

Density of minerals III: Oxides and stoichiometry

One might hypothesize that the density of oxides would decrease with greater proportions of "light" oxygen atoms. For example, one might expect density to decrease across the Fe oxides from wustite (FeO) to magnetite (Fe₃O₄) to hematite (Fe₂O₃). Further, one might expect that more dense than all of these would be native iron (Fe), where there is no oxygen at all. The plot at right shows that this hypothesis generally holds for the native forms and oxides of several transition elements. So far, so good.

However, the hypothesis above is not applicable to all oxides. Elements at the left of the period table behave differently, in that oxides are more dense than elemental forms. That's the case for the alkalis (Na and K are shown here) and alkali earths (Mg and Ca are shown here). Nearly the same is true for the next column of the periodic table (Al and Sc are shown here). By the fourth column of the periodic table, densities are nearly uniform (see Si and Ti here). Only by the fifth column (see V here) does the trend in the upper plot begin to emerge.

The hypothesis above also does not work well for elements far to the right in the periodic table. Native elements are commonly more dense than the corresponding Me₂O or MeO oxides, as we would expect above, but that trend soon breaks down. The Pb and Sn oxides provide good examples here, and the trend for Ga oxides has even more of an upswing to the right across the plot.

To summarize: for elements in the middle of the periodic table, the trend from native minerals to oxides with increasing proportions of oxygen is that greater proportions of oxygen lead to lesser density. On the other hand, for elements in the left three columns of the periodic table, oxides are more dense than elemental forms. Elements in the fourth and fifth columns make the transition in behavior between the two groups.

