3.5.P09

Multiple olivine He isotopic signatures from a single rock sample

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He isotope measurements of phenocrysts are assumed to image the $^3He/^4He$ of the surrounding magma at crystallization. However, mineral separates should be prepared with care to avoid artefacts from xenocrystals.

Recent He and Ne isotopic data from Terceira Island (Azores Archipelago) were interpreted in terms of plume-upper mantle mixing. The reported He isotope signatures for most of the samples range from 9.6 to 14.8 R/Ra [1,2]. For a porphyritic basaltic sample, we performed He isotopic analysis of 3 distinct separates corresponding to different types of olivines defined by petrographic characteristics and composition obtained by microprobe.

Most of the olivine crystals are green-yellow, with core Fo content ranging from 80 to 85% and NiO concentrations <0.20 wt% (Type I). Brown and light green olivine (Types II and III respectively) represent distinct populations with 73-75 and 88-89% Fo. NiO is virtually nonexistent in the first group whereas, in the later, NiO concentrations are usually >0.20 and up to 0.27 wt%. $K_{DFe/Mg}$ values are also different for each group. Calculated values for Type I olivines are close to 0.3, satisfying the equilibrium condition [3]. Values for Type II and III olivines range between 0.57-0.58 and 0.21-0.22, clearly representing desiquilibrium between olivine and the magmatic liquid as represented by the whole rock composition. Taking in account the low $K_{DFe/Mg}$ which characterizes type III olivines and the lack of evidence for olivine inverse zoning, we consider them to be xenocrystals.

Concerning the He isotope ratios, there are also some differences between the mean values obtained for the different olivine separates. Type I olivines are characterized by R/Ra values (9.7±0.2 and 9.6±0.6) similar to those that have been reported for Terceira, in opposition to the Type III olivine xenocrystals, which present lower R/Ra ratios (8.6±0.7). Type II olivines are characterized by intermediate R/Ra values (9.1±0.5) which, in addition to their Fo and Ni contents, can be explained either by considering them also as xenocrystals or, alternatively, as grains crystallized from late magmatic U enriched residues.

References

[1] Moreira M. et al. (1999) *EPSL* **169**,189-205.
[2] Madureira P, Moreira M, Mata J and Allègre CJ (in prep).
[3] Roeder, PE and Emslie, RF (1970) *Contrib. Min. Petrol.*, **29**, 275-289.

3.5.P10

Isotope systematics of argon and xenon in the mantle: Inferences from a four-isotope diagram

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Isotopic compositions of heavier noble gases (Ar, Kr and Xe) observed in mantle-derived materials are often indistinguishable from an atmospheric component of which origin is in many cases uncertain. This is the major source of difficulity in assessing the elemental and isotopic compositions of heavier noble gases in the mantle (especially the less-degassed portion of the mantle). In order to clarify the origin of this isotopically air-like component, we have plotted the isotopic compositions of Ar and Xe of a new dataset taken from recently collected Loihi basalts [1] as well as previously published data from the popping rock [2], Loihi dunites and Icelandic glasses [3] in a four isotope diagram (i.e., $^{136}Xe/^{130}Xe$ vs. $^{129}Xe/^{130}Xe$ vs. $^{40}Ar/^{130}Xe$ ratios). Thoes isotope ratios measured by multistep crushing from a single specimen yielded clear mixing trends all extending from the isotopically air-like composition to their respective mantle endmembers. However, from the four-isotope (3D) diamgram, it is clear that the Ar/Xe ratio of the isotopic air-like component is not atmospheric, but is more like that expected for the deep-seawater. The Xe/Ar ratio of contaminant had been fractionated to become higher than atmospheric Xe/Ar ratio. This leads to the conclusion that the Loihi samples with excess ^{129}Xe and ^{136}Ar and relatively low $^{40}Ar/^{36}Ar$ ratios (<500) [1] require a mantle source to have a Xe/Ar ratio of about 30 to 60 times the atmospheric to explain the distribution of the data in a $^{40}Ar/^{36}Ar$ vs $^{129}Xe/^{130}Xe$ diagram by binary mixing between the mantle and air-like components. Because it is highly unlikely that such a high Xe/Ar ratios can be achieved by elemental fractionation during the magma genesis, we suspect the presence of a mantle domain in the less-degassed part of the mantle supplying the Loihi magma being significantly enriched in Xe with respect to Ar.

References

[1] T. Matsumoto, Y. Kudo, J. Matsuda, K. Yamamoto and Y. Orihashi. (2003) *GCA* **67**, A280.
[2] M. Moreira, K. Kunz, C. Allegre, (1998), *Science* **279**, 1178-1181.
[3] M. Trieloff, J. Kunz, D. A. Clague, D. Harrison, and C. J. Allegre (2000) *Science* **288**, 1036-1038.