LUNAR TERRANES AND THE COMPOSITION OF THE REGOLITH. Randy L. Korotev, Department of Earth and Planetary Sciences, Campus Box 1169, Washington University, St. Louis, MO 63130 (rlk@levee.wustl.edu)

Introduction: In companion abstracts we suggest that the long-standing 'mare-highlands' dichotomy for the provinces of the lunar surface is no longer adequate in light of the new, global view of the Moon that we have obtained from the Clementine and Lunar Prospector missions [1–3]. The "Procellarum KREEP Terrane," i.e., the unique, mafic, Th-rich province in the Procellarum region [4–6], is distinct from the "Feldspathic Highlands Terrane" and originates from a major, lateral, geochemical differentiation early in lunar history. Here, the composition of lunar regolith is considered in the context of the terrane concept.

Terranes and Mixing: The composition of soil samples (<1-mm fines) collected on the Apollo missions can be modeled reasonably well as mixtures of three kinds of materials (Figs. 1–3; [7]):

(1) mare material of local provenance
(2) material of the Procellarum KREEP Terrane
(3) material of the Feldspathic Highlands Terrane

The mare material consists of crystalline mare basalt, volcanic glass, and brecciation products derived therefrom. Mare material in the Apollo soils derives from maria in both the Procellarum KREEP Terrane (e.g., Apollo 12) and the Feldspathic Highlands Terrane (Apollo 11).

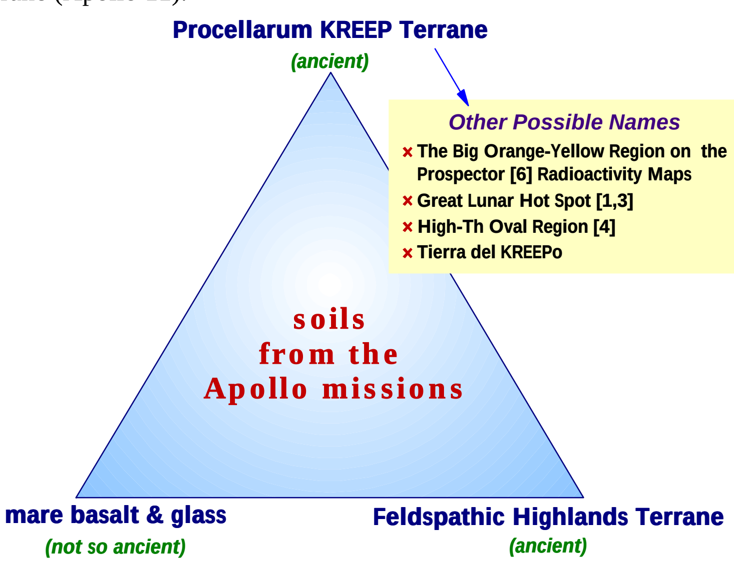

Figure. 1. Soils from the Apollo missions consist of materials from three geochemical provinces. In most Apollo soils, material from the Procellarum KREEP Terrane [1–3] is carried by Th-rich, mafic impact-melt breccias ("LKFM"). Although usually regarded as "highland" samples, these breccias probably do not derive from impacts into the Feldspathic Highlands Terrane [3].

Most of the Apollo sites were in or near the Procellarum KREEP Terrane [e.g., 8]. However in Apollo soils, most of the material of the Procellarum KREEP Terrane is not KREEP basalt, but mafic impact-melt breccias ("LKFM," "MKFM," and "VHA basalts") that were formed by impacts into the Procellarum KREEP Terrane [5].

It has been assumed by some that the principal material of the surface of the Feldspathic Highlands Terrane is (or was) ferroan anorthosite [e.g., 9,10] and, implicitly, that any Fe and Mg in highlands regolith derives from the other terranes, the maria, or from Mg-suite rocks (which, in some views, are intrusives into the Feldspathic Highlands Terrane [11,10] but which, in our view, may be unique to the Procellarum KREEP Terrane [3]). In regions of the Feldspathic Highlands Terrane uncontaminated by mare material or material of the Procellarum KREEP Terrane, however, highly feldspathic ferroan anorthosite such as samples found at Apollos 15 and 16 (typically >34% Al_2O_3) is probably rare. Most rocks intrinsic to this terrane are noritic or troctolitic anorthosites (28% Al_2O_3; $Mg' = 69 \pm 5$), at least on average [12,13].

Methods: Compositions of Apollo soils were modeled as mixtures of lithologic components occurring at the respective sites that represented the three apices of Figs. 1 and 2 [e.g., 14,15].

Results: Figs. 2 and 3 show that few Apollo soils are dominated by material of a single terrane; nearly all are mixtures. Each of the three possible 2-component mixtures are represented (Apollos 11, 12 and 16) and soils from the nominally "highland" stations of Apollos 15 and 17 (Apennine Front, North Massif) are subequal mixtures of all three components.

It is possible that material of the South-Pole–Aitken Terrane [1] also occurs at the Apollo sites, but because it is probably mainly feldspathic material, it is not compositionally distinct from the material of the Feldspathic Highlands Terrane.

