Noble gas isotopic compositions of gas samples from the Aegean Arc, Greece

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Introduction

The Aegean arc is characterized by the subduction of the continental African plate beneath the continental Eurasian plate, in contrast to most other arcs with oceanic plate subduction. Since noble gas isotopic compositions are excellent geochemical indicators to identify source materials and/or genetic processes of the volcanic products, this paper discusses noble gas isotopic systematics in gas samples from the Aegean arc.

Samples and Experiments

Total 47 gas samples were collected from 5 volcanic islands along the Aegean arc, 3 islands in the back-arc region, 2 sites in the Balkan Peninsula and 8 sites in the surrounding areas from 1988 to 2001. Among them, 13 samples are fumarolic gases collected from Nisyros and Santorini Islands on the volcanic arc, and others are bubbling gases released from hot or cold spring waters and geothermal gases. We have measured noble gas abundances and isotopic compositions of these samples.

Result and Discussion

$^3He/^4He$ ratios of the 47 samples range from $0.03R_A$ to $6.24R_A$ (R_A denotes the atmospheric ratio, 1.4×10^{-6}). Regional variation in $^3He/^4He$ ratio was systematically observed. The $^3He/^4He$ ratios along the volcanic arc ($2.31R_A$ to $6.24R_A$) showing significant contribution of mantle-derived helium, are higher than those of back-arc and surrounding areas. Especially, samples far from the volcanic arc (Balkan, Peloponnisos and Macedonia) show very low $^3He/^4He$ ratio ($0.03R_A$ to $0.39R_A$), suggesting major contribution of radiogenic helium derived from continental crust. Both along-arc decreases in the $^3He/^4He$ ratios from east (Nisyros) to west (Methana) and across-arc decreases from south (Nisyros) to north (Macedonia) are explained in terms of decreasing contribution of mantle helium due to the Aegean subduction system.

Repeated analysis of the $^3He/^4He$ ratio from Nisyros Island since 1993 showed the temporal variation possibly related to swarm activity, and the maximum $^3He/^4He$ ratio ($6.24R_A$) was obtained in 1999. It must be pointed out that this maximum value in the Aegean area is significantly lower than the MORB value and maximum values of many other arcs ($8.0R_A$) [Poreda and Craig, 1989]. This suggests that mantle-wedge beneath the Aegean arc is affected by the continental African plate subduction.

References

Poreda, R. and Craig, H., (1989), *Nature*. **388**. 473-478.

Pb isotopic variations in Kilauea magmas: from pre-shield to shield stages

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Volcaniclastic sediments found form a scarp below the mid-slope bench at water depths between 3,000 and 5,000m offshore south of Kilauea, Hawaii, contain abundant glass shards that represent submarine eruptions from an ancestral Kilauea volcano (Lipman et al., 2000; Sisson et al., 2001). Their major element compositions range from tholeiites/transitional basalts to alkali basalts to basanites and nephelinites. Pb isotopic compositions of the glasses were determined using a Cameca IMS 1270 ion microprobe at Woods Hole Oceanograhic Institution. Replicate analyses of basalt glass standards show that $^{208}Pb/^{206}Pb$ and $^{207}Pb/^{206}Pb$ ratios could be determined in basalt glasses with external precisions better than 0.15% (2σ) in a spot of 30 μm across. Results show that: (1) a range of Pb isotopic compositions observed in the glasses is much greater than the entire spectrum of the Hawaiian colvanics. $^{208}Pb/^{206}Pb$ ratios vary from 2.099 to 2.004 and $^{207}Pb/^{206}Pb$ from 0.864 to 0.805. (2) There appear to be three distinct compositions, with each being represented by diverse magmatic compositions. No significant mixing is apparent, and they form a linear array in a 208/206 vs 207/206 space, encompassing the entire Hawaiian Pb isotopic array. The least radiogenic composition ($^{208}Pb/^{206}Pb$ = 2.099, $^{207}Pb/^{206}Pb$ = 0.864) is on an extension of the Honolulu series array, whereas the most radiogenic composition ($^{208}Pb/^{206}Pb$ = 2.004, $^{207}Pb/^{206}Pb$ = 0.805) is far more radiogenic than any known Hawaiian magmas. The intermediate composition ($^{208}Pb/^{206}Pb$ = 2.041, $^{207}Pb/^{206}Pb$ = 0.827) is close to the "Kea" component proposed by Eiler et al. (1988). (3) It appears that the range of isotopic compositions of Kilauea magmas decreased with decreasing age with development of crustal plumbing systems where magma mixing takes place. In light of recent melt inclusion-based isotope studies, it is important to recognize that mixing of melts in crustal plumbing systems contributes to apparent reduction of isotopic heterogeneity of the source mantle.

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