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# **INDUSTRIAL / CONSTRUCTION MATERIALS & CONCRETE**

# 1. Non-Metallic (Industrial / Building) Minerals



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# Introduction

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

# Introduction.....contd.

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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.

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- 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.

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- 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.

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

# Non-Metallic (Industrial/Building) Materials

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

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

# ***Classification of Industrial Rocks***

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Two of the methods of classification include:

**1. Genetic classification** – how they 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**



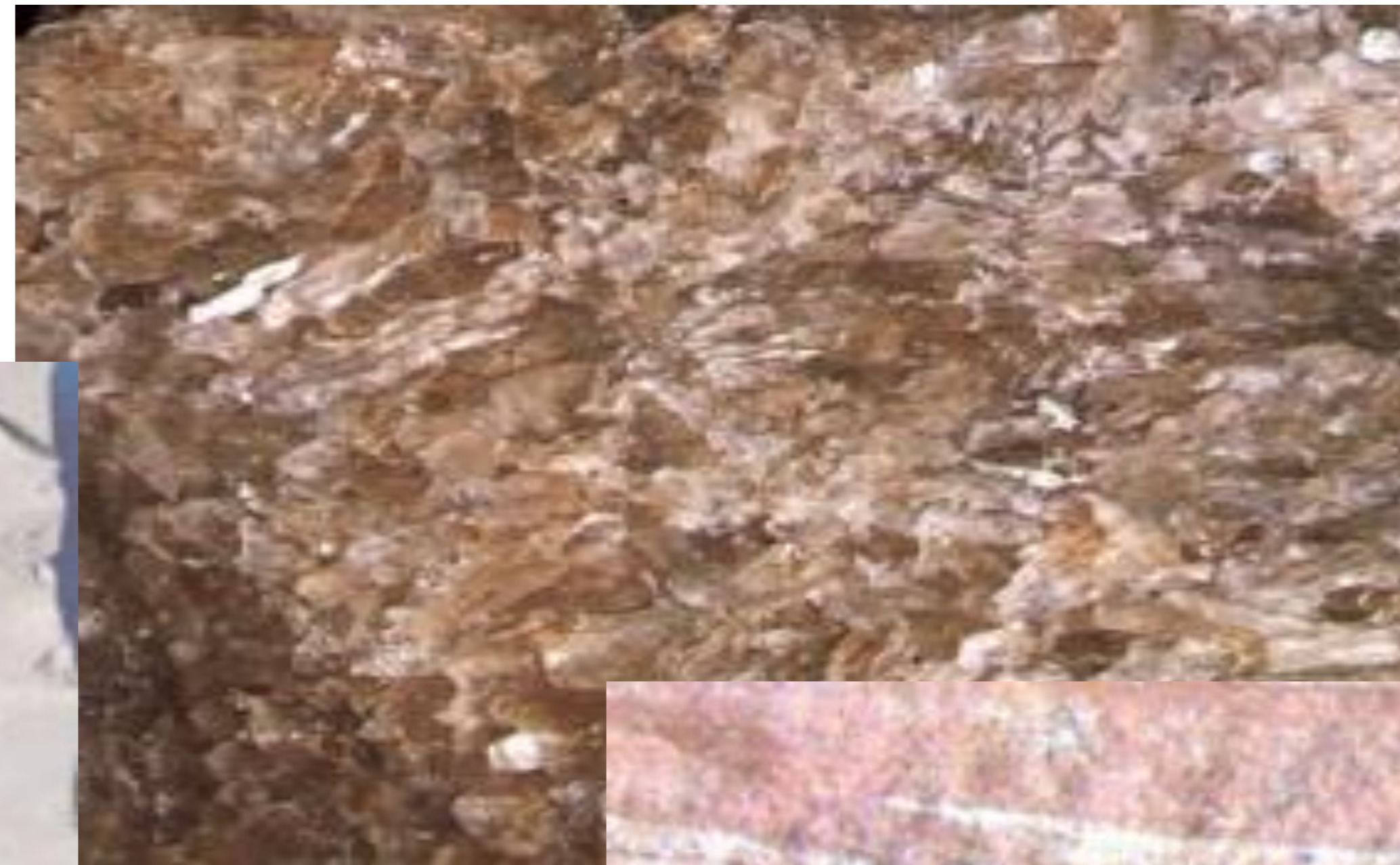
**Gneiss**



**Quartzite**

# ***Classification of Industrial Rocks.....contd.***

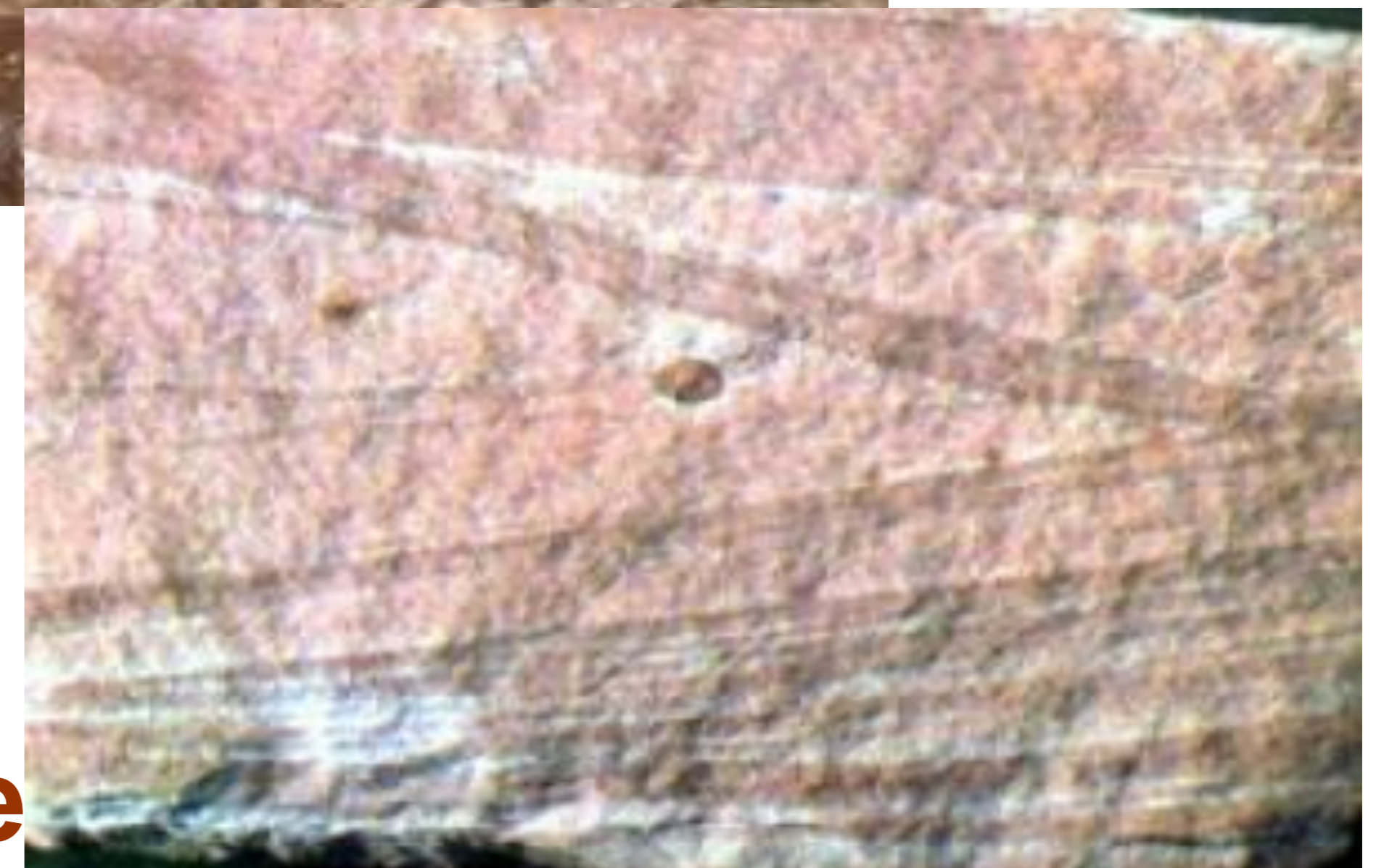
**C. Sedimentary Rocks** – Sandstone, Gypsum, Sand & gravel; Salt, Clay, Limestone & dolomite, Phosphate rock....



