GEY 221	Mineral Resources
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Energy Resources	

An energy resource is simply any geologic material from which energy can be harnessed examples include fossil fuel (coal, petroleum, oil shale), water, radioactive isotopes, wind e.tc. Human energy consumption has grown steadily throughout human history. Early humans had modest energy requirement but in today's society, humans consume as much as 110 times as much energy per person as early humans. Most of the energy we use today come from fossil fuel but fossils fuels have a disadvantage in that they are non-renewable on a human time scale, and cause other potentially harmful effects on the environment.

Energy Sources

There are 5 fundamental sources of energy:

1. Nuclear fusion in the Sun (solar energy)
2. Nuclear fission reactions.
3. Energy in the interior of the Earth.
4. Gravity generated by the Earth & Moon.
5. Energy stored in chemical bonds.

1.Nuclear Fusion in the sun.

The sun is formed through the fusion of Hydrogen and Helium and by thesame process of nuclear fusion solar energy is generated.

a)Solar Energy

This refers to energy sourced from the sun by electromagnetic radiation. It is a nearly unlimited resource, it is renewable, and largely, non-polluting and clean. It could be used directly for heat or converted to electricity for domestic uses with the use of photovoltaic cells but the challenge with solar energy is that the photovoltaic cells are expensive and have low efficiency (Usually not more than 20%) for most uses and improving its efficiency would require a whole roof covered with photovoltaic cells to generate enough electricity (about 1500watts) to run a typical home. Solar energy is a dispersed resource which often needs large collection areas thereby by occupying space during the installation of solar power facilities.

2.Nuclear fission reactions

This refers to reactions which involve the breakdown of radioactive isotopes and when these isotopes breakdown or decay, heat energy is released. Typical energy sourced in this manner is nuclear energy.

b)**Nuclear Energy**.

This is the energy sourced from the decay of radioactive isotopes which could be mined from within the earth. When notable naturally occurring radioactive isotopes such as ^{238}U, ^{235}U, ^{232}Th decay, they generate heat energy with could be used to generate electricity. Inorder to increase the rate of energy release and radioactive decay the isotopes are bombarded with neutrons. This reaction is usually carried out in a device called a pile through a process known as controlled fission. Nuclear reaction/fission generate large amount of energy from a little gram of radioactive material for example a gram of ^{235}U can generate energy worth about 13.7 barrels of oil. The disadvantages of this energy include the fact that nuclear power plant is costly to set-up, radioactive waste are harmful and there is no permanent waste management measure. It attracts global security concern as the same isotopes could be used to design nuclear weapons. Uncontrolled fission could trigger explosion which could be disastrous. A reference case is that of Chernobyl explosion of 26th April 1986 in Ukraine.

3) **Energy in the interior of the Earth**

Radioactive isotopes and magma are major sources of heat energy in the earth interior. A typical energy sourced from the earth interior is geothermal energy.

c) Geothermal energy.

This energy is generated in areas characterized by high heat flow especially areas close to plate boundary . It is a heat energy generated through vents in the form of steam/hot water when ground water makes contact with magma chamber. The steam could be used to warm the environment as well as powering turbines for electricity generation. This form of energy is used in Iceland, New Zealand, Italy etc. Geothermal power plants are economically competitive with other source of electricity and are largely (but not entirely) pollution free. The problem with this energy is that it is limited to plate boundary terrains and extracted water and steam are often corrosive and rich in dissolved element/heavy metals which clog or destroy pipes. Its not really a renewable resource on a human scale.

4)Gravity Generated by the Earth & Moon.

Gravitational pull of the Moon on the Earth causes tides. Tidal flow can be harnessed to drive turbines. This is also a nearly unlimited source of energy and is largely non-polluting. Water flowing downhill has a result of gravity can also be harnessed for energy to drive turbines and generate electricity which is known as **hydroelectric energy**. This sources of energy are mostly renewable, but only locally, and are generally non-polluting.

5. **Energy stored in chemical bonds**.

Energy stored in chemical bonds drives chemical reactions. When the reactions take place this energy is either released or absorbed. If it is absorbed, it is stored in the chemical bond for later use. If it is released, it can produce useful heat energy. electricity, and light.

Biomass Energy is another example. It involves burning (a chemical reaction) of wood, or other organic byproducts. Such organic material is produced by photosynthesis, a chemical process which derives energy from the Sun and stores that energy until the material is burned.

Fossil Fuels - Biomass energy that is buried within the Earth where it is stored until humans extract and burn it to release the energy. Among these sources are petroleum (Oil & natural gas), oil shale, tar sands, and coal.

