ORIGIN OF FERROAN OLIVINE IN MATRICES OF UNEQUILIBRATED CHONDRITES.

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Ferroan olivine (*fa*, $Fa_{50–100}$) is one of the major minerals in matrices of unequilibrated ordinary (UOCs) and carbonaceous (CV, CK, CO) chondrites. Two classes of models, nebular and asteroidal, have been proposed to explain its origin. According to the nebular models, matrix *fa* formed by gas-solid condensation under highly-oxidizing conditions resulted from evaporation of dust±ice-enriched nebular regions during chondrule formation [1]. Recent thermodynamic calculations, however, do not support these models [2]. According to the asteroidal models, matrix *fa* formed during fluid-assisted thermal metamorphism on the chondrite parent asteroids [3,4]. These models are consistent with the mineralogical observations and O- and ^{53}Mn-^{53}Cr isotope systematics of *fa* in CVs and MAC 88107 (ungr.) [3–7]. Here we report on the mineralogy and O-isotope compositions of *fa* in matrices of UOCs; ^{53}Mn-^{53}Cr measurements are in progress.

Ferroan olivine ($Fa_{60–99}$) is found in several textural occurrences in Ngawi: (*i*) 1–10 µm-sized grains in fine-grained rims around type I chondrules containing abundant opaque nodules composed of magnetite (*mgt*), Fe-Ni sulfide (*sf*), Ni-rich metal, and Fe-Ni carbides in their peripheries; (*ii*) *fa*±*mgt*±*sf* veins crosscutting fine-grained rims around chondrules; (*iii*) *fa* replacing opaque nodules in chondrule peripheries; (*iv*) *fa*+phyllosilicates replacing chondrule mesostasis; and (*v*) isolated coarse (10–30 µm) grains and grains overgrowing opaque nodules in the matrix. Coarse *fa* grains commonly contain inclusions of *sf* and *mgt* and show the inverse chemical zoning: fayalite content decreases towards the edges of the grains, suggesting Fe-Mg interdiffusion during thermal metamorphism. The similar textural occurrences of *fa* are found in fine-grained rims and matrices of QUE 97008, EET 90161 (L3.05), MET 96503 (L3.1), and MET 00452 (H3.5). The Δ^{17}O value of Ngawi *fa*, ~5‰, measured *in situ* by the UH Cameca ims-1280 is similar to those of coarse *mgt* grains in Ngawi and Semarkona [7].

These and previously published observations of the mineralogy and isotopic compositions of *fa* in matrices of metamorphosed ordinary and carbonaceous chondrites [3–7], and the nearly complete absence of *fa* in matrices of unmetamorphosed chondrites and cometary IDPs, support origin of matrix *fa* during fluid-assisted thermal metamorphism. ^{53}Mn-^{53}Cr and O-isotope studies of matrix *fa* in UOCs and CCs can be used to constrain time of aqueous alteration and, in combination with D/H measurements of organics and phyllosilicates, sources of water ice (inner *vs.* outer disk) that accreted into their parent asteroids [8].

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