبار للتحقق من صحة شهادة الثانوية العامة أو القبول في الجامعة أو الدراسات العليا أو التأهيل أو التسجيل أو الحصول على ترخيص لمزاولة المهنة كجيولوجي أو جيوفيزيائي محترف.

وتسهيلا لتحقيق الأهداف المرجوة وتذليل الصعوبات تم ذلك من خلال السلسلة الجيولوجية والجيوفيزيائية التي اشتملت على **٦** كتب عبارة عن **٢٠٢٠** سؤال وجواب في **١٠٠٠** صفحة أغلبها مدعم بالأشكال التوضيحية المبسطة لمساعدة المهتم بعلوم الأرض في اجتياز الاختبار بشرط أن يكون مؤهلاً وجادًا في هدفه. حاول المؤلف من خلال هذه السلسلة قدر الإمكان تغطية تخصصات علوم الأرض ممثلة في **٦** أجزاء رئيسية :

- **أصل وتطور الأرض** (علم الأحافير والطبقات الحيوي – جيوديناميكية باطن الأرض).
- **أسس الجيولوجيا** (علم الصخور والمعادن – الجيولوجيا التركيبية – الجيوكيمياء).
- **الثروات الطبيعية** (البترول – المياه – الخامات الاقتصادية – الاستشعار عن بعد و(GIS)
- **المخاطر الطبيعية** (الزلازل – البراكين – التسونامي – الانزلاقات الأرضية – الفيضانات – الانهيارات).
- **علم الزلازل** (الزلزالية الهندسية – هندسة الزلازل – تحليل المخاطر).
- **الجيوفيزياء التطبيقية** (المقاومية الكهربائية – الكهرومغناطيسية – الجاذبية – الاستكشاف السيزمي).

Based on the goals of the Saudi Society of Geosciences aimed at spreading scientific knowledge and culture to serve society in general and those interested in earth sciences in particular, the author has issued a scientific series of **12** books: **6** educational books, **4** geological books and **2** geophysical books. At some point in our lives, each of us may be required to take a test to validate a high school diploma, admission to university or graduate studies, qualification, registration, or obtain a license to practice as a professional geologist or geophysicist.

In order to facilitate the achievement of the desired goals and overcome the difficulties, the geological and geophysical series included 6 books consisting of **2020** questions and answers on **1000** pages, most of which are supported by simplified illustrations to help those interested in earth sciences pass the test, provided that they are qualified and serious in their goal. The author tried, as much as possible, through this series to cover the disciplines of earth sciences represented in **6** main parts (Series **7 - 12**).

Introduction

When Earth formed, over 4.5 billion years ago, there were just 12 minerals, including diamond and graphite. Over the next 2 billion years, plate tectonics began to act on mineral evolution. Earth's crust was subducted into the mantle, melted, remixed, and recycled, and the number of mineral species gradually increased to 1,500. Oxygen-rich environment produced more than 2,500 new oxide and hydroxide mineral species. Because Earth has plate tectonics and life, it now has over 5,000 minerals—10 times more than any other planet in the solar system. Plate tectonic movement is responsible for the recycling of rock materials and is the driving force of the rock cycle. The rock cycle is driven by two forces: (1) Earth's internal heat engine, which moves material around in the core and the mantle and leads to slow but significant changes within the crust, and (2) the hydrological cycle, which is the movement of water, ice, and air at the surface, and is powered by the sun. The rock cycle is still active on Earth because our core is hot enough to keep the mantle moving, our atmosphere is relatively thick, and we have liquid water.

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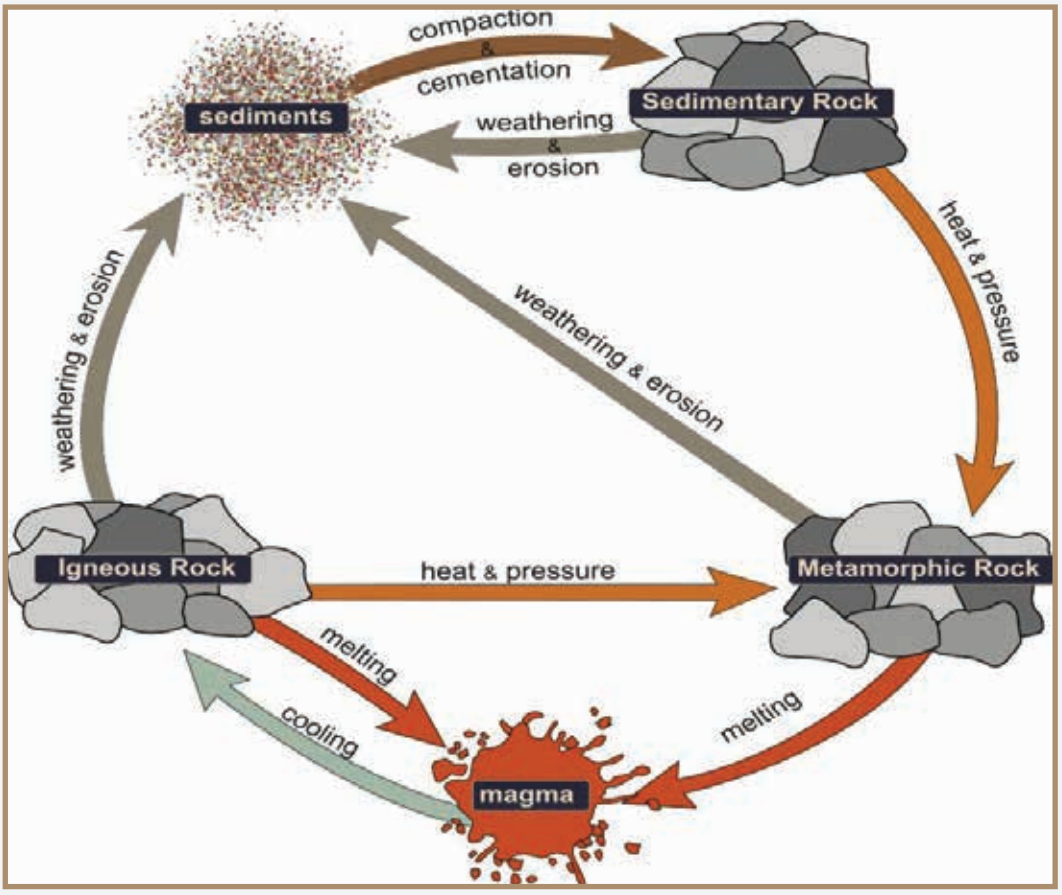
Questions & Answers in Rocks & Minerals



1 What is Petrology and Petrography?

Petrology is a branch of geology (Petro=rock, Logos=study). Petrology, scientific study of rocks that deals with their composition, texture, and structure; their occurrence and distribution; and their origin in relation to physicochemical conditions and geologic processes. It is concerned with all three major types of rocks—igneous, metamorphic, and sedimentary. Petrology includes the subdisciplines of experimental petrology and petrography.

Petrography is primarily concerned with the systematic classification and precise description of rocks.

2 What is Mineralogy?

Mineralogy is a branch of geology dealing with all aspects of minerals, including their physical properties, chemical composition, internal crystal structure, and occurrence and distribution in nature and their origins in terms of the physicochemical conditions of formation.

3 What is Crystallography?

Crystallography is the science that examines crystals, which can be found everywhere in nature—from salt to snowflakes to gemstones. Crystallographers use the properties and inner structures of crystals to determine the arrangement of atoms and generate knowledge that is used by chemists, physicists, biologists, and others.

4	What is the difference between a rock and a mineral?

A mineral is a naturally occurring inorganic element or compound having an orderly internal structure and characteristic chemical composition, crystal form, and physical properties. Common minerals include quartz, feldspar, mica, amphibole, olivine, and calcite.
A rock is an aggregate of one or more minerals, or a body of undifferentiated mineral matter. Common rocks include granite, basalt, limestone, and sandstone.

5	What are minerals classified by?

Minerals are most commonly classified by the Dana system. Minerals are classified by their hardness, specific gravity, color, luster, streak, cleavage and crystal form. Dana system of classification contains 78 different classes of minerals based on composition and then further classified by type and group. There are over 4,900 different types of minerals known in the world

6	What is a mineral assemblage?

A **mineral assemblage** refers to what minerals are in a particular rock that you're looking at. For example, A typical **granite** has a mineral assemblage of: Quartz + Feldspar + biotite mica +/- minor accessory minerals. A typical **basalt** has a mineral assemblage of: Olivine + plagioclase + pyroxene +/- minor accessory minerals.

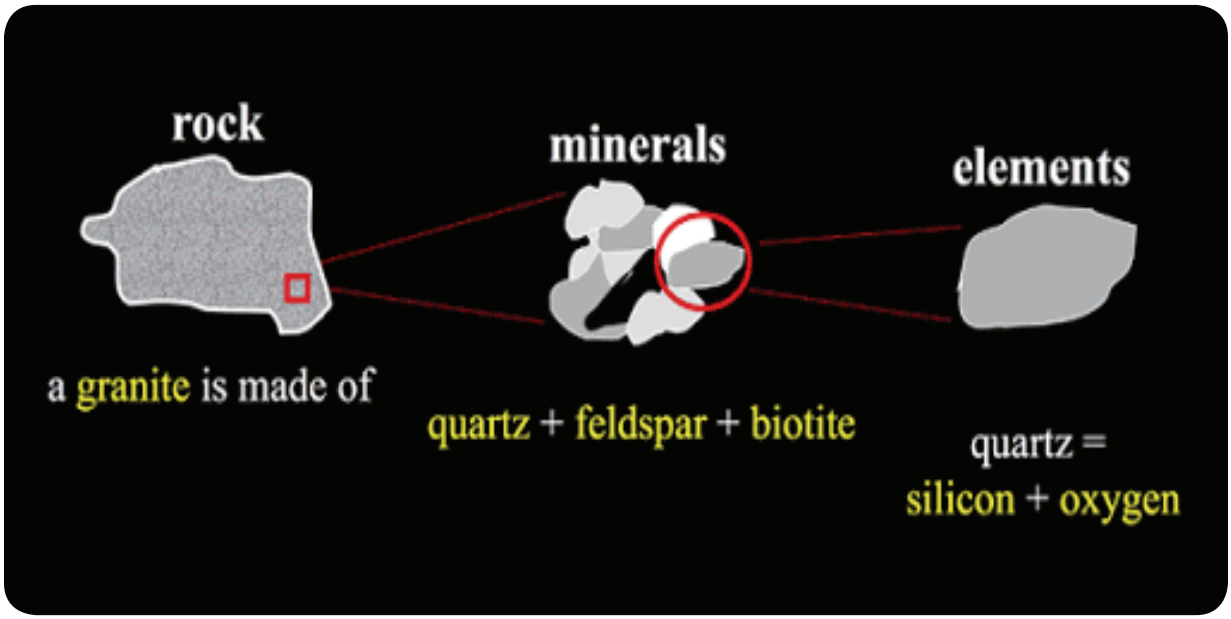
7 What factors cause the difference in the size of crystals formed?

One factor is the speed at which crystals are formed. The slower the crystals are formed the larger the crystals that are formed. Crystals that are formed near or on the surface tend to crystalize faster and therefore are usually smaller. Crystals deeper in the crust tend to crystalize slower and therefore are larger.

8 What are the differences among Rocks, Mineral and Elements?

Rocks are generally composed of an assemblage of minerals. For example, the andesite from Mars contains quartz, feldspar, amphibole, and other minerals. **Minerals** can be divided into their constituent elements. The mineral quartz is composed of two elements, silicon and oxygen. Other minerals may contain many elements. For example, the mineral amphibole is made up of a laundry list of elements including sodium, calcium, magnesium, iron, aluminum, silicon, and oxygen.

Elements are the last stop; they cannot be further divided into other materials but they can be separated into individual atoms. An atom is the smallest particle of an element that retains the characteristics of the element. All atoms are composed of neutrons, protons, and electrons. The protons and neutrons are present in the atom's nucleus that is surrounded by electrons.



9 What Minerals Form Rocks?

The list of minerals that commonly form rocks is short. Descriptions of some of the minerals, as they look in rocks, follow:

Quartz: is the last mineral to crystallize, so in igneous rocks it never has any definite shape. In rocks, it does not show flat faces. It is usually gray in igneous rocks; gray, white, yellow, or red in sedimentary rocks; and gray or white in metamorphic rocks. It has a glassy, or sometimes waxy, look to it.


Olivine
Ca-Plagioclase Feldspar
Halite
Pyroxene
Na-Plagioclase feldspar
Gypsum
Amphibole
Orthoclase feldspar
Limonite
Biotite
Hematite
Muscavite
Quartz
Calcite

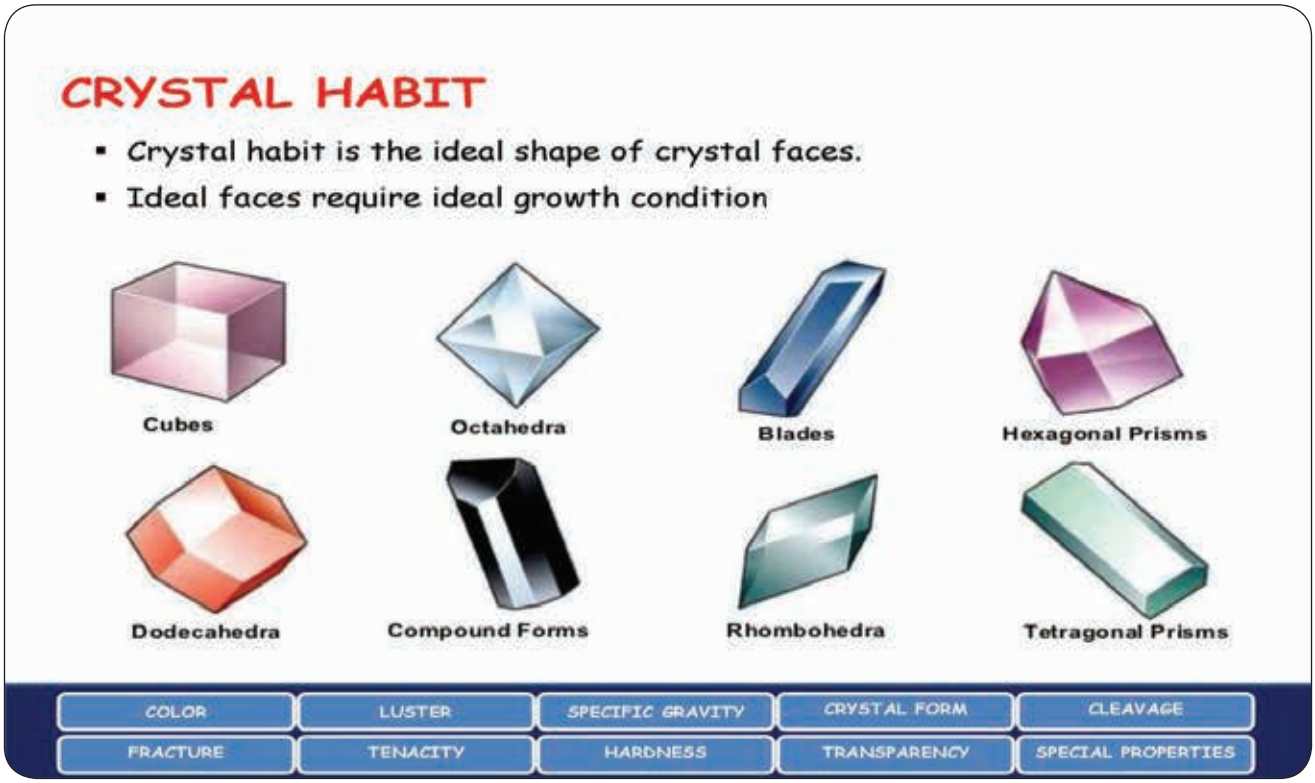
Potassic Feldspars*: (microcline, orthoclase) Potassic feldspars are pink or tan, sometimes white. They show flat, shiny faces in igneous rocks. The crystal grains are usually blocky and nearly rectangular. They look like good china.
Plagioclase Feldspars*: (albite, labradorite) Look like the potassic feldspars, except they are white to dark gray, sometimes black. They may show flashes of blue or green.
Micas*: (muscovite, biotite, phlogopite) Micas have very thin layers that peel off (or cleave) very easily. In rocks they are usually flakes or layers of flakes. Muscovite is silvery to brown; biotite is black; phlogopite is a reddish brown. Phlogopite may be found in marble.
Chlorite*: Like mica, but the flakes are usually not as thin and do not peel apart as easily. The color is medium to dark green, sometimes almost black but with a greenish tint.
Hornblende: Hornblende is dark green to black. It shows nearly flat, shiny faces in almost rectangular or long thin needle like crystals in rock. Hornblende is usually found in dark colored metamorphic rocks; sometimes in igneous rocks.
Actinolite and Tremolite: Actinolite and tremolite are usually in long thin blades or needle like crystals. Actinolite is dark green; tremolite is white to gray. The crystals may be parallel to each other, or spread from a point. Actinolite is usually found in schists or gneisses. Tremolite may be found in marble.
Olivine*: Olivine in rocks is an olive green to greenish yellow. In rocks it is in rounded grains. If there is much of it, it is almost sugary. It is found mostly in dark colored igneous rocks.
Calcite and Dolomite: The color is usually white, but can be other colors when impure. Crystal grains show flat shiny faces, often shaped like parallelograms. Calcite and dolomite are both soft. They are easily scratched with a steel point. Powdered calcite will fizz in white vinegar; dolomite will not. The minerals are found in limestone or dolostone (the rock is dolostone, the mineral is dolomite) and marble.

10 **Explain the process of fractional crystallization.**

During fractional crystallization minerals that melt and crystallize at higher temperatures solidify and crystallize first and are removed from the melt. This process creates a liquid melt that is changed in composition. As cooling continues minerals progressively crystallize out and produce changed magma compositions. Because fractional crystallization progressively extracts iron and magnesium from the magma, the magma that remains as fractional crystallization takes place becomes progressively more felsic (silicic).

11 **What are good crystals?**

Good crystals that show the external faces (euhedral) are relatively rare since they require the growth into an open space and not a lot of nucleation which would result in the growth of many numerous smaller crystals.



12 How fast do crystals grow?

Crystals grow at many different rates. The speed depends upon the supply of the elements, the degree of oversaturation present, and the mechanism of element transport.

13 **What is the process in which rocks and minerals break down into smaller pieces?**

Weathering is the process by which rocks and minerals break down into small pieces. Weathering involves.
1. Physical Weathering,
2. Chemical Weathering,
3. Biological weathering

there are various processes of weathering. all these processes together act on the rocks and minerals to break them down into smaller pieces.

14 **Why we study metamorphic rocks? How do crystals form ?**

Crystals can form in many different ways. Almost all of the earth is formed from crystals (except the parts that are molten). Most of the time, the crystals have grown in a way that they are crowded together and show no external faces (anhedral). Crystals grow when the solubility of elements in a liquid phase is exceeded and they need to transform into a solid or the energy needed to keep them liquid is not sufficient. A crystal can form from a vapor. Sulfur can condense from a vapor and form crystals in fumarole vents in volcanoes. A more common example for those of us in the North is the formation of frost on a windowpane. The ability of the air to contain water vapor is exceeded and crystals of ice grow. Crystals can also grow from solutions of ions in a fluid such as water. When a magma (molten rock) cools, crystals can form as the magma solidifies. Certain minerals will form at various temperatures and will drop out as the magma cools. This forms one of the major ores of chromium as chromite crystallizes as a magma solidifies.

15 How is a new mineral determined?

For each new proposed mineral, data on the chemical composition, crystallography, and physical properties is submitted to the Commission on New Minerals and Mineral Names of the International Mineralogical Association (CNMMN of IMA).

16 Are water and ice minerals?

Water does not pass the test of being a solid so it is not considered a mineral although ice; which is solid, is classified as a mineral as long as it is naturally occurring. Thus ice in a snow bank is a mineral, but ice in an ice cube from a refrigerator is not.

17 Why do different minerals have different shapes?

It all comes down to atoms. Each mineral's atomic structure is arranged in predictable, three-dimensional geometric patterns. When repeated, crystals grow larger following the same geometric pattern, forming the distinctive shapes for each mineral.

18 Why do some minerals sparkle?

Light interacts with the surfaces of minerals in different ways. Sparkling minerals are often vitreous (glassy) or adamantine (diamond-like) with hard, reflective surfaces. They are usually clear or translucent, allowing light to bounce off the surface as well as through the crystals. The greater the number of surfaces (natural or man-made), the greater the sparkling effect.

19 How can the same mineral be so many colors?

When light strikes an object, it reflects certain wavelengths of light back to our eyes, which is how we see its color. If an object appears green, it is reflecting green light and absorbing all the other wavelengths. A mineral's structure and chemical composition give it a characteristic color (or sometimes no color at all). Some color shifts are due to trace elements like copper. Other color variations come from structural aberrations in the crystals.

20 How Different types of bonds result in minerals of different strengths?

Type of bonds determine strength of minerals, rocks–Ionic bonds– Velcro analogy, weaker bonds–Covalent bonds– Rope analogy, stronger bonds. Minerals formed with covalent bonds are stronger and more resistant to destructive forces at Earth's surface–Silicates form more resistant rocks than most other mineral groups.

21	**What are Crystal forms?**

The arrangement of the faces of a crystal to form a particular shape –Common shapes are. 1. Prisms 2. Pyramids 3. Needles 4. Cubes 5. Sheets.

22	**What is the Cleavage?**

Minerals break along planes of weakness defined by atomic structure. Cleavage planes more likely to occur across weak bonds between ions. Example: mica forms sheets joined by weak ionic bonds.

23	**What is Hardness?**

Minerals ranked by their relative hardness using Mohs Hardness Scale–Harder minerals can scratch softer minerals–Softer minerals more likely to break down at Earth's surface–More resistant minerals more likely to be preserved (e.g., quartz sand on beaches)

24	**What is the Fracture?**

Fracture is breakage that is not flat. The two main kinds of fracture are conchoidal (shell-shaped, as in quartz) and uneven

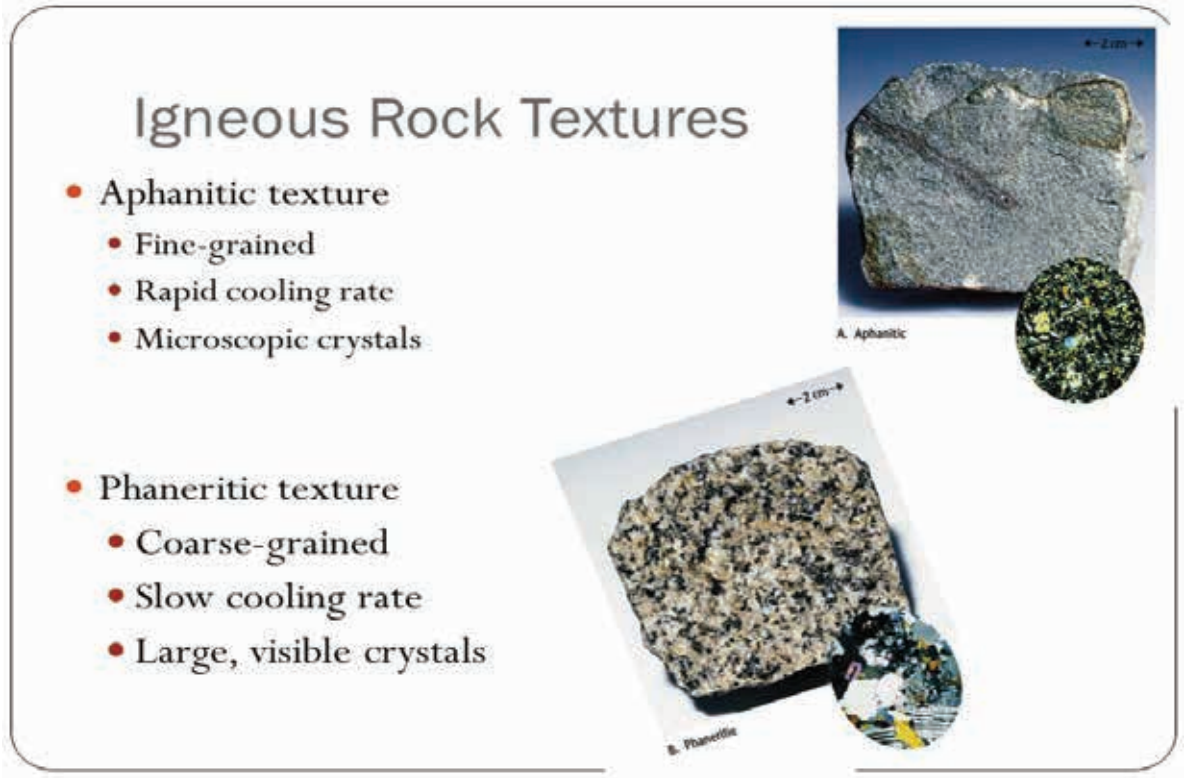
25 What are Heft and Taste?

Heft is how heavy a mineral feels in the hand, an informal sense of density. **Taste** is definitive for halite (rock salt), of course, but a few other evaporite minerals also have distinctive tastes.

26 What is Texture?

Texture refers to the physical appearance or character of a rock, such as grain size, shape, and arrangement. Size of crystals of minerals in igneous rocks depends on rate of cooling of magma–Rapid cooling produces microscopic crystals–Slow cooling produces large, visible crystals

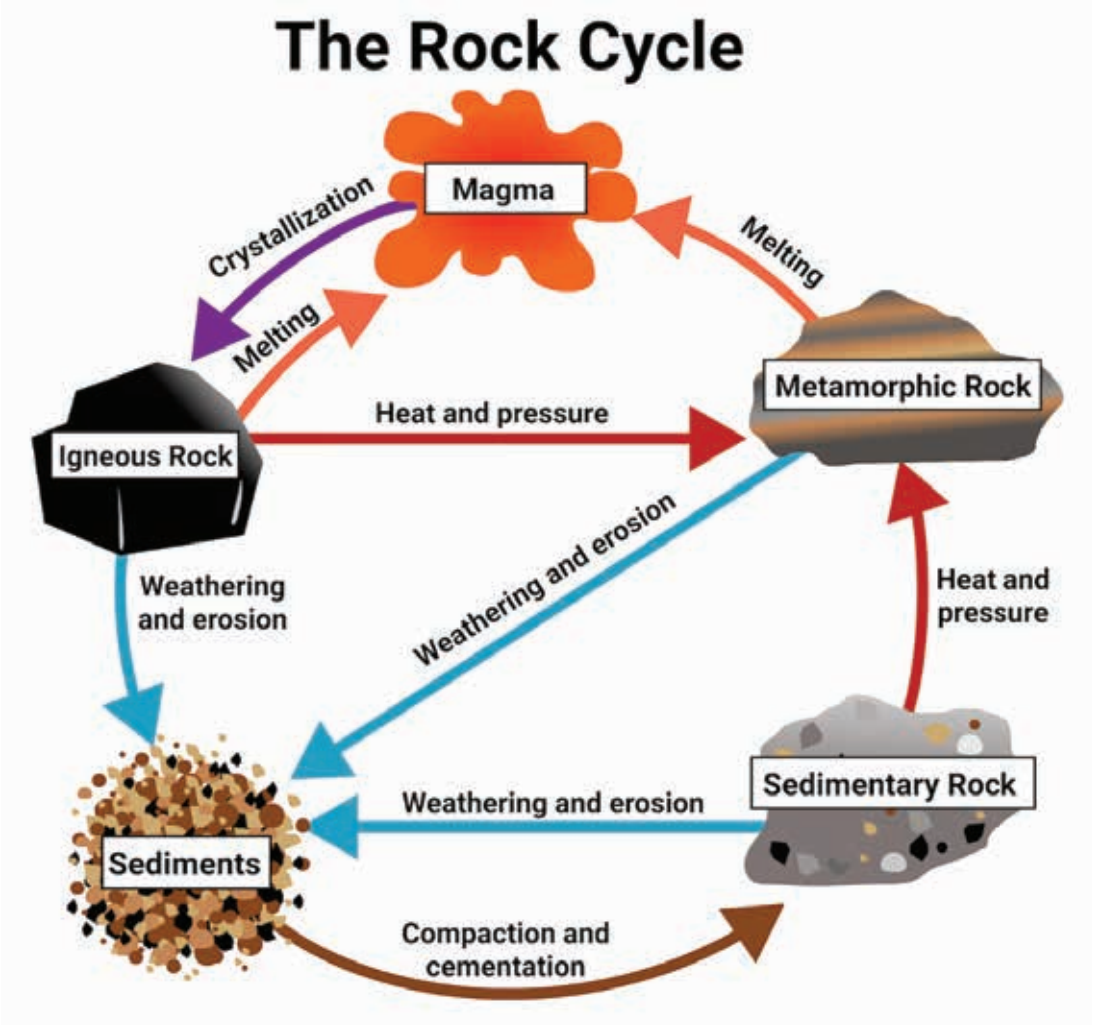
- Crystal size interpreted to learn where rocks formed. Slow cooling in plutonic rocks. Rapid cooling in volcanic rocks.



27 What is the Rock Cycle?

Rocks, like mountains, do not last forever. The weather, running water, and ice wear them down. All kinds of rocks become sediment. Sediment is sand, silt, or clay. As the sediment is buried it is compressed and material dissolved in water cements it together to make it into sedimentary rock. If a great amount of pressure is exerted on the sedimentary rock, or it is heated, it may turn into a metamorphic rock. If rocks are buried deep enough, they melt. When the rock material is molten, it is called a magma. If the magma moves upward toward the surface it cools and crystallizes to form igneous rocks.

This whole process is called the **Rock Cycle**. The Rock Cycle always Recycling. 1. Magma 2. Crystallization 3. Igneous rock 4. Erosion 5. Sedimentation 6. Sedimentary rock 7. Tectonic burial 8. Metamorphic rock 9. Melting of rock and mineral.

