

I-Pu-Xe in OIBs and the early separation of the plume source from the MORB source mantle

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The noble gases provide unique insights into mantle structure and the origin of the different mantle reservoirs. In particular, the noble gases are thought to provide one of the strongest evidence for regions of the deep mantle to have largely escaped melt extraction. However, the interpretation of the noble gas data remains a matter of active debate. For example, OIBs have lower $^{40}\text{Ar}/^{36}\text{Ar}$ and $^{129}\text{Xe}/^{130}\text{Xe}$ ratios than MORBs. This observation has been variously interpreted to reflect the sampling of a relatively undegassed mantle reservoir or preferential sampling of recycled plates with seawater derived atmospheric Ar and Xe. These two interpretations have very different implications for mantle differentiation, and the creation and destruction of mantle heterogeneities. Here I will present new He, Ne, Ar, and Xe data from Iceland that will allow the above interpretations to be critically evaluated.

The relative abundances of ^4He , ^{21}Ne , and Ar in the Iceland sample are in the same proportion as the mantle production rates for these isotopes. As a result, the sample preserves an elementally unfractionated pattern that allows the abundance pattern of the primordial noble gases in the plume source to be reconstructed. Strong linear relationships are observed between isotope ratios and elemental ratios (e.g. $^{40}\text{Ar}/^{36}\text{Ar}$ - $^3\text{He}/^{36}\text{Ar}$, $^{129}\text{Xe}/^{130}\text{Xe}$ - $^3\text{He}/^{130}\text{Xe}$) that reflect mixing between mantle-derived noble gases and shallow-level atmospheric contamination. Importantly, while the gas-rich 'popping rock' from the N. Atlantic ridge and the Iceland sample share a common shallow-level atmospheric contaminant, they trend towards very different mantle $^{40}\text{Ar}/^{36}\text{Ar}$ and $^{129}\text{Xe}/^{130}\text{Xe}$ ratios. Additionally, the Iceland sample has a large proportion of Pu-derived to U-derived fission xenon. Hence, for the first time, the Iceland data provides unequivocal evidence that the differences in Ar and Xe isotopic compositions between MORBs and OIBs cannot be generated solely through preferential re-circulation of atmospheric noble gases into the OIB source. The differences reflect a lower degree of outgassing of the plume source. Further, because ^{129}Xe is produced from extinct ^{129}I , the result demonstrates that chemical differences between OIBs and MORBs must have been established within the first 100 Myrs of Earth history and subsequent mantle convection has not wiped out the differences established in the early Earth.

Architecture of submicron organo-mineral domains in soil aggregates – Evaluation by NanoSIMS

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During soil aggregation primary soil particles such as clay and silt, iron and aluminium (hydro)oxides and particulate organic matter are bound together to complex aggregates. The spatial mixture of mineral and organic components results in diverse interfaces controlling soil organic matter stabilization but also sorption processes. Until nowadays it was hard to analyse the spatial distribution of mineral and organic domains within intact soil aggregates together with its turnover.

The nano-scale secondary ion mass spectrometry (NanoSIMS) enables us to analyse biogeochemical processes and properties of inner aggregate spheres at a submicron scale. NanoSIMS allows the simultaneous analysis of up to seven ion species with high sensitivity and lateral resolution. With Cs^+ as primary ions, negatively charged ions, like e.g. $^{12}\text{C}^-$, $^{13}\text{C}^-$, $^{12}\text{C}^{14}\text{N}^-$, $^{12}\text{C}^{15}\text{N}^-$, $^{27}\text{Al}^{16}\text{O}^-$ and $^{28}\text{Si}^-$, are collected with a lateral resolution down to 50 nm. Using O as primary ion, positively charged ions like e.g. $^{24}\text{Mg}^+$, $^{40}\text{Ca}^+$ and $^{56}\text{Fe}^+$, are collected with a lateral resolution down to 150 nm.

For the present study we used soil material of topsoils from an agricultural cropland and a forest. Both soils were derived from labelling experiments using litter enriched in ^{15}N (mustard litter on cropland soil, beech litter on forest soil). The air dried soil aggregates were embedded in an epoxy-resin, cut and polished in order to obtain a smooth inner aggregate surface. A cascade from reflectance light microscopy, scanning electron microscopy to NanoSIMS was used to evaluate architecture, elemental composition and ^{15}N location within intact soil aggregates.

A spatial mixing of mineral compounds into plant residues with still visible cell structures was shown within aggregates. We can demonstrate that the incorporated ^{15}N -labelled organic matter is not distributed homogeneously, but resides at specific micron-scale spots within soil aggregates. The packing of mineral and organic domains in soil aggregates showed distinctively alternating spatial patterns. The NanoSIMS technique therefore allows the combined *in situ* evaluation of specific aggregate structures and their possible functions in terms of organic matter sorption and turnover.