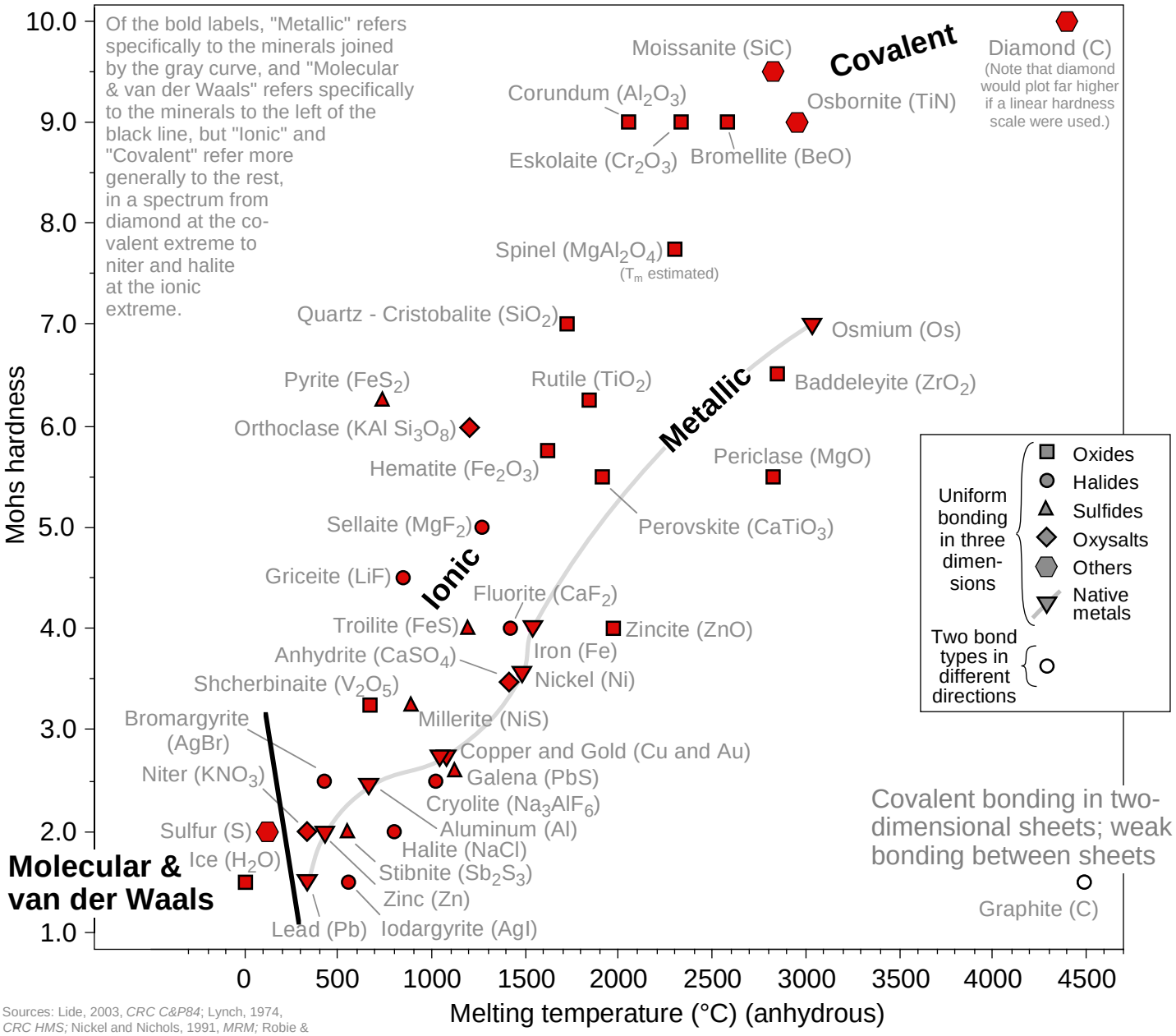
# Melting temperature and hardness of minerals




Sources: Lide, 2003, *CRC C&P84*; Lynch, 1974, *CRC HMS;* Nickel and Nichols, 1991, *MRM;* Robie & Hemingway, 1995, *USGS 2131;* Strunz and Nickel, 2001, *SMT*.

The plot at left shows that there is a general correlation between melting temperature of minerals and their hardness. This relationship is most striking for the native metals, which are connected by a curve here. However, the correlation holds for all the minerals shown with filled symbols ($r^2 = 0.733$).

The reason for this relationship is that both melting temperature (a measure of susceptibility to thermal destruction) and hardness (a measure of susceptibility to mechanical destruction) depend on bond strength. Minerals with three-dimensional frameworks of covalent bonds have great hardness and high melting temperatures; diamond is the ultimate example. At the other extreme, minerals of molecules held together by weak bonds like van der Waals forces (for sulfur) and hydrogen bonds (the molecular bond for ice) have low hardness and melting temperature.

Graphite falls off this trend, for good reason. Its strong covalent bonds in two dimensions preclude disintegration and melting except at extremely high temperature, but the weak bonds between sheets (i.e., in the third dimension) allow mechanical deformation that we recognize as a low hardness.