Crystal Magic II. . .

by Ben "Rainbow Moonflower Windsong" Waggoner

Quick review: Minerals are. . .

- naturally occurring
- usually solid
- *inorganic* (not made by living things)
- nearly constant chemical composition
- fixed crystalline structure, defined by the *unit cell*

So how do we identify minerals?

- chemical composition
- class of unit cell
- *crystal form* (shape of typical crystals)
- *cleavage* (natural way the mineral breaks)
- color
- density
- hardness
- other properties. . .

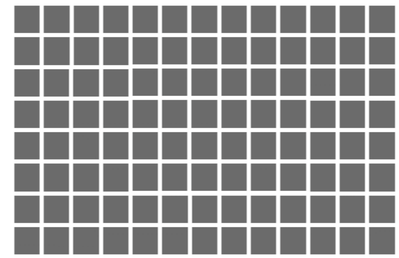
Classes of chemical composition

- native elements
  - gold (Au)
  - copper (Cu)
- sulfides
  - pyrite (FeS)
  - galena (PbS)
- halides
  - halite (NaCl)
  - fluorite (CaF_2)
- oxides and hydroxides
  - hematite (Fe_2O_3)

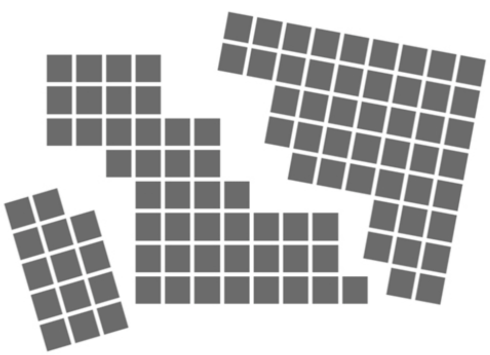
Classes of chemical composition

- carbonates
  - calcite ($CaCO_3$)
  - azurite ($Cu_3(CO_3)_2(OH)_2$)
- sulfates
  - gypsum ($CaSO_4 \bullet 2(H_2O)$)
- phosphates
  - turquoise ($CuAl_6(PO_4)_4(OH)_8 \bullet 5(H_2O)$)
  - apatite ($CaPO_4$)
- silicates
  - quartz (SiO_2)
  - almandine garnet ($Fe_3Al_2(SiO_4)_3$)

Cleavage is the "preferred" way in which a mineral fractures. Think of it like this: If a mineral is made up of many unit cells. . .



. . . then stress on the crystal will tend to break it along the boundaries of the unit cells.



Understanding the natural cleavage of a crystal is crucial for cutting gemstones. . .

Cullinan raw diamond,
3106 carats (= 621 grams = 1.3 pounds, largest ever found; South Africa,1905)

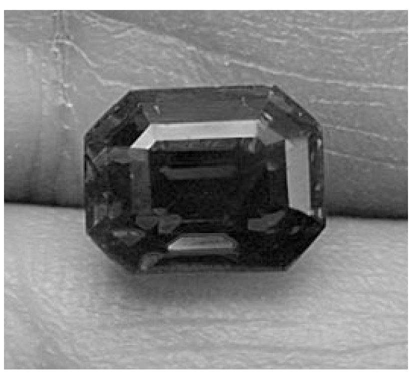
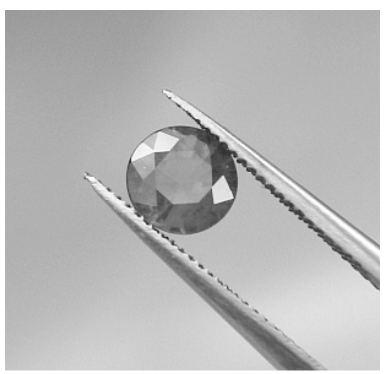
Star of Africa diamond cut from the Cullinan, 530 carats

Cleavage usually tells you something about the shape of the unit cell—but not always!

