

## Unit 2 – Rocks & Minerals

### Minerals are:

- naturally occurring
- have a definite chemical composition
- crystalline
- inorganic

## How many minerals are there?

approximately 4000, but:

- only a few hundred have economic value
- only 12 are common
- these 12 combine to form most rocks on earth

<http://webmineral.com/specimens.shtml>

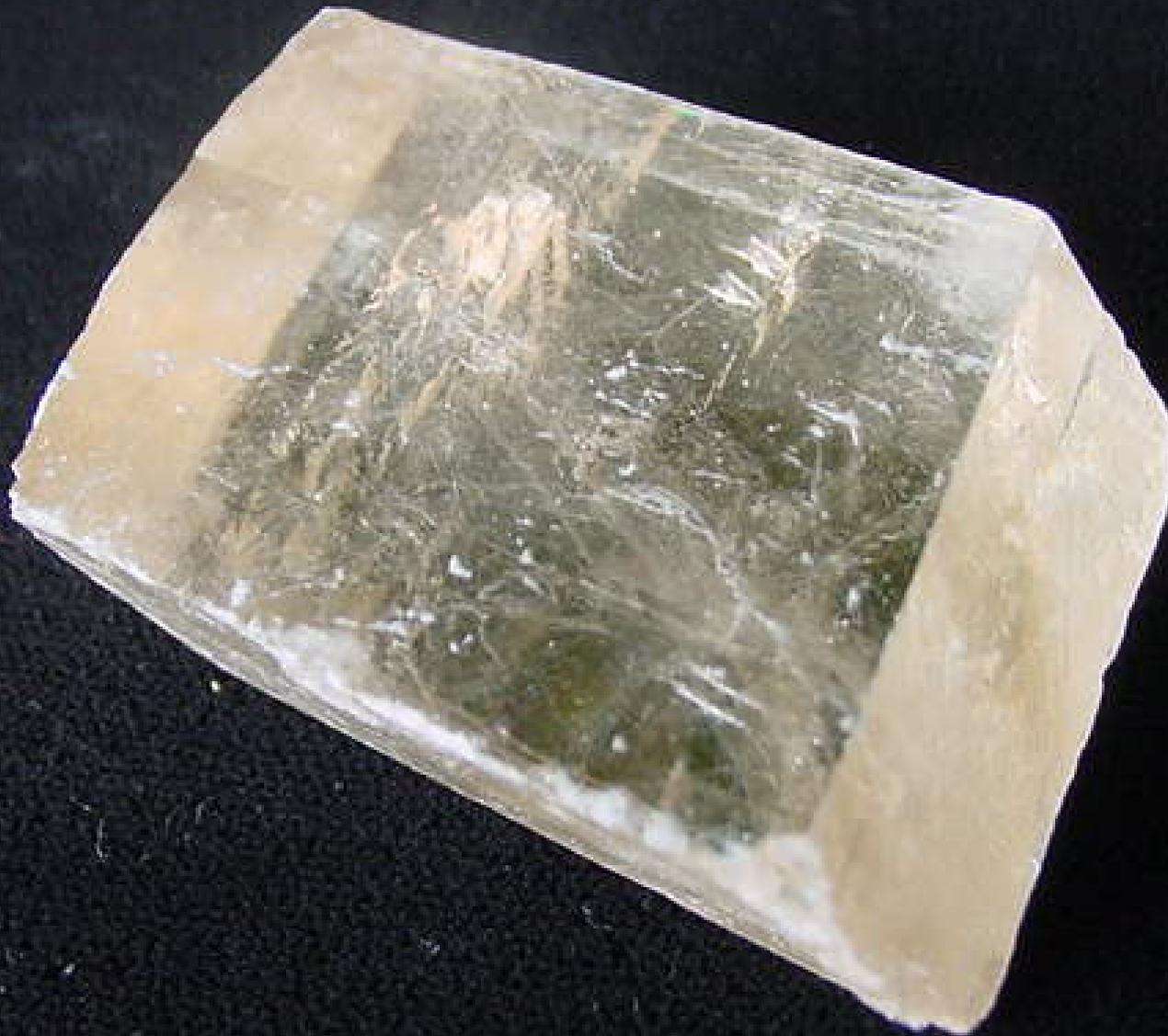
# How do we identify a mineral?

mineral properties:

1) luster

(metallic or nonmetallic)

# Calcite



graphite



## How do we identify a mineral?

mineral properties:

1) luster

2) hardness

\* most useful ID property

-hardness is identified by Moh's Scale

**Diamond----- 10**

Corundum ----- 9

Topaz ----- 8

Quartz ----- 7

Steel file (6.5)

Orthoclase ----- 6

Glass (5.5)

Apatite ----- 5

Knife blade (5.1)

Wire nail (4.5)

Fluorite ----- 4

Copper penny (3.5)

Calcite ----- 3

Fingernail (2.5)

Gypsum ----- 2

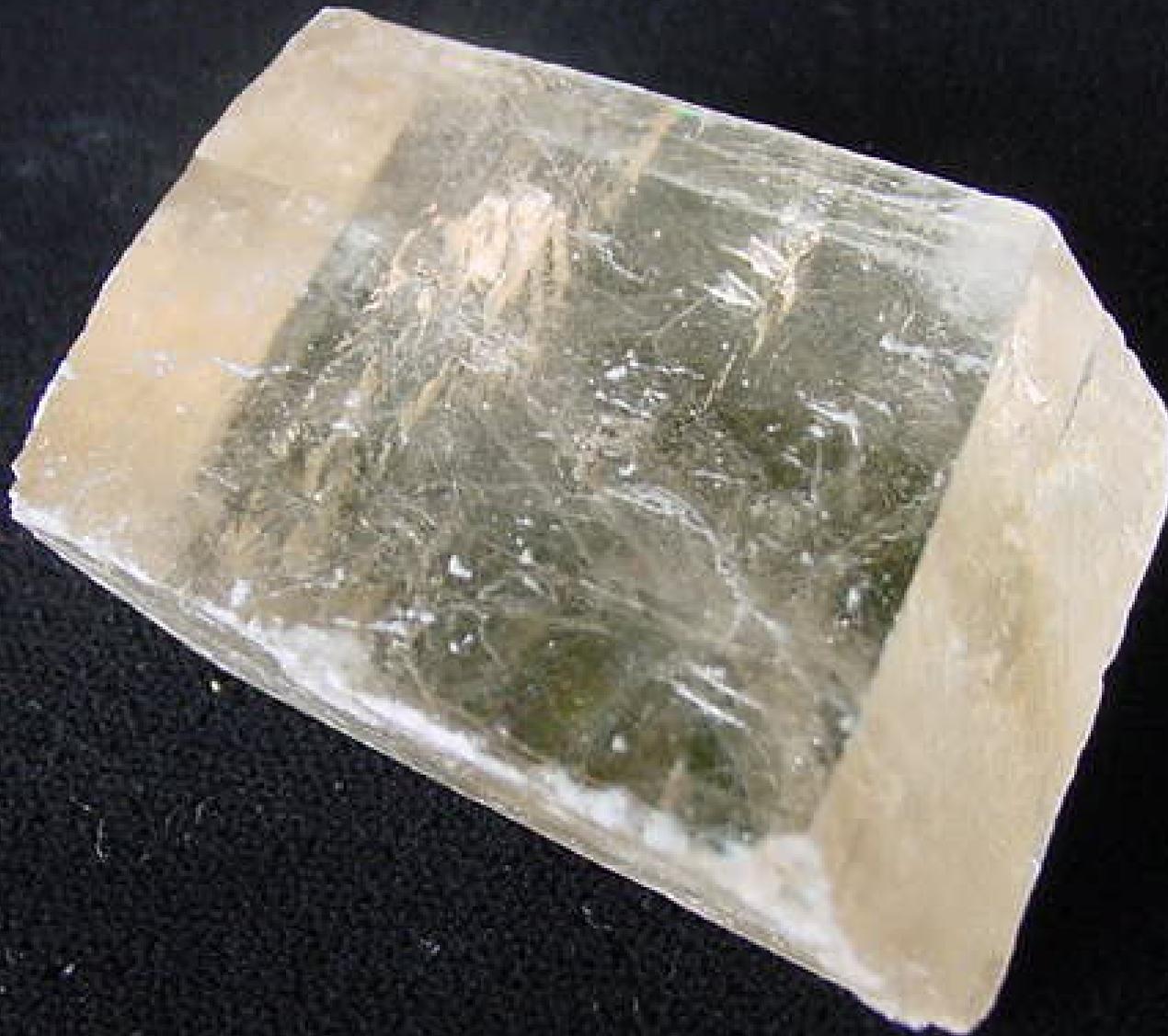
Talc ----- 1

# How do we identify a mineral?

mineral properties:

