Sulfur isotopic variations in mantle-derived magmas: Initial observations

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Deep recycling of large isotopic variations in surface sulfur reservoirs could contribute to large isotopic variations to be observed in mantle-derived melts, if the rate of isotopic equilibration is slow relative to the time scale of recycling. *In situ* sulfur isotope analysis protocols have been developed using a Cameca IMS 1280 at Woods Hole Oceanographic Institution. Instrumental mass fractionation factors were determined by replicate analyses of natural and synthetic glasses of basaltic compositions with well-documented isotopic compositions ranging in δ^{34}S from +12.2 to -5.3‰ (VCDT), and ranged from 0.9985 to 0.9918 between sessions. An internal precision of the data is ±0.4‰ (2σ). Samples analyzed here are undegassed submarine glasses and olivine-hosted melt inclusions, and effects of sulfur degassing, entrainment of seawater, assimilation of hydrothermally altered oceanic crust are considered to be absent or negligible.

Results show large variations for : (1) MORB (-9.5 ~ +10.5 ‰ for melt inclusions from a FAMOUS lava, (2) IABs (-2.5 ~ +9.6‰ for Galunggung; +1.8 ~ +8.9‰ for Krakatau; +10.5 ~ +17.3‰ for Augustine), and OIBs including (3) olivine-hosted melt inclusions from Kilauea 1960 picrite -1.4 to -10.1‰, (4) glasses from Loihi Seamount +0.5 ~ +5.8‰, and (5) dredged submarine glasses from Samoa show variations specific for individual islands, including -3.7 ~ +4.4‰ for Vailulu, -0.3 ~ +2.9‰ for Tau, and -0.6 ~ -12.9‰ for Malumalu, where radiogenic isotope signatures of recycled sediments are remarkable (Jackson *et al.* [1]).

It is evident that sulfur isotopic compositions of mantle-derived melts are enormously heterogeneous on various scale lengths, reflecting inefficient isotopic equilibration of oxidized (heavy) surface sulfur, light sediment-derived sulfur, and 'primary' mantle (0‰) sulfur during recycling.

[1] Jackson *et al.* (2007) *Nature* **448**, 684–697.

Chemical variation of adakites: A clue to the origin of EM1 and EM2 reservoirs

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Geochemical modeling of the origin of enriched mantle 1 (EM1) and enriched mantle 2 (EM2) is conducted from the perspective of adakite formation. For the model, the average composition of adakites is re-estimated from published data for eighteen trace elements. The estimated concentrations for highly incompatible elements are very high (about 100 times of primitive mantle). However, these high concentrations can be explained by melting of oceanic crust without sediment contribution. This result suggest that sediment melting appears unlikely to have affected the chemical composition of adakites, because sediment should have melted before the oceanic crust due to its lower solidus temperature [1-4].

Chemical variation of adakite can be produced by (1) condition of slab melting, (2) mantle-slab melt reaction in the mantle wedge and (3) crystal fractionation in the magma chamber. To examine these effects, broad correlations between trace elements and SiO_2 concentrations, and the MELTS program are employed. The estimated chemical compositions are used to evaluate the effect of the adakites recycling. The results suggest that recycling of a basic adakite can account for EM1 isotopic signatures with storage times of about 2.0 Gyr. The isotopic compositions of less-basic adakites and their evolved magmas shift towards EM2 values with increasing SiO_2 concentrations. In particular, evolved acidic adakite can produce EM2 isotopic signatures. These lines of evidence suggest that the recycling of adakites at various stages of evolution can conceivably produce the appropriate isotopic range between EM1 and EM2 reservoirs. Consequently, adakite recycling via sediment subduction or subduction erosion can account for the origins of EM1 and EM2 reservoirs. In the presentation, I will discuss genetic relationship between EM1 and EM2 based on my recent study [5].

[1] Shimoda & Tatsumi (1999) *Island Arc* **8**, 383–392. [2] Shimoda *et al.* (2003) *Geochem. J.* **37**, 503–518. [3] Shimoda *et al.* (1998) *EPSL* **160**, 479–492. [4] Kimura *et al.* (2003) *Island Arc* **12**, 22–45. [5] Shimoda (2009) *Lithos* **112**, 591–602.