5.1.P02

Ne isotope evidence that the OIB and MORB source noble gases are decoupled

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The difference between the noble gas signature observered in Mid Ocean Ridge Basalts (MORB) and Ocean Island Basalts (OIB) formed a cornerstone in the development of the layered mantle model. It is now clear from seismic tomographic imaging and numerical modelling techniques that chemical layering at the 670km discontinuity is very unlikely. More recent models that place the OIB-source mantle in either heterogonous blobs or even deeper layers in the mantle nevertheless still ascribe the noble gas signature of the MORB-source mantle to a flux of volatile rich material from the OIB-source mantle.

There is now clear evidence from CO_2-rich well gases that the MORB-source mantle has a Ne isotopic composition ($^{20}Ne/^{22}Ne$ =12.5) that is lower than Solar ($^{20}Ne/^{22}Ne$ =12.5). This is a result of the noble gases in the upper mantle being sourced as a trapped component in meteorites and/or other processes early in the early history of the Earth (<100Ma). Slow evolution of the MORB-source mantle from Solar to Observed by either nucleogenic ^{22}Ne production or modern air ($^{20}Ne/^{22}Ne$ =9.8) recycling can be ruled out. Reported $^{20}Ne/^{22}Ne$ close to Solar values in OIB then rule out the OIB-source mantle as a reservoir that supplies a significant amount of Ne, and by inference other noble gases, to the MORB-source mantle.

The MORB-source mantle ^3He concentration on which many mantle models are based is unsound. Higher ^3He concentrations in this mantle reservoir, by a factor of 3.5, remove any need for an OIB-mantle sourced noble gas flux into the MORB-source mantle and account for both the ^{40}Ar and heat-helium imbalances [1]. This new information from the MORB and OIB Ne isotope systems are consistent with such a view and suggests that a 'zero paradox' mantle model is not too far away.

References

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5.1.P03

Pb isotopes and trace elements in melt inclusions from Hawaiian basalts using LA-ICPMS and SR-XRF

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The trace-element patterns of melt inclusions in Mauna Loa olivines demonstrate compositional heterogeneities in the Hawaiian mantle source that are produced by mixing and reaction of mantle with recycled fragments of old oceanic lithosphere [1]. To get further insights of these processes, we have measured Pb isotopes in melt inclusions from samples of the Hawaii Scientific Drilling Project (HSDP). In addition, we have also determined the trace element composition in these inclusions by LA-ICPMS in our lab and SR-XRF at Hasylab (DESY).

Pb isotope measurements were done with a New Wave UP-213 laser system and an Element 2 ICPMS using 150 µm polished thick sections. Inclusions were ablated for about 10 – 30 s in single spots (40 – 60 µm diameter). Each analysis comprised about 100 – 300 runs of measurements of ^{206}Pb, ^{207}Pb and ^{208}Pb. Typical in-run precision (1 RSE) ranged from 0.2 – 0.4 %. These values are similar to the results obtained by SIMS [2]. Analyses of the MPI-DING reference glasses [3] show that our LA-ICPMS data agree with high-precision TIMS and MC-ICPMS values within 0.3 %.

The $^{208}Pb/^{206}Pb$ and $^{207}Pb/^{206}Pb$ ratios of 25 melt inclusions show large and systematic variations. $^{208}Pb/^{206}Pb$ ranges from 1.91 to 2.13, and $^{207}Pb/^{206}Pb$ varies from 0.778 to 0.877. Matrix values are uniform and within the melt inclusion fields. Their ranges are similar to whole rock data of HSDP samples. The isotopic diversity in melt inclusions is much higher than that of whole rocks. The range of variability of Pb isotope ratios is similar to those found in melt inclusions from Mangaia and Tahaa basalts [2]; however, the values of the Hawaiian basalts are systematically higher. The Pb isotope array can be explained by mixing of at least two end members. The number of end members is difficult to establish partly because of the analytical uncertainties involved.

References

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