THE PECORA ESCARPMENT (PCA) 91020 EL3 CHONDRITE AND THE EL3 PARENT ASTEROID. Y. Boleaga[1,2], M. K. Weisberg[2,3,4], D. S. Ebel[3,4], [1]City College, City University of New York, New York, NY 10031. (yboleag000@citymail.cuny.edu) [2]Dept. Physical Sci., Kingsborough College CUNY, Brooklyn, NY 11235. (mweisberg@kbcc.cuny.edu) [3]Dept. Earth and Environmental Sci., CUNY Graduate Center, New York, NY 10016. [4]Dept. Earth and Planetary Sci., American Museum of Natural History, New York, NY 10024.

Introduction: Enstatite (E) chondrites have important implications for the evolution of the inner Solar System and asteroid belt having stable isotope compositions that link them to the Earth -Moon system and possibly the other terrestrial planets [1-3]. Also, they represent extremes in the conditions that resulted in formation of chondrites in that they have unusual, reduced and/or sulfidized mineral assemblages, and compositions unlike any other primitive meteorite groups [4, 5]. The origin of E chondrites has been very controversial, and the role of impact is a major question. Here we present a petrologic study of the Pecora Escarpment (PCA) 91020 EL3 chondrite recovered from Antarctica.

We selected PCA 91020 because it is considered the most highly shocked enstatite chondrite, shock stage S5, and is characterized as having foliation, ellipsoidal chondrules and elongated opaque assemblages with a preferred orientation [6]. It was concluded by [6] that impact was responsible for the deformation and foliation. Here we present the preliminary results of our study of two thin sections of PCA 91020 to characterize the size, shape, texture and mineral compositions of its chondrules and opaque nodules. The goal is to be better understand the deformation history of this meteorite.

Methods: We used the petrographic microscope and scanning electron microscope (JEOL JSM-6390LV at Kingsborough) to document chondrule sizes, shapes and textures. The electron probe (Cameca SX 100 and SX5 at the AMNH) was used to construct element maps of the thin sections and analyze mineral compositions.

Results: PCA 91020 contains ellipsoidal chondrules and elongated opaque nodules in both sections studied (Fig. 1). The chondrules show radiating, porphyritic, cryptocrystalline and barred textures. They are dominantly enstatite-rich with few olivine-bearing chondrules (Fig. 1). Silicates in most chondrules show a cloudy (possibly shock darkened) appearance in plane polarized light.

The chondrules have apparent shapes that range from near-spherical to ellipsoidal and the opaque (metal-sulfide) nodules are clearly elongated in comparison to the nodules described in other EL3 chondrites, suggesting deformation. Long axes of chondrules and nodules are generally aligned producing a foliation (Fig. 1). 15 chondrules were measured. Their sizes range in length from 435 to 2882µm with an average length of ~1233µm and width ranges from 350 to 1704µm with an average of ~924µm. The aspect ratio ranges from 1.01 to 1.89 with an average of 1.31.

Mineral compositions are generally reduced, similar to other EL3 chondrites [e.g., 5]. Most chondrule enstatite is close to FeO-free. Less common are FeO-bearing pyroxene grains with up to 9 wt. % FeO. The FeO-bearing pyroxene is generally dusty, having tiny (sub-micrometer) round inclusions of Fe metal and in some case FeS. Olivine is minor in E3 chondrites and PCA 91020 is no exception. It occurs as rare crystals or poikilitically enclosed in enstatite in a few chondrules. The range of olivine compositions (0.1 to 7.0 wt. % FeO) is similar to olivine in EH3 and other EL3 chondrites (Fig. 2). The presence of olivine and range of compositions is consistent with PCA 91020 being an unequilibrated (type 3) E chondrite. Kamacite has (in wt. %) average (range) of 6.9 (5-8.6) Ni, 0.4 (0.2-0.4) Co and 0.6 (0.4-1.2) Si, which is within the range of other EL3 chondrites [5]. Schreibersite in the opaque nodules has (wt. %) 28 Ni and 15.3 P. Oldhamite (CaS) occurs in chondrules, as isolated grains in the matrix and associated with opaque nodules, but in all textural settings it shows varying degrees of degradation due to terrestrial weathering.

Discussion: PCA 91020 appears to show evidence of deformation throughout the meteorite in both the chondrules and the opaque (metal-sulfide) nodules, as previously described by [6] and shows a general alignment along the longest dimensions of the elongated chondrules, producing a foliated texture. The presence of deformation throughout the meteorite suggests the chondrules were deformed *in situ*. Such deformation and foliation, defined by alignment of elongated chondrules, is present in chondrites from many O and C chondrite groups [e.g, 7, 8, 9], as well in other EL3 chondrites to different degrees [6]. The origin of this feature in chondrites has been attributed to (1) accretionary sedimentation [7], (2) static deformation due to overburden compaction during progressive accretion [8]and (3) impact-induced deformation [e.g., 6, 9].

