Wall Roc Alteration

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Wall Rock Alteration

- Unstable (not in equilibrium) rocks undergo physical and chemical changes (in order to attain equilibrium) in the presence of early ground preparing hydrothermal fluids of ore solutions.
- The alteration may be very subtle (hydration of ferromagnesian minerals) to very intense (silicification of limestones).
- Indeed replacement ores are merely commercially valuable products of wallrock alteration.
- Wallrock alteration has been recognized a valuable tool in exploration, because the alteration halos around many deposits are widespread and easier to locate than the orebodies themselves.
- Alteration effects may have reached the surface, or may be blind and found only in underground workings or in drill holes.
- Alteration may range from simple recrystallization to addition, removal or rearrangement of chemical compounds.
- It may take place in advance of emplacement of the ore minerals, or during the final waning stages of hydrothermal activity.

Physical effects of alteration

- Alteration is a complex process of ion exchange whereby some constituents are removed, others are added and still others are merely redistributed.
- The physical effects of alteration include recrystallization, changes in permeability and changes in colour.
- Carbonate rocks are characteristically recrystallized along the borders of a vein or near an igneous contact.
- The recrystallized area is generally more permeable than the unaltered rock, suggesting that the ores owe their localization to increased permeability.
- Conversely argillization may reduce permeability of a rock, leaving the orebody enclosed within a relatively impermeable shell.
- Colour changes include bleaching, garkening and production of aureoles (zones) of various colours.
- Pastel colours are especially prominent around certain ore deposits and may form conspicuous leads to the ore.

Physical effects of alteration

- Clay minerals are generally white of light shades of green, brown or gray, hence argillization may produce a pronounced bleaching effect.
- Even a black basalt may be altered to a white or light green product of clay and other hydrous minerals.
- Addition of chlorite or epidote will produce a green colour.
- Pyrite is a standard alteration product around sulfide ore deposits (since iron is one of the most abundant metals in the earth's crust).
- Pyrite forms whenever sulfur is added to a host rock containing iron or ferromagnesian minerals.
- Pyrite causes a striking colour change eg. the pyritization of a red sandstone or shale will produce a bleached zone due to reduction of iron.
- Conversely, any pyritized rock is likely to be made conspicuous at the surface by oxidation of iron which will produce a red, brown-red or yellow weathered zone

Zoned Alteration

- At various distances from a vein, the conditions of temperature and chemistry are usually different.
- As a result of this different types of alteration are likely to be produced simultaneously at various distances from the vein or fissure.
- For example, in the outer fringes of the alteration zone, the ferromagnesians may have been slightly hydrated while the interior zone was being silicified or sericitized, and the intermediate zone argillized.
- The product of this is a zoning of different alteration products arranged symmetrically around the central vein.
- In some deposits this zoning is conspicuous and may be an excellent guide to ore.

Types of Alteration

- Advanced argillic - characterized by the clays dickite, kaolinite and pyrophyllite (all hydrated aluminum silicates) and quartz.

Sericite may be present as well as alunite and tourmaline.

Alteration involves the extreme leaching of cations, especially the difficult to leach alkalis and calcium, and the concentration of H+.

This type of alteration is characteristic of many epithermal precious metal deposits and a smaller number of mesothermal deposits such as Butte, Montana.

- Potassic alteration - characterized by secondary Kspar + biotite.

Anhydrite may be present, but its susceptibility to solution generally results in its dissolution in near surface environments.

As it is characterized by common silicates, potassic alteration is often difficult to detect. Pyrite and minor chalcopyrite and molybdenite are the only ore minerals associated with this alteration.

Types of Alteration

- Sericitization (Phyllic) - characterized by the assemblage quartz + sericite + pyrite. Generally the most common form of alteration. Sulfides present, in addition to pyrite, include chalcopyrite, bomite and a variety of less common copper sulfides.
- Argillic - characterized by kaolinite + montmorillonite. This alteration is more closely associated with disseminated deposits, porphyry coppers in particular. Sulfides are less common in association with this alteration type.
- Propylitic - characterized by the assemblage chlorite + epidote + calcite. Albite as well as other carbonates may be present. Due to presence of the green minerals chlorite and epidote this zone is usually easily recognizable by its color.
- Silicification - characterized by quartz or chert. Can be added by solutions as is the case in many low temperature deposits or the result of complete leaching of all cations plus aluminum.
- Dolomitization - addition of magnesium to limestone to form dolomite. Common in Mississippi Valley type deposits.

Types of Alteration

- Feldspathization - *kspar* + *albite*, forms in the deep zones of some porphyry copper deposits.
- Greisenization - *tourmaline* + *topaz* + *cassiterite* + *various tungsten-bearing minerals*. Common form of alteration on association with porphyry tin deposits.
- Fenitization - characterized by *nepheline*, *alkali feldspar and Na-bearing amphiboles*. Hematization - characterized by secondary *hematite*.
- Bleaching - not characterized by any specific mineral assemblage, but rather a color change between altered and unaltered rock. Generally the result of oxidation of Fe.