

## Building\_and\_Construction\_Materials

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## Non-Metallic (Industrial) Minerals



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### Introduction

Virtually everything we **use** or **build** or **create** in modern life **involves rock, mineral and fuel resources** taken from the Earth

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**Introduction.....contd.**

Earth has **92 natural elements**. About **99.7%** of it's crust is comprised of only **EIGHT** of these:

Oxygen	O	46.3%
Silicon	Si	28.2%
Aluminum	Al	8.2%
Iron	Fe	5.6%
Calcium	Ca	4.1%
Sodium	Na	2.4%
Magnesium	Mg	2.3%
Potassium	K	2.1%
Titanium	Ti	0.5%

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**Introduction.....contd.**

The remaining 0.3% contains a staggering number of rocks and minerals that are useful to modern society, but only occur in very limited quantities in nature

In fact, many resources are extremely rare...



**Gold**



**Diamonds**

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**Introduction.....contd.**

- The **EIGHT** common elements combine with 1000's of rare elements to form +/- 3,000 different minerals
- Key here is that:
  - Each mineral is potentially a resource, if people find a use for it.
- Minerals are valued primarily for their mechanical or chemical properties
  - As technologies evolve, so too do the related values of mineral resources.

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**Introduction.....contd.**

- Minerals are either *metallic* or *nonmetallic*
- Weight-wise, 90% of minerals that humans use are **nonmetallic!!**
- **Metallic minerals** have other, economic-based value...

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**Introduction.....contd.**

- 90% of **nonmetallic** mineral extraction is used for:
  - Building materials
    - Building stones / large stones
    - Coarse gravel
    - Fine sand

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**Non Metallic (Industrial/Building) Materials**

These are **rocks, minerals,** or other **naturally occurring** substance:

- of **economic value**, but which generally **excludes metals, fuels, & gemstones.**

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**Nonmetallic/Industrial Material Occurrences**

After finding rock / mineral deposits that appear to have possibilities to be commercially exploited, the following factors must be given attention:

- Location, with respect to transportation & market
- Amount & quality of desired material
- Ease with which to mine it
- Its amenability to concentration / processing
- Availability of water, fuel, power, or other necessary raw material.

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**Classification of industrial Rocks**

Two of the methods of classification include:

**1. Genetic classification** – how they formed. Industrial ROCKS fall into;

**A. Igneous Rocks** – Granite, Basalt & Diabase, Diorite, Pumice,.....etc.



**Granite**

**Basalt**

**Pumice**

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**Classification of industrial Rocks**

**B. Metamorphic Rocks** – Gneiss, Slate, Quartzite, Marble...



**Marble**

**Gneiss**

**Quartzite**

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### Classification of Industrial Rocks

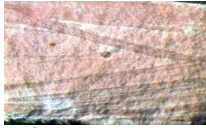
C. **Sedimentary Rocks** – Sandstone, Gypsum, Sand & gravel; Salt, Clay, Limestone & dolomite, Phosphate rock....



Crystalline Limestone



Gypsum



Sandstone

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### Classification of Industrial Minerals

1. **Genetic classification** – how they formed. Industrial MINERALS fall into;

a) **Igneous Minerals** – Mica, Nepheline, Feldspar, Lithium minerals, Beryl....



Feldspar



Mica

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### Classification of Industrial Minerals

➤ **Vein & Replacement Minerals** – Quartz crystal, Fluorspar, Barite, Magnesite...



Quartz Crystal



Fluorspar



Barite

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**Classification of Industrial Minerals**

**b) Metamorphic Minerals** – Vermiculite, Talc, Graphite, Asbestos ...



**Graphite**



**Asbestos**



**Talc**

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**Classification of Industrial Minerals**

**d) Sedimentary Minerals and sulfur** – Diamond, Diatomite, Borate, Potash minerals, Sodium minerals, Nitrates, Sulfur



**Diamond**



**Calcium Nitrate**



**Sulphur**

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**Importance of Industrial Minerals**

INDUSTRIAL MINERAL	USE(S)
Silica sand, limestone, soda ash, borates, feldspar, lithium	Glass/glasses, light bulbs
Kaolin, feldspar, talc, wollastonite, borates, alumina, zirconia	Ceramic tiles, plates, mugs, etc.
TiO <sub>2</sub> , kaolin, mica, talc, wollastonite, silica	Paint
Talc, kaolin, mica, wollastonite, flame retardants (ATH, Mg(OH) <sub>2</sub> )	Plastic white goods, e.g. fridge, washer
Treatment materials: lime, zeolites	Drinking water
Borates, soda ash, phosphates	Detergents & soaps
Gypsum, flame retardants	Wallboard, plaster
Marble, granite	Surfaces

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**Examples of Industrial 'Minerals' & their Uses**

**1. Limestone/Calcite**

- is a **sedimentary rock** composed largely of **Calcite** (calcium carbonate – CaCO<sub>3</sub>)
- often contains variable amounts of **silica** in form of **chert** or **flint**, as well as varying amounts of **clay, silt** and **sand**.



