COMPOSITIONS OF THREE LUNAR METEORITES: METEORITE HILLS 01210, NORTHEAST AFRICA 001, AND NORTHWEST AFRICA 3136. R. L. Korotev[1] and A. J. Irving[2] [1]Department of Earth and Planetary Sciences, Washington University, C/B 1169, Saint Louis, MO 63130 (korotev@wustl.edu); [2]Dept. of Earth and Space Sciences, University of Washington, Seattle, WA 98195 (irving@ess.washington.edu).

Introduction: We report on compositions obtained by instrumental neutron activation analysis on three new lunar meteorites, MET 01210 (Meteorite Hills, Antarctica; 23 g), NEA 001 (Northeast Africa, Sudan; 262 g), and NWA 3136 (Northwest Africa, Algeria or Morocco; 95 g). As in previous similar studies [1,2], we divided our samples into many (8–9) small (~30 mg) subsamples prior to analysis.

Results: All three meteorites are regolith breccias [3–5]. Compositionally, NEA 001 is feldspathic and at the mafic (high-Fe, -Sc, -Cr) end of the range of feldspathic lunar meteorites (Fig. 1a), presumably as a result of the observed minor component of mare material [4]. Concentrations of Ca, Sr, and Ba are high, compared to Apollo samples and cold-desert meteorites, as a result of terrestrial alteration [e.g., 1]. Concentrations of incompatible elements are low and similar to those of other feldspathic lunar meteorites (Fig. 1b). MET 01210 and NWA 3136 are "mingled" meteorites – breccias consisting of mare basalt (70–75%) and feldspathic highland lithologies (25–30%), perhaps with some admixture of KREEP material. In both meteorites concentrations of incompatible elements are at the low end of the range observed among mingled meteorites (Fig. 1b).

Relation to Other Lunar Meteorites: Meteorites found closest to MET 01210 are ALHA 81005 at 310 km and EET 87521/96008 at 430 km. No lunar meteorites have been previously found in northeast Africa. Thus neither MET 01210 nor NEA 001 is paired with another known lunar meteorite. The only other mingled meteorite from northwest Africa is the regolith breccia lithology of NWA 773, which is compositionally distinct from NWA 3136. Thus NWA 3136 is also not likely paired with any previously described lunar meteorite.

Although almost certainly a coincidence, MET 01210 and NWA 3136 are similar to each other in composition. Among previously described lunar meteorites they are most similar to the other low-Th mingled meteorites, Yamato 793274/981031, EET87521/96008, QUE 94281, and the regolith breccia lithology of NWA 773 (Fig. 1 and 2). We suspect, however, that neither MET 01210 nor NWA 3136 is source-crater paired with any other lunar meteorite. Compositional data can be used to address source-crater pairing because in regoliths and regolith breccias from a given site, two samples may differ in composition but nevertheless consist of the same components, albeit in slightly different proportions [1, 2]. As a consequence, on some 2-element plots regolith

