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Seawater alteration of accreting oceanic crust up to 1000°c -A physical model from the Oman ophiolite revisited

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Following the discovery of a high temperature (800°C) and a very high temperature (1000°C) hydrothermal alteration in the crust of the Oman ophiolite, a systematic structural and petrological study has been conducted throughout the entire ophiolite (1). It was backed by isotopic geochemistry which showed the seawater origin of the fluids (2). The results show that the crustal gabbros are extensively altered down to Moho by a large seawater flux, which was channeled through identified recharge and discharge circuits. A physical model explains how microcracks, constituting the recharge system, can propagate through the hot, accreting gabbros at the ridge of origin and how, in spite of their submillimeter width, they provide the large volume of seawater necessary for the observed alteration. Their propagation and orientation are controlled by the large anisotropy of thermal expansion of plagioclase in the gabbros.The discharge system originates in hydrous remelting pockets pasted along the magma chamber walls. This system is traced in cooling gabbros by hydrous gabbros dikes which connect higher in the crust to the greenschist facies veins of the well known hydrous circulation, operating at lower temperatures. These results from field studies are now integrated in a model of seawater circulation at fast spreading ridges which predicts that a narrow channel of seawater at 350°C sweeps upwards from the Moho, along the magma chamber wall (3). The high temperature alteration takes place in the cracking thermal boundary layer between this channel and the magma chamber wall. This model of high temperature, oceanic hydrothermal alteration has several implications concerning fast spreading oceanic ridges and related ophiolites.

1) Nicolas, A. et al., 2003. JGR,vol.108/B8, 7-1-7-20.
2) Bosch et al., 2004. J. Petrology, vol.45, 1181-1208.
3) Cathles, L.H., 1993. Economic Geology, vol 88, 1977-1988