PETROLOGY AND CHEMISTRY OF SOME APOLLO 16 LUNAR SAMPLES; V.C. Juan, J.C. Chen, C.K. Huang, P.Y. Chen and C.M. Wang Lee; Institute of Geology, National Taiwan University.

An anorthositic breccia, 60015,126, consists mainly of plagioclase (82%) with minor amounts of clinopyroxene (2%) set in a fine-grained devitrified glassy matrix (16%). The rock has a highly cataclastic texture. Preferred orientation of deformed plagioclase grains has been observed. The plagioclase minerals are commonly shattered, fractured and pulverized. Bending and dislocation of the original twin lamellae are also observed. Some grain boundaries in the rock are obscured due to melting caused by stress. The glassy matrix, showing cryptocrystalline structure, may represent melting product of plagioclase now partially devitrified.

An anorthositic gabbroic breccia, 61016,217, contains two parts. The upper two thirds is composed of anorthositic gabbroic breccia while the lower one third is composed of a single piece of maskelynitized feldspar. The breccia portion consists of 40% shocked mineral clasts (including 38% maskelynite and 2% mafics) and 60% matrix. The original zoning and twinning of plagioclase have been completely destroyed. Some (14%) maskelynites show relict feldspar in the central portions of the grains suggesting weakening of the shock intensity from the outer rim toward the interior. The matrix constituting 60% of the breccia portion is composed mainly (50%) of fine-grained pyroxenes and opaques and minor (10%) maskelynite, recrystallized maskelynite and plagioclase. The pyroxenes are characteristically equant and show wavy extinction suggesting considerable recrystallization. The parental rock of 61016,217 may be a hetrogeneous anorthositic gabbro which has been intensely shocked.

The section of a gabbroic breccia, 67015,88, having a complex modal composition can be devided into two parts, the upper half consists of 70% lithic and mineral clasts and 30% matrix and the lower half contains 35% mineral clasts, 5% lithic clasts and 60% matrix. As a whole the section consists of 30% lithic clasts and 25% mineral clasts set in a fine-grained glassy matrix (45%). The lithic clasts ranging from 0.1 x 0.2 mm to 4.3 x 3.0 mm include (1) pre-existing breccias (12%) (2) anorthosites (12%) (3) non-mare type basalts (4%) and (4) gabbros (2%). The mineral clasts include 70% plagioclase, 15% olivine, 10% pyroxene and 5% opaques. Many mineral clasts show fractures, secdonary lamellar twins and gradational boundary indicating that they have been subjected to stress. The rock has a complex history revealing three generations of brecciation and annealing.

60015,67 and 61016,146 have been chemically analyzed (Table 1) by means of AAS and coloremetric methods. The chemical difference existing between 61016,146 (this report) and 61016,3 (1) is due to modal heterogeneity. The Apollo 16 rocks are generally characterized by their high aluminum and calcium but low iron, titanium, sodium and potassium contents.

Fig. 1 illustrates the correlation of Al_2O_3 abundance of CaO, ΣFeO and MgO in the Apollo 16 rocks. 14310,197 (2) and average KREEP (1) are also plotted for comparison. The correlation may be attributed to the fact that most of the rock forming elements are either strongly concentrated in or excluded from plagioclase. It is evident that the regular correlations between Ca, Fe, Mg and Al in the Apollo 16 breccias are due to the presence of rocks with composition similar to those of KREEP breccia (or 14310) and anorthositic breccia (60015,67).

The Apollo 16 breccias studied are distinctly more rich in plagioclase in clasts and in the matrix than Apollo 14 breccias (2). The common occurrence of plagioclase-rich clasts and abundant shock features in the breccias of the Cayley formation in this part of lunar highland indicate not only the anorthositic nature of the lunar crust but also the mechanism of impact process. The surface and near surface materials may represent mixture of major impact in an anorthositic terrane (3) with local ingredients produced from repeated secondary impact craters (4).

