

# Minerals

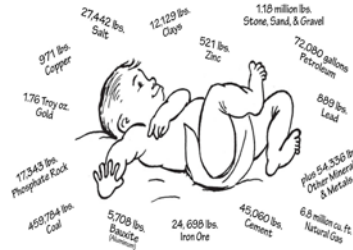


UNI EARTH AND ENVIRONMENTAL SCIENCE – HEINZEL

## Big Idea

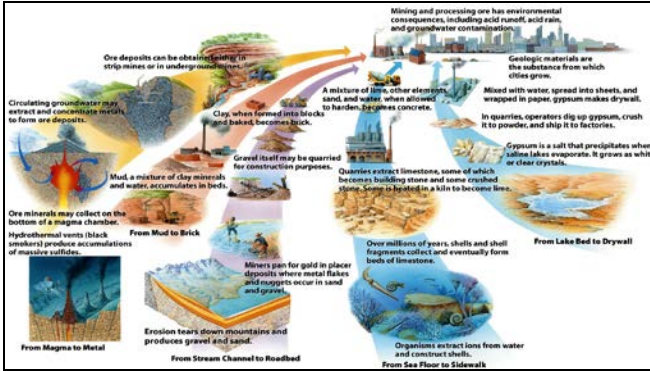
Humans depend on Earth for resources

Every American Born Will Need...



3.03 million pounds of minerals, metals, and fuels in their lifetime

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The Society for Mining, Metallurgy & Exploration Foundation  
Learn more at [www.MineralsEducationCoalition.org](http://www.MineralsEducationCoalition.org)



**Periodic Table  
of Elements**

1 H	2 He											10 Ne	11 Na	12 Mg											18 Ar																																										
3 Li	4 Be											9 F	8 O	7 N	6 C	5 B											17 Cl	16 S	15 P	14 Si	13 Al																																				
19 K	20 Ca	39 Y	38 Sr	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	81 Tl	80 Hg	79 Au	78 Pt	77 Ir	76 Os	75 Re	74 W	73 Ta	72 Hf	71 Ta	89 Ac	88 Ra	87 Fr	101 Ta	100 Hf	99 Ta	98 W	97 Re	96 Os	95 Ir	94 Pt	93 Au	92 Hg	91 Tl	90 Pb	89 Bi	88 Po	87 At	86 Rn	85 Po	84 Bi	83 Tl	82 Pb	81 Sn	80 In	79 Cd	78 Ag	77 Pd	76 Rh	75 Ru	74 Mo	73 Nb	72 Zr	71 Y	69 Rb	68 Sr	56 Ba	55 Cs
		* Lanthanide Series																																																																	
		+ Actinide Series																																																																	

Legend - click to find out more...

H - gas	Li - solid	Br - liquid	Tc - synthetic
Non-Metals	Transition Metals	Rare Earth Metals	Halogens
Alkali Metals	Alkali Earth Metals	Other Metals	Inert Elements

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### Mineral formation

1. Precipitation
2. Solidification
3. Solid-state diffusion (metamorphism)
4. Bio-mineralization
5. Fumerolic mineralization (precipitate from a gas)

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### Halite (NaCl)

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## Major Mineral Classes

There are over 4000 individual minerals!

Principle anions OR Anionic chains determine a mineral's group

Minerals are identified by their physical properties



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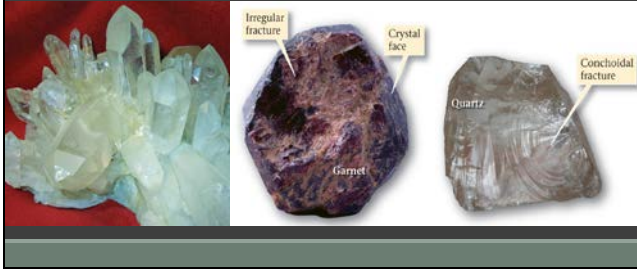
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## Silicates ( $\text{SiO}_4^{4-}$ )



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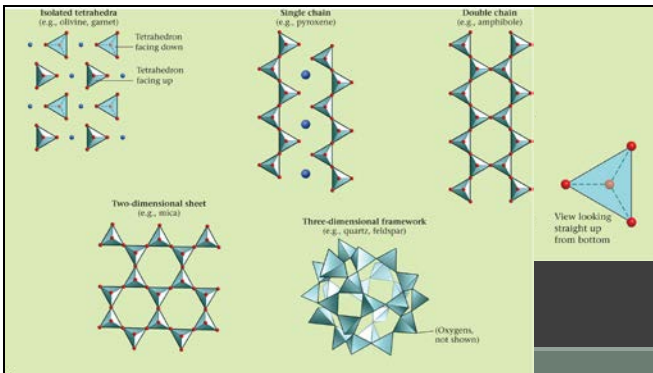
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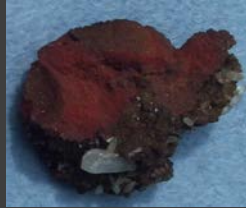
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Oxides (Metal cations bonded to O-anions)



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Sulfides (Metal cation bonded to  $S^{2-}$  anion)



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Sulfates (Metal cation bonded to  $SO_4^{2-}$  anion)



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Halides (halogen anion bonded to a cation)



