THEME 6: THE EARLY EARTH AND PLANETS

Session 6.3: From dust to planets

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This session collects submissions on the topic of extraterrestrial materials and will focus on determining the processes that occurred in the early solar system, such as the collapse of molecular clouds to proto-planetary disks, the formation of primitive meteorites and their components, and the accretion and differentiation of planetary bodies.

6.3.11

Iron isotope mineral fractionation in pallasites and iron meteorites

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Previous work presented two pallasite data showing a metal fraction with consistently higher $\delta^{57}Fe/^{54}Fe$ than that of the coexisting olivine [1]. Given the implications this might have on our understanding of planetary mantle-core differentiation, we extended this database to other pallasites, iron meteorites and chondrites.

Seven bulk chondrites, with $\delta^{57}Fe/^{54}Fe$ values between –0.1‰ to 0‰ relative to IRMM-14, tend to be slightly lighter than bulk iron meteorites, which have $\delta^{57}Fe/^{54}Fe$ values ranging from 0.04‰ to 0.2‰. At the mineral scale, taenite from two iron meteorites appears to show $\delta^{57}Fe/^{54}Fe$ values heavier by up to 0.3‰ than their kamacite counterpart, thus questioning the significance of bulk iron meteorite data. On three pallasites, we measured a heavier iron isotope composition for the metal fractions compared to olivines like Zhu et al. [1], but the range of $\delta^{57}Fe/^{54}Fe$ differences (from 0.32‰ to 0.07‰) is larger than that originally found. Troilite from two pallasites appears to be even heavier than the metal fraction whereas a schreibersite is lighter than its olivine counterpart. There is thus a general tendency for minerals to show a heavier Fe isotope composition as the coordination number of Fe increases, although troilite is an exception to this rule.

Iron meteorites are classically considered as remnants of asteroid cores and pallasites as core-mantle interfaces. The simultaneous finding that the metal fractions of pallasites have a higher $\delta^{57}Fe/^{54}Fe$ signature than the coexisting olivines, and that the iron meteorites are slightly heavier than chondrites could be an indication that planetary core-mantle differentiation is accompanied by sizeable iron isotope fractionation. In this hypothesis, resultant planetary mantles should be isotopically lighter than the chondritic starting material. That is not observed, however, since all planetary mantles analyzed [2] have $\delta^{57}Fe/^{54}Fe$ values equivalent to or heavier than those of chondrites. It thus appears that the moderate temperature and pressure metal-silicate fractionation that occurred in pallasite parent bodies is not readily transposable to planets as far as Fe isotopes are concerned.

References

[1] Zhu X.K. et al., (2002) *EPSL* **200**, 47-62.
[2] Poitrasson F., Halliday A.N., Lee D.C., Levasseur S. and Teutsch N. (2002). *EOS trans.*, **83**, F846.