POLYMICT EUCRITE NORTHWEST AFRICA 5232: COMPOSITION AND CLASSIFICATION OF CLASTS. K. D. van Drongelen[1,2], K. T. Tait[1,2], and D. A. Gregory, [1]Department of Geology, University of Toronto, Toronto, Ontario, Canada M5S 3B1 (k.vandrongelen@geology.utoronto.ca), [2]Department of Natural History, Royal Ontario Museum, Toronto, Ontario, Canada M5S 2C6 (ktait@rom.on.ca).

Introduction: Northwest Africa (NWA) 5232 is an 18.535 kg polymict eucrite (Fig. 1). Polymict eucrites are impact breccias that likely formed near the surface of a large differentiated asteroid and belong to the HED meteorite group [1]. The HED meteorites are interpreted to come from 4 Vesta; linking the HED group with this asteroid has been a focus of NASA's current Dawn Mission [2]. The polymict eucrites primarily consist of eucritic material with less than 10 vol% diogenite material and may include foreign material (e.g. CM clasts). The eucrite clasts can be subdivided into two groups: cumulate and basaltic, typically distinguished by their pyroxene major element contents, bulk trace and major elements, and textures [1].

This study aims at describing this large polymict eucrite and classifying its constituents. The large size of NWA 5232 and the variety of lithic clasts available provides the opportunity to analyze the clasts as individual lithologies, rather than averaging the constituents into a general overview of the polymict breccia as a whole, and to make contextual interpretations of these lithologies.

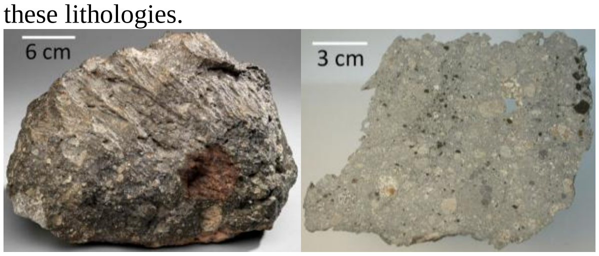

Figure 1: NWA 5232 main mass (left) prior to cutting and slice (right) of NWA 5232 taken from one end of the main mass.

Methods: Two large slices were cut with a low-loss wire saw at the Royal Ontario Museum (ROM) from one end of the main mass of NWA 5232 (Fig. 1) and six polished thin sections were prepared from part of this material. The polished sections were examined with a petrographic microscope, electron microprobe (EMP), scanning electron microscope (SEM), and Raman spectrometer. For mineral compositions, a Cameca SX50 EMP at the University of Toronto (UT) was used with a 1 µm beam, an accelerating potential of 15 keV, and beam current of 15 nA. To examine clast textures and identify minor and accessory phases, BSE images were collected with a JEOL JSM-6610LV SEM at the UT. A Horiba LabRAM Aramis confocal Raman spectrometer with SWIFT mapping stage at the ROM was used to identify terrestrial weathering phases using the 532 nm laser.

Petrographic Description: NWA 5232 is comprised of four main constituents: eucrite (lithic) clasts, CM clasts, melt clasts, and matrix. Clast sizes typically range from less than 0.5 mm to 3 cm and are variable in their distribution and angularity. The matrix is very fine- to coarse-grained, making up a significant proportion of this matrix-supported breccia. Various shock features were identified in the clasts and matrix, including bent pyroxene lamellae and pervasive fractures that were subsequently partially filled by terrestrial calcite.

NWA 5232 eucrite clasts show various textures, primarily subophitic of varying coarseness, and range in size from <0.5 mm to 3 cm, averaging 5 mm (Fig. 2). Distinguishing basaltic and cumulate eucrite clasts on the basis of texture alone is problematic as both groups may be medium- to coarse-grained, have pyroxenes with exsolution lamellae, and consist of the same major mineral phases (pyroxene and plagioclase). Minor and accessory phases include SiO_2, ilmenite, chromite, Fe,Ni-metal, and troilite.

