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Crystallography and Mineralogy
Lec. 4, 5: Mineral in the Geologic Environment

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What is a Mineral?

Naturally occurring, inorganic, crystalline solid with a specific chemical composition.

A specific chemical composition means that the composition of mineral has a chemical formula.

Example: halite (salt) is NaCl.

What are atoms and elements?

Atom: is the smallest unit of an element that retains the physical and chemical properties.

Element: is a substance that cannot be broken down into a simpler substance. Made of protons, neutrons and electrons.

examples: gold, iron, hydrogen, oxygen, sodium, chlorine, carbon, silicon, helium.

Protons, Neutrons, Electrons:

Protons have positive charge & mass of 1.

Neutrons have no charge & mass of 1.

Protons and neutrons make up the nucleus of an atom

Electrons have a negative charge, NO mass and are most important for chemical reactions.

Factors determine the mineral.

- 1 What elements are available.
- 2 Abundance of each elements.
- 3 Size & charge of each element.

4 Environment, pressure and temperature.

Geological environments:

Minerals are related to geological environments and processes. The important mineral environments include: magma, Pegmatite, Hydrothermal, Surface and Subsurface water, Metamorphic, Moon and Meteorite.

1. Minerals in Magmatic Systems: Include A) partial melting of source rocks. B) Separation of magma. C) Fractional crystallization. The most magmatic minerals are granite and basalt.

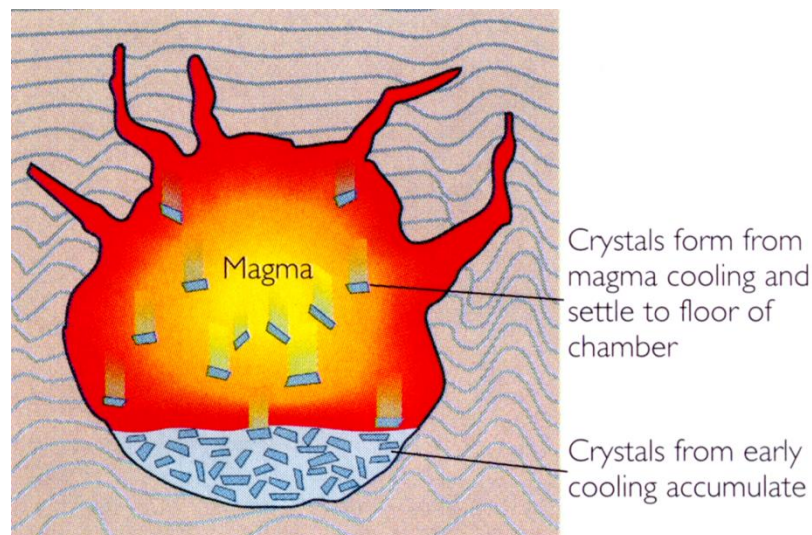


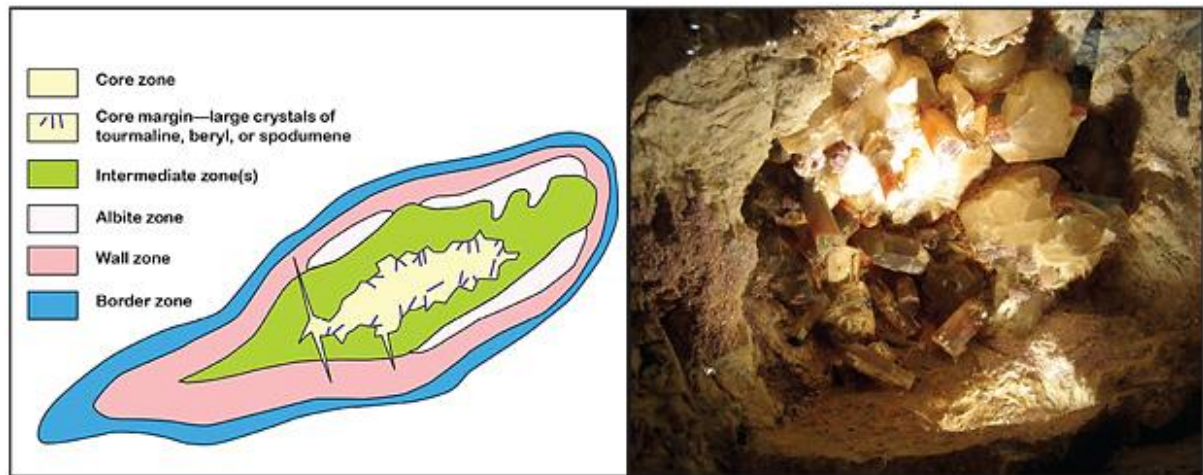
Fig. Minerals in Magmatic Systems.