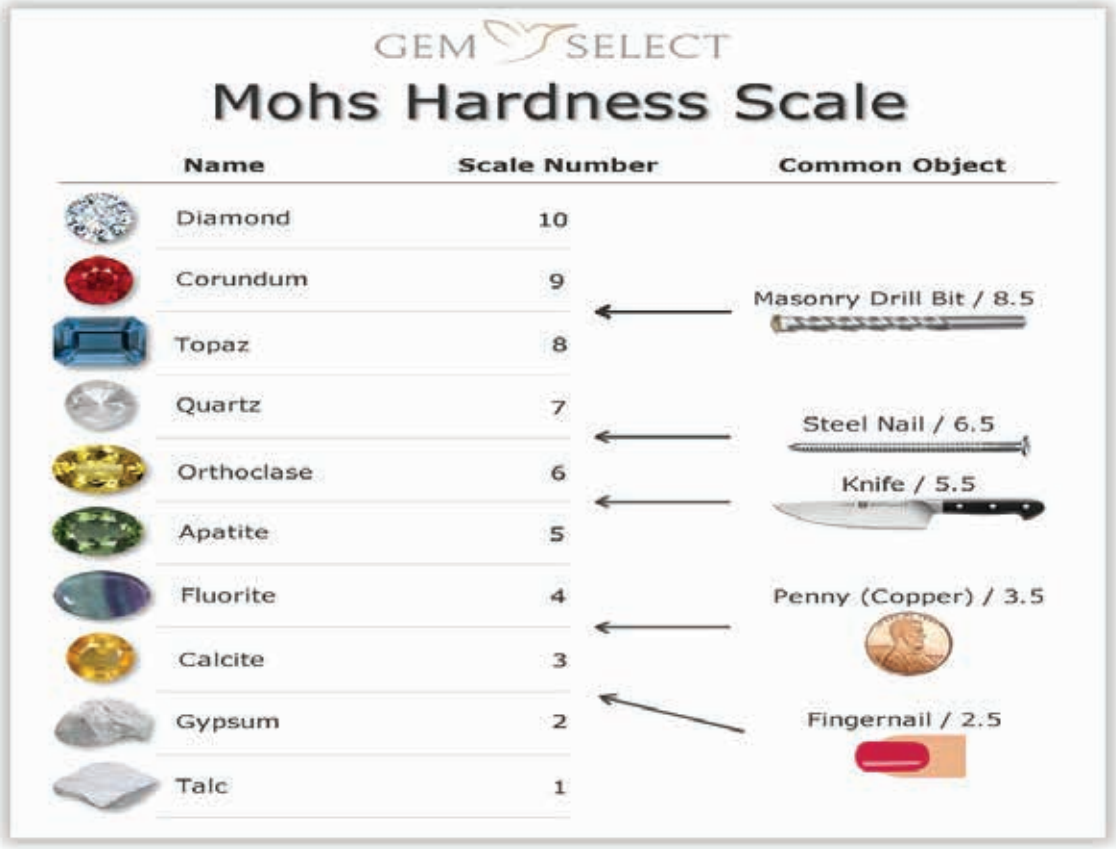


28 **Goals of study metamorphic petrology includes:**

- Academic goals: to deduce the following Protolith (original rock) composition Grade and conditions of metamorphism Tectonic setting under which the metamorphism have done
- Applied goals: Metamorphic rocks like other rock types hosted mineral resources e.g: Graphite, Talc, Magnesite, Asbestos, Corundum, vermiculites, garnets, etc.
- They used also as ornamental stones as Slates, Marbles, gneisses, metaconglomerates, greenstones and others

29 Define Moh's Hardness Scale?

Minerals are ranked from 1 to 10 based upon their relative hardness. Harder minerals can scratch softer minerals. Ten index minerals make up Moh's scale and other minerals are ranked relative to these. For example, a mineral that could scratch feldspar but not quartz would have a hardness of approximately 6.5.



30 How Mineral resources are formed?

Mineral resources result from specific geologic processes associated with formation of rocks.

- Can result from chemical reactions driven by changing temperatures and movement of fluids through rocks.
- Can result when minerals crystallize at different temperatures
  Can result from concentration of various types of rocks and minerals during erosion, transportation and deposition

31 What are Placer deposits?

Placers represent a natural recycling of older mineral deposits. Minerals that are weathered out of veins maybe carried downslope by streams. Stream flow serves to sort and concentrate the minerals. Metal-rich minerals are heavier than the rest of the material carried by the stream. Consequently, when flow velocity decreases the heavy minerals are among the first materials to be deposited. Suitable sites for deposition are the insides of stream bends (meanders)or at the stream mouth (delta).

32 What are Residual mineral deposits?

Water flowing through rocks on or near the land surface may remove soluble minerals to leave behind sufficient concentrations of economic minerals to form an ore. This process is most rapid in areas of high rainfall and high temperatures such as the tropics. Iron- and aluminum-rich laterite forms as a result of leaching of minerals from thicks oils in tropical regions. The world's principal source of aluminum ore is from a form of laterite known as bauxite.

33 What are the Aggregates?

Aggregates represent a subgroup of industrial minerals that are typically used for construction. Aggregates include sand, gravel, crushed stone, dolomite, and sandstone. Some of the uses of industrial minerals are:•Limestone used for crushed stone (construction) or lime(steel production).•Sand and gravel (construction).•Sandstone for building stone (construction), as a source for silicon (computer chips), for use in glass making •Clay is used to make bricks and ceramics and in the manufacture of glossy paper, paint, toothpaste . Gypsum used in making wallboard, plaster of Paris, and cement •Salt deposits are mined for table salt, used in water softeners, animal feed, and for ice control on roadways • Phosphate rock is used in manufacture of fertilizers.

34 What are the most common elements in the continental crust?

Eight elements (oxygen, silicon, aluminum, iron, calcium, magnesium, sodium, potassium) make up more than 98% of the continental crust.

35 What are silicates?

The most common minerals are composed of the most common elements. Silicon and oxygen make up over 70% of the continental crust by weight; minerals that contain both silicon and oxygen are known as silicates.

36 What is the difference between minerals, crystals, and rocks?

(i)–Minerals are made up of regularly arranged atoms. Minerals grow as distinct objects called crystals.

Crystals are made up of only one type of mineral. A crystal's atoms, ions, or molecules are arranged in an orderly, repeating pattern. Crystals can have different shapes, depending on how the groups of atoms are arranged. A rock is a mass of many crystals from one or several minerals. Granite is a rock made of 3 main minerals.

37 **How are crystals formed?**

Most come from a liquid evaporating (e.g., salt) or magma cooling. Minerals in the liquid precipitate out as the liquid evaporates. As more minerals precipitate out, the crystal grows in size. Crystals can grow forever, as long as they have the chemical elements and the environmental conditions necessary.

38 **What are the two most important properties that scientists use to identify minerals?**

Chemical composition (e.g., via microprobe analysis). **Crystal structure** (e.g., via X-ray diffraction analysis), which is reflected in the mineral's crystal symmetry and shape . Other properties that scientists use to help identify minerals include: Color –Luster, Streak, Hardness, Magnetism, Crystal system.

39 **What are the chief carbonate minerals?**

The chief carbonate minerals are calcite, aragonite, and dolomite, Calcite and aragonite are both composed of calcium carbonate, $CaCo_3$, but have different crystal structures Dolomite is similar to calcite but contains magnesium as well as calcium; its composition is usually represented as CaMg(Co) although the proportion of Ca may vary.

40 **Quartz and feldspar are both light in color and have a glassy luster. How could you distinguish a sample of quartz from one of feldspar?**

Feldspar is softer than quartz and has two nearly perpendicular cleavage planes whereas quartz does not exhibit cleavage . Feldspar occurs in approximately rectangular crystals whereas quartz crystals are hexagonal and are transparent or translucent.

41 **What are the process to move From Sediment to Sedimentary Rock?**

- **Transportation**

Movement of sediment away from its source, typically by water, wind, or ice
Rounding of particles occurs due to abrasion during transport
Sorting occurs as sediment is separated according to grain size by transport agents, especially running water
Sediment size decreases with increased transport distance

- **Deposition**

Settling and coming to rest of transported material
Accumulation of chemical or organic sediments, typically in water
Environment of deposition is the location in which deposition occurs

- Deep sea floor
- Beach
- Desert dunes
- River channel
- Lake bottom

- **Preservation**

Sediment must be preserved, as by burial with additional sediments, in order to become a sedimentary rock

- **Lithification**

General term for processes converting loose sediment into sedimentary rock
Combination of compaction and cementation

42 What igneous processes result in the formation of mineral resources?

Igneous processes that concentrate metals involve the interaction of water with hot rocks (near magma sources) or the formation of minerals from magmatic fluids. Hot waters dissolve out metal-rich minerals around magma chambers and then deposit the minerals (hydrothermal deposits) in cooler environments. Specific minerals may be segregated as magma solidifies. Igneous processes may cause metal-rich minerals to settle to the bottom of a magma chamber (crystal settling) or to become concentrated in veins around the magma chamber.

43 What sedimentary processes concentrate mineral resources?

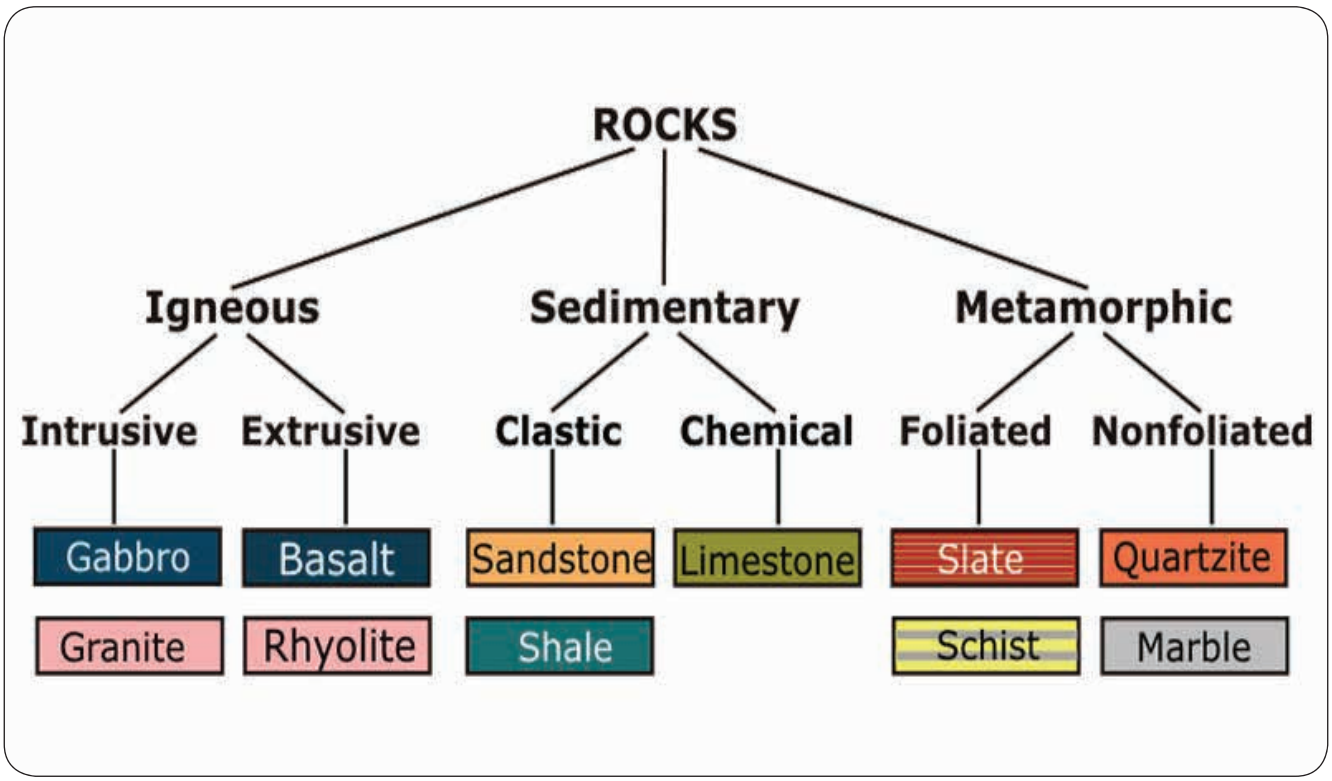
Processes such as chemical weathering, deposition in flowing water, and evaporation can all result in the concentration of minerals. Few precious metals are formed directly during the formation of sedimentary rocks but common metals such as iron and aluminum are typically the result of sedimentary processes. The majority of nonmetallic industrial minerals(e.g., sand and gravel, clays, gypsum) are formed by sedimentary processes.

44 What is the various color classification of mineral?

Idiochromatic- fairly constant color (eg) metallic minerals like copper group.
Allochromatic- variable color (eg) non-metallic minerals like quartz.
Pseudochromatic - false color. It is seen to show a set of colors in succession. The change of color is attributed to simultaneous reflection and refraction from the mineral
surface at different locations.

45 How are minerals formed?

Many minerals crystallize from liquids, principally magma/lava (molten rock), hot waters (e.g., geysers), or oceans. Others are formed when rocks are re-buried below the Earth's surface and exposed to high pressure and temperature. The minerals become unstable and they exchange chemical elements. This forms new minerals.



46 Why are minerals found in large quantities in some places and not others?

The Earth's surface is made up of plates that move. "**Plate tectonics**" describe this motion. Together with erosion, plate tectonics concentrate some of these elements in bodies of rocks that can be mined. Plate tectonics are the Earth's giant "recycling engine.

47 Are rocks and minerals the same things?

No. Minerals are made from individual elements or combinations of elements. Almost all rocks are made up of minerals (some contain organic material), and they usually contain more than one type of mineral. A rock's unique composition and the process by which it is formed determine its type.

48 Classify Chemical Sedimentary Rocks?

Carbonates : Contain CO_3 as part of their chemical composition. **Limestone** is composed mainly of calcite. Most are biochemical, but can be inorganic Often contain easily recognizable fossils. Chemical alteration of limestone in Mg-rich water solutions can produce dolomite. **Chert** . Hard, compact, fine-grained, formed almost entirely of silica. Can occur as layers or as lumpy nodules within other sedimentary rocks, especially limestones.

Evaporites. Form from evaporating saline waters (lake, ocean). Common examples are rock gypsum, rock salt.

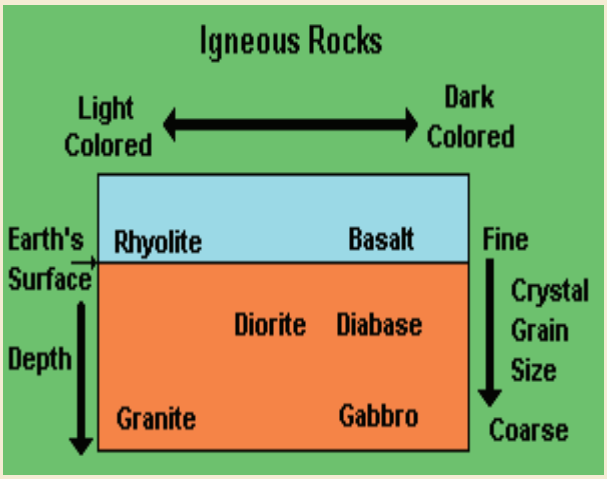
49	**Gypsum and anhydrite both contain calcium sulfate, CaSo. What is the difference between them?**
	Water molecules are incorporated in the crystal structure of gypsum, so its composition can be represented as CaSO. 2H.O Anhydrite does not contain water and has a different crystal structure.

50	**Granite and rhyolite have similar compositions but granite is coarse-grained whereas rhyolite is fine-grained. What does the difference in grain size indicate about the environments in which each rock formed?**
	Large mineral grains can form only during slow cooling , hence granite must have solidified inside the crust. Small mineral grains occur when cooling is rapid, hence rhyolite must have solidified at or near the earth's surface.

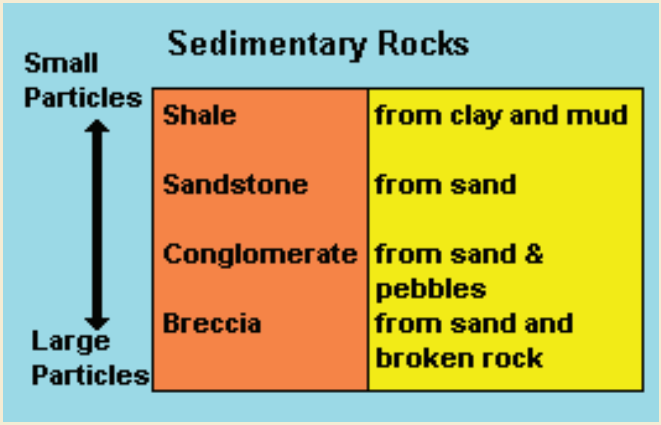
51 What Types of Rock ?

There are three different types of rock:

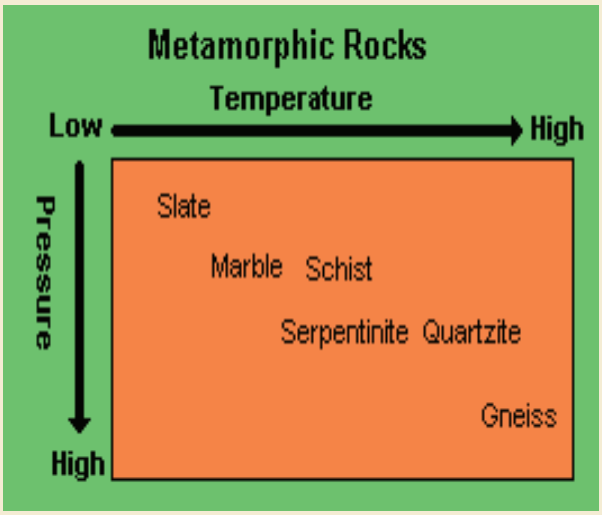
Igneous Rock is formed when a magma cools underground and crystallizes or when it erupts unto the surface of the ground, cools and crystallizes. Magma that erupts onto the surface is called lava. When magma cools slowly underground the crystals are large enough to see. When it cools quickly on the surface, the crystals are very small and you would need a magnifier or a microscope to see them. Sometimes, when the magma cools very quickly, it forms a kind of black glass that you cannot see through.



Sedimentary Rock forms from particles, called sediment, that are worn off other rocks. The particles are sand, silt, and clay. Sand has the largest particles while clay has the smallest. If there are a lot of pebbles mixed with the sand, it is called gravel. The sediment gets turned into rock by being buried and compacted by pressure from the weight above it. Another way it becomes rock is from being cemented together by material that has been dissolved in water. Often, both cementing and compaction take place together.



Metamorphic Rock is formed by great heat, or pressure, or both. The pressure can come from being buried very deep in the earth's crust, or from the huge plates of the earth's crust pushing against each other. The deeper below the surface of the earth, the higher the temperature, so deep burial also means high temperatures. Another way that high temperatures occur is when magma rises through the earth's upper crust. It is very hot and bakes the rock through which it moves. Hot liquids or gases from the magma also can cause chemical changes in the rock around the magma.



52 How rocks are collected?

Rocks are easier than minerals to collect. That is because they are found nearly everywhere. If you want to start a rock collection, try to find pieces of rock that are freshly broken off a ledge. A ledge is a bed of rock that is sticking out of the ground, or the side of a mountain. It is not loose, but is still part of the bedrock below the soil. Pieces of rock that have been buried in the soil, or rolled in a stream or river are not good to collect. It is difficult to see what they are or what they are made of and you really don't know where they came from..

- Collect clean fresh specimens.
- Make a label that has the name of the rock and the location where it was collected.
- Assign a number to each rock.
- Record in a notebook the name, location where you found it, and number of the rock.
- Paint a small white rectangle on each rock, and write the rock's number on it.

53 How is opal formed?

A. Opal is a metamorphic rock formed when sedimentary shale was exposed to excessive heat and pressure.

54 What causes the different colors of gemstones?

Gemstone (also called a **gem**, **fine gem**, **jewel**, **precious stone**, or **semi-precious stone**) is a piece of mineral crystal which, in cut and polished form, is used to make jewelry or other adornments. Gemstones have different colors because of the metals they contain within their crystal structures.

Agate

Alexandrite

Almandine

Amazonite

Amber

Amethyst

Ametrine

Andalusite

55 **Which stone is not a gemstone and What are the 5 most precious stones?**

Topaz, Opal and Pearl are gemstones but Cat's-eye is not a gem stone.
The 5 most precious stones are:

1. Diamond. Diamonds are by-far the most popular precious stones. ...
2. Emerald. Emeralds are a rare variety of the mineral beryl. ...
3. Sapphire. Sapphires are one of the hardest stones on the planet; only diamonds surpass them in hardness.
4. Ruby. The cost of a ruby is primarily decided by its color. ...
5. Red Coral.

56 **What is the rarest gem?**

Painite is a dark red crystal and considered the world's rarest gemstone.

57 **What are all the gemstones called?**

Gemstones are classified into different groups, species, and varieties. Other examples are the emerald (green), aquamarine (blue), red beryl (red), goshenite (colorless), heliodor (yellow) and morganite (pink), which are all varieties of the mineral species beryl**.**

58 What is Agate?

Agate is also called "The Earth Rainbow" because of its ability to come in such various shades and layers of color. The stone is a banded and layered mineral from the Quartz family. The variety of color these stones can come in is huge.

59 What isTurquoise?

Turquoise is said to be the oldest gemstone known to man in human history. Throughout time, this stone was honored as a symbol of wisdom and nobility. The blue-green hues of the stone and its light weight make it a versatile stone for carved figures, jewelry pendents and other accessories. While it is a more common stone

60 What is difference between felsic and mafic rock?

Felsic with predominance of quartz, alkali feldspar and/or feldspathoids: the felsic minerals; these rocks (e.g., granite) are usually light colored, and have low density.

Mafic rock, with predominance of mafic minerals pyroxenes, olivines and calcic plagioclase; these rocks(example, basalt) are usually dark colored, but not always, and have a higher density than felsic rocks. Ultramafic rock, with more than 90% of mafic minerals(e.g., dunite).

61 Classify Sedimentary rocks according to their source sediments?

- Clastic sedimentary rocks are composed of fragments of older rocks that have been deposited and consolidated. boulders greater than 25.6 cm, cobbles 6.4 to 25.6 cm, pebbles 2 mm to 6.4 cm, sand 1/16 mm to 2 mm, silt 1/256 mm to 1/16 mm, clay less than 1/256 mm
- Chemical sedimentary rocks form when minerals precipitate from a solution, usually sea water. Halite and gypsum are examples of minerals that precipitate from aqueous solutions to form chemical sedimentary rocks.
- Biochemical sedimentary rocks are composed of accumulations of organic debris. Coal and some limestones are examples of biological sedimentary rocks

62 How Metamorphic rocks are formed?

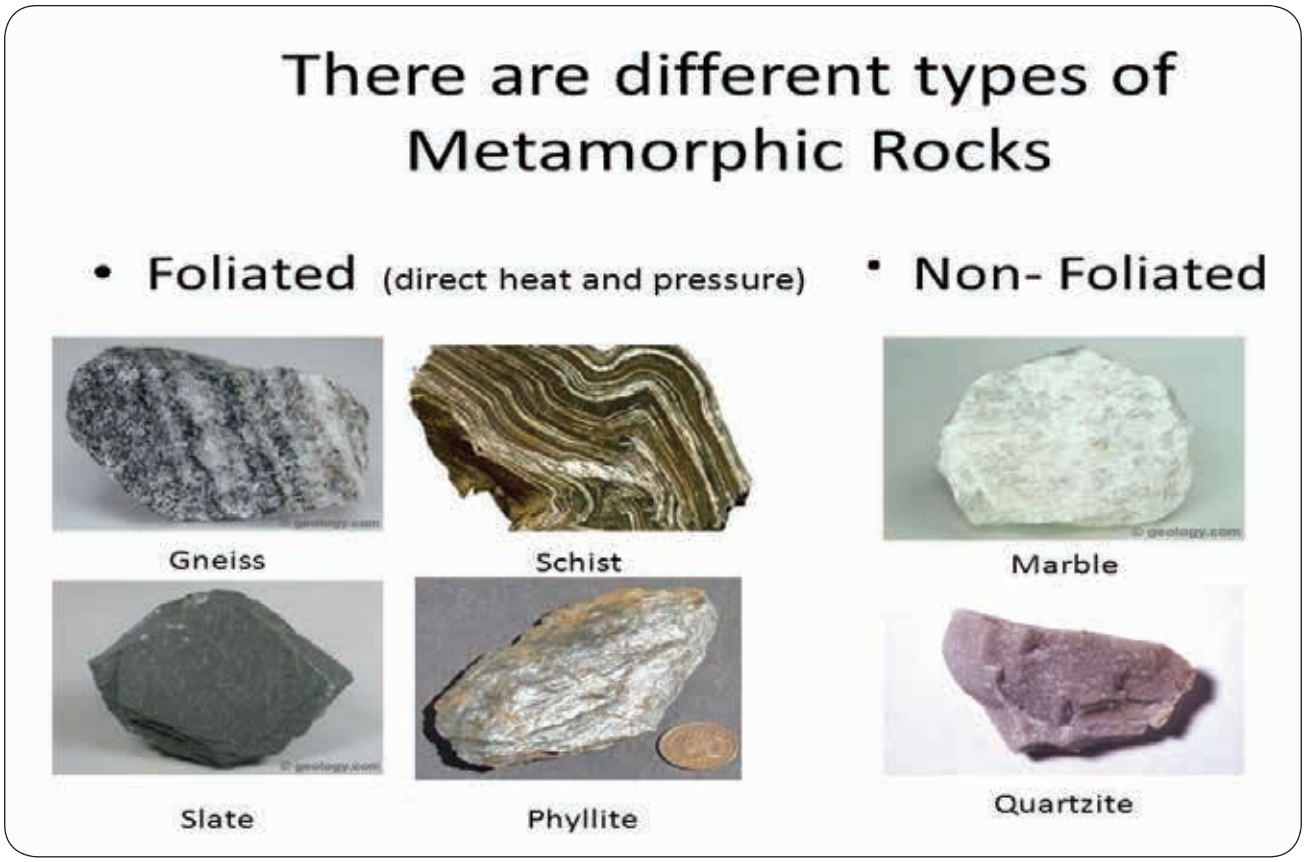
Metamorphic rocks result of the transformation of a pre-existing rock type, the protolith, in a process called metamorphism, which means “change in form”. The protolith is subjected to heat (greater than 150 ° C. and/or extreme pressure causing profound physical and/or chemical change. The protolith may be sedimentary rock, igneous rock or another older metamorphic rock.

63 What is Foliation?

refers to flat or wavy planar features (looking like layers) caused by the alignment of platy minerals such as mica. Foliation may also look like alternating bands of light and dark minerals.

64 **What is meant by Nonfoliated rocks?**

Rocks have interlocking grains with no specific pattern. They are classified based on composition, and this usually depends on the type of rock it originally formed from.



65 What is Chemical classification?

Acid igneous rocks containing a high silica content, greater than 63% SiO_2 intermediate igneous rocks containing between 52- 63% SiO_2 basic igneous rocks have low silica 45- 52% and typically high iron- magnesium content. Ultrabasic igneous rocks with less than 45% silica

66 What is the benefit of Understanding rocks?

It enables scientists to:
- Locate mineral resources (e.g., copper, gypsum)
- Find fossil fuels (e.g., oil, gas, coal)
- Assess the risk from natural hazards such as volcanic eruptions and tsunami
- Learn about Earth processes such as plate tectonics
- Discover the history and origins of other planets.

67 What are Original ideas about rocks formation?

Neptunism. Rocks formed in a global ocean when material sank to ocean floor or was precipitated from chemical reactions.
Plutonism. Heat from Earth's interior melted rocks or caused them to fuse together.

68 **Classify Igneous rocks according to their texture and composition?**

The same magma can form both rock types.
1. Volcanic rocks–form when magma rises to Earth's surface• Produces volcanoes, lava flows, tephra• Molten rock cools rapidly.
2. Plutonic rocks–form when magma solidifies below Earth's surface •Produces plutons that remain hidden until exposed by erosion• Molten rock cools slowly. Examples of Plutons Batholith, stock, sill, dike, laccolith.

69 **Define porphyry?**

Porphyry contains both large and small crystals. Which is the best explanation for the formation of this rock? The rock experienced a two-stage cooling process.

A. with initial slow cooling at depth followed by rapid cooling at the surface.
B. with initial rapid cooling at depth followed by slow cooling at the surface.
C. with initial rapid cooling near the surface followed by slow cooling at depth.
D. with initial slow cooling near the surface followed by rapid cooling at depth.

70 **What are the three types of Magma?**

- Basaltic magma–partial melting parts of asthenosphere
- Andesitic magma–partial melting of mantle rocks (with water)
- Rhyolitic magma-melting of parts of continental crust. Each magma type may produce two rocks – one volcanic, one plutonic. Less viscous, low silica magma likely to reach surface to form volcanic igneous rocks (e.g., basalt). More viscous, high silica magma likely to cool below surface to form plutonic igneous rocks (e.g., granite).

Magma Types

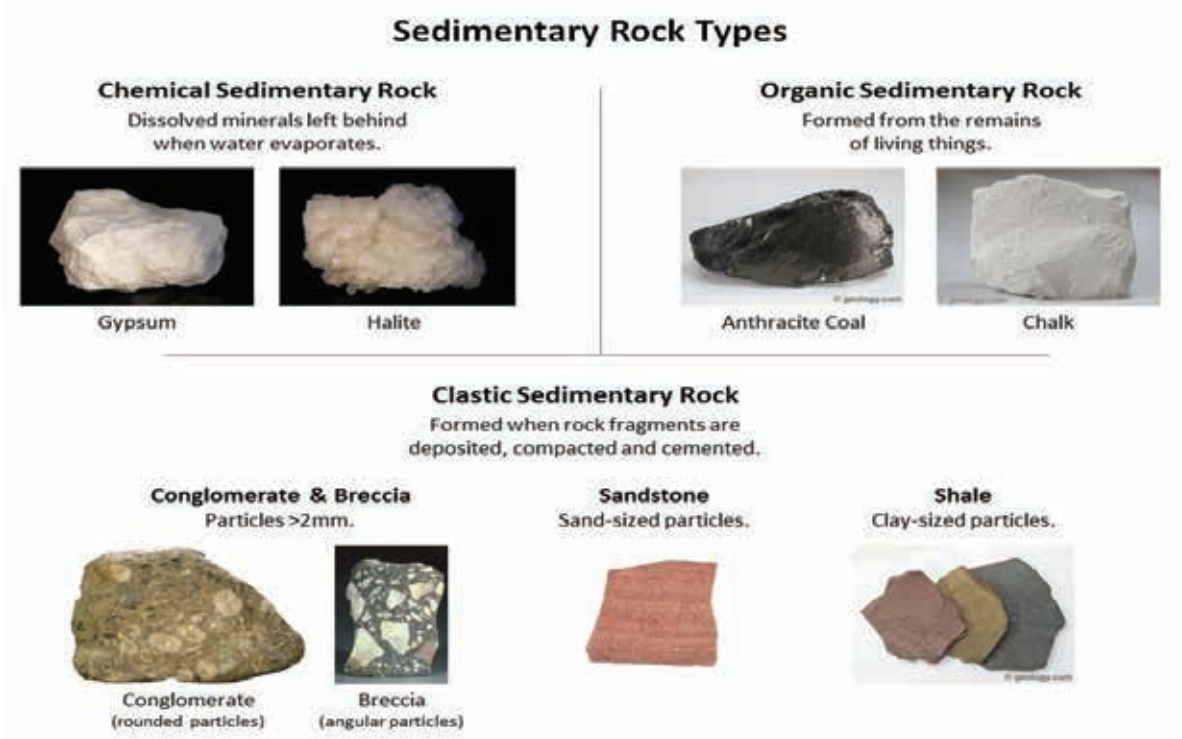
	viscosity	Gas content	Silica content	explosiveness	Location of magma
Basaltic magma	low	1-2%	~50%	least	Oceanic and continental crust
Andesitic magma	Intermediate	3-4%	~60%	intermediate	Subduction zone at continential margins
Rhyolitic magma	high	4-6%	~70%	greatest	Continential crust

71 **How Sedimentary rocks formed?**

Sedimentary rocks formed as horizontal layers (beds)–identified based on composition, thickness–oldest beds at bottom, youngest at top.

