ORIGIN OF SIDEROPHILE VOLATILE ELEMENT FRACTIONATIONS IN IIAB AND IVA IRON METEORITES.

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Introduction: Magmatic iron meteorites are remnants of cores of differentiated asteroids that formed during the first few million years of the solar system. Iron meteorites are classified by their mass fractions of siderophile elements (e.g. Ir, Au, Ga, Ge) which are correlated as a result of fractional crystallization. Their trace element abundances and fractionation trends define distinct groups [e.g. 1]. Each of these groups reflects a single parent body with different volatile element contents (e.g. Ga, Ge). In order to understand the fractionation processes of the siderophile volatile elements (SVE) Ag, Te, Se, S, Cd, In and Tl in the parent bodies, we determined the concentrations of these elements along with highly siderophile elements (HSE; Ir, Ru, Pt, Pd) in the relatively volatile-rich IIAB and the volatile-poor IVA iron meteorites. Fractional crystallization models for the IIAB and IVA iron meteorite cores were applied to determine the initial composition of SVE and HSE in the liquid core and to further constrain the composition of these elements in the parent bodies prior to metal-silicate segregation. The newly derived SVE and HSE abundances of the undifferentiated parent bodies are compared with non-carbonaceous meteorites, because Δ^{17}O-ε^{54}Cr genealogy links IIAB to ureilite/acapulcoite-lodranite [2] and IVA to the LL chondrite field [3].

Samples and Method: 10 IIAB and 12 IVA iron meteorites were selected to cover approximately the entire known compositional range of the IIAB and IVA iron meteorite cores. Iron meteorite chips were digested in reverse aqua regia along with a mixture of spike solutions in an High-Pressure-Asher (Anton Parr HPA-S) at 250 °C (P~100 bar) for 16 h. The elements of interest were purified by a three-step anion-cation exchange chromatography procedure, modified from [4,5]. Element analyses were conducted on an ELEMENT XR sector field ICP-MS at Freie Universität Berlin, using hydride generation, Aridus II and Scott type spray chamber sample introduction systems.

Results and Discussion: SVEs in IIAB and IVA iron meteorites are depleted to varying degrees compared to modeled core compositions assuming chondritic parent bodies. Silver, Te and Se concentrations in IIAB iron meteorites correlate in logarithmic plots with HSEs, whereas this is not the case for IVA iron meteorites. Concentrations of In and Tl in IIAB and IVA irons are homogeneous within analytical uncertainty and are decoupled from other elements. Mass fractions of trapped sulfides in the analysed IIAB and IVA bulk iron meteorites are ≤0.1 % and were determined by a simple mass balance, assuming the entire amount of S remained in the melt during fractional crystallization. Mass balance calculations using metal-sulfide partition coefficients of SVE show that the contribution of SVE in trapped sulfides in bulk iron meteorites are negligible (<1 %). Fractional crystallization models considering entrapment of metal melt [6] were constrained by parametrization from [7], assuming that the effect of C on solid metal-liquid metal partition coefficients of HSE are negligible. An initial S content of 17 and 3-9 wt.% [8] and an initial P content of 1.0 and 0.25 wt.% [9,10] were assumed for the IIAB and IVA cores, respectively. Fractional crystallization of the SVE was modeled for the IIAB iron meteorite core by linear correlation ("slope method", e.g. [11]) with Pd, and indicate that Ag, Te and Se are moderately incompatible in solid metal relative to liquid metal, while In and Tl were unaffected by fractional crystallization. In contrast, heterogeneous distribution of Ag, Te and Se in IVA iron meteorites cannot be explained by fractional crystallization of metal alone and may suggest that the IVA iron meteorite core underwent protracted admixing of Fe-Ni metal melts with a heterogeneous and depleted SVE composition to an early formed FeNi-FeS core [12]. SVE depleted compositions of the parent bodies were likely caused by early volatile loss during a magma ocean stage or volcanic outgassing under reducing conditions or even earlier during volatile loss from the solar nebula.

References: [1] Scott E. D. R. and Wasson J. T. (1975) *Reviews of Geophysics and Space Physics* 13(4):527-546. [2] Anand A. et al. (2022) *LPS LIII*, Abstract #1891. [3] Anand A. et al. (2021) *MetSoc LXXXIV*, Abstract #6154. [4] Wang Z. and Becker H. (2013) *Geostandards and Geoanalytical Research* 38:189-209. [5] Wang Z. et al. (2014) *Geostandards and Geoanalytical Research* 39:185-208. [6] Chabot N. L. and Zhang B. (2021) Meteoritical and Planetary Science 57(2):200-227. [7] Chabot N. L. et al. (2017) *Meteoritical and Planetary Science* 52(6):1133-1145. [8] Chabot N. L. (2004) *Geochimica et Cosmochimica Acta* 68:3607-3618. [9] Jones J. H. and Drake M. J. (1983) *Geochimica et Cosmochimica Acta* 47:1199-2109. [10] Scott E. R. D. et al. (1996) *Geochimica et Cosmochimica Acta* 60:1615-1631.[11] McCoy T. J. et al. (2011) *Geochimica et Cosmochimica Acta* 75:6821-6843. [12] Kruijer T. S. et al. (2014) *Science* 344(6188):1150-1154.