2. Minerals in Pegmatite Systems:

A) Contain a last stage mineral assemblage of large crystals 2.5 cm in size (1 in)..

B) Most pegmatites are composed of quartz, feldspar and mica, having similar composition of granite.

C) It has many zones: a border zone, a wall zone, intermediate zone, and core zone.



(Left) Diagram depicting the idealized zoning of a complex LCT-type pegmatite. The rarest and most interesting minerals, as well as the gem pockets, are normally found around the edges of the core zone. (Right) This photo shows the recreation of what a typical gem pocket looks like in a Southern California pegmatite, minus any pocket clay. The gems and other crystals lie in a jumble, just as they grew. It is available for public view at The Collector in Fallbrook, California.

Fig. Zones of Pegmatite

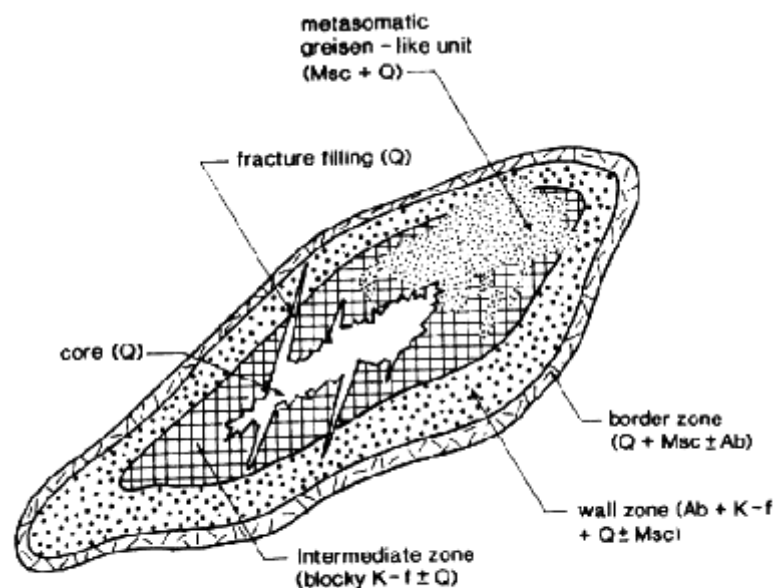


Figure 3 Internal structure of zoned pegmatites in schematic horizontal sections. (A) Concentric pattern of primary zones, with zonal control of the distribution of albite units, and core-margin mineralization; (B) Concentric pattern of primary zones cross-cut by fracture fillings, with a lithology-controlled, but, in part, fracture-related, metasomatic unit.

Fig. Zones of Pegmatite



Fig. Minerals in Pegmatite Systems

3. Minerals in Hydrothermal Systems: It is hot fluid, naturally occur in rock bed units and contain dissolved elements. Minerals precipitate from hot solution such as: A) hot spring. B) Shallow subsurface Environment at depth more than 2 km. C) Subvolcanic Environment.

