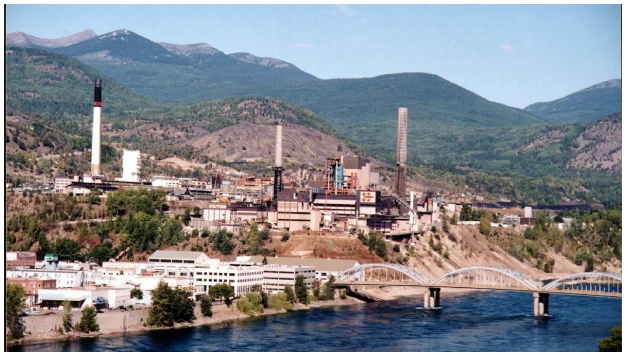
Introduction to Rocks, Minerals,

Mining and Processing



What is a mineral?

Periodic table of elements

1 1.0080 **H** Hydrogen																	2 4.0026 **He** Helium
3 6.94 **Li** Lithium	4 9.0122 **Be** Beryllium											5 10.81 **B** Boron	6 12.011 **C** Carbon	7 14.007 **N** Nitrogen	8 15.999 **O** Oxygen	9 18.998 **F** Fluorine	10 20.180 **Ne** Neon
11 22.990 **Na** Sodium	12 24.305 **Mg** Magnesium											13 26.982 **Al** Aluminium	14 28.085 **Si** Silicon	15 30.974 **P** Phosphorus	16 32.06 **S** Sulfur	17 35.45 **Cl** Chlorine	18 39.95 **Ar** Argon
19 39.098 **K** Potassium	20 40.078 **Ca** Calcium	21 44.956 **Sc** Scandium	22 47.867 **Ti** Titanium	23 50.942 **V** Vanadium	24 51.996 **Cr** Chromium	25 54.938 **Mn** Manganese	26 55.845 **Fe** Iron	27 58.933 **Co** Cobalt	28 58.693 **Ni** Nickel	29 63.546 **Cu** Copper	30 65.38 **Zn** Zinc	31 69.723 **Ga** Gallium	32 72.630 **Ge** Germanium	33 74.922 **As** Arsenic	34 78.971 **Se** Selenium	35 79.904 **Br** Bromine	36 83.798 **Kr** Krypton
37 85.468 **Rb** Rubidium	38 87.62 **Sr** Strontium	39 88.906 **Y** Yttrium	40 91.224 **Zr** Zirconium	41 92.906 **Nb** Niobium	42 95.95 **Mo** Molybdenum	43 97 **Tc** Technetium	44 101.07 **Ru** Ruthenium	45 102.91 **Rh** Rhodium	46 106.42 **Pd** Palladium	47 107.87 **Ag** Silver	48 112.41 **Cd** Cadmium	49 114.82 **In** Indium	50 118.71 **Sn** Tin	51 121.75 **Sb** Antimony	52 127.60 **Te** Tellurium	53 126.90 **I** Iodine	54 131.29 **Xe** Xenon
55 132.91 **Cs** Caesium	56 137.33 **Ba** Barium	57 - 71 **La-Lu** Lanthanides	72 178.49 **Hf** Hafnium	73 180.95 **Ta** Tantalum	74 183.84 **W** Wolframium (Tungsten)	75 186.21 **Re** Rhenium	76 190.23 **Os** Osmium	77 192.22 **Ir** Iridium	78 195.08 **Pt** Platinum	79 196.97 **Au** Gold	80 200.59 **Hg** Mercury	81 204.38 **Ta** Thallium	82 207.2 **Pb** Lead	83 208.98 **Bi** Bismuth	84 209 **Po** Polonium	85 210 **At** Astatine	86 222 **Rn** Radon
87 223 **Fr** Francium	88 226 **Ra** Radium	89 - 103 **Ac-Lr** Actinides	104 267 **Rf** Rutherfordium	105 268 **Db** Dubnium	106 269 **Sg** Seaborgium	107 270 **Bh** Bohrium	108 269 **Hs** Hassium	109 278 **Mt** Meitnerium	110 281 **Ds** Darmstadtium	111 282 **Rg** Roentgenium	112 285 **Cn** Copernicium	113 286 **Nh** Nihonium	114 289 **Fl** Flerovium	115 290 **Mc** Moscovium	116 293 **Lv** Livermorium	117 294 **Ts** Tennessine	118 294 **Og** Oganesson