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References: [1] Jolliff B. L. et al. (1999) this volume (terranes); [2] Wieczorek M. A. et al. (1999) this volume (terranes); [3] Korotev R. L. (1999) this volume (Great Lunar Hot Spot); [4] Haskin L. A. (1998) *J. Geophys. Res.* **103**, 1679–1689; [5] Haskin L. A. et al. (1998) *Meteoritics & Planet. Sci.* **33**, 959–975; [6] Lawrence D. J. et al. (1998) *Science* **281**, 1484–1489; [7] Korotev R. L. (1999) Workshop on *New Views of the Moon: Integrated Remotely Sensed, Geophysical, and Sample Datasets*, abstract number 6011; [8] Gillis J. J. et al. (1999) this volume (terranes); [9] Kempa M. J., Papike J. J., and White C. (1980) *PLPSC11*, 1341–1355; [10] Spudis P. D. and Davis P. A. (1986) *PLPSC17*, E84–E90; [11] Warren P. H. (1988) *PLPSC18*, 233–241; [12] Korotev R. L. (1999) this volume (feldspathic upper crust); [13] Korotev R. L. & Haskin L. A. (1988). *Geochim. Cosmochim. Acta* **52**, 1795–1813; [14] Korotev R. L. & Kremser D. T. (1992) *PLPSC22*, 275–301; [15] Korotev R. L. (1997) *Meteoritics & Planet. Sci.* **32**, 447–478.

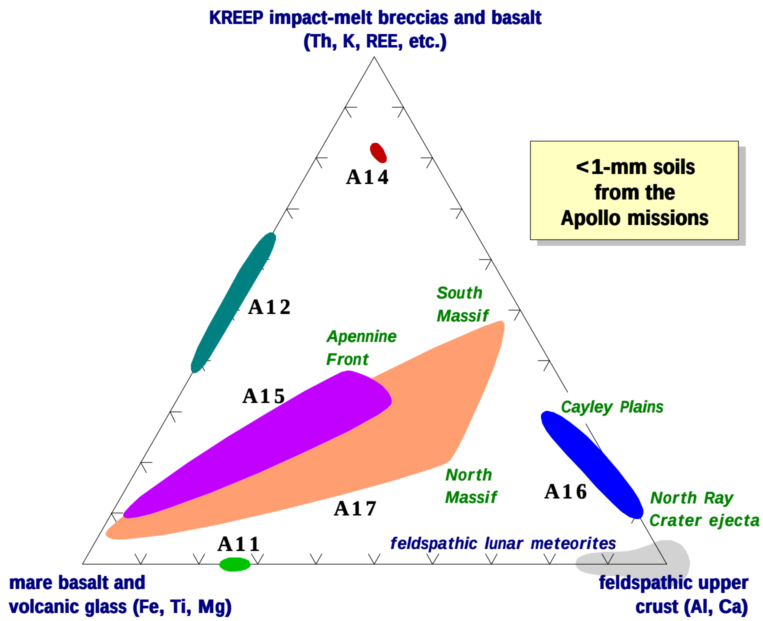

Figure 2. Results of mass balance models (e.g., [14,15]) for regolith of the Apollo sites. The apices of this plot correspond to those of Fig. 1. The Apollo 15 and 17 sites were at the interface of maria and highlands and both were in or near the Procellarum KREEP Terrane, thus soils from these mission cover a large range. Note that soils from Apollos 11 and 12, both mare sites, are substantially contaminated with materials from the Feldspathic Highlands Terrane (Apollo 11) or Procellarum KREEP Terrane (Apollo 12). Few Apollo soils are >80% mare basalt and only those from North Ray crater at Apollo 16 approach the composition of typical feldspathic highlands. Among lunar samples, the feldspathic lunar meteorites (range shown in gray) are most representative of regolith from the Feldspathic Highlands Terrane [12].

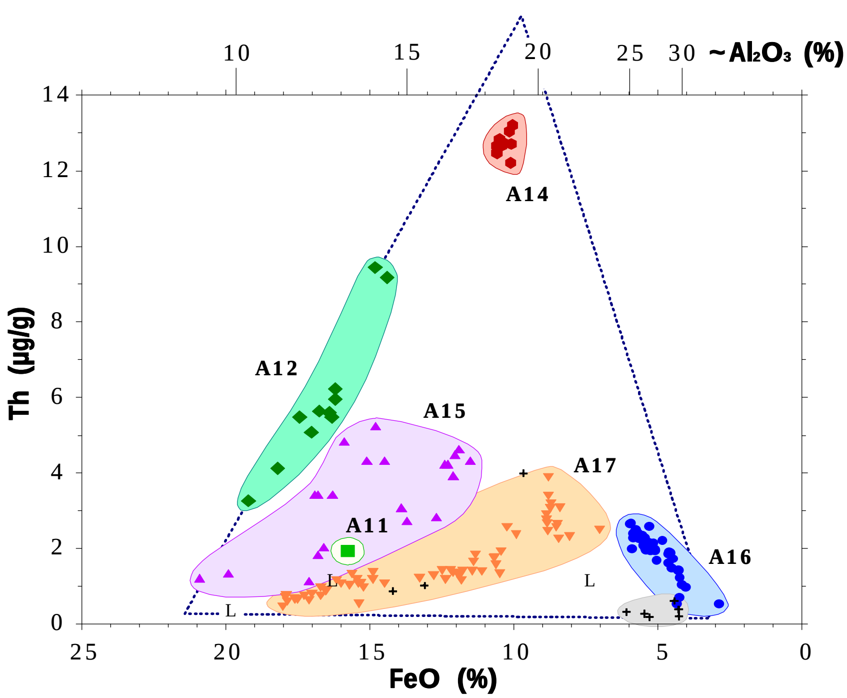

Figure 3. The relationships of Fig. 2 can be seen in raw concentration data for elements that can be determined by remote sensing. Each point represents an Apollo surface soil sample (◆, ▲, etc.), lunar meteorite regolith breccia (**+**), or Russian Luna site (L).