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A new look at the Apollo 11 regolith and KREEP

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Abstract. Although the Apollo 11 mission landed in Mare Tranquillitatis, ~50 km from the nearest exposure of highlands, small nonmare particles are conspicuous in the regolith. The nonmare portion of the Apollo 11 regolith is compositionally similar to the Apollo 16 regolith. At both sites most of the nonmare material is from the feldspathic highlands, but some is mafic impact-melt breccia with the chemical signature known as KREEP for its high concentrations of K, rare earth elements, and P. The composition of the Apollo 11 regolith corresponds best to a mixture of 66% crystalline mare basalt, 5% orange volcanic glass, 20% material of the feldspathic highlands, 8% KREEP-bearing impact-melt breccia, and 1% meteoritic material. The volcanic-glass and KREEP-bearing melt-breccia components account for the high concentrations of Mg and Cr in the regolith. The most KREEP-rich sample known from Apollo 11, 10085,1187, is an impact-melt breccia that bears a strong textural and compositional similarity to a unique Apollo 16 melt breccia, 64815. Although not of the maria, such breccias are also not of the highlands provenance. Global data obtained from orbit show that KREEP-bearing materials are most common at low elevations in the Imbrium-Procellarum region and are rare at high elevations. Thus, as at Apollo 16, the KREEP-bearing breccias of Apollo 11 are probably ejecta from the Imbrium impact into the low-lying, Procellarum KREEP Terrane. On the basis of these observation and others, we suggest that the general acceptance of KREEP as a material of the highlands is not supported by the data and results largely from historical accident.