Time scales and textural evolution during weathering of galena

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If galena (gn) bearing ore deposits are exposed to near-surface conditions, supergene alteration produces thermodynamically more stable secondary lead phases: cerussite (cer), anglesite (ang) and pyromorphite group minerals (PyGM; pyromorphite, mimetite and vanadinite).

The time scale and the evolution of textural zoning during formation of these secondary lead phases are not well understood. They form a spatially well-ordered zoning texture around the preexisting/relic galena which changes with time. Ang typically disappears first, with proceeding evolution cer dissolves and finally only the highly insoluble PyGM persist as perimorphoses.

To explain textures and temporal evolution thermodynamic models are presented exploring variable physiochemical conditions during weathering of gn. The models show that over the whole relevant pH-range PyGM are the most stable phases, precipitating at very low ion activities. Whether cer or ang is formed depends mainly on the pH of the supergene fluids. Calculated solubility diagrams show that under most surface conditions ang is the most soluble phase followed by cer and PyGM explaining the observed temporal evolution.

We also present calculations on the duration of pyromorphite crust formation using natural phosphate fluxes in arid environments. The calculations indicate that the formation of pyromorphite crusts of some millimeter thickness can be realized in geologically short time periods of tens to hundreds of years. This nicely agrees with observations in old mines.