Energy in the Interior of the Earth

Decay of radioactive elements has produced heat throughout Earth history. It is this heat that causes the temperature to increase with depth in the Earth and is responsible for melting of mantle rocks to form magmas. Magmas can carry the heat upward into the crust. Groundwater circulating in the vicinity of igneous intrusions carries the heat back toward the surface. If this hot water can be tapped, it can be used directly to heat homes, or if trapped at great depth under pressure it can be turned into steam which will expand and drive a turbine to generate electricity.

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Geology and Energy Resources

Exploitation for human use of nearly all of the energy sources listed above, requires geologic knowledge.

The direct use of solar energy to heat water and homes does not require geologic knowledge but the making of solar cells does requires knowledge of specific mineral deposits to manufacture the cells. Metals to produce wires (iron, copper, gold), batteries, (Li, Cd, Ni), and electric motors (Fe, Cu, Rare Earth Elements) all must be extracted from the Earth using geologic knowledge.

Hydroelectric energy requires geologic knowledge in order to make sure that dams are built in areas where they will not collapse (i.e areas with no major fault and low fracture density) thereby avoiding water leakage and harm on human population.

Finding fossil fuels and geothermal energy certainly requires geologic knowledge.

Nuclear energy requires geologists to find deposits of uranium to generate the fuels, geologists to find sites for nuclear power plants that will not fall apart due to such things as earthquakes, landslides, floods, or volcanic eruptions, and requires geologists to help determine safe storage sites for nuclear waste products.

Fossil Fuels

These simply refers to fuel/energy sourced from biogenic sediments ((i.e sediment of organic origin) or sediments of high organic components. The impact of burial and diagenesis on these sediments result in the formation of fossil fuels. Typical examples of fossil fuels are petroleum, (oil and gas), oil shale, tar sands etc. the kind of fossil fuel formed depends on the origin of the organic matter and their inherent/constituent organic compounds such as protein, lipid, carbohydrate, resin, wax, lignin etc.)

Petroleum

To produce a fossil fuel, the organic matter must be rapidly buried in the Earth so that it does not oxidize (react with oxygen in the atmosphere). Then a series of slow chemical reactions occur which turn the organic molecules into hydrocarbons- Oil and Natural Gas, together called Petroleum. ***Hydrocarbons*** are complex organic molecules that consist of chains of hydrogen and carbon.

Petroleum (oil and natural gas) consists of many different components such hydrocarbons, but the most important of these are a group known as the paraffins. ***Paraffins*** have the general chemical formula:

C_nH_{2n+2}

As the value of n in the formula increases, the following compounds are produced:

N	Formula	Compound	Use
1	CH_4	Methane	Natural Gas
2	C_2H_6	Ethane	
3	C_3H_8	Propane	
4	C_4H_{10}	Butane	
5	C_5H_{12}	Pentane	Gasoline
6	C_6H_{14}	Hexane	
7	C_7H_{16}	Heptanes	
8	C_8H_{18}	Octane	
9	C_9H_{20}	Nonane	
>9	various	Various	Lubricating Oils, Plastics

Formation of Petroleum

The organic matter that eventually becomes petroleum is derived from microscopic organisms, like plankton and bacteria (rich in Protein, Lipid and carbohydrate) which were originally deposited along with clays in the oceans. The resulting rocks are usually black shales that form the petroleum source rock. As the black shale is buried to depths of 2 to 4 km it is heated. This heating breaks the organic material down into waxy kerogen. Continued heating breaks down the kerogen with different compounds forming in different temperatures ranges:

Oil and gas – 90° to 160°C.
Gas only – 160° to 250°C.
Graphite – >250°C.

If temperatures get higher than the petroleum forming window (90 to 250 °C) then only graphite forms, which is not a useful hydrocarbon. Thus oil is not formed during metamorphism and older rocks that have been heated will also lose their oil forming potential.

Most oil and gas are not found in the source rock as compaction forces oil and natural gas from source rock into reservoir rocks where petroleum accumulate.

Petroleum Reservoirs

Reservoir rock contains pore space between the mineral grains (this is called ***porosity***). It is within this pore space that fluids are stored. Sands and sandstones are the best reservoir rocks because of the pore space left around the rounded sand grains. Highly fractured rock of also a good reservoir rock, because the fractures provide lots of open space. Limestone, if it has often been partially dissolved, also has high porosity.

