6.1.P02

Fe-isotope composition of pallasites

E. MULLANE[1], S.S. RUSSELL[1] M. GOUNELLE[2] AND T.F.D. MASON[3]

[1] Department of Mineralogy, The Natural History Museum, Cromwell Road, London SW7 5BD (etam@nhm.ac.uk)
[2] CSNSM-Université Paris 11, 91405 Orsay Campus, France
[3] Imperial College, Exhibition Road, London SW7 2BP

Pallasites formed at the core-mantle interface of a differentiated asteroid and comprise a ~50:50 mixture of olivine and FeNi-metal with accessory minerals (e.g. troilite and schreibersite). Three parent bodies can be distinguished [O-isotopes; 1,2], two of which are represented here: (1) Brenham and Imilac (Main group pallasites, PMG), (2) Eagle Station (Eagle Station grouplet, PES). Similarity in features such as metal composition [e.g.3] and O-isotopes [2] indicate that PMG and IIIABs may share a common parent body.

Analytical procedures are given in [4], and precision for the method is <0.09‰ [4]. All samples lie on the mass fractionation line already described for chondrules [5] and other meteorite samples [6]. Olivine signatures are identical to each other within error (δ^{56}Fe = -0.02 to -0.06‰ and δ^{57}Fe = -0.10 to -0.17‰), but metal separates fall between -0.28‰ (Brenham) to +0.16‰ (Eagle Station) for δ^{56}Fe and -0.44‰ to +0.13‰ for δ^{57}Fe. Thus, there is evidence of fractionation between metal and silicate components.

IIIAB iron meteorites and pallasites may share a common parent body where IIIABs are early-crystallized solids and where pallasite metal derives from mixing of evolved IIIAB magma with early-crystallized core or mantle-residue solids [6]. Henbury (IIIAB iron) is isotopically light in comparison to pallasite metal; +0.18‰ (δ^{56}Fe) lighter than Brenham and +0.62‰ (δ^{56}Fe) lighter than Eagle Station [7]. Could evolution of the metallic melt be accompanied by iron isotope fractionation? Certainly, magmatic and post silicate-metal mixing processes were complex, involving segregation of the IIIAB melt by km-sized dendrites [8], variable S content [8] and a highly evolved, oxidizing, magmatic gas phase which interacted with the pallasite components [6]. One, or all of these processes, including variable inclusion content, could have had a bearing on the Fe-isotope compositions of the metal. Further analyses and investigation are underway.

References

[1] Boesenberg J.S. et al. (2000) *Met. Plan. Sci.* **35**, 757-69.
[2] Clayton R.N. Mayeda T.K. (1996) *GCA* **60**, 1999-2017.
[3] Scott E.R.D. (1977) *GCA* **41**, 349-360.
[4] Mullane E. et al. (2003) Plasma Source Mass Spect. Roy. Soc. Chem. p.351-361.
[5] Mullane E. et al. (2003) *LPSC* **XXXIV**, No. 1027.
[6] Wasson J.T. & Choi B-G. (2003) *GCA* **67**, 3079-3096.
[7] Mullane E. et al. (2002) *Met. Plan. Sci.* **37**, 105.
[8] Haack H. & Scott E.R.D. (1993) *GCA* **57**, 3457-3472.

6.1.P03

The ^{182}W record of Earth's accretion and core formation

K. MEZGER[1], T. KLEINE[1], H. PALME[2] AND C. MÜNKER[1]

[1] ZLG, Institut für Mineralogie, Universität Münster, Corrensstr. 24, 48149 Münster, Germany (tkleine@nwz.uni-muenster.de)
[2] Institut für Mineralogie und Geochemie, Universität zu Köln, Zülpicherstr. 49b, 50476 Köln, Germany

The abundance of ^{182}W in Earth's mantle is ~2 ε units higher than in chondrites, indicating that core formation in Earth took place within the life-time of ^{182}Hf [1-3]. This ^{182}W excess provides a firm constraint that core formation in Earth cannot have ceased earlier than ~30 Myr (here, Myr is defined as the time elapsed since the start of the solar system). Estimating the latest time core formation can have terminated needs to take into account the complexities introduced to the Hf-W systematics by protracted accretion and concomitant core formation, resulting in core formation ages that vary from ~30 to more than 100 Myr. Provided that the Moon-forming event is the last large impact, the latest time core formation in Earth can have ceased is given by the age of the oldest lunar samples and is ~70-100 Myr.

The ^{182}W excess of Earth's mantle is substantially smaller than the 15-20 ε_W range expected if Earth's core formed by merging of metal cores of early differentiated planetesimals, indicating significant re-homogenization of newly accreted planetesimals with Earth's mantle. In continuous core formation models that assume growth of Earth at an exponentially decreasing rate, more than ~70 % of the newly accreted material must have equilibrated with Earth's mantle. Including the Moon-forming impact into these models implies more than ~50 % metal-silicate equilibration in the silicate proto-Earth. Such high degrees of metal-silicate equilibration can only be achieved if core formation occurred by the physical separation of liquid metal from mostly molten silicate providing strong support for the hypothesis of a terrestrial magma ocean. Model calculations show that formation of a magma ocean by a late Moon-forming impact is not sufficient in removing radiogenic ^{182}W from Earth's mantle. A high degree of metal-silicate equilibration of at least 50 % must have been established prior to Moon formation, implying that metal segregation in the proto-Earth already occurred in a magma ocean. Therefore, the Moon-forming impact is not the only impact that led to the formation of a magma ocean, indicating multiple formations of magma oceans or a protracted life-time of the magma ocean.

References

[1] Kleine T. et al. (2002) *Nature* **418**, 952-955.
[2] Schoenberg R. et al. (2002) *GCA* **70**, 1523–1529.
[3] Yin Q. et al. (2002) *Nature* **418**, 949-952.