INDUSTRIAL / CONSTRUCTION MATERIALS & CONCRETE

1. Non-Metallic (Industrial / Building) 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

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%

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.

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…*

Introduction.....contd.

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

Non-Metallic (Industrial/Building) Materials

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

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

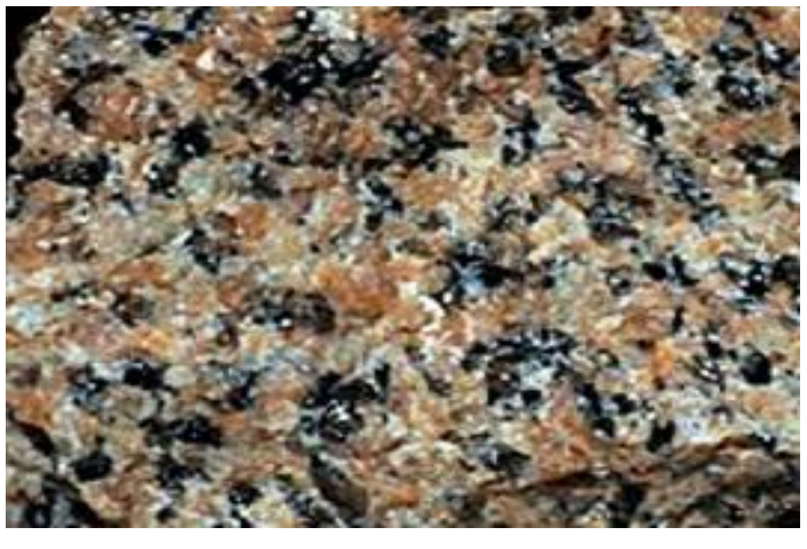
Classification of Industrial Rocks

Two of the methods of classification include:

1. **Genetic classification** – how the have formed.

   Industrial ROCKS fall into;

   A. Igneous Rocks – Granite, Basalt & Diabase, Pumice and pumicite….



Granite

Basalt

Pumice

Classification of Industrial Rocks…..contd.

