4.5 Billion Years of Mantle Evolution: Insights from He, Ne, Sr, Nd and Pb Isotopes in OIBs and MORBs

N.A. STRONCIK[1], S. NIEDERMANN[1], AND K. M. HAASE[3]

[1]Helmholtz-Centre Potsdam German Research Centre for Geosciences GFZ, Telegrafenberg, 14473 Potsdam, Germany, stroncik@gfz-potsdam.de, nied@gfz-potsdam.de
[2]GeoZentrum Nordbayern, Schlossgarten 5, 91054 Erlangen, Germany, karsten.haase@fau.de

The noble gas isotopic structure of the Earth's interior has been the subject of countless studies, as it provides important insights into mantle dynamic processes beyond the information obtained from major or trace elements or Sr, Nd, and Pb isotopes. However, the residence times of noble gases as well as their location in the mantle has been one of the most puzzling aspects of mantle geochemistry. Especially, the difference in the He isotopic composition between MORBs and OIBs is still the peg for advocating a layered mantle model. This contribution presents a multi tracer study (noble gases, trace elements, Sr, Nd, Pb isotopes) of magmatic samples from different ocean island and mid-ocean ridge settings, which has resulted in three major observations: (1) He isotopes show a much larger degree of heterogeneity compared to the Ne isotopes (e.g. Ne isotope ratios being homogeneously primitive where He isotope ratios vary), (2) the He and Ne isotopic composition of the upper mantle is heterogeneous at different spatial and temporal scales, and (3) the He isotopic ratios show a quite coherent behaviour with other tracers of mantle source composition (e.g. primitive He isotope ratios correlating positively with highly radiogenic Pb isotopic ratios). From these observations the following conclusions can be drawn: (1) high $^{3}He/^{4}He$ ratios in mantle-derived magmas are a robust indication for a plume origin but low ratios can be present in the same province and do not necessarily imply the contrary, (2) the mixing efficiency of convection processes in the upper mantle might be lower than assumed, and (3) the mantle material carrying the primitive noble gas isotope signal has experienced previous melting events and is most likely statistically distributed throughout the mantle.