THE ORIGIN OF THE PALLASITES EXPLORED USING TRACE ELEMENT ANALYSIS OF SEYMCHAN

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Pallasites are stony-iron meteorites composed of olivine crystals encased in metal and sulfides. The intimate mix of metal and silicates has typically been attributed to pallasites originating from the core-mantle boundary of their parent asteroid. However, paleomagnetic studies suggest that this may not be the case, since the pallasites were cold enough to record an ancient magnetic field generated when the core of their parent body was still molten and convecting [1, 2, 3]. Different formation scenarios have subsequently been proposed, including partial differentiation, formation through an impact that caused an influx of external metal, and ferrovolcanism [4, 5, 6, 7].

Using analogue laboratory experiments, [5] proposed a hybrid scenario in which pallasites formed in a partially differentiated mantle, where the metal started sinking to the centre to form a core. As the temperature increased due to radiogenic heating, the silicates underwent a relatively high degree of partial melting and melt migration to shallower depths, closing off the metal network [8], and leaving behind olivines with metal pockets. Subsequently, the parent body was hit by a differentiated impactor, resulting in incomplete core-merging and an influx of external core metal, and adding a second generation of metal in pallasites – the first generation may be represented by interstitial metal within the olivine aggregates, while the second generation forms interconnected 'matrix' metal.

In order to investigate the validity of this formation mechanism, we have investigated the meteorite Seymchan, which contains the two distinct textures that are suggestive of differing origins (interstitial metal and matrix metal, Fig. 1). For example, if the metals are found to have similar trace element concentrations, this may indicate a shared genetic origin, or a high degree of equilibration within the parent body. On the other hand, if the two types of metal have different trace element genetics which cannot be accounted for by crystallization of the metallic phases, this would argue for the introcution of exogenous metal through an impact on the pallasite parent body.

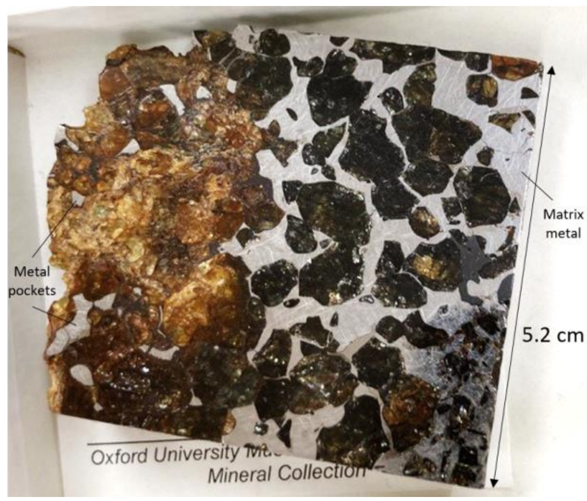

Figure 1. Sample Mt.519 of the pallasite Seymchan (Photo courtesy of the Oxford University Museum of Natural History).

To investigate the potential link between these metals, we analysed the respective trace element compositions of each type of metal, to determine their origins. We present electron probe micro analysis (EPMA) and laser ablation - inductively coupled plasma mass spectrometry (LA-ICP-MS) data on the refractory Fe, Ni, Ir, and Au, and the volatiles Ge, Ga and As contents, which have previously been used to characterise genetic links between different metal populations [9, 10], and we discuss implications for the evolution of the pallasite parent body.

References:
[1] Tarduno, J. A., et al. 2012. *Science* 338.6109: 939-942; [2] Bryson, J.F.J., et al. 2015. *Nature* 517.7535: 472-475; [3] Nichols, C. I. O., et al. 2021. *Journal of Geophysical Research: Planets* 126.7: e2021JE006900; [4] Johnson, B. C., et al. 2020. *Nature Astronomy* 4.1: 41-44; [5] Walte, N. P., et al. 2020. *Earth and Planetary Science Letters* 546: 116419; [6] Kruijer, T. S., et al. 2022. *Earth and Planetary Science Letters* 584: 117440; [7] Windmill, R., et al. 2022. *PNAS Nexus* (Accepted Manuscript Online); [8] Cerantola, V., et al. 2015. *Earth and Planetary Science Letters* 417: 67-77; [9] Goldstein, J. I., et al. 2009. *Geochemistry* 69.4: 293-32; [10] Scott, E.R.D. 1977. *Geochimica et Cosmochimica Acta* 41.3: 349-360.