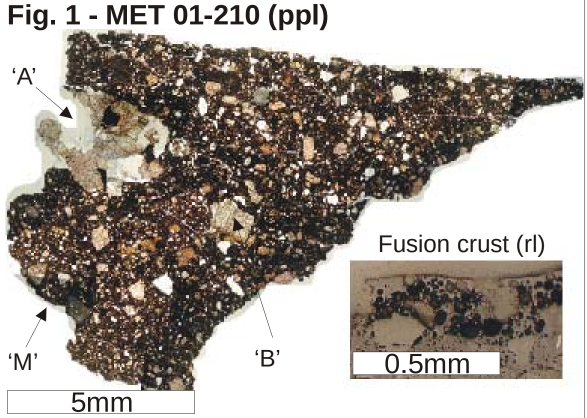
MINERALOGY AND PETROGRAPHY OF LUNAR MARE REGOLITH BRECCIA METEORITE MET 01-210. Allan D. Patchen, Lawrence A. Taylor, and James M.D. Day, Planetary Geosciences Institute, University of Tennessee, Knoxville, TN 37996, USA (apatchen@utk.edu)

Introduction: MET 01-210 is a 22.8g lunar regolith breccia collected in 2001 from the Meteorite Hills, Antarctica [1]. We present results that indicate this regolith breccia is composed predominantly of basaltic clasts and mineral fragments with lunar mare affinities, rather than being an anorthositic regolith breccia, as it was originally described.

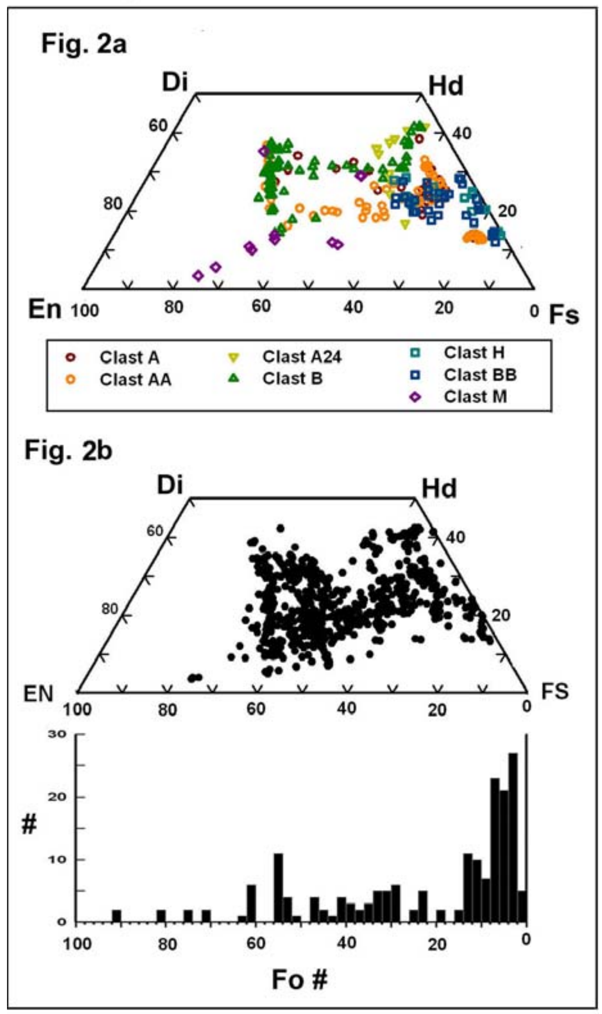
Petrography: MET 01-210 is a breccia consisting of basaltic clasts (≤ 3mm), angular pyroxene (≤ 2mm), plagioclase (≤ 2mm), olivine (≤ 0.8mm), and Fe-Ti oxide (≤ 0.8mm) fragments (Fig. 1). Less common are rounded clasts of agglutinate, and a few, apparently anorthositic clasts with irregular patches of glass (≤ 1mm diameter). The regolith-matrix is composed of heterogeneous glass with abundant, small, predominantly basaltic fragments, and is nearly opaque due to the abundant nanophase Fe^0 typical of agglutanitic glass. The ~300µm wide fusion crust is highly vesiculated (Fig. 1), probably due to outgassing of abundant implanted solar-wind particles within the regolith, as well as volatile-loss during formation of the fusion melt.

Fig. 1 - MET 01-210 (ppl)



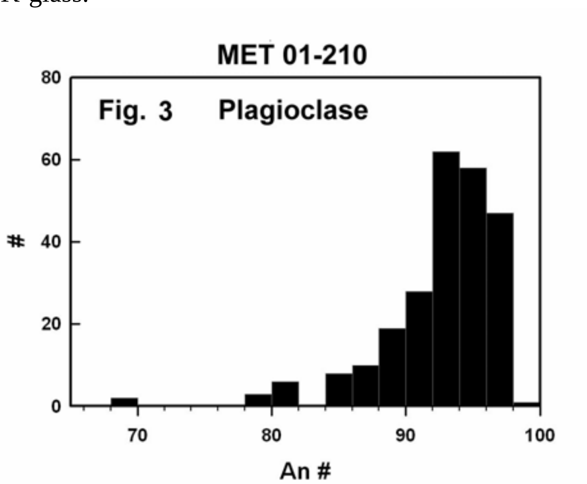
Mineralogy: *Pyroxene:* Pyroxene compositions from lithic fragments range from augite to ferroaugite, and include pigeonite, hedenbergite, and pyroxferroite (Fig. 2a). Zoning within each grain is toward Fe enrichment, to ferropyroxenes and pyroxferroite. Clast 'M' is anorthositic (An_{96}), and has higher Mg pyroxenes than most of the other clasts; this clast may be highland's in origin. Mineral fragments in MET 01-210 cover the same range of compositions for pyroxene found within clasts, with the exception of a few higher Mg pigeonites (Fig. 2b). Some pigeonite grains have exsolution lamellae up to 2µm wide. Symplecitic breakdown textures are present, both as parts of lithic fragments, and as discrete clasts. The symplecite texture consists of fayalite (Fo_{3-6}), hedenbergite ($Wo_{40}En_{6-10}$), and silica. Defocused beam analyses result in an approximate original pyroxene compositon of $Wo_{15}En_4$ in the basaltic clast and $Wo_{15}En_8$ for the mineral fragment that we analyzed – close to pyroxferroite compositions. The symplecite within the basalt is a three-phase assemblage and also has merrillite closely associated with it.