3) cleavage & fracture

# Calcite



# Sulfur



## How do we identify a mineral?

mineral properties:

3) cleavage & fracture

4) color



Quartz



Garnet



# How do we identify a mineral?

mineral properties:

3) cleavage & fracture

4) color

5) streak

## How do we identify a mineral?

mineral properties:

6) specific gravity (density)

7) crystal structure

8) smell

9) taste

10) magnetic

## How do we identify a mineral?

mineral properties:

12) Bubble with acid

13) Fluorescence

## Properties of Common Minerals

LUSTER	HARD-NESS	CLEAVAGE FRACTURE	COMMON COLORS	DISTINGUISHING CHARACTERISTICS	USE(S)	MINERAL NAME	COMPOSITION*
Metallic Luster	1-2	✓	silver to gray	black streak, greasy feel	pencil lead, lubricants	<b>Graphite</b>	C
	2.5	✓	metallic silver	very dense (7.6 g/cm <sup>3</sup> ), gray-black streak 	ore of lead	<b>Galena</b>	PbS
	5.5-6.5	✓	black to silver	attracted by magnet, black streak	ore of iron	<b>Magnetite</b>	Fe <sub>3</sub> O <sub>4</sub>
	6.5	✓	brassy yellow	green-black streak, cubic crystals 	ore of sulfur	<b>Pyrite</b>	FeS <sub>2</sub>
Either	1-6.5	✓	metallic silver or earthy red	red-brown streak	ore of iron	<b>Hematite</b>	Fe <sub>2</sub> O <sub>3</sub>
Nonmetallic Luster	1	✓	white to green	greasy feel	talcum powder, soapstone	<b>Talc</b>	Mg <sub>3</sub> Si <sub>4</sub> O <sub>10</sub> (OH) <sub>2</sub>
	2	✓	yellow to amber	easily melted, may smell	vulcanize rubber, sulfuric acid	<b>Sulfur</b>	S
	2	✓	white to pink or gray	easily scratched by fingernail	plaster of paris and drywall	<b>Gypsum (Selenite)</b>	CaSO <sub>4</sub> •2H <sub>2</sub> O
	2-2.5	✓	colorless to yellow	flexible in thin sheets 	electrical insulator	<b>Muscovite Mica</b>	KAl <sub>3</sub> Si <sub>3</sub> O <sub>10</sub> (OH) <sub>2</sub>
	2.5	✓	colorless to white	cubic cleavage, salty taste 	food additive, melts ice	<b>Halite</b>	NaCl
	2.5-3	✓	black to dark brown	flexible in thin sheets 	electrical insulator	<b>Biotite Mica</b>	K(Mg,Fe) <sub>3</sub> AlSi <sub>3</sub> O <sub>10</sub> (OH) <sub>2</sub>
	3	✓	colorless or variable	bubbles with acid 	cement, polarizing prisms	<b>Calcite</b>	CaCO <sub>3</sub>
	3.5	✓	colorless or variable	bubbles with acid when powdered	source of magnesium	<b>Dolomite</b>	CaMg(CO <sub>3</sub> ) <sub>2</sub>
	4	✓	colorless or variable	cleaves in 4 directions	hydrofluoric acid	<b>Fluorite</b>	CaF <sub>2</sub>
	5-6	✓	black to dark green	cleaves in 2 directions at 90° 	mineral collections	<b>Pyroxene (commonly Augite)</b>	(Ca,Na) (Mg,Fe,Al) (Si,Al) <sub>2</sub> O <sub>6</sub>
	5.5	✓	black to dark green	cleaves at 56° and 124° 	mineral collections	<b>Amphiboles (commonly Hornblende)</b>	CaNa(Mg,Fe) <sub>4</sub> (Al,Fe,Ti) <sub>3</sub> Si <sub>6</sub> O <sub>22</sub> (OH) <sub>2</sub>
	6	✓	white to pink	cleaves in 2 directions at 90°	ceramics and glass	<b>Potassium Feldspar (Orthoclase)</b>	KAlSi <sub>3</sub> O <sub>8</sub>
	6	✓	white to gray	cleaves in 2 directions, striations visible	ceramics and glass	<b>Plagioclase Feldspar (Na-Ca Feldspar)</b>	(Na,Ca)AlSi <sub>3</sub> O <sub>8</sub>
	6.5	✓	green to gray or brown	commonly light green and granular	furnace bricks and jewelry	<b>Olivine</b>	(Fe,Mg) <sub>2</sub> SiO <sub>4</sub>
	7	✓	colorless or variable	glassy luster, may form hexagonal crystals 	glass, jewelry, and electronics	<b>Quartz</b>	SiO <sub>2</sub>
7	✓	dark red to green	glassy luster, often seen as red grains in NYS metamorphic rocks	jewelry and abrasives	<b>Garnet (commonly Almandine)</b>	Fe <sub>3</sub> Al <sub>2</sub> Si <sub>3</sub> O <sub>12</sub>	

\*Chemical Symbols: Al = aluminum    Cl = chlorine    H = hydrogen    Na = sodium    S = sulfur  
 C = carbon    F = fluorine    K = potassium    O = oxygen    Si = silicon  
 Ca = calcium    Fe = iron    Mg = magnesium    Pb = lead    Ti = titanium