Another essential property of reservoir rock is that it must have good permeability. Permeability is the degree of interconnections between the pores. Low permeability means that the fluids cannot easily get into or out of the pore spaces. Highly cemented sandstones, unweatherd limestones, and unfractured rock have low permeability.

Since oil and natural gas have a density lower than that of water, the petroleum migrates upward. It would continue upward and seep out at the surface where it would oxidize, if it were not for some kind of trap that keeps it in the Earth until it is extracted.

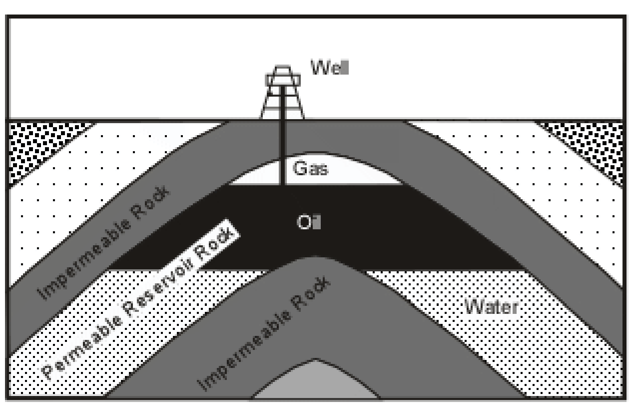
Oil Traps

An oil or gas reserve requires trapping in the reservoir. A trap is a geological configuration that holds oil and gas. It must be overlain by impermeable rock called a seal or caprock, which prevents the petroleum from migrating to the surface. Exploration for petroleum reservoirs requires geologists to find trap and seal configurations where petroleum may be found.

Oil traps can be divided into those that form as a result of geologic structures like folds and faults, called ***structural traps***, and those that form as a result of stratigraphic relationships between rock units, called ***stratigraphic traps***. If petroleum has migrated into a reservoir formed by one of these traps, note that the petroleum, like groundwater, will occur in the pore spaces of the rock. Natural gas will occur above the oil, which in turn will overly water in the pore spaces of the reservoir. This occurs because the density of natural gas is lower than that of oil, which is lower than that of water.

Structural Traps

- Anticlines - If a permeable reservoir rocks like a sandstone or limestone is sandwiched between impermeable rock layers like shales or mudstones, and the rocks are folded into an anticline, petroleum can migrate upward in the permeable reservoir rocks, and will occur in the hinge region of the anticline.

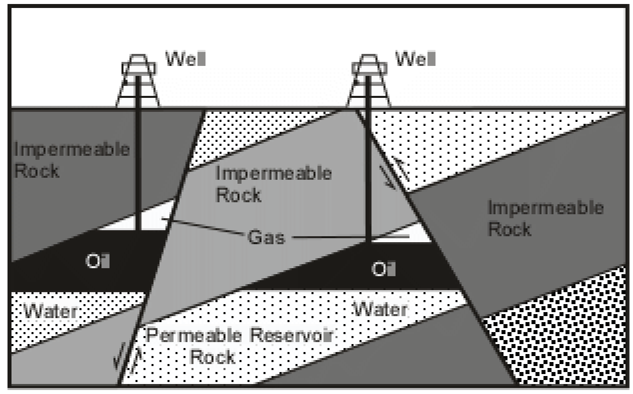


Since anticlines in the subsurface can often be found by observing the orientation of rocks on the surface, anticlinal traps were among the first to be exploited by petroleum geologists.

Note that synclines will not form an oil trap (Why?).

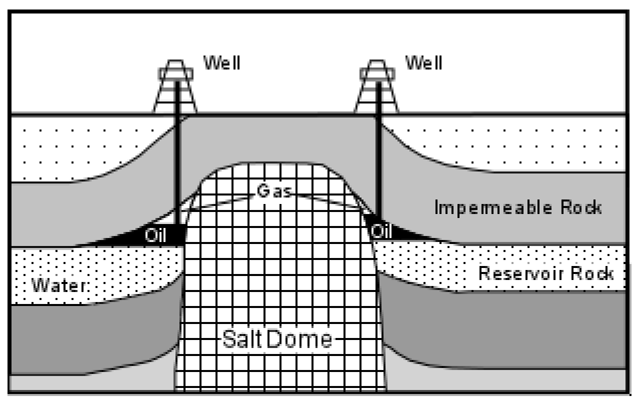
- Fault Traps

  If faulting can juxtapose permeable and impermeable rocks so that the permeable rocks always have impermeable rocks above them, then an oil trap can form. Note that both normal faults and reverse faults can form this type of oil trap.



