

Acid mine drainage I: chemical reactions for oxidation of sulfides

Many ore deposits from which humans extract metals like copper and zinc are rich in sulfide minerals. For example, copper is commonly mined from rocks rich in chalcopyrite (CuFeS_2) and zinc is commonly mined from rocks rich in sphalerite (ZnS). Such rocks are commonly also rich in pyrite (FeS_2).

As mining exposes these pyrite-rich rocks to the atmosphere, and/or leaves behind pyrite in contact with the atmosphere, the sulfur is oxidized from its reduced condition (S^{2-} or S^0) to its oxidized state (S^{6+}).

The inevitable result is the generation of acidic solutions, as is shown below. The waters draining from mines are thus commonly very acidic, and those waters are called "acid mine drainage".

The same reactions take place when pyrite-rich rocks are exposed to the atmosphere by natural erosion. Thus some acidity may be found in streams in regions of unmined pyrite-rich rocks. However, mining greatly accelerates exposure of pyrite to the atmosphere and thus commonly produces much more acidic drainage than the waters

produced by natural erosion and weathering.

The generation of acidity occurs with the oxidation of pyrite and marcasite (FeS_2) and, to a lesser extent, with pyrrhotite (Fe_{1-x}S). However, as x goes to zero and the stoichiometry of a sulfide goes to MeS (as in sphalerite), the generation of H^+ goes to zero as well (as is shown in the oxidation reaction for sphalerite below).

Part II of this series looks at some data from mines and considers further the chemistry of waters in those mines.