MET 01-210



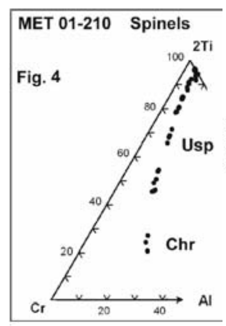
Olivine: Fosteritic olivines are found as isolated monomineralic grains (Fo_{94-60}). However, the compositions of the majority of olivines are unusual because of the predominance of fayalitic olivine (Fig. 2). These fayalitic olivines occur both as monomineralic grains up to 500µm in length, or as aggregates within the basaltic clasts, occurring with ilmenite, Fe-pyroxene and silica. The fayalites do not have inclusions of K-glass or silica, like those seen in many lunar basalt mesostases (the so-called 'swiss cheese' texture [3]). The formation of the unusually large amounts of fayalitic olivine is unusual, but we speculate that the effects of silicate liquid immiscibility (SLI) for separation of K-rich and REEP-rich fractions from the high-Fe melt [4] may be applicable in this case.

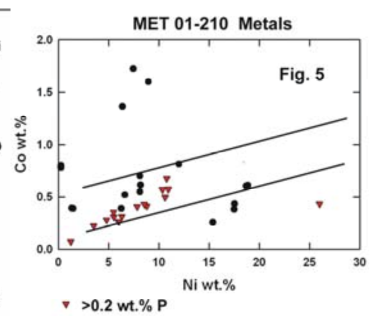
Feldspar: Plagioclase compositions range from An_{98} to An_{68} (Fig. 3). Normally zoned plagioclase with An_{96} cores and An_{80} rims were observed in the largest basaltic lithic clast. A single isolated mineral fragment had a composition of An_{68}. K-feldspar up to 70µm in length and containing 8-12wt.% BaO is present in 2 lithic clasts. These K-Feldspars are closely associated with silica, Fe-rich pyroxenes and K-glass.



Oxide phases: Ilmenite occurs both in basaltic lithic fragments and as monomineralic grains with bladed crystals up to 800µm in length. Ilmenites have a narrow range of compositions with MgO ranging from <0.03 to 0.85wt.%. ZrO_2 concentrations up to 0.42wt.% were measured in some ilmenites, but most possessed less than 0.08wt.%. Spinels (up to 800µm in length) predominantly contain less than 10wt.% Cr_2O_3 and are classified as ulvöspinels (Fig. 4). Ulvöspinels within basaltic clasts are associated with pyroxene, but not with primary ilmenite or fayalite. One spinel grain possessed a chromite core (38.8wt.% Cr_2O_3, 7.6wt.% TiO_2), zoning to a ulvöspinel rim (13.9wt.% Cr_2O_3, 25wt.% TiO_2), typical of low-Ti mare basalt fractionation.

Micellaneous phases: Merrillite (2.9-4.7wt.% Ce_2O_3), and apatite (1.7-2.2wt.% F, 1.7-2.0wt.% Cl) are present as part of the late-stage fractionate assemblage. Glasses also exhibit wide variations in compositions. Generally they form mixing trends between plagioclase and mafic mineral compositions; typical of melt-impact formation. K-rich glass is also present (3.9-9.3wt.% K_2O) and is associated with the mesostasis. Silica occurs as grains up to 0.4mm diameter and contains, on average, 0.5wt.% Al_2O_3. Troilite was found within basaltic clasts and as scattered grains within the regolith. FeNi metals occur as <20µm grains scattered throughout the matrix, in addition to the nanophase Fe^0 mentioned previously. The larger FeNi metal grains have a wide variation of Co and Ni contents (Fig. 5), many falling into the 'meteoritic' field. Several FeNi grains have elevated P, with a maximum of 1wt.% P_2O_5.





Similarity to charecterized lunar material: Meteorite MET 01-210 is a regolith breccia originating from a mare basalt terrain and which contains only minor highland's material. The range of pyroxene and olivine compositions are very similar to the ranges of some Luna 24 ferroan basalt and gabbro clasts [5] as well as typical low-Ti basalts (e.g., [6]), but fractionation has progressed to even more extreme Fe enrichment, resulting in pyroxferoite and extensive quanitities of faylite, along with K-feldspar.

[1] Ansmet Newsletter (2004), 27(1). [2] Aramovich *et al.* (2002) *Am. Min.*, 87, 1351-1359. [3] Taylor L.A. *et al.* (2004), *Am. Min*. [4] Neal C.R., Taylor L.A. (1989) *GCA*, 53, 529-541. [5] Taylor G.J. *et al.* (1978) Mare Crisium: The view from Luna 24, 303-320. [6] Day J.M.D. *et al.* (2005) *LPSXXXVI*, this volume.