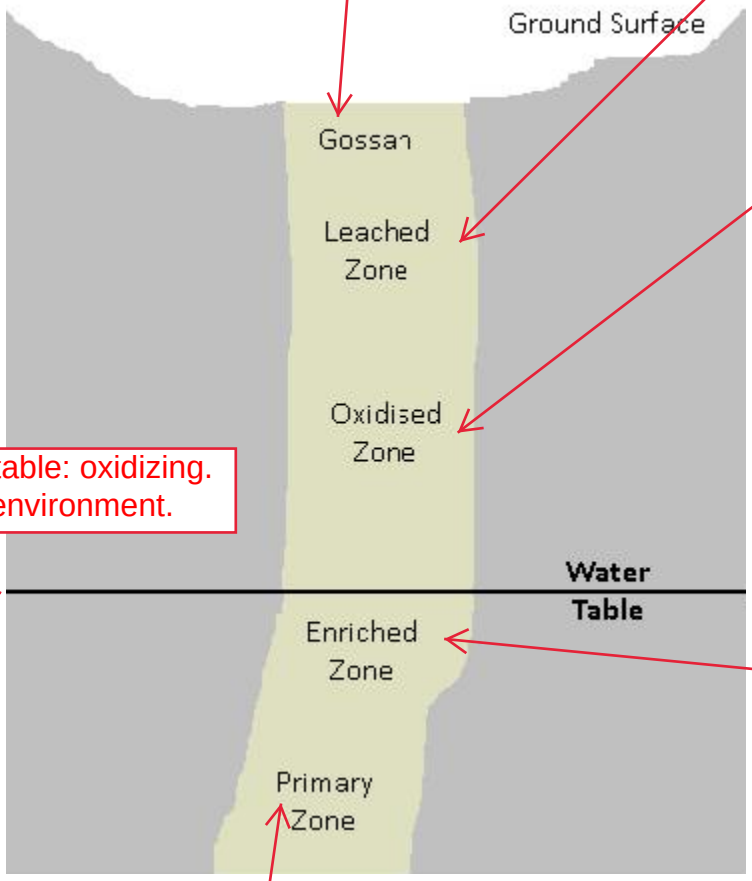
Idealized Mineral Vein

Gossan Cap Pyrite has oxidized to form goethite and limonite: a porous covering over the oxidized zone indicating ore reserves

Groundwater contains O2 &CO2, which oxidizes primary sulfide minerals as it percolates down. Sulfuric acid and solutions of oxidized metals form



Solutions traveling downward react with primary minerals to form secondary minerals such as sulfates, carbonates and limonite. Insoluble salts remain here, forming lead precipitates (anglesite, pyromorphite) and copper precipitates (malachite, azurite, cuprite, smithsonite)

Above the water table: oxidizing. Below: reducing environment.

Copper ions move down to form a zone of supergene sulfide enrichment. Covellite, chalcocite, and antive copper are stable in these conditions. The net effect of these supergene processes is to move metal ions from the leached zone to the enrichment zone, increasing the concentration.

Contains unaltered primary minerals.

At great depth, water can remain liquid at great temperatures and contain metals or other dissolved ions. Hypogene deposition occurs when the minerals crystallizer out of the hot aqueous solutions. Sulfur is a common component of the fluids, and most of the common ore metals (lead, zinc, copper, silver, molybdenum, and mercury) occur chiefly as sulfide and sulfosalt minerals. Examples of primary minerals formed in this way: pyrite, galen, sphalerite, and chalcopyrite.