CHEMICAL COMPOSITION OF LUNAR ANORTHOSITES AND THEIR PARENT LIQUIDS. N. J. Hubbard, P. W. Gast, and C. Meyer, Jr., NASA Manned Spacecraft Center, Houston, Texas 77058.

Two chemically distinct types of lunar anorthosites and related high Al basaltic rocks have been found in the lunar samples. The most common type of anorthosite has low K concentrations, is exemplified by the Apollo 15 specimen 15415, and is chemically similar to the type described by Wood et al. (1970) in the Apollo 11 soil. There is evidence for a second type of lunar anorthosite characterized by high K concentrations (Fig. 1) and containing minor minerals such as zircon, apatite, ilmenite and K-feldspar (Table 1 and Fig. 1). The mineral assemblages of the high K groups suggest that they were derived from KREEP basalts.

Our isotope dilution data (Table 2 and Fig. 2) show: 1) that Eu and Sr values are relatively constant except for one high K sample (12033,97,7) which has much higher Eu and Sr contents and 2) that abundances of Ba and the trivalent rare earths vary markedly. The second characteristic is related to mineralogical purity, as illustrated by plotting Ce vs Mg (Fig. 3).

Samples 15415 and 12033,97,7 are nearly pure plagioclase and we assume that their chemical composition is that of liquidus plagioclases. We can calculate some chemical characteristics of their parent liquids using liquid/plagioclase distribution coefficients measured on coexisting plagioclase phenocrysts and basalt glass or fine grained matrix from oceanic ridge basalts (last two columns Table 2) except for Eu (Green et al., 1971). The calculated rare earth, Ba and Sr patterns are shown in Fig. 4 along with the plagioclase data from which they were calculated and the pattern for KREEP basalt glass from 12033 soil. The calculated pattern for the low K anorthosites is unlike that of any lunar basalt observed to date and is essentially chondritic in relative abundances although much higher in concentrations. In particular the calculated Eu anomaly is very small and may really be nonexistent. Conversely, the KREEP anorthosite fragment appears to have crystallized from a liquid with substantial Eu and Sr anomalies and with much higher rare earth and Ba concentrations, similar to that observed for KREEP basalt glass.

Hubbard and Gast (1971) have suggested that the KREEP type of basalt was produced by 1-3% partial melting of a shallow primitive layer (<100 km deep) in the moon that was substantially enriched, relative to chondrites, in refractory trace elements, Ca and Al. They further suggested the plagioclase is a major component of that region of the moon. We suggest that the parent liquid calculated for the low K anorthosites was produced by much more extensive melting of a similar feldspar rich region.

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TABLE 1. Mineral Assemblages and K_2O Contents of Plagioclases from Anorthositic Coarse Fines:

High K Type	
14321,17	98% Plagioclase An85; 1% Zircon, 0.5% Whitlockite, 0.5% Pyroxene. K_2O = 0.15%.
12033,85c	99% Plagioclase An80, 1% Olivine Fa30, 1% Ilmenite. K_2O = 0.20%.
*12033,97,7	100% Shocked Plagioclase An88, small patches of high K content. K_2O = 0.30%.
Low K Type	
*14161,35,2	90% Plagioclase An95, 9% Olivine Fa40, 1% Orthopyroxene. K_2O = 0.04%.
*10085,11,146	White fragment donated by Elbert King. Not analyzed by microprobe. See Table 2 for partial chemical analysis.
*10085,11,47	White fragment donated by Elbert King. Not analyzed by microprobe. See Table 2 for partial chemical analysis.
10085,87,I	100% Plagioclase. K_2O = 0.01%.
10085,87,J	80% Plagioclase An95, 20% low Ca Clinopyroxene. K_2O = 0.01%.

*Samples that were analyzed by isotope dilution. See Table 2.

