COMPOSITIONS OF NORMAL AND ANOMALOUS EUCRITE-TYPE MAFIC ACHONDrites.

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Introduction: The most common asteroidal igneous meteorites are eucrite-type mafic achondrites – basalts and gabbros composed of ferroan pigeonite, ferroan augite, calcic plagioclase, silica, ilmenite, troilite, Ca-phosphate, chromite and Fe-metal [1]. These rocks are thought to have formed on a single asteroid along with howardites and diogenites. However, high precision O-isotopic analyses have shown that some mafic achondrites have small, well-resolved, non-mass-dependent differences that have been interpreted as indicating derivation from different asteroids [e.g., 2]. Some of these O-anomalous mafic achondrites also have anomalous petrologic characteristics, strengthening the case that they hail from distinct parent asteroids [3]. We present the results of bulk compositional studies of a suite of normal and anomalous eucrite-type basalts and cumulate gabbros.

Methods and Samples: Compositions were determined by: X-ray fluorescence spectrometry (XRF) done at NASA JSC (see [4] for methodology). The INAA analyses were done on ~50 mg splits taken from chips ~200-800 mg in mass. Samples for XRF/ICP-MS were done on splits of homogenized powders prepared from ~5 gram chips. Many Antarctic eucrites have suffered terrestrial mobilization of phosphate-hosted incompatible lithophile elements; we rely on the less mobile incompatible lithophile elements Zr, Nb, Ba, Hf and Ta to assess their origin (cf., [5]).

Results and Discussion: EET 87520, EET 87542 and GRA 98098 are main-group basaltic eucrites as evidenced by their normal O-isotopic compositions [3], and bulk rock molar $100\times\text{[MgO/(MgO+FeO)]}$ (mg#) and incompatible lithophile element contents (figure; literature data from compilation [1]). EET 87520, classified as an Mg-rich eucrite, has an mg# typical of main-group eucrites; its pyroxene compositions also match main-group eucrites [3]. Incompatible lithophile element contents in EET 87520 are similar to those of basaltic clasts from Sioux County [6]. EET 87542 suffered late, subsolidus reduction of FeO from pyroxene [3]. Nevertheless, the mg# and incompatible lithophile element contents of it are consistent with main-group eucrites. Our INAA data on GRA 98098 have incompatible lithophile element contents within the ranges of Nuevo-Laredo-group and Stannern-group eucrites. However, the larger, more representative, XRF/ICP-MS sample matches main-group eucrites (figure). Orlando, a moderately brecciated, medium-grained basalt, has incompatible lithophile element contents that are typical for main-group eucrites. Its pyroxene compositions also match the main group [3]; we did not determine a bulk rock mg# for Orlando.

Unbrecciated basalt QUE 94484 suffered late-stage reduction of FeO from the magma during crystallization, but has a normal eucritic O-isotopic composition [3]. Its mg# and incompatible lithophile element contents more closely match Stannern-group eucrites than main-group or Nuevo-Laredo-group eucrites (figure). The compositional data suggest that QUE 94484 might be a member of the Stannern group; further analyses are required to firmly establish this conclusion.

Anomalous basalt PCA 82502 is fine-grained and vesicular, and paired with PCA 91007 [3]. PCA 82502 has an mg# and incompatible lithophile element contents within the field of main-group eucrites (figure), and comparable to those in PCA 91007 [7]. The vescularity indicates a high magma volatile content, but the volatile lithophile element (Rb, Cs) contents of it are identical to those of main-group eucrites.

Anomalous cumulate gabbro EET 92023 contains Ni-rich metal, pyroxenes with high Fe/Mn ratios, and has an O-isotopic composition distinct from those of normal eucrites [3]. Its incompatible lithophile element contents are consistent with a cumulate origin, and are similar to those of Moore County (cf., [5]). Its bulk mg# is lower than that of Moore County because of the metal; the pyroxene mg#s of EET 92023 and Moore County are identical [3].