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Pressure variations during ultra-high pressure metasomatism?

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Incomplete reactions or apparent disequilibrium between minerals in metamorphic rocks from high pressure (HP) and ultra-high pressure (UHP) terrains are commonly observed in field and thin section. Here we show an example of a peridotitic body enclosed in migmatitic felsic Proterozoic gneiss at the Svartberget locality in the northernmost UHP terrain of the Western Gneiss Region (WGR) in Western Norway.

The WGR represents the basement of Baltica which became metamorphosed during the Caledonian Orogeny. In the highest grade parts of the WGR metamorphic temperatures were between 600-800 °C for several Ma, pressures reached the diamond stability field, fluids were available and yet well known pressure sensitive reactions such as from spinel- to garnet-peridotite went only locally to completion in the studied peridotite. Previously reported field observations, major, trace and isotope geochemistry, geochronology, mineral-chemistry and textures suggest that this peridotite body became metasomatised by supercritical fluids from the host rock gneiss during the Caledonian Orogeny. Contrasting pressure estimates, incomplete reactions and preserved compositional gradients in minerals from this body may indicate very rapid exhumation, very sluggish kinetics of diffusion, metasomatically disturbed equilibrium at low temperatures or a combination of the three. These possibilities call for a re-evaluation of existing methods in geothermobarometry.

Alternatively we may consider that pressure variations existed from the grain up to the outcrop scale during the metasomatism of the peridotite at UHP conditions. The mechanical responses to volume changes that are involved in chemical reactions in rocks may control the progress of reactions significantly (Schmid et al.[1], 2009). Our main results, obtained from numerical modelling, show that pressure variations may be generated, and maintained on the geological time scale, as a result of the mechanical response of the rocks during melting reactions in confined space.

[1]Schmid, D. W., Abart, R., Podladchikov, Y. Y., and Milke, R. (2009). Matrix rheology effects on reaction rim growth II: coupled diffusion and creep model. Journal of Metamorphic Geology, 27, 83-91.