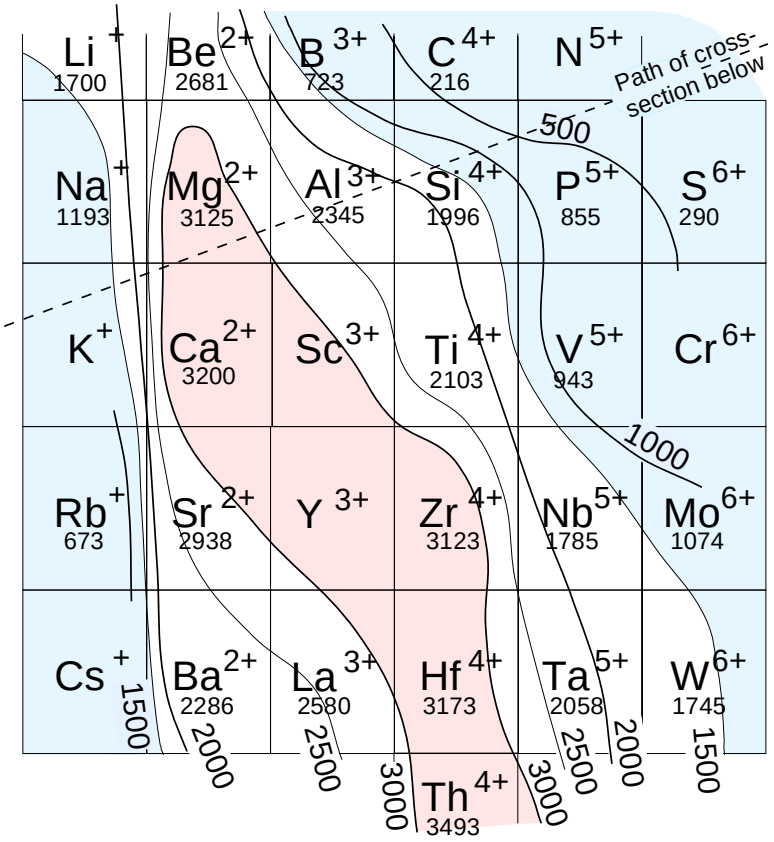
Bowen's Reaction Series III: Melting temperatures of oxides

This page is a step on the road to understanding Bowen's Reaction Series, the subject of a series of pages in this book. Pages IV and V will finish the job.

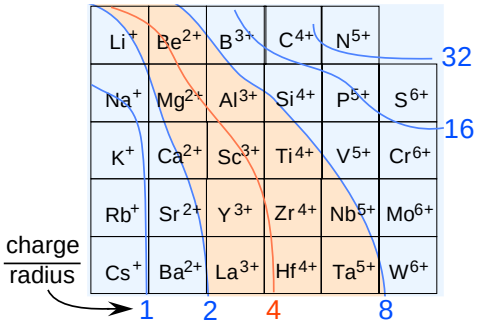
The diagram at left is a bit of the periodic table. Superposed on it are contours showing the melting temperatures (T_m) of the oxides of the cations in this part of the table. T_m is greatest for the swath of cations from Mg^{2+} to Th^{4+}.

On this part of the periodic table, ionic potential (charge ÷ radius) increases from lower left (z/r = 0.67 for Rb^+) to upper right (z/r = 45 for N^{5+}). The highest values of T_m for the oxides are thus those of the oxides of cations of intermediate ionic potential, rather than cations of low or high ionic potential. The reasons for that relationship are shown below: low ionic potential only allows weak electrostatic bonding to O^{2-}, and high ionic potential causes repulsions between cations, but intermediate ionic potential hits the happy medium of strong bonds without cation-cation repulsions.

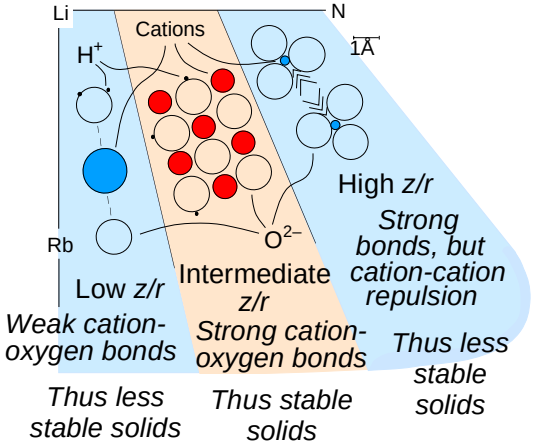
Melting T(K) of oxides of hard cations

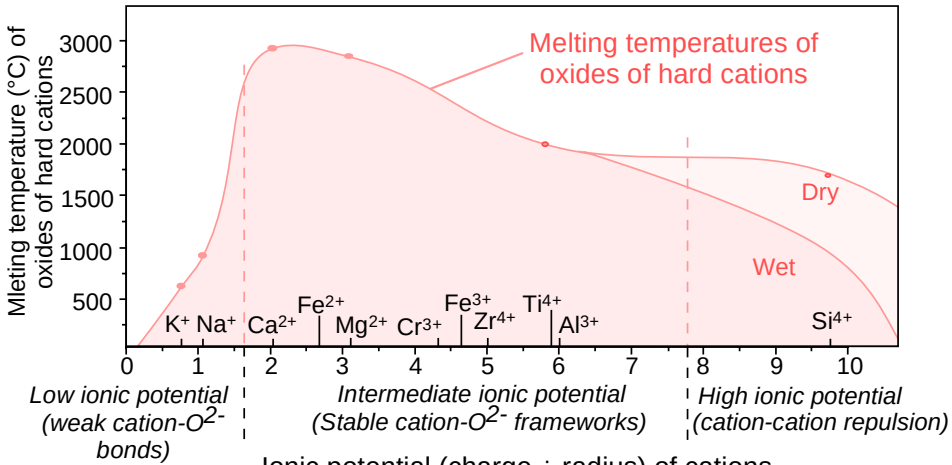


Contours of ionic potential:



Conceptual model of the behavior of oxides of hard (and intermediate) cations





If we make a profile across the periodic table, we can construct the diagram at lower left, where melting temperature of the oxides is plotted against ionic potential. With this diagram, we can proceed to Bowen's Reaction Series IV, where we will plot the minerals of Bowen's Reaction Series on this diagram.