**Gypsum**



**Crystalline Limestone**



**Sandstone**

# ***Classification of Industrial Minerals***

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**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**



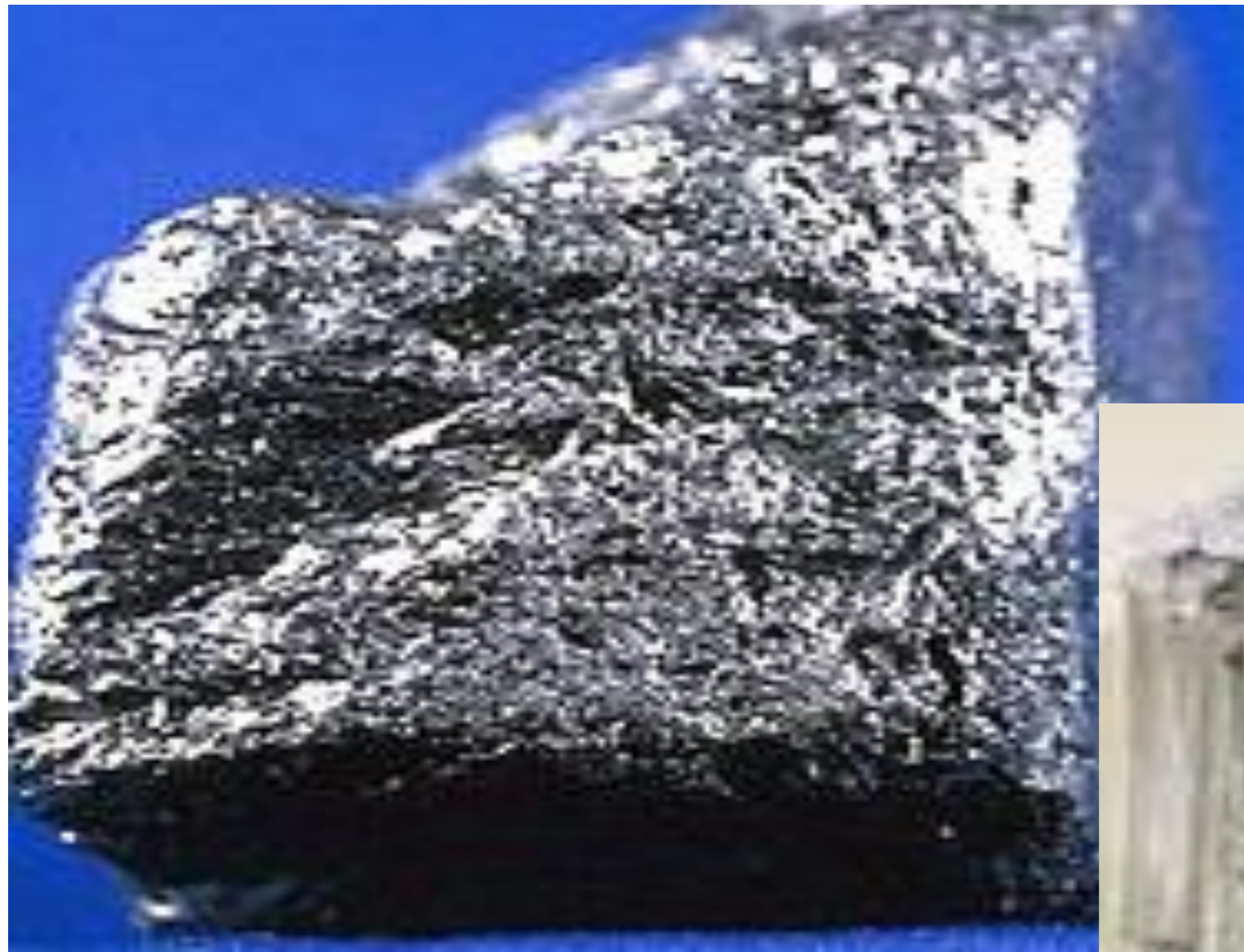
**Fluorspar**



**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**

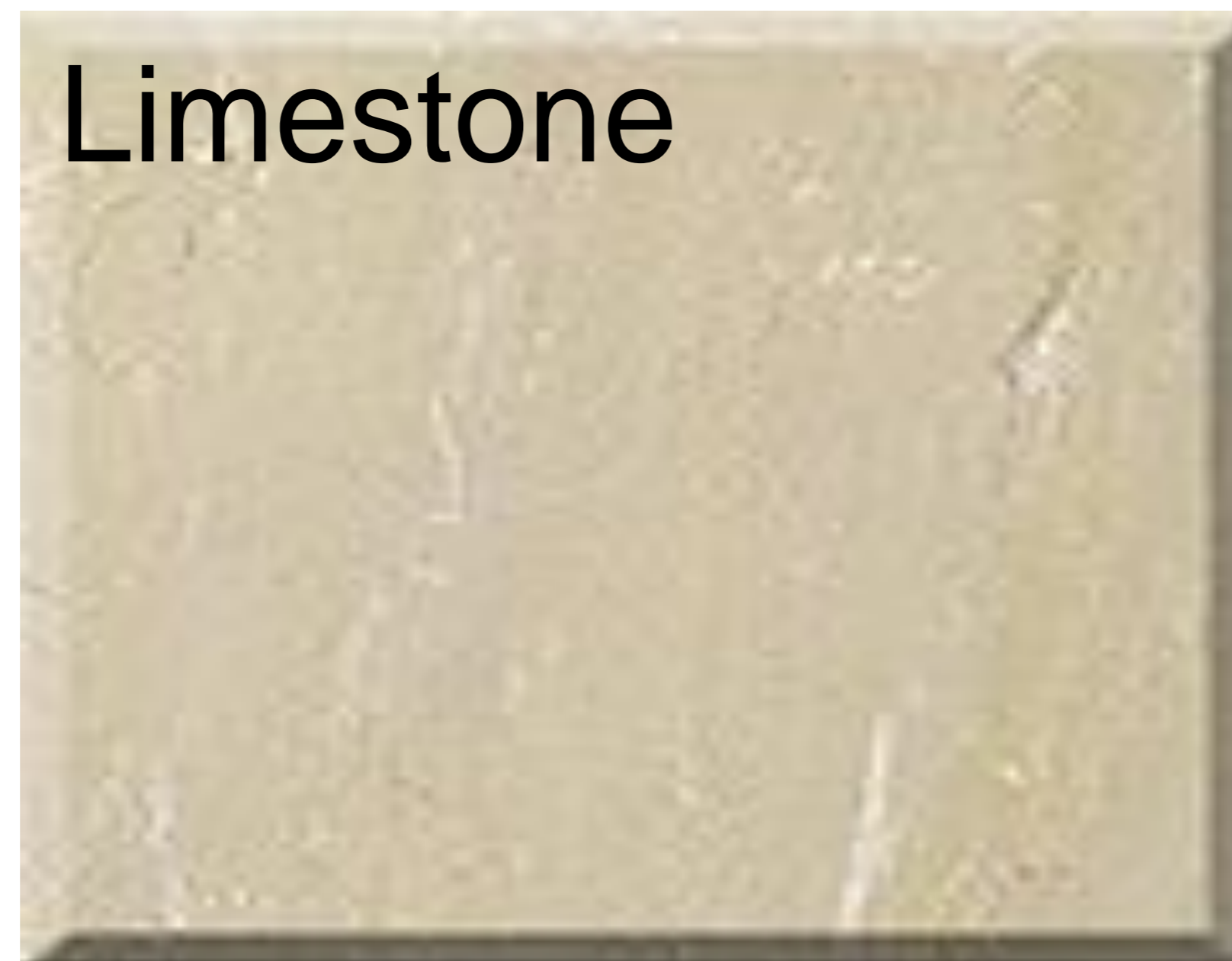


**Sulphur**

# Examples of Industrial Minerals & their Uses

## 1. Limestone/Calcite

- is a **sedimentary rock** composed largely of **Calcite** (calcium carbonate –  $\text{CaCO}_3$ )
- often contains variable amounts of **silica** in form of **chert** or **flint**, as well as varying amounts of **clay**, **silt** and **sand**.



# Construction Materials

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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*

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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

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- **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

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- 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 produced at 160° 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.*

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- **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

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- Masonry unit and does not infer any particular material
- 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 appearance.



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

### ➤ **Facing unit - speacilly**

made, or selected, to

give an attractive

appearance to blg.



1



2



3



4



6



7



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17



18



19

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

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- **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.

## 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.



# *General Properties of Brick*

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

# Characteristics of Industrial Minerals

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**Geologically**, most industrial minerals:

- are widespread
- have enormous reserves
- are easily accessible

# Characteristics of Industrial Minerals.....contd.

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## 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.

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**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.

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- *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.**

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- 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.

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## 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.

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

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

# Summary & Conclusions

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## 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**