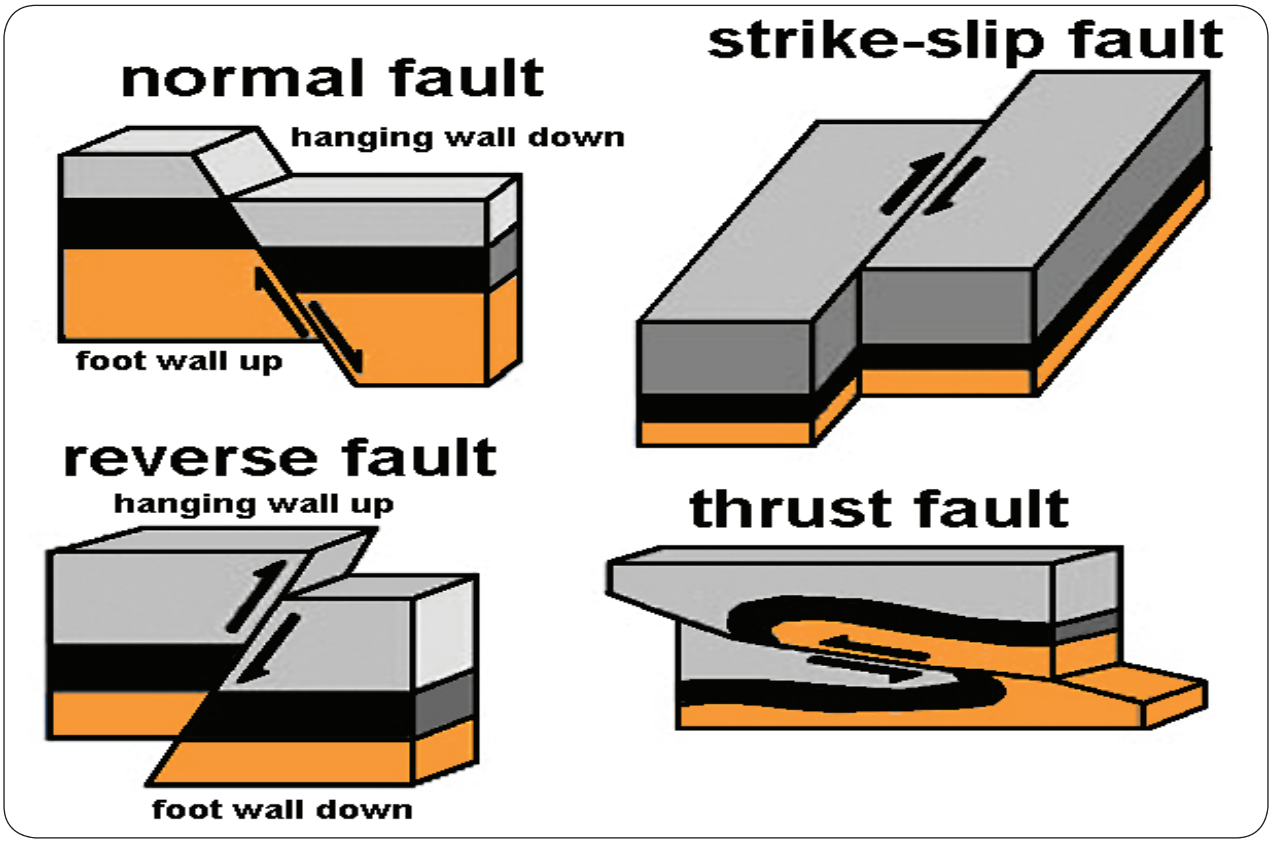
72 **What are types of sedimentary rocks?**

Three types : Clastic, Chemical, and Biochemical. Identified by materials that make up the rock and/or the process by which they formed.



73 What are the classifications of faults?

Faults are classified on the basis of their apparent displacement, ie, the direction of movement, of one block, with respect to the other along the fault plane.

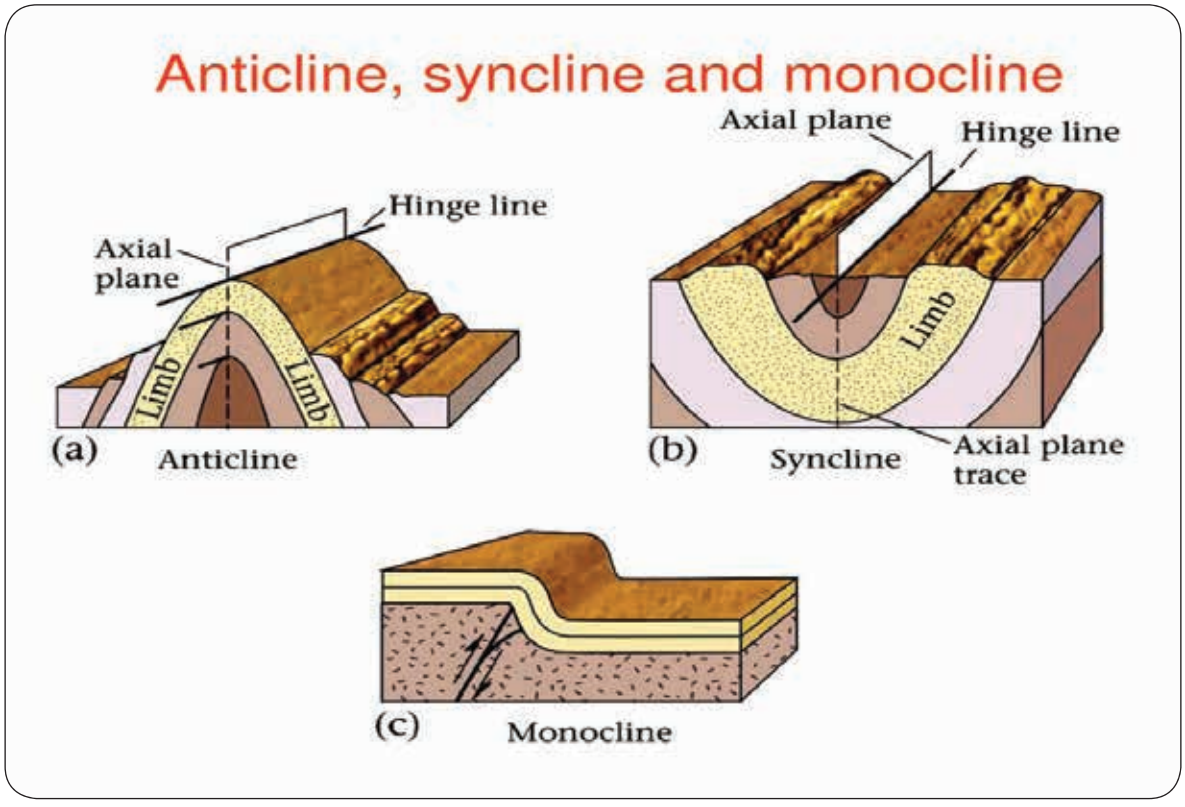


74 What is the Clastic Sedimentary Generation?

Generation is a Physical and chemical breakdown of any rock at Earth's surface (weathering) to form sediment. Sediment = rock and mineral fragments. Type equation here.Sediment classified by grainsize Clay →Silt → Sand → Gravel Rocks (Increasing grain size).

75	What are types of folds?

a) Symmetrical fold, b) Asymmetrical fold, c) Overturned fold, d) Isoclinal fold, e) Recumbent fold, f) Plunging fold, g) Open fold, h) Closed fold, i) Anticlinorium, j) Synclinorium, k) Dome l) Basin, m) Nonoclinal fold,



76 What is the Clastic Sedimentary Lithification?

Lithification–Sediment deposited when velocity of transport medium decreases –Larger grain sizes deposited first, finest grains remain in suspension and are deposited last–Over time, sediment is slowly compacted and grains are cemented together to form a new rock(lithification)

77 When Chemical Sedimentary Rocks are formed?

When minerals precipitate (crystallize) from a solution as a result of changing physical conditions–Solutions = fresh water in lakes, groundwater or seawater–Changing conditions commonly = increased temperatures (evaporation)

78 What are Biochemical Sedimentary Rocks?

Link the biosphere and geosphere • Form due to actions of living organisms that cause minerals to be extracted from solution OR • From the remains of dead organisms. Form due to actions of living organisms that cause minerals to be extracted from solution–The mineral calcite is present in the rock limestone formed by coral organisms that build tropical reefs

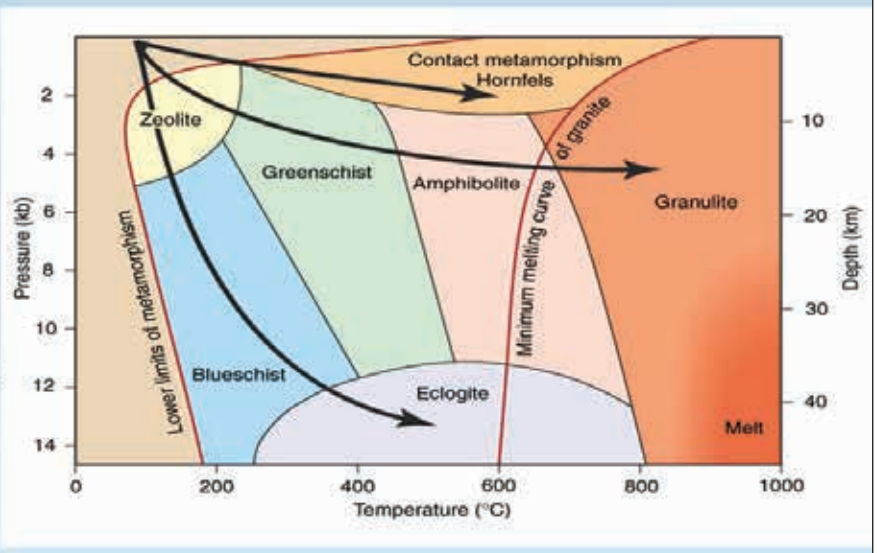
79 Define the Metamorphism?

Changes in mineral composition and texture that can occur in any solid rock• Changes due to increasing temperature and/or pressure and/or the presence of fluids. –Temperatures high enough to promote chemical reactions but not high enough to cause melting. Approximately 200°C - 1100°C, depending on rock type and conditions. Similar temperatures found deep in crust or near magma chambers

Metamorphic Facies

Different minerals form at different temperatures and pressures

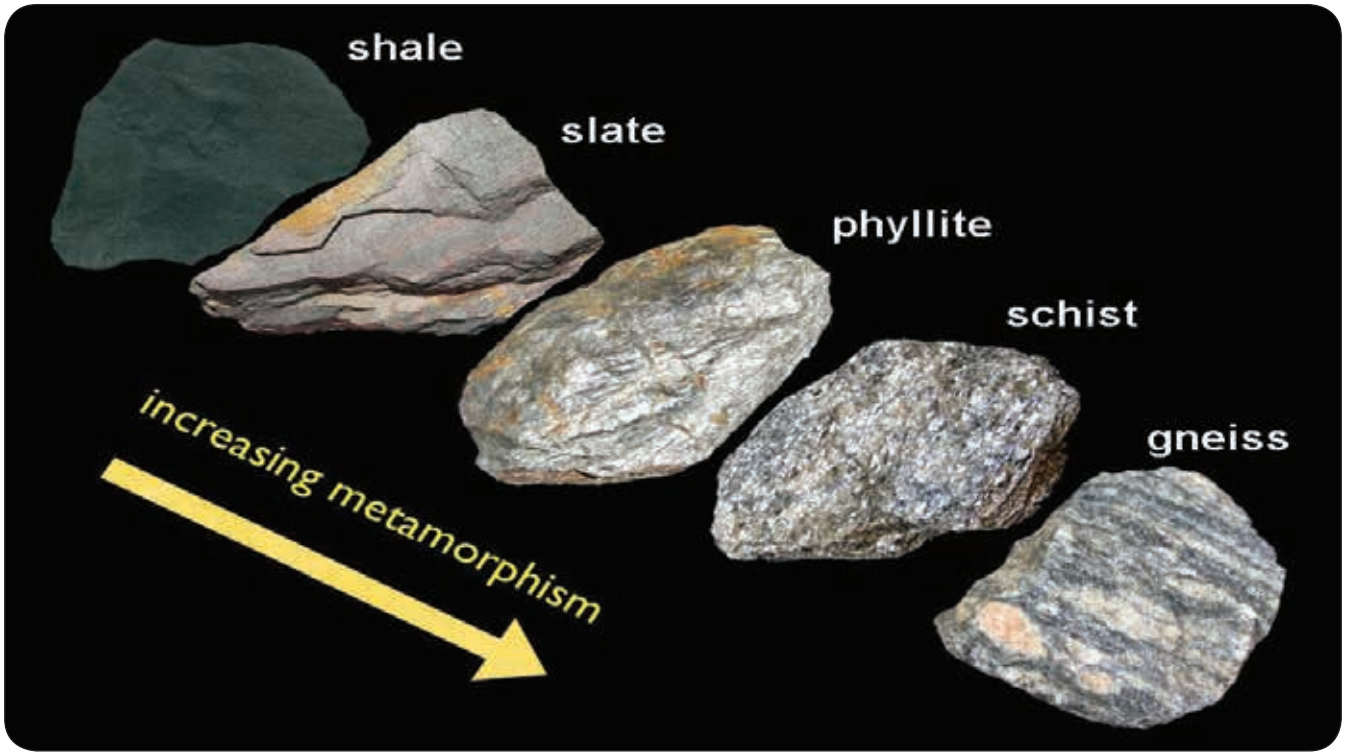
Group of stable minerals define a facies



80 What are the two types of metamorphism?

1. Contact metamorphism• Changes due to increases in temperature where rocks come in contact with heat source (e.g. magma chamber)–Example: limestone around a magma chamber is baked by the heat to form marble.

2. Regional metamorphism. Increased heat and pressure associated with associated with plate tectonic processes that form mountains–Increased pressures and temperatures cause tabular minerals to take on a preferred orientation, foliation, perpendicular to direction of pressure. Foliation is produced when tabular minerals grow perpendicular to the direction of pressure.



81 What is the effect of Weathering?

Rocks physically disintegrate into smaller piece sand the constituent minerals may undergo decomposition to form alternate minerals. The process of disintegration and decomposition is termed weathering and is influenced by the original rock type and climatic conditions. Weathered material forms sediments that are classified by increasing grain size as mud, silt, sand, and gravel.

82 What is the Erosion?

Sediment is removed (transported) from its place of origin by running water, winds, and/or glaciers. A muddy river is an indication that the river is carrying a large load of sediment. Clastic sediments are divided into coarse grain-size particles; gravel, includes pebbles, cobble sand boulders), medium grain-size (sand), fine grain-size (silt),or very fine sediment (clay). The process of erosion shapes the landscape and contributes to the formation of many of the distinctive landforms of a region (valleys, canyons, mountains).

83 Explain the stages of Deposition?

Clastic sediments are deposited when the velocity of the transporting medium drops. For example, rivers dump much of their sediment where they enter the relatively quiet waters of an ocean or lake; the landform that is created is a delta. This material may be redistributed along the coastline to form beaches. Winds in deserts may shape sand into dunes. Deposition concentrates sediments of the same size to gether. As the pile of sediment grows, sediment at the base of the pile becomes compacted, squeezing out water and forcing the grains closer together. Fluids circulating through the pile precipitate minerals to cement the grains together, converting the sediment into a cohesive aggregate, i.e., a rock. The processes of compaction and cementation that convert sediment into sedimentary rock are termed lithification.

84 How Rock salt is formed?

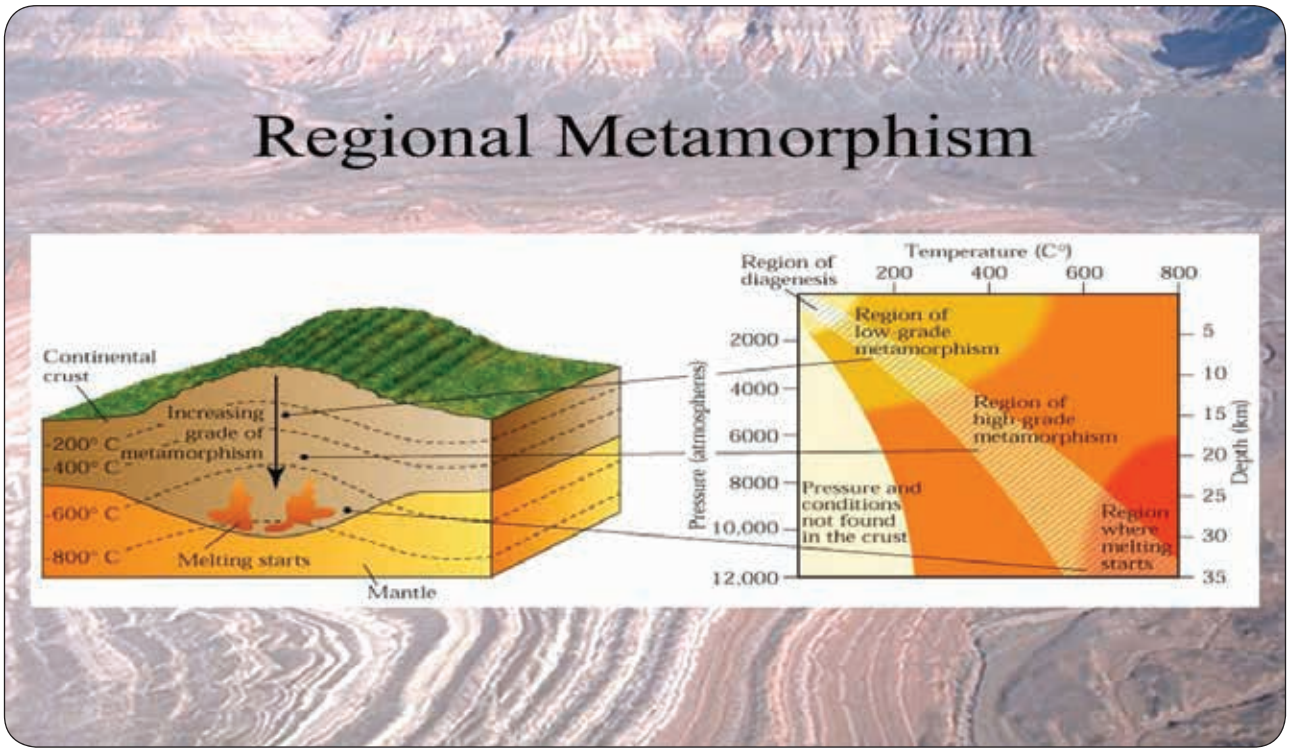
Rock salt forms as a result of changing physical conditions (increasing temperature). Minerals dissolved in seawater are precipitated when the water evaporates to form rocks such as gypsum and rock salt (halite). Evaporation typically occurred in restricted basins in arid climates. Thick salt deposits are interpreted to indicate that there must have been a constant supply of additional seawater to ensure the steady deposition of salts. These rock types are collectively termed evaporites

85 Does Marble Rock or mineral?

Marble is an example of a rock that may be formed by contact metamorphism. Marble forms when limestone is heated to high temperatures. Both marble and limestone may have the same composition but marble typically has larger grains.

86 What is the Regional Metamorphism?

Regional metamorphism occurs when rocks undergo increased temperatures and pressures and is typically associated with the formation of mountain belts. In these areas rocks may be buried to great depths (10-20 km). The additional pressure causes tabular minerals (e.g., mica) in the rock to grow parallel to each other and perpendicular to the direction of pressure (stress), generating a mineral alignment termed foliation. Increased temperatures and/or pressures generate more intense grades of metamorphism. Foliated metamorphic rocks in order of increasing metamorphic grade (low to high temperature) are slate, phyllite, schist, and/or gneiss.



87	**What characteristic properties can be used to identify minerals?**	
	Minerals can be identified by crystal form, color, cleavage, hardness, streak, and luster	

88 What are Intrusive Rock Bodies?

Volcanic neck : Shallow intrusion formed when magma solidifies in throat of volcano
Dike : Tabular intrusive structure that cuts across any layering in country rock
Sill : Tabular intrusive structure that parallels layering in country rock
Pluton : Large, blob-shaped intrusive body formed of coarse-grained igneous rock, commonly granitic. Small plutons (exposed over <100 km^2) are called **stocks**, large plutons (exposed over >100 km^2) are called **batholiths**

89 What are the most common igneous rocks?

Rhyolite (volcanic) and granite (plutonic) are igneous rocks formed from silica-rich magmas. Basalt (volcanic) and gabbro(plutonic) form from silica-poor magmas. Andesite (volcanic)and diorite (plutonic) form from magmas of intermediate composition.

90 What are the three basic types of sedimentary rocks?

Clastic sedimentary rocks are composed of rock and mineral fragments. Chemical sedimentary rocks are precipitated from a solution. Organic sedimentary rocks are composed of the remains of dead organisms.

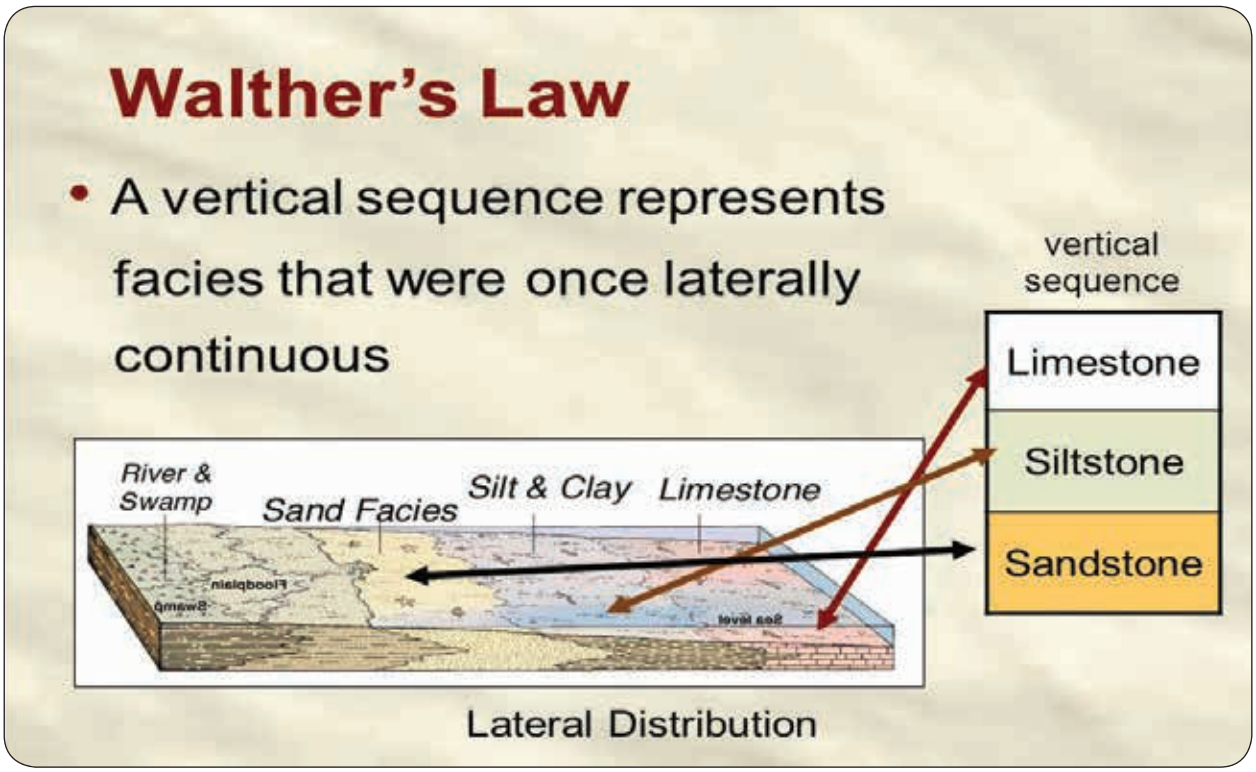
91 What controls the grain size of clastic sediments?

The velocity of transport may control the size of the sediment that can be carried (the exception is glaciers that carry sediment of all sizes trapped in the ice). Fast-flowing streams and strong winds can transport the largest grains. Transport velocity therefore results in sediments being sorted (arranged) by grainsize.

92 What is mean by facies? And types of facies

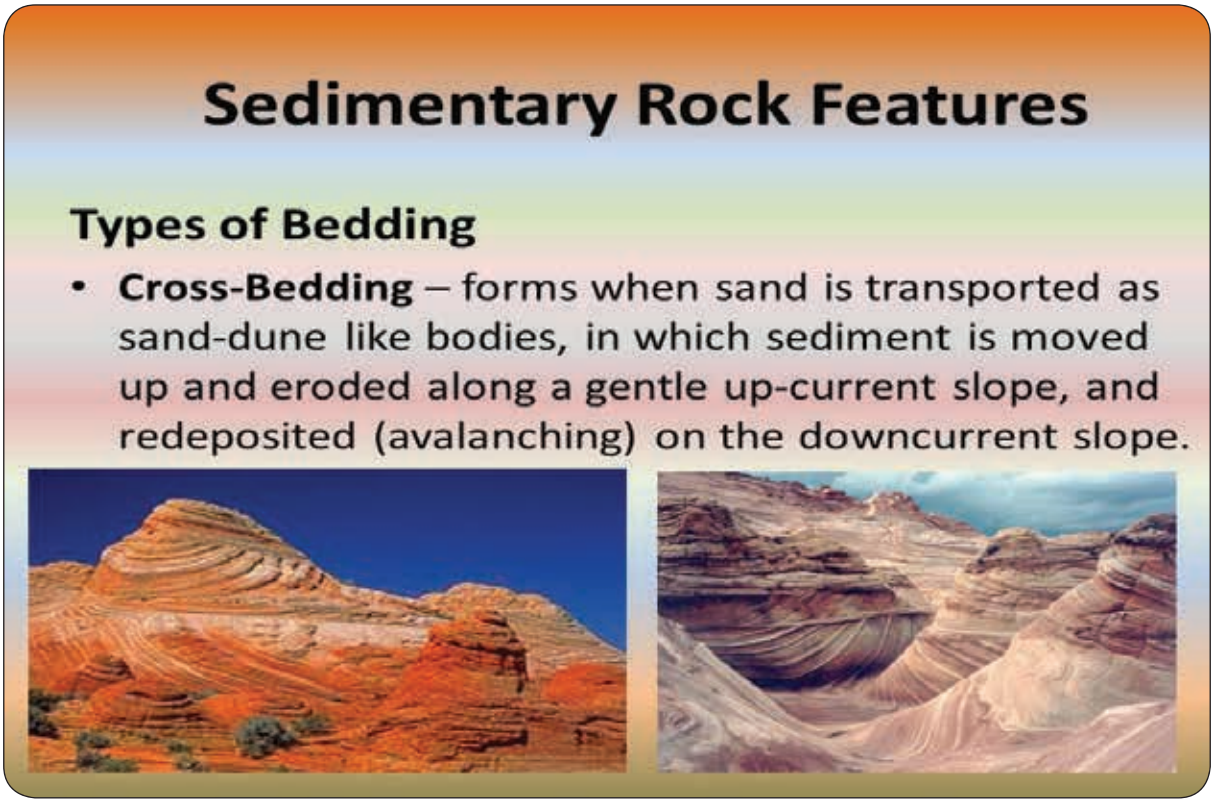
The concept of formation of a sedimentary rock is a particular type of environment is explained by the term facies. Three kinds of facies:

1. Continental facies
2. Transitional facies
3. Marine facies



93 **Define cross bedding?**

Sedimentary beds or layers are generally parallel to one another. But, sometimes, it has been observed that the beds lie slightly oblique to the major bedding planes



94 **Define sediments ?**

Sediment - loose, solid particles originating from: Weathering and erosion of pre-existing rocks. Chemical precipitation from solution, including secretion by organisms in water.
Classified by particle size : Boulder- >256 mm, Cobble- 64 to 256 mm
Pebble- 2 to 64 mm, Sand- 1/16 to 2 mm, Silt- 1/256 to 1/16 mm
Clay- <1/256 mm

95 What is meant by Viscosity of Rocks?

Viscosity: internal resistance to flow. Lower viscosity → **more fluid** behavior
Water, melted ice-cream. **Higher** viscosity → **thicker** Honey, toothpaste
Viscosity determined by: Higher temperature → lower viscosity
More silicon and oxygen tetrahedra → higher viscosity
More mineral crystals → higher viscosity

- Magma contains dissolved gases: **volatiles**

Solubility increases as pressure increases and temperature decreases

96 What is metamorphism?

Metamorphism represents changes in the composition and/ or texture of a rock that occurs in the solid state as a result of increasing temperature and/or pressure.

97 What is the temperature range for metamorphism?

The chemical reactions associated with metamorphism are practically inactive below approximately 200°C. Depending upon their composition, most minerals will melt at temperatures ranging from 600 to 1,000°C.

98 How does contact metamorphism occur?

Contact metamorphism occurs when rocks undergo metamorphism because they come in contact with a heat source (usually a magma body).

99 Where does regional metamorphism occur?

Regional metamorphism occurs when rocks undergo increased temperatures and pressures and is typically associated with the formation of mountain belts. In these areas rocks may be buried to great depths (10-20 km).

100 What factors influence the development of a foliation?

Foliations form when pressure causes tabular minerals in metamorphic rocks to grow parallel to each other and perpendicular to the direction of pressure (stress), generating an alignment of minerals.

