Samples of 28 Apollo 15 regolith breccias were analyzed for 25-30 elements by instrumental neutron activation as part of a consortium study involving D.S. McKay, R.V. Morris, and D.D. Bogard. The samples were selected to be "matrix rich", i.e., as free of clasts as possible. Eighteen surface soil samples were analyzed for comparison.

The purposes of this study are to compare the chemical compositions of the breccias to each other and to the compositions of the Apollo 15 soils and to contrast these observations with those on Apollo 16 regolith breccias [1]. The following observations are made:

1) Concentrations of siderophile elements in the breccia matrix samples are similar to those of the soils, but perhaps slightly lower, the same trend as observed at Apollo 16 [1]. However, most Apollo 15 regolith breccias have considerably greater values of Is/FeO than the Apollo 16 regolith breccias [3], indicating that the Apollo 15 breccias contain a greater proportion of regolith with significant surface exposure. Based on definitions developed for soils [4], one sample, 15026, is mature and 7 samples are submature [3]. Siderophile concentrations in those regolith breccias are essentially the same as for submature and mature Apollo 15 soils.

2) The composition of the matrix of many Apollo 15 regolith breccias falls within the range observed for the Apollo 15 soils (Fig. 1). About 40% of the breccias, however, have higher concentrations of incompatible trace elements (ITE) than the soils and 4 samples having ITE concentrations nearly as high as KREEP. These breccias must contain a higher proportion of KREEP or KREEP-like material than is present in the <1mm fines. One explanation is that the KREEP component is recent crater ejecta which occurs as a population of a coarse-grained lithic fragments in the soil. This population may not be a significant component of the <1mm fines because it has not yet been comminuted to this size range, but it may occur as clasts in the breccias and these have been sampled despite the effort to avoid clasts. Perhaps instead the ITE-rich samples were not formed in the soil in which they were found and represent an unsampled KREEPy soil from some unknown location. Yet another possibility is that they represent some older regolith at the Apollo 15 site and the current regolith is diluted with material of lower ITE concentrations. The consortium approach to the study of these samples should allow eliminating some of these possibilities.

3) The only other sample which lies significantly outside the range of the soils, 15688, is indistinguishable in composition from a mare basalt.

4) Compositions of the green glass-rich samples 15426 and 15427 (station 7, Spur crater, Apennine front) are similar to that of the 15421 soil and are distinct from samples not containing a large fraction of green glass. These samples, other station 7 soils, and station 7 regolith breccia 15459 fall on a mixing trend (Fig. 1) between "pure" green glass separated from the 15421 soil [2] and the station 2 soils (St. George crater, Apennine front). The other two station 7 regolith breccias are among those rich in ITE.

5) Except for most ITE-rich samples, most of the regolith breccias are similar in composition to the surface soils found at the station at which they were collected. All but 1 of the 10 breccia samples from station 6 are very similar to the station 6 soils or station 6 soils with some admixed KREEP. (Two samples of 1545 were analyzed, hence there are 11 station 6 points in Fig. 1.) There is a much stronger correlation than at Apollo 16
between the surface maturity index Is/FeO and the degree of compositional similarity between the regolith breccias and the soils. All of the submature and mature regolith breccias (Is/FeO > 30) are similar in composition to each other and to the soils from the stations at which they were collected. Conversely, the breccias with compositions most dissimilar to the soils have low values of Is/FeO. For example, the four samples richest in ITE have Is/FeO values of 0, 9, 21, and 26. The mare basalt-like sample, 15688, from station 9a has an Is/FeO value of zero and probably a small regolith component.

6) The 4 samples most enriched in ITE are mutually similar in composition but were found at 4 different stations, including both mare and Apennine front stations. The proportion of mare-derived material in these samples is at the low end of the range observed for the soils (Fig. 1). No regolith breccia sample with Sc and Fe concentrations as high and Al concentration as low as those of the stations 1, 4, 9, and 9a soils has high ITE concentrations. These observations favor the possibility that the high-ITE breccias are exotic at least to the station at which they were found.

REFERENCES

Figure 1. A plot of the concentration of Sm against that of Sc for the regolith breccias and the Apollo 15 soils. Sm is a typical and precisely measured incompatible trace element and can be regarded as a measure of the KREEP content of polymict samples. Sc, which is also precisely measured, correlates with the content of mare basalt in polymict samples at Apollo 15. Symbols for the regolith breccias are coded for maturity index [3]. Fields for soils (labelled by station no.), KREEP and mare basalt are indicated.