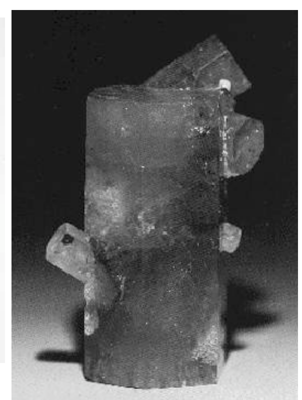
Quartz crystals have hexagonal unit cells and hexagonal crystal form, but no cleavage at all, i.e. they don't break in a "preferred" direction.

Mineraloids (which have no crystal structure), and some minerals with tiny crystals, tend to form curved, striated fractures called *conchoidal fractures*. (Conchoidal = shaped like seashell.)

Color often varies due to impurities in the mineral. The mineral *corundum* (aluminum oxide) is clear, but traces of iron and titanium make it a *blue sapphire*, while traces of chromium make it a *ruby*.

Beryl is beryllium aluminosilicate ($Be_3Al_2Si_6O_{18}$). A bit of iron makes beryl an *aquamarine*; manganese gives you a *red beryl*; and chromium gives an *emerald*.

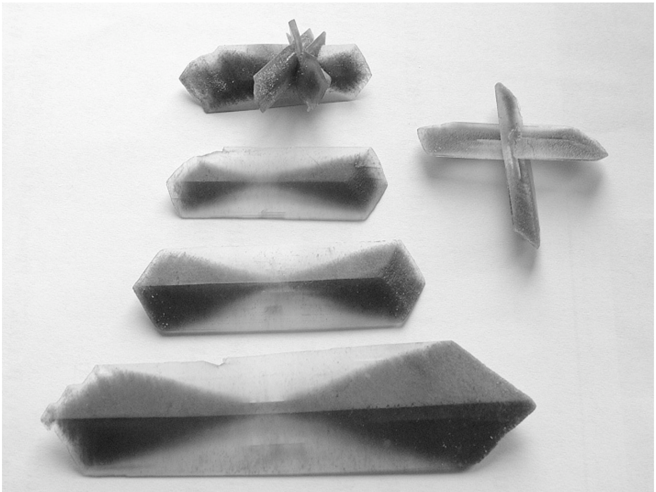




But how do minerals form?

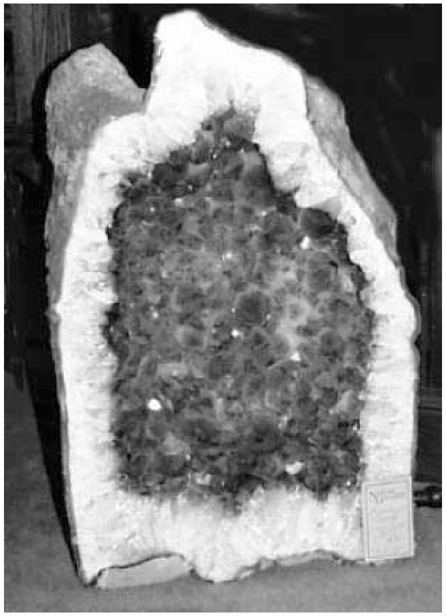
- We'll get into this in more detail when we talk about rock types next week. But for now. . .
- Minerals usually form by precipitation, either from a *solution* (chemicals dissolved in water) or from a *melt* (molten rock).
  - Minerals may also form when high pressure on a rock causes existing minerals to redissolve and chemically change.

Some minerals form when a concentrated solution evaporates. Halite (rock salt) and gypsum (calcium sulfate) are examples. . .

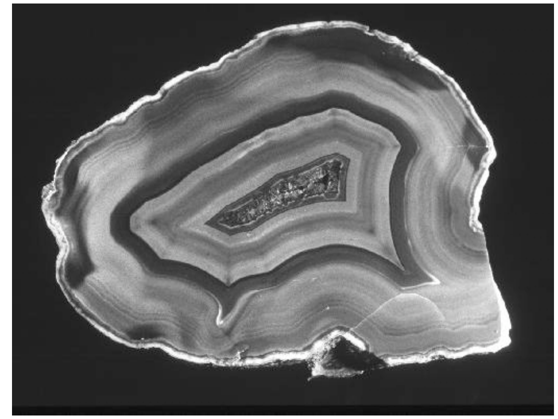
Selenite (translucent calcium sulfate) continuously forms crystals on the bed of a salt lake in Oklahoma. (The dark "hourglass" comes from trapped sand grains inside the crystal.)



