Elucidating the Deep Sulfur Cycle: A Progress Report of Techniques and Findings

N. SHIMIZU*[1] AND C. W. MANDEVILLE [2]

[1] Woods Hole Oceanographic Institution, Woods Hole, USA, nshimizu@whoi.edu
[2] USGS, Reston, USA, cmandeville@usgs.gov

We have developed a SIMS method for in-situ determination of sulfur isotopic composition in silicate glasses has been developed, using a Cameca IMS 1280 ion microprobe. Calibrations were carried out for instrumental mass fractionation against well-documented natural and synthetic glasses with $\delta^{34}S$ ranging from -6 to +12‰ . $\delta^{34}S$ in silicate glasses can be obtained with internal and external precisions ranging 0.4 – 0.7‰ (2σ). Accuracy is controlled by bracketing unknowns by repeated analyses of standards.

We used this method to determine ranges of natural variability in sulfur isotopic compositions in olivine-hosted melt inclusions from MORB, IAB and OIB to investigate how deep recycling of sulphur from oxidized and reduced surface reservoirs influences the sulfur isotopic compositions of mantle-derived melts. We found that (1) $\delta^{34}S$ of undegassed basalt MIs from arcs are most commonly heavy; Galunggung (Indonesia) ranging up to +10.7‰, Krakatau (Indonesia) to +8.8‰, and hydrous and highly oxidized (SO_4/total S =1) MIs from Augustine (Alaska) to +17.2‰, reflecting efficient recycling of oxidized sulfur into mantle wedge melting regions; and (2) Olivine-hosted melt inclusions from MORB and OIB display large variations in individual lavas; -10 to +10‰ for primitive FAMOUS MIs, -5 ~ +5‰ for depleted MIs from17°N (MAR), -6 ~ +2‰ for 26 – 29°N (MAR), among others, and MIs from 1960 Kilauea picrite range from -10 to -2‰. The variations are largest for MIs in Fo 90 – 91 olivines and appear to diminish as Fo decreases to Fo 82, reflecting the presence of large sulfur isotopic variability on local scales in the mantle and the effect of averaging during mixing of melt fractions prior to eruption of lavas.

It is evident that isotopic variations characterizing surface reservoirs survive during deep recycling. Elucidating co-variations with radiogenic isotopes and trace element abundance patterns will require a systematic approach to obtain sample suites that represent mantle endmember components.

U-Pb zircon ages of Early Archean gneisses from northern Labrador

M. SHIMOJO[1]*, S. YAMAMOTO[1], K. MAKI[2], T. HIRATA[2], Y. SAWAKI[3], K. AOKI[1], A. ISHIKAWA[1], Y. OKADA[4], K.D. COLLERSON[5], AND T. KOMIYA[1]

[1]Department of Earth Science and Astronomy, The University of Tokyo, Komaba, Meguro, Tokyo, 153-8902, Japan (*correspondence: shimojo@ea.c.u-tokyo.ac.jp)
[2]Laboratory for Planetary Sciences, Kyoto University, Kyoto, Japan
[3]Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Kanagawa, Japan
[4]Department of Earth and Planetary Sciences, Tokyo Institute of Technology, Tokyo, Japan
[5]School of Earth Sciences, The University of Queensland, Brisbane, Qld. Australia

Early Archean crustal records are rare, but contiguous units are best preserved in N. Labrador and the NWT (Canada) and in SW Greenland. The Saglek-Hebron area (N. Labrador), located at the W. extension of the North Atlantic Craton (NAC), contains well-preserved Eo-Paleoarchean suites including pre-3.8 Ga Nanok Fe-rich monzodioritic gneiss, the Nulliak supracrustal assemblage (*ca.* 3.8 Ga), 3.7-3.6 Ga Uivak I TTG gneisses, 3.5-3.4 Ga Uivak II augen gneisses and Mesoarchean 3.2 Ga Lister gneiss [1-3]. Saglek dykes are present in the Eo and Paleoarchean gneisses, but not in the younger Lister gneisses. Despite confirmation of the antiquity of the area [3,4] a comprehensive zircon U-Pb dating with LA-ICPMS employing cathodluminescence (CL) imaging has not been undertaken for orthogneisses and supracrustal suites. CL images are essential to discuss inherited grains, pristine core and overgrowth.

We conducted LA-ICPMS U-Pb geochronological study of zircons from TTG Uivak I gneiss from the Saglek-Hebron area. The CL images of zircon grains display internal structures of oscillatory zoning and homogeneous core with overgrowth rim. Results show that samples collected as Uivak I TTG gneisses can be classified into three groups based on the distribution of zircon ages. The first group of TTGs is characterized by both presence of older zircons than 3.8 Ga, with the maximum age of 3914 ± 40 Ma in $^{207}Pb/^{206}Pb$ age, and apparent lack of 3.6 to 3.8 Ga zircons. These are obviously members of the Nanok gneiss. Based on intrusive relationships observed in the field, the Nanok gneiss is pre-date emplacement of the protoliths of the Uivak I gneisses. The second and third groups have clear peaks at 3.7-3.6 Ga and *ca.* 3.3 Ga in their age distribution of zircon cores, indicating that TTGs of the second and third groups correspond to Uivak I gneiss and the Lister gneiss, respectively. Importantly, overgrowth rims of zircons we analyzed here show *ca.* 2.7 Ga, which reflect zircon growth during late Archean thermal event in the NAC, possibly associated with assembly of different terranes within the gneiss complex. We show that the combination of *in-situ* U-Pb dating and CL imaging can reveal the tectonothermal history of early Archean from the gneisses in N. Labrador.

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