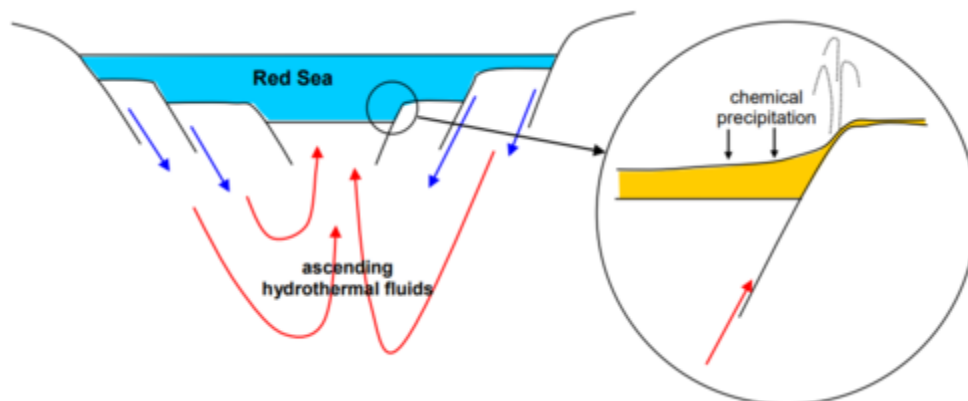


Fig. Hydrothermal Systems

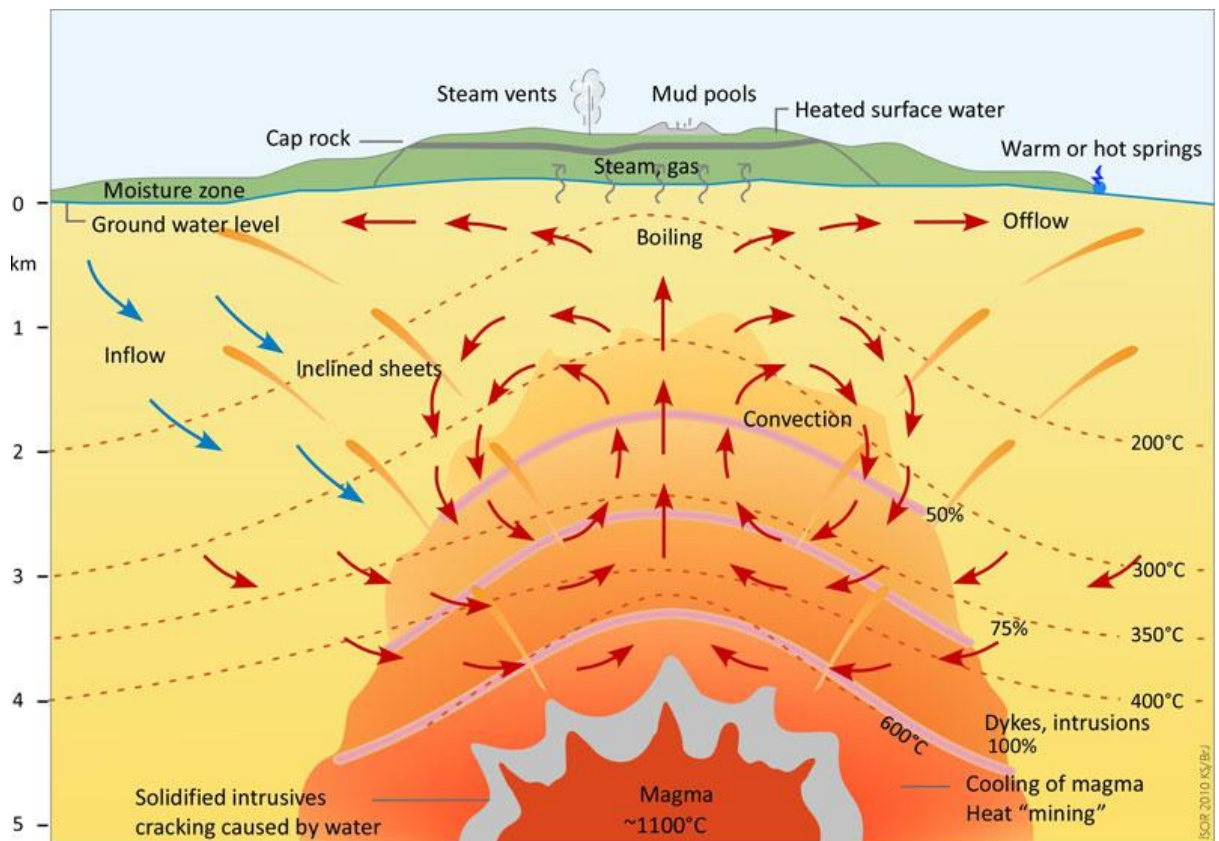


Fig. Hydrothermal Systems

4. Minerals of water systems: Many minerals are deposits from surface water. Oceans, seas, and lake contain high amount of dissolved salts. Many minerals are deposits from saline water after evaporation, such as CaCO_3 , CaMgCO_3 , CaSO_4 , and NaCl .

