
The data given in Table 1 are selected from a collection of over 40 new analyses of lunar rocks. Table 2 lists 10 new analyses of Apollo 16 rocks and soils. These analyses along with other published data suggest that lunar rocks can be categorized into four groups: 1) Mare and mare-like basalts, 2) KREEP basalts, with a subgroup centered around 14310 and perhaps containing Apollo 16 KREEP, 3) A newly recognized group of Very High Al₂O₃ basalts (VHA basalts) (such as 61156, 62295, 61016B, 15273, 43, and 2200766) with 20-24% Al₂O₃, and 4) Anorthositic rocks with greater than 24% Al₂O₃. The first three categories have clearly negative Eu and Sr anomalies. The fourth category usually has positive Eu and Sr anomalies. Definite examples of groups 2 and 3 occur at Apollo 15 and 16 sites, with one or more of these groups present at all sites. The REE, Ba, and U values in the VHA basalts are 1/3 to 1/4 those of KREEP basalts. The relative abundance of trivalent REE, Ba, and U is essentially identical with that of KREEP basalts. The grouping of these rock types in terms of Al₂O₃, Eu, and Sr is illustrated in Figures 1 and 2. Similar groups can be identified on FeO-MgO plots (Gast, this volume). REE, Ba, and U values for mare basalts (Figure 4 and Table 1) show that there are mare-like basalts with lower FeO and higher Al₂O₃ values than mare basalts that have REE, Ba, and U patterns above those of Apollo 15 and Apollo 12 (not shown) mare basalts. The chemical characteristics of the four categories described here have the following genetic constraints: 1) VHA basalts are not a mixture of KREEP basalts and anorthosite, 2) KREEP basalts cannot be residuum from the formation of anorthosites or from crystallization of VHA basalts, 3) VHA basalts cannot be derived from the same source as KREEP basalts simply by increasing the extent of partial melting, and 4) anorthosites were derived from liquids with a wide range of trace element concentrations. Pure plagioclase anorthosites such as 15415 have the lowest Sr and Eu values, suggesting that they are the most primitive anorthosites yet analyzed. Anorthosites like 64423, 13, 1, but not anorthosites like 15415, may have been derived from VHA basalts. We suggest that the differences in composition observed in rocks with negative anomalies (groups 1-3) originated during partial melting; i.e., during the formation of these liquids. The VHA basalts do not correspond to "Highland" basalt or to "low-K Fra Mauro" basalts of Reid et al., (Meteoritics, 1972). A consideration of TiO₂ and REE values suggests that "Highland" basalt, if a true rock type, is to be associated with rocks like 15418 and 15415. Alternatively, "Highland" basalt may be a mechanical mixture of VHA basalts and materials more plagioclase rich than "Highland" basalt.
LUNAR ROCK TYPES

Bansal, B. M.

Table 1. Chemical data for known or proposed primary lunar rock types. All data are from ion exchange procedures followed by colorimetry (Al₂O₃), atomic absorption (FeO, MgO, CaO and Na₂O) and stable isotope dilution mass spectrometry (all else).

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Table 1 (continued). *These values may be up to 5% low.

Table 2. X-ray fluorescence analyses of Apollo 16 samples.

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Fig. 1. Eu and \( \text{Al}_2\text{O}_3 \) data for lunar rock types. Highland basalt (Reid et al., 1972) has \( \text{Al}_2\text{O}_3 \approx 26\% \) and thus may be a mixture of very high \( \text{Al}_2\text{O}_3 \) basalts and more aluminous materials.

Fig. 2. Sr and \( \text{Al}_2\text{O}_3 \) data for lunar rock types. Note the wide range in Sr and Eu (Fig. 1) values for samples with more than 26\% \( \text{Al}_2\text{O}_3 \).

Fig. 3. REE, Ba and U data for several lunar samples with more than 16\% \( \text{Al}_2\text{O}_3 \) and a green glass clod (15303 GGC). Note the general similarity in slope for the aluminous samples.

Fig. 4. REE, Ba and U data for A-15 mare basalts and four examples of mare-like basalts. Note that the slope of the pattern approaches that of the aluminous samples in Fig. 3.