

Cations and anions III: Geochemical perspectives on ionic bonding

In Part I of this series, we observed that many "elements" exist in nature only in charged form, and that we never encounter elemental Na, K, Mg, Ca, Sr, K, Cl, Br, etc. That has implications for how Earth scientists think about ionic bonding and about the formation of ionic compounds.

In a chemistry lab, it might be reasonable to say that an ionic com-

ound consists of atoms that gain or lose electrons, so that their resulting positive or negative charges allow bonding as the result of electrostatic attraction. That would be compatible with Reaction 1 below for the precipitation of halite. In a chemistry lab, one might even say that ionic compounds form when some atoms (e.g., Na, K, Mg, Ca, etc.) give up electrons and other

atoms (e.g., F, Cl, Br, etc.) accept electrons, resulting in positive and negative charges that allow bonding as the result of electrostatic attraction. That view would be Reaction 2 at left. However, both of those reactions would only take place in a chemistry laboratory in which elemental Na and Cl were available as reagents produced by the chemical industry.

In nature, a much more reasonable reaction would be Reaction 3, which assumes that our reactants are ions, and have always been ions. The abundance of water on and in the Earth means that Reaction 4, where those ions are hydrated or at least travelling in solution, is a good candidate too. However, the non-existence in nature of uncharged forms of many of the elements means that we often need not think in terms of Reactions 1 or 2.

This isn't to say that there aren't chemical reactions where we have to keep track of electrons. Fe, Mn, Cu, Cr, Mo, U, Se, S, O, N, and C, to name just a few, provide us with interesting redox chemistry with their multiple valence states. For more, see this book's page on the basics of redox chemistry.

