Linking solution composition and surface topography to the rate and mechanisms of diopside dissolution

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Whereas the dissolution rate of silicate minerals has been extensively studied at far-from-equilibrium conditions, extrapolating such rates over a broad range of solution composition has proven challenging. Regarding diopside, recent studies [1, 2] suggested that below 125 °C, an unexpected drop of the rate occurred for Gibbs free energies of reaction (ΔG_r) as low as –76 kJ.mol^{-1}, with severe consequences on our ability to predict the rate of complex processes such as carbonation reactions [2].

The mechanism responsible for such a drop remains unclear and therefore needs to be deciphered. An examination of our previous data [2] led us to envisage that two different, non-exclusive aspects were worth investigating: (i) the possible passivating ability of interfacial, nm-thick Si-rich layers developed on weathered silicate surface, and (ii) the stop of etch pits formation on crystal surface, which were found to be responsible for drops of olivine [3] and albite [4] dissolution rates, respectively.

Our ongoing experiments aim at better constraining these two mechanisms, and determining in turn whether one of them could explain the above-mentioned drop of diopside dissolution rate. Classical flow-through experiments with controlled SiO_2(aq) concentrations are combined with both *ex situ* AFM measurements and *in situ* monitoring of the topography of the dissolving surface of diopside in a hydrothermal AFM flow-cell (e.g. [5]). By investigating the dissolution of several cleavages, we will show how these latter techniques represent a powerful tool for studying the anisotropy of diopside dissolution, and determining which face ultimately controls its dissolution rate. An attempt to link these observations to macroscopic determination of diopside dissolution rates as a function of fluid composition will be discussed.

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Zone of Anomalous Mantle

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The most striking characteristic of both the Siberian and Slave diamond fields is their linear distribution. The concept of the "Corridor of Hope" was introduced [1] to refer to a northwest trend that appears to have controlled the emplacement of the most significantly diamondiferous kimberlites of the Slave craton. With displaced northern [2, 3] and southern extensions the corridor is 2300 km long.

The Siberian diamond fields have a linear distribution over 1000 km with one offset. The linear is described [4] as a "Zone of Anomalous Mantle" and mantle xenoliths and xenocrysts [5] show that Hartsburgite makes up a significant part of the lower mantle beneath 190-240 km thick lithospheric Archean terrane to the south but is missing beneath 125 km thick lithospheric Proterozoic terrane to the north.

Helmstaedt [6] proposed a model for the Slave craton in which Paleoproterozoic lithosphere has underplated Mesoarchean lithosphere beneath the corridor and the upper edge of the underplating Proterozoic is 270 km west of the corridor and controls the geometry of the corridor. Significantly Mirny is 250 km NW of the Akitkan Proterozoic fold belt and there is evidence [7] for a Proterozoic fold belt 250 km east of the Alakit/Daldyn/Muna diamond fields.

A modified 2.0-0.8 Ga reconstruction of the Proterozoic Supercontinent [8] has the Siberian "Zone of Anomalous Mantle" lined up with the N American corridor.

Conclusion

Proterozoic lithosphere underplated an Archean craton (Siberia & N America) on its Pacific ocean side that resulted in a single zone of anomalous mantle. Except where the zone was cut by the Aekit Proterozoic orogenic belt that separated, thinned and destroyed the base of the adjoining Siberian and N American (Alaska North Slope) cratons, it is extremely favourable for hosting diamondiferous kimberlites.

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