COMPOSITIONAL STUDY OF TWENTY-ONE APOLLO 15 LUNAR ROCKS AND SOILS *

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Data are presented for the abundances of 29 major, minor, and trace elements in 14 igneous rocks and 7 soils (from Stations 2 and 6) collected by the Apollo 15 Mission at the base of the Apennine Front and the Hadley Rille Sites. The semimicro, analytical system used in these determinations was a combination of chemical, X-ray fluorescence, and emission spectrographic techniques described previously (1,2,3).

The analyzed Apollo 15 igneous rocks fall into two general types: vesicular, porphyritic basalts and vuggy, medium-grained gabbros. The ranges of the major element composition (in weight percent) are: SiO_2 (44-49), Al_2O_3 (5-10), FeO (19-23), MgO (8-12), CaO (9-11), Na_2O (0.3-0.4), K_2O (0.05-0.08), TiO_2 (1-3), P_2O_5 (0.05-0.12), MnO (0.25-0.31), Cr_2O_3 (0.3-0.7). Compared with the igneous rocks returned from previous missions, the average composition of the Apollo 15 basalts is lower in CaO, Na_2O, K_2O, P_2O_5, Rb, Ba, Be, Nb, Y, Yb, and Zr, and is higher in FeO, MgO, MnO, Cr_2O_3, Cu, and V. Some Apollo 15 elemental ratios calculated from average values of composition data are: Si/Al 4.8, Ca/Si 0.33, Mg/Fe 0.37, Fe/Ni 2200, Cr/Ni 43, Ni/Co 1.2, Al/Ti 3.6, K/Ba 9.2, Ba/V 0.32, Ba/Sr 0.49, and Cr/V 17. Compared with elemental ratios derived for data concerning igneous rocks collected by previous Apollo missions, the Ca/Si and Ba/Sr ratios are lowest and the Si/Al ratio is highest in the Apollo 15 samples.

Comparison of the various Apollo 15 soils shows that their elemental abundances are similar, except for slight variations in some constituents. The major element compositions of these soils range (in weight percent) as follows: SiO_2 (46-47), Al_2O_3 (16-18), FeO (11-12), MgO (10-11), CaO (11-12), Na_2O (0.4-0.5), K_2O (0.18-0.22), TiO_2 (1.3-1.5), P_2O_5 (0.15-0.25), MnO (0.15-0.17), and Cr_2O_3 (0.22-0.30). Compared to Station 2 soils, Station 6 soils are higher in SiO_2, Na_2O, P_2O_5, Cr_2O_3, Zn, Cu, Nb, La, Y, Yb, and Zr but lower in Al_2O_3. Excepting SiO_2, the major-element composition of the Apollo 15 highland soils is more like those collected by the Apollo 14 Mission at the other highland area (Fra Mauro Formation) than to the maria soils. The highland soils (Fra Mauro and Apennine-Hadley sites)

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are higher in Al_2O_3 and, to a lesser degree, in SiO_2 but notably lower in FeO when compared to the Apollo 11 and 12 maria soils.

Compared with the Apollo 15 igneous rocks, the Apollo 15 soils are characterized by higher Al_2O_3, CaO, K_2O, Na_2O, P_2O_5, Li, Rb, Ni, Ba, Sr, Be, Nb, La, Y, Yb, and Zr but lower FeO, TiO_2, MnO, Ga, Co, V, and Sc contents. Another notable difference between these igneous rocks and soils is that the soils have a reasonably constant FeO, MgO, CaO, and MnO content. The higher concentrations of Ni in the analyzed soils as compared to the rocks can reflect a measurable meteoritic component.

Similar to the lunar soils returned by previous Apollo missions, each of the Apollo 15 soils has a greater reducing capacity (ranging from +1.49 to +2.53 weight percent expressed as FeO) than can be accounted for by its FeO content. The Apollo 15 igneous rocks exhibit a much lowerexcess reducing capacity than the related soils, ranging from 0.00 to 0.58 percent. On gabbro (sample 15065,31) has a greater reducing capacity than the other igneous rocks, being comparable to that of lunar soils - i.e., +1.28 percent. This excess reducing capacity may reflect the influence of a highly reducing environment or an oxygen deficiency during the formative sequences.

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