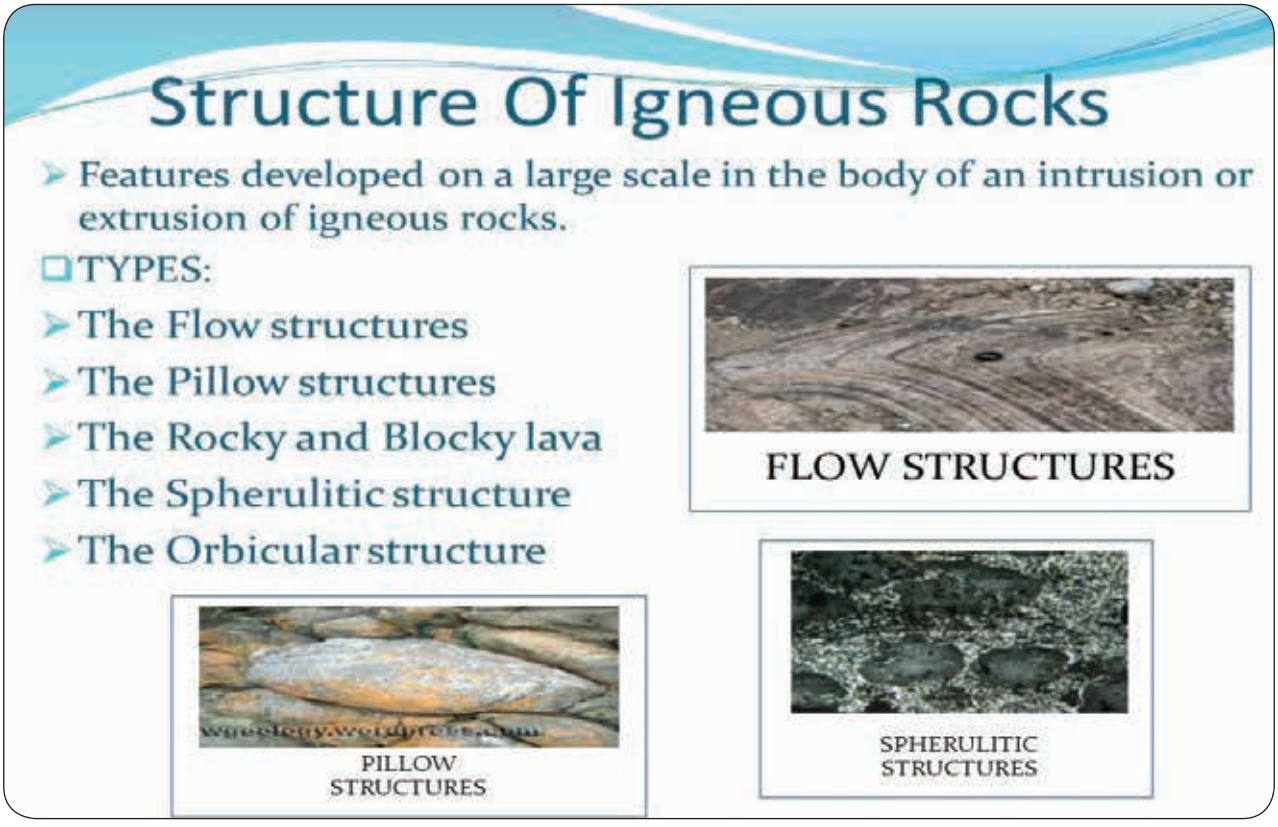
101 What is the concentration factor?

A rock containing economic concentrations (reserves) of metallic minerals is known as an ore. Metals are uneconomical to produce in their natural concentrations in the crust. The concentration factor is the degree of concentration necessary to for economic mining. The degree of concentration is dependent upon the quality and quantity of the ore body, mining costs, and the market price of the mineral. Metals such as copper are concentrated between 50 to 200 times normal levels in commercial mines. Rare, expensive minerals (e.g., gold) have concentration factors measured in the thousands.

102 **What are the various types at structure in igneous rock?**

The structures are:

1. flow structure
2. Pillow structure
3. ropy and blocky lava
4. Spherulitic structure
5. Orbicular structure



103 **Rocks seem very strong. Can wind and water break them and wear them down?**

Absolutely! Wind, water, and ice are erosional forces that can have a dramatic effect on rocks and soil, particularly over great expanses of time. Even minute, imperceptible changes can become enormous changes when they continue over millions of years. Weathering, erosion, and deposition are forces that constantly change and reshape Earth's surface.

104 **Once a rock is made, can it ever change?**

Yes. Through the rock cycle, each of the major rock groups—igneous, sedimentary, and metamorphic—can be transformed into any other type. Sediments from the weathering of any of these three kinds of rock can be compressed to form sedimentary rocks. Igneous rock is made from magma that once might have been any of the three rock types. Finally, both sedimentary and igneous rocks can be transformed into metamorphic rock, and existing metamorphic rock can undergo further changes when exposed to intense heat and pressure under Earth's surface.

105 **Are rocks always heavy and hard to break?**

No. A small piece of rock will weigh less than a larger piece of rock of the same type. A rock's characteristics depend on the minerals that make it up and how the rock was formed. For example, a rock may contain quartz crystals, which are very hard, while calcite or mica in the same rock may be softer and easy to scratch or peel away. Some rocks, such as pumice, are very light and can often float on water. Pumice is made when frothy lava cools quickly on Earth's surface. Rocks that are formed below the ground under high pressure and heat, such as marble, are very dense and heavy.

106 **Does soil turn into rock, or does rock turn into soil?**

Both processes occur as part of the rock cycle. Weathering causes large rocks to break apart into smaller and smaller pieces that eventually become sediment and part of soil. Erosion moves rocks and soil to areas where layers of sediment build up. When these layers of sediment are subjected to pressure over a long period of time, sedimentary rock forms.

107 **Rocks and minerals may look pretty, but are they actually important?**

Yes, they are. Rocks, minerals, and soil are extremely important to all plants and animals, including humans. Plants and some animals live and grow in soil and depend upon minerals in the soil for growth and development. Many animals, including humans, eat plants that have grown in soil. Humans also rely on rocks, minerals, and soil for many things. Almost every product in your daily life requires some kind of mined mineral. For example, aluminum is used to make bicycles, fluorite is used to make the fluoride found in toothpaste, iron and steel are used to make pots and pans used for cooking, clay is used in floor tiles, and so on.

108 **So what is everything made of—elements or atoms?**

Both! For all intents and purposes, elements are the building blocks of all matter, both living and nonliving. Elements are basic substances that combine (in compounds) to make up all matter. Each element is made of only one kind of atom and cannot be broken down into other substances. Each atom of a particular element has a specific combination of subatomic particles that distinguishes it from atoms of any other element.In order of abundance, shale, sandstone, and limestone. Shale is formed from clay, sandstone from sand grains, and limestone from shell fragments or as a chemical precipitate.

109 What distinguishes the various clastic (cemented fragment) sedimentary rocks from one another?

The most common caustic sedimentary rocks are shale, sandstone, and conglomerate. They are distinguished according to grain size, from small (1/16 mm) through medium(1/16 mm to 2 mm) to large (2mm) in the above order .

110 What are well known Sedimentary Structures?

Sedimentary structures : Features within sedimentary rocks produced during or just after sediment deposition. Provide clues to how and where deposition of sediments occurred. **Bedding:** Series of visible layers within a rock, Most common sedimentary structure.
Cross-bedding. Series of thin, inclined layers within a horizontal bed of rock. Common in sandstones. Indicative of deposition in ripples, bars, dunes, deltas.
Ripple marks. Small ridges formed on surface of sediment layer by moving wind or water. **Graded bedding.** Progressive change in grain size from bottom to top of a bed.
Mud cracks. Polygonal cracks formed in drying mud.
Fossils. Traces of plants or animals preserved in rock. Hard parts (shells, bones) more easily preserved as fossils.

111 What are Cycles of Sedimentation?

First cycle. Material is eroded, transported, deposited.
Additional cycles. Burial, lithification, uplift, exposure, transport. Redeposition - second cycle of sedimentation. Increasing clastic detrital textural and mineralogical maturity with each cycle. **Resistant minerals.** Can survive repeated weathering, erosion, transport. Quartz, lithic fragments of chert, zircon (highly resistant).

112 What is breccia ?

The term breccia is used to designate any rock that contains angular particles. Thus sedimentary breccia is a clastic sedimentary rock consisting largely of gravel-sized angular particles; conglomerate is similar but has rounded particles. Volcanic breccia consists of lava fragments that either stuck together while still hot or were cemented together in the same manner as a sedimentary rock. The rock fragments in a fault breccia originated during movement along a fault.

113 Classify Clastic Sedimentary Rocks?

Breccia and Conglomerate. Coarse-grained clastic sedimentary rocks. Sedimentary breccia composed of coarse, angular rock fragments cemented together. Conglomerate composed of rounded gravel cemented together

Sandstone. Medium-grained clastic sedimentary rock. Types determined by composition: 1. Quartz sandstone- >90% quartz grains 2. Arkose- mostly feldspar and quartz grains.

Graywacke - sand grains surrounded by dark, fine-grained matrix, often clay-rich

Shale : Fine-grained clastic sedimentary rock. Splits into thin layers (fissile). Silt- and clay-sized grains. Sediment deposited in lake bottoms, river deltas, floodplains, and on deep ocean floor. Siltstone. Slightly coarser-grained than shales. Lacks fissility. Claystone. Predominantly clay-sized grains; non-fissile. Mudstone. Silt- and clay-sized grains; massive/blocky

114 **What happens to the density of a rock that undergoes metamorphism ?**

The density increases because the pressures under which metamorphism occurs lead to more compact rearrangements of the atoms in the various minerals.

115 **Gneiss is by far the most abundant metamorphic rock. Why? Describe the appearance of gneiss.**

Gneiss is abundant because it can be formed from a wide variety of sedimentary, igneous. and other metamorphic rocks. It is coarse-grained, foliated, and often consists of layers of different mineral composition which lead to a banded appearance larger in scale than the foliation.

116 **Shale is a sedimentary rock that consolidated from mud deposits. What are the various metamorphic rocks that shale can become under progressively increasing temperature and pressure?**

In order of increasing metamorphism. Shale can become slate, schist, and gneiss.
(a) What is the origin of limestone?
(b) What rock does limestone metamorphose into?
Limestone is produced both by consolidation of shell fragments and by precipitation of calcite (calcium carbonate) from solution.

117 **What is the difference between quartz and quartzite?**

Quartz is a mineral whose chemical composition is SiO. Quartzite is a hard rock formed by the metamorphism of sandstone; it consists largely of quartz with micas, feldspars, and garnet also present.

118 **In what rock category does bituminous (soft) coal belong? Anthracite (hard) coal?**

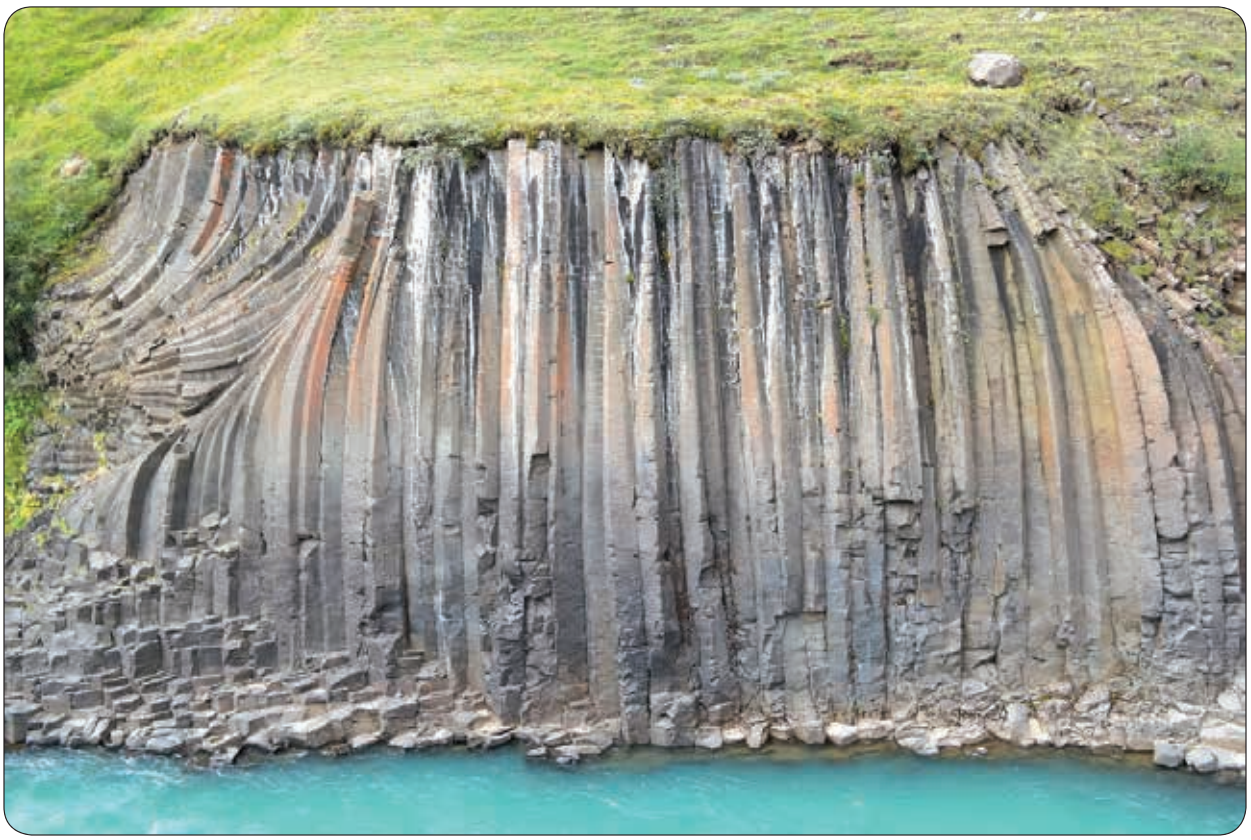
Bituminous coal can be considered as a sedimentary rock, anthracite as a non-foliated metamorphic rock.

119 **How are chemical and mechanical weathering related?**

By breaking exposed rock into small fragments, mechanical weathering increases the surface area of a given volume of rock and so promotes the rate at which chemical weathering occurs. Chemical weathering can also lead to mechanical weathering, since many minerals in which they are incorporated.

120 **What is mean by Master joints?**

The joints always occur in sets and groups. A set of joints means, joint occurring in the same dip or strike. A group of joints means a few sets of joints having almost the same trend. If a few sets or groups of joints appear for a considerable length in a rock, such joints are called major joints or master joints.



121 **What characteristics of a sedimentary rock would suggest an arid climate at the time the original sediments were deposited?**

The presence of well-sorted, rounded sand grains, the absence of clay and gravel, and cross-bedding in large, sweeping curves are characteristic of sediments deposited by winds in desert regions.

122 Is glacier ice a type of rock?

Yes – glacier ice, like granite, is a type of rock. Glacier ice is actually a mono-mineralic rock (a rock made of only one mineral, like limestone which is composed of the mineral calcite). The mineral ice is the crystalline form of water (H_2O). It forms through the metamorphism of tens of thousands of individual snowflakes into crystals of glacier ice. Each snow flake is a single, six-sided (hexagonal) crystal with a central core and six projecting arms. The metamorphism process is driven by the weight of overlying snow. During metamorphism, hundreds, if not thousands of individual snowflakes recrystallize into much larger and denser individual ice crystals. Some of the largest ice crystals observed at Alaska's Mendenhall Glacier are nearly one foot in length.

123 What are the Three V's of Volcanology?

Viscosity, Volatiles, Volume. Viscosity may be low or high Controls whether magma flows easily or piles up. **Volatile** abundance may be low, medium or high. May ooze out harmlessly or explode. **Volume** may be small, medium or large. Greater volume → more intense eruption. Energy Sources for Natural Disasters

124 What are the two types of minerals according to occurrence in an igneous and metamorphic rock?

Igneous and metamorphic rocks are two types of rocks (the third being sedimentary), but each can contain many different "types" of minerals. For example, feldspar is a type of aluminum-silicate mineral, representing a range of chemical compositions variously rich in calcium, potassium, sodium and barium. Different types of feldspar can occur in both igneous and metamorphic rocks. Similarly, both types of rock can contain amphiboles, pyroxenes, quartz and a variety of other minerals. Complicating this is the fact that, through weathering, minerals can change into other minerals; for example, feldspars can break down to various types of clay minerals. So, there are many more than two "types" of minerals that can occur in both types of rock.

125 **Is it possible for two igneous rocks to have the same mineral composition but be different rocks?**

It's actually common. A big part of how we classify rocks is their texture. You can have a granite and a rhyolite, then grind them up and throw them through a mass spectrometer or x-ray defractometer and they would look the same. However, the granite cooled slower, so therefore has larger crystals. Crystal size (and therefore cooling history) plays a huge part in how we name igneous rocks.

126 **What type of rock can turn into an igneous rock?**

Igneous rock are rocks made from volcanism. Sedimentary rocks are formed by the hard parts of biologic organisms, accumulation of sand, silt, clay, calcium carbonates (limestone) and magnesium carbonates (dolomite/dolostone) that forms due to pressure of the materials accumulating at the bottom of the oceans. Time and pressure creates the sedimentary rocks as the oceans transgress and regress due to volume of water changing as temperatures rise (water volume increasing and transgressing) and cool (water volume decreasing due to regressions) forming clastic (quartz dominated) and carbonate (calcium and magnesium dominated) rocks in layers at the bottom of the oceans. Metamorphic rocks take igneous or sedimentary rocks then subject them to high temperature and pressure conditions (ex. when continental plates and oceanic plates collide with the denser plate sub-ducting under the lighter plate. At the boundaries is where metamorphic rocks are formed).

127 How could a metamorphic rock change into a igneous rock?

A metamorphic rock doesn't actually change into an igneous rock, as the process of melting results in a melt, which crystallizes into a completely different kind of rock, rather than a gradual transition in form and mineralogy. If complete melting of the metamorphic rock occurs the original chemical composition of the metamorphic rock determines the kind of igneous rock that results, e.g. a mica schist melts to a granite composition. Anyway, complete melting occurs at a temperature called the liquidus, which depends on pressure. Typically a granite melt forms at 15km or greater depth at temperatures above about 750°- 1,000°C. The temperature also depends on the amount of water bound in the metamorphic minerals; the more water the lower the melting temp. There has been a lot of experimental work on this question.

128 How long does it take for an igneous rock to change to metamorphic?

It depends on the source rock's chemistry, temperature, pressure, time, and uplift. I mean metamorphic rocks are formed in-situ under high temperature and pressure; they're baked and are thus made less viscous. Specific subsurface environments produce specific Chrystal assemblages indicative of the environment in which they form. These crystals may be and typically are unstable. Thus once out of the conditions they caused them to form they alter into a more stable form. Then they are exhumed, and examined in thin section or hand sample, revealing a "story" about where the rocks have been. The crystals and alteration thereof tell us quite a lot about their history by default of geochemistry.

129 What's the biggest meteorite?

The largest known meteorite on earth is the Hoba meteorite which was found in Grootfontein Namibia in 1920 It is estimated to weigh 66 ton and is roughly 9 feet x 9 feet x 3 feet deep and is composed of about 84% iron, 16% nickel, and trace amounts of cobalt and other metals.

130 **What are the 3 types of meteorites?**

Stony Meteorites, Chondrites and Achondrites.

131 **Define Stony Meteorites?**

The majority of meteorite finds are stony meteorites, consisting mostly of silicate minerals. There are two main types of stony meteorite: chondrites (some of the oldest materials in the solar system) and achondrites (including meteorites from asteroids, Mars and the Moon).Both chondrites and achondrites have many subgroups based on their compositions, structures and the minerals they contain.

132 **What is Chondrites?**

At over 4.5 billion years old, chondrites are some of the most primitive and pristine rocks in the solar system and have never been melted. Chondrites have a distinctive appearance, made from droplets of silicate minerals mixed with small grains of sulphides and iron-nickel metal. Their millimetre-sized granules give chondrites their name, from the Greek 'chondres' meaning sand grains.

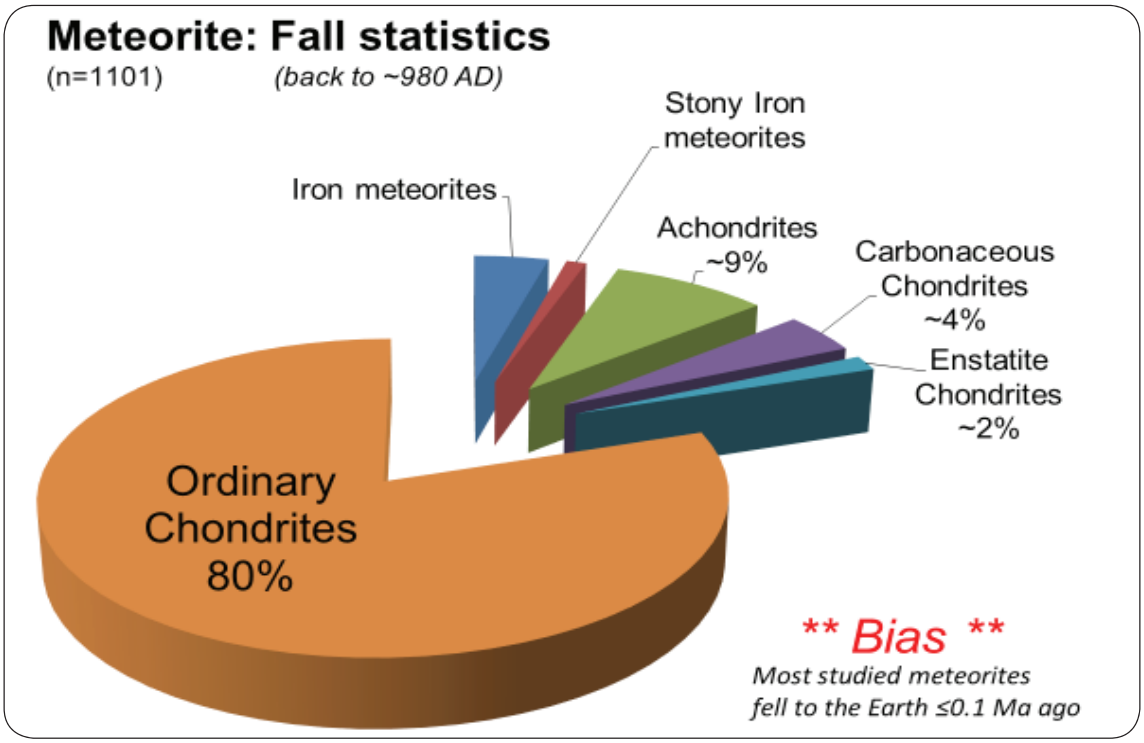
133 **What is Achondrites?**

Achondrites include meteorites from asteroids, Mars and the Moon. They are igneous, meaning at some point they were melted into magma. When magma cools and crystallizes, it creates a concentric layered structure. This process is known as igneous differentiation. The rocky planets Mercury, Venus, Earth and Mars were formed in this way, giving them planetary crusts, mantles and cores. Achondrites can tell us a lot about the internal structure and formation of the planets, including our own.

134 What is Iron Meteorites?

Most iron meteorites are thought to be the cores of asteroids that melted early in their history. They consist mainly of iron-nickel metal with small amounts of sulphide and carbide minerals. During the decay of radioactive elements in the early history of the solar system, many asteroids melted and the iron they contained, being dense, sank to the center to form a metallic core. Meteorites from melted asteroids are also known as differentiated meteorites, as they have experienced major chemical or physical changes, solidifying from a molten state. Sometimes they have an iron core and concentric layers, surrounded by a silicate mantle and crust. This type of structure is very similar to terrestrial planets (Mercury, Venus, Mars and Earth), which also have metallic cores. Iron meteorites can tell us a great deal about how the metallic cores of planets formed.

Iron-Stony Meteorites———Stony-iron meteorites consist of almost equal parts iron-nickel metal and silicate minerals including precious and semi-precious gemstones. They are considered some of the most beautiful meteorites. There are two different types of stony-iron meteorites: pallasite and mesosiderite



135 What is meant by Pallasite and Mesosiderite?

Pallasites contain big, beautiful olive-green crystals- a form of magnesium-iron silicate called olivine- embedded entirely in metal. Sometimes the olivine does not occur as a single crystal but as a cluster. Elsewhere it can create a pattern of veins through solid metal. The scientific jury is still out on exactly how pallasite meteorites formed. Some scientists believe they formed in melted asteroids in a similar way to iron meteorites, where dense iron metal sinks toward the center to form an iron core. Pallasites are thought to be samples of the boundaries between a metal core and the silicate, olivine-rich mantle around it. If this is the case, they could tell us a lot about the formation of Earth and other terrestrial planets.

Mesosiderite meteorites are breccias, a variety of rock composed of broken fragments of minerals or rock cemented together by a finer material. The fragments are roughly centimeter-sized and contain a mix of igneous (solidified) silicate and metal clasts (rocks made of pieces of older rocks). Mesosiderites form when debris from a collision between two asteroids is mixed together. In the crash, molten metal mixes together with solid fragments of silicate rocks. Mesosiderites can therefore both record the history of both meteorites and reveal a snapshot of the conditions required for asteroids to melt and form iron cores.

136 **What are the similarities between asteroids and meteors?**

A lot of meteoroids are asteroids whose orbit in the asteroid belt gets disturbed by some massive object. They then end up spiraling in toward the enormous gravity of the Sun. If they head in on just the right trajectory, the Earth's gravitational pull can capture them. When it does; they enter our upper atmosphere traveling at enormous rates of speed relative to the Earth. The slowest move at about 25,000 MPH (40,233.6 KPH) and the fastest at 160,000 MPH (257,495 KPH). At such speeds, friction with our atmosphere raises their surface temperature rapidly, causing them to melt and burn. We call that phenomenon a shooting star or a meteor. Most burn up or explode while still in the upper atmosphere, but a few are large enough to make it all the way to the ground. These are called meteorites.

137 **Do all types of rocks contain minerals?**

No. The vast majority of rocks are made of minerals. However, the definition of a rock that I remember learning is that a rock is "an aggregate of minerals or mineral-like matter." There is, by design, some built-in ambiguity in this definition; whereas, the definition for a mineral is much more strict. Coal is not made of minerals but is a rock. There also exists naturally occurring asphalt which is also not a mineral but is a rock. Coquina may also be considered a non-mineral rock depending on the definition of organic. These examples and a few others are considered rocks, but do not contain minerals in the strict sense.

138 What is the most toxic mineral?

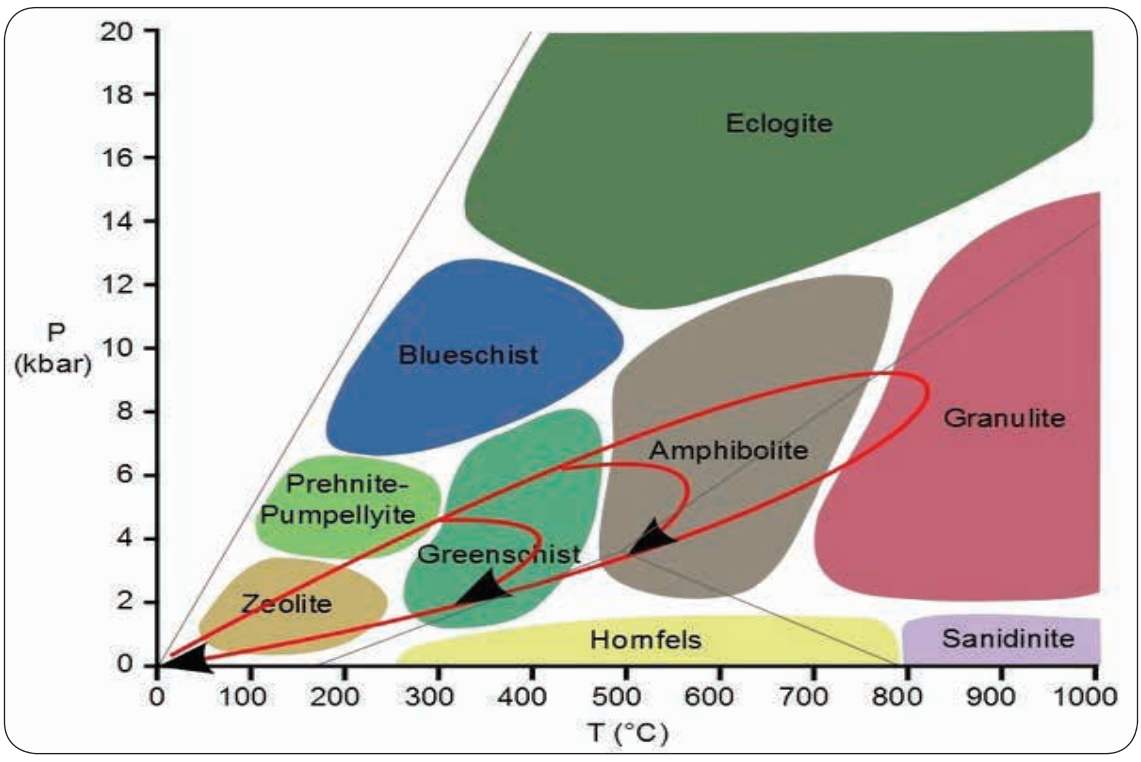
Cinnabar, or better known as mercury sulphide, is the single most toxic mineral to handle on earth. The mineral is the world's main source of mercury and has been mined as far back as the Neolithic Age. Mercury has traditionally been used as a pigment for ceramics and tattoos, though in the modern age, it's been employed in a wide variety of scientific equipment, as well as a number of heavy industrial applications, not to mention the mercury switches that help modern electronics work.

139 Why are fossils found in sedimentary rocks?

Sedimentary rocks can contain fossils because, unlike most igneous and metamorphic rocks, they form at temperatures and pressures that do not destroy fossil remains. Dead organisms can become sediments which may, under the right conditions, become sedimentary rock.

140 Can igneous rocks turn into metamorphic rocks?

All rocks that are heated under pressure can undergo metamorphism. If they reach melting point it's game over, because they're now magma. When that cools it becomes an igneous rock. Here's a graph showing the kinds of metamorphic mineral assemblages created under varies temperatures and pressures:



141 Is the igneous rock stronger than metamorphic rock?

Both igneous and metamorphic rocks are stronger than sedimentary rocks. In the case of igneous rock it directly crystallizes from a melt and hence chances of inborn fractures or voids or other structural weakness are less. But it also depends on the lattice structure of the individual crystals in the rock. In the case of a metamorphic rock, it is a transformation of the original crystals and minerals to a new mineral. Metamorphic rocks tend to have schistosity, gneissic texture or a plane of weakness on the least stressed direction. So metamorphic rocks even though strong tend to have one plane along which it would be vulnerable. In summary based on the above Igneous rocks are stronger than metamorphic rocks.

142 What would happen if the rock cycle stopped?

Stone manually breaks into sharper one is a kind of weathering. “weathering” is in the rock cycle. Moving sand or soil using a black hole to change the landscape is one of transportation. “transportation” also part of the cycle too. If the rock cycle stopped, you cannot do anything. Rocks will be indestructible. No erosion. No deposition. No crystallization. No plate tectonics. No volcano. No earthquake. And no technology, building, tools, and civilization. Sand will stick together, you wouldn’t be able to play it. And last, No more known Earth.

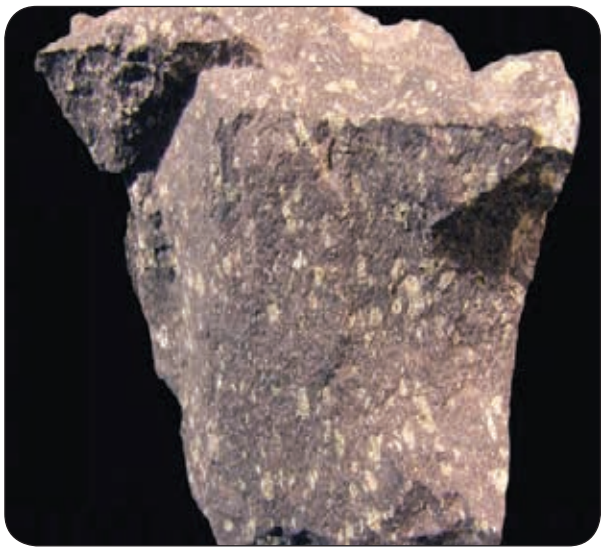
143 What is kimberlite, and what are its uses?