Since faults are often exposed at the Earth's surface, the locations of such traps can often be found from surface exploration.

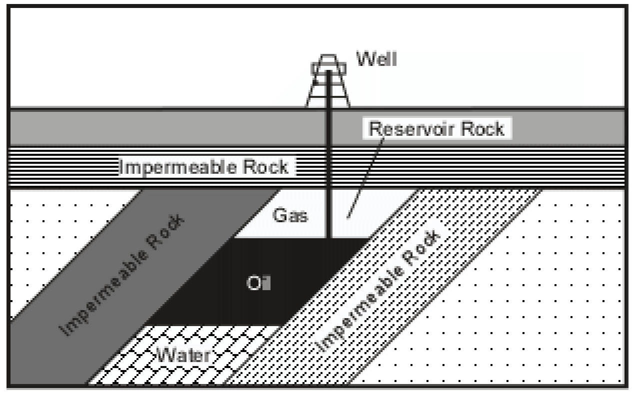
- Salt Domes - During the Jurassic Period, the Gulf of Mexico was a restricted basin. This resulted in high evaporation rates & deposition of a thick layer of salt on the bottom of the basin. The salt was eventually covered with clastic sediments. But salt has a lower density than most sediments and is more ductile than most sedimentary rocks.



  Because of its low density, the salt moved upward through the sedimentary rocks as salt domes. The intrusion of the salt deforms the sedimentary strata along its margins, folding it upward to create oil traps. Because some salt domes get close to the surface, surface sediments overlying the salt dome are often domed upward, making the locations of the subsurface salt and possible oil traps easy to locate.

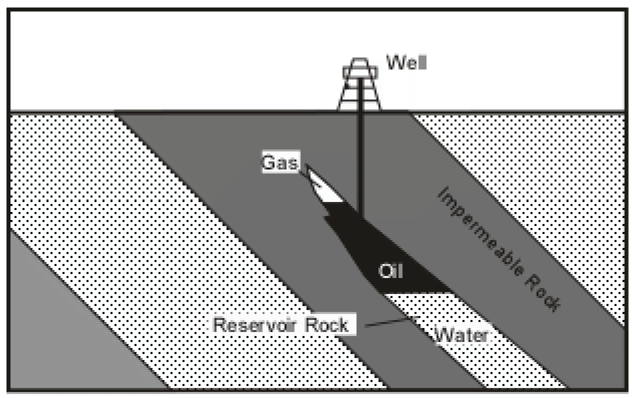
  Stratigraphic Traps

- Unconformities - An angular unconformity might form a suitable oil trap if the layers above the unconformity are impermeable rocks and permeable rocks layer are sandwiched between impermeable layers in the inclined strata below the unconformity.



This type of trap is more difficult to locate because the unconformity may not be exposed at the Earth's surface. Locating possible traps like this usually requires subsurface exploration techniques, like drilling exploratory wells or using seismic waves to see what the structure looks like.

- Lens Traps
  Layers of sand often form lens like bodies that pinch out. If the rocks surrounding these lenses of sand are impermeable and deformation has produced inclined strata, oil and natural gas can migrate into the sand bodies and will be trapped by the impermeable rocks.



This kind of trap is also difficult to locate from the surface, and requires subsurface exploration techniques.

Petroleum Distribution/accumulation

For petroleum to accumulate in a source rock, the following conditions must be satisfied.

1. There must be a source rock.
2. There must be a migration pathway so that the petroleum can move upwards
3. There must be reservoir rock
4. There must be oil trap to prevent the oil from migrating out of the reservoir.

Because these features must develop in the specified order, development of an oil reserve is geologically rare. As a result, petroleum reserves are geographically limited. The largest known reserves are currently in the Persian Gulf (see figure 14.15 in your text)..

Although the distribution of petroleum reserves is widespread, the ages of the petroleum and the reservoirs is somewhat limited. Since older rocks have had more time to erode or metamorphose, most reservoirs of petroleum occur in younger rocks. Most petroleum is produced from rocks of Cenozoic age (for example the Niger Delta Basin is of tertiary age), and less produced from rocks of Mesozoic and Paleozoic age**.**

