WINONAITE PETROGENESIS: FIRST RESULTS FROM TRACE ELEMENT DISTRIBUTIONS. C. Floss[1], S. Colton[1,2], J. Reid[1], G. Crozaz[1], B. Jolliff[1] and G. Benedix[1], [1]Dept. of Earth and Planetary Sciences, Washington University, St. Louis, MO 63130, USA; [2]Southwest Research Institute, San Antonio, TX 78249, USA; (email: floss@wuphys.wustl.edu).

Introduction: Winonaites are primitive achondrites related by oxygen isotopes to silicate inclusions in IAB iron meteorites [e.g., 1-3]. One detailed model of their origin [2,3] suggests they underwent limited partial melting, followed by impact breakup and reassembly of the parent body. Mixing of unmelted to partially melted silicate material and molten metal was followed by extended metamorphism during slow cooling of the re-accreted body.

We are using the ion probe to study trace element distributions in individual minerals from winonaites and IAB silicate inclusions in order to constrain the origins of these meteorites and their relationships to one another. In particular we will evaluate the roles silicate partial melting and metamorphism may have played on their parent body. Here we report on three winonaites, Winona, Tierra Blanca and Hammadah al Hamra (HaH) 193.

Results: Tierra Blanca is coarse-grained (~200 µm) with large poikilitic calcic pyroxenes [2,4] that enclose smaller olivine, orthopyroxene and plagioclase grains. Winona is finer-grained (~100 µm) with equigranular textures, but contains regions dominated by coarse-grained (300–500 µm) olivine, interpreted as partial melt residues by [2]. HaH 193 has not been studied and we report on its petrology and mineralogy in a companion abstract [5]. Our section contains large poikilitic orthopyroxenes enclosing olivine, plagioclase and clinopyroxene; it also contains large grains of the amphibole edenite that seem to be of pre-terrestrial origin [5].

REE compositions in plagioclase show some variability, but have similar ranges in all three meteorites. However, REE and other incompatible trace element (e.g., Ti, Y, Zr) abundances in orthopyroxene and clinopyroxene show distinct ranges with little or no overlap. There are no consistent trends among the three meteorites, but abundances of incompatible trace elements (including the REE) are highest in the clinopyroxene and orthopyroxene of Winona. Apatites in HaH 193 have flat to somewhat LREE-rich patterns with negative Eu anomalies, as typically observed for this mineral, but in Winona they show a continuum of patterns from LREE-rich with negative Eu anomalies to HREE-rich with slight positive Eu anomalies, similar to those seen in some lodranite phosphates [6].

Discussion: The trace element data so far provide only limited support for silicate partial melting. Most compelling are the variable REE patterns in apatite from Winona combined with elevated trace element abundances in pyroxenes, which suggest some melting and redistribution. However, the pyroxene data from the other winonaites may be more consistent with equilibration of initially heterogeneous minerals in compositionally distinct regions of the winonaite parent body. Furthermore, trace element compositions of coarse olivines in Winona do not differ from those of finer-grained olivines, although depleted abundances are expected if the former are indeed partial melt residues, as suggested by [2]. A complicating factor is that the winonaites seem to have experienced complex histories, including impact brecciation and metamorphism, which may have obscured or modified trends due to partial melting.

References: [1] Clayton and Mayeda (1996) GCA 60, 1999. [2] Benedix et al. (1998) GCA 62, 2535. [3] Benedix et al. (2000) MAPS 35, 1127. [4] King et al. (1981) Met. 16, 227. [5] Floss et al. (2003) this vol. [6] Floss (2000) MAPS 35, 1073.