- **Kimberlites** are **rare volcanic igneous rocks** which are associated or located within **sills** and **volcanic tubes** deep within the earth's crust.
- They were first discovered in **Kimberley (South Africa)** and are hence named after that **type area**.
- They are also classified as **ultramafic rocks** and are majorly **diamond-bearing** or serve as **hosts** for diamonds.
- They are widely **mined** in **South Africa** and the rest of the world for **diamond extraction** and are also considered as an interesting horizon of study for **petrologists** and **geologists** around the world.

144 What is the major difference between a lamproite and a kimberlite rock?

Kimberlite | rock "Kimberlite occurs in the uplifted centers of continental platforms. In the Kimberley district, South Africa, it forms pipes (funnels, more or less oval in cross section, that become narrower with increasing depth) and, occasionally, dikes.

Lamproite (a source rock for diamonds) "Both kimberlites and some lamproites may contain large volumes of rounded olivine crystals (macrocrysts) that originated from the upper mantle underlying the Earth's crust. Rocks containing high volumes of these olivine crystals are often the most rich in diamonds. Kimberlites and lamproites have different chemical compositions and contain different assemblages of minerals.



145 Define Structural Domes and Basins?

Domes are structures in which the beds dip away from a central point. Sometimes called doubly plunging anticlines.
Basins are structures in which the beds dip toward a central point. Sometimes called doubly plunging synclines.

146 Define Joints and Faults?

Joints - fractures bedrock along which no movement has occurred Multiple parallel joints are called joint sets.

Faults- fractures in bedrock along which movement has occurred. Considered "active" if movement has occurred along them within the last 11,000 years. Categorized by type of movement as dip-slip, strike-slip, or oblique-slip.

147 **Sandstone, siltstone, shale. The three rocks are all made up of very, very small sediments. What is the name of the process which takes these compacted sediments and solidifies them together?**

It is called **diagenesis**. Diagenesis occurs in several stages. First, compaction happens as the particles are pressed together by the increasing weight of what is above.

148 **What is Mechanical weathering?**

In **Mechanical weathering**, the process involves only fragmentation or break down of the rock into smaller fragments / pieces. In nature, the physical breaking of rocks are caused by several processes. Waterfalls, landslides during their fall cause extensive breakdown of rocks. Thus gravity contributes to mechanical disintegration of rocks. However, all the processes involve widening of the fractures, resulting in the detachment of blocks surrounded by the weak planes

149 **Explain the term chemical weathering?**

Chemical weathering involves chemical reactions resulting in the alteration of the rock leading to the formation of new alteration products. Water is the best fluid that directly affects rocks by way of Dissolution; Leaching (making porous); Hydration; Oxidation Hydrolysis. etc

150 What is biological weathering?

Biological weathering involves breakdown of rocks by living organisms (Bacteria & fungi). Living organisms release organic acids viz., Oxalic acid; Phenolic acid; Folic acid, Acetic Acid, Humic acid etc.. which cause decomposition of rocks. Some of the microorganisms penetrate into mineral crystals and remove specific ions from the inter layers. Eg: removal of K+ from mica layers by fungi is an example of this type. Man is also responsible for unnatural weathering of rocks for construction of buildings, dams, bridges etc. There are two process which are concerned with the biological weathering are : 1. Bio- physical process 2. Bio- chemical process

151 Explain spheroidal weathering?

It is a complex type of weathering observed in jointed rocks and characterized with the breaking of original rock mass into spheroidal blocks the original solid roc is split into small blocks b development of parallel joints due to insolation. Simultaneously, the chemical weathering processes corrode the borders and surfaces of the blocs causing their shapes roughly into spheroidal contours.

152 Explain pedestal rock?

Pedestal rock: The rock particles, travel along with blowing wind are commonly more concentrated near the surface of the earth than higher up in the atmosphere blasts of wind, therefore , cause more of abrasion near the earth's surface than in the higher horizons. Vertical columns of rocks are thus, more readily worn out towards their lower portions and as a result pedestal rocks or mushroom rocks are formed..

153 **Explain deflation?**

Deflation is the process of simply removing the loose sand and dust sized particles from an area, by fast moving winds. Wind deflation can successfully operate in comparatively dry regions with little pr no rainfall and where the mantle is unprotected due to absence of vegetation.

154 **What is the crystalline structure?**

Explains the geometric shapes that crystals take on when they grow under favorable conditions

155 **Write the difference between luster and streak.**

The color of mineral in powder form is called as **streak**.
the appearance of mineral surface in reflected light is called as **luster**.

156 **What are the various fractures present in a mineral?**

The common types of fractures are even, uneven, conchoidal, splintery, hackly and earthy.

157 **Write any two structure of a mineral.**

Tabular structure, elongated structure, bladed structure, lamellar structure, fibrous structure, granular structure.

158 **Describe the specific gravity of a mineral?.**

In mineralogy, the term specific gravity signifies “the ratio between the density of a mineral and that of water at 4° Celsius”. It has no unit.

159 **What is the chemical composition of feldspar group?.**

In chemical constitution, feldspar are chiefly aluminosilicates of N, K and ca with following general formula: WZ4O8 In which W= N, K, Ca and Ba Z = Si and Al

160 **Explain the phosphorescence characteristics of a mineral.?**

It is similar to fluorescence in essential character but in this case light is emitted by mineral not during the act of exposure to radiation but after the substance is transferred rapidly to a dark place.

161 **List the various types of mica?.**

Light micas : Muscovite , paragonite , lepidolite.
Dark micas : Biotite , Phlogopite , zinnwaldite

162 **List any four uses of clay minerals.**

- Filter in papers
- Manufacture of Ceramics
- Talcum powder
- Filter in paint and Used in rubber Industry.

163 **Do rocks last forever?**

Yes and no. While they seem hard and unyielding, rocks change and break down over time through the processes of weathering and erosion. Even large mountains are eventually weathered away. However, the material that makes up rocks is never lost. Small parts or particles of rocks can undergo changes through the rock cycle, and form new rocks.

164 **How will you distinguish the three kinds of rocks?**

- The igneous rocks are characterized by its hard, compact, massive, interlocking and strong structure.
- The sedimentary rocks are characterized by it bedded or layered structure.
- The metamorphic rocks are characterized by its banded or foliated structure.

165 **What are the various types of sedimentary structure?**

Mechanical structure: i. Stratification or bedding ii. Lamination and cross bedding iii. Ripple marks iv. Rain marks v. Joints land cracks.
Chemical structure: i. Concretionary structure ii. Oolitic structure iii. Geode structure
Organic structure : i. Foot print of animals ii. Leaf impression of plants iii. Markings of insects

166 **What are the three size classes for clastic sediments?**

Clastic sediments are divided into large grain-size particles(gravel), medium grain-size (sand), or fine grain-size (mud, silt, clay).

167 **What are the factors allowed in texture of sedimentary rocks?**

The factors are: i. Origins of Grains ii. Size of grains iii. Shape of grains iv. Packing of grains v. Fabric of grains vi. Crystallization trend.

168 **Define the following term: i. Rudites ii. Arenites iii. Lutites?**

Rudites: There are also called rudaceous and include all coarse grained rocks of heterogenous composition.
Rudites are made p of bounders, cobles and Pebbles collectively known as gravels.
Arenites: These are also called arenaceous rocks. These are made up to sediments of sand grad (2 mm- / 16 mm)
Lutites: These are also called argillaceous rocks. It may be defined as sedimentary rocks of the finest grains size.

169 **Define conglomerates:?**

These are sedimentary rock at clastic nature and also belong to rudaceous group. They consist mostly of rounded fragments of various sizes but generally above 2mm. Cemented together is clays or mixed matrix.

170 **What is mean by folds?**

The earth's crust is tilted out of the horizontal and is bent into folds. Such a fold may ranges from a microscopic crinkle to great arches and troughs even up to 100 kms across. A set of such arches and troughs is called a fold.

171 What is mean by Anticline and Syncline?

When the beds are unfolded in an arch-like structure, it is called an anticline. When the beds are down folded in trough like structure, it is called a Syncline. It may be noted that in an anticline the oldest rock is in the center, where as in a syncline the youngest rocks is in the center

172 Explain Causes of folding?

The interior of the earth is getting cooler and cooler day by day, which is sure to Cause some shrinkage in the earth's crust. This stink age is responsible for the Compressive and shearing stress to be developed within the earth's crust. Some time these stresses are small in magnitudes but go on exerting pressure for a sufficient length of time and result in buckling or folding of the layers of the earth's crust.

173 Which Organics in Sedimentary Rocks?

Coal. Sedimentary rock forming from compaction of partially decayed plant material. Organic material deposited in water with low oxygen content (i.e., stagnant).
Oil and natural gas. Originate from organic matter in marine sediment.
Subsurface "cooking" can change organic solids to oil and natural gas.
Can accumulate in porous overlying rocks.

174 Why is continental crust felsic, not mafic?

Most magma is generated by melting the mantle (makes a mafic melt) but we see a whole range of compositions from mafic to felsic.

How do we get different compositions? This is due to : Crystallization (differentiation), Assimilation and Magma mixing.

175 Explain the Causes of Faulting?

The interior of the earth becoming cooler day by day, which is sure to cause some shrinkage in the earth's crust. This stink age is responsible for the stress to be developed within the earth's crust. These stresses, when greater in magnitudes exert so much pressure that the layers of the earths crust are fold due to compressive stresses and after wards when the stresses are released, fractures are formed. If the stresses still continue, the blocks move up or down along the fault plane depending upon the direction of stresses and their intensity. Such a fracture, along which a movement has taken place, is called a fault.

176 What are Metamorphic Textures?

Textures are small-scale penetrative features. Relict Textures

- Inherited from original rock
- "Blasto-" = relict
- Any degree of preservation
- Pseudomorphs of minerals or pre-metamorphic textures/structures

177 **What are the criteria for the recognition of a fault?**

- Discontinuity of strata
- Repetition and omission of strata
- Physiographic features
- General.

178 **What is mean by Joints?**

When sufficient tensile stress in developed between two successive points, a crack is developed at right angle to the direction of the stress, such cracks are called joints.

179 **What is meant by Schistosity?**

A preferred orientation of inequaint mineral grains or grain aggregates produced by metamorphic processes. Aligned minerals are coarse grained enough to see with the unaided eye. The orientation is generally planar, but linear orientations are not excluded

180 **Define out crop?**

A little consideration will show that the out crop of a rock is affected by the angle of dip also. If a rock has a vertical dip then the outcrop will be less, than that when the same rock is dipping at some angles.

181 **What are the different forms of out crops?**

Rock outcrops give us important information about geological structures, rock types and past processes. Good outcrops are key to geological mapping and understanding local geological history.
a) Outlier, b) Inlier, c) Unconformity, d) Overlap, e) Cross bedding.

182 **Define over lap?**

An over lap is particular type of an unconformity, in which the overlying strata extends so as to over lap the underlying strata.

183 **What is the Chemical Composition of Magmas?**

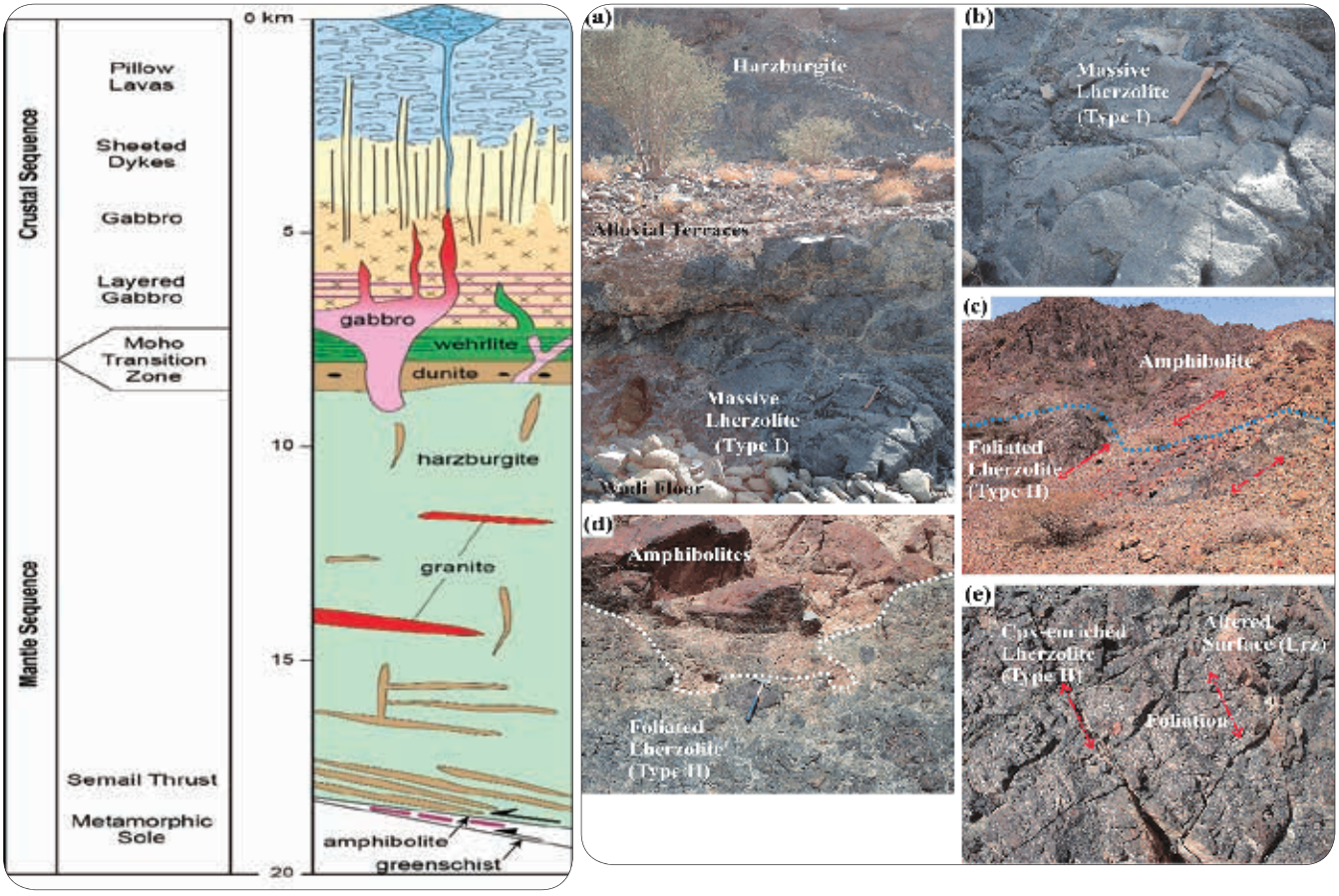
A preferred orientation of inequaint mineral grains or grain aggregates produced by metamorphic processes. Aligned minerals are coarse grained enough to see with the unaided eye. The orientation is generally planar, but linear orientations are not excluded

184 **What are the classifications of joints?**

a) **Geometrical classification**, Stricken joints, Dip joints, Oblique joints
b) **Genetic classification**, Tension joints, shear joints

185 What is meant by Ophiolites and how is formed?

Ophiolites are suites of temporally and spatially associated ultramafic, mafic, and felsic rocks that are interpreted to be remnants of ancient oceanic crust and upper mantle. Ophiolites show significant variations in their internal structure, geochemical fingerprints, and emplacement mechanisms. These differences are controlled by (1) the proximity, when formed at the magmatic stage, to a plume or trench; (2) the rate, geometry, and nature of ocean-ridge spreading; (3) mantle composition, temperature, and fertility; and (4) the availability of fluids.



Field photographs of the Sarami basal peridotites from the central Oman ophiolite.

186 **Distinguish between concordant and discordant bodies of intrusive rock . Give examples of each class ?**

A concordant pluton is intruded between older rock beds and hence lies parallel to them sills and laccoliths are examples.

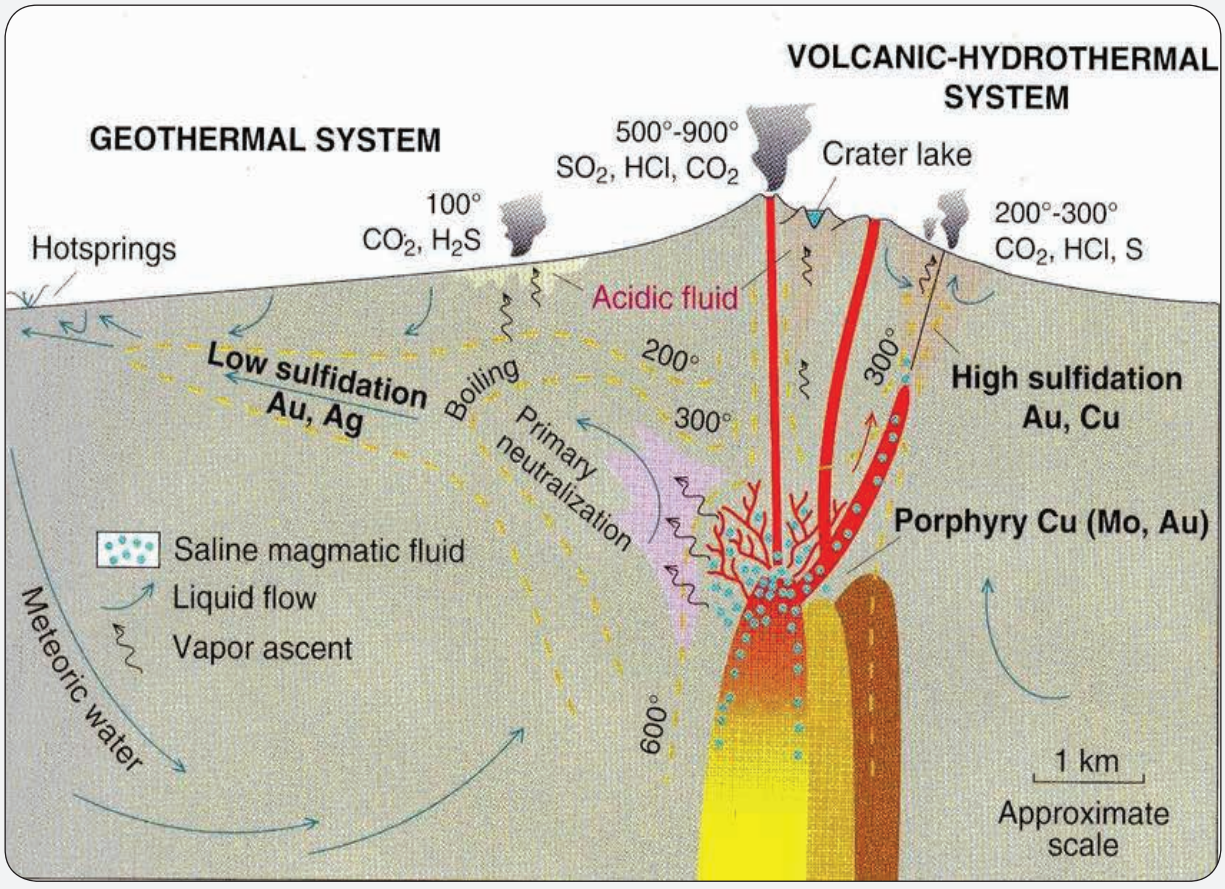
A discordant pluton cuts across older rock beds dikes and batholiths are examples.

187 **masses of igneous rock are found to intrude the folded sedimentary and metamorphic rocks of large mountain ranges. What does this suggest about the time sequence of the various events in the formation of these ranges ?**

The first phase was the deposition of sediments in a geosyncline and their hardening into rocks then the folding and raising of the sedimentary layers, and finally the intrusion of plutons.

47

Questions & Answers in Geochemistry



Introduction

The composition of rocks, ores and minerals is often investigated to determine their content of economically interesting substances, such as metals and precious metals. Geochemistry is an important field in the study of mineral deposits because mineralization involves several processes, of which chemical processes are the ones that finally result in the precipitation of metals or formation of minerals. Studying the geochemical characteristics of mineral deposits is, therefore, important in: (a) understanding ore genesis (the usage of term 'ore' here does not necessarily mean a mineral deposit that can be exploited at an economic profit); (b) mineral deposit classification; (c) mineral exploration; (d) extractive metallurgy or mineral processing; and (e) geo-environmental studies. Knowledge of ore genesis is important in developing geo environmental models for mineral deposits.

1 What is Geochemistry?

Geochemistry is a tool to answer fundamental questions about earth and environmental materials- What is this made of? How does this behave, both naturally and in interaction with humans? What can this tell us about the earth's history, and humanity's interactions with the environment? Geochemistry is crucial to addressing many of the most pressing questions facing humanity, such as air, water, and soil quality, energy resources, and environmental health.

2 Why is it difficult to date clastic sedimentary rocks by radiometric methods?

A **clastic sedimentary rock** consists of fragments of that rocks that have become cemented together. The parent rocks may have been of very different ages since erosional debris is commonly transported for some distance from its origin to the place of deposition . Since the age of a sedimentary rock refers to the time it became lithified. The only relationship between the age of the rock and the ages of the fragments of which it is composed is that the rock is younger than the fragments; but it is seldom possible to say how much younger. Only in a few cases does the cementing material contain sufficient potassium to permit its dating by the potassium argon method.

3 Why is the potassium-argon method more generally useful than the other radiometric methods?

The **half-life** of rubidium 87 is 47 billion years, so the rubidium-strontium method can only be used to date extremely old rocks. Potassium 40 has the more suitable half-life of 1.3 billion years and is a much more widespread constituent of minerals than uranium. Such common minerals as the micas, the feldspars, and hornblende all contain sufficient potassium to permit their dating by the potassium-argon method.

4 **What are the two basic conditions that must be met by a radioactive nuclide in order that it be useful in dating a particular kind of rock?**

The nuclide must occur in at least one of the minerals fund in the rock, and it must have a half-life that is roughly comparable with the age of the rock (within a factor of 10 to 100 . depending upon the details of the situation) .

5 **Who is Victor Moritz Goldschmidt?**

Goldschmidt (1888 - 1947) is a Swiss mineralogist and geologist is considered the father of geochemistry. His major achievement is the so-called Goldschmidt geochemical classification of the elements. He contributed significantly to the roles of ionic size, coordination and atomic substitution in crystal lattices. He gave a practical definition for the science geochemistry, as it deals with: 1. the abundance of elements in rock, mineral or crystal 2. the distribution of the elements, and 3. lows governing the abundance and distribution of elements in rock, mineral or crystal.

6 **Briefly, discuss the Goldschmidt Classification of the Elements?**

Goldschmidt (1929; 1937) used various chemical considerations to classify elements **as lithophile** (coined from the Greek for "rock-loving," indicating it is found in silicates), s**iderophile** ("iron-loving," therefore partitioning into the Fe-rich metal of planetary cores**), chalcophile** ("copper-loving," meaning it is found in sulfides, like Cu), and a**tmophile** (gas-loving). The Goldschmidt classification of the elements derived predominantly from the distribution of elements between the various mineral phases that make up meteorites, but it can be predicted to a large extent from the standard-state Gibbs free energies of formation of the oxide $(\Delta_f G^\circ_{(Ox)})$ and sulfide $(\Delta_f G^\circ_{(S_{ulf})})$ of the element in its lowest commonly encountered nonzero valence state.

7 What is Geochemical classification of Elements?

Geochemists classify elements in various ways based on their abundance, behavior, and distribution in the Earth. Elements can be qualitatively classified into **major** (>0.4 wt%), **minor** (0.1–0.4 wt%), and **trace** elements (<0.1 wt%). Major elements are those that define the primary structure of a given phase, which can be a mineral, liquid, or vapor. Major elements are abundant enough that they dictate a system's physical properties, including the assemblage of phases. Trace elements are not essential to the structure of a phase and do not directly influence the properties of a phase or system

8 What are Goldschmidt's Rules and Ringwood's modifications?

- The ions of one element can extensively replace those of another in ionic crystals if their radii differ by less than approximately 15%.
- Ions whose charges differ by one unit substitute readily for one another provided electrical neutrality of the crystal is maintained. If the charges differ by more than one unit, substitution is generally slight.
- When two different ions can occupy a particular position in a crystal lattice, the ion with the higher ionic potential forms a stronger bond with the anions surrounding the site.

Ringwood (1955) proposed the modifications to explain discrepancies with respect to the first three Goldschmidt rules. For example, Na+ and Cu+ have the same radius and charge, but do not substitute for one another.: His modifications as follows :

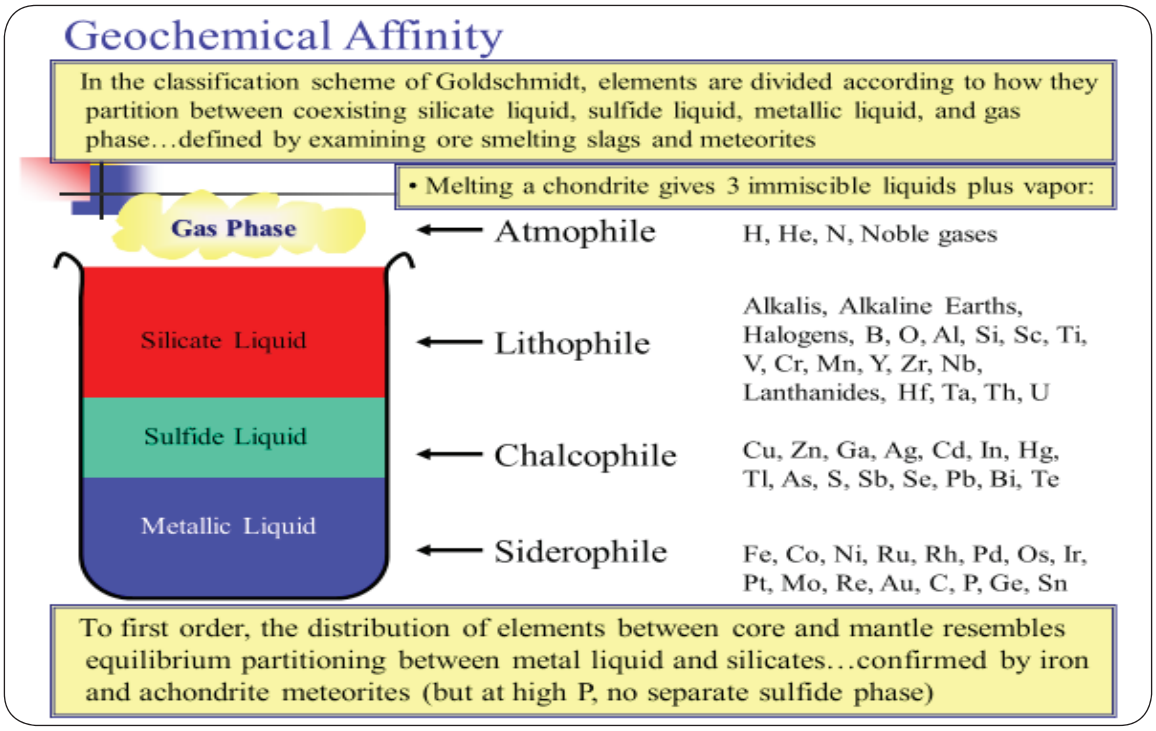
- *Substitutions may be limited, even when the size and charge criteria are satisfied, when the competing ions have different electronegativities and form bonds of different ionic character.*

9 What is Chalcophile?

The term **chalcophile** (derived from the Greek for copper-loving) was originally introduced by Goldschmidt (1923) to describe the group of elements that are concentrated in sulfide minerals in meteorites. Traditionally this group is defined as the elements Ag, As, Bi, Cd, Cu, Hg, In, Pb, S, Sb, Se, Te, Tl, and Zn.

10 What are Atmophile elements?

According to Goldschmidt geochemical classification, **atmophile** (literally "gas-loving") are those elements that are extremely volatile, i.e., they form gases or liquids at the surface of the Earth, and they are usually concentrated in the terrestrial atmosphere and hydrosphere. The atmophile elements are Hydrogen (H), Carbon (C), Nitrogen (N), and noble gases, namely Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr), Xenon (Xe), and Radon (Rn).



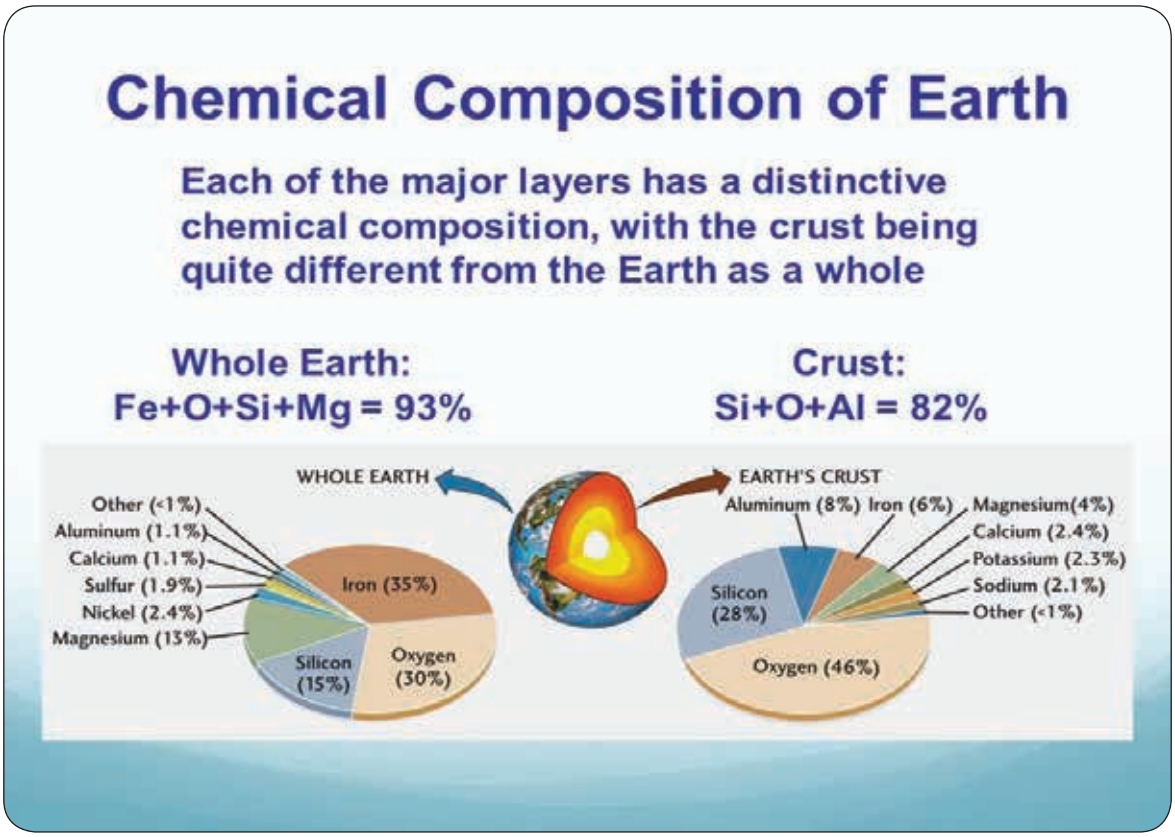
11 Define Fick's First Law?