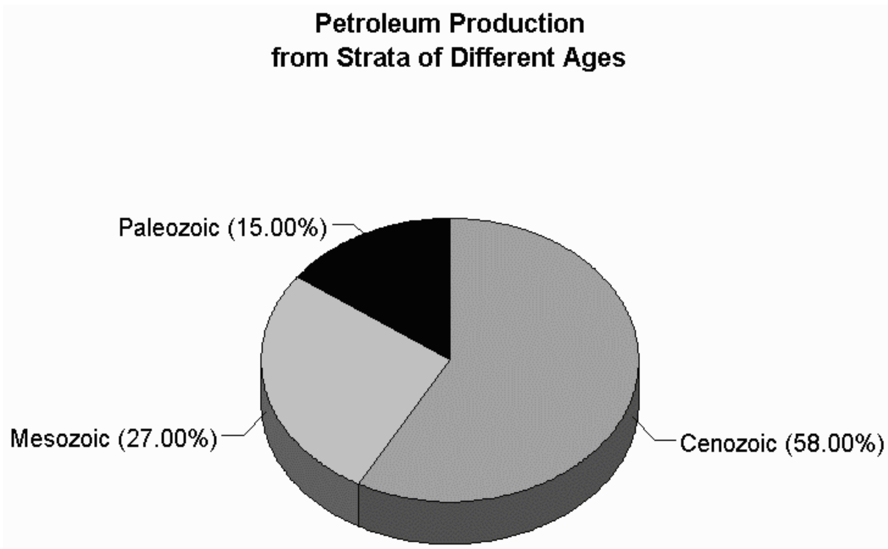


Figure: diagram showing petroleum production from strata of different ages.

Oil Shale and Tar Sands.

- *Oil shale* is a kerogen impregnated shale. Oil can be extracted from oil shales, but they must be heated to high enough temperatures to drive the oil out. Since this process requires a lot of energy, exploitation of oil shale is not currently cost-effective. Oil shale is considered a profitable energy resources when a ton of shale yields 40liters or more of oil when heated since heating a ton of shale is equivalent burning 40liters of oil. Oil shale is found in Brazil, china, most abundant in Colorado, USA. There are no oil shales in Nigeria but there are potential oil shale in Turonian Ezeaku shale (Lower benue Trough and the Lokpanta shales near okigwe, Imo State, Nigeria.

- ***Tar Sands*** are sandstones that have thick accumulations of viscous oil in their pore spaces. Extraction of this oil also requires heating the rock and is therefore energy intensive and not currently cost effective. They are richly found in Irele, Agbabu and Illubirin communities of Ondo state Nigeria.

Coal

Coal is a combustible sedimentary/metamorphic rock produced in swamps where there is a large-scale accumulation of organic matter from plants. As the plants die they accumulate to first become peat. Compaction of the peat due to burial drives off volatile components like water and methane, carbon (IV) through a process known as coalification thereby producing a black- colored organic- rich coal called ***lignite***. Further coalification results in the conversion of lignite to carbon rich **sub-bituminous coal** and **bituminous coal**. compaction and heating result. If the rock (bituminous coal) becomes metamorphosed, a high grade coal called ***anthracite*** is produced. However, if temperatures and pressures become extremely high, all of the carbon is converted to graphite. Graphite will burn only at high temperatures and is therefore not useful as an energy source. Anthracite coal produces the most energy when burned, with less energy produced by bituminous coal and lignite.

Coal is found in beds called ***seams*,** usually ranging in thickness from 0.5 to 3m, although some seams reach 30 m. The major coal producing period in geologic history was during the Carboniferous and Permian Periods, the continents were apparently located near the equator and covered by shallow seas. This type of environment favored the growth of vegetation and rapid burial to produce coal. Typical geologic formations in Nigeria where coal can be found are the Ogwashi-Asaba Formation in Delta State, Mamu and Nsuka Formations in Enugu state, Kabba Formation in Kogi Sate etc.

Known reserves of coal far exceed those of other fossil fuels, and may be our best bet for an energy source of the future. Still, burning of the lower grades of coal, like lignite and bituminous coal produces large amounts of waste products, like SO_2 and soot, that pollute the atmosphere. This problem needs to be overcome before we can further exploit this source of energy.

Environmental Impact Of Coal

Mining of coal is still a problem from an aesthetic point of view. Seams near the surface are often strip mined and backfilled, leaving temporary scars on the landscape. Deep coal seams have to be mined through tunnels, which often collapse, catch fire, or explode as a result of ignition of coal dust or methane released from the coal. Coal miners often suffer from black-lung disease from years of breathing coal dust.

Energy for the Future

Currently, society relies mostly on fossil fuels for energy (39% natural gas, 24% natural gas, 23% Coal, 8 % nuclear, and 6% other). Since fossil fuels are non-renewable sources of energy, at least in human lifetimes), we need to ask how much longer society can rely on this source. Further, what are the options for the future?

