CHEMICAL AND OXYGEN ISOTOPIC VARIABILITY OF ACCRETIONARY RIM AND MATRIX OLIVINE IN ALLENDE: DIFFUSION-CONTROLLED PROCESS.

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Introduction: Accretionary rims (ARs) in CV chondrites are porous, non-equilibrium assemblages of fine-grained olivine that occur around chondrules and Ca-Al-rich inclusions (CAIs) and resemble the matrix of each meteorite [1]. The correlation of chemical and oxygen isotopic compositions with rock properties provides powerful constraints on the environment and conditions of olivine formation and subsequent evolution. We thus examined the petrography, mineralogy and *in situ* O isotopic composition of olivine in ARs and the matrix of the CV chondrite Allende and compared them to rock porosity and grain size.

Results: We studied olivine from the AR around two fluffy type-A CAIs (TS24F1 and TS25F1) and around one porphyritic olivine pyroxene chondrule. Around CAIs, the AR present a layered structure of two to three layers that differ in olivine grain size and mineral chemistry [1,2]. The inner layer usually consists of relatively coarse-grained (20-50 µm) forsterites, whereas the middle and outer layers consist of typically matrix fine-grained fayalitic olivine laths (5-10 µm). Chondrules only exhibit a single layered AR similar to the outer layer around CAIs [3]. There is a progressive and continuous variation in olivine composition from ^{16}O-rich forsterite (Fa_1; $\Delta^{17}O \sim -25$ ‰) to ^{16}O-poor fayalite (Fa_{45}; $\Delta^{17}O \sim +1$ ‰), suggesting mixing between two reservoirs. There is also a progressive increase in fayalite and $\Delta^{17}O$ values with decreasing grain size. Regardless of layer location, the finest grains (<5 µm) are the most FeO-rich and ^{16}O-poor, whereas grains in the intermediate size range (5-15 µm) are equally enriched in FeO as the finest grains but are still ^{16}O-rich.

Discussion and Conclusions: The variation in FeO and isotopic composition with grain size is typical of a diffusion-controlled process, with faster exchange for Fe than for O. Fe-Mg [4] and O [5] diffusion models under anhydrous conditions indicate that Allende olivine probably exchanged Fe-Mg and O isotopes at temperatures around 450˚C and 550˚C, respectively, for a time scale of 1 My. Under similar time-temperature constraints, models predict complete Fe and O equilibration for <5 µm grains; only 50% O equilibration and almost full Fe equilibration for 10-15 µm grains; and minimal exchange (<10%) for larger grains (>20 µm), in agreement with observations of Allende olivine. The distribution of chemical and isotopic heterogeneities indicates that these signatures usually vary among layers, with a continuous increase in fayalite and $\Delta^{17}O$ values in the direction of the matrix. These signatures are higher in those areas where the rock is more porous, reflecting not only a grain size effect but also a rock fabric control. In summary, the correlation of porosity and grain size with composition appears to indicate a strong control of rock properties on the exchange process, suggesting it occurred in the parent body. During fluid assisted metamorphism [6], initially ^{16}O-rich forsterite probably exchanged *in situ* with an FeO-rich and ^{16}O-poor fluid reservoir.

References: [1] MacPherson G. J. et al. 1985 *GCA, 49,* 2267-2279. [2] Cosarinsky M. et al. 2002 *Meteorit Planet. Sci.* 37:A38. [3] Cosarinsky M. et al. 2003 *Meteorit Planet. Sci.* 38:A64. [4] Chakraborty S. 1997 *J. Geophys. Res*. 102: 4119-4128. [5] Gérard O. and Jaoul O. 1989 *J. Geophys. Res*. 94: 12317-12331. [6] Krot A. N. et al. 2003 *Meteorit Planet. Sci.* 38:A73.