



High pressure experimental constraints on the fate of water during subduction of oceanic crustal material into the deep mantle

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Knowledge of the abundance and distribution of H₂O in the Earth's deep mantle remains highly controversial.

The chief means of replenishment of the Earth's interior with volatiles over much of geological time is subduction, but constraints are very poor as natural samples from the deep Earth's interior subduction zones are inaccessible. High pressure experimental investigations can overcome that problem by simulating deep mantle conditions and processes.

We aim to experimentally determine the maximum storage capacity, substitution mechanism and behaviour of H₂O in hydrous and nominally anhydrous minerals (NAMs) during subduction of hydrated oceanic crustal material into the deep upper mantle.

A particular interest is to determine the H₂O content of NAMs at the conditions where nominally hydrous phases (such as phengite) are breaking down to release H₂O that would then leave the slab.

By applying a novel experimental approach formerly used for peridotite mantle compositions [1, 2], small amounts of H₂O in eclogitic NAMs such as garnet, clinopyroxene, coesite/stishovite etc. will be determined for the first time in high pressure experiments as a function of pressure, temperature and bulk composition by using interlayers of the NAMs and volatile-rich oceanic crustal material of MORB composition.

Here we present the first results of experimentally determined melting and phase relations of an altered oceanic basalt composition GA1 [3] containing varying amounts of H₂O (up to 7wt.%) at varying temperatures (sub-solidus to near solidus) and pressures (6-10 GPa; i.e. from ~200 to ~330 km depth) using multi anvil apparatuses at University of Bayreuth, Germany.

Experiments yield well-crystallised assemblages of garnet ± clinopyroxene ± coesite/stishovite ± rutile ± phengite ± vapour. Similar to previous studies [e.g. 4-8], the stability of phengite varies as a function of pressure, temperature, buffering mineral paragenesis and bulk H₂O concentration. In addition, K₂O in phengite and clinopyroxene decrease with increasing bulk H₂O content at subsolidus conditions at given pressure and temperature, suggesting a leaching role of i.e. K₂O by a vapour-rich fluid.

References

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