✓ = dominant form of breakage

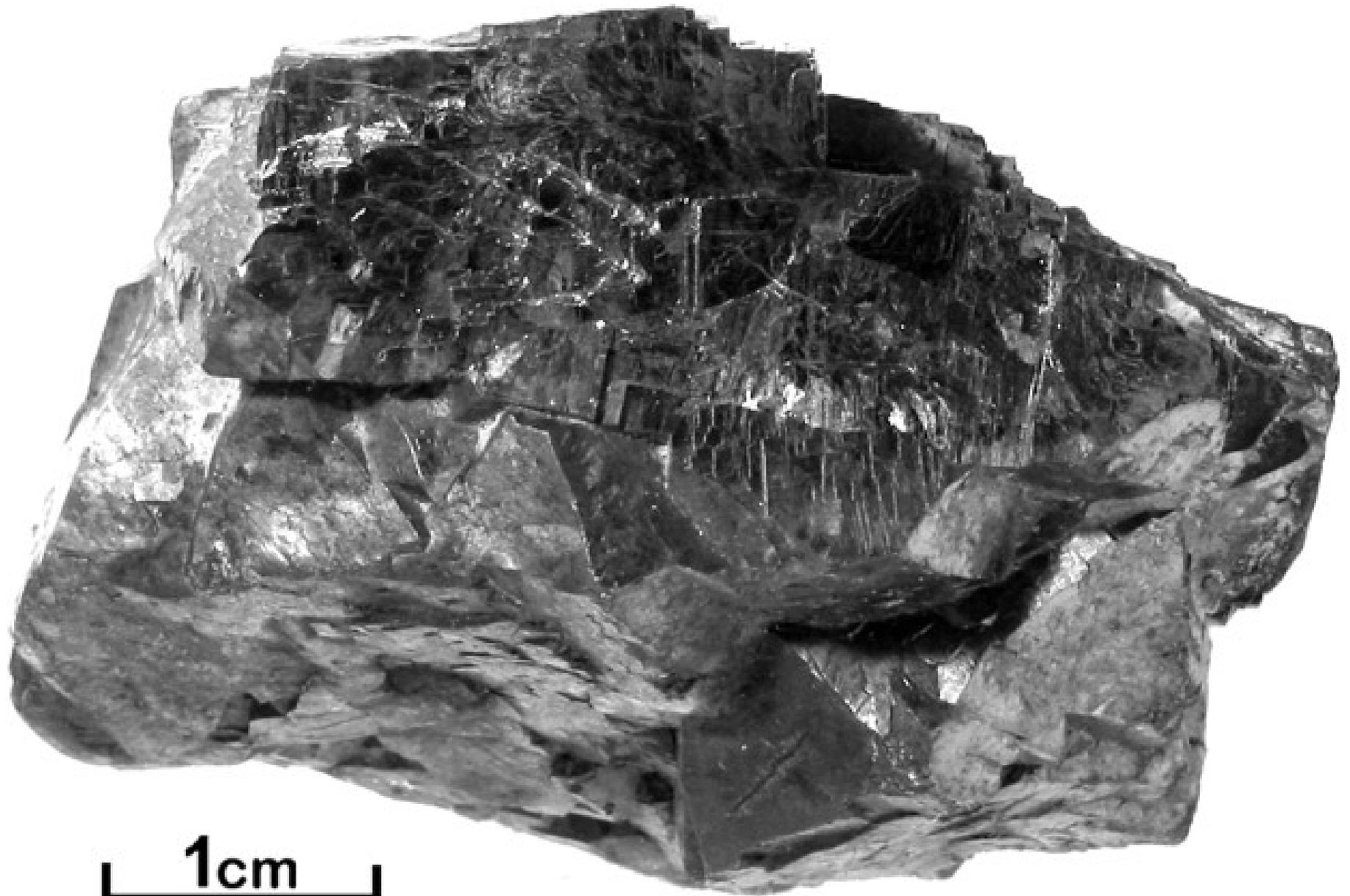
# Mineral Pictures

<http://webmineral.com/specimens.shtml>

# Reference Table Minerals

graphite

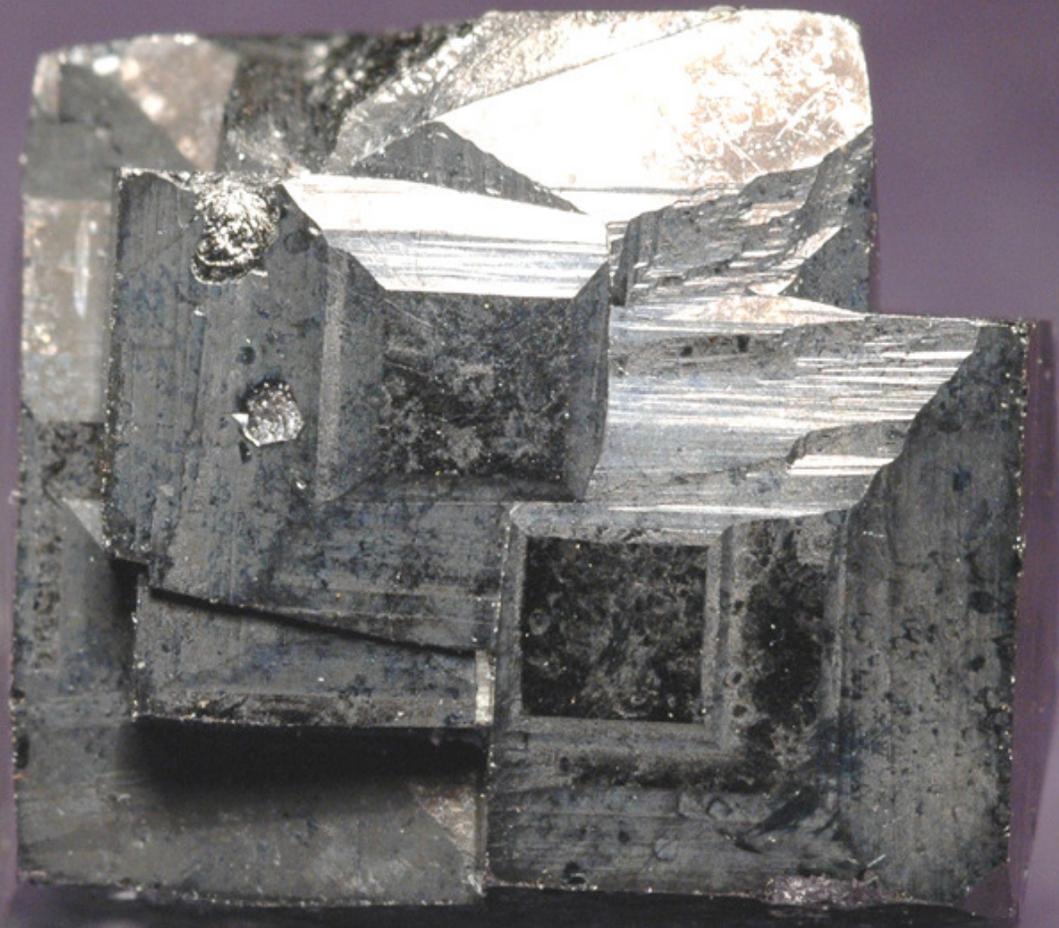




1cm

galena

magnetite



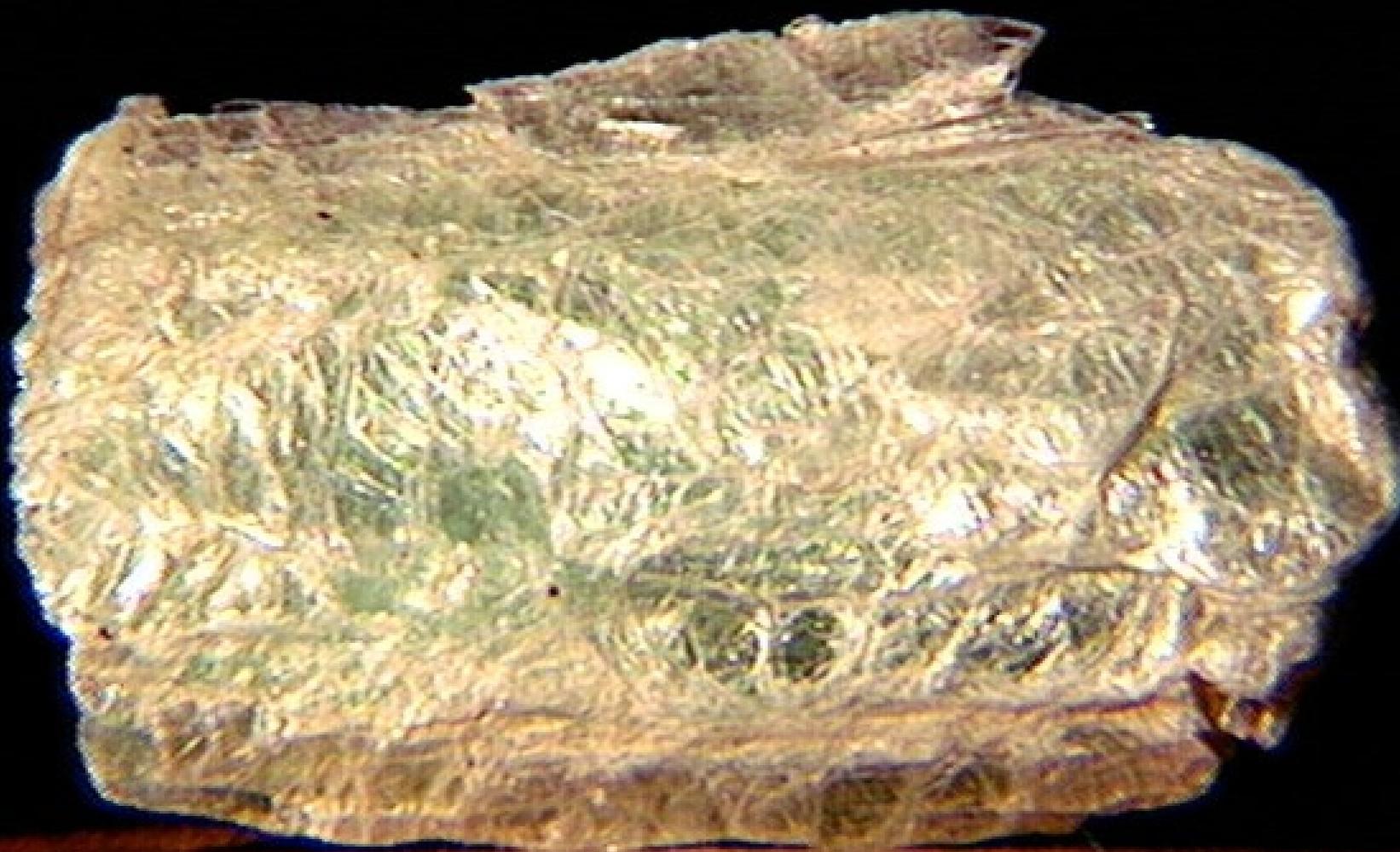
