Geophysical Research Abstracts
Vol. 12, EGU2010-11631-1, 2010
EGU General Assembly 2010

The 238U/235U isotope ratio of the Earth and the solar system: Constrains from a gravimetrically calibrated U double spike and implications for absolute Pb-Pb ages

Stefan Weyer (1), Janine Noordmann (2), Greg Brennecka (3), and Stephan Richter (4)

(1) Institut fuer Geologie und Mineralogie, Universitaet zu Koeln, Germany (sweyer@uni-koeln.de), (2) Institut für Geowissenschaften, Goethe Universität, Frankfurt am Main 60438, Germany (J.Noordmann@em.uni-frankfurt.de), (3) School of Earth and Space Exploration, Arizona State University, Tempe, Arizona 85287, USA (brennecka@gmail.com), (4) Institute for Reference Materials and Measurements, JRC-EU, Retieseweg 111, 2440 Geel, Belgium (Stephan.RICHTER@ec.europa.eu)

The ratio of 238U and 235U, the two primordial U isotopes, has been assumed to be constant on Earth and in the solar system. The commonly accepted value for the 238U/235U ratio, which has been used in Pb-Pb dating for the last $\sim$ 30 years, was 137.88. Within the last few years, it has been shown that 1) there are considerable U isotope variations ($\sim$1.3%■) within terrestrial material produced by isotope fractionation during chemical reactions [1-3] and 2) there are even larger isotope variations (at least 3.5%■) in calcium-aluminum-rich inclusions (CAIs) in meoteorites that define the currently accepted age of the solar system [4]. These findings are dramatic for geochronology, as a known 238U/235U is a requirement for Pb-Pb dating, the most precise dating technique for absolute ages. As 238U/235U variations can greatly affect the reported absolute Pb-Pb age, understanding and accurately measuring variation of the 238U/235U ratio in various materials is critical, With these new findings, the questions also arises of "How well do we know the average U isotope composition of the Earth and the solar system?" and "How accurate can absolute Pb-Pb ages be?"

Our results using a gravimetrically calibrated 233U/236U double spike IRMM 3636 [5] indicate that the U standard NBL 950a, which was commonly used to define the excepted "natural" 238U/235U isotope ratio, has a slightly lower 238U/235U of 137.836 $\pm$ 0.024. This value is indistinguishable from the U isotope compositions for NBL 960 and NBL112A, which have been determined by several laboratories, also using the newly calibrated U double spike IRMM 3636 [6]. These findings provide new implications about the average U isotope composition of the Earth and the solar system. Basalts display a very tight range of U isotope variations ($\sim$0.25-0.32%■ relative to SRM 950a). Their U isotope composition is also very similar to that of chondrites [4], which however appear to show a slightly larger spread. Accepting terrestrial basalts to be the best representation of the U isotope composition of the Earth and the solar system, and the new 238U/235U for SRM 950a of 137.836, this would result in an average 238U/235U for the Earth and the solar system of $\sim$ 137.80. The effect of a revised 238U/235U ratio on Pb-Pb ages is age dependent. It results in an age overestimation of $\sim$0.8 Ma for the age of the solar system and up to 1.5 Ma for very young material (with bulk Earth U isotope composition).

[1] Stirling, C.H., Andersen, M.B., Potter, E.-K., et al. (2007) EPSL 264, 208–225; [2] Weyer, S., Anbar, A. D., Gerdes, A., et al. (2008) GCA 72, 345-359. [3] Bopp, C.H., Lundstrom, C.C., Johnsons, T.M., Glessner, J.G. (2009) Geology 37, 611-614. [4] Brennecka, G.A., Weyer, S., Wadhwa, et al. (2010) Science, 327, p. 449. [5] Richter, S., Alonzo-Munoz, A., Eykens, R., et al. (2008) IJMS 269, 145-148. [6] Richter, S., et al. EGU meeting 2010.