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

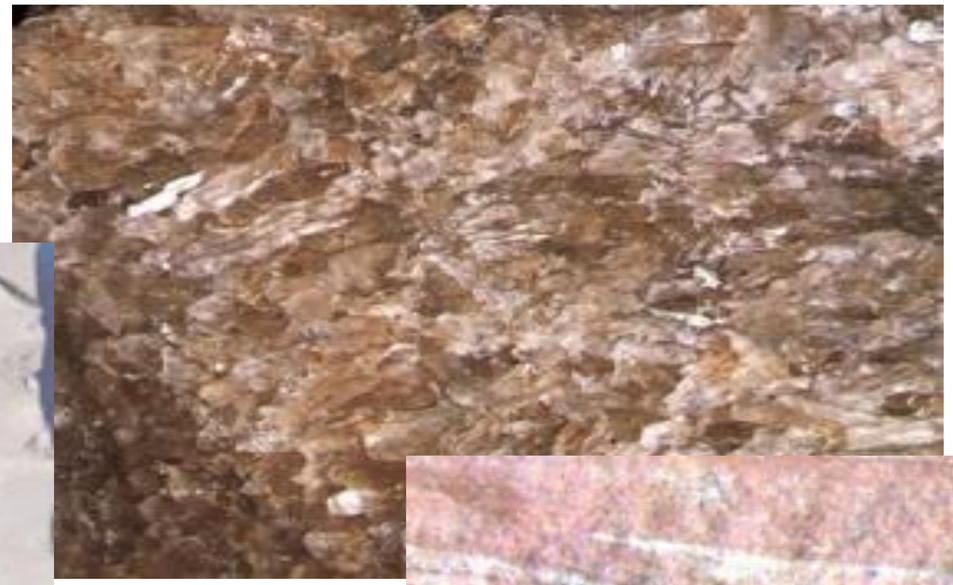
Marble

Gneiss

Quartzite

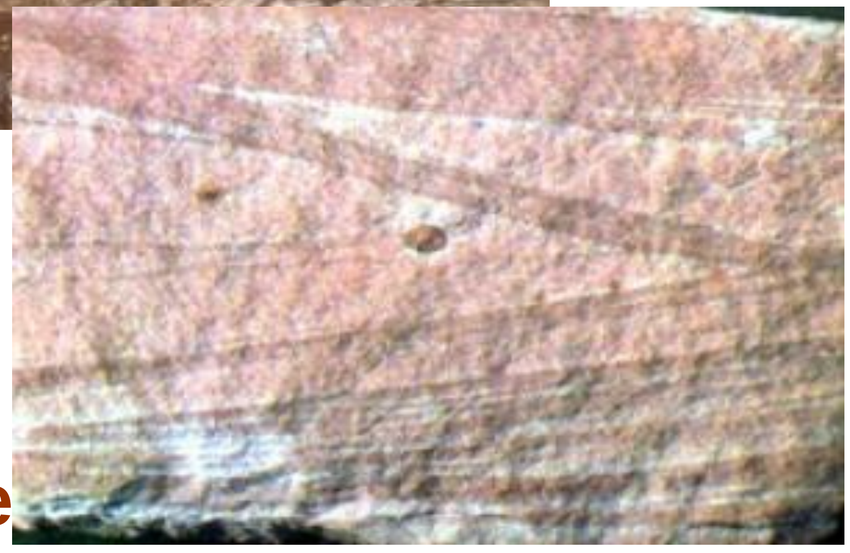
Classification of Industrial Rocks…..contd.

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



Gypsum

Crystalline Limestone



Sandstone

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

Classification of Industrial Minerals…..contd.

B. Vein & Replacement Minerals – Quartz crystal, Fluorspar, Barite, Magnesite…

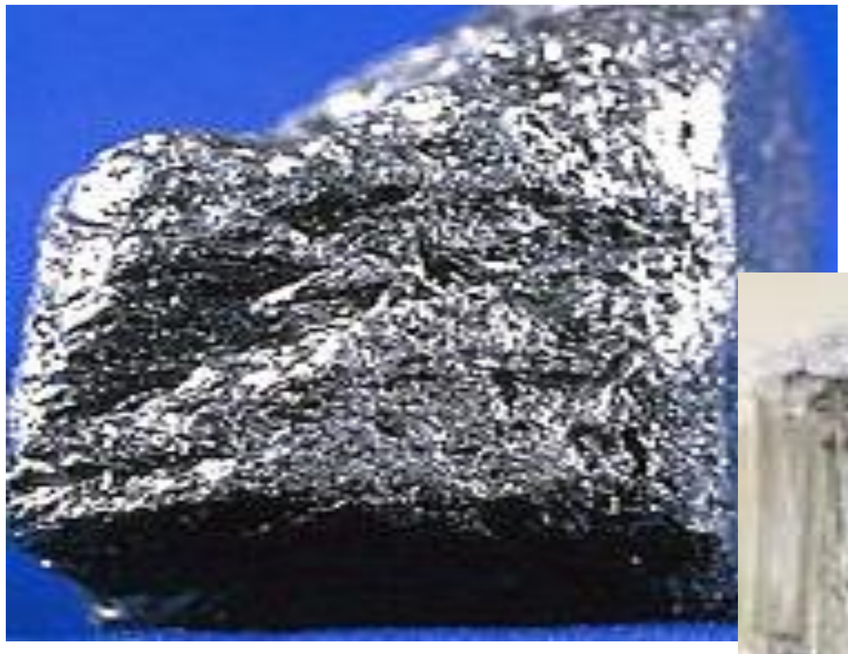
Quartz Crystal

Fluorspar

Barite

Classification of Industrial Minerals…..contd.

C. Metamorphic Minerals – Vermiculite, Talc, Graphite, Asbestos …



Graphite

Asbestos

Talc

Classification of Industrial Minerals…..contd.

