ENIGMATIC ENCLAVES OF SILICA AND AUGITE, WITHOUT FELDSPAR, IN EUCRITE NWA 10553.

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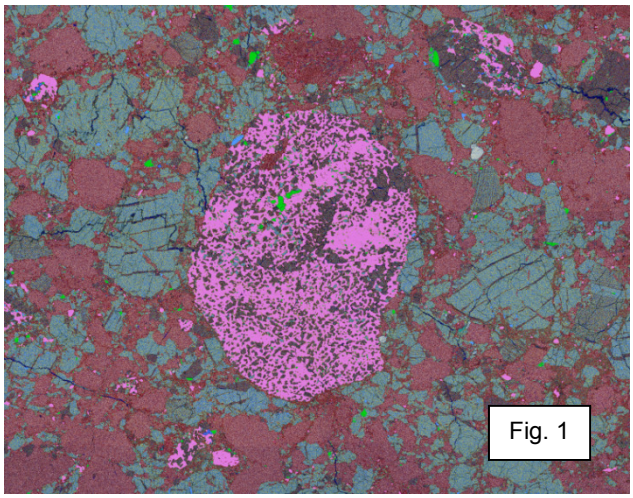
Eucrites are not compositionally diverse. Modal silica/(silica+plag) is never greater than 0.24 (the Caldera gabbro); in the vast majority of cases <0.15 [1, 2]. Yet in this context, within eucrite breccia NWA 10553, specifically as several tens of discrete enclaves, frequently ovoid and up to 3 mm across, we have found a fundamentally novel variety of silica enrichment: silica consistently linked (intergrown) with augitic pyroxene, with only minor proportions of other phases, and with feldspar conspicuously near-absent. As we know of no existing name for such a material, we refer to it as silica-augite intergrowth (SAI).

Our studies of NWA 10553 [3] have thus far focused mainly on three sequential large (4 cm^2) polished sections. Mineralogical-textural studies are complicated by moderate Saharan weathering, typical eucritic thermal metamorphism, plus intense shock metamorphism. Plag and the silica phase(s) show tortured crystallinity with local isotropism. Tiny shock-melt veins are pervasively present. The rock also contains a few elongate voids (up to 200 µm wide and traceable for up to 2 cm), which curiously involve virtually no strike-slip displacement, only dilation. At the sample margin one of these is largely filled with frothy glass, which may be inward-migrated fusion crust. In general, although brecciation and even shock-melting occurred pervasively on a sub-mm scale, there is no clear evidence of brecciation-displacement on a larger scale than that. The rock is texturally battered and features mineralogical incongruities (see below), but this breccia may be essentially monomict, or possibly genomict. Oxygen isotopic results obtained at UCLA, average $\delta'^{18}O = 4.421$, $\Delta'^{17}O = -0.231$, confirm the eucrite classification.

Fig. 1 shows an x-ray map of a large (3×2 mm) SAI enclave, with silica = shocking pink, opx = teal blue, plag = red, augite = dark grayish green, and ilmenite = bright green. This large enclave contains only 1 vol% plag; the rest of it is mainly silica with lesser augite and traces of ilmenite, opx and Cr-spinel (bright blue). The SAIs consistently have augite >> opx. With augite Al_2O_3 content averaging 0.95 wt%, the big enclave's bulk composition has merely 0.7 wt% Al_2O_3. Some large SAI areas elsewhere in NWA 10553 have more augite than silica, but these tend to be less ovoid, more internally heterogeneous in silica/px ratio, and (at pyroxene-dominated margins) less obviously distinct from normal basaltic augite-silica associations.



SAI mineral compositions are evolved, but only mildly so, compared to the rest of NWA 10553. However, the present SAI solid-solution compositions may have been moderated during metamorphism. The minor SAI plag is An85-89, whereas average non-SAI plag is An92 [3]. SAI pyroxenes are consistently ferroan, averaging En33Wo41 for augite and En40Wo1.7 for (largely exsolved) opx; whereas non-SAI pyroxenes are mostly toward the magnesian ends of the ranges En32-36Wo~44 and En42-50Wo2 (cpx and opx). Abundance of phosphate (merrillite) appears to be at roughly the same trace level within the enclaves as in the rest of the rock. The rock's scattered trace of olivine (Fo32-35) has been found exclusively outside the SAI enclaves. Curiously, the olivine seems largely concentrated as inclusions within and along the margins of a handful of the most magnesian of the large opx-dominated pyroxene grains, with which such ferroan olivine was possibly never in equilibrium (cf. Fo42 olivine with *mg*-52 low-Ca px in lunaite ALH 81005 [4]). These olivines may be of secondary/metasomatic origin. The SAI enclaves in some ways resemble pyroxferroite breakdown material (PBM), but the SAIs are not FeO-rich and lack olivine (pyroxferroite breakdown yields equal volumes of silica and olivine). The extreme Al_2O_3 depletion (near-absence of feldspar) rules out origin from pockets of late-stage melt, unless some weird shift in environmental conditions drove plag off the liquidus until the residual melt was squeezed out. Oxygen fugacity does not appear to have been abnormal. The trace of Cr-spinel in the SAI consistently shows stoichiometry implying near-zero Fe_2O_3, albeit spinel elsewhere in the rock shows up to 1.4 wt%. At this early stage of our investigation of NWA 10553, origin of the SAI enclaves remains mysterious.

References: [1] Delaney J. S. et al. (1984) Proceedings 15th Lunar Plan. Sci. Conference, C251-C288. [2] Mayne R. G. et al. (2009) Geochimica Cosmoch. Acta 73, 794-819. [3] Liu Y. (2016) "NWA 10553" in Met. Bull. 105. [4] Goodrich C. A. et al. (1984) Proceedings 15th Lunar Plan. Sci. Conference, C87-C94.