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Reaction porosity in oceanic detachment faults: potential for enhanced hydrothermal circulation and the subsurface biosphere.

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Reaction porosity has been documented in Troodos epidosites (**https://doi.org/10.1111/gfl.12117**), and suggested to be a significant permeability enhancement mechanism in the upflow zone of black smoker fluids. Here we present SEM, EPMA, and XCT data from the detachment fault zone of the Atlantis Massif oceanic core complex, along with results from reaction path modelling. Porosity generation takes different forms in different detachment fault lithologies (Fig. 1). In gabbroic and diabasic rocks at IODP Site U1309, the first mineral to dissolve is pyroxene, although plagioclase can be completely dissolved in extreme cases creating fluid conduits up to 10 cm in diameter. Minerals filling the porosity are mainly actinolitic amphibole and albitic plagioclase. In gabbroic layers within serpentinised ultramafic rocks sampled in IODP Exp. 357, plagioclase is first to dissolve, with porosity fill dominated by chlorite, and extensive replacement chloritization of pyroxene. Chlorite geothermometry suggests that porosity fill began at temperature > 400 °C and extended to temperatures < 80 °C. In samples from Exp. 357, cell counts were generally low, but highest in samples taken close to rection porosity zones. We hypothesise that the physical and chemical environment of porosity fill was favourable to growth of extremophile microbes, possibly exploiting fluids rich in H_2, CH_4 and more complex organic species, such as those seen in the nearby Lost City vent field.

Both the origin of prebiotic gases and organic molecules, and the capability of the subseafloor to sustain microbial life, are major objectives of IODP Exp. 399 [https://doi.org/10.14379/iodp.sp.399.2022]. The reaction porosity zones are an explicit target for the Expedition. XCT data has been collected on 5 samples and estimates of current porosity, and the progressive evolution of porosity and permeability will be provided, together with modelling of the fluids responsible for the very different reaction paths in Fig. 1. An update on the preliminary results of Exp. 399 will be provided.

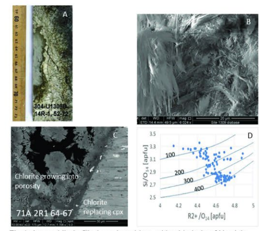

Fig 1: A: amphibole filled vug in gabbro, with wide halo of Na-rich plagioclase, interpreted as a fluid flow pathway in the detachment fault zone of the Atlantis Massif, IODP site U1309. B: fibrous amphibole replacing clinopyroxene in a diabase intrusion into the gabbros of image A. C: Chlorite filled vug in former plagioclase in small gabbro body in serpentinised peridotite, IODP Exp. 357. D: Chlorite geothermometry (Bourdelle and Cathelineau, 2015) showing porosity fill in image C over a wide temperature range (contours in °C)

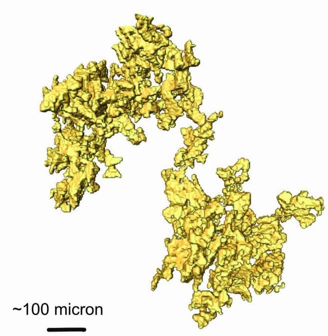

Fig 2: Single pore in amphibole filled vug in Fig. 1A.