Non-Renewable Resources

First we look at the reserves of various non-renewable energy resources. Look at figure 14.28b in your text. Note that Uranium (for nuclear energy) and Coal appear to be most plentiful, while Tar sands and oil shale are currently not economical. The current known oil reserves will likely run out sometime between 2050 and 2150.

Currently we are consuming oil at a rate 3 times that of the discovery of new resources. Even in terms of 4,000 years of human history, the oil age will be very short lasting only 150 to 200 years.

Coal reserves could last for about 300 years if we can cope with the associated pollution. Natural Gas is cleaner and can probably last for another 200 years.

Nuclear seems like a good bet in terms of available resources, but can it be made cheap, clean, and safe? Will the recent problems with nuclear reactors during the March 11, 2011 earthquake have an effect on the future of nuclear energy?

Tar Sands and Oil Shale will require research to find more efficient way to extract, the resource, but will likely be necessary to replace oil in the short term.

Renewable Resources

Wind power is limited to areas with high consistent winds, and so is limited to very specific areas. The wind mills are not aesthetically pleasing to look at as it make a lot of noise and kill large numbers of birds, all problems that would need to be overcome to expand this resource. As for **hydroelectric resources**, they will not likely increase, since most rivers are already dammed and there are few places left where new hydroelectric facilities could be built.

Geothermal energy is limited to areas of known thermal activity (mainly recently active volcanic areas). It is a great local resource, but will never play a major role as an energy resource.

Solar energy is a huge source, but requires other resources (Li, Rare Earth Elements) to exploit. Many of these problems might be overcome with new research and the development of new technologies.

Hydrogen Fuel Cells are another promising resources with plenty of supply, but needs further research and technological deverole.

Mineral Resources	

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Mineral Resources

They refer to any naturally occurring, crystalline, inorganic geologic material having a definite chemical composition and can be exploited for domestic, commercial and industrial consumption. They differ from geologic resources as geologic resources refers to any valuable earth material. The material may not necessarily satisfy the requirements of mineral resources as highlighted above. For example, from the geologic point of view, petroleum is a geologic resource but not a mineral resource in that it is not crystalline and inorganic. In essence all mineral resources are geologic resources but not all geologic resources are mineral resources. Almost all Earth materials are used by humans for something. We require metals for making machines, sands and gravels for making roads and buildings, sand for making computer chips, limestone and gypsum for making concrete, clays for making ceramics, gold, silver, copper and aluminum for making electric circuits, and diamonds and corundum (sapphire, ruby, emerald) for abrasives and jewelry.

Mineral resources can be divided into two major categories - Metallic and Nonmetallic. Metallic resources are those which consist mainly of metals and are valuable source of metals like Gold, Silver, Tin, Chalcocite (Copper), Galena (Lead), Sphalerite (Zinc), hamatite (Iron), Nickel, Chromium, and Aluminum. Nonmetallic resources are things like sand, gravel, gypsum, halite, dimension stone.

Terms associated with mineral resources

Mineral Deposit: This refers to any rock volume/sediment having one or more mineral enrichment. For example a sandstone that is endowed or enriched with haematite is termed a mineral deposit. When the rock volume/sediment is endowed with one or more minerals of economic quantity, it is termed an **ore.**

Grade: This is the percentage concentration of desired mineral or element in a mineral deposit. For example the percentage content of hematite in the sandstone is known as as its grade.

Concentration Factor: This the ratio of economic mineral concentration to average crustal abundance of a mineral in a deposit. It is used to determine the mineral concentration that will be necessary for profitable exploitation.

The table below lists average crustal abundances and concentration factors for some of the important materials that are commonly sought. For example, Al, which has an average crustal abundance of 8%, has a concentration factor of 3 to 4. This means that an economic deposit of Aluminum must contain between 3 and 4 times the average crustal abundance, that is between 24 and 32% Aluminum, to be economical.

Substance	Average Crustal Abundance	Concentration Factor
Al (Aluminum)	8.0%	3 to 4
Fe (Iron)	5.8%	6 to7
Ti (Titanium)	0.86%	25 to 100
Cr (Chromium)	0.0096%	4,000 to 5,000
Zn (Zinc)	0.0082%	300
Cu (Copper)	0.0058%	100 to 200
Ag (Silver)	0.000008%	~1000
Pt (Platinum)	0.0000005%	600
Au (Gold)	0.0000002%	4,000 to 5,000
U (Uranium)	0.00016%	500 to 1000

Origin of Mineral Resources

The formation of mineral resources is traceable to three origins;

1) Magmatic origins
2) Sedimentary origin
3) Surface process-related origin

1) **Magmatic origin**; Mineral resources of this origin are the Hydrothermal deposit.