# Pyrite



Hematite



# Talc



# Sulfur



# Gypsum



Muscovite  
Mica

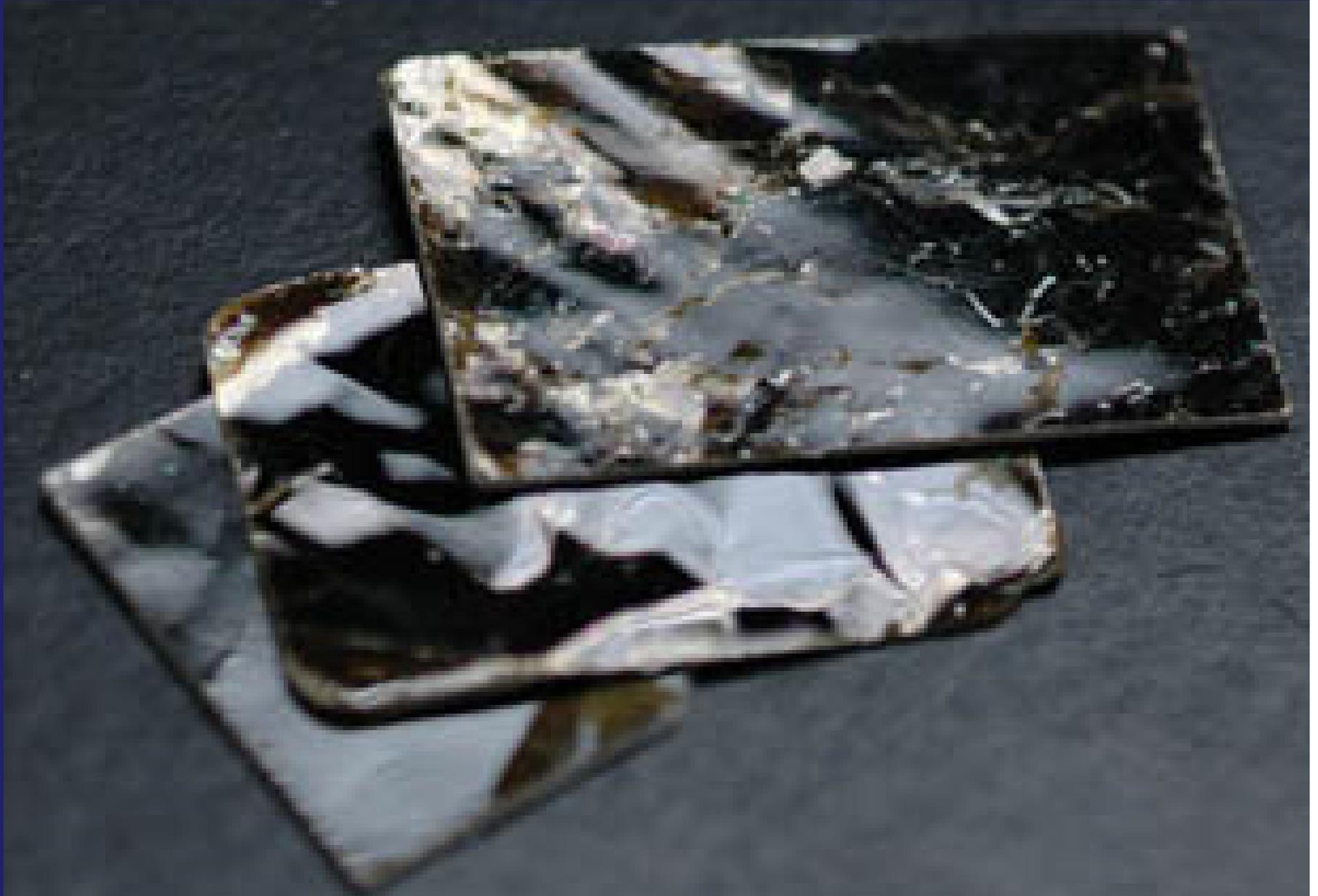




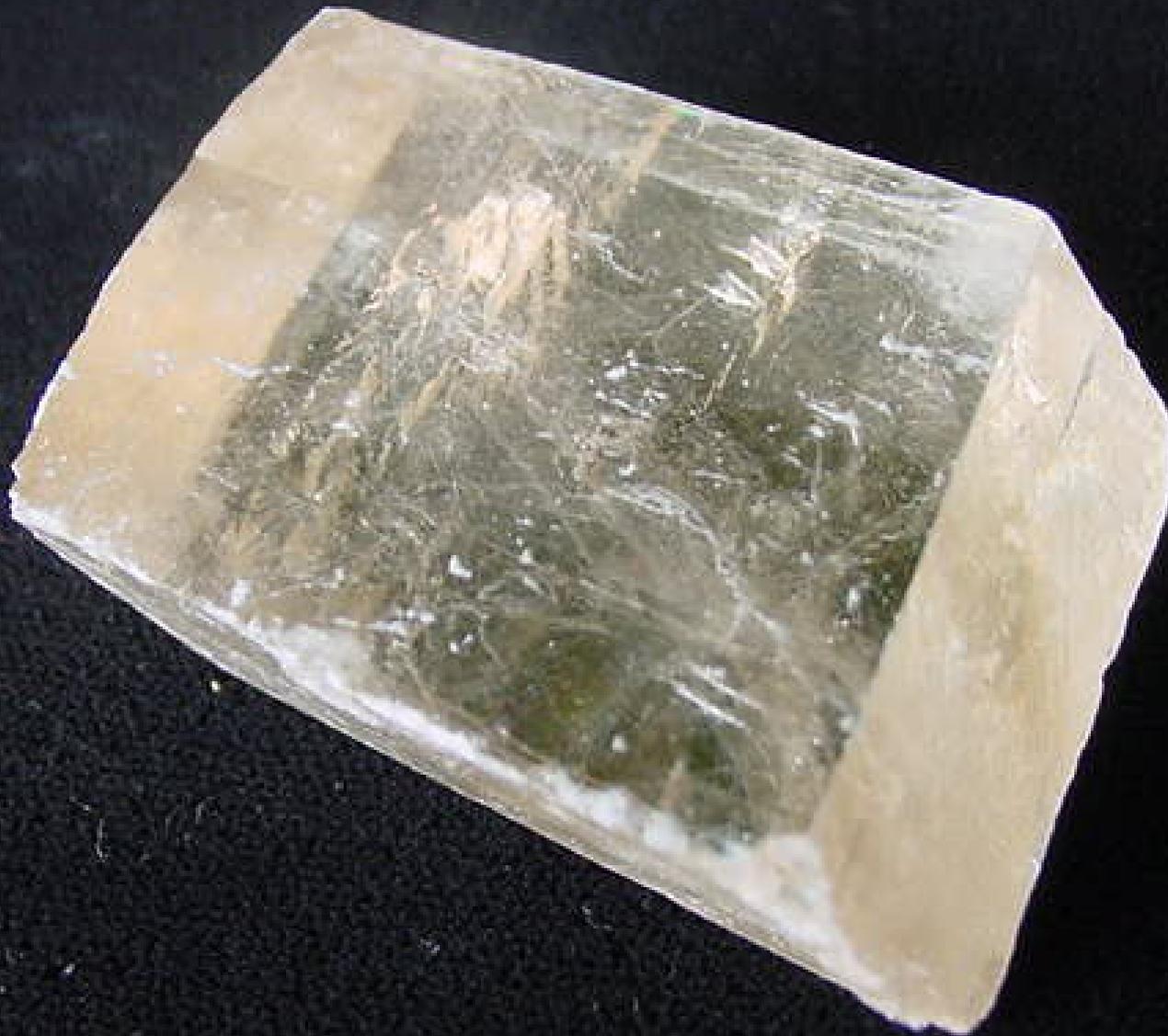
halite

HALITE (Sodium Chloride, Rock Salt)  
Formed by the evaporation of  
saline waters, & with intergrowth of

