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Trace Element Systematics for Meteoritic Pentlandite-Pyrrhotite Partial Melting Experiments

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We are conducting a series of partial melting experiments with synthesized pentlandite-pyrrhotite assemblages doped with a suite of trace elements: PGEs, W, Au, Cu, Mo, As, Sn, Se, Te, Sb, and Ge in concentrations ranging from 10-200 ppm, corresponding to their relative proportions in the sulphides of oxidized chondritic assemblages (i.e., Rumuruti-type chondrites). These experiments are designed to provide trace element distribution coefficients for modeling sulphide melt fractionation in asteroids and to identify achondrite meteorites that preserve trace element signatures of this process. This study will also provide a method to assess the geochemical evolution of segregated sulphide melts that constitute the cores of oxidized asteroids [1-2] by quantifying trace element systematics between pentlandite-rich melts and precipitated Ni-rich metal. While no sulphide meteorites have been reported in the meteoritic record, some Ni-rich iron meteorites may preserve trace element signatures indicating that they formed in equilibrium with a S-rich liquid [e.g., 2]. Additionally, these new trace element distribution coefficients may also be applied to investigations of terrestrial magmatic sulfide ore deposits.

Sulphides were synthesized by doping elemental sulphur powder with standard trace element solutions and mixing with Fe and Ni metal powders in suitable proportions for chondritic pentlandite-pyrrhotite assemblages. Mixtures were sealed in evacuated silica glass tubes and placed vertically in a box furnace for 48 hours at temperatures between 900-1,040°C to observe the distribution of trace elements during partial melting of sulphides below the chondrite silicate eutectic temperature. The silica glass assembly was quenched in water at the end of each run, and the run products were extracted and prepared for analysis with EPMA and LA-ICP-MS. We have also developed a new analytical standard for analyzing this suite of elements following the same experimental methods to produce pyrrhotite with 4.95 wt% Ni, then sintering the sulphide standard powder at 0.5 GPa and 900°C for 8 hours. We will report on the experimental results, as well as the analytical parameters of our new sulphide standard for laser ablation and its availability to the scientific community.

[1] Crossley et al. (2020) *MAPS* 55: 2021-2043 [2] Crossley et al. (2023) *MAPS* doi:10.1111/maps/13959.