D. Sedimentary Minerals and sulfur – Diamond, Diatomite, Borate, Potash minerals, Sodium minerals, Nitrates, Sulfur

Diamond

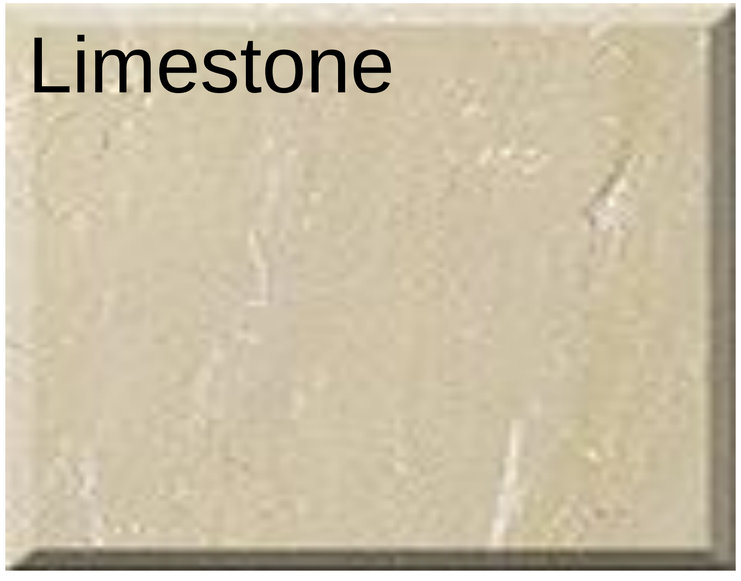
Calcium Nitrate

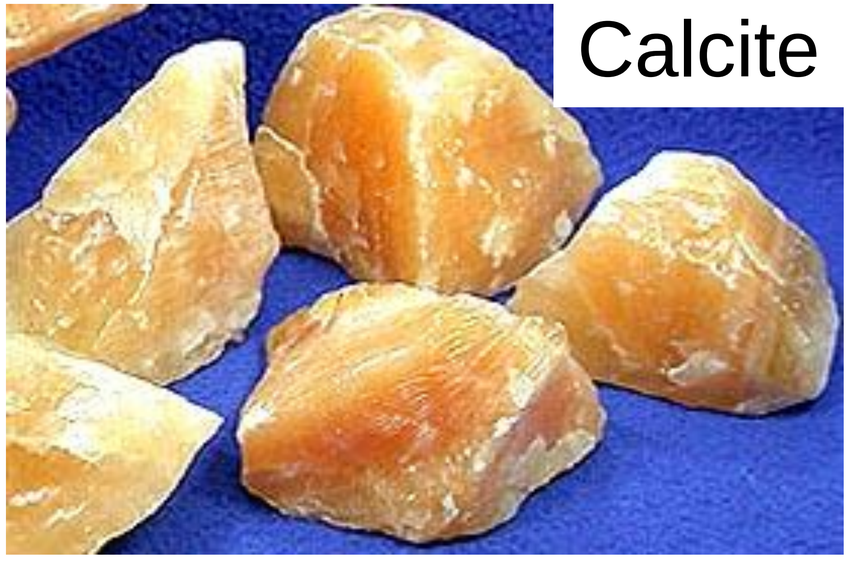
Sulphur

Examples of Industrial Minerals & their Uses

1. Limestone/Calcite

- is a sedimentary rock composed largely of Calcite (calcium carbonate – $CaCO_3$)
- often contains variable amounts of silica in form of chert or flint, as well as varying amounts of clay, silt and sand.





Construction Materials

In this section, we shall discuss:

- Aggregate
- Asphalt
- Brick

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.

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)

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.

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.

Asphalt

- Is also known as **bitumen**
- Is dark brown to black, in colour
- Is hydrocarbon product of petroleum distillation residue.
- At least 80% carbon, which explains its deep black color, & has sulphur.
- Primarily used as sealant for rooftops & a durable surface coat for roads, airport runways, playgrounds & parking lots.

http://www.ekocozum.com/blog/wp-content/uploads/2008/05/asfalt.jpg

Types of Asphalt

Two major types are used

in construction:

- Rolled asphalt
- Mastic asphalt.

1) Rolled Asphalt

- Made of *aggregate, or solid materials,* e.g., sand, gravel, or recycled concrete, with an asphalt binder.

- Used to make roads & other surfaces, e.g., parking lots, by being applied in layers and compacted.

- Different types of rolled asphalt are distinguished according to process used to bind aggregate with asphalt.