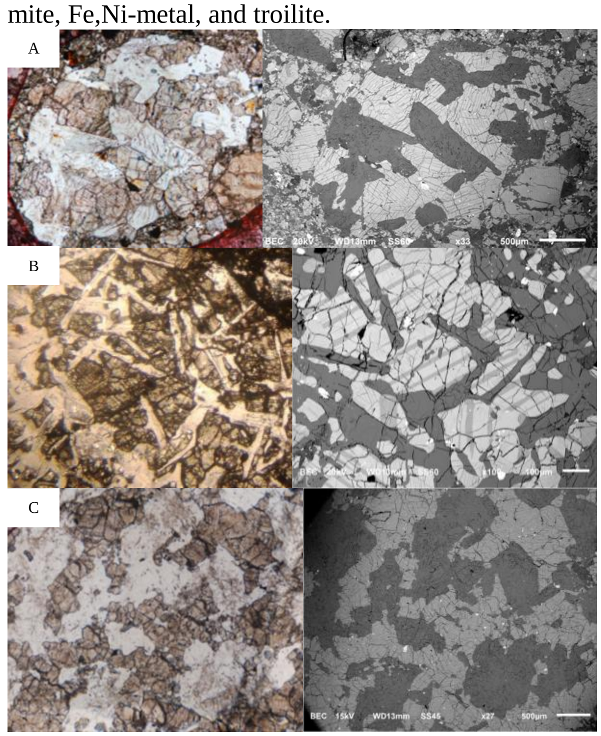

Figure 2: Various clast textures are observed in NWA 5232. (Left) photomicrographs in PPL; colorless minerals are primarily plagioclase and the light brown minerals are pyroxene. (Right) BSE images of the same clasts (scale bars of A and C are 500 µm; B scale is 100 µm); dark gray minerals are plagioclase and light gray minerals (with exsolution lamellae) are pyroxene. (A) and (B) are basaltic eucrites and (C) is a cumulate eucrite.

NWA 5232 contains two types of dark clasts: CM carbonaceous chondrite clasts and impact melt clasts. The dark clasts are generally subangular and range widely in size and distribution (Fig. 1). The CM clasts are <0.5 to 12 mm in size, are distinguished by the presence of <0.5 mm chondrules (Fig. 3), and contain olivine, pyroxene, troilite, pentlandite, Fe,Ni-metal, and a P-bearing Fe,Ni-sulphide (characteristic of CM chondrites [3]). The melt clasts range in size from <0.5 to 5 mm and contain grains of pyroxene and plagioclase with minor Ni,Fe metal, SiO_2, and troilite (Fig. 3).

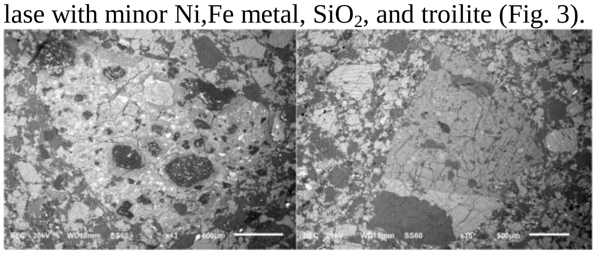

Figure 3: BSE images of a CM clast (left) and melt clast (right). Scale bars are 500 µm.

Results and Discussion: Establishing planetary/astroidal parentage is fundamental in the analysis of a meteorite and can be done by various methods. One of the most readily accessible methods is to examine the pyroxene (Mn vs. Fe) and plagioclase (An) compositions by EMP [4]. Data for pyroxenes obtained from the lithic clasts of NWA 5232 match the HED reference line well (Fig. 4). Plagioclase compositions are well within those expected for eucrite material (An_{79-91}, average $An_{87} \pm An_{1.8}$, and K(afu) = 0.003 ± 0.001) [4]. Additionally, the identity of eucrite and CM clasts has been confirmed by oxygen isotope work [5].