It is considered that the concentration gradient of elements in mineral and rock resulted from an evidence of diffusion, and the nonequilibrium state was frozen in them. The mobile element found the concentration gradient in material is useful as the tracer to estimate the timescale. The tracer diffuses in a manner to decrease the concentration gradient from the material surface. In such cases, the flux density of species, *i*, in the three dimensions is given by $J_i = -D_i \rho \nabla C_i$.

12 What is the mineral composition of Crust and mantle?

Mantle makes up >2/3 of earth's mass composition approximated by pyrolite.

Mantle		**Crust**
SiO2	45%	60 %
MgO	30-40%	4 %
FeO	8-13%	4 %
Al_2O_3	3%	15 %
CaO	3%	6%
High Mn, Cr, Ti		**Low Mn, Cr, Ti**



13 How Magmatic Differentiation processes affect rock types?

Wide variety of specific reactions happen as igneous, metamorphic, and sedimentary rocks form, change, transport ions, and 'decompose' which result in geochemical differentiation.

In case of Magma composition :

- Hot material in different parts of the mantle?
- Melts some rocks into it – interacts with surrounding material (Partial Melting)
- Fractional crystallization leads to crystals form and get separated form source.

14 Define what is meant by Trace Elements?

A trace element is an element present at concentration too low to significantly affect the phase relations; hence it is a passive agent in the processes determined by the major and minor elements. In particular the behavior of the trace element does not depend on its own concentration (Henry's Law). To use trace elements, we need to know how they are distributed, or partitioned, among phases. Most often this is expressed by looking at the ratio of concentration in a solid phase to concentration in the liquid phase, the partition coefficient

$$D_i = \sum_j f^j D_i^{j/melt}$$

When several minerals are present in the rock, then we can find the bulk partition coefficient by a suitable weighted average of mineral partition coefficients:

$$D_i^{mineral/melt} = \frac{[i]^{mineral}}{[i]^{melt}}$$

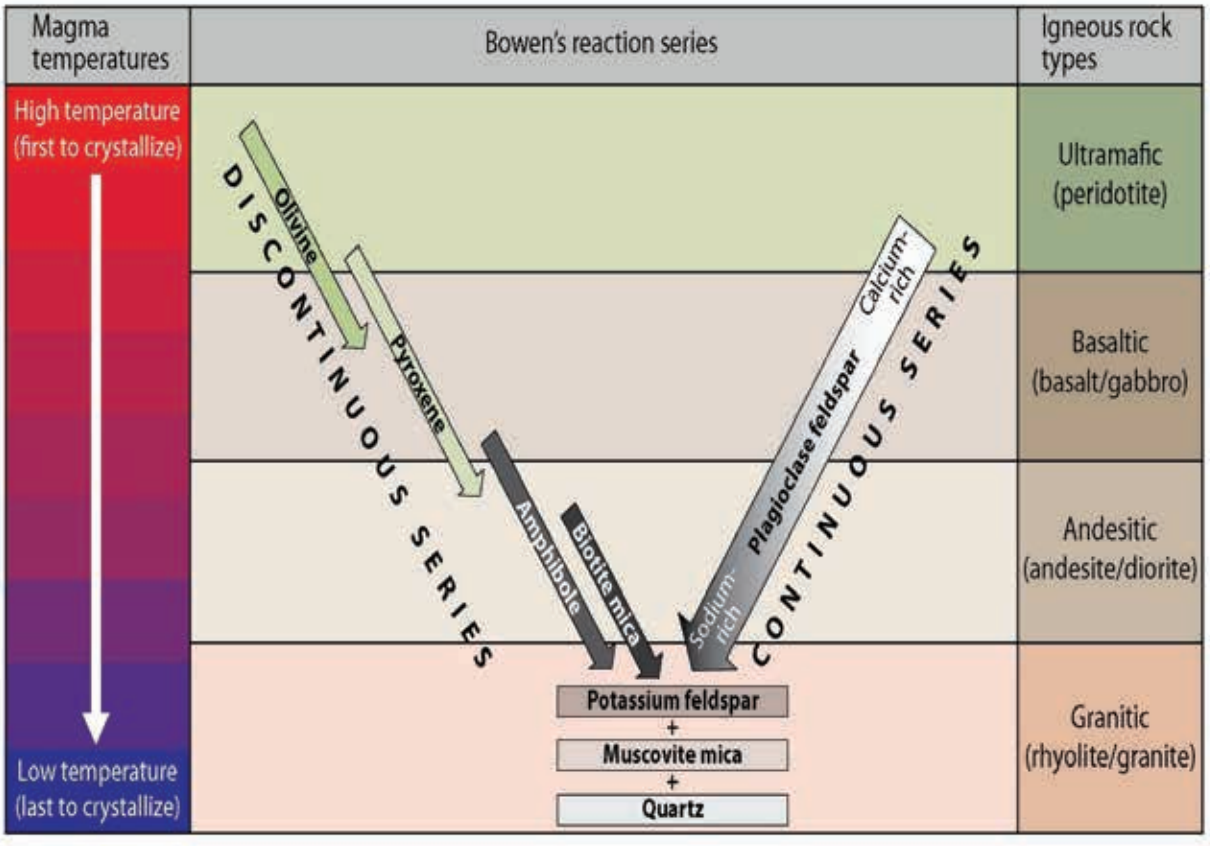
If the bulk partition coefficient < 1, the trace element is termed **incompatible**.
If the bulk partition coefficient > 1, the trace element is **compatible.**

15 What are the Processes of chemical differentiation?

- **Partial Melting**: Melting of a different solid material into a hotter liquid
- **Fractional Crystallization**: Separation of initial precipitates which selectively differentiate certain elements. Equilibrium is KEY? Hotter temperatures mean faster kinetics
- **Melting**: First bit to melt from a solid rock is generally more silica-rich. At depth in the crust or mantle, melting/precipitation is a P-T process

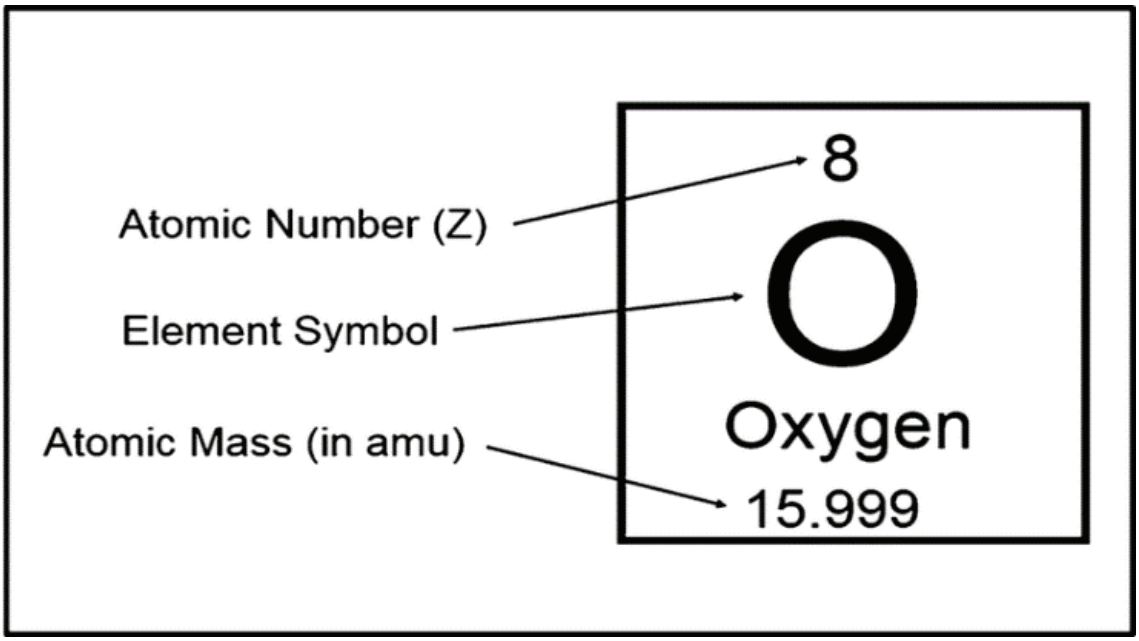
16 Discuss Bowen's reaction series?

Bowen's reaction series is a means of ranking common igneous silicate minerals by the temperature at which they crystallize. Minerals at the top have a relatively high crystallization temperature, which means that they will be the first minerals to crystallize from a magma that is cooling. IF they are chemically compatible with the magma as it continues to cool, they will grow larger by addition of external layers of additional material. They then may become the phenocrystsal in a porphyritic igneous texture. If they are chemically incompatible, they will react with the melt. What ultimately determines this chemical compatibility is in large part the total silica content of the melt. Generally, Minerals which form are thus a function of melt composition and how fast they cool (re-equilibration?)



17 Define the relations between Atomic No. and Atomic mass?

The term **atomic number**, conventionally denoted by the symbol *Z*, indicates number of protons present in the nucleus of an atom, which is also equal to the number of electrons in an uncharged atom. The number of neutrons is represented by the *neutron number* (**N**). Because the mass of these nuclear particles is each approximately equal to one unified atomic mass unit (**u**), the sum of the protons plus neutrons is designated as the *mass number* (**A**). The mass of the electron is more than 1800 times smaller than the proton mass and, therefore, can be neglected in calculating the mass number. For any element, the mass number is equal to the atomic weight rounded off to the nearest integer value.



18 What is Electronegativity?

Electronegativity is a measure of the electron attracting power of an atom, or group of atoms, in a molecule. Several electronegativity scales exist, based on different physical properties, but all of them are highly correlated. Electronegativity is used for a variety of purposes in chemistry, providing both an intuitive concept with which to rationalize chemical trends and values that are highly correlated with a number of chemical and physical properties.

19 Which one of the most important petrogenetic processes?

Fractional crystallization is one of the most important petrogenetic processes contributing to the compositional diversity of magmas and associated igneous rocks of the Earth's continental and oceanic crust. N.L. Bowen, brought this mechanism to the fore in the early part of the twentieth century. A multicomponent silicate liquid (melt) undergoes fractional crystallization when crystals precipitated from the melt do not remain in equilibrium with residual melt during crystallization.

20 How many types of trace-element substitution?

There are three types :

CAMOUFLAGE: Occurs when the minor element has the same charge and similar ionic radius as the major element (same ionic potential; no preference.

Zr^{4+} (0.80 Å); Hf^{4+} (0.79 Å). Hf usually does not form its own mineral; it is camouflaged in zircon ($ZrSiO_4$).

CAPTURE: Occurs when a minor element enters a crystal preferentially to the major element because it has a higher ionic potential than the major element.

For example, K-feldspar captures Ba^{2+} (1.44 Å; Z/r = 1.39) or Sr^{2+} (1.21 Å; Z/r = 1.65) in place of K^{+} (1.46 Å, Z/r = 0.68). This requires coupled substitution to balance charge: $K^{+} + Si^{4+} \leftrightarrow Sr^{2+} (Ba^{2+}) + Al^{3+}$

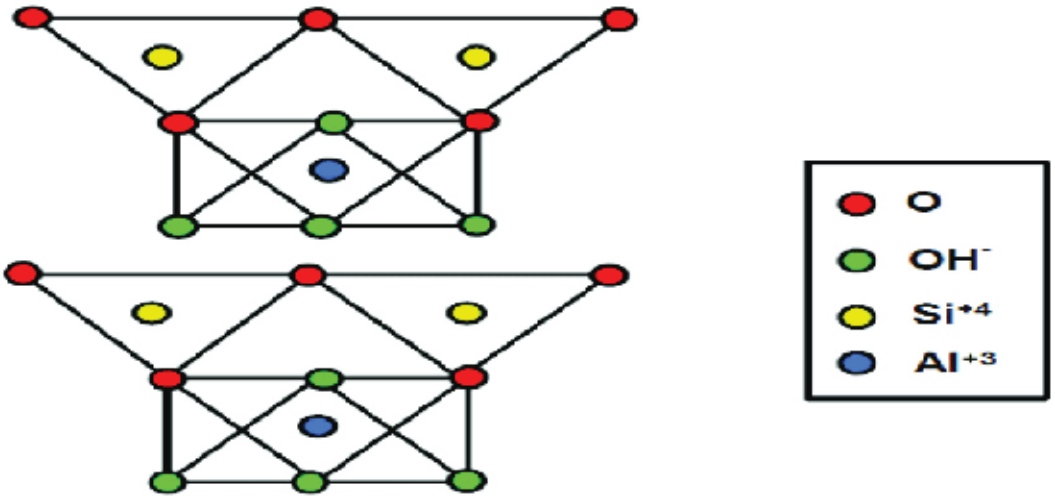
ADMISSION: Involves entry of a foreign ion with an ionic potential less than that of the major ion.

Example Rb^{+} (1.57 Å; Z/r = 0.637) for K^{+} (1.46 Å, Z/r = 0.68) in K-feldspar. The major ion is preferred.

21 How Kaolinite is formed?

The most common alteration product of feldspars is kaolinite, $Al_2Si_2O_5(OH)_4$, which serves as a model for the formation of clays by weathering. The reactions of feldspars to kaolinite illustrate some of the basic trends:

- K, Na, Ca are highly soluble and readily ***leached*** by chemical weathering.
- Excess Si can be removed as silicic acid although quartz is relatively insoluble.
- Al is extremely insoluble, and is essentially conserved as clays.
- Weathering is a hydration process, leaving H_2O bound in the altered minerals.
- **$2\,KAlSi_3O_8 + 9\,H_2O + 2\,H^{+} \rightarrow Al_2Si_2O_5(OH)_4 + 2\,K^{+} + 4\,H_4SiO_4$**
- Note the H^{+} on the left-hand side...only acidic water can drive this reaction



22 **What are causes of Attraction between a particular mineral surface and an ion or molecule?**

This is due to: (1) Electrostatic interaction (unlike charges attract), (2) Hydrophobic/hydrophilic interactions, and (3) Specific bonding reactions at the surface.

23 **What is the different between Sorbate and Sorbent?**

Sorbate: The species removed from solution.
Sorbent: The solid onto which solution species are sorbed.

24 **Define The Sorption and its types?**

Sorption is the Removal of solutes from solution onto mineral surfaces. There are three types of sorption:

1. **Adsorption** - solutes held at the mineral surface as a hydrated species.
2. **Absorption** - solute incorporated into the mineral structure at the surface.
3. **Ion exchange** - when an ion becomes sorbed to a surface by changing places with a similarly charged ion previously residing on the sorbent.

25 Show the reactions of Cation exchange capacity?

CEC is the concentration of ions, in meq/100 g soil, that can be displaced from the soil by ions in solution. Exchange reactions involving common, major cations are treated as equilibrium processes. The general form of a cation exchange reaction is:

$$nA^{m+} + mBX \rightarrow mB^{n+} + nAX$$

The equilibrium constant for this reaction is given by:

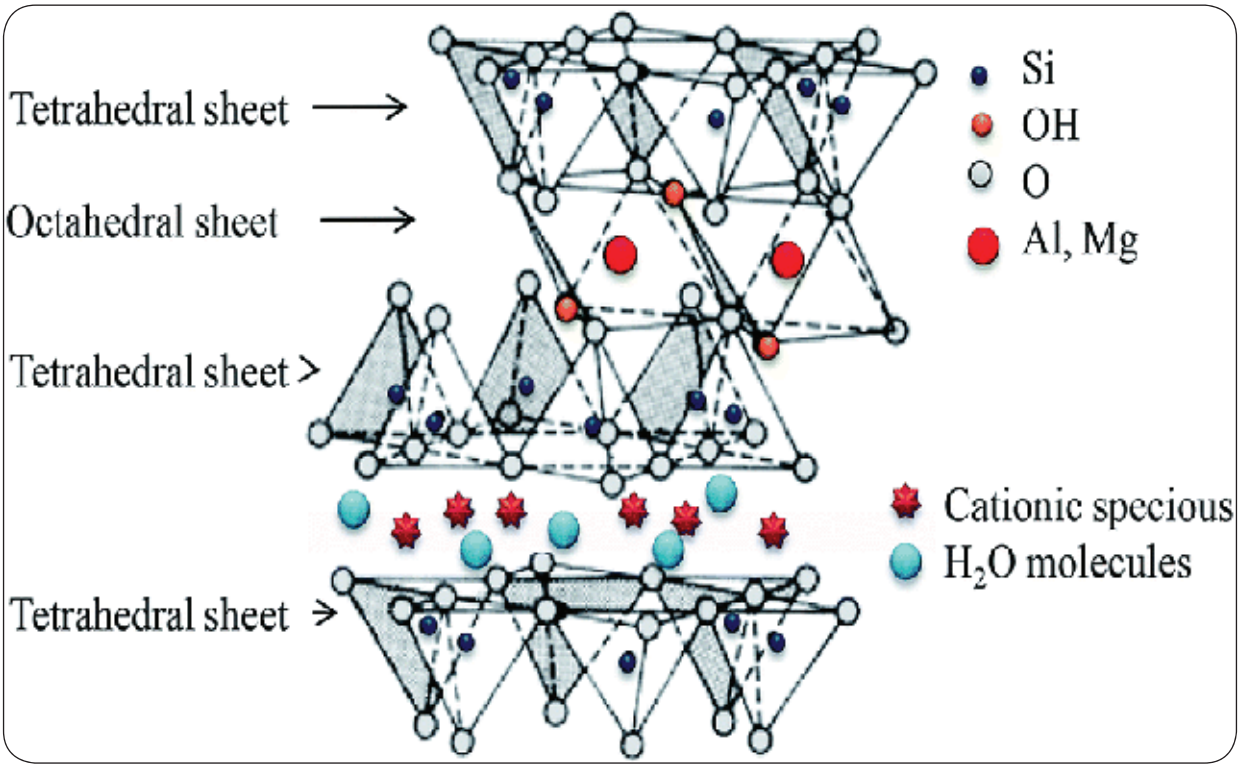
$$K = \frac{a_B^m}{a_A^n} \frac{N_A^n}{N_B^m}$$

26 Describe Clay Minerals?

Clay minerals can be described as hydrated aluminosilicates having grain size less than 4 microns. They are composed of two main structural units namely **tetrahedral** (silica) and **octahedral** (alumina). Clays can have significant chemical substitution, they undergo phase transitions as diagenesis proceeds.

Illite $\rightarrow$ **Smectite +** $Mg^{2+} + Fe^{2+} + SiO_2 + H_2O$

$Al_2Si_4O_{10}(OH)_2 * nH_2O + KAlSi_3O_8 \rightarrow KAl_2(AlSi_3)O_{10}(OH_2) + 4\ SiO_2(aq) + n\ H_2O$



27	**Define Gibbs Free Energy?**

Gibbs Free energy describes the potential chemical energy possible between potential reactants. In battery for instance, the fact that there is x driving force when anode and cathode are in contact provides a certain amount of power → determined by G. Any reaction out-of-equilibrium with the potential to go there can supply energy to organisms.

28 What are the mechanisms of Heat Transfer?

Conduction. Transfer of heat through a material by atomic or molecular interaction within the material.

Radiation. Direct transfer of heat as electromagnetic radiation.

Convection. Transfer of heat by the movement of the molecules themselves. Advection is a special case of convection.

29 What is conductive heat flows?

Heat flows from hot things to cold things. The rate at which heat flows is proportional to the temperature gradient in a material. Large temperature gradient – higher heat flow. Small temperature gradient – lower heat flow.

30 What is the Equilibrium Geotherms?

The temperature vs. depth profile in the Earth is called the geotherm. An equilibrium geotherm is a steady state geotherm. Therefore:

Since this is a second order differential equation, we should expect to need 2 boundary conditions to obtain a solution. A possible pair of bc's is: T= 0 at z = 0, $Q = Q_0$ at z = 0 Note: Q is being treated as positive upward and z is positive downward in this derivation.

31	How does passive sampling of soil vapors compare to other geochemical methods?

Passive sampling is based on the direct detection of vapors emanating from mineralization. Typical compounds include sulfur compounds, alkanes, and methylated organics that result from oxidation-reduction reaction during mineralization. This is different from many other surface geochemical techniques, which look for inorganic compounds. The primary advantages of passive sampling (days) versus short term, "active" sampling (minutes) include the ability of passive techniques to successfully work in soils with low permeability or high moisture, to yield high sensitivity by concentrating the vapors, to work in a variety of ambient conditions and to detect a broader range of compounds than active methods.

32	What impact does the deposit depth have on the success of surface geochemistry?

In theory, the deeper the mineralization, the more sensitive the surface technique needs to be for accurate and sensitive detection. Successful surveys have been conducted over deposits as deep as 600 meters.

33	Can different oxidation states or zonation be separately identified?

This is possible if the mineral sources are chemically different. Integrating sample data from known mineralized zones and background areas (modeling) is critical for success in this application.

34	**Does surface geochemistry also identify the depth to the mineralization?**

Surface geochemical methods primarily delineate the aerial extent of mineralization but do not yield information regarding deposit depth.

35	**Does surface or shallow contamination interfere with results?**

Organic compounds from shallow contamination can be detected but, with the appropriate geochemical method, can be excluded from the final geochemical interpretation.

36	**How does soil type or moisture impact results?**

Sampling with passive techniques integrates signal over time, therefore these impacts are minimized and do not affect results. However, results from active soil gas methods that sample over a very short period of time can be significantly impacted by soil moisture or permeability. AGI's passive sampler uses proprietary engineered hydrophobic adsorbents along with water management techniques that minimize the effects of moisture.

37	**What is the optimal sample spacing?**

This varies with deposit type; a porphyry system may only require one sample per square kilometer, whereas a vein deposit would require closer sample spacing depending on the objectives and deposit model in order to design an effective survey.

38 What evidence is there in favor of the idea that the earth's interior is very hot ? What temperatures are believed to occur there?

Three observations that support the notion of high interior temperatures are :

- Measurements made in mines and wells indicate that temperature increases with depth.
- Molten rock from the interior emerges from volcanoes.
- The outer core is liquid, which means it must be at a high temperature.

The present temperature distribution within the earth is believed to increase fairly rapidly in the mantle from less than 100 C at its top to perhaps 3000 C at the core boundary. The rise is slower in the core, and the temperature at the center of the earth is estimated to be in the neighborhood of 4200C , though this figure is far from being certain.

39 What is the chief factor that determines the viscosity of a magma, that is, how readily it flows? What kinds of landscapes are produced by volcanoes whose lavas have relatively high and relatively low viscosities?

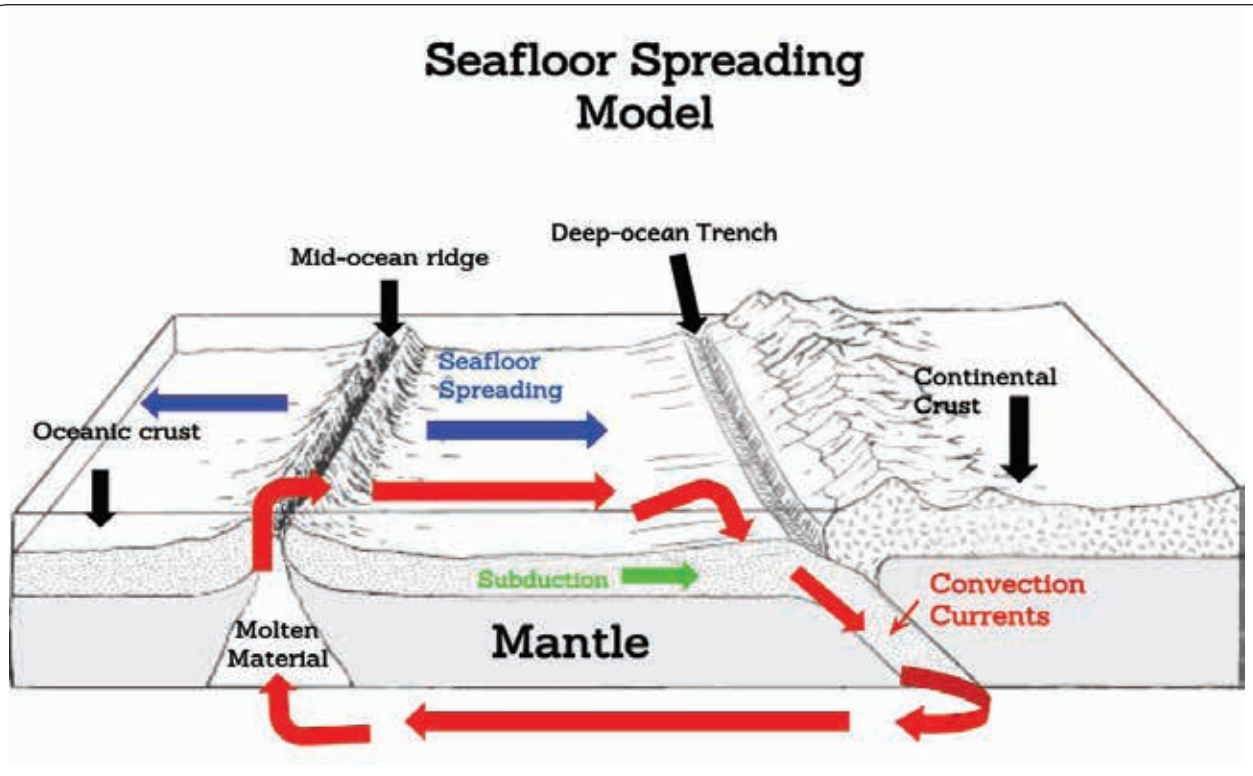
The greater the silicon content of a magma, the higher its viscosity and the less readily it flows. Highly viscous lavas usually produce steep conical mountains and, in general, a rugged landscape; less viscous lavas spread out to produce more even landscapes.

40 What are the three types of magma?

- Basaltic magma
- Andesitic magma
- Rhyolitic magma

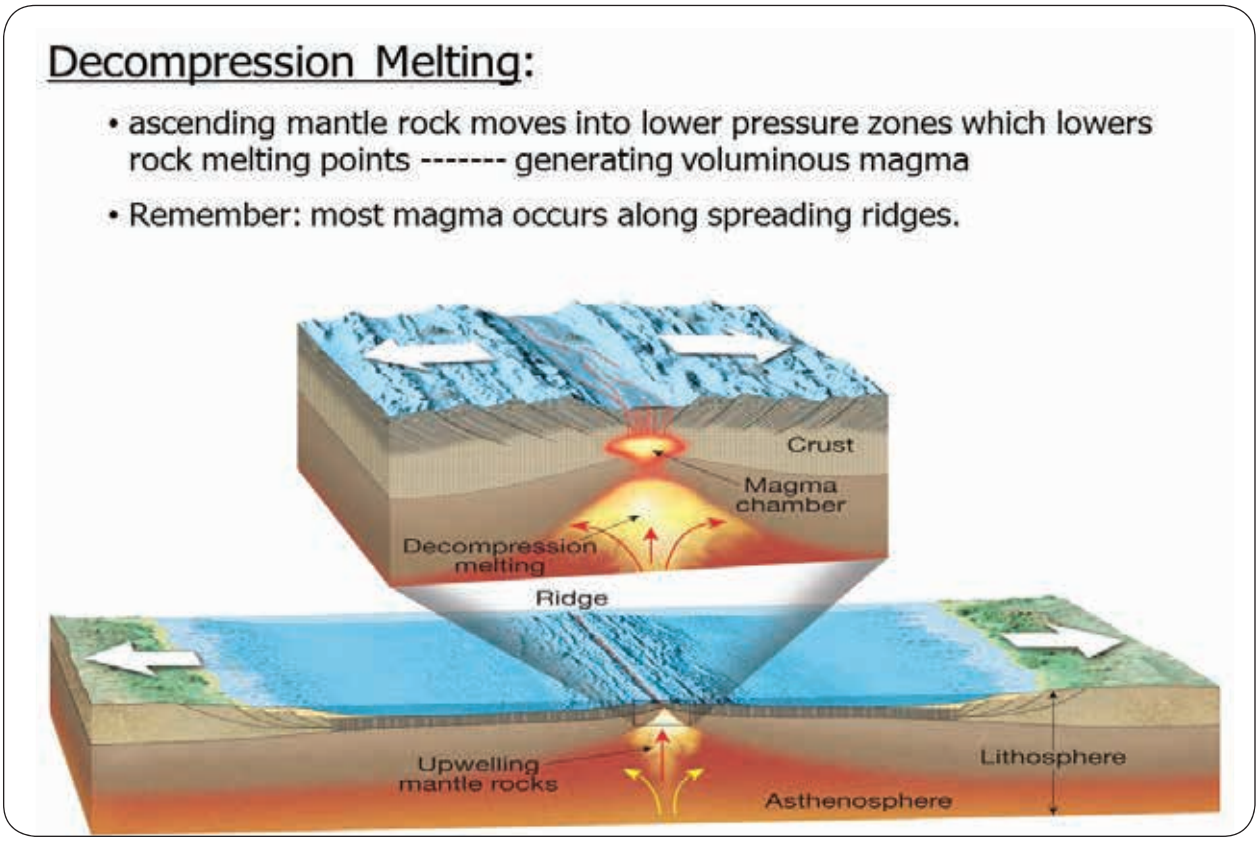
41 How do we measure seafloor spreading today?

By satellite triangulation. The procedure does not differ much from your GPS. That is satellite triangulation. Commercial GPS can be precise to the nearest few meters.
Military systems, that are also used for scientific research, can be exact to a few centimeters.



42	**Describe the three processes that are responsible for the formation of magma.**

Magmas form from melting within the Earth. There are three types of melting: decompression melting, where magmas form when hot rock from deep in the mantle rises to shallower depths without undergoing cooling (the decrease in pressure facilitates the melting process);flux melting, where melting occurs due to the addition of volatiles such as CO_2 and H_2O;and heat transfer melting, where melting results from the transfer of heat from a hotter material to a cooler one.



43 **Why are there so many different compositions of magma? Does partial melting produce magma with the same composition as the magma source from which it was derived?**

Magmas are formed from many different chemical constituents. Partial melting of rock yields magma that is more felsic (silicic) than the magma source because a higher proportion of chemicals needed to form felsic minerals diffuse into the melt at lower temperatures. Magma may incorporate chemicals dissolved from the solid rock through which it rises or from blocks of rock that fall into the magma. This process is called assimilation. Finally, fractional crystallization can modify magma composition as minerals crystallize out of a melt during the cooling process, causing the residual liquid to become progressively more felsic.