Types of Rolled Asphalt

a) Hot mix asphalt concrete (HMAC)

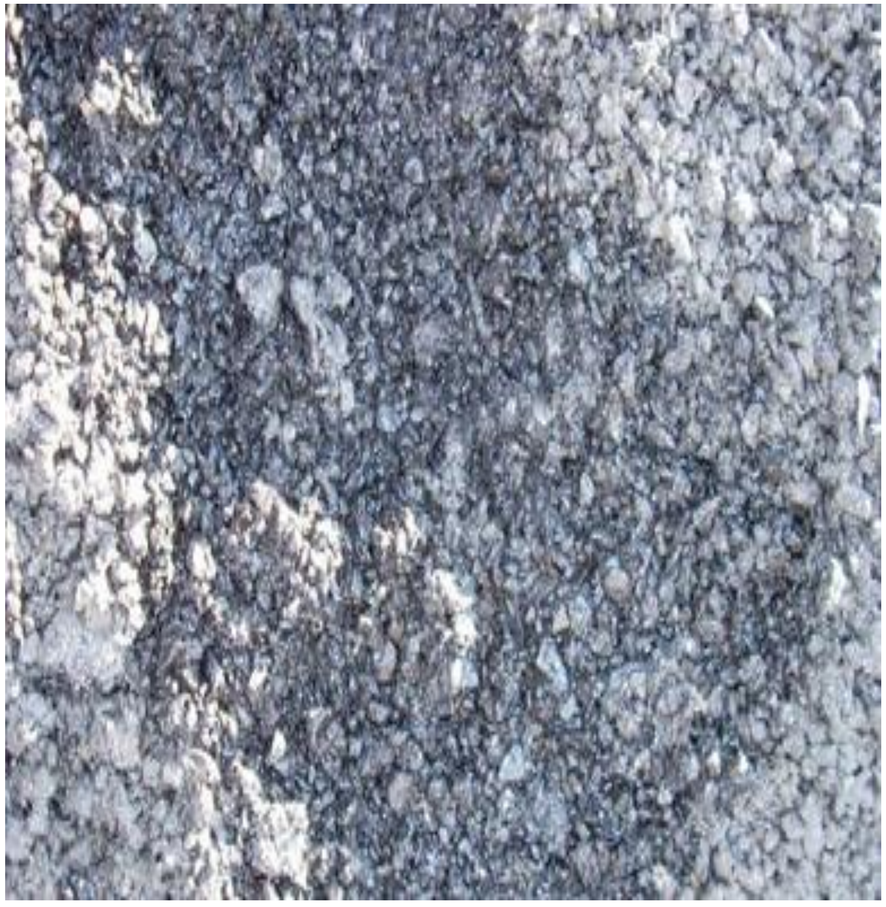
- Is roduced at 160^{o} C.
  - this high temperature serves to decrease viscosity & moisture during manufacturing process, resulting in a very durable material.

- is most commonly used for high-traffic areas, e.g., busy highways and airports.

Types of Rolled Asphalt…..contd.

b) Cold mix asphalt concrete,

- Is emulsified in soapy water before mixing it with aggregate, to eliminate need for high temperatures altogether.
- The asphalt produced is not nearly as durable as HMAC
- Is typically used for low traffic areas, or to patch damaged HMAC.



2) Mastic Asphalt

- Is also called sheet asphalt.
- Has lower bitumen content than rolled asphalt.
- Is used for some roads and footpaths.
- Also used in roofing and flooring.

2) *Mastic Asphalt…..contd.*

- Stone mastic asphalt (SMA), is another variety.
- Becoming increasingly popular as an alternative to rolled asphalt.
- Benefits include
  - Anti-skid property
  - Absence of air pockets

But if improperly laid, it might cause slippery road conditions.

3) Brick

- Masonry unit (pieces of bricks and stone used to make a building) and does not infer any particular material (bricks can be made from different materials/soils)

