Hf-W dating of main-group pallasites

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Pallasites are stony-iron meteorites consisting mainly of olivine and FeNi metal, providing us a unique opportunity to study an interior of their parent body. Classically, pallasites have been thought to represent the core-mantle boundary of their parent body, since there are some links with IIIAB irons, which are the representative of the core (e.g. Clayton & Mayeda, 1996). Yet, some recent studies suggest pallasite formed at a shallower region than the core-mantle boundary likely by impact mixing (e.g. Yang et al., 2010; Tarduno et al., 2012). Chronological investigations of pallasites are important since they enable to determine the ages and the timescales of crystallization of pallasite minerals. Although the Al-Mg dating of pallasite olivine yielded a model age of 1.27 Myrs after the CAI formation (Baker et al., 2012), other chronological constraints are still required for resolving the two contrasting models of pallasite formation. Here we apply the Hf-W chronology to four pallasites to constrain when the metal segregated on their parent body. Previously reported W isotopic data of pallasites show a large variation in $\varepsilon^{182/184}$W (Quitté et al., 2005), some of which correspond to the model ages older than CAIs. These isotopic data may reflect multiple causes and effects, such as a nucleosynthetic anomaly, radiogenic and neutron capture effects. We combined the W and the Pt isotopic measurements to evaluate the neutron capture effect which may lead to misinterpretation in age. Also, we measured unradiogenic W isotopes to estimate if the nucleosynthetic anomaly existed in the pallasite parent body. The obtained $\varepsilon^{182/184}$W values corrected for the neutron capture effect by using Pt isotope data range from -3.53 ±0.14 to -3.45 ±0.18, which correspond to the model Hf-W ages of -0.30 ±1.43 to 0.31 ±1.74 Myrs after the CAI formation. Moreover, the $\varepsilon^{183/184}$W values are indistinguishable from the terrestrial value, suggesting that the pallasite parent body accreted in the inner solar system. The model Hf-W ages obtained in this study are coincident with the model Hf-W ages of magmatic irons (Kruijer et al., 2013) and the model Al-Mg age of pallasite olivine, suggesting its magmatic origin rather than impact origin. The implication is that the pallasite metal was originated from the planetary core and was segregated within first 2 Myrs of the solar system evolution.

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