44 **Why does magma rise from depth to the surface of the Earth?**

Magma rises toward the surface of the Earth because it is less dense than solid rock and buoyant relative to its surroundings. Buoyancy lifts magma upward through denser rock just as buoyancy lifts less dense Styrofoam upward through denser water. Magma also rises because the weight of the overlying rock produces pressure at depth that literally squeezes the magma upward.

45 **What factors control the viscosity of a melt, and how does viscosity affect the behavior of magma or lava?**

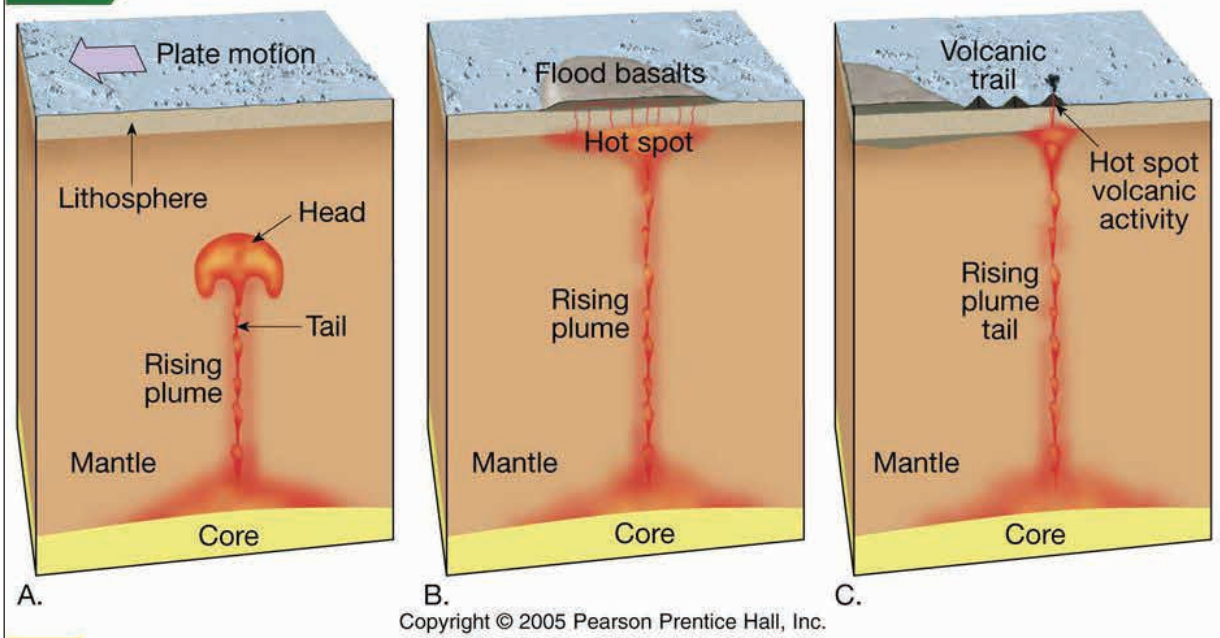
Viscosity in a melt is controlled by its composition (specifically, silica content) and temperature. Temperature affects viscosity because heat causes chemical bonds to break more easily. Therefore, a hotter lava of a given composition is less viscous than a cooler lava of the same composition. Magmas and lavas with higher viscosity are stickier and flow less smoothly.

46 **What factors control the cooling rate of a magma?**

The main factor that affects the cooling time of a magma is how fast heat transfers from the melt into its surroundings. The rate of heat transfer depends on the temperature of the environment in which cooling takes place, the shape and size of the molten mass, and the ability of the surroundings to extract heat.

47 **Hot spots can also cause volcanic activity. These develop because of a concentration of radioactive elements inside the mantle. Where do hotspots occur in a tectonic plate?**

Anywhere. Hot spots are unique in that they form volcanoes that aren't necessarily related to subduction or any other form of tectonic activity. A good example of hot spots is Hawaii. The Hawaiian islands were formed by hotspots in a process that is still ongoing. Kauai, the most northwesterly Hawaiian island, is the oldest island and was formed first, which is evidence that the Pacific plate is moving northwest. Loihi is the name of an underwater volcano in Hawaii, which is believed to be the next island that will be formed.



- **A. Rising mantle plume; B. Rapid decompression melting producing flood basalts; and C. Rising plume tail produced by linear seafloor volcanic chain**

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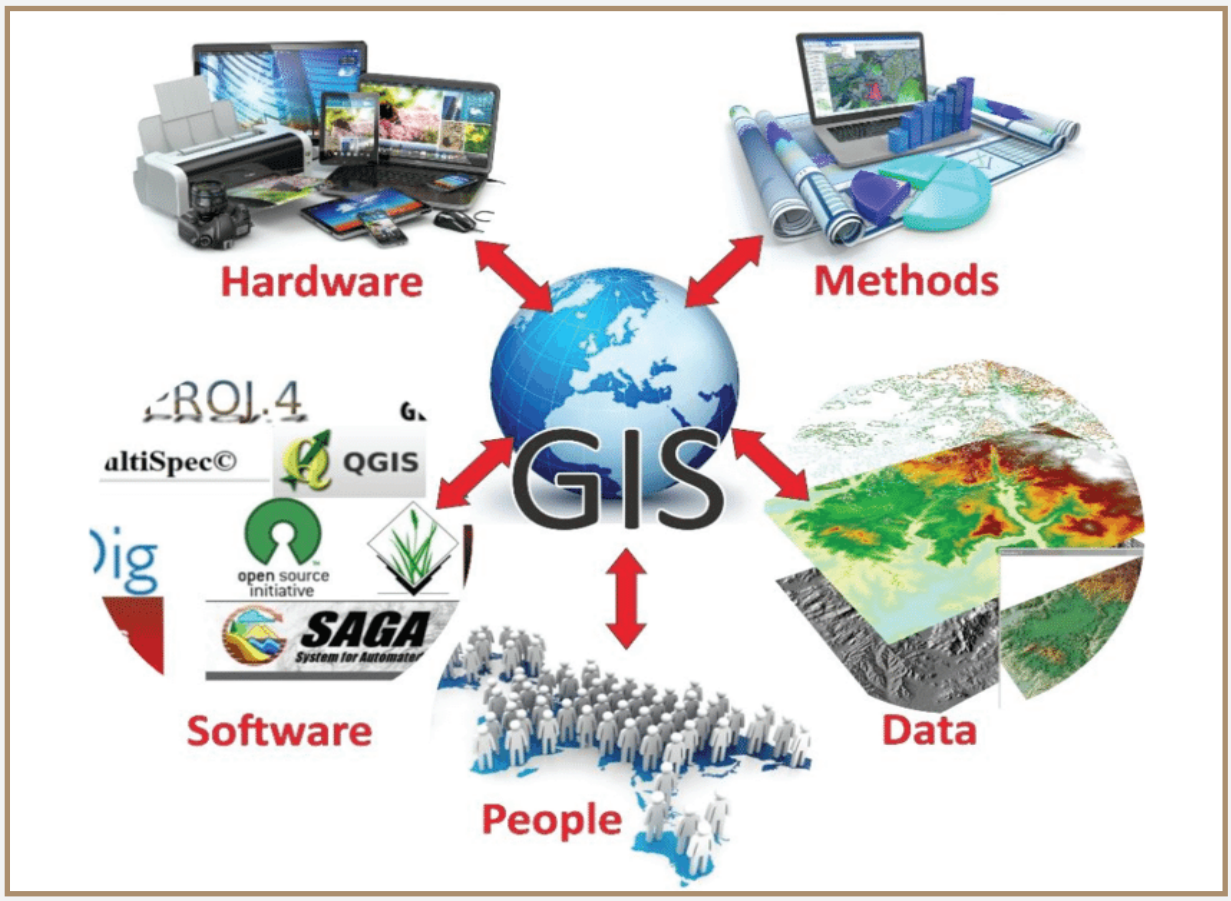
Questions & Answers in Remote Sensing & GIS



Introduction

Geographical Information Systems (**GIS**) and Remote Sensing (**RS**) techniques have emerged as efficient and powerful tools in different fields of science over the last two decades. The GIS has the ability to store, arrange, retrieve, classify, manipulate, analyze and present huge spatial data and information in a simple manner. The RS technique is used to collect detailed information in space and time even from inaccessible areas. GIS offers, GIS Digitization, Geo Referencing & Image Registration, Generation of special Purpose maps, GIS Survey, Contour and Thematic Mapping. **Remote Sensing** is used to take measurements of the earth without making actual contact and with the use of sensors placed on satellites. Remote Sensing offers, Agriculture Mapping, Forestry Mapping, Temporal Mapping, Thermal Mapping, Land Use/Land Cover Mapping.

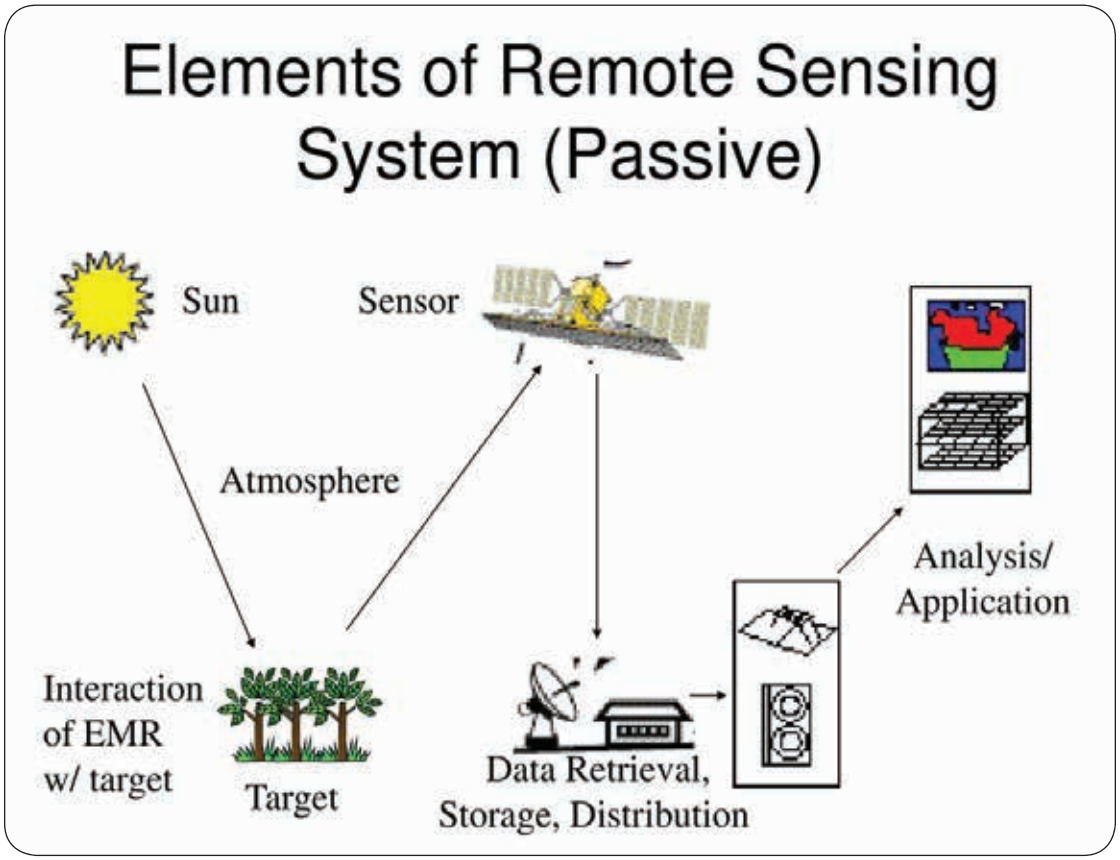
1 What is remote sensing?

Remote sensing is the science of acquiring information about an object or phenomenon by measuring emitted and reflected radiation. There are two primary types of remote sensing instruments -- active and passive.

2 What are types of Remote Sensing?

A. **Passive sensors** respond to external stimuli, gathering radiation that is reflected or emitted by an object or the surrounding space. The most common source of radiation measured by passive remote sensing is reflected sunlight. Popular examples of passive remote sensors include charge-coupled devices, film photography, radiometers, and infrared.

B. **Active sensors** use internal stimuli to collect data, emitting energy in order to scan objects and areas whereupon a sensor measures the energy reflected from the target. RADAR and LiDAR are typical active remote sensing tools that measure the time delay between emission and return in order to establish the location, direction, and speed of an object. The remote sensing data gathered is then processed and analyzed with remote sensing hardware and computer software, which is available in a variety of proprietary and open source applications.



3 What is Remote Sensing Used For?

Remote sensing technology is used in a wide variety of disciplines in thousands of different use cases, including most earth sciences, such as meteorology, geology, hydrology, ecology, oceanography, glaciology, geography, and in land surveying, as well as applications in military, intelligence, commercial, economic, planning, and humanitarian fields.

4 What is the Importance of Remote Sensing?

Remote sensing makes it possible to collect data from dangerous or inaccessible areas, with growing relevance in modern society. It replaces slower, costly data collection on the ground, providing fast and repetitive coverage of extremely large areas for everyday applications, ranging from weather forecasts to reports on natural disasters or climate change. Remote sensing is also an unobstructed method, allowing users to collect data and perform data processing and analysis offsite without disturbing the target area or object. Monitoring floods and forest fires, deforestation, polar bears, chemical concentrations, and earthquakes are just a few cases in which geospatial remote sensing provides a global perspective and actionable insights that would otherwise be unattainable.

5 What is Advantages of Microwave Remote Sensing?

Microwave remote sensing encompasses both passive and active remote sensing, covering wavelengths ranging from one centimeter to one meter-- the microwave's longer wavelength is an important feature in remote sensing as it can penetrate haze, rainfall, dust, and cloud cover more effectively than visible and infrared. Remote sensing of the environment using microwave remote sensing is therefore unaffected as the longer wavelengths are not susceptible to atmospheric scattering. Microwave energy can be detected and data can be gathered under most environmental conditions. Applications include sea ice monitoring and global soil moisture mapping.

6 What are Applications of Remote Sensing to Climate Changes?

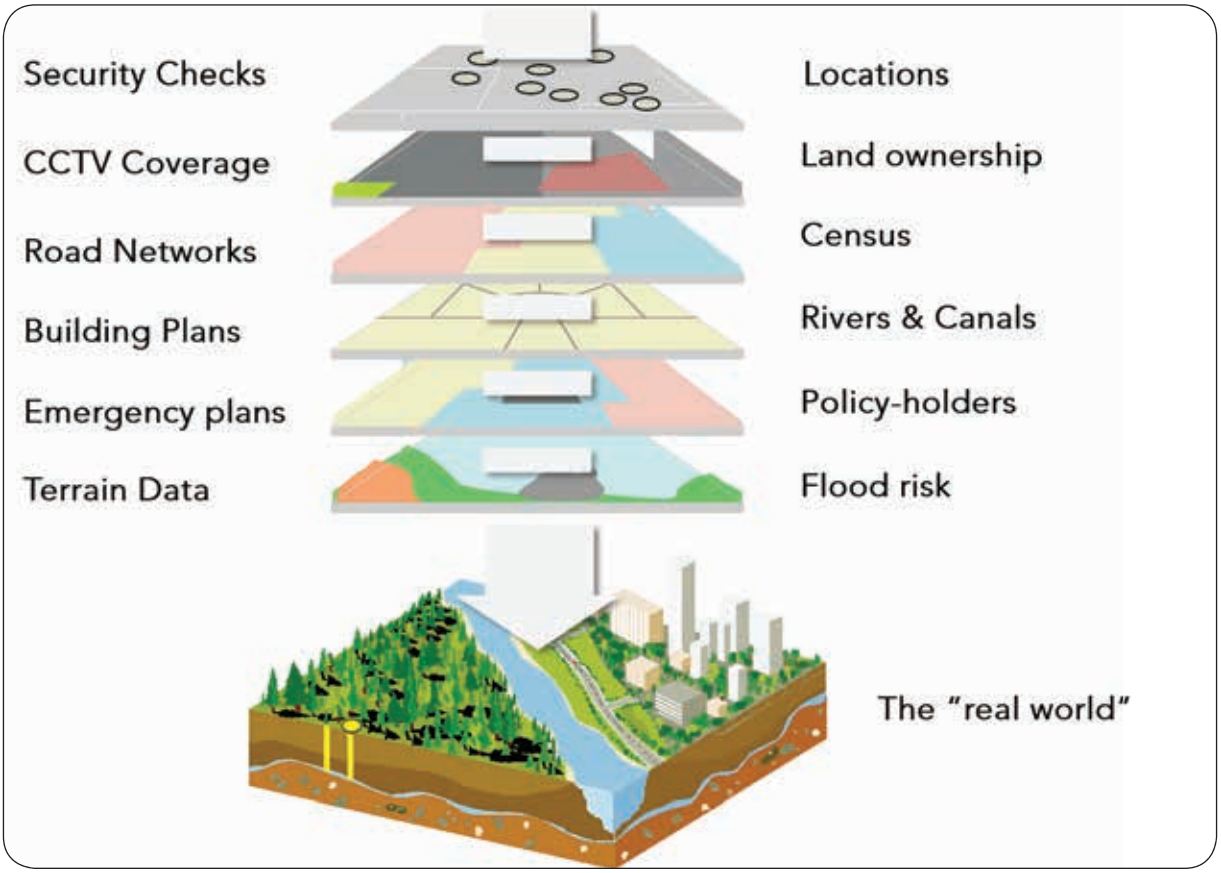
Application of remote sensing in the studies of climate change has provided major advances in understanding the climate system and its changes, by quantifying spatio-temporal states and processes of the atmosphere, oceans, and lands. Satellite sensors have aided in the detection and measurement of the cooling effects of increased stratospheric aerosols and the spatial pattern of sea-level rise, which otherwise went unobserved by conventional climate models observations.

7 What are Limitations of Remote Sensing Data?

Remote sensing is ultimately managed by human operators that make crucial decisions regarding which sensors should be used to collect data and when, resolution specifications for the collected data and sensor calibration, and the selection of the platform that will carry the sensor, all of which expose this method to a certain degree of human error. Inaccuracy may also be introduced by the electromagnetic spectrum radiation emitted from powerful active remote sensing systems, which can be intrusive and affect the target phenomenon being investigated. Remote sensing instruments may contribute inaccurate, un-calibrated data if the hardware system becomes un-calibrated. There may also be cost related limitations. It is an expensive method that requires extensive, special training for image analysis

8 What is the History of Remote Sensing?

The earliest practices of modern remote sensing consisted of primitive photographs of the earth's surface taken from tethered balloons for the purpose of topographic mapping in the 1840s. Systematic aerial photography using modified aircrafts was developed for military surveillance and reconnaissance purposes during the first World War and through the Cold War. With the emergence of the space program in the 1960s, instrumentation on Earth observing and weather satellites such as the Nimbus and Landsat provided global measurements of various data for military, civil, and research purposes. IKONOS, the first commercial satellite built to collect very high resolution imagery, was commissioned .



by Lockheed Martin, launched in 1999, and decommissioned in 2015.

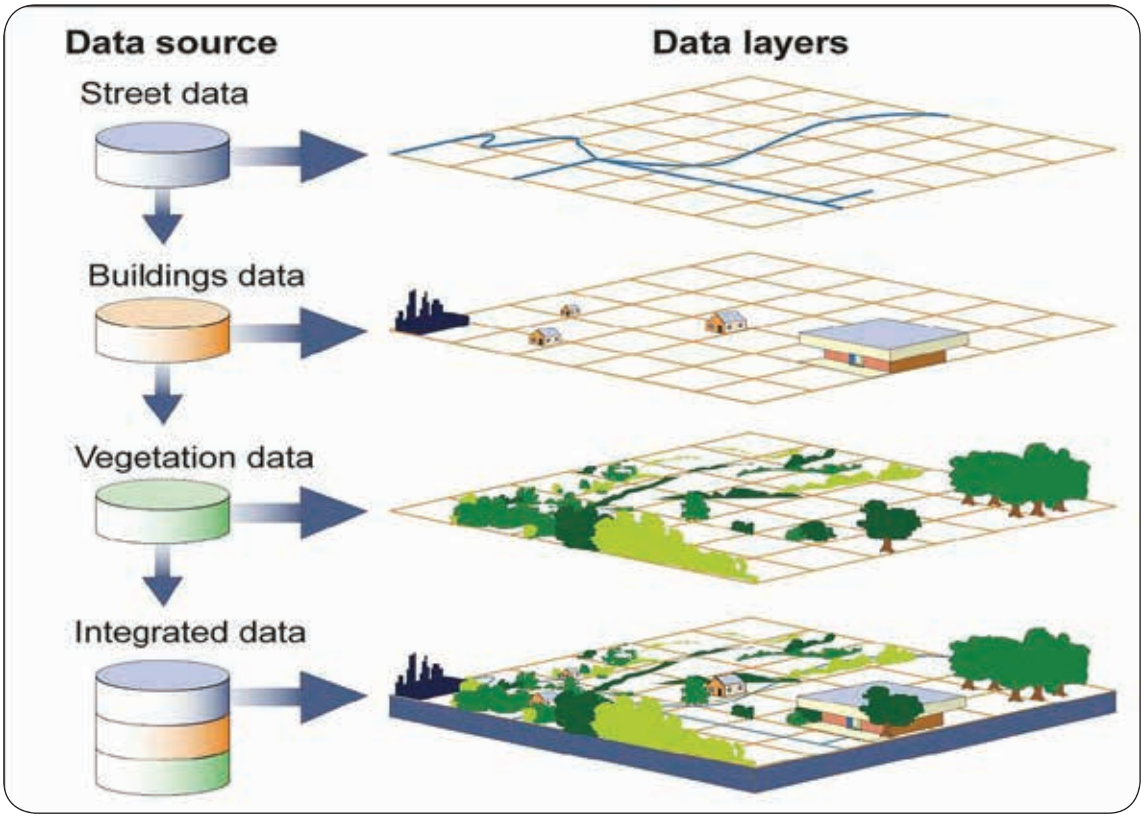
9 What are Advantages and Disadvantages of Remote Sensing?

Advantages of remote sensing are: a) Provides data of large areas b) Provides data of very remote and inaccessible regions c) Able to obtain imagery of any area over a continuous period of time through which the any anthropogenic or natural changes in the landscape can be analyzed d) Relatively inexpensive when compared to employing a team of surveyors e) Easy and rapid collection of data f) Rapid production of maps for interpretation.

Disadvantages of remote sensing are: a) The interpretation of imagery requires a certain skill level 9b) Needs cross verification with ground (field) survey data c) Data from multiple sources may create confusion d) Objects can be misclassified or confused e) Distortions may occur in an image due to the relative motion of sensor and source

10 What is GIS?

Geographic information system (**GIS**) is a computer-based tool for mapping and analyzing feature events on earth. GIS technology integrates common database operations, such as query and statistical analysis, with maps. GIS manages location-based information and provides tools for display and analysis of various statistics, including population characteristics, economic development opportunities, and vegetation types. GIS allows you to link databases and maps to create dynamic displays. Additionally, it provides tools to visualize, query, and overlay those databases in ways not possible with traditional spreadsheets. These abilities distinguish GIS from other information systems, and make it valuable to a wide range of public and private enterprises for explaining events, predicting outcomes, and planning strategies.



11 What is the difference between geo-coding and geo-referencing?

Geo-coding is when you associate a place name or an address with map coordinates. Geo-referencing is the process of associating plain digital images taken from a satellite.

12 Name the two data structures that have the capacity to hold spatial data?

The two data structures that can hold spatial data include raster and vector.

13 Differentiate between GIS commands and tools?

Commands do not require interaction with the map, they just rely on surface. Tools on the other hand require interaction with the map canvas.

14 Name applications of the Arc GIS desktop?

Arc Map, Arc catalog and Arc toolbox.

15 What is the role of GPS in GIS?

Competent decisions can only be rendered by reliable data and though **GIS** is an amazing data management tool, using it with **GPS** helps in validating the data analysis and results.

16 What does the scale on a map shows?

Where you are, How the size of the map relates to the size of a real place and direction as North, east, south, west.

17 What does the legend or map key tell?

Direction, What the symbols on the map mean and The distance between the equator and a point north or south on the earth's surface.

18 List the satellite navigation systems ?

The navigation systems are as follows:

- **GLONASS :** Russia's global navigation system.
- **IRNSS** (Indian Regional Navigational Satellite System),
- **COMPASS** : People's republic of china's global system.

19 Explain briefly the working principle of GPS ?

A Global Positioning System's receiver calculates its position by precisely timing the signals sent by Global Positioning System satellite high above the earth. These distances and satellite location are used to compute the location of the receiver using the Navigation Equations. Although 4 satellites are required for normal operation, fewer apply in special cases.

20 **Explain the structure of GPS ?**

The structure of **GPS** have three main segments. These are as follows: Page segment, Control segment and User segment

21 **What is trilateration?**

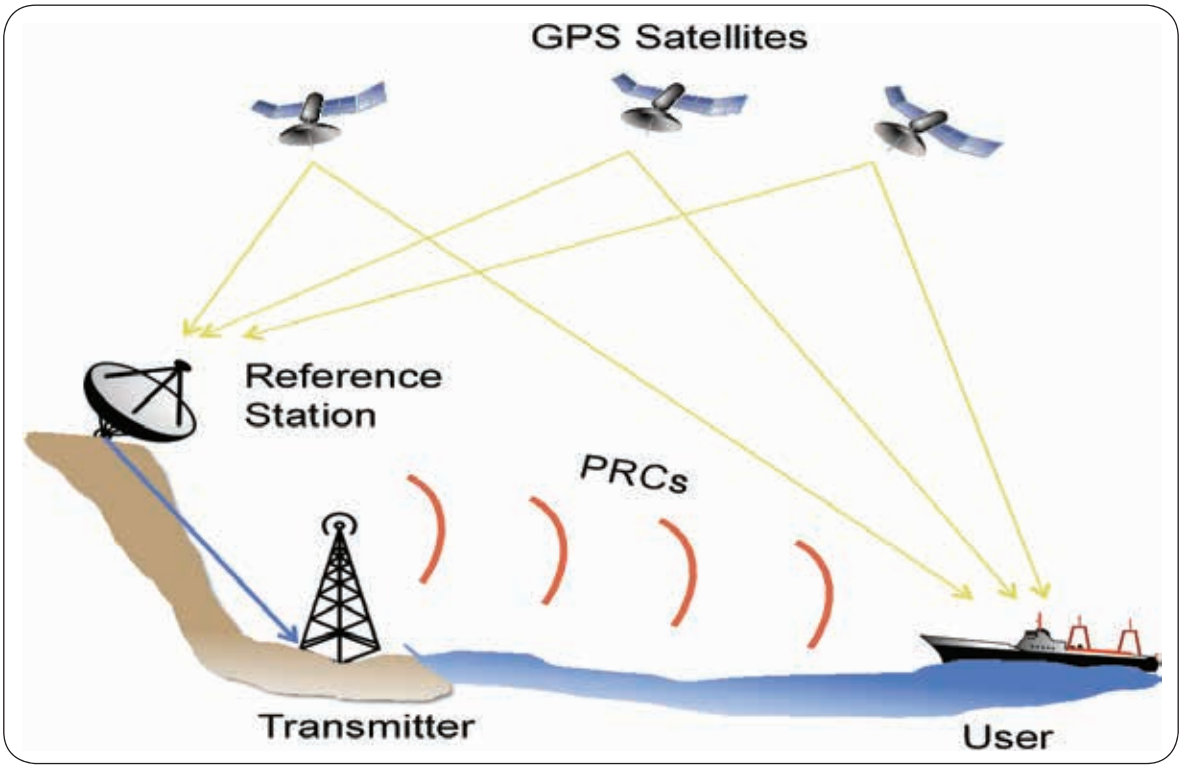
A **GPS** receiver uses trilateration (a more complex version of triangulation) to determine its position on the surface of the earth by timing signals from three satellites in the Global Positioning System.

22 **What is the difference between triangulation and Trilateration?**

As **GPS** satellites broadcast their location and time, trilateration measure distances to pinpoint their exact position on Earth. While triangulation is associated with surveying, no angles are actually involved in **GPS** positioning. Surveyors use triangulation to measure distant points – not **GPS** receivers

23 What is Differential GPS (DGPS)?

In the basic form of **DGPS**, the position of a reference receiver at a monitoring or reference station is surveyed in, that is, its position is known accurately. The user receiver should be no more than about 300 miles away from the reference receiver which makes pseudo range measurements, just as any user receiver would. However, because the reference receiver knows its position accurately, it can determine "biases" in its pseudo range measurements. For each satellite in view of the reference receiver, these biases are computed by differencing the pseudo range measurement and the satellite-to-reference receiver geometric range. These biases incurred in the pseudo range measurement process include errors arising from ionospheric delay, tropospheric delay, and satellite clock offset from **GPS** time. For real-time applications, the reference station transmits these biases, called differential corrections, to all users in the coverage area of the reference station. Users incorporate these corrections to improve the accuracy of their position solution.



24 What is difference between Spatial and Temporal resolution?

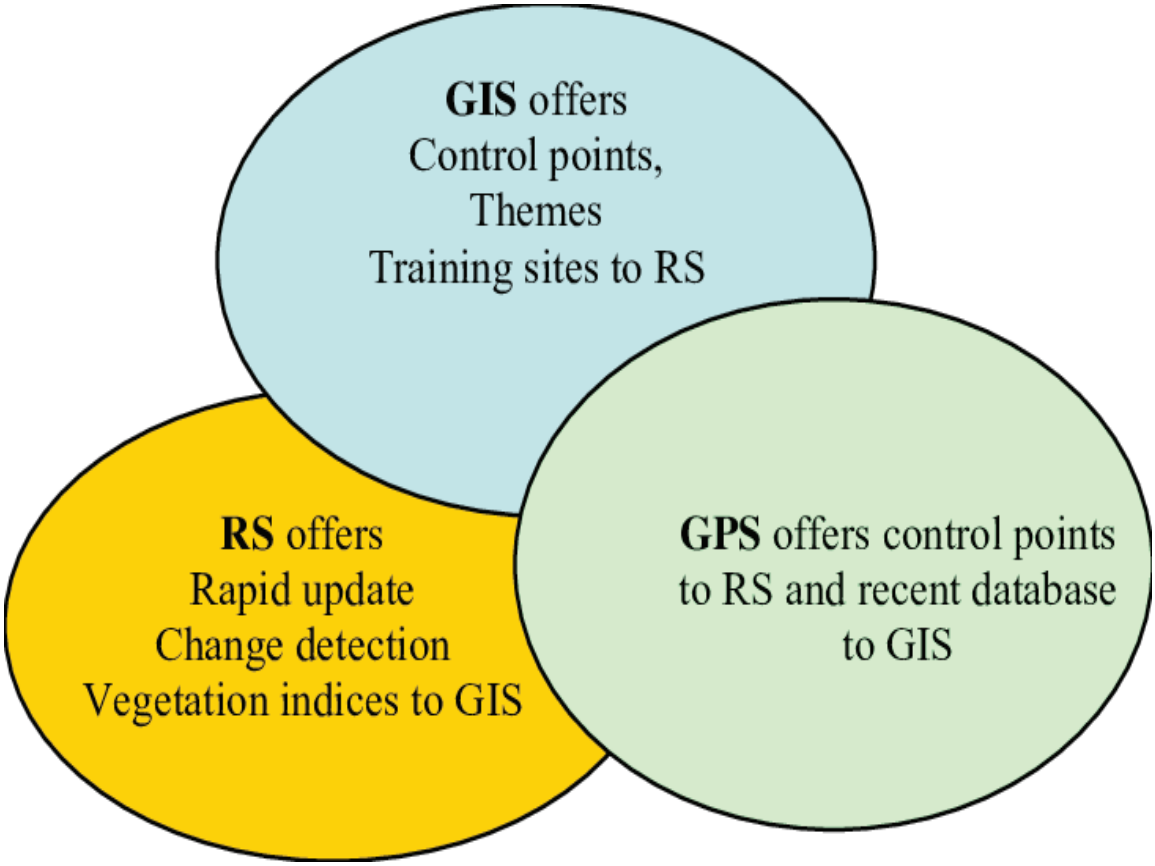
Spatial-Anything / event that occur in space has a spatial dimension – e.g environmental phenomena like air pollution, biodiversity conservation.