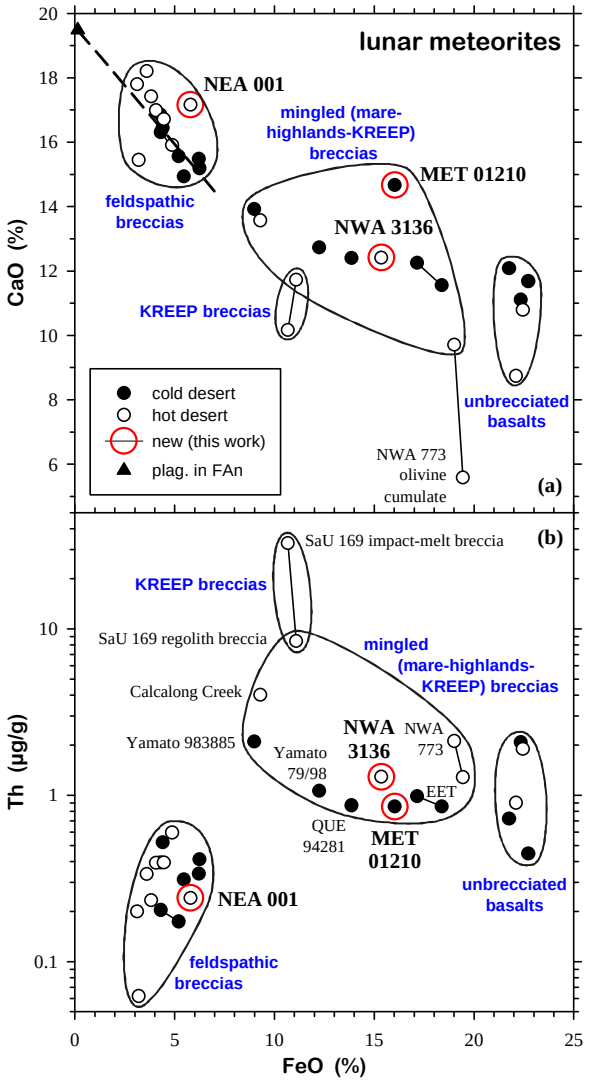

Figure 1. All lunar meteorites for which there are data are plotted. Points connected by a line represent different stones of a pair or different lithologies within a single stone. In (a), the dashed line is defined by the mean composition of plagioclase in ferroan anorthosite (triangle) and the mean composition of the cold-desert feldspathic meteorites. Several hot-desert meteorites, including NEA 001, are enriched in CaO from terrestrial calcite.

subsamples tend to plot along mixing lines between end-member lithologic components. For example, QUE 94281 and Yamato 793274/981031 are strongly suspected to be source-crater paired [6,7] and subsamples of the two meteorites overlap in composition (Fig. 2). In Fig. 2a subsamples of NWA 3136 plot near the end of the trend of EET 87/96 subsamples, suggesting a possible relationship. However, in Fig. 2b it is clear that NWA 3136 must be unrelated.

Overall, NEA 001 is most similar in composition to Yamato 79119 and, to a lesser extent, Yamato, 82192/3, ALHA 81005, and PCA 02007 (e.g., Fig. 3a). NEA 001 is coarse grained and subsamples scatter more in composition than most other feldspathic lunar meteorites that we have studied (Fig. 3b). (The exception is Yamato 82/86; for clarity individual subsamples of Yamato 82/86 are not plotted in Fig 3b.) Because all of the feldspathic lunar meteorites are similar in composition, to a first approximation, compositional arguments can, at best, provide only weak evidence for or against source-crater pairing. Certain element pairs are useful, however, because they reflect important lithological differences. The Cr/Sc ratio, for example, correlates strongly with Mg/Fe among feldspathic lunar meteorites, and both ratios vary considerably among the feldspathic lunar meteorites. When Sc and Cr data for subsamples are considered, there is no evidence to suggest that NEA 001 is related to Yamato 791197. NEA 001 could, however, represent a regolith like ALHA81005, but with a greater proportion (~2%) of mare basalt (with high Sc and low Cr/Sc; see Fig. 3b).

