

Bowen's Reaction Series IV: Toward a broader explanation

Part II of this series of pages on Bowen's Reaction Series provided a Si^{4+} -centered explanation of Bowen's Reaction Series. This page tries to explain Bowen's Reaction Series in terms of all the cations involved. It draws heavily on Part III of this series, which looked at the melting temperatures of oxides to assess the importance of ionic potential in determining the temperature of formation of minerals.

The diagram below shows the compositions of minerals that form in the crystallization of silicate melts. The different shades of blue correspond to the different branches of Bowen's Reaction Series. The sizes of the squares correspond to the relative abundance of the cations in each mineral.

Graphically speaking, there are two things to note. First, the large squares are in the middle of the diagram at its upper (high-temperature) end, but they drift to the right as one moves down through the diagram to lower temperatures. Secondly, the leftmost squares drift to the left as one passes downward through the diagram from higher temperatures to lower temperatures.

So what does that mean? The minerals high in Bowen's Reaction Series - the minerals that form at higher temperatures - are minerals that preferentially incorporate cations of intermediate ionic potential like Mg^{2+} . On the other hand, the minerals lower in Bowen's Reaction Series - those that form at lower temperatures - are minerals that increasingly incorporate either cations of lower ionic potential like Na^+ and K^+ and/or the cation of exceptionally high ionic potential, Si^{4+} . The cations of low ionic potential form weak bonds to O^{2-} , explaining their entry into minerals only at low temperatures, and cations of high ionic potential have such focused positive charge that they repel each other when brought in close proximity, as they must be in a Si^{4+} -rich mineral.