Limestone



Calcite

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**Uses of Limestone**

- The manufacture of **quicklime** (calcium oxide) and **slaked lime** (calcium hydroxide)
- **Cement** and **mortar**
- Pulverized limestone is used as a soil conditioner to neutralize acidic soil conditions
- Crushed for use as **aggregate** – the solid base for many roads
- Is popular in **architecture** as building stone
- Used in Glass making
- Used in Toothpaste
- Added to flour as a source of calcium

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**2. Sand**

- a naturally occurring **granular material** comprised of **rock & mineral** particles.
- transported by wind & water & deposited in the form of **beaches, dunes, sand bars**.
- Mainly constituted of **silica (SiO<sub>2</sub>)**, usually in the form of **quartz, iron oxides, zircon, rutile, ilmenite, monazite, garnet**.

**Heavy mineral sands** are a class of **ore** deposits that are an important source of **rare earth elements, & industrial minerals of diamond, sapphire, garnet...**

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*Uses of sand*

- Sand is often a principal component of **concrete**.
- It is the principal component in **glass** manufacturing.
- Graded sand is used as an **abrasive** in **sandblasting** and is also used in **media filters** for filtering **water**.
- **Brick manufacturing plants** use sand as an additive + a mixture of **clay** and other materials for manufacturing bricks.
- Is sometimes mixed with **paint** to create a **textured** finish for walls, ceilings or a non-slip floor surface.
- **Railroads** use sand to improve the traction of wheels on the rails.

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**Other Minerals and their Uses**

*Metallurgical Processes*

- Bauxite
- Iron oxide
- Silica
- Barite
- Quartz
- Pumice
- Dolomite
- Graphite
- Magnesite
- Asbestos

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**Other Minerals and their Uses.....contd.**

*Chemicals' Industry*

- Barite
- Bauxite
- Dolomite
- Limestone
- Lithium
- Pumice
- Magnesite
- Borates
- Phosphates
- Zeolite

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**Other Minerals and their Uses.....contd.**

**Agricultural Sector**

- Phosphates
- Borates
- Clays
- Perlite
- Dolomite
- Talc
- Vermiculite
- Peat

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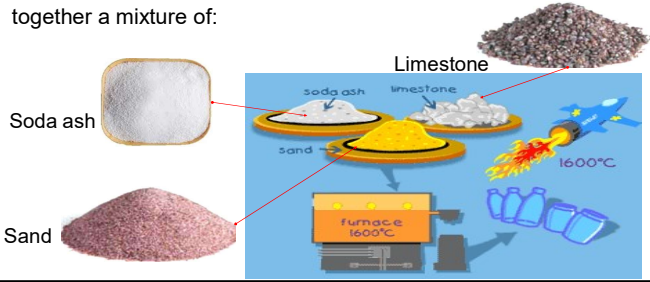
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**In the Manufacture of Glass.....**

...there are many different types of glass, each with its own properties and uses, but all essentially made by heating together a mixture of:



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**Construction Materials**

In this section, we shall discuss, especially:

- Aggregate, and
- Brick

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**a) Aggregate**

- Collective term for **sand, gravel & crushed stone** mineral materials **in their natural/processed state.**
- Roads & highways constitute largest single use of aggregate at 40 percent of total usage.



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**a) Aggregate – Origin & Production**

- Can either be **natural** or **manufactured**
- **Natural aggregates** – generally extracted from larger rock formations from quarrying (open excavations)
  - **Manufactured rock** – typically consists of industrial by-products, e.g. slag (by-product of metallurgical processing of **steel, tin & copper**)

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**a) Aggregate – Physical Properties**

- **Toughness & resistance to abrasion** – Aggregates **must be hard & tough** enough **to resist crushing, degradation & disintegration** from activities, e.g. *manufacturing, stockpiling, placing & compaction.*
- **Durability and soundness.** Aggregates **must be resistant to breakdown & disintegration** from weathering (wetting/drying), or else, they might break apart prematurely & cause pavement distress.