I) Hydrothermal Deposits; These are mineral deposits which are precipitated from cooling water-rich magma (Hydrothermal fluids) which were injected into fracture or pore spaces in crustal rocks. Hydrothermal deposits can assume forms of vein deposit, porphyry deposit or hot spring. Examples of hydrothermal deposits are the ore veins of chromium, Tin (Cassiterite) as well as diamond and Gold in fractures (veins) or pore spaces in rocks. Typical Nigerian examples are the Cassiterite veins in Precambrian and Jurassic rocks of Nigeria.

2) **Sedimentary origin:**

Although clastic sedimentary processes can form mineral deposits. Mineral resource of sedimentary origin refer to those formed by the chemical sedimentation, where minerals are precipitated directly out of water and such minerals are termed **sedimentary deposit.** Examples are:

Examples:

- **Evaporite Deposits -** Evaporation of lake water or sea water results in the loss of water and thus concentrates dissolved substances in the remaining water. When the water becomes saturated in such dissolved substance they precipitate from the water. Deposits of halite (table salt), gypsum (used in plaster and wall board), borax (used in soap), and sylvite (potassium chloride, from which potassium is extracted to use in fertilizers) result from this process. Typical Evaporite in Nigeria is Halite deposit of Okposi-Uburu in Ebonyi state, Nigeria.

- **Banded Iron Formations** – These refers to sedimentary rocks consisting of alternating bands of iron rich chert and iron bearing minerals that were deposited in basins within continental crust during the Proterozoic (2 billion years or older). They appear to be evaporite type deposits, but if so, the composition of sea water must have been drastically different than it is today. Prominent locations of banded iron formation in Nigeria are Itakpe, Ajabanoko, and Ogbomoso areas of Nigeria.

4) Surface process-related origin
These are mineral resources whose origin are traceable to processes of weathering, erosion, transportation, leaching etc. Examples are:

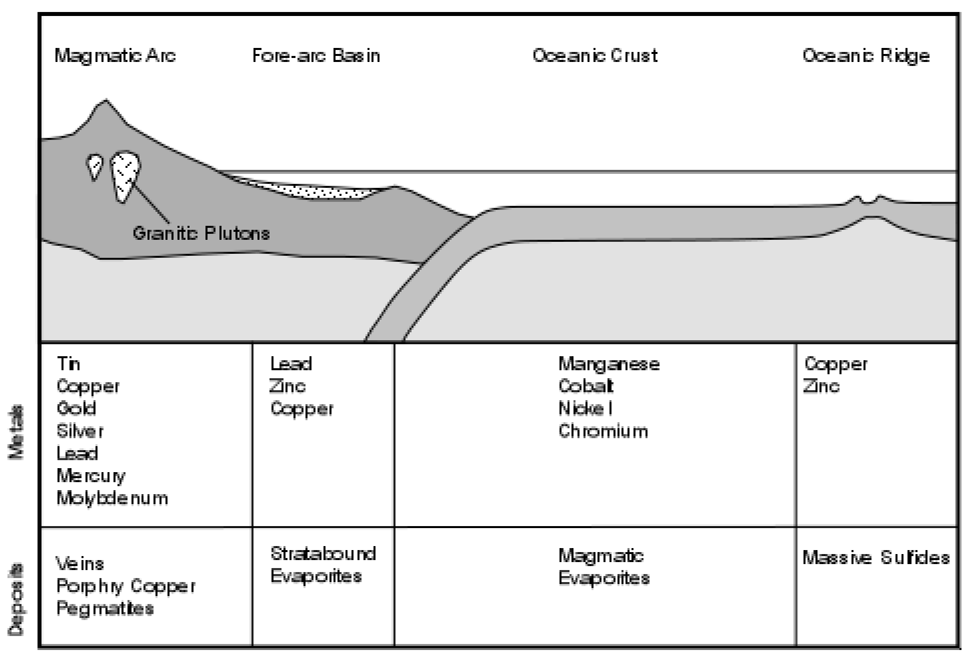
Placer Ore Deposits – These are minerals with high specific gravity that are found in stream sediment (point bars), plunge pool of water falls etc. They are traceable to weathering and transportation mineral bearing fragment from an ore body into streams. They occur in any area where current velocity is low, such as in point bar deposits, between ripple marks, behind submerged bars, or in holes on the bottom of a stream. The California gold rush in 1849 began when someone discovered rich placer deposits of gold in streams draining the Sierra Nevada Mountains. The gold originally formed in hydrothermal veins, but it was eroded out of the veins and carried in streams where it was deposited in placer deposits.

