TRACE ELEMENT TRENDS IN WINONAITE PYROXENES: EQUILIBRATION OF HETEROGENEOUS PRECURSORS.

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Introduction: Winonaites and silicate inclusions from IAB iron meteorites formed on a common parent body that may have undergone partial melting and incomplete differentiation, followed by impact breakup and reassembly of the debris [1, 2]. We are studying the trace element distributions of individual minerals from these meteorites to evaluate the roles that silicate partial melting and metamorphism played in their formation.

Results: The meteorites we have studied to date span the range of grain sizes seen in winonaites, from Pontlyfni, which has a fine-grained (~75 μm) equigranular texture, to HaH 193, which consists of very coarse-grained (up to 5 mm) poikilitic orthopyroxene grains enclosing smaller grains of olivine, plagioclase and clinopyroxene [3, 4]. Although variable REE patterns in apatite, similar to those seen in some lodranites [5], may suggest redistribution of the REE, trace element abundances in pyroxenes define distinct uniform groups within a given meteorite. Among the winonaites, however, some systematic trends are evident. Abundances of Ti, Zr, Mn, Y, Cr, Sc and V are lowest in both clino- and orthopyroxene from Pontlyfni and are highest in the pyroxenes from Winona. Mount Morris and HaH 193 pyroxenes have intermediate abundances of these elements. While depletions of highly incompatible trace elements such as Ti, Zr and Y, suggest melt removal [e.g., 5], the concurrent depletions in Mn, Cr, Sc, and V (elements that are more compatible in pyroxene) suggest more complex processes. Moreover, pyroxenes from NWA 1463, the most primitive winonaite [6], and Tierra Blanca are similar to those of Mount Morris and HaH 193 for most trace elements, but have distinctly higher Mn, Cr and V.

Discussion: The distinct trace-element groupings in winonaite pyroxenes suggest equilibration of minerals with initially heterogeneous and distinct compositions, rather than partial melting of a compositionally homogeneous precursor. In addition, the systematic trends among the winonaites are decoupled from their mineralogies. Whereas the lodranites exhibit mineralogical indications of silicate melt removal (e.g., depletion of plagioclase) consistent with their incompatible trace element depletions [5], the winonaites studied here all have approximately chondritic silicate mineral abundances [4]. Moreover, Pontlyfni, with the lowest incompatible trace element abundances, contains plagioclase- and clinopyroxene-enriched areas that have been interpreted as silicate partial melts [1], whereas the trace element-rich Winona contains coarse olivine that could represent a partial melt residue [1]. Impact brecciation and mixing of lithologies, followed by varying degrees of metamorphism in different parts of the parent body, may have obscured early partial melting trends.

References: [1] Benedix et al. (1998) GCA 62, 2535. [2] Benedix et al. (2000) MAPS 35, 1127. [3] Floss et al. (2003) MAPS 38, A22. [4] Floss et al. (2006) Am. Mineral., submitted. [5] Floss (2000) MAPS 35, 1073. [6] Benedix et al. (2003) MAPS 38, A70.