

Effect of heterotrophic bacteria (*Pseudomonas reactants*) on olivine dissolution kinetics in the context of CO₂ storage in basalts

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This work is aimed at quantification of olivine (Fo₉₂) dissolution kinetics in batch and mixed-flow reactors in the presence of aerobic gram-negative bacteria (*Pseudomonas reactants* HK 31.3) extracted from deep underground oxygen-bearing water of basaltic aquifer. The release rate of mineral constituents was measured as a function of time in the presence of live, actively growing, dead cells and bacterial exometabolites in constant-pH (6 to 9), bicarbonate-buffered (0.001 to 0.05 M), nutrient-rich and nutrient-free media in batch reactors at 0-30 bars of CO₂. In most studied conditions, the dissolution is stoichiometric with respect to Mg and Si release and no formation of secondary phases was evidenced by microscopic examination of post-reacted grains. In batch reactors at 30 bar pCO₂ and 0.05 M NaHCO₃ in the presence of live bacteria, we observed a plateau of constant Mg and Si concentration after 500-700 hrs of reaction time in solutions undersaturated with respect to all possible secondary phases. SEM observation of reacted grains revealed the presence of biofilm-like surface coverage that may prevent mineral dissolution during long-term exposures. In contrast, short-term olivine dissolution rate at pH around 6 and 30 atm pCO₂ is only weakly affected by the presence of live bacteria up to 4 g humid biomass/L, in agreement with previous results on wollastonite (CaSiO₃) dissolution rate in the presence of another gram-negative bacteria *Pseudomonas aureofaciens* [1]. Overall, this work demonstrates inhibiting rather than accelerating effect of bacterial activity on silicate mineral reactivity under conditions of CO₂ storage.

[1] Pokrovsky, Shirokova, Bénézech, Schott & Golubev (2009) 'Effect of organic ligands & heterotrophic bacteria on wollastonite dissolution kinetics.' *Amer. J. Sci.* **309**, 731-772, DOI, 10.2475/08.2009.05.

Spreading ridge geometry controls the symmetry of plume-ridge interaction

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The Iceland, Galápagos and Azores plumes have been previously identified as interacting asymmetrically with adjacent spreading centres. Here we present evidence for the geometry of plume-ridge systems as being the important control on the dispersal of a plume's compositional signature in the shallow asthenosphere. First bathymetric and isotopic data along Mid-Atlantic Ridge and Galápagos Spreading Centre is re-examined: searching a geographical region, the misfit of observables about potential plume centres is mapped. It is found that the locus of minimum misfit for plume swell coincides with independently constrained plume centre locations. However, the profiles of incompatible elements and their isotopes retain a high misfit over the searched area, inferred to reflect non-plume-symmetric spatial variations in the composition of mantle sampled by the ridges. To explain this result, a kinematic model is developed exploiting the geometry of plume ridge systems. It assumes the radial outflow of a compositionally heterogeneous plume source, consisting of a depleted mantle component and enriched blebs. These blebs then progressively melt out during flow through the melting regions under spreading centres. Asymmetry in trace element and isotopic profiles can thus be attributed to the details of ridge geometry near plumes; ridges receive plume material that has experienced variable extents of depletion, as a function of its distance transited through the deep parts of melting regions. Observed asymmetry around Iceland and the Galápagos is therefore explained by radially symmetric plumes interacting with asymmetrically distributed ridge systems.