Residual Ore Deposits – These are mineral resources concentrated by the impact of intense chemical weathering in rocks. During chemical weathering and original body of rock is greatly reduced in volume resulting in dissolution and leaching of less soluble minerals thereby leaving behind the less soluble ones which accumulate to form residual ore deposits. by the process of leaching, which removes ions from the original rock. Laterites are typical examples of minerals formed via this process. The most important kind of laterites is *bauxite*, an ore of Aluminum, formed in tropical climates where high temperatures and high water throughput during chemical weathering produces highly leached lateritic soils rich in both iron and aluminum. Laterites are present in temperate regions such as Arkansas, France, China which implies these regions once had a tropical climate in the geologic past.

In addition, an existing mineral deposit can be turned in to a more highly concentrated mineral deposit by weathering in a process called *secondary enrichment*. A typical example is the leaching of exposed chalcopyrite to form an underlying layer of chalcocite, a process termed as supergene enrichment.

Mineral Deposits and Plate Tectonics

Because different types of mineral deposits form in different environments, plate tectonics plays a critical role in the location of different geological environments. The diagram to the right shows the different mineral deposits that occur in different tectonic environments.



Mineral Exploration and Production.

Ores are located by evidence of metal enrichment. Geologists look for hints in rocks exposed near the surface, for example, the enrichment process often results in discoloration of the soil and rock. When such hints are found, geophysical survey's involving measuring gravity, magnetism, or radioactivity are conducted. Geochemical surveys are conducted which analyze the composition of water, sediment, soil, rocks, and sometimes even plants and trees.

Once it is determined that a valuable material could be present, the deposit is assessed by conducting core drilling to collect subsurface samples, followed by chemical analysis of the samples to determine the grade of the ore If the samples show promise of being economic to mine, then plans are made to determine how it will me mined.

If the ore body is within 100 meters from the surface, open-pit mines, large excavations open to the air are used to extract the ore before processing. Open pit mines are less expensive and less dangerous than tunnel mines, although they do leave large scars on the land surface. If the ore body is deeper, or narrowly dispersed within the non-ore bearing rock tunneling is necessary to extract the ore from underground mines. Mine tunnels are linked to a vertical shaft, called and adit. Ores are removed from the walls of the tunnels by drilling and blasting, with the excavated ores being hauled to the surface from for processing. Underground mines are both more expensive and dangerous than open pit mines and still leave scares on the landscape where non-ore bearing rock is discarded as tailings.

Global Mineral Needs

Because the processes that form ores operate on geologic time scales, the most economic mineral resources are essentially nonrenewable. New deposits cannot be generated in human timescales. But, as mentioned previously, as the reserves of materials become depleted it is possible to find other sources that are more costly to exploit.Furthermore, mineral resources are not evenly distributed. Some countries are mineral-rich; some are mineral-poor.This is a particular issue for strategic mineral resources. These strategic metals are those for which economical source do not exist in the U.S., must be imported from other potentially non-friendly nations, but are needed for highly specialized applications such as national security, defense, or aerospace applications. These metals include, Manganese, Cobalt, Platinum, and Chromium, all of which are stockpiled by the U.S. government in case supplies are cut off.

How long current mineral resources will last depends on consumption rates and reserve amounts.Some mineral resources will run out soon, for example global resources of Pb, Zn, and Au? will likely run out in about 30 years. U.S. resources of Pt, Ni, Co, Mn, Cr less than 1 year. Thus, continued use of scarce minerals will require discovery of new sources, increase in price to make hard-to-obtain sources more profitable, increased efficiency, conservation, or recycling, substitution of new materials, or doing without.

Environmental Issues

Extraction and processing has large environmental impacts in terms of such things as air quality, surface water quality, groundwater quality, soils, vegetation, and aesthetics. Acid mine drainage is one example, Sulfide minerals newly exposed to Oxygen and water near the surface create sulfuric acid. Rainwater falling on the mine tailings becomes acidified and can create toxic conditions in the runoff. This can mobilize potentially dangerous heavy metals and kill organisms in the streams draining the tailings.

References

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