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**a) Aggregate – Physical Properties.....contd.**

➤ **Particle shape & surface texture** – are important for proper compaction, load resistance & workability.

Generally, **angular-shaped particles** with a **rough surface texture** are best.

materials that are dangerous to health, or which might cause failures in buildings, or are damaging to environment.

➤ **Cleanliness & deleterious materials** – **Aggregates must be clean**.... vegetation matter, soft particles, clay lumps, & excess dust might prevent binder-aggregate bonding & affect performance by quick degradation.

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**b) Brick**

➤ Most bricks are made from some form of clay, while

➤ Others are made of concrete, crushed rock aggregate, and Portland cement, while

➤ yet others, are **made from sand & lime**, sometimes with addition of crushed flint.

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**Types of Brick**

➤ **Common unit** - suitable

for general construction, with no special claim to give an attractive appearance.



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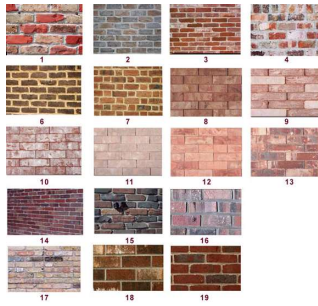
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*Types of Brick.....contd.*

➤ **Facing unit -**

specally made, or  
selected, to give an  
attractive appearance  
to building.



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*Types of Brick.....contd.*

- **Engineering brick-** fired clay brick, having a dense and strong semi-vitreous body, conforming to defined limits for water absorption and compressive strength
- **Soft mud bricks-** most economical, burned at high temperature to achieve strength.

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*Uses of Brick*

- In metallurgical industry glass industry for lining furnaces.
- Used as a refractory (silica, magnesia bricks)
- Used to make walls, fences, barbeques, etc.



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**General Properties of Brick**

- Hard
- Compact
- Durable
- Cheap
- Come in several earth-tone colors.
- Holds heat well/insulates.

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**Characteristics of Industrial Minerals**

**Geologically**, most industrial minerals:

- are widespread
- have enormous reserves
- are easily accessible

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**Characteristics of Industrial Minerals.....contd.**

**Economically:**

- development of industrial minerals needs less investments
- are cheaper to obtain
  - If they are closer to the market
  - As some specialty minerals demand a higher market price than metals.

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**Characteristics of Industrial Minerals.....contd.**

**Technologically**, industrial minerals:

- need less processing
- need less energy
- have less –ve impact on the environment
- possess exceptionally attractive properties for industry.

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**Characteristics of Industrial Minerals**

- *Without a market, an industrial mineral deposit is merely a geological curiosity.*
- Demand for IMs feeds back from the end-use market, to the end product, to the intermediate end product, and back to the mineral supplier.

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**Geological Characteristics of Industrial Minerals**

Geologically, most of the industrial minerals:

- are widespread
- have enormous reserves
- are easily accessible

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**Economic Characteristics of Industrial Minerals**

Economically, development of IMs

- needs less investments
- is cheaper to obtain
  - If they are closer to the market
  - As some specialty minerals demand a higher market price than metals.

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**Technological Characteristics of Industrial Minerals**

Technologically, IMs:

- need less processing
- need less energy
- have less –ve impact on the environment
- possess exceptionally attractive properties for industry.

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**Importance of Industrial Minerals**

- existence and performance of a Mineral consuming market directly affects demand for mineral raw materials, i.e. industrial minerals
- When there is no market demand, there will be no mineral supply, & therefore, no mineral development

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**Factors influencing Industrial Minerals' Pricing**

These include:

- Source & Volume of mineral
- Quality of mineral dictated by desired end use
- Further processing requirements
- Freight/shipping costs of mineral.

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**Factors influencing Industrial Minerals' Pricing.....contd.**

- Port handling
- Warehousing/storage costs
- Mineral inspection & Insurance costs
- Relationship of buyer & seller

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**Geologist's place within Industrial Rocks and Minerals' sector:**

- 1- Fundamental geologic research
- 2- Searching for new deposits
- 3- Appraisal of mineral properties
- 4- Searching for extensions of known deposits

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**Summary & Conclusions**

Industrial Minerals:

- are high volume, low value, but vital commodities
- are prerequisite raw materials for a wide range of industrial and domestic products
- Supply is driven by Market demand
- supply chain employs people & businesses.

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**End of lecture**

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