PCA 91020 is classified as shock stage 5, the most heavily shocked among the EL3 chondrites [6]. Shock

features identified by [6] include the presence of enstatite laths intergrown with metal, rapidly solidified metal-troilite textures and the possible presence of maskelynite. However, enstatite laths intergrown with metal is a characteristic feature of opaque (metal-sulfide) nodules in all EL3 chondrites regardless of shock stage. A study of silica polymorphs in E chondrites by [10] found silica glass and tridymite in PCA 91020, and no evidence of high pressure polymorphs. Additionally, if foliation in chondrites is a result of impact, the absence of such textures in many highly shocked chondrites need to be better understood.

Conclusions: Thus, PCA 91020 is an EL3 chondrite with deformed chondrules and inclusions. Impact was likely an important process in the evolution of all chondrite parent bodies including the EL asteroid. The chondrule deformation and foliation in PCA 91020 may have been produced by impacts. However, there are inconsistencies in reconciling an impact hypothesis with all of the observations and further work is needed to better test this and other hypotheses for deformation of chondrules in PCA 91020 and other EL3 chondrites.

Acknowledgments: This project was supported by NASA Emerging Worlds Grant # 80NSSC18K0589 to M. K. Weisberg, PI and the City University of New York EDGE Program.

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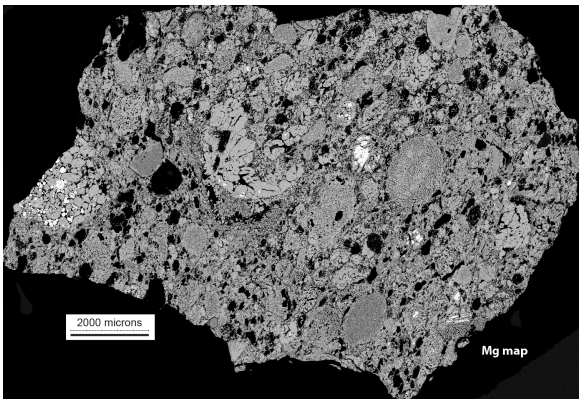

Figure 1. Mg element map of PCA 91020, 12 (10 µm/pixel) showing elongated chondrules and alignment of the chondrules and metal-sulfide nodules along their longest dimensions. Brightest areas are olivine, medium grey is dominantly enstatite and black areas are metal and sulfides.

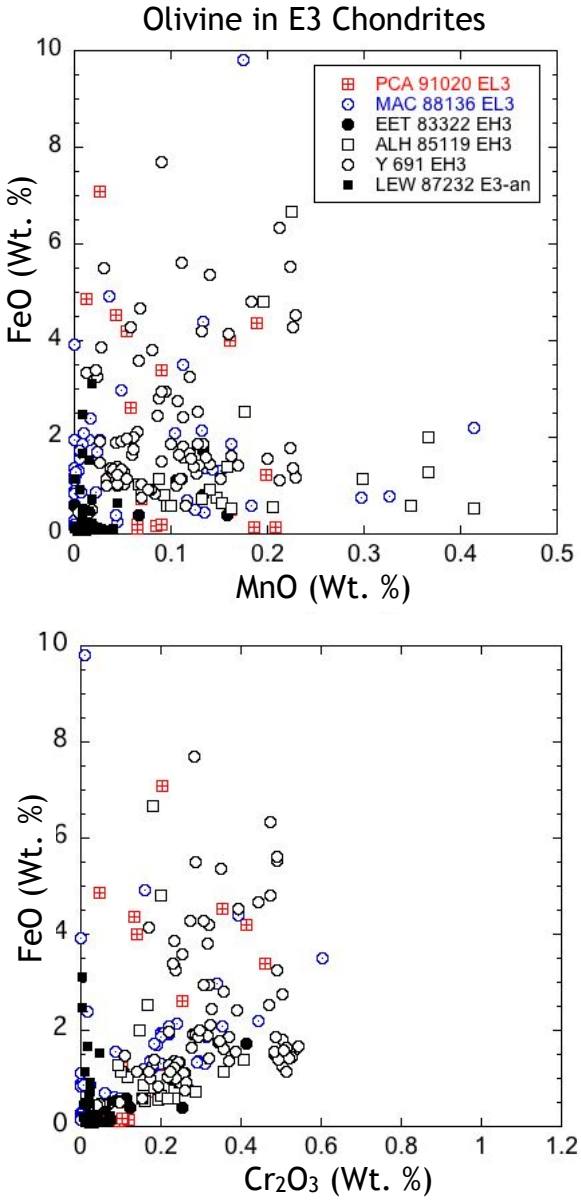

Figure 2. Olivine compositions of PCA 91020 compared to olivine in other E3 chondrites. PCA 91020 olivine has a range of compositions similar to other unequilibrated E chondrites.