MINERAL RESOURCE EXTRACTION TECHNIQUES (WHICH TECHNIQUES ARE APPLICABLE IN PAKISTAN)

Course Title : NATURAL RESOURCE MANAGEMENT(ENV-403)



 SUBMITTED TO : MS. KASHMALA YOUSAF

SUBMITTED BY : TAYYAB RAZA [20 -UON-0793 ]

**Dept. of Environmental Sciences**

**UON**

## **Resources**

A resource is anything that can be useful, which covers quite a bit. In geology, we generally refer to things that can be commercially useful as resources, but not all resources are necessarily converted to money.

Resources can be classified as one of three types.

### Three Types of Resources:

* **Renewable**: resources that can be remade, regrown, refreshed, or regenerated within a reasonable human timespan. The keyword in the definition is "can". Because a resources is renewable doesn't mean it will be renewed, just that given the right conditions it is possible. Examples of renewable resources are food products and the plants, animals, fungi, and protists they come from in addition to other products.
* **Non-Renewable**: resources that take a lsaong time to form and also may only form under only special conditions - more than what is possible or practical for humans to wait for. Anything that cannot be renewed within a reasonable human timespan is considered non-renewable. Examples include all fossil fuels, minerals, and ore.
* **Perpetual**: gray area between renewable and non-renewable. Something that is in either infinite supply (for human purposes) like sunlight and wind, or which contains a supply that, even if it is technically non-renewable, it can be considered as such for humans, such as water.

### **Mineral Resources**

**Minerals** are inorganic compounds and elements with a regular crystalline structure found in the earth's crust that can be used for a variety of purposes.  Resources can often be obtained from minerals or mineral-like matter. This can be broken down into metallic and non-metallic mineral resources. In this definition, the word mineral is used loosely - things that do not technically meet the definition of a mineral can still be thought of as a mineral resource (as mineral-like matter, like volcanic glass).

Mineral resources can be organized into four main categories:

* **Identified Resources** :   Identified as having a known location, quality, and quantity.
* **Reserves** :   Resources that can be used in a cost effective manner given the current prices of the specified resource.
* **Undiscovered Reserves** :   Reserves of a given resource that are believed to exist.
* **Other Resources** :   Mineral resources that have not yet been discovered or identified resources that are not considered to be reserves.

All minerals that are valuable to humans and, therefore, economically desirable for extraction are collectively called **ore minerals**.

Some common and important ores include:

|  |  |
| --- | --- |
| **Ore** | **Metal/Use** |
| Argentite | Silver |
| Barite | Barium |
| Bauxite | Aluminum |
| Beryl | Gemstones |
| Bornite | Copper |
| Cassiterite | Tin |
| Chalcocite | Copper |
| Chromite | Chromium |
| Cinnabar | Mercury |
| Cobaltite | Cobalt |
| Galena | Lead |
| Gold | Gold |
| Hematite | Iron |
| Ilmenite | Titanium |
| Magnetite | Iron |
| Molybdenite | Molybdenum |
| Sphalerite | Zinc |
| Uraninite | Uranium |
| Wolframite | Tungsten |

## **Non-Metallic Mineral Resources**

Not all mineral resources are used to obtain metals. Some resources produce non-metallic items that can be used commercially. This includes many resources that become building materials.

|  |  |
| --- | --- |
| **Resource** | **Use** |
| Rock Salt | Food additive, aquarium supplies, snow/ice melt |
| Sand | Concrete, building materials, playgrounds, beach replenishment, glassmaking |
| Clay | Building materials, ceramics, art supply, pottery |
| Gypsum | Building materials (drywall) |
| Limestone | Road base, building materials, lime, cement |

## **Formation of Mineral Deposits**

Minerals can be formed through a variety of processes.

## **Extraction of Mineral Deposits**

Ores are not useful, generally, by themselves. They must be mined - removed from their native surroundings using tools or machinery. Although in ancient times, mining was performed with simple tools, modern mining requires extensive amounts of heavy machinery. A location where mining occurs is a mine, although mines may be used to obtain resources other than ores or mineral resources (coal, for example, is mined). There are several common types of modern mining:

### **Subsurface mining**

Sometimes minerals resources are far below the surface of the earth. In these cases, **subsurface mining** must be used. Subsurface mining is the digging of tunnels or shaft into the ground to obtain ores or other useful deposits and includes:

* **Shaft mining** - vertical shafts dug into the earth
* **Drift mining** - horizontal shafts dug into the earth
* **Slope mining** - diagonal shafts dug into the earth

The **room and pillar method** is the most popular technique for subsurface mining.   This type of mining involves cutting networks of open areas (or rooms) into horizontal layers of coal.   Pillars of solid coal are created and left in place for structural stabiliy

Another method of subsurface mining is called **solution** **mining**.Also known as **in-situ leach (ISL) mining**, this technique can be used to extract mineral resources that are soluble in water.   In solution mining hot water is forced into mineral ore followed by compressed air.   The air causes the solution of hot water and dissolved mineral ores to rise to the surface.

