Acid mine drainage II: patterns in acid mine drainage

Part I of this series discussed the chemical reactions of acid mine drainage. The plots below show data from mine drainage waters in a variety of mines. The concentration of selected heavier metals is shown on the vertical axis, and pH is shown on the horizontal axis. There are at least four things to note:

1) The overall trend toward greater concentration of metals in more acidic (lower pH) waters. That can viewed two ways, one in terms of the effect of acidity on metals that would normally be housed in solid hydroxide minerals:

$$Me(OH)_2 + 2H^+ \text{ - - > } Me^{2+} + 2H_2O$$

and the other in terms of release of adsorbed cations from mineral surfaces (S) in response to greater acidity:

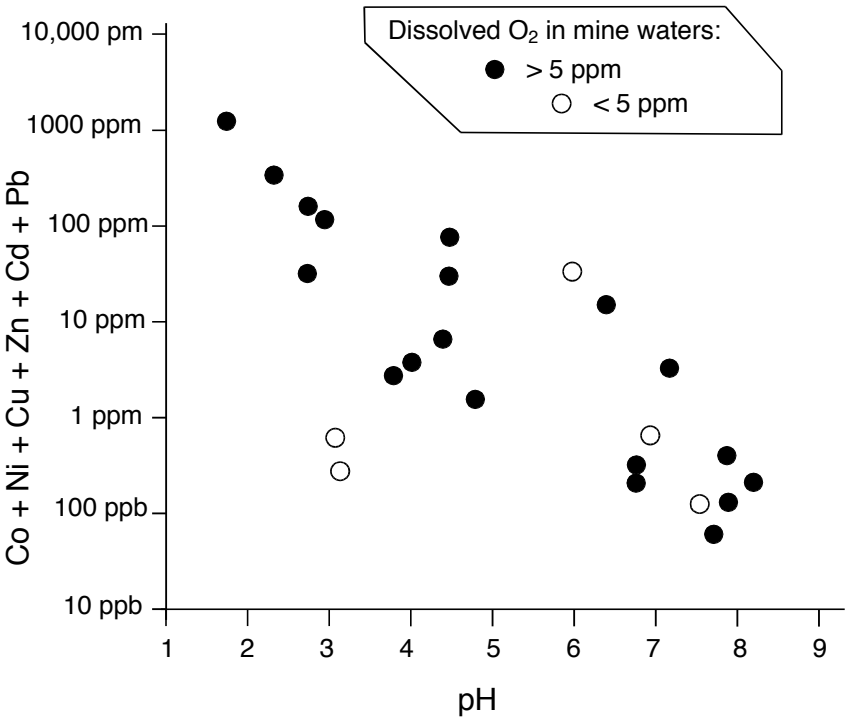
$$\boxed{S}\text{-}Me^{2+} + 2H^+ \text{ - - > } \quad H^+\text{-}\boxed{S}\text{-}H^+ + Me^{2+}$$

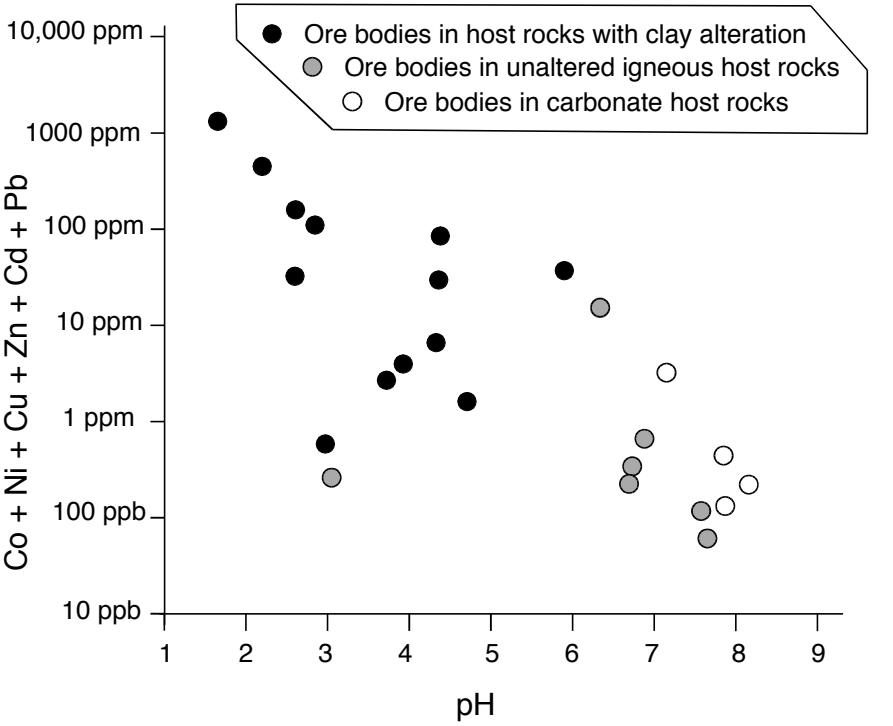
For more on the latter, see the *SFMG* page on "Adsorption of cations, and adsorption isotherms".

2) The extremely large concentrations of metals and extremely low pH of the waters plotting at the upper left of these graphs. They are "extreme" in the sense that no natural waters have these characteristics.

3) The slight tendency toward lesser concentrations of metals and greater pH in mines where the concentration of O_2 is smaller (as on the plot at left). That makes sense, because O_2 is needed to sustain the oxidation of sulfides that causes acidity with H_2SO_4.

4) The greater concentration of metals and lower pH in mines hosted by clay-rich rocks that have little capacity to buffer acidity (as on the plot at right). On the other hand, mines in carbonate rocks that can buffer acidity have waters with smaller concentrations of metals and higher pH.





Data are from Plumlee, G.S., Smith, K.S., Ficklin,, W.H., and Briggs, P.H., 1992, Geological and geochemical controls on the composition of mine drainages and natural drainages in mineralized areas, *in* Kharaka, Y.K., and Maest, A.S., Water-rock interaction: Proceedings of the 7th International Symposium on Water-rock Interaction, Vol. 1: Rotterdam, A.A. Balkema, p. 419-422.