Volatile recycling in the sub-Arctic upper mantle

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The ultra-slow spreading Gakkel Ridge has two well separated magmatic regions, the West Volcanic Zone (WVZ) and the East Volcanic Zone (EVZ). Radiogenic isotope (He, Pb, Nd, Sr) and trace element studies have shown that MORBs in the WVZ are similar to the basalts of the Southern Hemisphere "Dupal" isotopic province, while basalts in the east resemble the NorthAtlantic/Pacific domain of the upper mantle [1, 2]. We present heavy noble gas data on vesiculated glasses along the ridge and mantle source compositions that show clear differenes between the two regions. Multi-step crushing extraction of volatiles from a single sample allows us to study volatile fractionation during magma degassing, mixing of atmospheric and mantle derived volatiles, to identify samples with only two apparent mixing components, and to determine the heavy noble gas source composition of such samples.

We confirm that the WVZ displays a wider range of $^{4}He/^{3}He$ ratios with higher values than observed in the EVZ. [1]. The more radiogenic He is associated with more nucleogenic Ne, lower estimated $^{40}Ar/^{36}Ar_{E}$ and surprisingly low $^{129}Xe/^{130}Xe_{E}$ ratio of the mantle. Component analysis of fission derived Xe isotope data yields a MORB-like (low) ratio of Pu to U derived ^{136}Xe, precluding sampling of an ancient volatile rich reservoir along the ridge. The systematically less radiogenic heavy noble gas signature of the mantle beneath WVZ may indicate the presence of subduction related metasomatizing fluids with atmospheric heavy noble gases. This is consistent with [1] who suggested that delaminated SCLM from the Spitzbergen could be sampled along the WVZ of the Gakkel ridge. Additionally, we estimated the $^{128}Xe/^{130}Xe_{E}$ ratio of the MORB source using the excess $^{128}Xe/^{130}Xe$ and $^{129}Xe/^{130}Xe$ ratios (w. res. to the atmosphere) we observed in all of our samples erupted at the extreme depths of the Gakkel. The simple difference from the chondritic value predicts that ~87% to 92% of the Xe is from atmosphere recycled back into the upper mantle.

[1] Goldstein (2008) *Nature* **453**, 89-93. [2] Graham (2009) *AGU abstract*, #V31F-051F-05.