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Evidence for the presence of variably dehydrated recycled subducted oceanic lithosphere in sources along the Reykjanes Ridge and implications for the mantle water cycle

A.R.L. Nichols (1), C.G. Macpherson (2), R.J. Wysoczanski (1,3,4), and M.R. Carroll (5)

(1) Institute for Research on Earth Evolution (IFREE), Japan Agency for Marine Earth Science and Technology (JAMSTEC), Yokosuka, Japan (nichols@jamstec.go.jp), (2) Department of Earth Sciences, University of Durham, UK, (3) School of Geography, Environment and Earth Sciences, Victoria University of Wellington, New Zealand, (4) National Institute of Water and Atmospheric Research (NIWA), Wellington, New Zealand, (5) Department of Earth Sciences, University of Camerino, Italy

H_2O/Ce have been obtained for a suite of submarine erupted basalts from the Reykjanes Ridge. Despite absolute water contents increasing northwards towards Iceland, from $\sim$ 0.2 to $\sim$ 0.4 wt.%, H_2O/Ce show the opposite trend. They decrease from values ($\sim$ 400) that are higher than the global average for MORB, to values (212) close to average for Atlantic MORB ($\sim$ 250) at the northern end of the ridge. Assimilation of hydrothermally altered oceanic crust, which elevates H_2O/Ce, does not appear to be affecting high H_2O/Ce samples. Meanwhile, low H_2O/Ce samples are erupted at water depths too deep for degassing of H_2O to be significant. Instead, we relate the H_2O/Ce variations to the presence of variably dehydrated recycled Palaeozoic oceanic crust or upper mantle in the sources of the Reykjanes Ridge basalts.

Thirlwall et al., (2004, GCA, 68, 361-386) have measured Sr-Nd-Pb isotope data for the same suite of Reykjanes Ridge samples, and on the basis of negative Δ^{207}Pb, suggest that their sources have incorporated recycled Palaeozoic oceanic lithosphere. The isotope data define at least three source components in which the recycled material has undergone variable alteration and/or stripping of its mobile components. The dominant source components along the Reykjanes Ridge are two depleted components, but an enriched component is constrained by samples from the north and a seamount in the south. H_2O/Ce vary systematically with the isotope data. The depleted components require higher H_2O/Ce (350 – 450) than normal Atlantic MORB sources, while the enriched component is characterised by low H_2O/Ce (180). The variations between the H_2O/Ce of each component can be explained by variable dehydration during subduction, dehydration or rehydration of the components as a result of hydrogen diffusion, and/or the components being residues of melting at different depths. The depleted Reykjanes Ridge components have lost between 82 and 93 % of their water during, or since, subduction, while the enriched component has lost 93 to 96 % of its water. In terms of the mantle water cycle, from the creation of Palaeozoic oceanic crust at mid-ocean ridges (where a H_2O/Ce of 250 is assumed to represent an original pristine value for oceanic crust), through subduction, to its subsequent recycling in the Reykjanes Ridge basalts, the hydration and dehydration processes have resulted in $\sim$ 140 – 180 % net gain of water in the high H_2O/Ce depleted components. In the low H_2O/Ce enriched component, on the other hand, these processes have resulted in $\sim$ 30 % net loss.