## Biotite Mica



# Calcite



# Dolomite





fluorite



pyroxene

# Hornblende



Photo: Tarbuck and Lutgens

amphiboles



Potassium Feldspar



Plagioclase Feldspar



Olivine



Quartz

# Garnet



Garnet



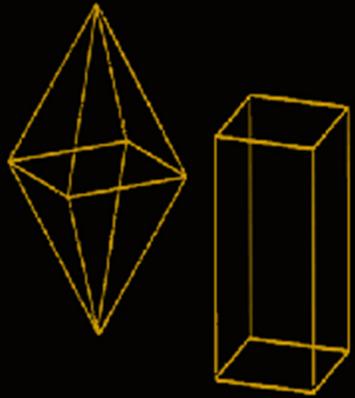


# Mineral Chart

## Earth Science Reference Tables



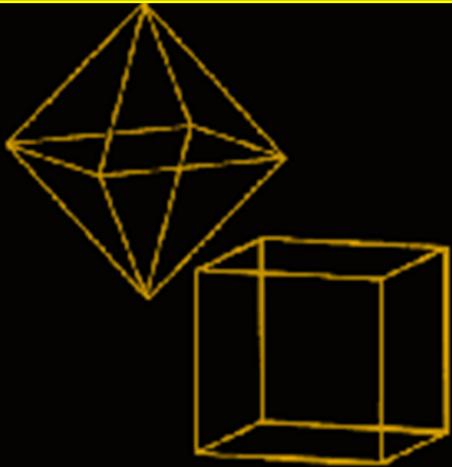
**Acrobat Document**



**Tetragonal**  
(2 axis equal,  
1 different)



**Hexagonal**



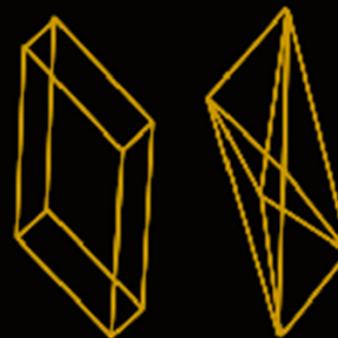
**cubic**



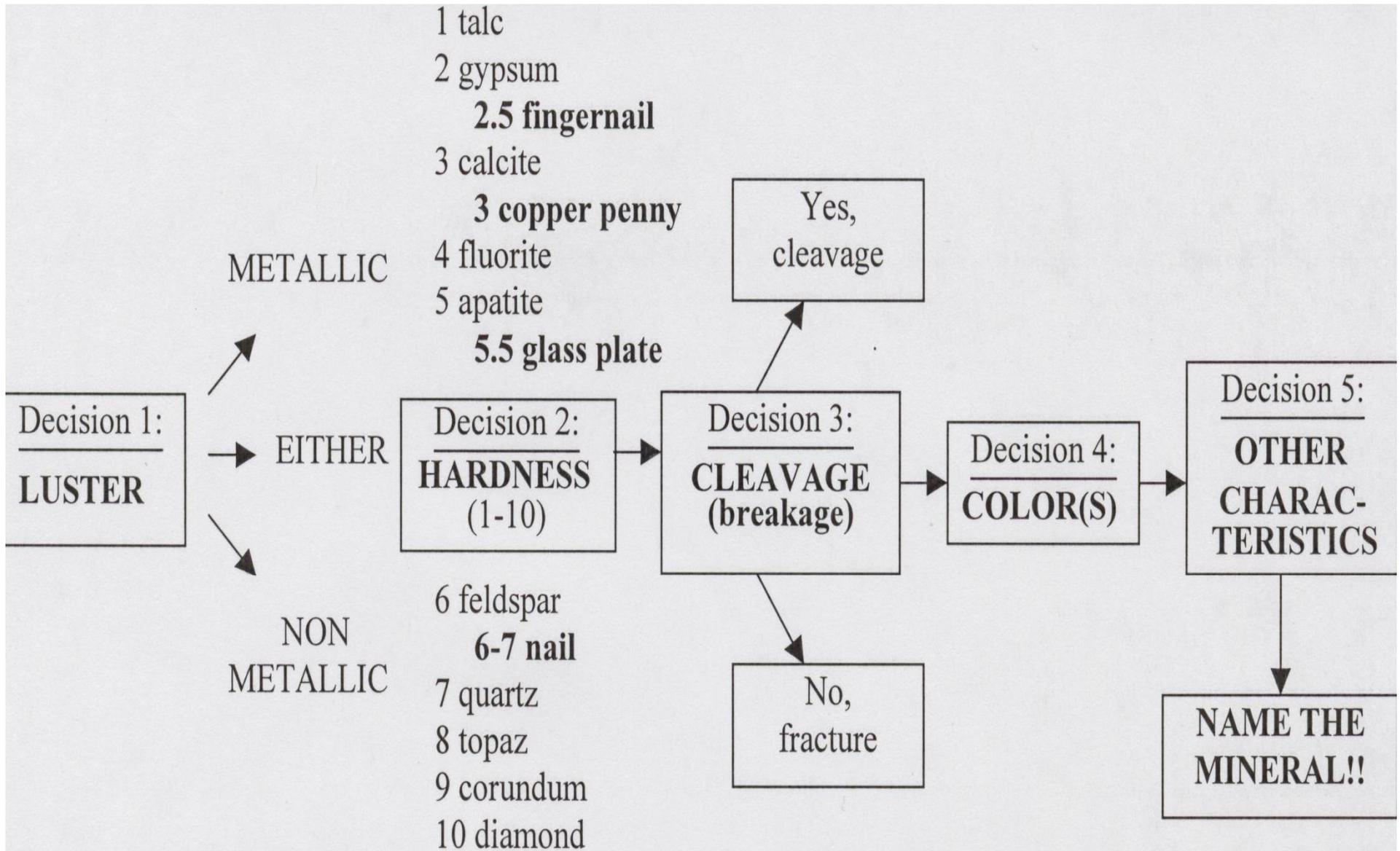
**Orthorhombic**  
(3 axis unequal)



**monoclinic**



**triclinic**



# Mineral Chemical Makeup

$H_2O = ?$

water

2 parts hydrogen to one part oxygen

# Mineral Chemical Makeup

Graphite = C

Diamond = ?



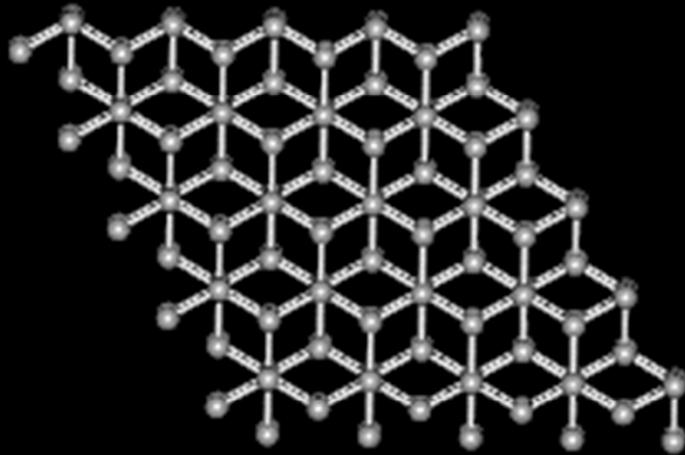
# Mineral Chemical Makeup

Graphite = C

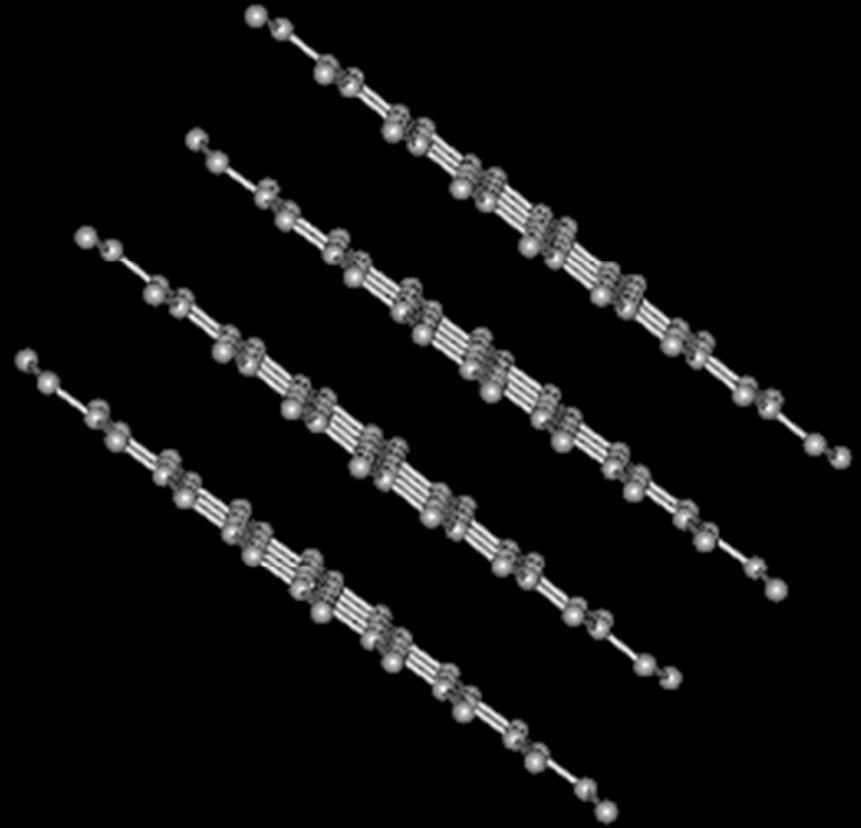
Diamond = C

How is this possible?

