

Oxide Zone Mineralisation

The Earth's crust and the rocks and minerals comprising it are made from predominately only a very few elements with oxygen and silicon making up about 75% of the constituent elements, some six of the more common ones another 24%, and all of the rest of the elements listed in the periodic table comprising about 1.5%. In spite of this the Earth's crust is very heterogeneous and due to various geochemical processes over time deposits of minerals containing the less common elements have accumulated in places. These deposits include ores and where the less common elements include the heavier metals these are often present as sulfides or sulfosalts. It was this class of compounds with about a thousand known species that Professor Williams wished to speak on this evening.

Sulfides and sulfosalts usually form deep in the Earth's crust, sometimes as melts or sometimes as quasi-melts, in an environment of high temperatures, high pressures and very low oxygen pressures. One thing that collectors might not be aware of about specimens of metal sulfides that they may have in their collections, is that with very few exceptions, now that these minerals are out of the environment in which they were formed they are decomposing. The rate at which this will be occurring will vary considerably from species to species and whilst for the most part they are insoluble in and un-reactive with water the presence of oxygen will be gradually oxidising them. In the natural situation in rocks containing sulfide minerals a key feature of the chemistry of the suite of minerals found is whether the rock or ore is above or below the water table which will exclude oxygen from the minerals below this level. Above the water table the minerals are within the oxidation zone.

Stressing that he could not deal with the entire class of secondary sulfide minerals in one evening, Professor Williams proceeded to list and describe a number of these. Whilst the large majority of sulfate minerals have been formed in the ambient temperature secondary oxidised zone environment of orebodies there are a few exceptions. Dolerophanite, $\text{Cu}_2(\text{SO}_4)\text{O}$, and chalcocyanite, CuSO_4 , are found as volcanic sublimates and are in fact high temperature primary minerals. Both have been found in the suite of minerals formed during volcanic eruptions such as that of Mounts Vesuvius, Etna, Stromboli and the island of Vulcano. By contrast copper sulfate minerals formed in the oxidised zone such as brochantite, $\text{Cu}_4(\text{SO}_4)(\text{OH})_6$, and antlerite, $\text{Cu}_3(\text{SO}_4)(\text{OH})_4$, always carry water. Once sulfide minerals have been oxidised they become more reactive and soluble in water with a larger range of species potentially being formed and there are many more secondary minerals known than there are primary minerals. The particular balance or concentration of ions and conditions of oxygen level, temperature and water in an oxidised zone will produce a particular suite of minerals but changing the conditions even very slightly will lead to other minerals being formed. Apart from the considerable range of copper sulfate minerals the inclusion of other metal elements, zinc, lead, arsenic, etc, into the secondary zone environment leads to an even larger range of minerals. With constantly changing conditions in the oxidised zone a large mix of sometimes very similar but different minerals may be formed.