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Carbonates ( $\text{CO}_3^{2-}$  anionic group)



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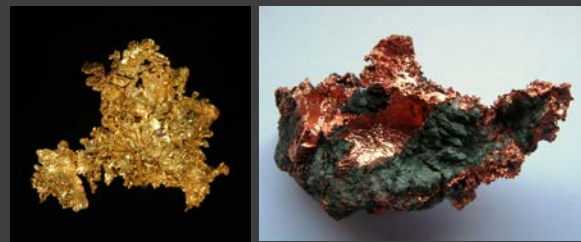
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Native metals (a pure mass of a single metal)



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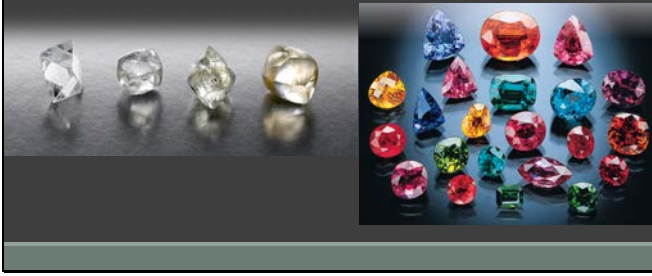
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## Precious stones Vs Gems



Gem Name	Material/Formula	Comments
Amber	Fossilized tree sap	Composed of organic chemicals; amber is not strictly a mineral.
Amethyst	Quartz/SiO <sub>2</sub>	The best examples precipitate from water in openings in igneous rocks; a deep-purple version of quartz.
Aquamarine	Beryl/Be <sub>3</sub> Al <sub>2</sub> Si <sub>6</sub> O <sub>18</sub>	A bluish version of emerald.
Diamond/C	Diamond/C	Brought to the surface from the mantle in igneous bodies called diamond pipes; may later be mixed in deposits of sediment.
Emerald	Beryl/Be <sub>3</sub> Al <sub>2</sub> Si <sub>6</sub> O <sub>18</sub>	Occurs in coarse igneous rocks (pegmatites; see Chapter 6).
Garnet	Garnet (e.g., Mg <sub>3</sub> Al <sub>2</sub> (SiO <sub>4</sub> ) <sub>3</sub> )	A variety of types differ in composition (Ca, Fe, Mg, and Mn versions); occurs in metamorphic rocks (see Chapter 8).
Jade	Jadeite/NaAlSi <sub>3</sub> O <sub>6</sub> Nephrite/Ca <sub>2</sub> (Mg,Fe) <sub>3</sub> (Si <sub>4</sub> O <sub>10</sub> )(OH) <sub>2</sub>	Jade can be one of two minerals, jadeite (a pyroxene) or nephrite (an amphibole); both occur in metamorphic rocks.
Opal	Composed of microscopic spheres of hydrated silica packed together	Most opal comes from a single mining district in central Australia; occurs in bedrock that has reacted with water near the surface.
Pearl	Aragonite/CaCO <sub>3</sub>	Formed by oysters, which secrete coatings around sand grains that are accidentally embedded in the soft parts of the organism. Cultured pearls are formed the same way, but the impurity is a spherical bead that is intentionally introduced.
Ruby	Corundum/Al <sub>2</sub> O <sub>3</sub>	The red color is due to chromium impurities; found in coarse igneous rocks called pegmatites and as a result of contact metamorphism (see Chapters 6 and 8).
Sapphire	Corundum/Al <sub>2</sub> O <sub>3</sub>	A blue version of ruby.
Topaz	Al <sub>2</sub> SiO <sub>4</sub> (F,OH) <sub>2</sub>	Found in igneous rocks, and as a result of the reaction of rock with hot water.
Tourmaline	Na(Mg,Fe) <sub>3</sub> Al <sub>3</sub> (BO <sub>3</sub> ) <sub>3</sub> (Si <sub>3</sub> O <sub>10</sub> )(OH,F) <sub>4</sub>	Forms in igneous and metamorphic rocks.
Turquoise	CuAl <sub>6</sub> (PO <sub>4</sub> ) <sub>4</sub> (OH) <sub>8</sub> • 4H <sub>2</sub> O	Found in copper-bearing rocks; a popular jewelry gem in the American Southwest.

## Geode



Latin – Earthlike

Geologic recourses of great beauty

1967, named the official state rock by the Iowa General Assembly

Warsaw and Keokuk formations of SE Iowa, W. Illinois, and NE Missouri

May also be found in NE Iowa near Jesup



## How do geodes form?

- 1) Geode precursors were concretions (nodules formed by outward growth around some nucleus) which grew within soft, unlithified sediment.
- 2) The outer shells of these concretions were replaced subsequently by chalcedony.
- 3) The interiors of the concretions were dissolved, leaving a hollow space into which quartz and other crystals may grow.

Brian J. Witzke

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## How do geodes form?

- 4) Minerals/crystals inside geodes were transported in groundwater (saturated) solutions and then precipitated as replacements of the geode walls or as crystalline growths within their hollow interiors.
- 5) The ultimate source of the mineralizing waters remains speculative.
- 6) Many common geode mineral, especially quartz, are weakly soluble. Therefore, substantial volumes of water had to migrate through the lower Warsaw strata to precipitate the observed minerals.

Brian J. Witzke

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