U isotopic composition of Allende chondrules and implications for Pb-Pb geochronology

M. H. HUYSKENS[1], Q.-Z. YIN[1], M. E. SANBORN[1], Y. AMELIN[2], R. MERLE[2], AND K. YAMASHITA[3]

[1]Department of Earth and Planetary Sciences, University of California-Davis, mhuyskens@ucdavis.edu;
2Research School of Earth Sciences, The Australian National University;
3Graduate School of Natural Science and Technology, Okayama University, Japan.

For many solar system materials, the U isotopic composition has been shown to be similar to the bulk Earth. However, some chondrites as well as achondrites, vary from this average and large differences have been found in CAIs. Due to these variations, determining the $^{238}U/^{235}U$ ratio is of special importance when using U-Pb in early solar system chronology, since currently reported variations in the $^{238}U/^{235}U$ ratio can result in an age difference of up to 5 Ma. For chondrules, there are currently $^{238}U/^{235}U$ ratios determined for seven fractions of pooled chondrules [1] and three individual chondrules [2]. To this date, it is not clear if the U isotopic composition of chondrules is homogeneous.

Here, we report the U isotopic composition for the large (>10 mm) chondrule A25-2 from the CV3 chondrite Allende weighing ~3.6 g, for which Pb isotopic data have been previously reported [3]. From this chondrule, 461 mg were dissolved and analysed for U isotopic composition. The $^{238}U/^{235}U$ ratio of the chondrule A25-2 (referred to as megachondrule) was determined to be 137.764±0.016. This is identical, within uncertainty, with $^{238}U/^{235}U$ ratios of three individual chondrules reported previously. However, there is a small difference between the large individual chondrules and small pooled chondrules from Allende. This suggests possible variation in the $^{238}U/^{235}U$ ratio for chondrules, hence assuming a homogeneous U isotopic composition might lead to biased ages. Thus, we propose to use the entire range of U isotopes determined so far for calculation of Pb-Pb ages of chondrules, if direct determination is not possible, which currently leads to an additional uncertainty of 0.59 Ma.

Recalculating the age of the chondrule A25-2 [3] using the determined U isotopic composition results in an age of 4565.58±0.89 Ma (2σ, considering Pb and U analytical uncertainty). This is the first case where both U and Pb isotopes have been determined in a single chondrule.

[1] Brennecka G. A. et al. (2015) *MAPS, 50,* 1995-2002. [2] Connelly J. N. et al. (2012) *Science, 338,* 651-655. [3] Amelin Y. et al. (2014) *LPSC,* A#2646.