Pieces of Eight Minerals

What can an old corroded coin tell us about groundwater pollution and the formation of ore deposits? Plenty, it turns out. A recent article (Craig, et al., 2002) detailing the mineralogy of an 1800 Spanish piece of eight is a good example of how a seemingly esoteric report can have wide implications. The authors take as their subject a silver coin recovered from the wreck of a Spanish frigate that sunk in November of 1800 in the stormy waters off Ecuador. It is thought that the coin was minted in Lima from silver mined from the famous workings at Potosi. The coin was obtained for study from a museum in Florida, then sawn and analyzed with sophisticated equipment including the electron microprobe. The coin had apparently been buried, and corrosion products had formed, cementing a thick crust of sediment and shell fragments to the coin. If you watch a lot of public TV you've likely seen such dark encrusted coins waved about by triumphant divers.

The formation of these corrosion products is a mineralogical process. However, unlike other mineralogical processes, there are two important things known about this. First the composition and size of the coin, the starting point for all the later mineralogical changes, is exactly known. Spanish pieces of eight were carefully made as legal tender to a constant mass: 27.064 grams to be exact. They were also made of about 90% silver and 10% copper, a proportion verified by analysis of the unaltered coin within the crust. Second, the mineralogical process went on for a known length of time. In the case of the coin, it was buried for approximately 140 years. This allows some indication of the rates of mineral forming events to be estimated, over lengths of time not duplicated in the lab.

The corrosion material consisted mostly of silver and copper sulfides: acanthite and covellite. Acanthite is Ag2S and covellite is CuS. Acanthite can accommodate some copper atoms as impurities and covellite can accommodate some silver. Both minerals do so in these crusts. Acanthite is by far the most common mineral in the crust. Several rare silver copper sulfides, jalpaite, stromeyerite and mckistryite, also occur. A hydrated copper chloride, atacamite is also seen. It is clear that the copper and silver come from the coin, and that the water and Cl in atacamite come from seawater. However, where did the sulfur originate? The authors appeal to S released metabolically by bacteria dwelling in the sediment in which the coin was buried. The released sulfur, originally dissolved in seawater, would readily react with the metal of the coin. How do these facts relate to ore formation and ground water pollution? In the first case, we often observe an enriched cap of silver and copper sulfides called a supergene deposit over lower grade ore deposits. These deposits seem to form from ground water redepositing the metals under relatively cold conditions. Here on the coin is a small scale supergene deposit also formed in relatively cold conditions within a span of time measured in tens, not millions, of years. Many of the minerals in the corrosion crust are important ore minerals that form in real deposits such as Butte Montana. The study of these corrosion products is a study of the chemical processes involved in these ore processes.

The coin also demonstrates the relative range of movement of heavy metals within surficial water. It demonstrates that the presence of sulfur in the environment locks up many of the metals as solid minerals rather than allow them to travel widely through groundwater. The little bacteria that release reactive sulfur from their metabolic processes may in fact be our friends when it comes to minimizing heavy metal pollution in ground water.

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Reference:

Craig, James; Callahan, John; Kimbell, Joe and Solberg, Todd; 2002, “Corrosion Mineralogy of an 1800 Spanish Piece of Eight”, The Canadian Mineralogist, vol. 40, p. 585-594.