atomic number — atomic mass

1 1.0080
H
Hydrogen

symbol
name

57 138.91 **La** Lanthanum	58 140.12 **Ce** Cerium	59 140.91 **Pr** Praseodymium	60 144.24 **Nd** Neodymium	61 145 **Pm** Promethium	62 150.36 **Sm** Samarium	63 151.96 **Eu** Europium	64 157.25 **Gb** Gadolinium	65 158.93 **Tb** Terbium	66 162.50 **Dy** Dysprosium	67 164.93 **Ho** Holmium	68 167.26 **Er** Erbium	69 168.93 **Tm** Thulium	70 173.05 **Yb** Ytterbium	71 174.97 **Lu** Lutetium
89 227 **Ac** Actinium	90 232.04 **Th** Thorium	91 231.04 **Pa** Protactinium	92 238.03 **U** Uranium	93 237 **Np** Neptunium	94 244 **Pu** Plutonium	95 243 **Am** Americium	96 247 **Cm** Curium	97 247 **Bk** Berkelium	98 251 **Cf** Californium	99 252 **Es** Einsteinium	100 257 **Fm** Fermium	101 258 **Md** Mendelevium	102 259 **No** Nobelium	103 266 **Lr** Lawrencium

alkaline metals	alkaline earths	transition metals	basic metals	metalloids
no metals	halogens	noble gases	lanthanides	actinides

What is a Mineral?

- Naturally occurring
- Homogeneous solid
- Inorganically formed
- Definite chemical composition
- Ordered atomic arrangement

What is a rock?

What are the 3 types of Rock?

3 Types of Rocks:

- Sedimentary
- Igneous:
  - Extrusive - volcanic
  - Intrusive
- Metamorphic

Highland Valley Copper Mine

- Large Open Pit, mining granite that contains 0.35 % Cu and 0.0015% Mo

- Copper in the form of Chalcopyrite $CuFeS_2$
- Molybenum as Molybdenite MoS_2

Mine 178,000 tonnes/day of ore to the Mill (concentrator).

What happens in the Mill?

Mill (Concentrator)

- The Mill crushes and grinds the rock to enable separation of the minerals.
- Produces a copper concentrate in the predominately of Chalcopyrite
- Produces a Molybdenum concentrate in the form of Molybdenite
- Copper concentrate is trucked to Ashcroft, train to Vancouver, ship to Korea, Japan