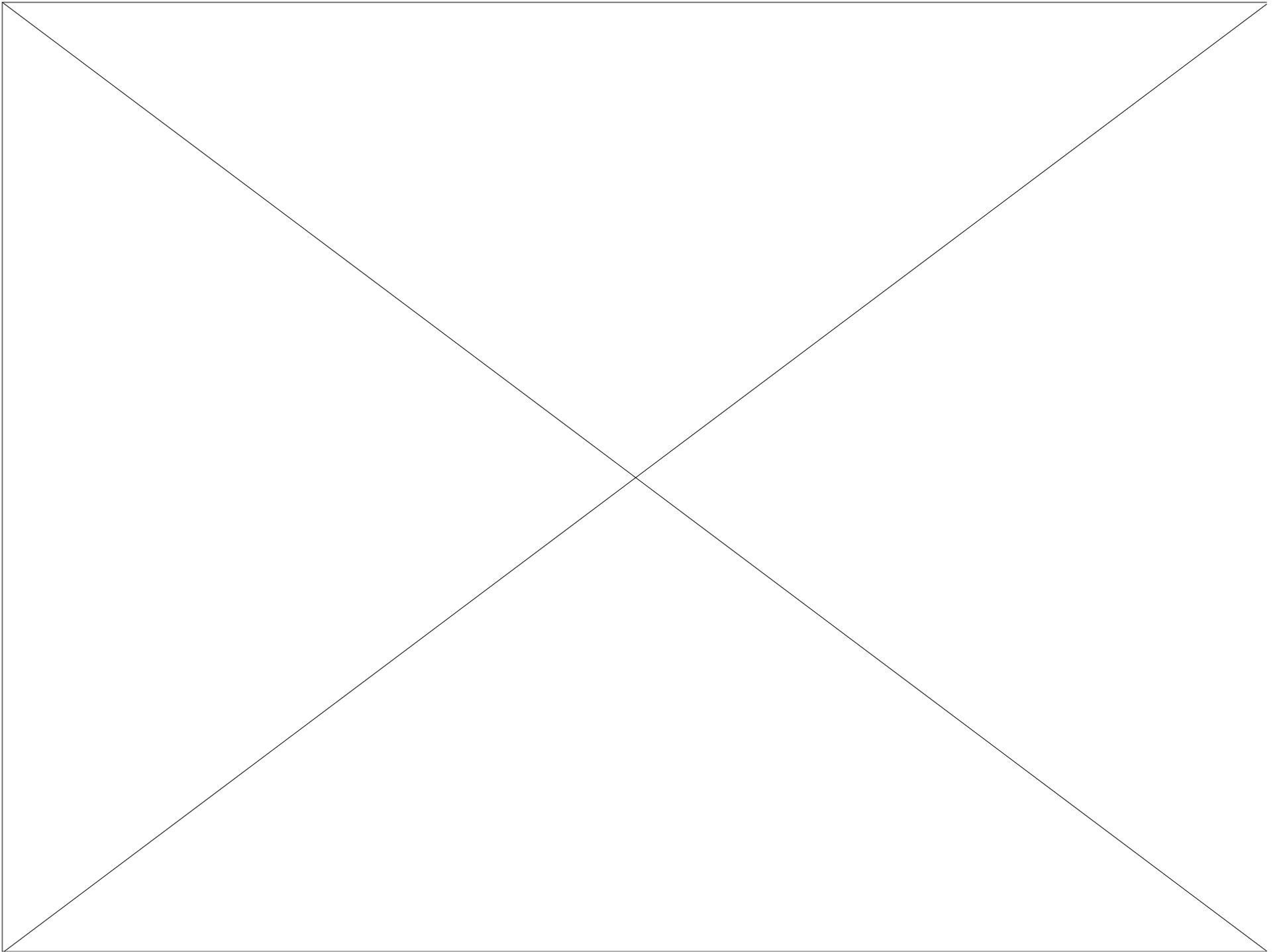
**\*The internal arrangement of atoms!\***



**Diamond molecules are tightly packed**



**Graphite Molecules are layered weakly in sheets**



## Average Composition of Earth's Crust, Hydrogen

<b>ELEMENT</b> (symbol)	<b>CRUST</b>	
	Percent by mass	Percent
Oxygen (O)	46.10	
Silicon (Si)	28.20	
Aluminum (Al)	8.23	
Iron (Fe)	5.63	
Calcium (Ca)	4.15	
Sodium (Na)	2.36	
Magnesium (Mg)	2.33	
Potassium (K)	2.09	
Nitrogen (N)		
Hydrogen (H)		
Other	0.91	

# Mineral Groups

## 1) silicates

oxygen and silicon combine to make up  
1/2 of all minerals

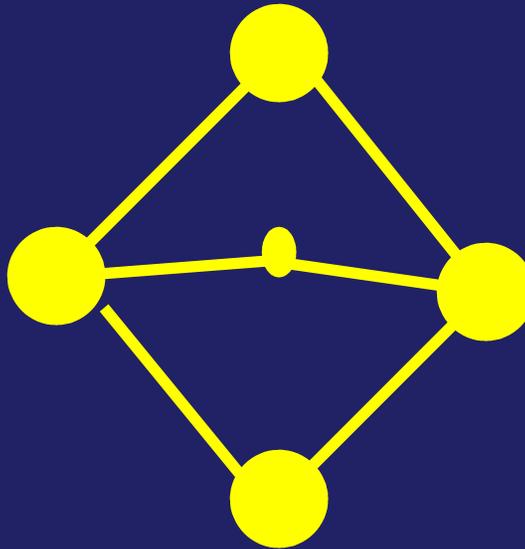
Formula for silicate:  $\text{SiO}_4$

# Mineral Groups

The silicatetrahedra:  $\text{SiO}_4$

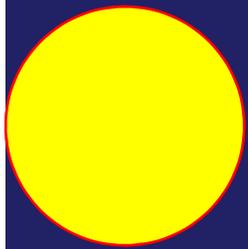
● = oxygen

● = silicon



# Mineral Groups

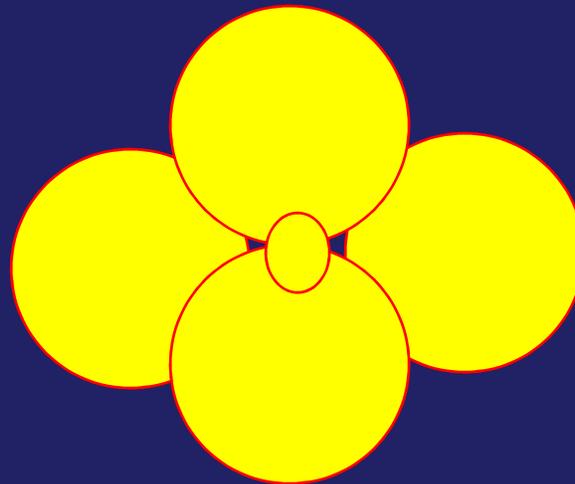
The silicatetrahedra:  $\text{SiO}_4$  is also drawn like this



= oxygen



= silicon



# Mineral Groups

## 1) silicates

oxygen and silicon combine to make up  
 $\frac{1}{2}$  of all minerals

## 2) Oxide group: compounds made up of oxygen and one other element

## 3) Carbonate group: made of one or more metals combined with a carbon and three oxygen atoms.

## Properties of Common Minerals

LUSTER	HARD-NESS	CLEAVAGE FRACTURE	COMMON COLORS	DISTINGUISHING CHARACTERISTICS	USE(S)	MINERAL NAME	COMPOSITION*
Metallic Luster	1-2	✓	silver to gray	black streak, greasy feel	pencil lead, lubricants	<b>Graphite</b>	C
	2.5	✓	metallic silver	very dense (7.6 g/cm <sup>3</sup> ), gray-black streak 	ore of lead	<b>Galena</b>	PbS
	5.5-6.5	✓	black to silver	attracted by magnet, black streak	ore of iron	<b>Magnetite</b>	Fe <sub>3</sub> O <sub>4</sub>
	6.5	✓	brassy yellow	green-black streak, cubic crystals 	ore of sulfur	<b>Pyrite</b>	FeS <sub>2</sub>
Either	1-6.5	✓	metallic silver or earthy red	red-brown streak	ore of iron	<b>Hematite</b>	Fe <sub>2</sub> O <sub>3</sub>
Nonmetallic Luster	1	✓	white to green	greasy feel	talcum powder, soapstone	<b>Talc</b>	Mg <sub>3</sub> Si <sub>4</sub> O <sub>10</sub> (OH) <sub>2</sub>
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	2-2.5	✓	colorless to yellow	flexible in thin sheets 	electrical insulator	<b>Muscovite Mica</b>	KAl <sub>3</sub> Si <sub>3</sub> O <sub>10</sub> (OH) <sub>2</sub>
	2.5	✓	colorless to white	cubic cleavage, salty taste 	food additive, melts ice	<b>Halite</b>	NaCl
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	3.5	✓	colorless or variable	bubbles with acid when powdered	source of magnesium	<b>Dolomite</b>	CaMg(CO <sub>3</sub> ) <sub>2</sub>
	4	✓	colorless or variable	cleaves in 4 directions	hydrofluoric acid	<b>Fluorite</b>	CaF <sub>2</sub>
	5-6	✓	black to dark green	cleaves in 2 directions at 90° 	mineral collections	<b>Pyroxene (commonly Augite)</b>	(Ca,Na) (Mg,Fe,Al) (Si,Al) <sub>2</sub> O <sub>6</sub>
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7	✓	dark red to green	glassy luster, often seen as red grains in NYS metamorphic rocks	jewelry and abrasives	<b>Garnet (commonly Almandine)</b>	Fe <sub>3</sub> Al <sub>2</sub> Si <sub>3</sub> O <sub>12</sub>	

