MILLER RANGE 090687, A DISTINCTLY FERROAN AND DACITIC EUCRITE

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I report on the petrography and mineral chemistry of the diminutive (0.77 g) eucrite Miller Range 090687 (hereafter "MIL"). This meteorite is both dacitic and ferroan, unlike any previously known HED. Brief descriptions for NWA 5721 [1] and NWA 7881 [*Met. Bull.*] indicate them to be comparably ferroan, but in neither case is silica enrichment indicated. A small ophitic clast in howardite DOM 10100 [2, 3] is more dacitic than MIL 090687 but of normal-eucritic *mg*. Another small ophitic clast ("C") in polymict eucrite NWA 8658 (this work) has a similarly low *mg* and is almost as dacitic as MIL, but the representativeness of the *mg* is questionable, because clast C's coarse (and thus, far from well-sampled) pyroxene is highly unequilibrated and inhomogeneous.

A preliminary mode of MIL shows (in vol%) plagioclase 38, pyroxene 30.5, silica 21.5, olivine 9.6, ilmenite 0.3, troilite 0.2, and traces of Cr-spinel and phosphate. The silica/plag ratio easily qualifies the rock as a dacite. The bulk composition, calculated from compositions of conveniently rather homogeneous constituent minerals, has an *mg* (≡ mol% MgO/[MgO+FeO]) of 24, which is to be compared to a range of about 32.5-42 for the many previously known noncumulate eucrites apart from NWA 5721 and 7881. The bulk *mg* is so low in part because the rock's 10 vol% olivine is Fo13. The pyroxene (apart from scattered micron-scale exsolution lamellae) is exclusively high-Ca (average En20Wo39), and occurs in the form of large (~ 1 mm) polycrystals, likely glomerocrysts. Olivine is almost entirely confined to large inclusions within the pyroxene-dominated polycrystals, which also contain significant proportions of silica. However, two enclaves within the rock have polycrystals (about 3/10 of the total) that are relatively pure pyroxene, devoid of olivine. The olivine-poor enclaves also feature especially low abundance of ilmenite and troilite, suggesting that they may be the earliest-crystallized parts of the sample. These mafic-silicate distribution systematics are enigmatic, but I speculate that the olivine-rich polycrystals may have originally consisted largely of pyroxferroite, which during slow cooling near the rock's solidus decomposed into olivine+augite+silica.

For the NWA 5721 meteorite [1] suggested "a differentiated parent body distinct from that yielding eucrites." Oxygen isotope and trace element measurements are planned (soon) but not yet available to confirm the HED affinity of MIL. However, pyroxene FeO/MnO averages 33.9, close to the eucrite norm. MIL's plagioclase is not only Na-poor, it is unusually Na-poor, for such an evolved HED lithology: average An91.6, with only very limited zoning. MIL's very trace proportion of phosphate is probably weathered merrillite (EPMA analyses are mostly low-sum, even with corrections for unmeasured heavy REE, and strangely diverse in, inter alia, REE, Mn and sulfur). The rock's ilmenite and Cr-spinel occur as tiny intergrown grains, and the spinel is unusally low in ulvöspinel content (average 1.92 wt% TiO_2). The calculated bulk TiO_2 content of MIL, 0.52 wt%, is remarkably moderate for such an extremely low-*mg* material. However, the sample is conceivably a partial cumulate and/or simply deficient in ilmenite due to unrepresentative sampling. Using pyroxene *mg*-Ti/Al systematics to infer the parent-melt TiO_2, a higher TiO_2, 1.3 wt%, is suggested. Ca/Al is uncommonly high in MIL (1.39, by weight), especially considering the overall-HED correlation between Ca/Al and TiO_2.

None of the three new dacites (MIL, DOM, NWA 8658-C) fits neatly into the long-established subclassification of noncumulate eucrites into a Main Group plus two "trends", but MIL appears to represent an extreme extension of the Nuevo Laredo trend, while the DOM 10100 clast [3] extends the Stannern trend. The Nuevo Laredo trend probably formed by fractional crystallization of a Main Group (MGNL) magma, in the case of MIL most likely in a shallow-crustal magma chamber. Origin of the Stannern trend remains enigmatic. A widely cited crustal remelting model [4, 5] carries implausible implications: abundant extremely depleted crustal restites; and also consistently low proportions of the secondary melts within the final Stannern trend materials (putatively mixtures of melts from crustal remelting with coeval Main Group melts). Experimental simulations of the secondary partial melting model do not produce sufficiently MgO-depleted melt products [6]. The model's requirement that Main Group material dominates in the final mixture is particularly inconsistent with the extremely low MgO content of the DOM 10100 dacitic clast. As for the ultimate origin of the MGNL, diogenite-composition magma is highly implausible (long-depleted sources do not continue to melt! [7]) and so there must be a very major component of diogenite-residual basalt among HEDs. The only manifest candidate for that component is MGNL material.

References: [1] Bunch T. E. et al. (2011) 42nd Lunar Planet. Sci. Conf.: abstract #1615. [2] Hahn T. M., Jr., et al. (2015) 78th MetSoc Meeting: abstract #5085. [3] Hahn T. M., Jr., et al. (2017) 48th Lunar Planet. Sci. Conf.: abstract #1759. [4] Barrat J. A. et al. (2007) *Geoch. Cosmoch. Acta* 71: 4108-4124. [5] Yamaguchi A. et al. (2009) *Geoch. Cosmoch. Acta* 73, 7162-7182. [6] Crossley S. D. et al. (2017) 48th Lunar Planet. Sci. Conf.: abstract #2821. [7] Warren P. H. (1985) *Geoch. Cosmoch. Acta* 49. 577-586.