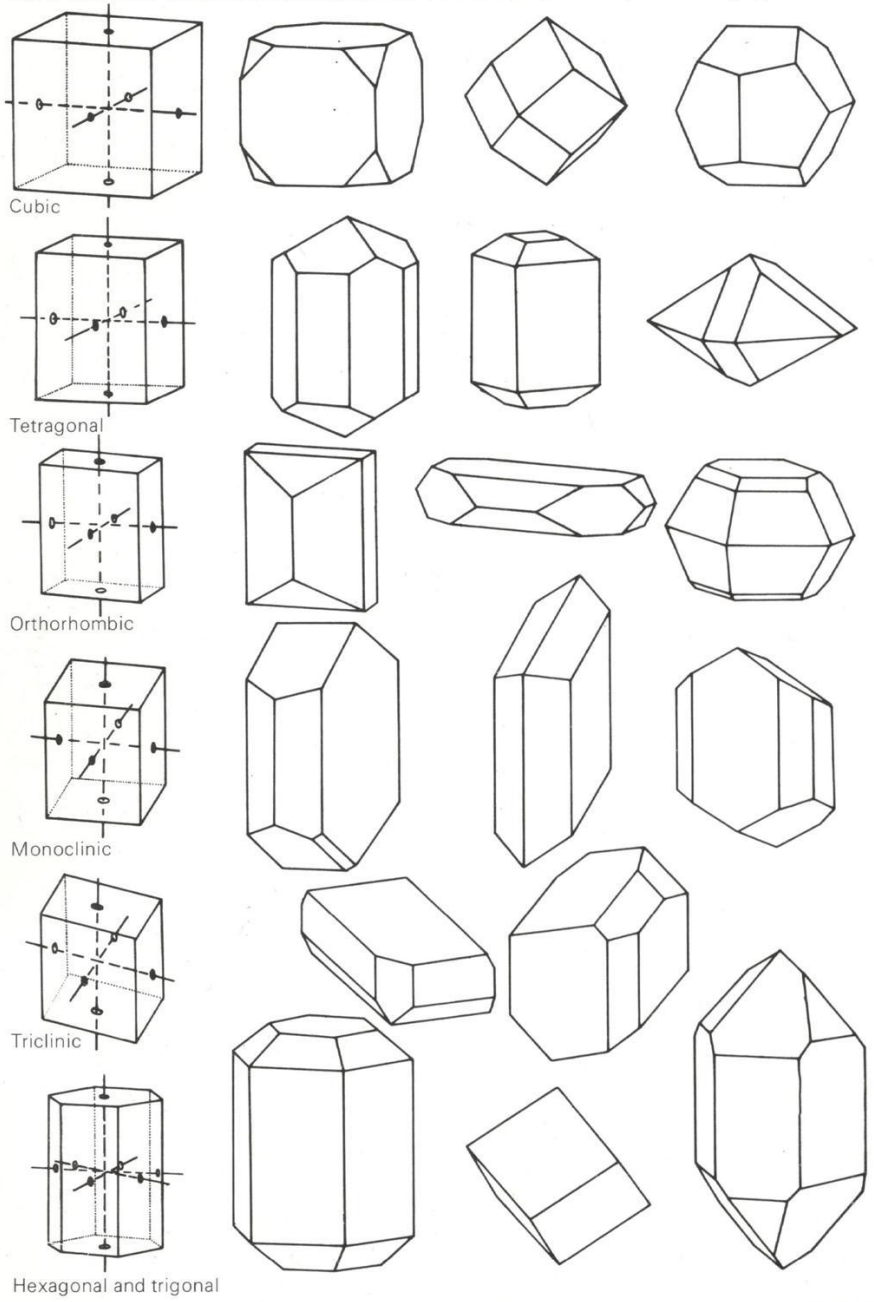
What happens at a smelter?

Smelting - Trail

- Smelters separate the elements.
- Trail the inputs are Sphalerite ZnS and Galens PbS
- Produces pure Zinc and Lead ingots
- Sphalerite can contain Germanium which is also recovered.
- Galena commonly contains Silver which is also recovered.

Minerals form crystals when they are free to grow without constraint and crystals faces form in a regular shape as an expression of its regular atomic arrangement. On the basis of their symmetry crystals can be grouped into seven crystal systems.

Fig. 5 Reference axes of the crystal systems and some examples of crystals belonging to each



- Physical Properties
  - Specific Gravity
  - Hardness
  - Cleavage
  - Fracture
- Optical Properties
  - Transparency
  - Reflection and refraction
  - Lustre
  - Colour
  - Streak
  - Fluorescence
- Other
  - Magnetic, piezoelectric, radioactive

When we go on field trips what rock types are we looking at and what are we finding?

In what rock type are agates found in?

How did the agates form?


