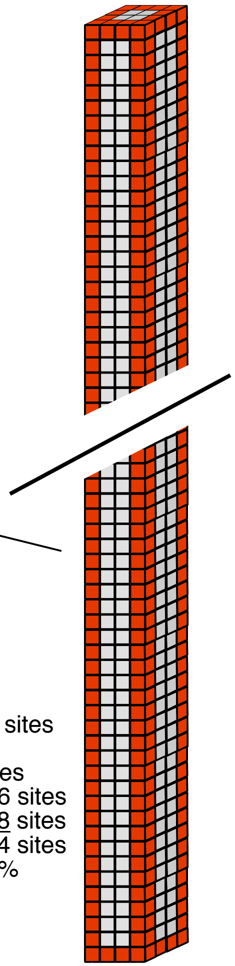
An explanation of the greater solubility of acicular, rather than equant, crystals

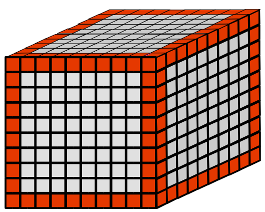
One commonality in the solubility and/or stability of minerals is that more acicular polymorphs or habits are more soluble (and thus less stable) than more equant forms. Examples include the greater solubility of aragonite than calcite (two polymorphs), the greater stability of equant rather than elongate calcite (two habits), and the greater stability of equant quartz than fibrous quartz like chalcedony.

This page proposes that these difference can be explained at least in part by the greater proportion of edge and corner atomic sites on elongate crystals. Two keep the math simple, the main plot considers crystals of only ~1000 sites (and thus atoms), which would be a very small crystal. The result is a >4x increase in the proportion of edge and corner sites with an increase in length-width ratio from 1 to 37. The inset at right shows that the proportion of edges and corners diminishes with more sites, but the >4x increase with L/W from 1 to 37 remains the same.

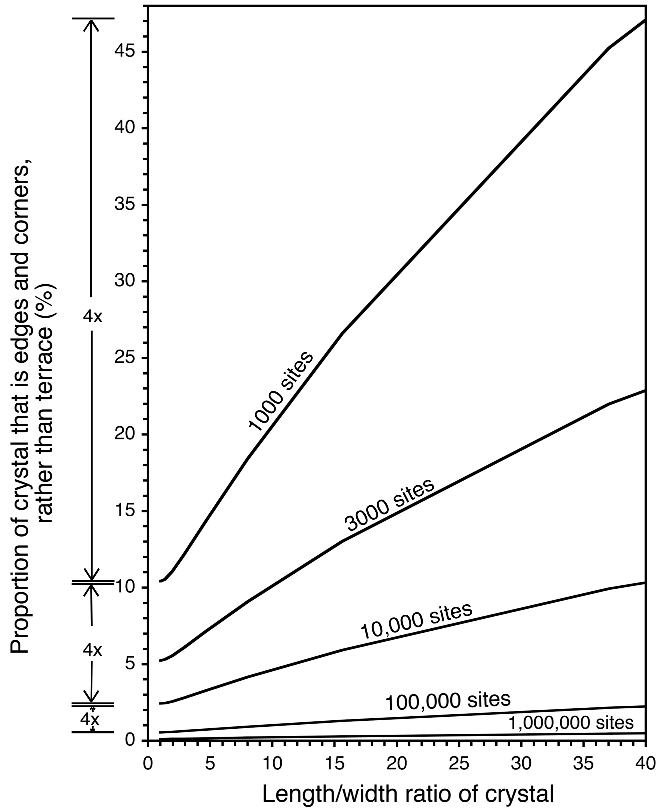
One way to understand the greater solubility of more elongate forms (i.e., their equilibrium with solutions of greater concentration) is that the greater proportion of weakly-bonded corner and edge sites requires a solution with more solute ions at the ready to replace the ions that leave those sites.



4 x 4 x 62 sites = 992 sites
Length/width = 15.5
edges: 4 x 60 + 16 sites = 256 sites
corners: 8 sites
edges + corners = 264 sites
264/992 = 26.6%



10 x 10 x 10 sites = 1000 sites
Length/width = 1
edges: 12 x 8 sites = 96 sites
corners: 8 sites
edges + corners = 104 sites
104/1000 = 10.4%



Proportion of crystal that is edges and corners, rather than terrace (%)

Length/width ratio of crystal