Geophysical Research Abstracts,
Vol. 10, EGU2008-A-07924, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-07924
EGU General Assembly 2008

Neon, helium and argon isotope systematics of the Hawaiian hotspot

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Noble gases, especially helium, are used as tracers for mantle reservoirs, based on the assumption that high ^{3}He/^{4}He ($>$8 R$_A$) represent material from the deep, supposedly less degassed mantle whereas lower ratios ($\sim$ 8 R$_A$) are thought to represent the upper mantle. In this study we determined the noble gas systematics of samples from several Hawaiian volcanoes. The studied volcanoes include Mauna Kea, from which we mainly investigated drill core samples of the Hawaii Scientific Drilling Project (HSDP), Mauna Loa, Kilauea and Kohala (all located on the Island of Hawaii) as well as Haleakala, Maui. He ratios from this study show a variation from 7-18 R$_A$. It is known that OIBs show a wide range of He ratios, from MORB-like values up to as much as 35 R$_A$. Samples of this study have ^{20}Ne/^{22}Ne and ^{21}Ne/^{22}Ne of up to 11.14$\pm$0.49 and 0.0365$\pm$0.0062, respectively, which are higher with respect to the atmospheric value, thereby supporting the theory of a partly less degassed source region for the Hawaiian hotspot deep in the mantle. When using Ne as a tracer for a less degassed source of the Hawaiian mantle plume, one has to be aware that atmospheric contamination is a severe problem. By the technique of stepwise heating however, this problem can partly be circumvented. ^{40}Ar/^{36}Ar ratios are predominantly close to the atmospheric composition, but a few samples show elevated values of up to 3790. Following the approach of Honda et al. (1993), the expected He isotopic composition can be calculated from a given Ne isotopic composition. Calculated He ratios for samples of this study, however, do not correlate well with the measured He ratios. Moreover, calculated ^{4}He/^{40}Ar*, ^{3}He/^{22}Ne$_s$ and ^{4}He/^{21}Ne ratios for the sample suite (where * denotes radiogenic and nucleogenic components and S means solar) are lower than the respective production and primordial ratios. These observations may be explained

by a preferential loss of He from the magma source.

References

M. Honda, I. McDougall, D. Patterson, Solar noble gases in the Earth; the systematics of helium-neon isotopes in mantle derived samples, Lithos 30 (3-4) (1993) 257–265.