Table 1. Chemical analyses of breccias

		Anorthositic breccia 60015,67	Anorthositic gabbroic breccia 61016,146
SiO_2	(%)	43.97	44.00
TiO_2	(%)	0.02	0.66
Al_2O_3	(%)	35.83	24.90
ΣFeO	(%)	0.36	4.50
MnO	(%)	0.00	0.04
MgO	(%)	0.25	11.00
CaO	(%)	18.95	14.80
Na_2O	(%)	0.34	0.40
K_2O	(%)	0.01	0.07
		99.73	100.37
Co	(ppm)	44	51
Cr	(ppm)	<15	600
Cu	(ppm)	2	2
Li	(ppm)	<6	<6
Ni	(ppm)	30	268
Rb	(ppm)	<2	2.1
Sr	(ppm)	156	180

Taylor, et al. (5) suggested that highlands are composed mainly of gabbroic anorthosite low K and medium K Fra-Mauro basalts and subordinate anorthosite. Rocks with modal composition similar to that of 68416,77 (6) might be abundant in the lunar highlands and they could be the parental rocks for the feldspar clasts in the Apollo 16 breccias. Juan, et al. (2) have emphasized that 14310 might represent a primary high-Al basaltic magma that played an extremely important role of developing a whole spectrum of differentiates in the early stage of lunar evolution. Rocks with compositions similar to 14310 and its differentiates should be considered as important ingredients in the formation of Apollo 16 regoliths.

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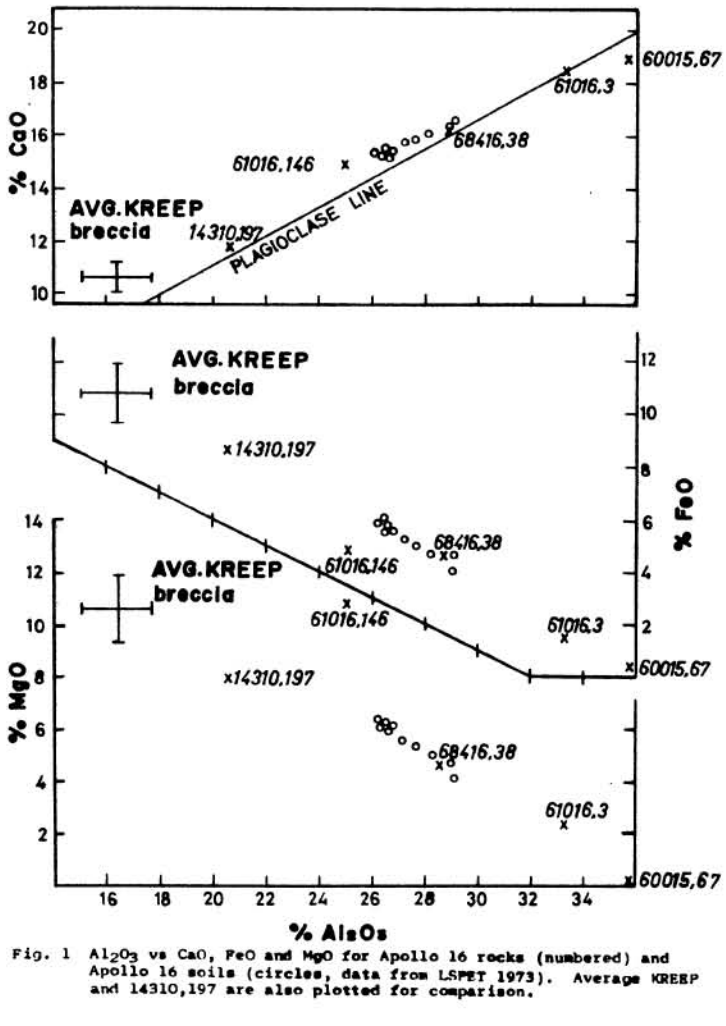

Fig. 1 Al_2O_3 vs CaO, FeO and MgO for Apollo 16 rocks (numbered) and Apollo 16 soils (circles, data from LSPET 1973). Average KREEP and 14310,197 are also plotted for comparison.