The relationship between crystal surface reactivity and surface roughness

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Surface area and reactivity change in tandem during mineral dissolution reactions. Here we investigate the evolution of surface reactivity of A_3B (e.g. feldspar) crystals through observation of changes in kink site density during crystal-accurate dissolution simulations. These simulations employ Monte-Carlo codes capable of resolving fundamental relationships in silicate mineral dissolution kinetics [1].

As a first approximation, the results show that kink site density increases linearly with surface area. However, the correlation shows broad variability, and it is important to understand how surface morphology, as expressed by surface roughness parameters, controls reactivity [2]. Fig. 1 illustrates that an increase in roughness depth (Rt) results in an linear increase in kink site density, and thus in surface reactivity as well.
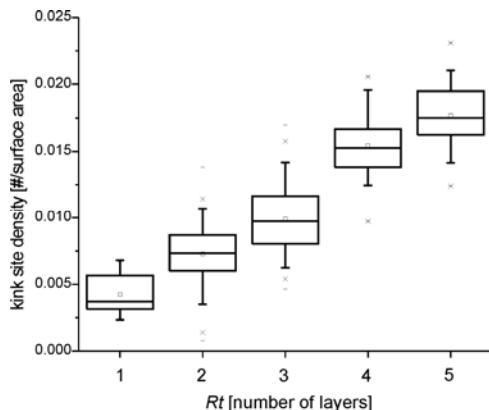

Figure 1: Range of kink site density (shown as common box-whisker plots) as a function of the surface topography (expressed by the number of layers which form the rough crystal surface).

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[2] Fischer & Luttge (2007) *Am. J. Sci.* **307(7)**, 955-973.

Light elements in subduction zones: Perspective from volatiles

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Magma ascent towards the surface releases volatiles. Variations in CO_2, N_2, He and isotopes (C, N, He, H, O) with tectonic setting show that gas emissions are influenced by contributions from the crust, mantle and slab. Data of δD and $\delta^{18}O$ of steam shows that H_2O in arc volcanoes is a mixture of magmatic and meteoric water. Melt inclusion work on δD of arc tephras confirms that slab-derived water dominates magmatic water in arc magmas [1]

Mass balance of volatiles emitted from arc volcanoes versus those subducted shows: 1) nitrogen mass balance seems dependent on the thermal regime of the subduction zone: input approximately equals output in Central America but exceeds output in the Izu Bonin Marianas [2-4] 2) CO_2 input exceeds output in Central America and globally [5-7]. 3) Water mass balance remains largely unknown but recent work suggests a global balance for water in subduction zones [8, 9]. Future directions will benefit from 1) comparison of gas emission studies with petrologic approaches (melt inclusions, radiogenic isotopes) 2) evaluation of discrepancies between tracers for fluid and sediment contributions (i.e. Ba/La, Li, Be, B) and H_2O, CO_2, N_2 and Cl contents of gases and magmas 3) exploration of tracers that allow for estimates of volatiles contributed from serpentinites (i.e. Cl isotopes).

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