Temporal –anything / event relating to or limited by time, e.g disasters in 2014, hourly PM10 concentration at a specific site.

25 What Geospatial information presents?

Geospatial information presents the location and characteristics of different attributes of the atmosphere, surface and sub-surface. It is used to describe, display and analyze data that have discernible spatial aspects, such as land use, water resources and natural disasters. Geospatial information allows for the visual display of different statistics in a map-based layout, which can make it easier for users to work with and understand the data.

26 **Illustrate the relationships among RS, GIS and GPS?**



27 **What is meant by aerial photography & Imageries?**

The photographs of the earth taken from aircrafts are called the aerial photographs, while the pictures taken from the satellites are called the imageries.

28 **Define aerial photographs?**

Aerial photographs of the region are taken by cameras placed in the aircrafts. Aerial photos give three dimension of the photographed area. These photos contain a detailed record of the ground at the time exposure.

29 What are the characteristics of air photos?

Shape and size, flight and photo data

30 What are the kinds of air photos?

Vertical air photos, oblique air photos, anusaics, photostrips, stereoprain.

31 Define stereo meter?

The instrument is used under a mirror stereoscope for measuring heights and areas of objects from air photos.

32 What is mean by measuring dots?

A stereo meter consists of two small Tran's parent glass or plates attached to a long metallic bar. A clear dot is etched on earth of the plates called "measuring dots".

33 What is Photogrammetry?

Photogrammetry is the science of making measurements from photographs, especially for recovering the exact positions of surface points. Moreover, it may be used to recover the motion pathways of designated reference points located on any moving object, on its components and in the immediately adjacent environment.

34 What is meant by Spectral Resolution?

The number and dimension of the specific EMR wavelength regions to which sensor is sensitive A. Broadband: few, relatively broad bands B. Hyper-spectral: many, relatively narrow bands. Radiometric Resolution · Ability of a sensor to distinguish between objects of similar reflectance · Measured in terms of the number of energy levels discriminated · Affects ability to measure properties of objects

35 What is Planck's Law (energy of photon)?

Q=hvo where : Q=energy of quantum in Joules
(J)o h= Planck's constant=6.626 x 10^{-34} (Js)o v=frequency of EMR wave (cycles s-1) or (Hz).

36 What is Wien's Displacement Law?

Used to identify λ of maximum energy emission (λmax) Inversely related to temperature o λmax = K/T K = constant 2898 µK T = temperature (K) Sun: T = 6000K; λmax = 0.48 µm Earth: T = 300K; λmax = 9.66µm

37 What is passive sensing?

Where information is recorded just from the sunlight bouncing off objects. B. Where the satellite or aircraft produces or beams a signal towards the object or land. C. Where images are produced by computer, not actively by humans. D. Where you don't have to move to produce an image.

38 What is active sensing?

Where information is recorded just from the sunlight bouncing off objects. B. Where the satellite or aircraft produces or beams a signal towards the object or land. C. Where images are produced by computer, not actively by humans. D. Where you don't have to move to produce an image.

39 What can GIS do?

GIS works with different applications: land use planning, environmental management, sociological analysis, business marketing, weather prediction, city planning, waste-water panning, urban planning, navigation tools, and many more.

40 What are Map data types?

There are **two types of map data: Discrete and Continuous. Discrete:** objects in real world with specific locations or boundaries, such as cities, roads, or soil units. **Continuous:** quantity that is measured and recorded everywhere over a surface, such as temp or elevation

41 What are Data formats?

There are two data formats that GIS is handy with: **Vector and Raster data formats.** Both data systems store spatial and attribute data, but in different ways. Both are georeferenced, meaning that the information is tied to a specific location on the earth's surface using x-y coordinates defined in a standard way: a coordinate system**. Vector model**: stores discrete data—eg, points (no dimension), lines (1D), and polygons (2D). **Raster Model**: stores continuous data—set of spatial data represented as series of small squares called cells or pixels.

42 What are feature classes?

A feature class can contain only one kind of geometry—point, line, or polygon. Feature classes can be stored in several different formats. Some formats contain only one feature class, whereas some store multiple feature classes and are called feature datasets.

43 What are attributes?

Objects in feature class have information stored about them, such as their name and populations. This information is called attributes and is stored in table.

44 What is map scale?

Map scale is a measure of the size at which features in a map are represented. The scale is represented as a fraction, or ration, of the size of objects in the page to the size of the objects on the ground. Large-scale maps (with smaller denominator) show a relatively small area, such as quadrangle, whereas small-scale maps (with large denominator) show a relatively larger areas, such as states or countries.

45 What is Resolution?

Resolution refers to the sampling interval at which data are acquired. Resolution may be spatial, thematic, or temporal.
Spatial resolution indicates at what distance interval measurements are taken or recorded.
Temporal resolution indicates how frequently measurements are taken. Eg, census, temperature, precipitation etc.

46 What is precision?

Precision refers to either number of significant digits used to record a measurement or the statistical variation of a repeated single measurement.

47 What is metadata?

Metadata is a data of the data which stores information about the dataset, such as where it came from, how it was developed, who assembled it, how precise it is, and whether it can be given to another person.

48 What are shapefiles?

Shapefiles are data models containing a features class composed of points, lines, or polygons, but never a mixture. The attributes are stored in dBase file. Shapefiles can store multipart features, in which a single feature includes multiple objects.

49 What are geodatabases?

A **geodatabase** can contain many different objects, including feature classes, networks, tables, raster, and topology. There are 3 types of geodatabases:
Personal geodatabases: designed by use by individuals or small workgroups and are stored in a single Microsoft Access file. –limited to 2GB.
File geodatabases: stored in system folder, and each file can be up to 1TB. – can be accessed by multiple operating systems, including Linux or Unix.
Enterprise (SDE) geodatabase: stores GIS data within a commercial relational database management systems (RDBMS), such as Oracle or SQL Server. —designed to meet security and management needs for large data sets accessed by multiple users.

50 What is geographic coordinate system (GCS)?

It is a measurement of angles from the center of the earth and has units of degrees. Longitudes—measure horizontal angles east or west of the Prime Meridian (-180 to +180), and Latitudes are vertical angles above or below the equator (0 to -90, 0 to +90).

51 What is Map Projection?

A **GCS** is a three-dimensional coordinate system, but maps need to be flat. The conversion of 3D map into 2D map is called Map Projection. Projection is mainly done to avoid distortions: Area, Distance, Shape, and Direction. Based on shape of the surface onto which **GCS** locations are projected, the projections are grouped into 3 major classes:

52 What are major classes of Projection?

A. **Cylindrical Projection**: uses a cylindrical surface that lies tangent to (touches) the earth at the equator along a great circle. Cylindrical Projections are of 3 types: ***Equilateral:*** surface tangent to the earth at equator ***Transverse:*** rotate the cylinder sideways making it tangent along a line of longitude ***Oblique:*** places tangent at an angle.

B. **Conic Projection**: uses cone on the sphere. ***Tangent:*** cone is tangent to the globe along the line of latitude. ***Secant:*** cone is places through the sphere touching two places.

C. **Azimuthal Projection:** a plane is placed tangent or secant to the sphere. This projections are used for displaying the earth's poles, and for that reason they are sometime called **polar projections.** Other names for this method are **stereographic and orthographic projection.**

53 What is a table?

A **table** is a data structure for storing multiple attributes about a location or an object. It is composed of rows, called **records**, and columns, called **fields** or **attribute fields**. An attribute table consists of information about features in a geographic data set**. In a shapefile**, the row is linked to the spatial feature in a separate file using a unique ID number called feature ID, or FID. **In geodatabase**, the file stores both the attributes and the x-y coordinates in the same data file, although the coordinates are not visible in the tables, and it uses an Object ID, or OID.

54 What is a Database Management System?

The system that are designed to store, manipulate, analyze, and protect tabular data of all kinds are **Database Management Systems.**
There are various systems used to store data, such as INFO database (used for coverage), the dBase table (used for shapefiles), the Microsoft Access engine (used for personal geodatabases), and large-scale relational database management system (RDBMS), such as SQL Server (used for enterprise geodatabases).

55 What are Types of databases?

Flat file database: stores rows of into in a text or binary file; simple but not efficient. **Hierarchical database:** has multiple files, each of which contains different records and fields; parent tables can be linked to child hence defining the relationships.

Relational database: also has multiple tables stores as files, however, the relationships are not defined ahead of time; user defines can temporarily associate two tables if they share a common field. This association is called a **join.**

56 What is a Join?

In **GIS**, the tables are combined using a common field called a **key,** and this combining of two tables is called **Join.** The key field must be of the same data types in both tables. When a join is performed, the two tables become one. The join can be removed when it is no longer needed.

57 What is a Spatial Join?

A **spatial join** is similar to an attribute join, except that, instead of using a common field to decide which rows in the table match, the *locations* of the spatial features are used. The spatial join uses either a containment criterion (one feature inside the other) or a proximity criterion (one feature close to another).

58 What is a Map Overlay?

Map overlay combines two feature classes to create a new feature class containing information from both inputs. Both features and attributes may be combined.

59 What is a buffer?

A **buffer** is constructed to delineate areas that fall within a certain set of features. Buffers can be created for points, lines, and polygons.

60 What is a Boolean Overlay?

Boolean overlay is similar to vector overlay, but it is uses map algebra with Boolean rasters and operators.

61 What is Euclidean Distance?

The **Euclidean Distance** is a distance function that produces a raster in which each cell represents the shortest distance from a set of specified objects.

62 What is Interpolation?

Interpolation is a method to estimate the values in between the measurements. It takes measured values at points and distributes them across a raster.

63 What is a Reclassify function?

The **Reclassify** function changes the values of a raster according to a scheme designed by the user, such as classifying a slope map into three regions of low, medium, or high slope.

64 What are the components of GIS?

Hardware: fast processing computer with high storage. GIS Software: produced and distributed by ESRI. Data Storage: data are voluminous so requires high storage devices. Can be online too. Information output hardware: Digitizer, scanner, printer etc. Fast processing internet connection. GIS Data: Gathering data, assessing their accuracy, and maintaining them. GIS personnel: trained person.

65 What are the functionalities of GIS?

Varies widely. But providing the means to collect, manage, and analyze data to produce information for better decision is common goal and the strength of GIS. Data entry: digitizing, scanning, text files, and the most common spatial data formats.

Data management tools: building data sets, editing spatial feature and their attributes, managing coordinate systems and projections.

Thematic Mapping: symbolizing map features in different ways and combining layers for display.

Data Analysis: exploring spatial relationships in and between map layers.

May layout: creating soft and hard copy maps with tiles, scale bars, north arrows, and other maps elements.

66 What are the new trends and directions in GIS?

ArcGIS online, Web GIS, ArcGIS Pro, ESRI Story Maps, **ArcGIS** Story Maps, ArcGIS Map Journals.

67 What do GIS Professionals do?

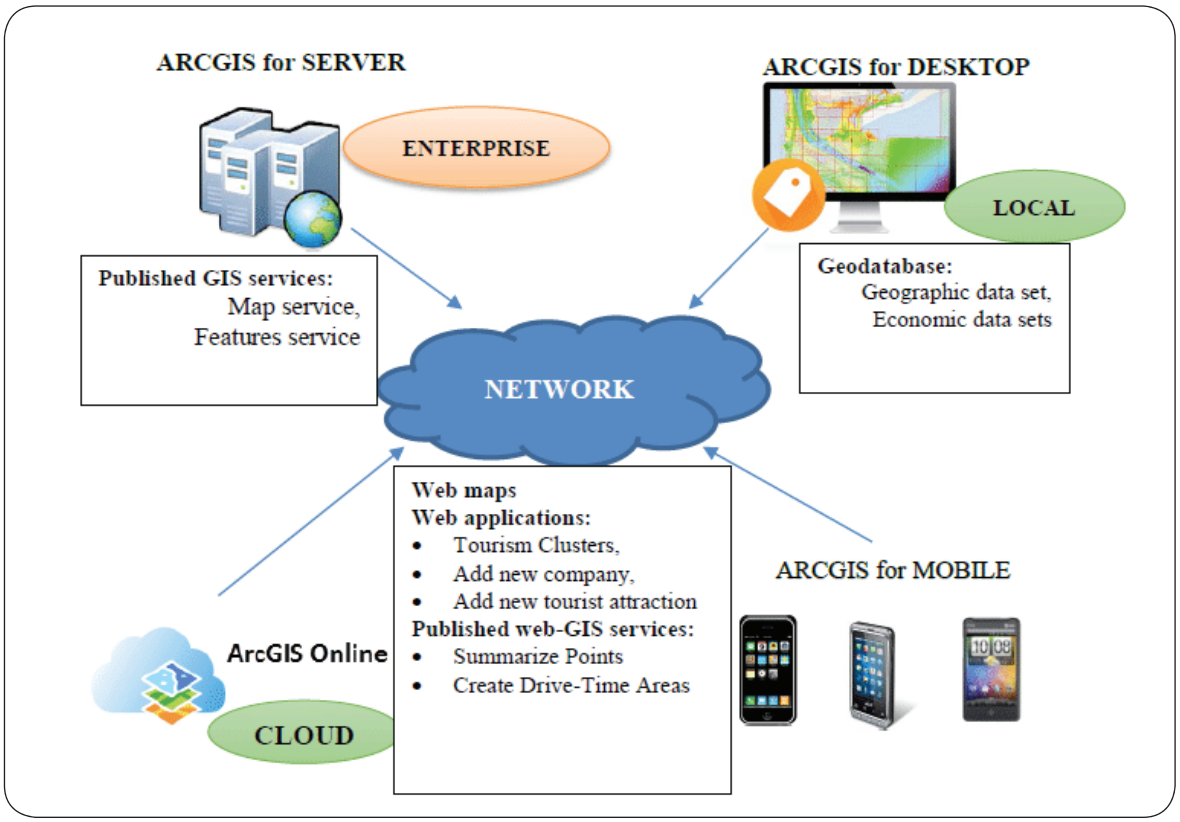
- **Primary Data Providers**: create base data. Surveyors, land-use panning professionals, photogrammetrists, remote sensing professionals, GPS experts
- **Application GIS**: Geographers, hydrologists, land-use planner, business analyst, utilities experts, statistician, etc. who use GIS tools and skills to make their work efficient, productive, and valuable.
- **GIS Developer**: skilled software and hardware engineers—build and maintain GIS software
- **GIS Database Distributor**: experts in computer science and networking, Internet protocols, and/or database management systems—set up and maintain the complex server and network systems that allows data services, Server GIS, and Enterprise to operate.

68 What ArcGIS ?

ArcGIS is a geographical information system (GIS) software that allows handling and analyzing geographic information by visualizing geographical statistics through layer building maps like climate data or trade flows. It's used to develop and illustrate groundbreaking research. The system has the capacity to create geographical information accessible throughout a company, institution, privately or publicly on the internet. Therefore, the software essentially works as a platform whereby geographical information can be linked, shared and analyzed.

69 How Does ArcGIS Work?

Like many GIS software, ArcGIS creates maps that require categories organized as layers. Each layer is registered spatially so that when they're overlaid one on top of another, the program lines them up properly to create a complex data map. The base layer is almost always a geographical map, pulled out of a range of sources depending upon the visualization needed (satellite, road map, etc). This program has a lot of them available to users and also contains live feed layers including traffic details. The first three layers are called feature or vector layers, each containing individual functions distinguished through the platform. These are: **points** (like landmarks, buildings), **lines** (like roads and other 1D schemata), **polygons** (like political information and geographical census, called 2D data), **raster images** (a base vector layer like an aerial picture).



70 **The arrangement of terrain features which provides attributes: the shape, size and texture of objects, is called**

A.	spectral variation	C.	temporal variation
B.	spatial variation	D.	None of these .

71 **Electromagnetic radiation :**

A.	produces a time varying magnetic field and vice versa	C.	is capable to travel across space
B.	once generated, remains self-propagating	D.	All of these

72 **Pick up the important characteristic of a target which facilitates its identification from the following:**

A.	spectral variation	C.	temporal variation
B.	spatial variation	D.	All of these

73 **Which one of the following frequency regions is a part of sun's radiation?**

A.	Ultraviolet frequency region	C.	Infrared frequency region
B.	Visible frequency region	D.	All of these

74 **The instruments which provide electromagnetic radiation of specified wave length or a band of wave lengths to illuminate the earth surface, are called :**

A.	sensors	C.	active sensors
B.	passive sensors	D.	None of these

75 **Due to perturbation of the orbit, satellite orbit parameters are frequently updated on measurements carried out by its**

A.	six ground stations	C.	five ground stations
B.	four ground stations	D.	three ground stations

76 **Coherence of two electromagnetic waves takes place if their phase difference is :**

A.	constant in time	C.	constant in time and space
B.	constant in space	D.	None of these

77 **The part radiation due to scattered/diffused radiation entering the field of view of a remote sensor other than that from the required target,**

A.	reduces the contrast of the image and also its sharpness	C.	increases both the contrast and sharpness
B.	increases the contrast of the image but reduces the sharpness	D.	reduces the contrast but increases the sharpness

78 **The basic requirement of any sensor system, is :**

A.	radiometric resolution	C.	spectral resolution
B.	spatial resolution	D.	All of these

79 **Which one of the following helps to identify the objects on the earth surface ?**

A.	atmospheric window	C.	radiometric error
B.	signature	D.	None of these

80 **The spectral region of the electromagnetic radiation which passes through the atmosphere without much attenuation is known as:**

A.	ozone hole	C.	ozone window
B.	atmospheric window	D.	black hole

81 **The remote sensing techniques applied for the earth's surface features, is generally confined to the following wave lengths :**

A.	0.4 to 1.3, 1.5 to 1.8, 2.2 to 2.6 μm	C.	4.2 to 5.0, 7.0 to 15.0 μm and 1 cm to 30 cm
B.	2.2 to 2.6, 3.0 to 3.6, 4.2 to 5.0 μm	D.	All of these

82 **Which one of the following statements is correct?**

A. The function of an information system is to improve ones ability to make decisions
B. The information system is the chain of operations
C. A map is a collection of stored, analyzed data, its stored information is suitability used in making decisions
D. All the above

83 **The interaction of the electromagnetic radiation produced with a specific wave length to illuminate a target on the terrain for studying its scattered radiance, is called:**

A.	passive remote sensing	C.	neutral remote sensing
B.	active remote sensing	D.	None of these

84 **The normal altitude of GPS satellite is about**

A.	16, 200 km	C.	24, 400 km
B.	20, 200 km	D.	36, 100 km

85 **Orbital radius of GPS satellites is approximately:**

A.	15,200 km	C.	18,400 km
B.	26,600 km	D.	36,000 km

86 **An analyst uses a database management system to copy selected records from two source files into a new destination file. Which of the following operations. selects only thoserecords that appear in one, but not both, of the source files?**

A.	Intersection	C.	Union
B.	Difference	D.	None

87 **Vector is a representation strategy involving sampling attributes at fixed intervals.**

A.	True
B.	False

88 **_____ generally refers to the spatial arrangement among geographic objects and may be managed within a geographic information system through the application of rules such as "Adjacent to" or "May not have gaps".**

A.	Topography	C.	Proximity
B.	Topology	D.	Connectedness

89 **Which of the following statements is true regarding geospatial data precision?**

A. It is common to find mixed resolution data within the same dataset
B. Precision is only important to "small scale" analyses and will not affect "large scale" analyses
C. A GIS dataset built to map "small scale phenomena" may be inappropriate to use in "large scale" analysis
D. Imprecise data is not useful at any scale

90 **_____ is a measure of the accuracy of an entire geospatial dataset.**

A.	Statistical Significance	C.	P-Value
B.	Root mean square error	D.	Reflection

91 **Which of the following is an accurate statement about a hillshade?**

A. A hillshade identifies the downslope direction of the maximum rate of change in value from each cell to its neighbors
B. Hillshades are used to determine the azimuth faced for each pixel
C. Hillshades will vary based on the hemisphere and season of the initial collect
D. A hillshade is a process that creates a shaded relief from a surface raster by considering the illumination source angle and shadows

92 **The process of using data points with known values to estimate values at unknown points (in same region or nearby region) is called spatial _____.**

A.	Prediction	C.	Adjustment
B.	Interpolation	D.	Reflection

93 **Which of the following is produced by atmospheric scattering?**

A. An oversaturation of the entire visible spectrum
B. A hazy appearance in the blue end (400-500 nm) of the visible spectrum
C. An undersaturation in the red end (600-700 nm) of the visible spectrum
D. A reduction in the exploitability of all satellite imagery

94 **The spatial resolution of most of the bands of the Landsat Enhanced Thematic Mapper Plus sensor is _____ not including the panchromatic and thermal infrared bands.**

A.	About 1 meter	C.	About 30 meters
B.	About 15 meters	D.	About 80 meters

95 **Which two wavelength bands are combined to calculate the Normalized Difference Vegetation Index (NDVI)?**

A.	Near-infrared and thermal infrared	C.	Visible red and near-infrared
B.	Visible infrared and thermal infrared	D.	Visible green and visible red

96 **Which of the following is a key strength of principal components analysis (PCA)?**

A.	Material differentiation	C.	Data Reduction
B.	Noise segregation	D.	Anomaly detection

97 **Juan and Esperanza are working with an image with the data confined between the values 97 and 167. Juan says that he can increase the contrast in the image by applying a linear contrast stretch. Esperanza says that he can increase the contrast in the image through the histogram equalization method. Who is correct?**

A.	Juan is correct	C.	Juan and Esperanza are both correct
B.	Esperanza is correct		

98 **The relation between velocity, wavelength and frequency can be given as _____**

A.	λ = c / r	C.	λ = c / h
B.	λ = c / f	D.	λ = h*c / f

99 **Remote sensing uses which of the following waves in its procedure?**

A.	Electric field	C.	Gamma- rays
B.	Sonar waves	D.	Electro-magnetic waves

100 **Which of the following is not a principle of remote sensing?**

A.	Interaction of energy with satellite	C.	Electro-magnetic spectrum
B.	Electromagnetic energy	D.	Interaction of energy with atmosphere

101 **Which among the following waves is having less wavelength range?**

A.	0.03mm	C.	0.03m
B.	0.03nm	D.	0.03km

102 **In visible region, the blue light is having a wave length range of _____**

A.	0.42-0.52 micrometer	C.	0.42-0.92 micrometer
B.	0.24-0.52 micrometer	D.	0.22-0.32 micrometer

103 **Which of the following field is used by the EM waves?**

A.	Solar field	C.	Electric field
B.	Polarized field	D.	Micro field

104 **Among the following, which describes Stefan- Boltzmann formula?**

A.	$M = \sigma/T^4$	C.	$M = \sigma+T^4$
B.	$M = \sigma-T^4$	D.	$M = \sigma*T^4$

105 **Which of the following is not a classification of scattering principle?**

A.	Faraday scattering	C.	Mie scattering
B.	Rayleigh scattering	D.	Non-selective scattering

106 **Which of the following can act as an example for air-borne platform?**

A.	LISS-III	C.	MOS
B.	Dakota	D.	LISS-II

107 **Polar orbiting satellites are generally placed at an altitude range of _____**

A.	7-15 km	C.	700-1500 km
B.	7000-15000 km	D.	70-150 km

108 **GIS uses the information from which of the following sources?**

A.	Non- spatial information system	C.	Global information system
B.	Spatial information system	D.	Position information system

109 **Among the following _____ can be expressed as an example of hardware component.**

A.	Keyboard	C.	Auto CAD
B.	Arc GIS	D.	Digitalization

110 **Which of the following formats can be used for GIS output?**

A.	DXF	C.	GIF
B.	PDF	D.	HTML

111 **Which among the following is not related to GIS software's?**

A.	CAD	C.	Arc View
B.	Arc GIS	D.	STAAD Pro

112 **Among the following, which do not come under the components of GIS?**

A.	Hardware	C.	Compiler
B.	Software	D.	Data

113 **Which of the following doesn't determine the capability of GIS?**

A.	Defining a map	C.	Retrieving data
B.	Representing cartographic feature	D.	Transferring data

114 **Which of the following acts a benefit of GIS?**

A.	Maintaining geo spatial data	C.	Accurate data information
B.	Data sharing	D.	Presence of data retrieval service

115 **Which among the following is a server based hardware platform of GIS?**

A.	Autodesk Revit	C.	Arc GIS
B.	STAAD Pro	D.	Google-maps

116 **Study of geometric objects will come under the category of _____**

A.	Surveying	C.	Surface geometry
B.	Cartography	D.	Topology

117 **Which type of data set is not used in GIS related software's?**

A.	Vertex	C.	Poly line
B.	Point	D.	polygon

118 **Among the available formats, which are most commonly used in case of GIS?**

A.	GIF	C.	JPEG
B.	TIFF	D.	DXF

119 **The point data feature can be used to represent _____**

A.	Location	C.	3D area
B.	Area	D.	Volume

120 **The polygonal data feature uses which of the following data format?**

A.	Scientific character	C.	Character
B.	Math	D.	Integer

121 **Which of the following justifies the usage of topology?**

A.	Terrain of the area	C.	Climatic conditions
B.	Geometry of the model	D.	Atmospheric conditions

122 **Which feature of GIS can share the boundary of the polygon?**

A.	Polygons	C.	Dongle nodes
B.	Poly lines	D.	Silver polygons

123 **Which of the following indicate topological primitive?**

A.	Poly line	C.	Node
B.	Point	D.	Polygon

124 **Which of the following acts as a key to GIS?**

A.	Topology	C.	Software
B.	Platform	D.	Terrain

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قسم الجيولوجيا والجيوفيزياء – كلية العلوم – جامعة الملك سعود
دكتوراه في الجيوفيزياء (١٩٩٠م) جامعة مينيسوتا - أمريكا

- المشرف على مركز الدراسات الزلزالية – جامعة الملك سعود
- المشرف على كرسي استكشاف الموارد المائية في الربع الخالي
- رئيس الجمعية السعودية لعلوم الأرض
- رئيس قسم الجيولوجيا والجيوفيزياء - جامعة الملك سعود (سابقا)
- مؤسس ورئيس تحرير المجلة العربية للعلوم الجيولوجية AJGS
- رئيس فريق برنامج زمالة عالم مع جامعة أوريغون الحكومية الأمريكية ومعهد ماكس بلانك الألماني.
- مستشار مدينة الملك عبد العزيز للعلوم والتقنية ومدينة الملك عبدالله للطاقة الذرية
- مستشار هيئة المساحة الجيولوجية وهيئة المساحة العسكرية والدفاع المدني
- باحث رئيس في عدة مشاريع بحثية مدعمه من مدينة الملك عبد العزيز للعلوم والتقنية وشركة أرامكو
- باحث رئيس في مشاريع مع وزارة الطاقة الأمريكية وجامعة كاليفورنيا ومعمل ليفرمور الأمريكي
- باحث رئيسي ومشارك في مشاريع بحثية مع جامعات الاباما وبنسلفانيا وأوريغون الامريكية
- المشرف على المحطة الدولية للزلازل GSN من ضمن منظومة الـ IRIS / IDA
- المشرف على المصفوفة الزلزالية الدولية بالتعاون مع معهد ليفرمور الأمريكي LLNL
- باحث رئيسي في ١٣ مجموعة عمل أمريكية وألمانية.
- عضو الجمعية الأمريكية للزلازل SSA والإتحاد الأمريكي للجيوفيزياء AGU
- عضو لجنة كود البناء السعودي SBC وعضو المنتدى الخليجي للزلازل GSF
- عضو لجنة تخفيف مخاطر الزلازل في دول شرق البحر الأبيض المتوسط RELEMR
- نشر أكثر من ١٥٠ بحث في مجلات علمية محكمة.
- ألف ٢٣ كتاب علمي .
- أصدر موسوعة رقمية في علوم الأرض من ١٤ مجلد و ١٠٧ ملف علمي.
- أنجز ٤٠ مشروع محلي و٧٤ تقرير فني و١٦ مشروع دولي
- شارك في أكثر من ١٢٥ مؤتمر محلي ودولي و٧٥ ندوة وورشة عمل متخصصة.
- ضمن قائمة (المنجزون البارزون العرب) و قائمة Who's Who في قارة اسيا للتميز العلمي
- ضمن قائمة Who's Who في العالم للإسهامات العلمية
- حصل على ٨٥ درع تكريمي وشهادات تقدير من المملكة وعمان والكويت والأمارات والأردن ومصر وتونس والجزائر وألمانيا وامريكا.
- حصل على جائزة المراعي للإبداع العلمي عام ٢٠٠٥ م
- حصل على جائزة التميز الذهبي من مدينة الملك عبدالعزيز للعلوم والتقنية عام ٢٠٠٦ م
- حصل على جائزة أبها التقديرية للإسهامات العلمية عام ٢٠٠٧م
- حصل على جائزة جامعة الملك سعود للتميز العلمي عام ٢٠١٣ م
- حصل على جائزة الاتحاد الامريكي للجيوفيزياء للتعاون الدولي والنشاط البحثي عام ٢٠١٣ م
- حصل على جائزة جامعة السلطان قابوس للإسهامات العلمية عام ٢٠١٣ م
- حصل على جائزة الملك سعود لإدراج المجلة العربية للعلوم الجيولوجية في قائمة الـ ISI
- حصل على جائزة أفضل رئيس تحرير مجلة عام ٢٠١٧علمية من الناشر الألماني SPRINGER
- حصل على جائزة ألبرت نيلسون ماركيز للإنجاز مدى الحياة عام ٢٠١٨ من منظمة Who's Who

- **Abdullah M. Al-Amri,** is a professor of earthquake seismology, Director of Seismic Studies Center at King Saud University (KSU). He is the President of the Saudi Society of Geosciences; Founder and editor-in-chief of the Arabian Journal of Geosciences **(AJGS)**.
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