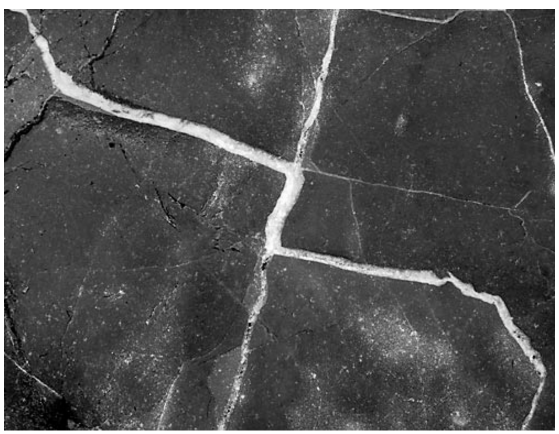
Calcite (calcium carbonate) precipitating from groundwater forms these stalactites in Carlsbad Caverns, NM.



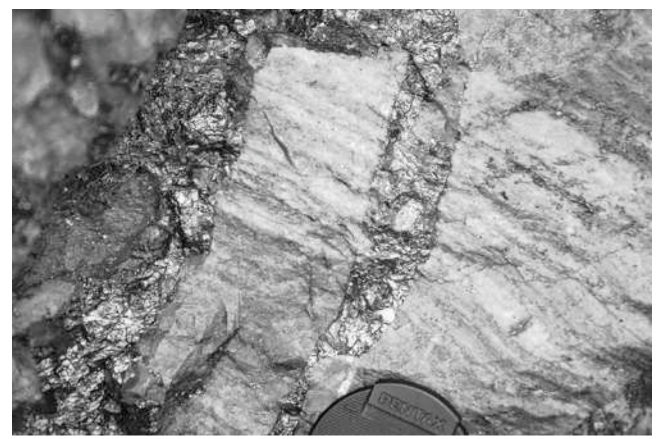
Mineral-rich water that fills a hollow cavity in a rock (a *vug*) may precipitate out large crystals, if there's enough room for them to grow. This is how you get geodes. . .



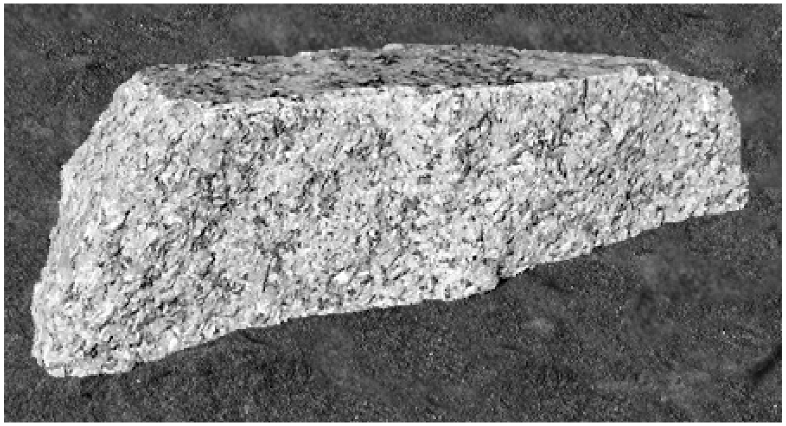
Sometimes a cavity becomes filled with a mineral that forms microscopic crystals. Agates (banded microcrystalline quartz) form this way.