(c) Vlastislav Snášel

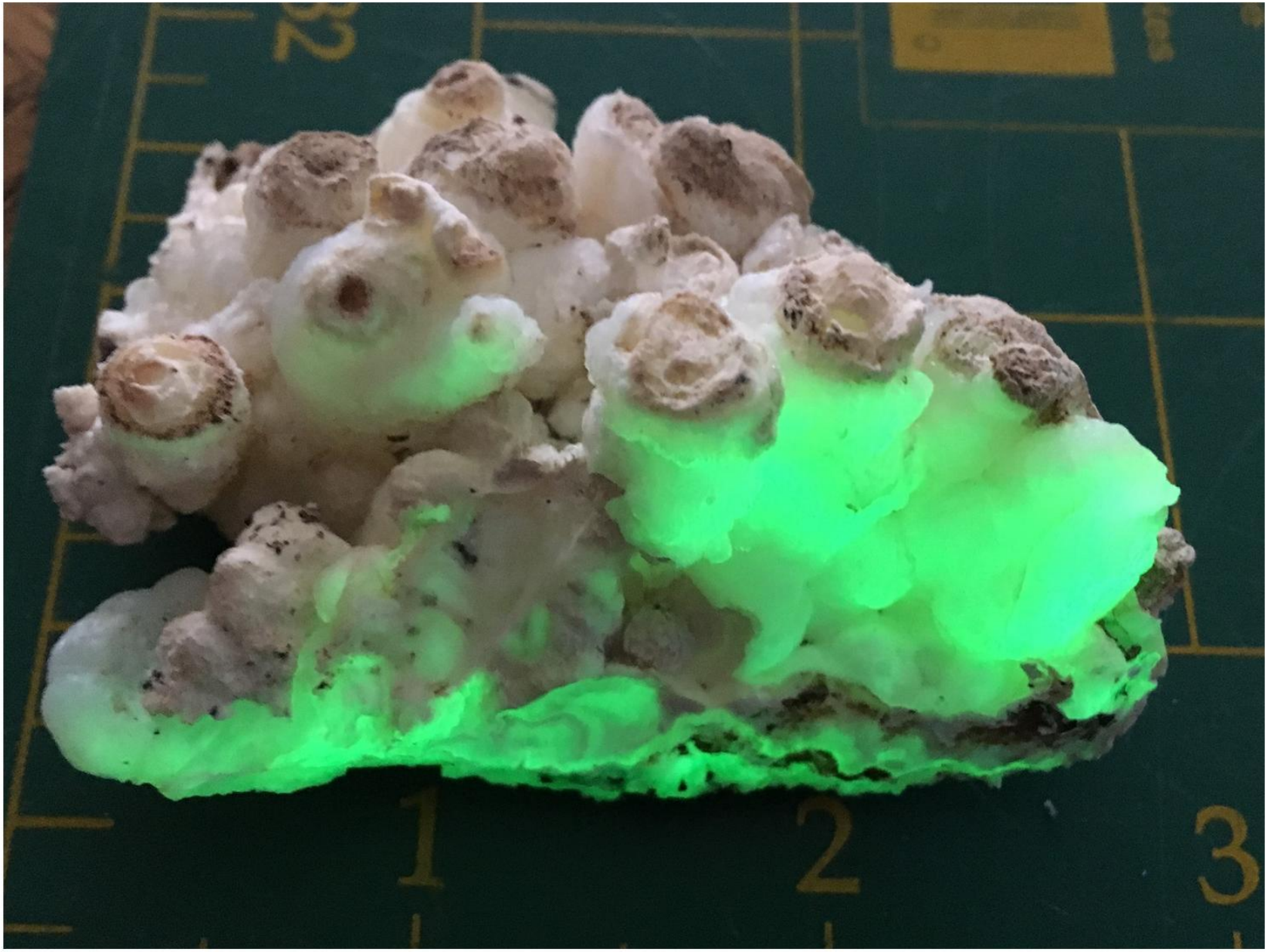
What is the composition of quartz?

What is the composition of agate?

What is the difference between a quartz crystal and agate?

What is the difference between chalcedony and agate?

What is the composition of opal?


1
2
3