Surface water and ground water carry dissolved minerals into lakes and seas where they crystallize, forming minerals like calcite and aragonite.



5. Minerals in metamorphic Systems: The original rock (igneous, sedimentary or metamorphic) is subjected to heat (temperatures greater than 150 to 200 °C) and pressure (1,000 bar) or more, causing physical or chemical change. Metamorphic minerals are form only at the high temperatures and pressures associated with the process of metamorphism. These minerals, known as index minerals, include sillimanite, kyanite, staurolite, andalusite, and some garnet.

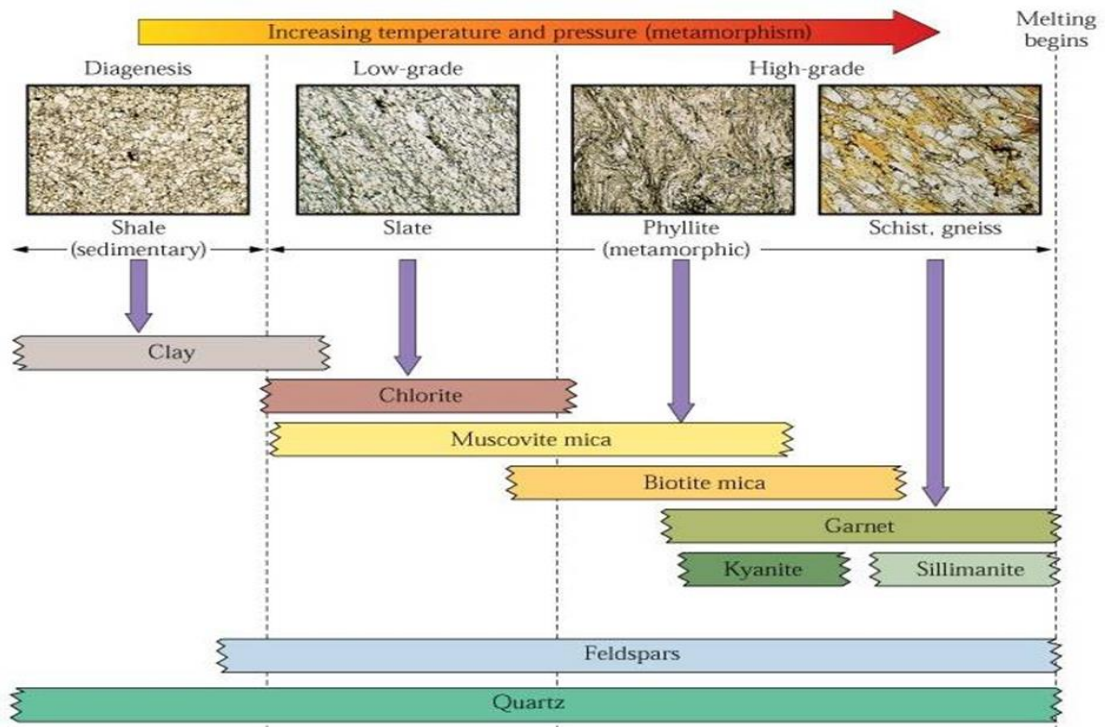


Fig. Metamorphic minerals and degree of metamorphism

6. Minerals in **moon** and **meteorite** system: Moon rock or lunar rock is rock that is found on the Earth's moon. Elements of moon surface include, oxygen (O), silicon (Si), iron (Fe), magnesium (Mg), calcium (Ca), aluminium (Al), manganese (Mn) and titanium (Ti). Meteorite: are the rock ejected naturally from the Moon's surface.



Fig. Type of meteorite