

5348

EFFECTS OF IMPACTS ON SM-ND AND LU-HF INTERNAL ISOCHRONS OF EUCRITES

A. Bouvier^{1, 2}, J. Blichert-Toft², J. D. Vervoort³, and F. Albarède². ¹The University of Arizona, Department of Geosciences, USA. E-mail: abouvier@geo.arizona.edu. ²Ecole Normale Supérieure de Lyon, France. ³Washington State University, Pullman, Washington, USA

Eucrites are among the most ancient basalts of the solar system, thus bearing witness to its earliest episodes of planetary differentiation. Previous studies (i.e., [1–3]) have yielded scattered ages at 3.0–4.5 Ga, indicating that impacts may have disturbed the isotopic systems in these rocks. In order to shed new light on the apparent differences between terrestrial and meteoritic $\gamma^{176}\text{Lu}$ determinations [4–6], we examined the combined Sm-Nd and Lu-Hf isotope systematics in one cumulate (Moama) and five basaltic (Bérèba, Bouvante, Juvinas, Millbillillie, and Stannern) eucrites. These samples yield relatively imprecise ages for whole-rock (WR) and internal (WR, pyroxene PX, and plagioclase PL) isochrons for both Sm-Nd and Lu-Hf systems. The WR isochrons yield a Sm-Nd age of 4559 ± 150 Ma and a Lu-Hf age of 4637 ± 86 Ma. Individual Sm-Nd and Lu-Hf internal isochrons also give imprecise ages. Of these, Moama and Juvinas yield Sm-Nd ages of 4520 ± 33 Ma and 4532 ± 53 Ma, respectively, and Millbillillie and Juvinas yield the least scattered Lu-Hf results, with ages of 4566 ± 93 Ma and an impossibly old 4697 ± 35 Ma, respectively, when using $\gamma^{176}\text{Lu} = 1.867 \times 10^{-11} \text{ y}^{-1}$ [7, 8].

The most probable explanation for these inconsistent results is open-system behavior in the eucrites. Sm-Nd and Lu-Hf data for the 6 PX-PL pairs do not consistently plot on their respective WR isochrons. The Sm-Nd PX data alone define two separate trends corresponding to 3.4 ± 0.5 Ga ($n = 4$) and 0.92 ± 0.06 Ga ($n = 2$), while the Lu-Hf PX data form a single trend corresponding to 3.8 ± 0.6 Ga ($n = 6$). We suggest that these ages correspond to two major episodes of bombardment in the solar system, both previously recognized on the basis of Rb-Sr and Ar-Ar chronometry of HEDs and chondritic meteorites [1, 3]. While the Lu-Hf isotope system appears to have been reset only during the first event, the Sm-Nd isotope system in some eucrites indicates two major events.

If we use the internal Lu-Hf isochrons for Millbillillie and Juvinas to determine $\gamma^{176}\text{Lu}$ by age comparison [9, 10], we obtain values of approximately 1.87×10^{-11} and $1.92 \times 10^{-11} \text{ y}^{-1}$, respectively. The former value is consistent with the terrestrial $\gamma^{176}\text{Lu}$ value [7, 8], while the latter is consistent with the extraterrestrial value [4–6]. The reasons for these complexities are not completely understood [11], but constraining the isotopic systematics of individual meteorites, such as these eucrites, will ultimately help explain the discrepancy between the terrestrial and meteoritic $\gamma^{176}\text{Lu}$ decay constant determinations.

References: [1] Birck J.-L. and Allègre C. J. 1978. *Earth and Planetary Science Letters* 39:37–51. [2] Tera F. et al. 1997. *Geochimica et Cosmochimica Acta* 61:1713–1731. [3] Bogard D. D. 1995. *Meteoritics* 30: 244–268. [4] Patches P. J. and Tatsumoto M. 1980. *Nature* 288:571–574. [5] Blichert-Toft J. et al. 2002. *Earth and Planetary Science Letters* 204:167–181. [6] Bizzarro M. et al. 2003. *Nature* 421:931–933. [7] Scherer E. et al. 2001. *Science* 293:683–687. [8] Söderlund U. et al. 2004. *Earth and Planetary Science Letters* 219:311–324. [9] Miura Y. N. et al. 1998. *Geochimica et Cosmochimica Acta* 62:2369–2387. [10] Lugmair G. W. and Shukolyukov A. 1998. *Geochimica et Cosmochimica Acta* 62:2863–2886. [11] Albarède F. et al. 2006. *Geochimica et Cosmochimica Acta* 70:1261–1270.

5351

ELEMENTAL MAPS OF MARS FROM THE MARS ODYSSEY GAMMA-RAY SPECTROMETER

W. V. Boynton¹, R. C. Reedy², G. J. Taylor³, and the GRS team. ¹Lunar and Planetary Laboratory, The University of Arizona, Tucson, Arizona 85721, USA. E-mail: wboynton@lpl.arizona.edu. ²Institute of Meteoritics, MSC03-2050, University of New Mexico, Albuquerque, New Mexico 87131, USA. ³Hawai'i Institute of Geophysics and Planetology, University of Hawai'i, Honolulu, Hawai'i 96822 USA

Introduction: Gamma rays that were measured by an advanced Ge spectrometer on the polar-orbiting Mars Odyssey spacecraft [1] have been used to map the distribution of H, Si, Cl, K, Fe, and Th. These gamma rays are emitted from depths to tens of centimeters and are used to infer elemental abundances over footprints with radii of ~500 km or more.

Spectra from June 2002 have been accumulated, processed, and sorted into spatial bins. Many corrections are applied to the data. The final count rates for gamma rays from specific elements are compared to theoretical values to get elemental abundances. Only decay data are needed to model abundances for the naturally radioactive elements K and Th. Computer codes that model the production and transport of neutrons are needed for interpreting the measurements for other elements, with absolute abundances normalized to the silicon abundances measured by Mars Pathfinder [2]. To date for cosmic-ray-produced gamma rays, only regions within about 45° of the equator have been analyzed to avoid regions with high concentrations of H that complicate data analysis. Details on the data processing and many results and interpretations are in a series of papers to be published in *Journal of Geophysical Research*.

Elemental Results: The maps of elemental abundances for H, Si, Cl, K, Fe, and Th all show variations. There are two regions with high abundances of H (about 7% of hydrogen, equivalent to water) near the equator, in Arabia Terra and around Gusev crater. There is a region of low Si abundance west and south of Olympus Mons. Iron tends to be higher in the northern lowlands. Chlorine varies by a factor of ~4 with the highest values in the Medusae Fossae formation west of Tharsis. K and Th correlate well and vary by factors of ~5 and ~10, with most higher abundances in regions of the northern lowlands.

These elemental abundances show some spatial clustering. About 8 regions account for most of the variations [3, 4]. Except for K and Th, these elements do not have strong correlations among themselves. These element abundances do not correlate significantly with geology or other mapped data for Mars.

Future Work: The gamma rays for Ca, Al, S, and U are weak and often have interferences, but some elemental abundances should be obtainable. Analyses of spectra further poleward will involve modeling high H concentrations in wet layers below dry layers. Work will continue on mapping seasonal variations near the poles of enhancements of Ar in the atmosphere and thicknesses of the carbon dioxide caps.

References: [1] Boynton W. V. et al. 2004. *Space Science Reviews* 110: 37–83. [2] Wänke H. et al. 2001. *Space Science Reviews* 96:317–330. [3] Taylor G. J. et al. 2006. Abstract #1981. 37th Lunar and Planetary Science Conference. [4] Gasnault O. 2006. Abstract #2328. 37th Lunar and Planetary Science Conference.