GEOCHEMICAL SURVEY OF APOLLO 16 REGOLITH BRECCIAS. Randy L. Korotev Dept. of Earth & Planetary Sciences and the McDonnell Center for the Space Sciences, Washington University, St. Louis, MO 63130

Samples of 19 Apollo 16 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.

The purposes of this study are to compare the chemical compositions of the breccias to each other and to the compositions of the Apollo 16 soils and to contrast these observations with those made for the Apollo 15 regolith breccias [6]. The following observations are made:

1) Most Apollo 16 surface soils are submature and mature with respect to surface exposure [9]. These have high concentrations of siderophile elements (SE) as a result of 2-3% meteoritic component. Surface maturity indices for the Apollo 16 regolith breccias are very low compared to the soils [8], but the average concentrations of SE are only slightly lower than for the submature and mature soils. Apollo 16 soils with Is/FeO values as low as found in the breccias usually have much lower concentrations of SE. Breccia 63507 is very rich in SE (1020 ppm Ni and 51 ppb Ir) and has the greatest value of Is/FeO, but is still only "submature"; all the rest are immature [8].

2) The molar ratio Mg/(Mg+Fe) is more variable in the breccias than in the soils and averages slighlty, but probably insignificantly, greater (0.69 +/- 0.025 vs. 0.67 +/- 0.02). As this ratio differs for different high-Fe and Mg components at the site, it is useful for evaluating the relative importance of different components in polymict samples.

3) The breccia matrix samples are generally more anorthositic than the Apollo 16 surface soils. None has Sc concentrations as high as those of the stations 5 and 6 soils (Fig. 1). Six of the 19 samples have Sc concentrations lower than those of any Apollo 16 surface soil. Of the four of these for which Al was determined, two have greater Al concentrations. However, these samples are similar to some of the more anorthositic soil samples from the 60009/10 core. As with these core samples [e.g., 3], the breccias are the compositional equivalents of a two component mixture of typical soil material (i.e., 9-10 ppm Sc and 6 ppm Sm, Fig. 1) "diluted" with anorthosite. The anorthosite may be present as small clasts in the matrix-rich samples. The "diluent" must be anorthosite and not a noritic anorthosite material such as that associated with North Ray crater which has a significant concentration of Fe, Sc, etc. (Note in Fig. 1 that soils from North Ray crater usually plot to the high-Sc side of the trend of the submature and mature soils). There is probably little North Ray crater component in the breccias.

4) Six of the 19 breccia matrix samples have greater concentrations of Sm than do soils with the same Sc concentration (Fig. 1). Two of the three breccia samples with the greatest absolute Sm concentrations have Al concentrations at the extreme low end of the range for the soils. Al was not measured in the third (60019) in this work, but the analysis of [10] has even lower Al and higher REE. Of the rock types found at Apollo 16 with high concentrations of incompatible trace elements (ITE), the poikilitic melt breccias (e.g., 65015) are the most likely candidates as KREEP is rare. The overall composition of the most ITE-rich regolith breccias is most similar to that of the VHA-type melt breccias, but slightly more anorthositic.

5) Compositions of surface soils from a given Apollo 16 station are usually similar to each other and the range usually overlaps with that from only a few other stations [4]. The regolith breccias are much less systematic.

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Eleven of the breccia matrix samples are from the LM and station 1 area. Surface soils from these stations form a relatively tight compositional cluster (except for 60051 and 61221). The regolith breccias from these two stations cover the range observed for all the breccia samples. Surface soils from stations 5 and 6 have the highest concentrations of Sm. Two of the five breccias from these stations are among the five samples richer in Sm than any surface soil. The soils from station 11 contain the lowest ITE concentrations among the surface soils. No regolith breccias were found at station 11, but two of the three found at nearby station 13 are among the three samples with the lowest Sm concentrations.

6) The third station 13 regolith breccia is the submature sample, 63507, discussed above. It is similar in composition to the LM area soils. It is also similar to the sample with the next highest value of Is/FeO, 60255. The only other samples with Is/FeO > 7 are 61175 and 61536, which are compositionally similar to the station 13 soils. In fact, the 4 breccia matrix samples with the greatest values of Is/FeO are among the only 6 samples which fall inside the compositional range of the surface soils in Fig. 1. The tendency of regolith breccias with high Is/FeO values to resemble most closely the soils in bulk composition is even more striking in the Apollo 15 samples [6]. A better statement of the observation is, perhaps as expected, that regolith breccias with high maturity indices are the products of incorporation of a high proportion of mature regolith.

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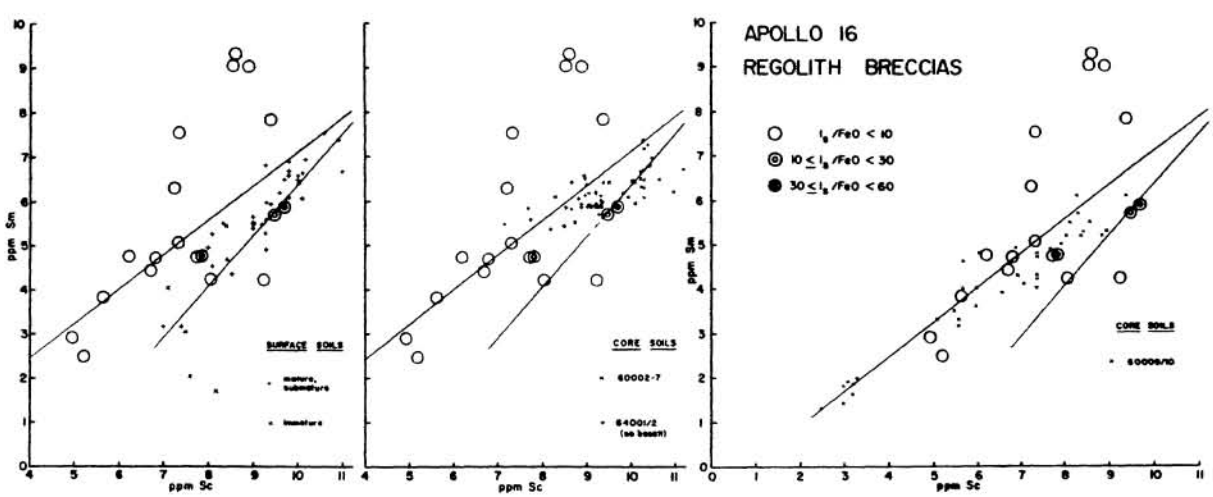
Figure 1. Plots of the concentration of Sm against that of Sc for the regolith breccias and the Apollo 16 soils. Sm is a typical and precisely measured incompatible trace element and can be regarded as a measure of the KREEP content of polymict samples. Sc, which partitions preferentially into clinopyroxene during igneous processes and is also precisely measured, anticorrelates with Al and feldspar content. Symbols for the regolith breccias are coded for maturity index [8]. The two lines in each plot represent the mixing trends for Apollo 16 soils discussed by [4]. One trend is between the high Sc and Sm soils (e.g., station 5 and 6) and the North Ray crater soils (station 11); the other is between the high Sc and Sm soils and anorthosite (essentially zero ppm each Sc and Sm). Soils from stations 4 and 8 and the 60009/10 core lie on the "anorthosite trend" as do the most Sc-poor regolith breccias. Sources of soil data: surface soils [4], deep drill core [5], 64001/2 [5,7], and 60009/10 [1,2,3].



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