

## Density of minerals I: Inter-radical cations

This is the first of eight pages illustrating various controls on the density of minerals. This page demonstrates what anyone who has ever hefted a piece of barite or cerussite knows: minerals with cations of great atomic weight are very dense. Here the simple carbonates (carbonates with no OH<sup>-</sup>, H<sub>2</sub>O, or extra O<sup>2-</sup>) are used to make that point.

In the upper plot, density is plotted against atomic weight of the inter-radical cation. The carbonates collectively show a strong overall correlation of density and atomic weight. However, the two (or three) different groups shown display little resolution.

A more effective way to consider the effect of a cation's atomic weight on mineral density might be to calculate ionic density of the cation. Ionic radius can be used to a spherical ionic volume, and atomic mass divided by that volume to yield ionic density.

In the lower plot, mineral density is plotted against ionic density. This plot provides more resolution between the carbonates of monovalent cations and those of divalent cations, and between the rhombohedral and orthorhombic carbonates of divalent cations. That improved resolution allows demonstration of two points. First, cation density plays a greater role in determining mineral density among the cations of monovalent cations (the slope of the regression line is steeper) because charge balance requires a stoichiometry in which the cation:CO<sub>3</sub> ratio must be twice that in carbonates of divalent cations. The carbonates of Tl<sup>+</sup> and Ag<sup>+</sup> are thus more dense than the corresponding carbonates of Pb<sup>2+</sup> and Cd<sup>2+</sup>. Secondly, the orthorhombic carbonates with their nine-fold coordination are more dense than the rhombohedral carbonates with their six-fold coordination. That's in accord with the general observation that minerals of higher coordination are denser, a theme developed further in Part V of this series.