\*Chemical Symbols: Al = aluminum    Cl = chlorine    H = hydrogen    Na = sodium    S = sulfur  
 C = carbon    F = fluorine    K = potassium    O = oxygen    Si = silicon  
 Ca = calcium    Fe = iron    Mg = magnesium    Pb = lead    Ti = titanium

✓ = dominant form of breakage

# Deadliest Jobs in America:

# Deadliest Jobs in America:

## 1) Fisherman (142 per 100,000)



# Deadliest Jobs in America:

## 2) Pilot (88)



# Deadliest Jobs in America:

## 3) Logging Worker (82)



# Deadliest Jobs in America:

## 4) Structural Steel Worker (61)



## Deadliest Jobs in America:

5) Coal miners (50)



# Mineral Mining

## 1) Surface mining

- removing soil and extracting mineral deposit close to the surface

  - examples: coal & sand

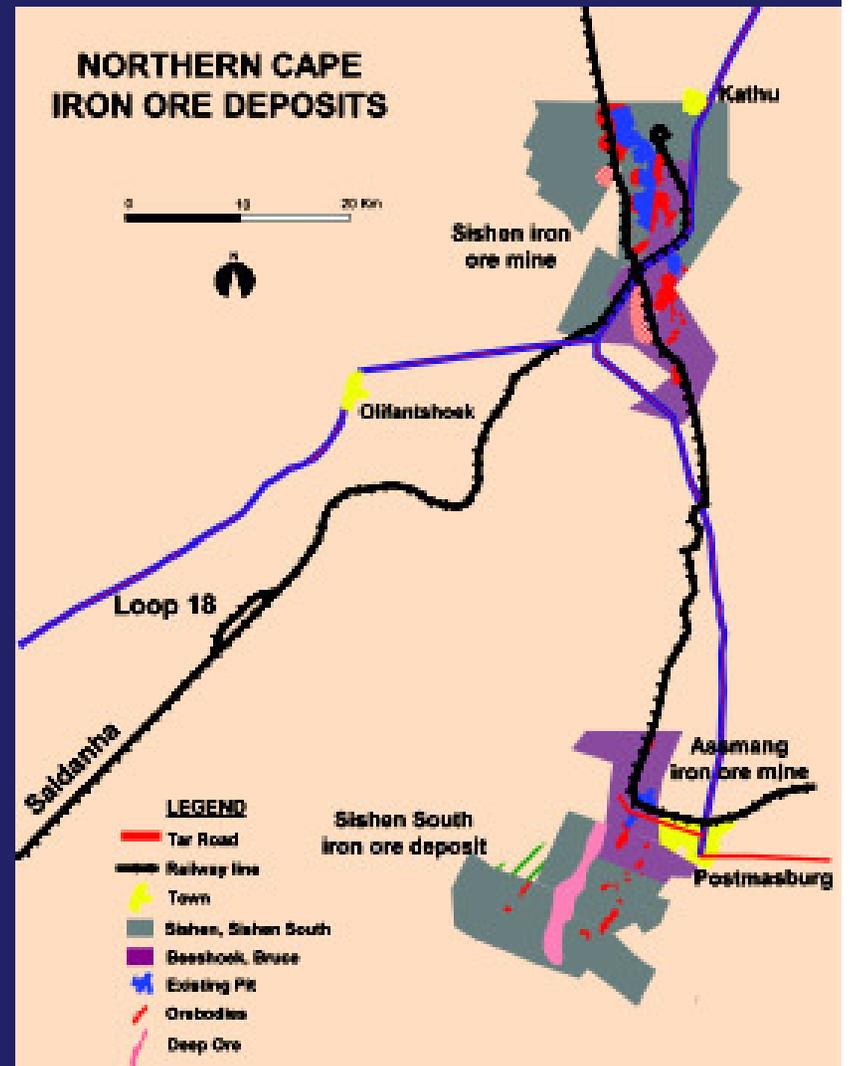
- changes topography of land

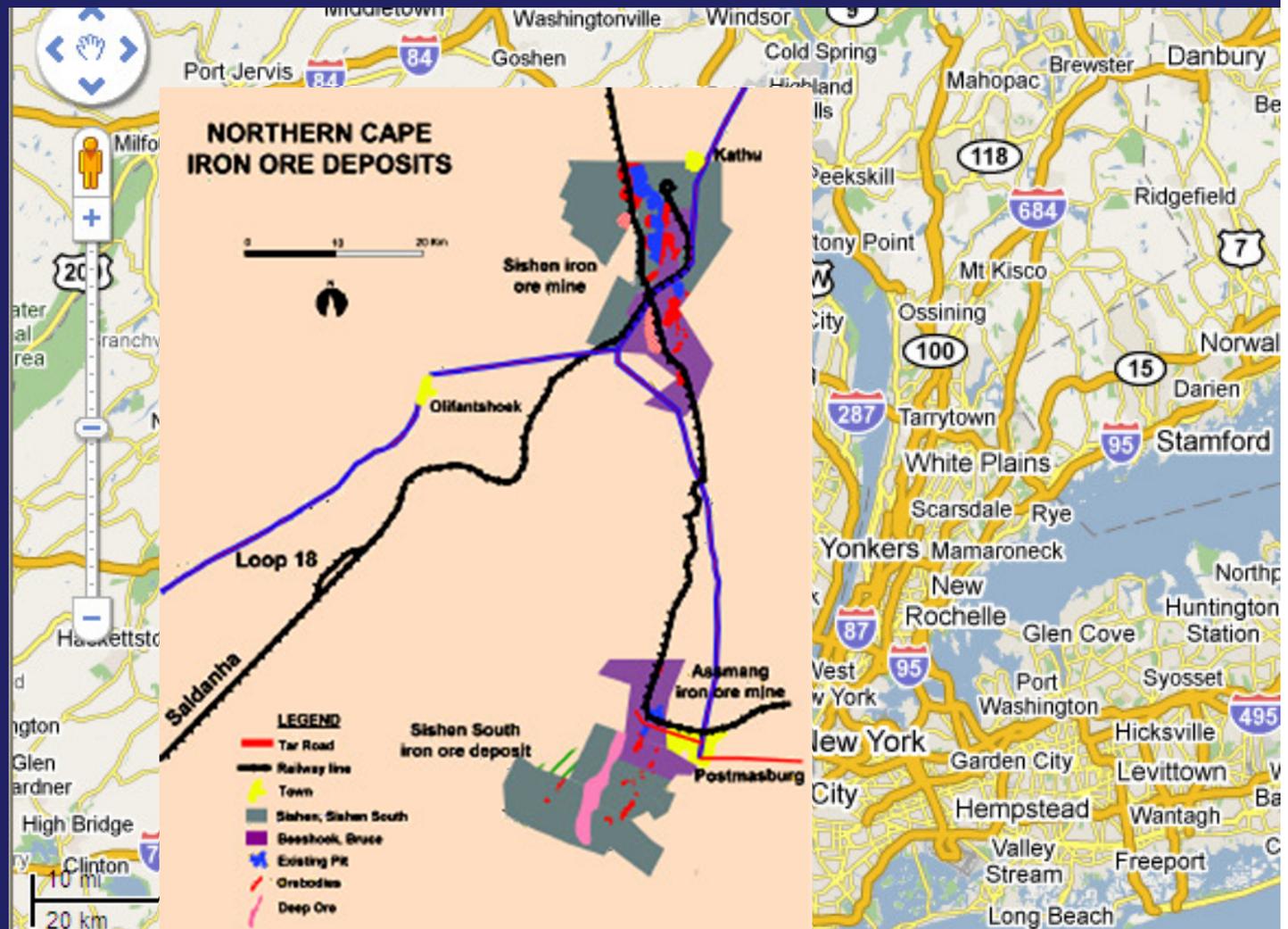
- toxic runoff from mining equipment

- most cost effective mining method



Coal mine in Wyoming