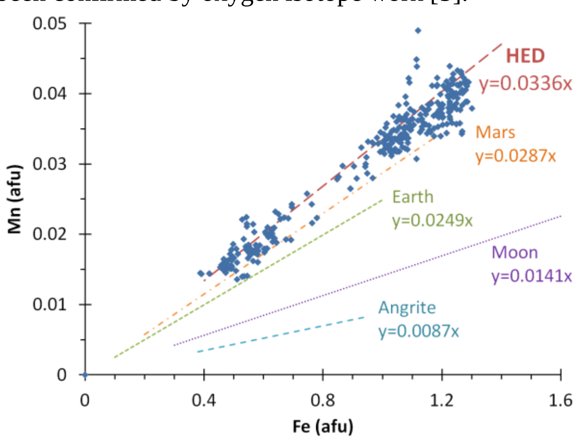

Figure 4: Mn versus Fe in pyroxene plot illustrating the HED character of the lithic clasts in NWA 5232 [4].

Pyroxene and Plagioclase Major-Element Compositions. Eucrites are subdivided into cumulate and basaltic (or noncumulate) eucrites primarily by their pyroxene and plagioclase major-element compositions [1]. To establish the character of the lithic clasts of NWA 5232, a minimum of 12 EMP pyroxene data points were taken of each individual selected clast. The EMP data were then plotted on a pyroxene quadrilateral (Fig. 5). Of the 30 individual eucrite clasts analyzed with EMP, only one plotted outside of the basaltic eucrite field as a cumulate eucrite (Fig. 2C).

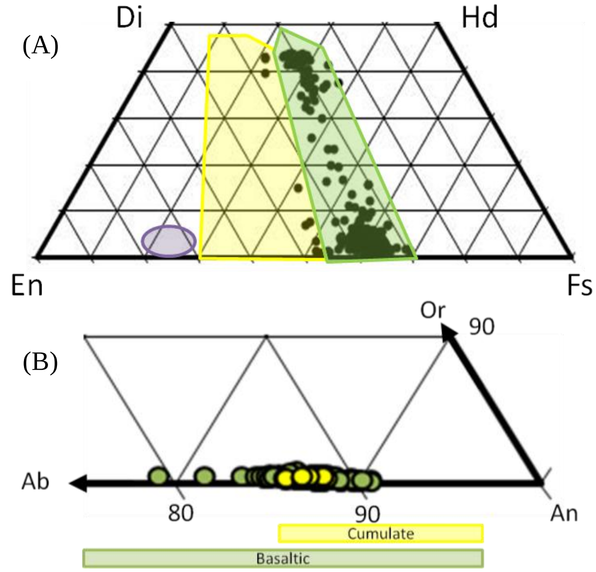

Figure 5: (A) NWA 5232 Eucrite clast pyroxene compositions in black. Three types of HED material are highlighted: basaltic eucrites (green), cumulate eucrites (yellow), and diogenites (purple) [6,7]. The points in the cumulate eucrite field are from a single eucrite clast. (B) Section of plagioclase ternary of NWA 5232 basaltic clasts (green) and cumulate eucrite clast (yellow). Cumulate and basaltic eucrite plagioclase compositional ranges illustrated as yellow and green bars, respectively [1].

Conclusions: NWA 5232 is a polymict eucrite comprised of eucrite, CM, impact melt clasts, and matrix. Lithic clasts are primarily basaltic eucrite clasts and no diogenite material was identified. Futher work is needed to differentiate between Nuevo Laredo- and Stannern-Trend basaltic eucrites by examination of bulk element compositions of clasts in NWA 5232 [1].

References: [1] Mayne R. G. et al. (2009) *Geochimica et Cosmochimica Acta*, *73*, 794-819. [2] Li J.-Y. (2011) *Icarus*, *216*, 640-649. [3] Nazarov M. A. et al. (1998) *LPS XXIX*, Abstract #1628. [4] Papike J. J. (2003) *American Mineralogist*, *88*, 469-472. [5] Kuehner S. M. et al. (2009) *LPS XL*, Abstract #2315. [6] Takeda H. (1997) *Met. & Planet. Sci.*, *32*, 841-853. [7] Graham and Midgley (2000) Triangular diagram plotting spreadsheet (TRI-PLOT).

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