TRACE ELEMENT COMPOSITIONS OF NORMAL, DUSTY, AND CLEAR OLIVINE IN CHAINPUR CHONDRULES.

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Introduction: As part of a continuing study of trace-element compositions of olivine in chondrules from UOCs such as Sahara-97210 (LL3.2) and Chainpur (LL3.4) [1], we have obtained the first trace element data for dusty olivine and coexisting clear olivine, in addition to normal igneous olivine, in chondrules from Chainpur. Dusty olivine contains micron-sized Ni-poor metal dust and is widely agreed to have formed by FeO-reduction of olivine during chondrule formation [2,3].

Dusty and clear olivines: We analyzed two porphyritic-pyroxene-olivine (PPO) chondrules that contain dusty-metal-bearing olivine and clear olivine. The clear olivine shows normal Fe-Mg zoning. The dusty and clear grains have the lowest concentration of Ni (10-22 and 16-34 µg/g, respectively) of all olivine analyzed to date, much lower than in normal igneous olivine from Chainpur (124 ± 35 µg/g, N = 13). Co contents are also low in both dusty and clear olivine (~6-12 and ~5 µg/g, respectively) compared to normal igneous olivine in Chainpur (25-130 µg/g). Low Ni and Co contents in dusty olivine were found despite analyzing metal dust with SIMS (~2 wt% overall in the dusty olivines, as inferred from EMPA data), indicating the olivine must be highly depleted in these elements. The P content of clear olivine (14-26 µg/g) is significantly lower than in coexisting dusty olivine (130-230 µg/g), and lower than in normal igneous grains (range 25-1000 µg/g, mean ~300 µg/g).

Formation of the PPO chondrules: Clear olivine probably formed by igneous crystallization from melts that were produced during the reheating event that caused metal dust to exsolve in dusty olivine. Similar, and low, abundances of Ni and Co in the dusty and clear olivine implies that they equilibrated with melt under reducing conditions sufficient to cause metal saturation and low $D^{ol/melt}$ values, corresponding to fO_2 values less than 3.9 log units below the CCO and NNO buffers [4]. This is consistent with the observed Fa contents of olivine (Fa_{4-9}) in the chondrules. Evidently, normal olivine crystallized with higher $D^{ol/melt}$ and fO_2 values, leading to higher Ni and Co contents. The low P content in clear olivine is also attributed to formation under low fO_2, but evidently P in the dusty olivine was out of equilibrium with the chondrule melt. Heating during chondrule formation must have been sufficiently long to allow Ni and Co to diffuse out of the dusty olivine, but not so long as to allow P to diffuse out. Based on Ni and Co diffusion data [5] and the size of the dusty relicts, this heating duration is estimated as about a few hours.

References: [1] Ruzicka A. and Floss C. (2004) *Lunar Planet Sci. XXV*, #1422. [2] Leroux H. et al. (2003) *Meteorit. Planet. Sci*. 38, 81-94. [3] Jones R.H. and Danielson L.R. (1997) *Meteorit. Planet. Sci.* 32, 753-760. [4] Ehlers K. et al. (1992) *Geochim. Cosmochim. Acta* 56, 3733-3743. [5] Morioka M. (1981) *Geochim. Cosmochim. Acta* 45, 1573-1580.