Geophysical Research Abstracts
Vol. 14, EGU2012-11135, 2012
EGU General Assembly 2012

Early differentiation of the silicate Earth : new constraints from isotopic investigation of rocks from the lunar highlands

M. Boyet (1), R. Carlson (2), L. Borg (3), J. Connelly (4), and M. Horan (2)

(1) Laboratoire Magmas et Volcans, UMR CNRS 6524, Universite Blaise Pascale, Clermont-Ferrand France (m.boyet@opgc.univ-bpclermont.fr), (2) Department of Terrestrial Magnetism, Washington, DC 20015-1305 USA, (3) Chemical Sciences Division, Lawrence Livermore National Laboratory, Livermore CA 94550 USA, (4) Centre for Star and Planet Formation, University of Copenhagen, Denmark

The isotopic similarity in O, Mo, W, Si, and Fe between lunar and terrestrial samples suggests that the two planetary bodies were equilibrated in the energetic aftermath of the giant impact that gave birth to the Moon [1]. Coupled 142Nd-143Nd isotope systematics of lunar samples including both low-Ti and high-Ti mare basalts along with KREEP basalts have been used to constrain the age of crystallization of the lunar interior [2-5]. These studies show that the Sm-Nd system in the lunar mantle closed in the interval of 180-250 Ma after the beginning of solar system formation, depending on the model considered for lunar mantle differentiation (1 or 2 stage-model and initial lunar Sm/Nd ratio). Does this age represent the age of Moon formation? A prolonged lunar magma ocean (LMO) might be expected given the insulating effect of the thick plagioclase crust, so closure of the Sm-Nd system in the lunar mantle, particularly in a late stage LMO component like KREEP, might substantially post-date lunar formation. We have recently determined a new age of 4360±3 Ma for the ferroan anorthosite (FAN) 60025 using the 207Pb-206Pb, 147Sm-143Nd and 146Sm-142Nd isotope systems [6]. This study is the first in which a single sample of FAN yielded consistent ages from multiple isotope dating techniques, strongly suggesting that this age indicates the time at which the sample crystallized.

In order to pursue the question of whether Moon formation occurred over 100 Ma after solar system formation, we have investigated a number of lunar rocks sampling the highland crust from both the FAN and the Mg-suite groups. Internal Sm-Nd isochron on the norite 77215 yields an age of 4296±20 Ma, in agreement with the young age determined on 60025. We will show that our new data obtained on the 146Sm-142Nd systematics of the lunar crust support the scenario of a relative young age for the Moon. Thus, these results offer a unique opportunity to better constrain the composition of the terrestrial mantle at the time of the giant impact. Sm-Nd isotope data obtained on the oldest lunar samples will be modelled and compared to the different geochemical estimates proposed for the Hadean mantle composition coming from coupled 146,147Sm-142,143Nd isotope studies performed on both 4.3 Ga old samples from the Nuvvuagittuq greenstone belt [7] and 3.7 Ga old rocks from the Isua Supracrustal Belt [8-11].

[1] Pahlevan and Stevenson, 2007. EPSL 262, 438 ; [2] Nyquist et al., 1995. GCA 59, 2817 ; [3] Rankenburg et al., 2006. Science 312, 1369 ; [4] Boyet and Carlson, 2007. EPSL 262, 505 ; [5] Brandon et al., 2009. GCA 73, 6421 ; [6] Borg et al., 2011. Nature 477, 70 ; [7] O'Neil et al., 2008. Science 321, 1828 ; [8] Boyet et al., 2003. EPSL 214, 427 ; [9] Caro et al., 2003. Nature 423, 428 ; [10] Bennett et al., 2007. Science 318, 1907 ; [11] Rizo et al., EPSL 312, 267.