

High-temperature hydration of Atlantis Bank gabbros (Southwest Indian Ridge): constraints from trace element and Sr-B isotopic compositions of amphibole-plagioclase pairs

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The interaction processes between seawater-derived fluids and deep levels of the lower oceanic crust are fundamentally unknown. To fill this gap, we present here a petrological and geochemical investigation of brown amphibole veins and brown amphibole mylonites from the gabbroic section of Atlantis Bank, an oceanic core complex from the Southwest Indian Ridge. Amphibole veins and amphibole mylonites were inferred to have formed during the early stages of the exhumation evolution, around the ductile-brittle transition, and are concentrated in the top ~200 m of the gabbroic section [1].

The samples were collected from IODP Hole U1473A. Amphibole veins typically host minor amounts of plagioclase, and the amphibole mylonites consist of amphibole, plagioclase, and accessory Fe-Ti-oxide phases. Amphibole in veins and mylonites overall has 8.1-9.1 wt% Al₂O₃ and 1.5-2.0 wt% TiO₂ and contains relatively high concentrations of Cl (0.2-0.3 wt.%) and B (1.5-3.3 ppm). The coexisting plagioclase has 32-47 mol% anorthite, 1.4-3.8 ppm of B, and Sr isotopic signature overlapping that of Atlantic Bank basalts. The amphibole-plagioclase pairs remarkably record high crystallization temperatures, which cluster at 810-830 °C.

Vein and mylonitic amphiboles have lower Mg# and higher concentrations of Ti, Mn, REE, and HFSE than the enclosing gabbros. Such chemical differences argue against the formation of amphibole veins and amphibole mylonites through the interaction of solid-state gabbros with seawater-derived fluids and suggest the involvement of a melt component. We envision that the ductile-brittle transition was associated with a forming fracture network in the carapace of the exhuming gabbroic section. The fracture system aided the migration of seawater-derived fluids and enabled the interaction with variably evolved rising melts. Boron isotope analyses of amphibole are currently in progress to constrain the process of fluid-melt interaction and help disentangle the downward pathway of seawater.

[1] MacLeod, Dick, Blum & Expedition 360 Scientists (2017) Proc. Int. Ocean Discov. Program 360.