Hard X-ray microprobes using mirrors: Capabilities, applications and future developments

S.R. SUTTON[1,2], M. NEWVILLE[2], P. ENG[2], M.L. RIVERS[1,2] AND A. LANZIROTTI[2]

[1]Department of Geophysical Sciences, University of Chicago, Chicago, IL

[2]CARS, University of Chicago, Chicago, IL (sutton@cars.uchicago.edu)

Kirkpatrick-Baez mirrors are being increasingly utilized for production of synchrotron x-ray microbeams for x-ray fluorescence microprobes because of their achromaticity, photon density gains in excess of 10^4, and long working distances (cms). Two such instruments are in use at the GeoSoilEnviroCARS sector (undulator and bending magnet sources) at the Advanced Photon Source (APS, Argonne, IL, USA) and as well as one at Beamline X26A (bending magnet source) at the National Synchrotron Light Source (NSLS, Upton, NY, USA). These instruments are utilized primarily for research on problems in low temperature geochemistry, environmental science, igneous petrology, planetary science, and other earth science related topics although applications in biological and materials science are also common. The science is driven by the requirement for determination of the compositions, structures, oxidation states, and bonding characteristics of chemical species in materials with trace element sensitivity and micrometer spatial resolution.

The microprobe has capabilities for microbeam applications of x-ray fluorescence, x-ray absorption fine structure, fluorescence tomography, and x-ray diffraction. The high elemental sensitivity (down to 10 ppb) and spatial resolution (down to 1 μm) offers the possibility of establishing the chemical behavior of a larger number of elements within a given system.

Scientific research areas include: (1) uranium redox reactions and diffusion in soils, (2) biogeochemistry of toxic metals, (3) speciation and partitioning of ore-forming metals in hydrothermal fluids, (4) cosmochemistry of primitive solar system materials, (5) oxygen fugacity of igneous systems using multivalent cation proxies, (6) biogeochemical reactions occurring in the rhizospheres of hyperaccumulating plants, and (7) the roles of metals in human disease.

Future developments include plans for a new state-of-the-art, medium energy storage ring at Brookhaven National Laboratory to replace the existing NSLS. NSLS-II will have insertion device sources with ultra-high brightness in the low to hard x-ray region. These sources will be well-suited to extend the capabilities of the microprobe to higher spatial resolution and greater sensitivity.

Os isotopic compositions of primitive magma of high-Mg andesite in the Setouchi volcanic belt

KATSUHIKO SUZUKI, RYOKO SENDA, KENJI SHIMIZU AND YOSHIYUKI TATSUMI

Institute for Research on Earth Evolution (IFREE), Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Yokosuka, Japan (katz@jamstec.go.jp)

High magnesian andesites (HMAs) can occur in subduction zone settings such as Aleutian Island and SW Japan. The high Mg/Fe ratios of HMAs provide evidence for their equilibration with upper mantle peridotite. Geochemical modelling of HMA magma formation in the Setouchi volcanic belt (SVB) suggests its derivation by partial melting of subducted lithosphere, and subsequent melt-mantle interaction [1, 2]. Osmium isotope is a sensitive tracer of crust and sediment, because of significant contrast between a high Os isotope ratio of crust and sediments ($^{187}Os/^{188}Os>0.5$) and a low ratio of wedge mantle ($^{187}Os/^{188}Os\sim0.13$). Therefore, Os isotope provides information on slab component contribution to the mantle source of island arc lavas. We obtained the radiogenic Os isotope compositions ($^{187}Os/^{188}Os$ = 0.1718 to 0.2041) for the HMAs in the SVB in bulk rock analyses, suggesting input of subducted components in the generation of such HMAs [3]. However, the possible effect of crustal assimilation resulting in high Os isotope ratios during magma ascent cannot be ruled out, as pointed out for volcanic rocks in continental arcs (e.g., Woodhead & Brauns [4]).

Olivine phenocrysts in the Setouchi HMAs contains several Cr-spinels with size ranging from a few μm to 30 μm. We extract these Cr-spinels from large amounts (~30kg) of HMAs for determination of Os isotopic compositions of primitive magma because being the early stage fractionating phase, Cr-spinels preserve the chemical and isotopic compositions of very primitive magma free from any later stage crustal contamination effect. We found that the Os isotope ratios of Cr-spinels are less radiogenic than those of bulk compositions of boninites and tholeiite in the Izu-Bonin arc, indicating that the Os isotope ratios of primitive arc magma cannot be obtained in bulk rock analysis. This result is important in the discussion of the contribution of subducted lithosphere components to generation of high-Mg andesitic magma in the SVB.

[1] Shimoda *et al.* (1998) *Earth Planet. Sci. Lett.* **160** 479-192. [2] Tatsumi & Hanyu (2003) *G-cubed* **4** 2003GC000530. [3] Suzuki & Tatsumi (2006) *Geochem. J.* **40** 297-307. [4] Woodhead & Brauns (2004) *Earth Planet. Sci. Lett.* **221** 309-323.