Seafloor hydrothermal fluid evolution: A fluid inclusion study

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Fluid inclusions offer the only available samples of uncontaminated sub-seafloor fluids. To date, microthermometry of such fluid inclusions trapped in rocks of the ocean crust has revealed that there exist fluids of a wide range of salinities in fluids trapped in both modern and ancient hydrothermal systems. Here we report direct analyses of the chemistry of individual inclusions using LAICPMS. This method allows assessment of multiple generations of fluids within the same sample, giving information on the full range of fluids, rather than simply bulk compositional data.

Samples from different levels in the hydrothermal systems in both the Troodos ophiolite, Cyprus and ODP/IODP Hole 1256D are being studied. By studying ophiolitic and *in situ* ocean crust in tandem it is hoped a greater understanding of fluid evolution will be reached as well as establishing any further oceanic-ophiolitic similarities or differences.

Microthermometry from Troodos samples has revealed a combination of fluids of black smoker vent salinity (~1.5-7 NaCl wt% eq) and hyper-saline fluids (~25-45 NaCl wt% eq) in the system. Given the relatively good constraints on temperature and pressure in these systems it is evident that these fluids are not a simple phase separated pair, if assuming a purely seawater fluid source.

Heating and freezing of fluid inclusions from the sheeted dikes and upper plutonics in Hole 1256D indicates trapping temperatures ranging from 250 to 470°C. Many of these fluid inclusions fall within the temperature-salinity range observed in black smoker vent fluids, however many are more saline and trapped at higher temperatures. The samples from the granoblastic dikes at the base of the sheeted dike complex and some plutonic samples also host hyper-saline (>40 NaCl wt% eq), high temperature (>450°C) fluid inclusions.

Subsequent laser ablation of fluid inclusions from both sites has provided a much more detailed insight into the nature of the fluids, indicating that the fluids take up metals very efficiently and it is apparent that Mg loss from the seawater is slow, with it still being present in reasonable quantities at the base of the system.

Geochemical modeling, based on the fluid chemistries of these systems is in progress and will be presented at the meeting.

Igneous, alteration and exhumation processes recorded in abyssal peridotites from an oceanic core complex of the Central Indian Ridge

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Oceanic core complex (or megamullion) has been interpreted to be the exhumed footwalls of long-lived detachment faults at slow spreading ridges [1, 2]. Data on oceanic core complex has never been reported from the Central Indian Ridge (CIR). We conducted Japanese submersible SHINKAI 6500 dives on an oceanic core complex in the CIR at 25°S (termed 25°S OCC hereafter). It is interesting to note that an unique hydrothermal field (Kairei hydrothermal field) which is characterized by relatively high H_2 content in hydrothermal fluid and unique ecosystems is located at the east of the 25°S OCC [3].

Two less-deformed serpentinized peridotites were recovered from the ridge-facing slope whereas three highly deformed talc-chlorite-serpentine schist were from the top surface of the OCC. The massive peridotites are clinopyroxene-bearing harzburgite. One less-deformed peridotite was cut by leucocratic veins and was geochemically modified by a melt for the formation of the leucocratic veins. The Cr# (=Cr/(Cr+Al) atomic ratio) of spinel not modified by the melt is overlapped with higher range of that in the other abyssal peridotites collected from the CIR [4], indicating moderate degree of partial melting. The schist also contains ilmenite-bearing altered gabbroic fragments, indicating that the deformation and alteration of both gabbros and peridotites were localized along the detachment fault during the formation of the OCC.

In situ microanalysis of trace elements of the primary igneous minerals and their secondary minerals revealed that selective elements, such as Rb, Sr, Ba, Pb and U, are enriched in the secondary minerals. In particularly, Uranium content is steeply increased at the outermost margin of orthopyroxene psudomorph, indicating that the uptake of U was occured in the later alteration processes at lower temperature conditions.

[1] Blackman *et al*. (1998) *JGR* **103,** 21315-21333. [2] Tucholke *et al*. (1998) *JGR* **103,** 9857-9866. [3] Takai *et al*. *Paleon. Res.* **10,** 269-282. [4] Hellebrand *et al*. (2002) *J. Petrol.* **43,** 2305-2338.