

## Compositions of phyllosilicates from the TAG hydrothermal system at 26°N on the Mid-Atlantic Ridge as guide to seafloor entrainment of seawater: Results from ODP Leg 158

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The TransAtlantic Geotraverse (TAG) hydrothermal system east of Mid-Atlantic Ridge at 26°N in a water depth of 3670 m is one of the largest known massive sulfide accumulations on the seafloor (2.7 million tonnes of sulfide; [1]). Anhydrite is an ideal tracer in active hydrothermal systems, but (unlike phyllosilicates) it dissolves after hydrothermal activity has ceased. Phyllosilicate compositions can provide useful constraints on sub-seafloor seawater entrainment, which supplement and extend the record in gangue. Calibrating the phyllosilicate record of fluid evolution against that of anhydrite in the TAG seafloor may hence provide us with a useful tool in studying fluid mixing in hydrothermal stockwork zones underlying ancient volcanogenic massive sulfide deposits.

Results from trace element concentrations indicate that the paragonite patterns are fairly uniform and – compared to N-MORB – show positive Ba, U, Pb, Sr anomalies. In contrast, chlorite patterns are variable and can be divided into 3 different types: chlorite type A occurs in a breccia from the peripheral part of the upflow zone and in the deepest part of Holes 957E and 957C. Type A shows negative Sr and Ba anomalies and positive U and Pb anomalies. Chlorite type B occurs throughout Holes 957E and 957C in the central part of the mound, but is lacking in samples from the periphery of the upflow zone. Type B shows no or small Sr anomalies but positive U, Ba, and Pb anomalies. Chlorite type C occurs in alteration halos of basalt from underneath the mound. It shows no significant U anomalies, but negative Ba anomalies and large positive Pb anomalies.

The results suggest that the different chlorite pattern types relate to sub-seafloor fluid flow dynamics, which are variably dominated by (i) seawater entrainment and heating, (ii) mixing of seawater and hydrothermal fluid, and (iii) pooling and conductive cooling of hydrothermal fluids.

[1] Hannington, M.D. de Ronde, C.E.J. & Petersen, S. (2005) *Economic Geology* **100**, 111–141.

## Ultra-depleted eclogites: Residues of TTG melting

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Eclogites from the Bellsbank diamond mines (SA) fall into categories A and B of Coleman [1]. We collected eclogites from a coarse concentrate dump from the present day production. These fall into three groups, one in A (Mg-rich) and two groups B1 (Fe-rich) and B2 (Ca-rich). They are derived from a temperature range between 850 to 1050°C (A and B1) and 1050 to 1150°C (B2). All xenoliths have exceptionally fresh and clear clinopyroxenes. REE patterns from A and B1 show the ultra-depleted character in their REE patterns which were LREE depleted in both cpx and grt. However, the LREE up to Sm were re-enriched in most cases disturbing the Sm-Nd system. Both phases have extremely high  $\epsilon_{\text{Hf}}$  with one sample giving the highest  $\epsilon_{\text{Hf}}$  ever measured with 13753 in garnet and 6518 in cpx. Such values require a long time integrated history with very high Lu/Hf in the bulk rock. We suggest that the eclogites are derived in the early Archean from picritic to basaltic protoliths of low pressure origin, which were subsequently subducted and partially molten with not much time delay. The products of the partial melting process should be TTG melts according to experimental work (e.g. [2]). The partial melting generated the high Lu/Hf ratios in the residue which are necessary to reach such extreme high  $\epsilon_{\text{Hf}}$  values as found in our rocks. The higher temperature Group B2 eclogites have positive Eu anomalies which indicate a low pressure origin as plagioclase cumulates. These eclogites still have higher  $\epsilon_{\text{Hf}}$  as most known eclogites and may also have been involved in the partial melting process. Lu-Hf grt-cpx two-point isochrones give eruption ages around 120 Ma for samples with  $T > 950^\circ\text{C}$ ; lower-T samples give increasing ages with decreasing temperature. The Sm-Nd isotope system does not give any consistent information on the origin of the rocks because of subrecent addition of LREE to the rocks.

[1] Coleman *et al.* (1965) *JGSA Bull.* **76**. [2] Rapp *et al.* (2002) *Nature* **425**.