Mg and Si isotopes in the solar system

R. CHAKRABARTI* AND S.B. JACOBSEN

Dept. of Earth and Planetary Sciences, Harvard University,
Cambridge, MA 02138 (rama@eps.harvard.edu)

Chemical heterogeneity in our solar system is well-documented. Silicate portions of the Earth, Moon and Mars are different from the chondritic meteorites in their volatile element budgets and in Mg/Si. Isotopic compositions also vary between Earth and other Solar System bodies. Chemical and isotopic differences between Earth and bulk meteorites can be broadly attributed to the following processes: (1) Terrestrial fractionation, (2) Fractionation and incomplete mixing in the solar nebula prior to accretion and (3) Late injection of pre-solar material and its inhomogeneous distribution.

It has been suggested [1] that the Earth and Moon have heavier Si-isotopic compositions compared to meteorites, all of which have indistinguishable Si-isotopes, resulting from core formation on Earth. Several efforts have been initiated to resolve the Mg isotopic compositions of the bulk Earth and meteorites [2, 3] but available results are contradictory.

We have initiated a combined Mg- and Si-isotopic study in terrestrial and planetary samples to address the following questions: (1) What are the BSE Mg- and Si-isotopic compositions? (2) Does the BSE and average chondrites have resolvable differences in Si and Mg-isotopic compositions and (3) if they are different, what is the most plausible explanation? So far our Mg-isotopic data suggest that terrestrial olivines from peridotites and whole-rock basalts show similar Mg-isotopic compositions which are slightly lighter than those of whole-rock chondrites. Olivines from several pallasites show heavier Mg isotopic compositions compared to both chondrites and terrestrial samples. This difference suggests that pallasites, likely derived from the core-mantle boundary of early differentiated planetesimals, sampled Mg-isotopic heterogeneity in the solar nebula.

[1] Georg, R. B. *et al.* (2007) *Nature* **447**, 1102-1106. [2] Wiechert, U. & Halliday, A. N. (2007) *EPSL* **256**, 360-371. [3] Teng F-Z *et al.* (2007) *EPSL* **261**, 84-92.

In situ SIMS micro-baddeleyite U-Pb dating method for mafic rocks

K.R. CHAMBERLAIN[1]*, T.M. HARRISON[2],
A.K. SCHMITT[2], L.M. HEAMAN[3], S.M. SWAPP[1],
AND A.K. KHUDOLEY[4]

[1]Dept. of Geology and Geophysics, Univ. of Wyoming,
Laramie, WY, 82071 USA
(*correspondence: kchamber@uwyo.edu)
[2]Department of Earth and Space Sciences, UCLA,
Los Angeles, CA 90095-1567, USA
[3]Dept. of Earth and Atmospheric Sciences, University of
Alberta, Edmonton, AB T6G 2E3, Canada
[4]Geological Department, St. Petersburg State University,
University nab. 7/9, St. Petersburg, 199034, Russia

Baddeleyite (ZrO_2) is a favorite target for U-Pb dating of mafic and ultramafic rocks. Although samples with grains that are large enough (100-200 micron long) for traditional separation and dating methods are scarce, micro-baddeleyite crystals (<20 microns long) are nearly ubiquitous. With refined methods, it is possible to separate 10 to 20 micron long grains for ID-TIMS analysis.

We are currently developing an *in situ* technique to date micro-baddeleyite crystals using the CAMECA *ims* 1270 ion microprobe, avoiding the separation and dissolution steps of ID-TIMS and permitting analysis of even smaller grains (2-5µm). The ion microscope optics of the *ims* 1270 can reduce the effective sampling diameter of a 20 µm primary ion beam to a few to 10 µm. An aperture blocks undesired secondary ions, in particular common Pb ions emitted from host phases surrounding micro-baddeleyite, and the target crystals can be dated in polished thin sections. CAMECA *ims* 1270 analytical conditions also involve oxygen-flooding the sample chamber (~10^5 Torr) to enhance Pb secondary ion yields for baddeleyite by approximately 10-fold, and a UO_2/U vs. U/Pb relative sensitivity calibration. Three baddeleyite standards analyzed under these conditions yielded U/Pb reproducibilities that only marginally exceeded those determined for NIST610 glass, suggesting that crystal orientation related bias in U-Pb sensitivity is minor to absent. Proterozoic-aged standards yielded 2 sigma precisions on $^{207}Pb/^{206}Pb$ dates from 1% to 0.2%. Preliminary results for micro-baddeleyite from Ordovician and Mesoproterozoic-aged mafic sills analyzed *in situ* yield U-Pb ages roughly equivalent in precision to those achieved on larger standard baddeleyite grains. Precisions on Phanerozoic $^{206}Pb/^{238}U$ dates are ~6%; Precambrian $^{207}Pb/^{206}Pb$ date precisions are 1% or less. The *in situ* technique is applicable to most unmetamorphosed to low-grade mafic rocks including dikes, sills, fine-grained volcanic rocks and extra-terrestrial rocks, greatly increasing the number of mafic samples that are dateable by U-Pb methods.