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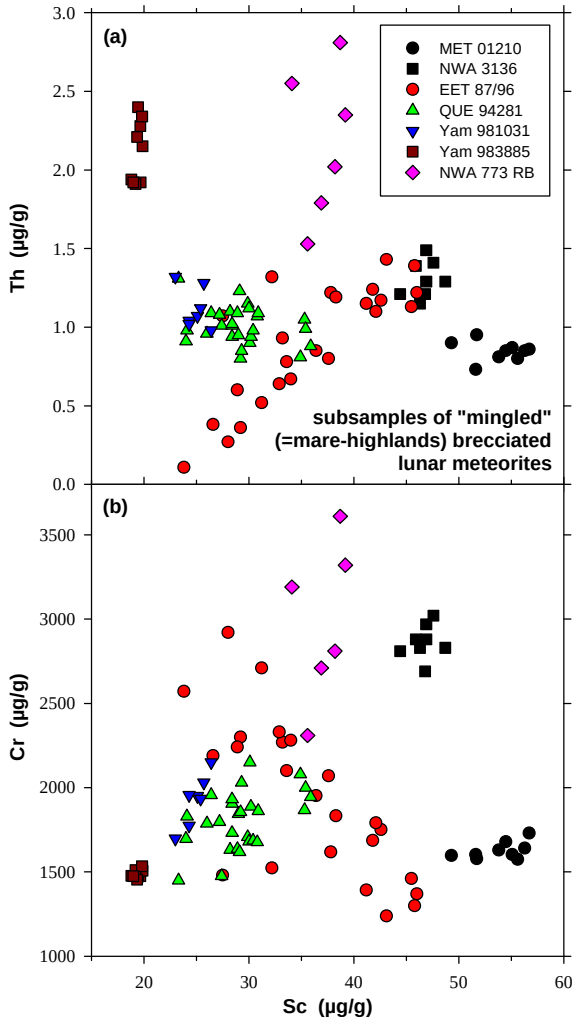

Figure 2. Subsamples of regolith breccias tend to cluster or plot along mixing lines. There is little or no evidence here to suggest that MET 01210 or NWA 3136 is related to another meteorite. All low-Th "mingled" (mare-highlands breccias) are plotted.

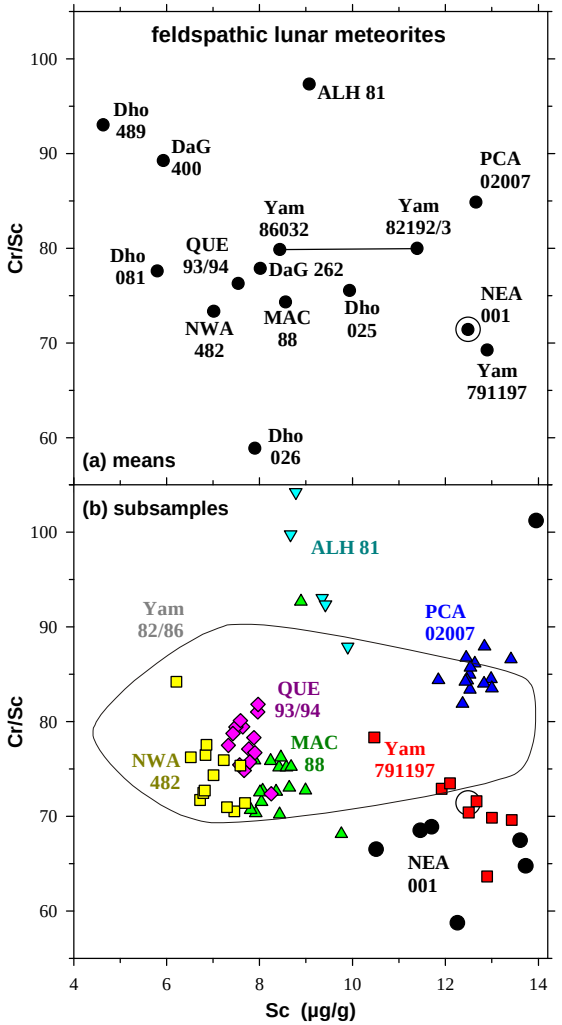

Figure 3. Sc and Cr/Sc differentiate feldspathic lunar meteorites and both elements are determined precisely (1-2%) by INAA. (a) Mean compositions. (b) Subsamples: NEA 001 subsamples do not plot along the trend of Yamato 791197 subsamples. NEA 001 might derive from a regolith like that of ALHA 81005 but with a greater proportion of mare basalt. The large field represents the range of Yamato 82192/821933/86032 subsamples (paired).