

Linkage of polyhedra in minerals

Almost anyone familiar with mineralogy knows that silicate tetrahedra can be linked, so that silicates form not only nesosilicates (where there is no linkage of tetrahedra) but also sorosilicates, cyclosilicates, inosilicates, phyllosilicates, and tectosilicates. On the other hand, carbonate minerals consist solely of structures with isolated carbonate groups (and thus they are all "neso-carbonates", to coin a redundant term).

This diagram puts those differences in perspective by surveying behavior of mineral groups across part of the periodic table. To the left are minerals with six-fold and eight-fold coordination of cations, so that we don't speak of "aluminates" or "titanates", and in which polyhedra are extensively linked, so that the minerals are "tecto"-type structures. In the middle, in the red field, are the groups of minerals, including silicates, with varying degrees of polyhedral linkage. Farther to right are mineral groups in which polyhedral linkage is rare, and finally at far right, in the blue field, are mineral groups where there is no polyhedral linkage at all.

The diagram shows that this variation in kinds of mineral structures is correlative with the ionic potential or density of charge (z/r) of the ion of the radical group. As one moves to the right across the table, one finds cations like Si^{4+} , P^{5+} and S^{6+} with increasing charge (z) but decreasing size (r),

so that density of charge increases to the point that cation-cation repulsion precludes sharing of O^{2-} anions and thus precludes polyhedral linkage (e.g., in carbonates, nitrates, and sulfates).

From this perspective, one realizes that the reason for the abundance and diversity of silicate structures is not that Si^{4+} is abundant. Instead, it's because Si^{4+} has an ionic potential that allows it to enter into minerals with different degrees of polyhedral linkage.

