

Advances in elucidating reactivity and speciation at the mineral/water interface: The role of analytical techniques and computational modeling

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The use of state-of-the-art, *in situ* spectroscopic and microscopic techniques has greatly advanced our understanding of biogeochemical reactivity and speciation at the mineral/water interface. These techniques enable one to make measurements at small spatial and rapid temporal scales and simulate natural environmental conditions. The use of these tools, coupled with computational modeling approaches, is rapidly advancing a number of research frontiers in geochemistry and related scientific fields including mineral/microbe interactions, real-time measurements of contaminant retention and transformations at mineral surfaces, speciation of heterogeneous systems, nanoparticle reactivity and speciation, humic substance structure and reactivity, and rhizosphere biogeochemistry. This paper will illustrate the application of advanced techniques, particularly the use of synchrotron-based tools, as well as molecular modeling approaches, in advancing research frontiers dealing with biogeochemical interfacial phenomena.

Petrogenesis of Archaean sub-lithospheric mantle preserved in the Otrøy peridotite massif, Norway

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Peridotites on Otrøy Island in the Western Gneiss Region, Norway, are dominantly (~60%) spinel dunite (<10% pyroxene) that are inter-banded with garnet dunite (~35%) and mafic lithologies (garnetite, gnt websterite, gnt pyroxenite). Garnets are characterised by pyroxene exsolution microstructures indicative of Si-rich garnet precursors containing >19 mol % majorite, implying derivation from sublithospheric depths ≥ 350 km. Re-Os and Sm-Nd systematics of both spinel and gnt dunite yield Archaean model ages. Dunite and gnt pyroxenite define Sm-Nd whole rock errorchrons of 3.0 ± 0.4 and 3.3 ± 0.2 Ga, respectively. Major element compositions of spl dunite are compatible with formation by > 40% melting at depth (FeO < 7wt%), but HREE depletion and flat HREE pattern (0.005 x PM) is evidence of the majority of melt extraction under gnt absent conditions. Minor LREE enrichment, $(Ce/Yb)_n < 6$, indicates metasomatic enrichment post initial melt extraction. Garnet dunites lie on major, trace element and isotopic mixing lines between spl dunite and gnt pyroxenite consistent with formation by tectonic mixing and subsequent re-equilibration at ultra-high pressure. Petrogenesis of the suite therefore requires extensive melting in the Archaean in a ridge type tectonic setting, subsequent subduction to > 350 km, remelting of mafic enclosures and underplating beneath the Laurentia craton before exhumation associated with mid Proterozoic and Caledonian orogenies before emplacement into the crust at ca 430 Ma.