ELEMENTAL VOLATILITY DURING VACUUM MELTING OF MARTIAN METEORITE NWA 8114.

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Introduction: Elemental volatility is a fundamental process whenever condensed materials are subjected to high temperatures, either in the solar nebula or in subsequent planetary impacts. However, the rules governing volatility remain poorly understood outside of reducing nebular contexts. Condensation from gases more oxidizing than canonical solar nebula conditions is known to volatilize elements that are refractory under nebular conditions, e.g., V, Ba, Ce, W and U [1]. Vacuum evaporation is known to create locally oxidizing environments which have been experimentally investigated for REE fractionation [2]. Uranium loss from Australasian tektites has been observed [3]. Analyses of the CB chondrite Gujba have demonstated that Ba, Ce, W and U behaved as volatile elements during a possible impact event [4]. Here, we present the results of a vacuum heating experiment performed on Martian meteorite NWA 8114, paired with NWA 7533 for which we have bulk compositions [5], that demonstrate extreme losses of U and volatile elements.

Experimental and Analytical: Laser heating for Xe extraction was performed on three aliquots of NWA 8114 at RELAX [6-7]. Samples were laser heated in 13-20 steps, 3-5 steps beyond the melting point, in vacuum ~1E-9 mbar, until Xe was no longer evolved. The residual glass bead was mounted in epoxy and analyzed by LA-ICP-MS (FSU) for >60 elements using a 100 μm spot, ablated for 20 seconds at 50 Hz [4-5].

Results: The three glasses were chemically similar in many major and refractory trace element abundances to NWA 7533 [5], with the exceptions of Ba and Bi which were enriched (contamination?). Among elements refractory under nebular conditions, w.r.t. bulk NWA 7533, U was depleted from 0.001-0.02; W was depleted 0.1-0.25; V was depleted 0.3-0.7. Abundances of Fe and Mn were identical (±1-3%) to bulk NWA 7533, but Na, K, Rb, P, Cu, Zn, Sn and Tl were depleted to <0.01 of their original abundances. A severe loss of Ni (<0.01), some loss of Cr and Co, but none of Fe, imply that some siderophile component may have been lost to the container walls. This complicates the interpretation of losses of volatile chalcophile or siderophile (Ga, Ge) elements, but As, Mo, Ag, Cd, Sb and Pb showed an order of magnitude less depletion than Na, P and Zn.

Discussion: This vacuum melting experiment was not controlled for heating temperatures or durations, but monitored for Xe evolved. The severe depletions of U, Na and Zn indicate that U is extremely volatile under oxidizing conditions which may have implications for impact melts. No resolvable Ce anomalies were produced, implying that U is far more volatile than Ce under these conditions and comparable to Zn in volatility under superheated, oxidizing conditions.

References:

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