MET01210: ANOTHER LUNAR MARE METEORITE (REGOLITH BRECCIA) WITH EXTENSIVE PYROXENE EXSOLUTION, AND *NOT* PART OF THE YQ LAUNCH PAIR

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MET01210 has been classified as a lunar anorthositic breccia [1]. Actually, it is a regolith breccia that contains more mare basalt than highland matter. The bulk Al_2O_3 content (microprobe fused-bead analysis in excellent agreement with analyses of the fusion crust) is 16.7 wt%, and the lithic and mineral clast components in thin section appear to be of mainly mare origin. From pyroxene *mg* vs. Ti/(Cr+Ti) zonation trends (132 analyses), the dominant mare component probably was a basalt (or diabase) with ~2.2 wt% TiO_2.

A highland component is definitely present, however. There are small aphanitic anorthositic impact melt clasts, and four of the five regolith spheroids identified to date are highly aluminous (24-35 wt% Al_2O_3). One of these, only 16 µm in diameter, is of HASP composition, with 35 wt% Al_2O_3 and just 34 wt% SiO_2 (Kempa and Papike [2] looked for and did not find a relationship between spheroid size and frequency of HASP; our observations, most notably for lunaite QUE93069 [3], consistently find HASP most abundant among the smallest highland spheroids —and of course surface area/volume relationships should favor HASP development in relatively small objects.) The only mare or mainly mare spheroid is notably high in TiO_2, 4.6 wt%, particularly considering that the Al_2O_3/FeO wt. ratio is 1.51, implying that the high-Ti mare component has been heavily diluted with highland matter.

Pyroxene exsolution textures are useful recorders of rock thermal histories [4]. The mare component of MET01210 is far from uniform, in this respect, but roughly half of the pyroxenes display exsolution to extents that vastly exceed the norm (<<0.1 µm typical lamella width) for Apollo mare basalts [4]. In the largest clast in the studied thin section (probably a mare basalt, although as sampled the plag/pyroxene ratio is slightly >1), the pyroxenes are not only exsolved, they are also remarkably equilibrated in terms of *mg* and, at scales beyond the 1-3 µm scale of exsolution, also Ca. This degree of equilibration is reminiscent of the textures found in pervasively (and thus enigmatically) among eucrites [4]. This clast is exceptional, but exsolution lamellae of order 1 µm wide are fairly common among groundmass (and overwhelmingly mare) MET01210 pyroxenes.

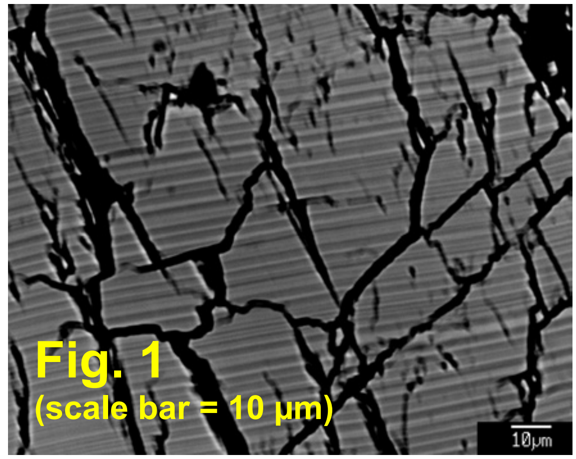

Fig. 1
(scale bar = 10 µm)

MET01210 thus joins lunaites Y793274, QUE94281, EET87521, and (to a lesser degree) As-881757, in having undergone a remarkable extent of slow cooling or annealing, in comparison to Apollo mare basalts [4, 5]. An important issue is to determine how many separate launch provenances are actually represented by this suite. Y793274 and QUE94281 are very probably launch-paired [4, 5]. Cosmic-ray exposure evidence (reviewed in [3]) precludes any form of pairing with As-881757. Korotev et al. [5] argue for inclusion of EET87521 in the "YQ" launch pair. While this seems a strong possibility, our own EET87521 data, especially for vanadium, leave it far from certain.

We also employed INAA and MFBA to determine the bulk composition of MET01210 (data are still slightly preliminary — analysis only commenced in December). The bulk REE pattern is remarkably near-flat at ~20×CI. In this case, the composition clearly falls well off the YQ(E?) mixing trends, in several respects. For example, on plots using Al_2O_3 as the *x*-axis, the bulk MET01210 TiO_2 (1.67 wt%) is about twice the level of the tight YQ mixing trend; its Sc (52 µg/g) is about 1.7 times higher; and Co (25 µg/g) is at least 20% too low. Thus, MET01210 augments previous indications that the consistently rapid and monotonic style of cooling that was so pervasive among Apollo-collection mare basalts was accompanied by more complex thermal histories, suggestive of some form of lava ponding (perhaps in craters, or as a result of rapid effusion) or else reheating, as in a impact debris blanket.

However, the presence as well of unequilibrated, yet geochemically similar, pyroxenes in MET01210 militates against any hypothesis requiring involvement of the whole region of MET01210's provenance in such a thermal event(s).

References: [1] Ant. Met. Newsl. 27(1) (2004). [2] Kempa M. J. & Papike J. J. (1980) PLPSC 11, 1635. [3] Warren P. H. et al. (2004) MaPS, submitted. [4] Arai T. and Warren (1999) MaPS 34, 209. [5] Korotev R. L. et al. (2003) Ant. Met. Res. 16, 152.