REEVALUATING THE UNBRECCIATED EUCRITES FOR EVIDENCE OF METASOMATISM.

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Introduction: Duke and Silver [1] were the first to observe the breakdown of pyroxene to silica and troilite within eucrites. This reaction was not attributed to metasomatism until many decades later; however, now, metasomatism in eucrites has been identified by many authors [e.g. 2,3,4,5,6,7,8,9]. Barrat et al. [4] created a three-stage classification scheme that describes progressive metasomatism within the eucrites: Stage 1 results in Fe-enrichment along fractures in pyroxene; in Stage 2, fayalitic olivine veinlets form; Stage 3 sees the development of Fe-rich, but Al-depleted pyroxenes and the formation of secondary Ca-rich plagioclase. Both fluid-driven [4,8,9] and vapor-driven alteration [10] have been suggested as mechanisms for the metasomatic alteration.

Old Data, New Age: The eucrite collection is dominated by equilibrated samples, as the Eucrite Parent Body (EPB; Vesta), is widely believed to have undergone a late-stage, widespread, perhaps even global, metamorphic event [11,12]. However, metasomatism is found primarily in unequilibrated eucrites [4,7,13]. Almost ten years ago, Mayne et al. [14], surveyed the unbrecciated eucrite population and presented data on 31 different eucrites, but metasomatism was not considered in their description of these samples. In this study, we reevaluate the data from [14] to examine the evidence for metasomatism in the unbrecciated eucrites.

In the first round of analysis, all unequilibrated or partially-unequilibrated eucrites were identified using the criteria outlined in [14]. 12 eucrites were selected for review: Queen Alexandra Range (QUE) 99033, Graves Nunataks (GRA) 98098, Grosvenor Mountains (GR0) 95533, Queen Alexandra Range (QUE) 94484, Elephant Moraine (EET) 92004, Pescora Escaprment (PCA) 91078, Elephant Moraine (EET) 90029, Lewis Cliff (LEW) 88010, Lewis Cliff (LEW) 88009, Pescora Escaprment (PCA 82501), Allan Hills (ALH) 81001, and MacAlpine Hills (MAC) 02522. The data was reevaluated using the following procedure: (1) SEM mineral maps of each sample were examined for textural evidence of metasomatism, such as the breakdown of pyroxene to silica and troilite. (2) Electron microprobe analyses (EMPA) of pyroxene were mapped to their recorded locations in each sample. Analyses close to fractures were compared to those in pyroxene cores to identify if they were Fe-rich (Stage 1 metasomatism). (3) All EMPA analyses were plotted to identify any Fe-rich, Al-poor pyroxenes (Stage 3 metasomatism). Textural and mineralogical evidence of metasomatic features (breakdown of pyroxene) was identified in GRO 95533, QUE 94484, EET 90029, and PCA 82501 (Figure 1); however, none of the unbreccaited eucrites examined showed Stage 1-3 metasomatism.

Comparison: All samples in the eucrite literature that have Stage 1 and 2 metasomatism are brecciated eucrites (monomict or polymict). The effects of early-stage metasomatism in terrestrial systems is strongly controlled by the ability of fluids to permeate the rock; it is possible this also holds true for Vesta, where the fractures from impacts make it easier for the metasomatizing fluid to travel. The breakdown of pyroxene to silica and troilite, which is likely vapor-controlled [10], is observed in the unbrecciated unequilibrated eucrites. This suggests that there may be several controls on the metasomatism of eucrites and that both fluid- and vapor-driven alteration occur in different populations of eucrites.

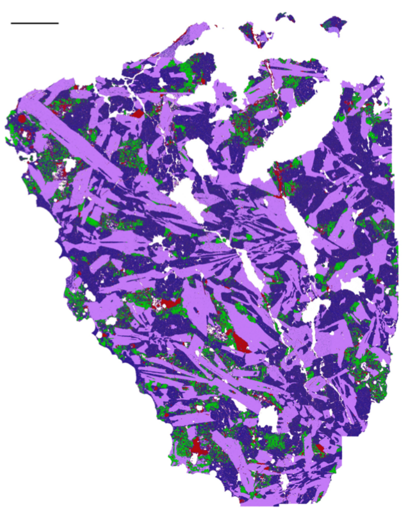

Figure 1: SEM mineral map of QUE 94484. Pink=plagioclase, purple=pyroxne, green=silica, red=oxides/sulfides. Areas rich in silica and sulfides are formed from the breakdown of pyroxene during metasomatism. Scale bar is 1mm.

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