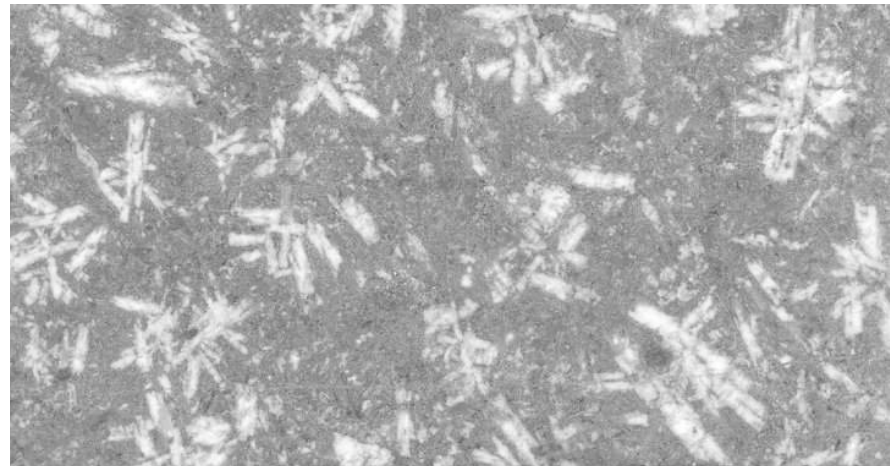
If mineral-rich water percolates through a crack in rock, minerals may precipitate out but not have room to form distinct crystals. That's how these *veins* of *massive* quartz were formed.



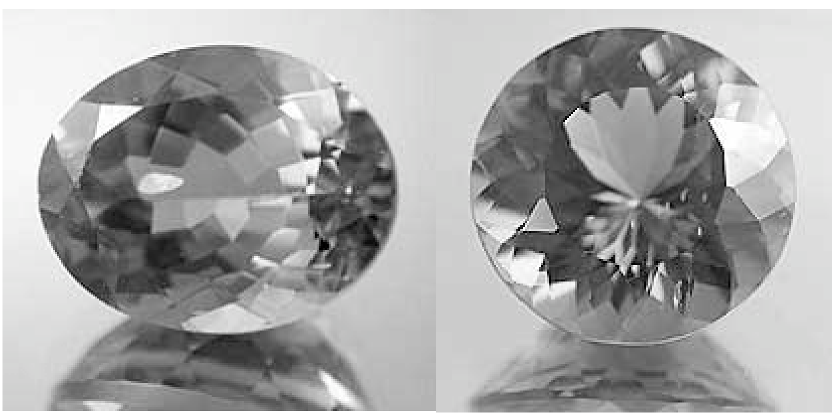
Very hot, high-pressure, and mineral-rich water (called *hydrothermal fluids*) is responsible for forming vein deposits of many minerals, including metal ores—such as this vein of gold from a mine in Zambia.



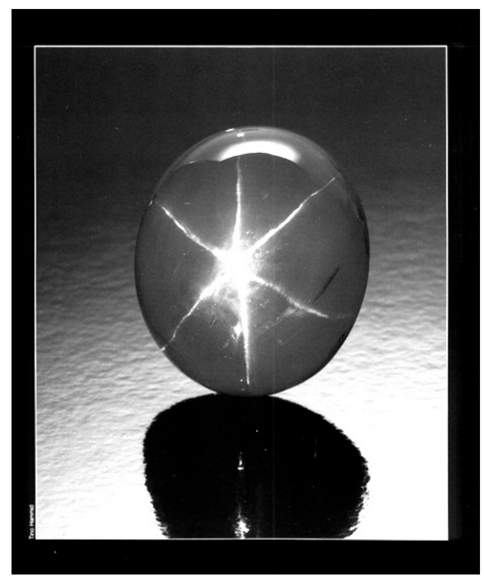
Minerals also form when molten rock cools. This granite is composed of quartz (white), mica (black), and feldspar (reddish).



The "snowflakes" in this rock, called snowflake porphyry, are crystals of the mineral feldspar that formed as the rock slowly cooled from molten magma.



The mineral *olivine* (magnesium-iron silicate) also may crystallize in cooling molten rock. When the crystals are large and well-formed, they're called *peridot*.



As this corundum (Al_2O_3) crystal formed (probably out of a melt), tiny needles of a different mineral, *rutile* (TiO), precipitated out inside it. These catch the light in a very distinctive way. . . hence the name "star sapphire".

A bit on economics. . .

- In law and industry, "mineral" means "anything valuable dug out of the ground". . .
  - Thus oil and gas are minerals according to the US government, even though geologists wouldn't call them that.
- "Ore" means "any rock you can get metal out of at an economic profit"
  - Thus a rock or mineral may go from being an ore to not being an ore, and back, depending on the economics of the situation