# Mineral Mining

## 2) Subsurface mining

- removing a mineral from a deep deposit through the use of tunnels

  - examples: coal, gold, diamonds

- dangerous to workers

- better for the environment

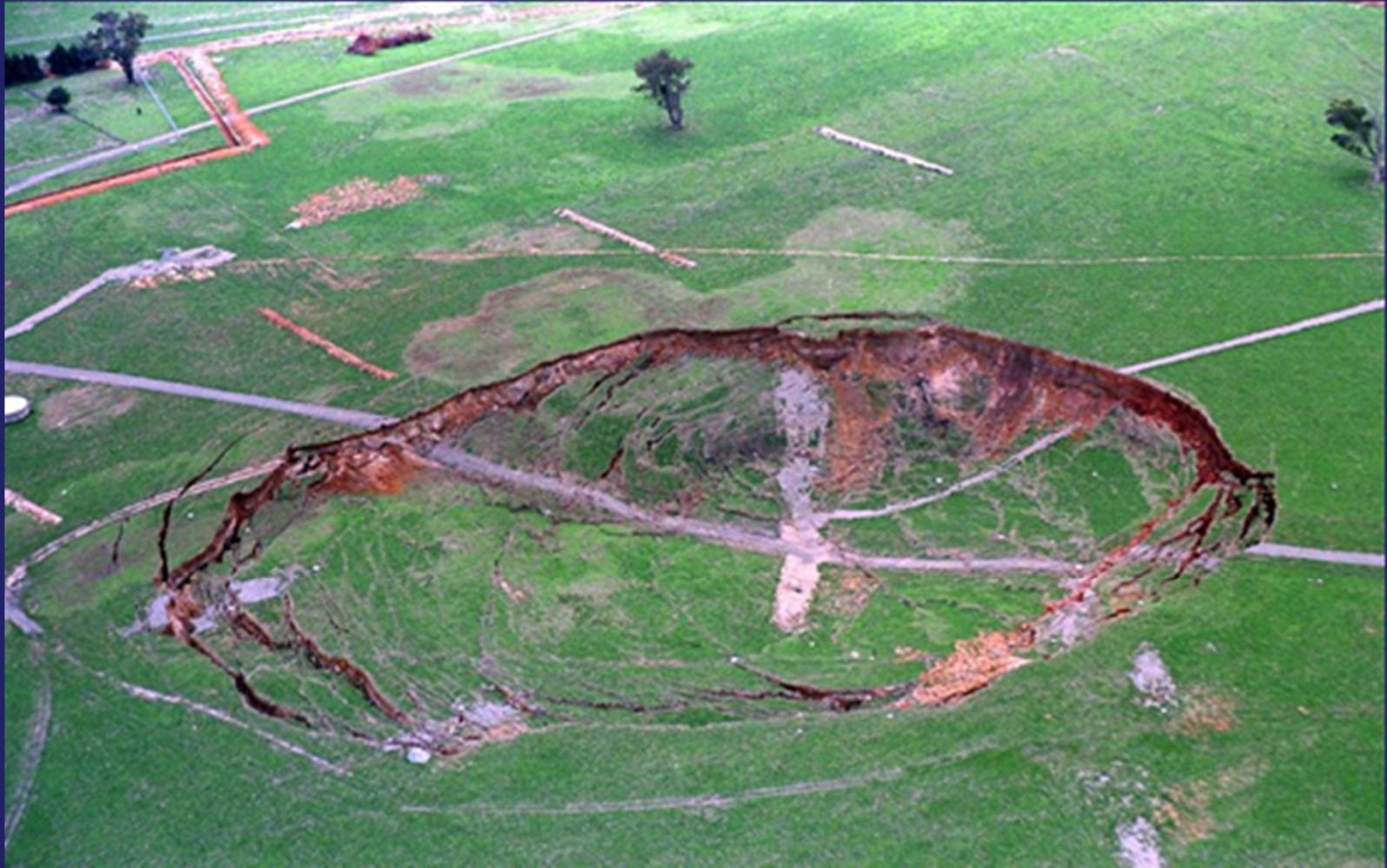
- subsidence possible



Iron ore tunnel



Coal miners resting in a mine shaft  
Makarwal, Pakistan



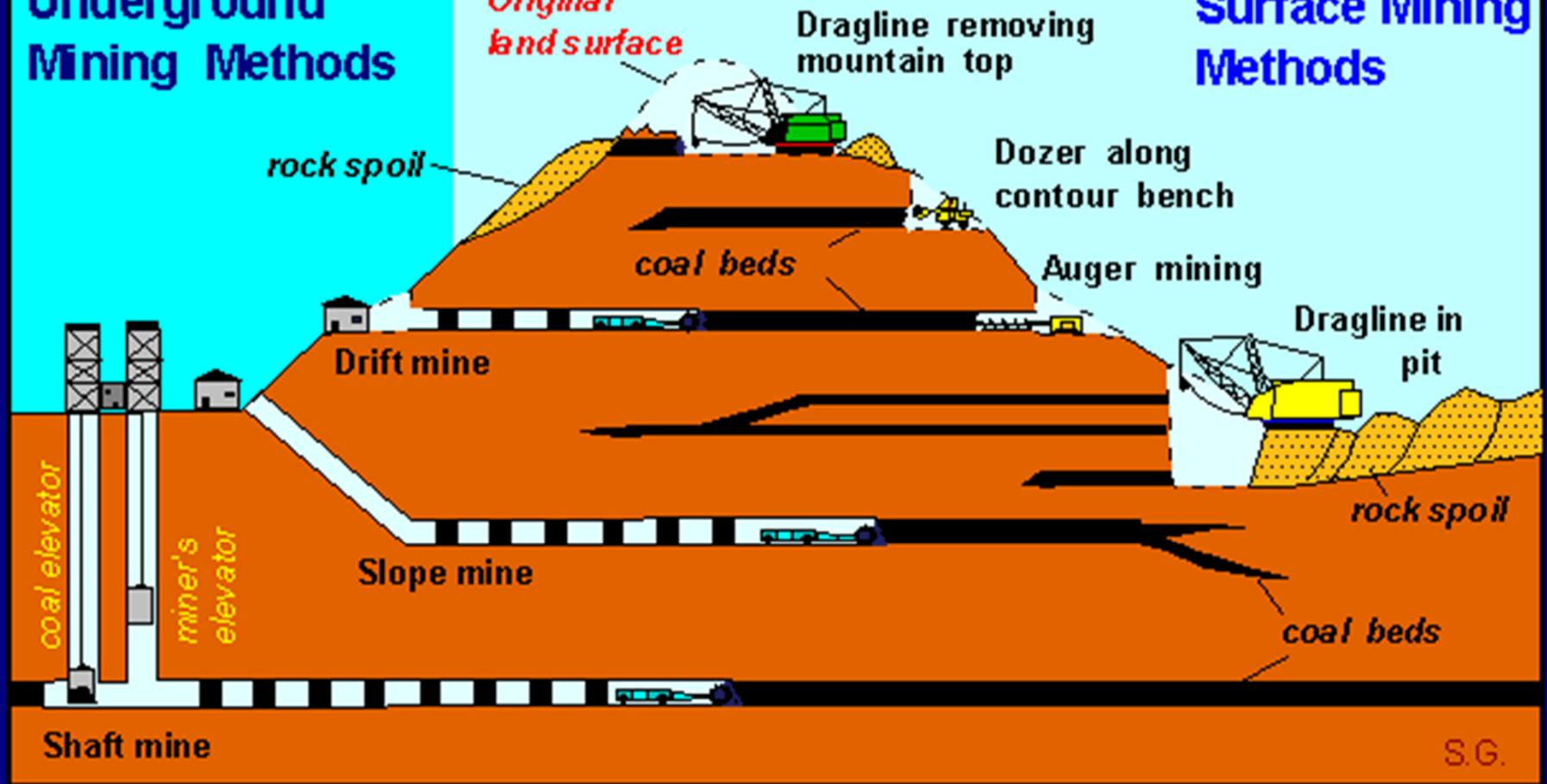
## Maurie Mole!

[http://www.youtube.com/watch?v=fntXH9jJ3Gk&eurl=http%3A%2F%2Fwww%2Eminesub%2Ensw%2Egov%2Eau%2Ftemplates%2Fmaurie%5Fmole%5Fminesub%2Easpx%3FpageID%3D4266&feature=player\\_embedded](http://www.youtube.com/watch?v=fntXH9jJ3Gk&eurl=http%3A%2F%2Fwww%2Eminesub%2Ensw%2Egov%2Eau%2Ftemplates%2Fmaurie%5Fmole%5Fminesub%2Easpx%3FpageID%3D4266&feature=player_embedded)

## Underground Mining Methods

*Original  
land surface*

## Surface Mining Methods



## 30 Days as a Coal Miner

<http://www.hulu.com/watch/22466/30-days-working-in-a-coal-mine>

