



Transient Hydrothermal Alteration in Fault Zones Cutting the Lower Oceanic Crust, Hess Deep Rift

Andrew McCaig (1), Sofya Titarenko (1), Robert Cliff (1), Savov Ivan (1), and Boyce Adrian (2)

(1) Leeds University, Earth and Environment, Leeds, United Kingdom (a.m.mccaig@leeds.ac.uk), (2) SUERC, Rankine Avenue, Scottish Enterprise Technology Park, East Kilbride G75 0QF

IODP Expedition 345 drilled the first holes in the lower plutonic crust at a fast-spreading ridge, recovering primitive layered gabbros [1]. Alteration occurred as: 1) a largely static pseudomorphic alteration, predominantly in the greenschist and sub-greenschist facies with mainly talc and serpentine replacing olivine, and prehnite replacing plagioclase. Talc sometimes overprints serpentine mesh texture. 2) an overprinting metasomatic alteration, spatially related to cataclastic fault zones and macroscopic veins, dominated by prehnite and chlorite. Secondary clinopyroxene and epidote locally overprint the prehnite-chlorite assemblage, but the last events are veins of prehnite and zeolite. Metamorphosed dykes show chilled margins within the cataclasites, and are themselves affected by cataclastic deformation. Faults, dykes and overprinting alteration are all inferred to be related to the westward propagation of Cocos-Nazca spreading forming Hess Deep.

$^{87}\text{Sr}/^{86}\text{Sr}$ ratios of small whole rock samples of cataclasites and dyke rocks are in the range 0.7037 – 0.7048, indicating alteration by seawater at moderate integrated fluxes. The highest values were in cataclasites overprinted by prehnite. Sampling of individual minerals has been undertaken using a microscope mounted drill, and shows that alteration is mainly affecting secondary minerals, with late prehnite veins ranging up to Sr isotope ratios of 0.7054. $\delta^{18}\text{O}$ values range from +1 to +6 per mil. Combined with metamorphic data this indicates alteration at temperatures between 200 and 400 °C. Secondary clinopyroxene and talc replacing serpentine are interpreted to indicate transient prograde hydrothermal events. Preliminary modelling using Comsol Multiphysics suggests that the temperatures of the overprinting alteration, as well as transient prograde events, could be achieved in a permeable fault slot cutting through crust 0.5 to 1 m.y. old.

The prehnite-chlorite assemblage is predicted to be important in off-axis alteration, common in any location where faults intersect the Moho, including transform faults, near axis normal faults at slow spreading ridges, and perhaps bending faults at subduction zones.

[1] Gillis, K.M., Snow J. E. and Shipboard Science Party (2014) Primitive layered gabbros from fast-spreading lower oceanic crust. *Nature*, 505, 204–207.