Mn-Cr SYSTEMATICS OF PALLASITE OLIVINE BY SIMS: CONTRASTING Cr IN BRAHIN AND BRENHAM.

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Introduction: Pallasite meteorites are mixtures of Fe-Ni metal and olivine and would appear to be good candidates for ^{53}Mn-^{53}Cr dating ($t_{1/2}$ 3.7 Ma). However, conflicting ion-probe results have been reported for these rocks, with some workers finding elevated ^{53}Cr/^{52}Cr correlated with ^{55}Mn/^{52}Cr [1, 2] while others do not [3]. Recently, it has been suggested that a statistical effect at low count rates arising from the reduction of data as a series of ratios could introduce positive bias into isotope measurements for some applications [4], leading [5] to retract earlier findings of elevated ^{53}Cr/^{52}Cr in pallasite olivine [1, 2]. To investigate whether in-situ accumulated radiogenic ^{53}Cr exists in these meteorites, we have re-analysed olivine from two petrographically contrasting pallasites: Brahin (which has a fragmental texture), and Brenham (with rounded olivine).

Methods: *In situ* isotopic analysis was performed using Sensitive High-mass Resolution Ion Microprobe Reverse Geometry (SHRIMP-RG) on olivine and chromite from Brahin and olivine from Brenham. The primary sputtering beam was run at high current (17-66 nA as a mixture of O^- and O_2^-) and focused to a ~30 micron diameter spot, giving strong Cr secondary ion beams and hence minimising the effect described by [4]. $^{52}Cr^+$, $^{53}Cr^+$ and $^{55}Mn^+$ were measured with an electron multiplier, and San Carlos olivine was used as an external standard to correct for instrumental fractionation on $^{53}Cr^+/^{52}Cr^+$ and $^{55}Mn^+/^{52}Cr^+$.

Results: We find that olivine and chromite in Brahin has normal Cr isotopic composition within analytical error (~1 ‰ 1σ). In contrast, Brenham olivine shows Cr-isotope excesses (up to 6 ±1‰ 1σ) within a few 10's of microns of olivine rims. These are well correlated with ^{55}Mn/^{52}Cr and imply an initial ^{53}Mn/^{55}Mn of 2.55 (±0.62) × 10^{-5} at the time of isotopic closure of Cr in Brenham olivine rims.

Discussion: Our finding of isotopically normal Cr in Brahin is in agreement with [3], while our initial ^{53}Mn/^{55}Mn for Brenham is even higher than originally reported by [1, 2]. Previous ion-probe studies had 30-250 counts per cycle for $^{52}Cr^+$ over 150 cycles [5], but with higher beam currents and improved ion transmission we have achieved 1-4 × 10^4 counts per cycle, with 80-200 cycles for each analysis. We estimate bias arising from the effect highlighted by [4] to be ~0.1‰ for our measurements.

The contrasting Mn-Cr systematics found here is good evidence for localised Cr-isotope variation in some, but not all, pallasites. The initial ^{53}Mn/^{55}Mn found for Brenham is not compatible with current understanding of extinct nuclide chronology (with Solar System initial ^{53}Mn/^{55}Mn of 9.1 (±1.7) × 10^{-6}; [6]) and probably represents concentration of radiogenic ^{53}Cr at olivine rims. This appears to be related to the arrangement of olivine, with the interconnected networks in Brenham [7] exhibiting anomalous Cr while isolated olivine fragments in Brahin do not.

References: [1] Hsu et al. 1997 28th LPSC, Abstract # 1783. [2] Hsu W. 2005 Geochemical Journal 39, 311. [3] Tomiyama T. et al. 2007 38th LPSC, Abstract # 2007. [4] Ogliore et al. 2011 42nd LPSC, Abstract # 1592. [5] Huss et al. 2011 42nd LPSC, Abstract # 2608. [6] Nyquist et al. 2009 Geochimica et Cosmochimica Acta, 73, 5115-5136. [7] Spinsby et al. 2008 Computers & Geosciences 34, 1-7.