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THE AGE OF THE SOLAR SYSTEM REVISITED

M. Wadhwa; [1]; *A. Bouvier;* [1];
1. Arizona State University, Tempe, AZ, USA.

Body: Calcium-aluminum-rich inclusions (CAIs) in chondritic meteorites are believed to be the earliest solids to form in solar protoplanetary disk [1]. As such, their absolute ages have been taken to represent the time of formation of the Solar System. Recently, several high precision Pb-Pb studies of CAIs from the CV3 chondrites Efremovka and Allende have been conducted, and estimates of the Pb-Pb ages for CAIs range from 4567.1 ± 0.1 Ma [2] to 4568.5 ± 0.5 Ma [3]. This age range of ~1-2 Ma is significantly larger than the time interval for CAI formation estimated from 26Al-26Mg isotope systematics [4,5]. To resolve the question of the absolute formation age of CAIs and to, thereby, obtain better constrains on the age of the Solar System, we have conducted high precision Pb-Pb and Al-Mg studies of CAIs from the CV3 meteorites Allende, Leoville and NWA 2364 [6-8]. Our results show that the initial 26Al/27Al ratio in these CAIs at the time of last equilibration of Mg isotopes was, within errors, the same as the canonical value (i.e., ~5 × 10^-5) and that this equilibration event for each of these CAIs occurred within a span of ~300,000 years. We obtained a Pb-Pb internal isochron age for an Allende CAI (based on 3 leached residues of interior fragments and 1 radiogenic leachate having 206Pb/204Pb ratios up to ~3,500) of 4567.6 ± 0.1 Ma (MSWD = 0.2) [6]. For the NWA 2364 CAI, however, we obtained an older Pb-Pb internal isochron age of 4568.7 ± 0.2 Ma (MSWD = 1.4) [7] based on even more radiogenic compositions than those that we obtained for the Allende CAI (3 leached residues of interior fragments and their most radiogenic leachates having 206Pb/204Pb ratios up to ~10,200). This older age is consistent with the Hf-W and Al-Mg model ages of CAIs, if these short-lived chronometers are anchored to the angrite D'Orbigny for which precise Pb-Pb, Al-Mg and Hf-W systematics were recently reported [9-11]. If the older age of 4568.7 ± 0.2 Ma for the NWA 2364 CAI represents the age of the Solar System, it is as yet unclear why the Pb-Pb ages recorded by CAIs analyzed thus far from Allende and Efremovka are resolvably younger. Recent work on high precision U isotope analyses of CAIs has shown that the 238U/235U ratio can vary up to ~3.5 ‰ in Allende CAIs [12], and this could potentially result in an uncertainty of as much as ~5 Ma in the previously determined Pb-Pb ages of CAIs. We are currently evaluating whether variations in U isotope compositions of CAIs may result in the range of CAI ages reported thus far.

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