### **Surface mining**

Surface mining is the mining of materials at the surface where miners are under the sky, not the ground, and includes

* **Open-pit mining** is the removal of material through an open hole in the surface, usually quite wide.
* **Strip mining** is the removal of surface materials to allow access to shallow materials underneath.
* **Mountaintop removal** is the literal removal of a mountaintop to expose materials - this is common in coal mining.

In **surface mining** extraction occurs when **overburden** (layers of rock and soil on top of a mineral resource) is removed and discarded as a waste product.   Approximately 90% of non-fuel mineral resources and 60% of coal is extracted in the United States using surface mining.

## **Processing**

Mining alone is usually not enough to make use of most ores or other mineral resources. These ores and other resources generally must be processed before their final use. Bauxite, for example, contains aluminum which may eventually be useful. However, bauxite is not pure, and even bauxite, which is closer to purity, must have the bauxite separated from other nearby minerals that may have been attached, then remove the aluminum from the bauxite. **Smelting** is the process of melting a metal out of mineral ore. **Tailings** are the remnants left over from the ore after the metals have been removed. The tailings are generally not useful and must be disposed of, which often presents environmental concerns. (Human environmental impacts are discussed in a later module.)

**Mineral Resources of Pakistan Mining Methods**

Depending on the type and location of various minerals, different mining methods are used. These include:

**Open-pit or Open Cast Mining**

Used for mining of rocks or minerals which are on or near the surface e.g. iron ore, coal, limestone and chromite.

A layer of rock spread over the mineral is first removed. This layer is called “overburden”.

Overburden is removed by giant excavators and power shovels and mining starts.

The mineral is then scooped up and loaded on lorries or railway wagons and carried to the respective destinations.

This method of mining is much cheaper and less dangerous and involves less time and labour as compared to other methods of mining.

**Adit-tunnel or Adit Mining**

Used to mine those minerals that have been exposed as a result of human efforts or erosion along the hill slopes e.g., a coal seam on a hillside.

Now, in order to reach deeper layers of the minerals, a tunnel is bored along the hill slope.

This tunnel may be horizontal or may be parallel to the slanting seams of the mineral up   or down the slope.

An example of this type of mining is found at the Scr coalfield near Quetta. It is cheaper than the shaft mining.

**Shaft-tunnel or Shaft Mining**

Used to extract deeply placed minerals that are not exposed to the surface.A vertical shaft is bored downwards to the place where mineral deposits are present. Powerful boring devices are used for this purpose.

Tunnels are then excavated in different directions depending on the slope and location of minerals which are excavated on the surface and loaded on lorries or railway wagons.

As compared to Open-pit and Adit types, Shaft mining is most expensive and dangerous.

**Problems / hazards associated with the Adit and Shaft Mining methods**

Both are expensive as both involve powerful and huge machinery.

Both involve a lot of labour and time.

Poisonous gases filled in the mine may suddenly leak and cause serious injury to the miners and may even prove fatal.

Pockets of water present in the mine may get punctured due to the use of heavy vibrating machinery and the subsequent flood may prove fatal for the workers inside the mine or cause them injury.

Perhaps the most serious accident comes in the form of the collapse of the mine roof and this poses very serious danger to the miners who may even die as has happened several times in many countries.

**Measures to Minimise Dangers**

Making carefully prepared feasibility reports based on detailed surveys and maps.

Training the miners to cope with any emergency situation.

Providing miners with appropriate safety devices like masks and safety lamps.

**Hand-panning Method**

This is used to sift gold / silver particles from a mixture of the particles of sand and gravel.

Grains or particles of the precious metal from its exposed veins are carried away and deposited in river sand and gravel.

The whole mixture is collected in a pan and the metal particles are separated by skilful shaking of the pan.

Practised in northern mountainous regions and might be used in the copper, gold and silver mines of Saindak in south-western Balochistan.

