EET87513 CLAST N: A CM2 FRAGMENT IN AN HED POLYMICT BRECCIA; P.C. Buchanan¹, M.E. Zolensky², A.M. Reid¹, and R. A. Barret³; ¹Department of Geosciences, University of Houston, Houston, TX 77204-5503; ²SN2, NASA Johnson Space Center, Houston, TX 77058; ³Lockheed ESCO, 2400 NASA Rd. 1, Houston, TX 77058.

I. INTRODUCTION. Xenoliths of material resembling carbonaceous chondrites have been found in several HED polymict breccias (e.g. Kaopta, Bholghati). Most workers [1-5] have concluded that these clasts are related to CM2 meteorites on the basis of texture, bulk composition, and mineralogy. The present study reports data on clast N, a carbonaceous chondrite fragment from the howardite EET87513 large enough (~4x3mm on the surface of the slab from which it was separated) to extract bulk samples for INAA and oxygen isotope analysis and to provide a thin section for electron microprobe, SEM, and TEM analysis. Preliminary data for this clast have been reported in Buchanan et al. [6] and Zolensky et al. [7]. INAA was performed at Oregon State University by Y.-G. Liu and R. A. Schmitt and bulk oxygen isotopic composition was determined at the University of Chicago by T. K. Mayeda and R. N. Clayton. These data confirm that EET87513 clast N is a fragment of CM2 material.

II. DESCRIPTION/DISCUSSION. EET87513 clast N is composed of fine-grained, opaque matrix and coarser-grained, ferromagnesian silicates (Fig. 1), with some of the latter present as chondrules and aggregates (up to 250µm in diameter). Size range of chondrules and aggregates is consistent with that reported for CM2 meteorites [8]. These coarse-grained silicates are predominantly olivine (Fo90-99) with lesser amounts of orthopyroxene (Wo1-5En90-98). Matrix makes up ~75 vol. % of the clast and is composed primarily of concentrations of sulfides (pyrrhotite and pentlandite) and fine-grained silicates which form flowing, undulating textures wrapping around larger silicate grains, chondrules, and aggregates. Fuchs et al. [9] and Bunch et al. [4] describe similar textures in Murchison and in CM-like clasts from the howardite Jodzie. McSween (10) reports that CM2 meteorites contain 57-85 vol. % matrix.

Preliminary results of STEM analysis of matrix minerals from EET87513 clast N are published in Zolensky et al. [7]; the dominant matrix mineral in this clast is flaky and platy serpentine intergrown with minor amounts of flaky saponite. Fig. 2 shows the 7A basal lattice fringes of this serpentine which are corrugated with abundant edge dislocations. Zolensky et al. [7] interpret this morphology as indicating that matrix material of this clast has been heated to less than ~400°C. Matrix saponite, though not found in most CM2 meteorites, has been found in Murray [13] and in the heated CM meteorite Beligica-7904 [11, 12, 13] and apparently indicates high water:rock ratios and/or temperatures during aqueous alteration [13]. Other matrix minerals present include chromite, tochilitene, tochilitene-serpentine [13], pyrrhotite, pentlandite, enstatite, olivine, diopside, and carbonaceous spheres [7].

In Fig. 3, bulk lithophile and siderophile element composition of EET87513 clast N [Y.-G. Liu and R. A. Schmitt, personal communication] are normalized to CI composition [14] and compared with bulk compositional ranges of CM, CO, and CV chondrites reported in Klemmein and Wasson [15]. Except for anomalous enrichments in the elements Sm and Au and depletion in Lu, these data suggest that EET87513 clast N is either a CM or CO chondrite. In Fig. 4, bulk oxygen isotope composition of this clast [T. K. Mayeda and R. N. Clayton, personal communication] is compared with ranges of oxygen isotope compositions for CR, C3, and CM chondrites taken from Clayton [16]; the composition falls to the 16O-rich end of the CM trend.

III. CONCLUSIONS. On the basis of texture, matrix mineralogy, bulk composition, and oxygen isotopic composition, EET87513 clast N is a fragment of CM2 material. Matrix saponite indicates that this clast probably underwent aqueous alteration with higher water:rock ratio and/or temperature than typical CM2 materials [13]. Morphology of matrix serpentine indicates that this clast has been heated to less than ~400°C following aqueous alteration [7].

Fig. 1 BSEI of a portion of EET87513 clast N.

Fig. 2 TEM image of a flake of matrix serpentine from EET87513 clast N. 7Å basal lattice fringes are obvious and are corrugated (arrow).

Fig. 3 Bulk abundances of lithophile and siderophile elements for EET87513 clast N [Liu and Schmitt, personal communication] normalized to CI compositions [14] and compared with ranges of abundances for CM, CO, and CV meteorites reported in Kallemeyn and Wasson [15]. Squares represent maximum and minimum values for CV chondrites. Triangles represent maximum and minimum values for CO chondrites. Circles represent maximum and minimum values for CM chondrites.

Fig. 4 Bulk oxygen isotopic composition of EET87513 clast N [Mayeda and Clayton, personal communication] compared with ranges of compositions for C3, CR, and CM chondrites taken from Clayton [16]. Terrestrial fractionation line and refractory inclusion line are also shown [16].