The geochemistry of aqueous fluids and hydrous melts in subduction zones

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Aqueous fluids and silicate melts released from dehydrating slabs play a crucial role in mass transfer in subduction zones. Therefore, it is important to quantify the nature and composition of these mobile phases in order to understand elemental transport from the slab to the mantle wedge and the consequences for arc magmatism. We performed experiments at 2-3 GPa and temperatures between 700 and 1100°C on a K-free, H_2O-saturated and trace element-doped basaltic composition representing altered, oceanic lithosphere. This pressure-temperature range corresponds to a depth in subduction zones where hydrous phases, most prominently epidote group minerals and amphibole, are stable and constitute hosts for a number of trace elements like REE, HFSE, some LILE as well as U and Th.

Due to experimental and analytical difficulties in measuring the composition of fluids and melts directly and quantitatively, a "freezing stage" [1] is employed to determine compositions of frozen liquids and fluids by Laser ablation-ICP-MS. By applying this method, the loss of any potential precipitates and unquenchable solutes upon preparation for subsequent analyses is prevented. The employment of diamond traps in the experiments allows mobile phases to be collected in the trap and being analysed by this procedure. Coexisting eclogitic residual mineral assemblages are likewise measured by EMPA and LA-ICP-MS in order to obtain partition coefficients between fluids/melts and solid residual phases.

Preliminary results show hydrous phase assemblages with amphibole and epidote stable at lower temperatures (700 and 800°C), that are replaced by dominantly anhydrous phase assemblages with clinopyroxene and garnet coexisting with trondhjemitic melt at higher temperatures. Rutile is present as accessory mineral at all temperatures. H_2O contents of the liquid phase indicate an aqueous fluid being stable at 700°C and hydrous melts coexisting with eclogite above 800°C. Partition coefficients between hydrous mobile phases and the solid residue indicate garnet controlling Heavy REE at higher temperatures while Light REE, as well as Th and Sr, show strong compatibilities and suggest epidote group minerals controlling these elements below 800°C.

[1] Aerts M. *et al.* (2010) *American Mineralogist,* **95**, 1523-1526.

Recycled material in MORB sources: Os isotopes and HSE in the fossil Galapagos Rise lavas

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There is now growing evidence from trace elements and lithophile-element based isotopes (e.g. Sr, Nd, Pb) that enriched lithologies (e.g. pyroxenites) are significant contributors to the heterogeneous signatures of the Earth's mantle and a major source component in enriched basaltic melts such as the E-MORBs or OIB [1, 2].

Owing to the opposite geochemical behaviour of Re and Os during partial melting, the Re-Os isotopic system may be most sensitive to trace recycling and thus provide further insights into the mantle heterogeneity and its origin. We have analysed N-MORBs and E-MORBs from the fossil Galapagos Rise for $^{187}Os/^{188}Os$ ratios and highly siderophile elements (HSE). The distinct signatures in trace elements and Sr-Nd-Pb isotopic systems between these N- and E-MORBs have been attributed to variable contributions of a pyroxenitic source component due to variable mantle melting degrees and the ceasing of the spreading [3].

Both E- and N-MORBs show the overall positive-sloped HSE patterns, typical of partial melts. However, the E-MORBs are generally richer in Os, Ir, Ru Pt and Pd but contain less Re than the N-MORBs. E-MORBS contain 3.5 to 38 ppt Os and 117-230 ppt Re (Re/Os=6-33) while the N-MORBs have <1-4.5 ppt Os and 230-1190 ppt Re (Re/Os=115-690). N-MORBs have slightly radiogenic to radiogenic initial $^{187}Os/^{188}Os$ ratios (0.19-0.74) while the E-MORBs have extremely radiogenic initial $^{187}Os/^{188}Os$ ratios (0.90-0.99). Strikingly, the Galapagos Rise MORBs define a positive trend between Os concentrations and initial $^{187}Os/^{188}Os$ ratios, opposite to what is usually observed in OIB [4]. This trend suggests that the extremely radiogenic signatures of the E-MORBs may be a primary feature revealing a MORB source reservoir with a long-term Re-enrichment (i.e. high Re/Os).

Whole-rock pyroxenites and eclogites as well as their sulfides and platinum group minerals are likely candidates as source materials since they can develop similarly radiogenic signatures especially if residing in the mantle for a few billion years [5].

[1] Stracke and Bourdon (2009), *GCA* **73**, 218-238. [2] Sobolev et al., (2007) *Science* **316**, 412-417.[3] Haase et al., (2011) *G3*, **12**, Q0AC11. [4] Widom (1997), *Physica A* **244**, 484-49. [5] Luguet et al., (2008), *Science* **319**, 453-456.