**Quarrying**

It is the excavation of rock or mineral from an open working on the surface.

Many minerals, especially those used as building material, are quarried such as limestone, sandstone and granite.

A number of methods and tools are used in quarrying and they include hand tools, explosives and power saws.

Use of tools depends on the purpose for which the mineral is quarried and the degree of accessibility

Major hand tools include drill, wedge and hammer.

Wedge is driven by a hammer to split a big lump of rock into two smaller pieces or to chip pieces off a big rock.

**Drilling**

Drilling method is used to tap oil and gas.

Oil, gas and coal are collectively known as the fossil fuels as they are formed from decomposition of organic matte (animals & vegetation) over a period of several million years.

As a result, oil and gas in particular are located hundreds of meters underground or even under the seabed.

Mineral (rock) oil is located in porous spaces of sedimentary rocks (a rock formed from pre-existing rocks).

Major location is in dome-shaped anticlines (the arch or upfold in layers of rock strata) between two layers of non-porous rocks that constitute an oil trap since the mineral oil is literally trapped with gas above and water below.

After locating the drilling site, a derrick or drilling rig (a very tall steel structure that holds the drilling pipes and other equipment) is set up.

Wells are drilled to greater depths to pump mineral oil from the ground.

Occasionally, the oil leaks up to form puddles on the surface and this saves a lot of labour and expenses.

**Difficulties in fully exploiting the mineral wealth of Pakistan**

In spite of having rich deposits of various minerals, Pakistan has not been able to maximally tap this potential because of the following reasons:

**Lack of finance**

Most of the spending is made on non-developmental schemes like defence and debt servicing.

Lack of technical expertise and modern equipment like satellite imaging. Pakistan does not produce a great number of mining engineers.

Geographical constraints like climatic hazards and inaccessible areas.

Poorly functioning mining institutes as mismanagement and corruption have become recognised factors in Pakistan.

Lack of political will and the element of inconsistency also contribute to poor progress shown by the mining sector. A glaring example is the Saindak Copper Project that continued to face various bottlenecks throughout the 1990s.

Successive governments have failed to give any priority to the mining sector.

**Steps taken by the Government to develop the mining industry**

Various organizations have been set up that include:

Pakistan Mineral Development Corporation (PMDC)

Geological Survey of Pakistan (GSP) and Survey of Pakistan. The two bodies make efforts to develop minerals.

Resource Development Corporation, exclusively set up to develop the Saindak Project.

Gemstone Corporation of Pakistan (GCP) to explore and exploit gemstone reserves.

he Government announced the National Mineral Development Policy in 1995 to attract foreign investment in order to promote the mining activities at provincial level.

It was supposed to have developed the Mineral Investment Facilitation Authority (MIFA) but unfortunately it has not been fully successful.

The Central Government is considering to give the mining sector to the respective provincial governments.

**Effects of mining on the environment**

Mining is a human activity and it has a number of undesirable effects.

Large scale mining involves several processes that eventually cause environmental degradation.These include:

Deforestation as trees are cut down in order to clear land and to construct houses for the miners and such infrastructure facilities as roads and lines of communication.

As a result of removing vegetation cover, soil is exposed to eroding agents (wind and water) and the natural landscape is deformed.

Blasting of rocks involves heavy explosion that causes cracks on the adjacent land surface and causes dangerous vibrations and noise pollution.

Digging of earth in the underground mining causes craters and depressions that may become flooded in the rainy season if left unfilled.

Mining waste causes surface pollution if it is disposed untreated. The same waste pollutes ground water if it leaks to rivers and lakes and thus poses serious health hazards.

Most of the miners in Pakistan are constantly exposed to the particles of various minerals as they are not provided with any safety devices and hence they are likely to develop a number of respiratory and digestive system ailments.

The same dust and smoke pollutes the air in general and may affect the health of people living in the neighbouring areas.

**How to protect our environment against mining hazards**

Scientific planning should be done before starting the mining activity.

Miners should be provided with a properly designed kit that maximally protects their skins, eyes and breathing apparatus. Moreover, there should be better health, education and housing arrangements for them.

Arrangements should be made to treat the waste of mining so that it does not pollute air and water. Proper waste disposal units should be developed.

Water treatment plants should be set up to keep water clean and uncontaminated.

Steps should be taken to protect the environment from the after effects of mining activity. For example, filling of craters and reafforestation schemes.

Research programs should be encouraged to devise ways to make mining pursuit as much environment friendly as possible.

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