Modeling the dissolution and growth of whole mineral grains

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The reactivity of crystal surfaces reflects the distribution and interaction of kinks, steps, and defect-related sites. During the dissolution of whole mineral grains (e.g., Fig. 1), substantial changes are commonly observed along discontinuities such as grain edges, twin boundaries, and other complex macro-features [1]. We wish to understand the evolution of these changes during the dissolution and growth of the entire crystal, and how they relate to the integrated flux of material from the particle. We examine this general kinetic problem through a series of Monte Carlo models, beginning with simulations of dissolution and growth using a simple cubic Kossel crystal, and culminating in virtual experiments involving complex crystal structures. We can use these simulations to explore a variety of problems, including (1) the contribution of these features to the integrated rate as a function of crystal diameter, (2) how processes such as uptake and release at kink sites are coordinated with diffusive transport, (3) whether the changes observed during dissolution are reversible under growth conditions, (4) how the mean and variance of the reaction rate at these edge sites compare to those on interior terraces as a function of defect density, and (5) the implications for the behavior and properties of poly-crystalline grains and nano-particles.

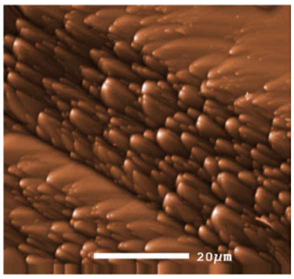

Fig. 1. Etching of face edges of dolomite [2].

[1] Zhang & Luttge (2009) *Geochim. Cosmochim. Acta* **73**, 6757–6770. [2] Arvidson & Mackenzie (1999) *Amer. J. Sci.* **99**, 257–288.

Paleozoic tholeiite magmatism in the Kola Province, Russia: Relations with alkaline magmatism

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The Kola alkaline province, formed in the northeastern part of the Fennoscandian Shield include Khibina and Lovozero plutons, carbonatite intrusions, and numerous alkaline dikes, as well as remnants of subalkaline and alkaline extrusives. The discovered manifestations of tholeiite magmatism in the region are represented by dolerite dikes forming three swarms: Pechenga, the Barents Sea coast, and the East Kola. $^{40}Ar/^{39}Ar$ geochronology obtained for 5 dolerite dikes, together with Sm–Nd mineral isochron data yield a 405-385 Ma time span of tholeiitic magmatism in Kola part of the Fennoscandian Shield. In the Sm–Nd system, the εNd(T) values (+0.9...+5.4) are close to those for alkaline rocks of the province. They testify that the tholeiite melts originated from sources with a significant share of a depleted mantle component. Trace elements characteristics suggest that the Paleozoic dolerites belong to a group of continental plateau basalts.

The finding of the Devonian tholeiites leads to the need to define their position in the general evolution model of Paleozoic magmatism, and, first of all, to define their relationships with alkaline melts. Analysis of the spatial distribution of the Paleozoic dolerite dykes shows that they are located on the periphery of the area of predominant development of alkaline intrusions and alkaline dike swarms. The set of geochronological data shows that the main manifestations of alkaline magmatism occurred in the period of 380-360 Ma. The initial melts of the Paleozoic alkaline intrusions corresponded to olivine melanephelinite, which was generated under the conditions of garnet lherzolite facies. According to the above mentioned materials, we suggest that the tholeiites correspond to the initial phase of the Paleozoic plume-lithosphere interaction, during which the occurrence of tholeiite melts in the peripheral zone of the plume was the result of partial melting of the mantle substrate under the conditions of spinel lherzolite facies. During the subsequent development of the process of plume–lithosphere interaction, the deep mantle areas corresponding to the conditions of garnet lherzolite facies were in the zone of melting. The partial melting of these lherzolites under the conditions of mantle metasomatism led to the formation of melanephelinite melts, the basis of formation of the Paleozoic Kola alkaline province.