

Comparative solubility of minerals II: Explanations via ionic strength and cation-cation repulsions

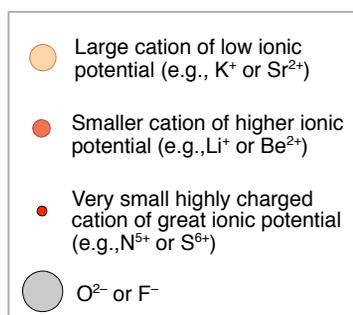
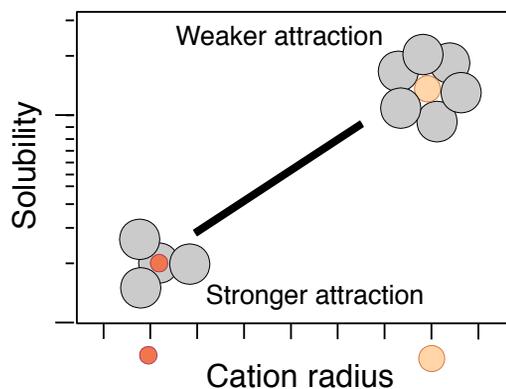
Part I of these four pages demonstrated an interesting result with regard to the solubility of minerals: for fluorides and oxides of hard cations, solubility *increases* with cation size, but among nitrates and sulfates of exactly the same cations, solubility *decreases* with

increasing cation size. This page tries to explain this difference in terms of the constraints on minerals with radical groups like NO_3^- and SO_4^{2-} , as opposed to minerals with no entity of great positive charge like the N^{5+} of NO_3^- or the S^{6+} of SO_4^{2-} .

Minerals with no radical group, and thus with no intra-radical cation (e.g., fluorides and oxides)

Among these minerals, solubility *increases* with cation size. This can be explained by the greater ionic potential (charge ÷ radius) of small cations, and thus their greater attraction and stronger bonds to the anions of the mineral in question. Conversely, larger cations have smaller ionic potential, and their attraction to anions is weaker.

Because smaller cations commonly have smaller coordination numbers, one might think that trends in solubility could be explained by calculated bond strength (charge ÷ coordination number). We will return to that hypothesis, and disprove it, in Part IV of this series.



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Minerals with a radical group, and thus with an intra-radical cation (e.g., nitrates and sulfates)

Among these minerals, solubility *decreases* with cation size. This can be explained by the greater ionic potential (charge ÷ radius) of small cations like Li^+ and Be^{2+} , and thus the greater repulsion between such cations and the cations of great ionic potential like S^{6+} at the core of radical groups like sulfate (SO_4^{2-}). These repulsions make an unstable, and thus soluble, mineral. On the other hand, large cations like K^+ and Sr^{2+} with smaller ionic potential do not cause such large repulsion and thus form more stable, and less soluble, minerals.

Part III of this series shows the cartoons below at higher resolution.

