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Elemental and isotopic compositions of noble gases in the mantle: Pete's path

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Noble gases are tracers of the origin of the volatiles on Earth and other terrestrial planets. The determination of their isotopic compositions in oceanic basalts allows discriminating between different possible scenarios for the origin of volatiles (chondritic, solar, cometary). However, oceanic basalts show a ubiquitous component having atmospheric noble gas compositions, which reflects a shallow air contamination. This component masks the mantle composition and only step crushing is able to (partially) remove it. Nevertheless, the exact mantle composition is always unconstrained due to the uncertainty on its complete removal. Developed by Pete Burnard (Burnard et al., 1997; Burnard, 1999), single vesicle analysis using laser ablation is a challenging technique to determine the mantle composition, free of atmospheric contamination. We have used this technique to measure He, Ne, Ar isotopes and CO_2 in single vesicles from both MORB and OIB (Galapagos, Iceland). Vesicles are located using microtomography and the noble gases are measured using the Noblesse mass spectrometer from IPGP using an Excimer laser to open the vesicles. Both Galapagos and Iceland samples show that the 20Ne/22Ne ratio is limited to $\sim$12.8 in the primitive mantle, suggesting that the origin of the light noble gases can be attributed to irradiated material instead of a simple dissolution of solar gases into a magma ocean (Moreira and Charnoz, 2016). Such a scenario of incorporation of light noble gases by irradiation also explains the terrestrial argon isotopic composition. However, the Kr and Xe contribution of implanted solar wind is small and these two noble gases were carried on Earth by chondrites and/or cometary material.

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