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

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

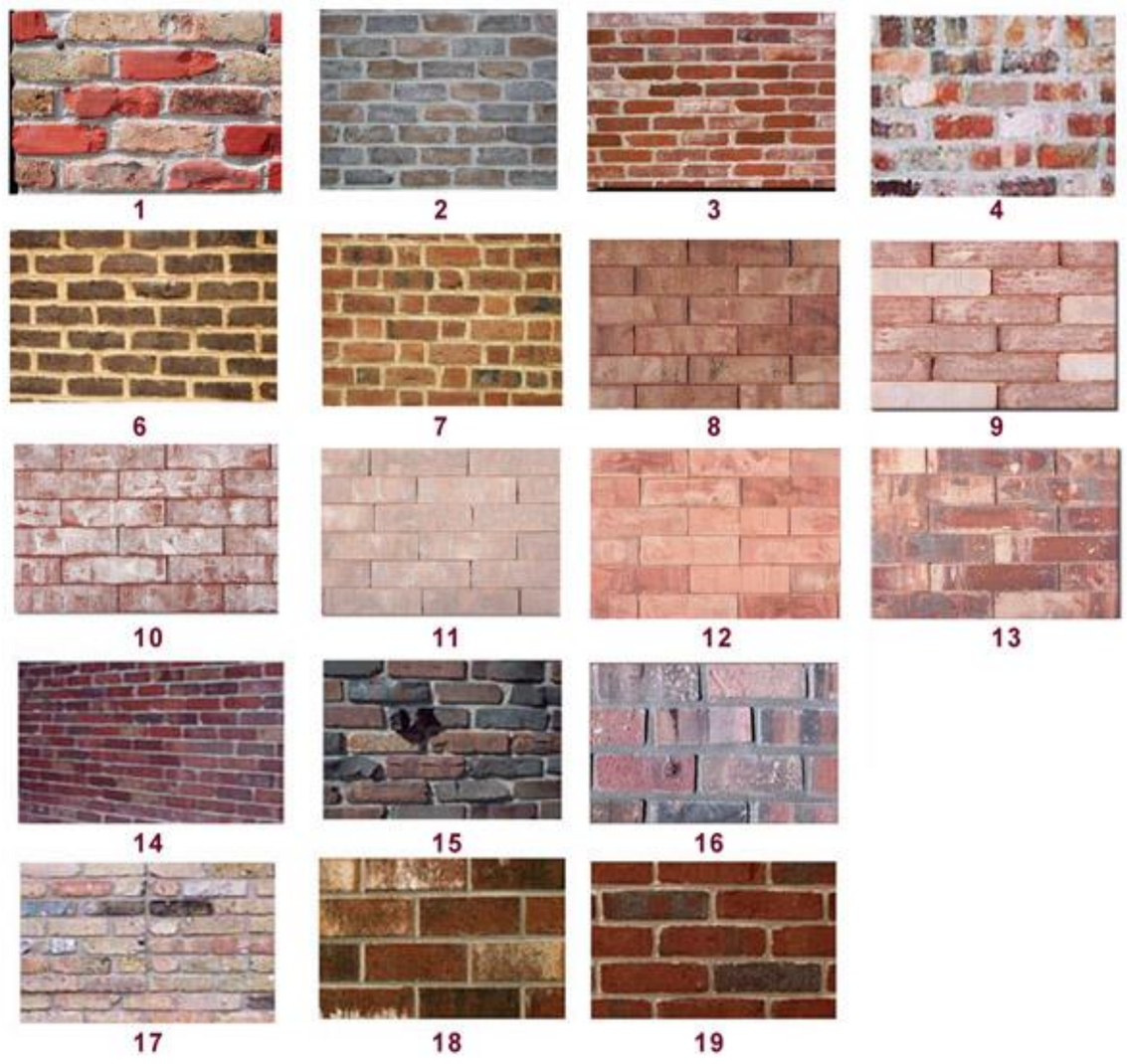
- yet others, are made from sand & lime, sometimes with addition of crushed flint.

Types of Brick

- **Common unit** - suitable for general construction,with no special claim to give an attractive appereance.

Types of Brick…..contd.

- **Facing unit** - speacilly made, or selected, to give an attractive appearance to blg.



Types of Brick…..contd.

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

Uses of Brick

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

General Properties of Brick

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

Characteristics of Industrial Minerals

Geologically, most industrial minerals:

- are widespread
- have enormous reserves
- are easily accessible

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

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

Characteristics of Industrial Minerals…..contd.

- *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.

Characteristics of Industrial Minerals…..contd.

- 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

Characteristics of Industrial Minerals…..contd.

Factors influencing Industrial Minerals' pricing

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

Characteristics of Industrial Minerals…..contd.

Factors influencing Industrial Minerals' pricing *(contd.)*

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

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

End of lecture