The search for solar argon in the Earth's mantle

J. Kunz
C. J. Allègre
Institut de Physique du Globe de Paris, 4 place Jussieu, 75252 Paris Cedex 05, France

Rare gas ratios with radiogenic or fissiogenic contribution (^{4}He/^{3}He, ^{40}Ar/^{36}Ar, ^{129}Xe/^{130}Xe, ^{136}Xe/^{130}Xe) allow us to investigate time scales in the evolution of the Earth (Kunz *et al.*, 1998, and references therein). 'Stable' ratios (^{20}Ne/^{22}Ne, ^{38}Ar/^{36}Ar, ^{124}Xe/^{130}Xe) on the other hand give us information about the initial compositions and by which processes they have been produced. The first indisputable discovery of non-atmospheric neon ratios in mid-ocean ridge basalt (MORB) glasses (Sarda *et al.*, 1988) was subsequently followed by similar observations for oceanic island basalt (OIB) samples (Honda *et al.*, 1991; Valbracht *et al.*, 1997). It is now commonly accepted that the Earth's mantle contains a solar neon component (^{20}Ne/^{22}Ne = 13.8), which is clearly distinct from atmospheric neon with ^{20}Ne/^{22}Ne = 9.8. (Note, that there remains some ambiguity, whether pristine mantle neon probably has a lower-than-solar ^{20}Ne/^{22}Ne ratio, see: Yatsevich and Honda, 1997; Moreira *et al.*, 1998.) This observation fits together with experimental results that Earth's mantle ^{3}He/^{22}Ne ratio is also solar-like (Moreira *et al.* 1998). However, these findings contrast with atmospheric rare gas ratios ^{22}Ne/^{36}Ar, ^{84}Kr/^{36}Ar and ^{130}Xe/^{36}Ar found in MORB samples (Moreira *et al.* 1998). Additionally, Kunz *et al.* (1998) measured atmospheric isotopic ratios for the non-radiogenic/non-fissiogenic xenon constituents ^{124,126,128,130}Xe. The apparent paradox between a solar He-Ne mantle component combined with atmospheric Ne-Ar-Kr-Xe composition is not yet sufficiently explained by current Earth accretion and evolution models. It also raises the question about a presumed solar ^{36}Ar/^{38}Ar ratio (0.1825 or maybe ~ 0.175, see Pepin, 1998) in the mantle.

Recent publications addressed this question and searched solar argon in mantle derivates. Valbracht *et al.* (1997) measured ^{38}Ar/^{36}Ar ratios below the air value (0.188) in glass samples and olivine phenocrysts from the Loihi seamount, Hawaii. These deviations are rather small, but they correlate with ^{20}Ne/^{22}Ne ratios. This indicates that the low ^{38}Ar/^{36}Ar values are not an experimental artefact. Pepin (1998) reports on a similar observation for recently published MORB data that show clear evidence for plume-on-ridge interaction. Thus, both studies most likely give estimates of ^{38}Ar/^{36}Ar ratios in the lower mantle.

Until now, 'normal' MORB samples that are representative for the upper mantle rare gas reservoir have always shown atmospheric ^{38}Ar/^{36}Ar values within the limits of experimental accuracy. It is the aim of our study to investigate the presence of a solar argon component in the MORB source by analysing the 'popping rock' 2ΠD43, which is the most pristine rare gas sample of the upper mantle (Moreira *et al.*, 1998, Kunz *et al.*, 1998). However, the large amounts of ^{40}Ar present in this sample cause some analytical problems. Though using a Baur-Signer source for ionisation, we see a small mass fractionation that slightly depends on the gas amout introduced for analysis. Additionally, we observe some interferences from ^{40}Ar in the mass range of ^{38}Ar. These effects are quite small, but they can lower the ^{38}Ar/^{36}Ar ratios as some solar argon contribution. Thus, these effects need some special attention in addition to standard data evaluation. This supplementary correction is monitored by independent measurements of crustal rocks with high ^{40}Ar/^{36}Ar ratios but atmospheric ^{38}Ar/^{36}Ar values.

This study is still in progress and we will present first at the conference. However, applying the above mentioned correction to an already existing but unpublished data set (^{40}Ar/^{36}Ar and other rare gas ratios are published in Moreira *et al.*, 1998.) on a stepwisely crushed popping rock sample appears to yields a trend: The MORB source seems to contain a lower-than-air ^{38}Ar/^{36}Ar signature, but it may not reach as low values as suggested for solar argon.

References

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