

INSIGHTS INTO FE-NI METAL SURVIVAL IN THE HYDRATED FINE-GRAINED RIMS IN THE Y791198 CM2 CARBONACEOUS CHONDRITE.

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Introduction: Fe-Ni metal grains occur juxtaposed against hydrous secondary minerals in fine-grained rims around chondrules, etc. in the weakly altered CM chondrite, Yamato 791198. These metal grains have been cited as conclusive evidence for pre-accretionary alteration [1,2]. In contrast, a number of lines of evidence have been reported that cannot be adequately explained by nebular or pre-accretionary alteration, e.g., [3-5]. In an effort to resolve this controversy, we have undertaken a SEM and TEM study of the Fe-Ni metal grains in the fine-grained rims of Y791198.

Results: Fe-Ni metal grains in Y791198 fine-grained rims are both rare (1-2 grains per rim) and very small (<10 μ m). We are applying focused ion beam (FIB) techniques to prepare site-specific TEM sections of Fe-Ni metal grains. So far, we have studied one FIB-prepared metal grain (~4 μ m) using a variety of TEM techniques. These studies demonstrate conclusively that the metal grain shows clear evidence of alteration at the sub- μ m level. Z-contrast STEM imaging shows that locally the grain has developed reentrant features, a few 10s of nm in depth, similar to Fe metal that has experienced pitting corrosion [8-11]. These reentrant features have a lower Z than the rest of the metal grain and show an O-enrichment in EFTEM maps that is consistent with local oxidation of the Fe.

Discussion: These observations are evidence that metal grains in Y791198 have undergone aqueous alteration, although the extent of alteration is extremely limited. We propose that the limited extent of reaction can be explained by considering the geochemical behavior of altering fluids. Computer modeling of aqueous alteration in CM chondrites [6] suggests that immediately after fluid-rock contact, the pH of the fluid soared from 7-9 and then continued to rise to 12. This effect can be attributed to the rapid consumption of H⁺ ions required for hydrolysis of the precursor anhydrous materials, which may have been amorphous [7]. Studies of the corrosion behavior of Fe metal in alkaline solutions [8-11] show that increases in pH (>10) result in a significant increase in corrosion resistance. Also, the corrosion susceptibility is inversely proportional to Ni-content and as little as 2wt% Ni is needed to inhibit corrosion [8]. Corrosion resistance is a result of formation of a protective film [8] and the presence of organics, HCO₃⁻ and dissolved silica act to inhibit corrosion [9-11]. The corrosive effects of dissolved sulphide and Cl⁻ are neutralized in alkaline solutions [9]. These observations show that the presence of Fe-Ni metal grains is not definitive evidence for pre-accretionary alteration. Instead, the resistance of metal grains during the early stages of alteration is consistent with the predicted increase in alkalinity of the early fluid. This is also congruent with the observation that the FIB-prepared metal grain is not pristine, but shows evidence of incipient alteration. These results are entirely consistent with an early, alkaline stages of parent body alteration, as modeled by [6].

References: [1] Metzler *et al.* (1992) *GCA* **56** 2873. [2] Lauretta *et al.* (2000) *GCA* **64** 3263. [3] Tomeoka & Buseck (1985) *GCA* **49** 2149. [4] Hanowski & Brearley (2000) *MAPS* **35** 1291. [5] Browning *et al.* (1996) *GCA* **60** 2621. [6] Zolensky *et al.* (1989) *Icarus* **78** 411. [7] Chizmadia & Brearley (2003) *LPSC XXXIV*. [8] Whitman (1924) *Ind. & Engr. Chem.* **16** 665. [9] Mao *et al.* (1994) *Corrosion* **50** 321. [10] Amaral & Muller (1999) *Corrosion* **55** 17. [11] Malik (1995) *Corrosion* **51** 321. **Acknowledgements:** Funded by NASA grant NAG5-9798 (A. J. Brearley, PI).