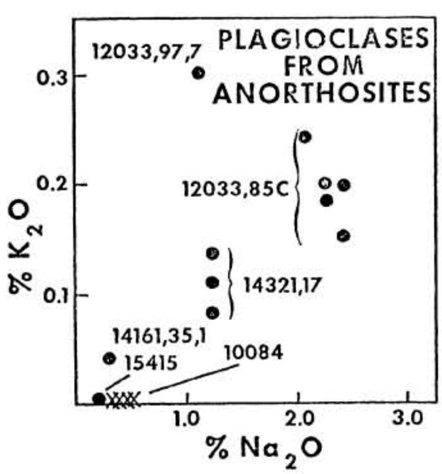

Fig. 1

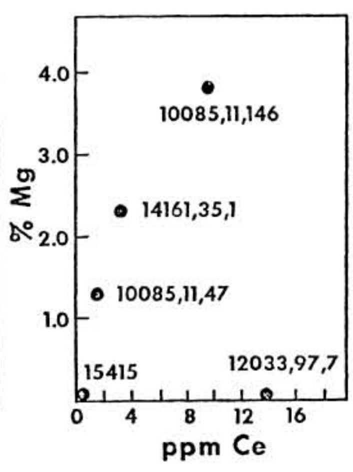

Fig. 3

Chemical Composition of Lunar Anorthosites and Their Parent Liquids

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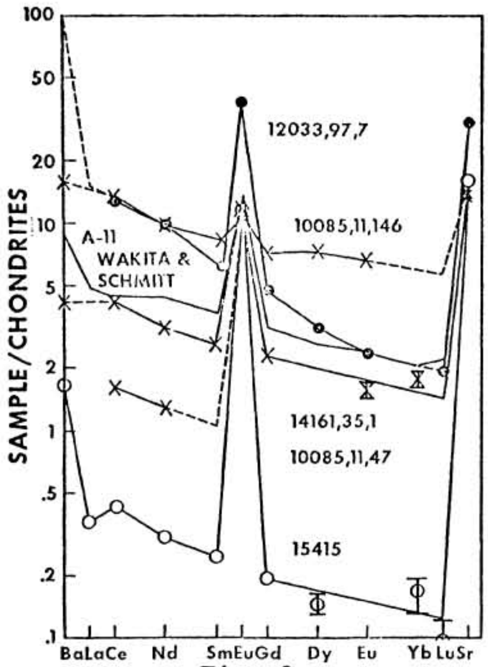

Fig. 2

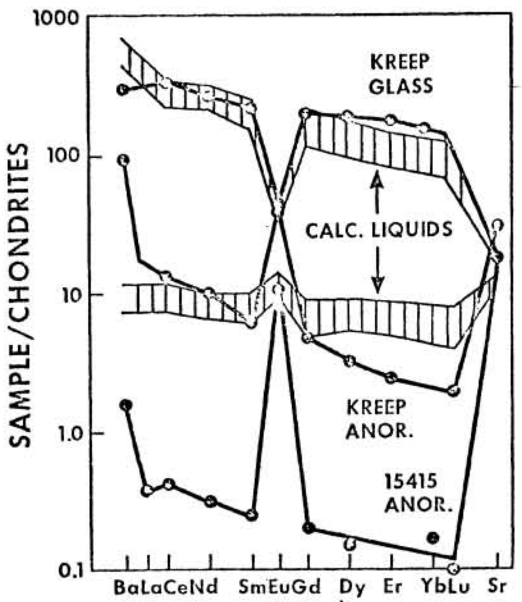

Fig. 4

TABLE 2

Chemical and Isotopic Data for Lunar Anorthosites and Related Fragments

	10085,11,47 3.1 mg	10085,11,146 5.2 mg	12033,97,7 38.2 mg	14161,35,1 11.1 mg	15415,11 53.3 mg	15415,11 90.9 mg	Range of Liquid/Plagioclase Distribution Coefficients
La ppm	-	-	-	-	-	0.118	
Ce "	1.3	9.59	12.8	3.33	0.32	0.35	27 - 18
Nd "	0.74	5.51	5.61	1.87	0.20	0.175	33 - 22
Sm "	0.35	1.55	1.14	0.49	0.049	0.0457	41 - 25
Eu "	0.648	0.842	2.63	0.756	0.807	0.806	1.2* - 0.8*
Gd "	-	1.83	1.19	-	0.06	0.050	46.0 - 24
Dy "	-	2.29	0.96	-	0.06	0.044	57 - 31
Er "	-	1.38	0.49	0.34	-	0.019	59 - 33
Yb "	-	1.71	-	0.37	0.05	0.035	63 - 34
Lu "	-	-	0.068	-	-	0.0034	
Ba "	26.3	61.4	356	16.0	6.2	6.28	7.1 - 4.6
Sr "	150	160	342	163	178		0.84 - 0.66
Ca %	-	10.3	11.5	12.7	-	-	
Mg %	1.54	3.81	0.038	2.30	0.0970	0.0966	
Rb ppm	-	1.27	2.87	0.32	0.17	0.15	
K "	-	549	2,060	148	127	120	
$Sr^{87/86}$	.69897 ±29	.70110 ±110	0.69963 ±10	0.69960 ±23	0.69938 +9 -18		
K/Rb	-	432	718	463	748	800	
U	-	-	-	0.058	0.011	0.015	
K/U	-	-	-	2,500	9,500		

*Values bracket those of Green et al. (10).