FIRST RESULTS OF CONSORTIUM STUDY OF APOLLO 17 STATION 7 BOULDER SAMPLES by The International Consortium

Four hand-specimen-size samples were collected by Eugene Cernan and Harrison Schmitt from a boulder about 2.5 m. in diameter at Station 7 at the foot of North Massif at Taurus-Littrow (1). A large, off-white, moderately coherent clast (77215) is the oldest material in the boulder. It is cut by dark veinlets (77075) which are continuous with the "blue-gray matrix-rich" breccia" (77115) which surrounds the white clast. These three samples were collected from a fractured block, enclosed by a largely unfractured, highly vesicular rock (77135), the youngest material in the boulder. The principal rock type, 77135, is described in another abstract (2). The mineralogical assemblages of the others are also briefly described in a second abstract (3). Samples of 77135 and three xenoliths it contained were distributed for consortium study. Small samples of 77075 and 77215 were also distributed for exploratory studies. Parts of 77115 are being distributed.

Mineralogical and petrographic study by Chao and Minkin (2) concluded that 77135 is a fragment-laden pigeonite feldspathic basalt which crystallized from a melt of possibly igneous origin. It shows no effects of shock or thermal metamorphism. It contains a suite of troctolitic to anorthositic xenoliths. The three xenoliths selected for systematic consortium study are a recrystallized troctolitic breccia, a fine-grained troctolitic anorthosite and an olivine-rich spinel-present troctolite (2). Petrographic evidence indicates that the xenoliths and xenocrysts were affected by the melt and that they are approaching equilibration. This would have a direct bearing on their age and magnetic characteristics.

The major elements (analyzed by David Nava) and the minor and lithophile trace elements (analyzed by J.A. Philpotts, S. Winzer, S. Schuhmann, C.W. Kouns and R.K.L. Lum) of 77135 and 77075 (table 1 and fig. 1) are similar and are characterized by moderate Al_2O_3 (~18 wt.%), MgO>FeO, and moderate alkalies (Philpotts and Nava, 1974, written communication). The heavy trace elements analyzed by Morgan et al between 77135 and 77075 are also similar (4). The composition of 77215, however, is unique (table 1). Clearly the composition of 77135 represents a rock type of great importance in occurrence in the upper crust of the lunar highlands.

The Rb/Sr internal isochron age of a recrystallized troctolitic breccia (,57) in 77135 measured by Tatsumoto et al (5) is 3.90 ± 0.03 b.y. (2σ) and an initial $^{87}Sr/^{86}Sr$ of 0.69928 ± 0.00004 (2σ). A possible model age based on an assumed initial $(^{87}Sr/^{86}Sr)_{LIM}$ = 0.69885 ± 0.00004 of this clast is 4.52 b.y. The preliminary U-Th-Pb study (5) also suggests that xenoliths in 77135 may include components of very old material (possibly as old as 4.55 b.y.).

The $^{40}Ar/^{39}Ar$ ages of two samples of 77075,18 were determined by the Bern group (Stettler, Eberhardt, Geiss and Grögler) to be 3.99 ± 0.03 and 3.96 ± 0.08 b.y. respectively. The first sample was larger and gave a high temperature plateau age. It is thus possibly older than the recrystallized troctolitic breccia xenolith enclosed in 77135. This age relationship is consistent with the relative ages on the basis of geologic evidence.

The meteoritic elements (Ir, Re, Au, Ni, Ge, Sb, etc.) were determined in five samples by Morgan et al of the Chicago group (4); they are 2 orders

of magnitude above indigenous level. The five samples contain four different meteoritic components, judging from their position on ternary IrAuGe or ReAuGe plots (fig. 2). One peculiar matrix sample (,10) contains a group 1 meteoritic component which is assigned to the Imbrium body while the more normal matrix and black dike sample contain a group 2 component assigned to the Serenitatis impacting body. The meteoritic components of the recrystallized troctolitic breccia and the troctolitic anorthosite fall into separate groups (5 and 6, fig. 2) assigned to the Nectaris and Humorum bodies. Such an interpretation assumes an impact origin for the melt.

The magnetic properties of two samples of the matrix of 77135 and one sample of the recrystallized troctolitic breccia xenolith have been investigated by M.D. Fuller (1974, written communication). The magnitude of natural remanent magnetism is comparable for all three samples, although the direction was initially widely scattered. Preliminary AF demagnetization experiments produced somewhat similar amplitude changes in all three samples. The directional changes brought about in the two matrix samples suggest that the harder fraction of magnetization in each is oriented similarly. In contrast, the magnetization of the recrystallized troctolitic breccia xenolith diverged from the direction defined by the other two samples. It is, however, still too early to state whether all three samples are carrying a magnetic record of the same event in the history of the rock. The ratio of NRM over saturation isothermal remanent magnetization is similar to the values found in several non-mare basalts and certain well annealed breccias. In this respect these rocks are quite different from mare-basalts.

Experimental crystallization under controlled oxygen fugacity (Fe/FeO buffer) in Mo capsules of a melt of 77135 composition has been carried out by O'Hara et al, the Edinburgh group (1974, written communication). Spinel was the first liquidus phase to crystallize at 1253°C, and pyroxene did not begin to crystallize until below 1200°C, after nearly 60% of the melt had crystallized. It is possible that the small chip of 77135 (early allocation) given to O'Hara might have contained a large enough troctolitic clast to make the starting composition unrepresentative. A synthetic glass of the composition of 77135 published by PET was also explored but also gave evidently wrong proportions of olivine and pyroxene (O'Hara, written communication). The bulk composition for the crystallization experiments should be corrected by subtracting the plagioclase and olivine xenocrysts and xenoliths. The results of modal analysis of 4 thin sections will be used to adjust the starting composition for further experiments.

We are encouraged that data from various investigations by members of this consortium have been consistent and should reveal the evolution of a major lunar highland rock type of widespread distribution.

References

(1) Apollo 17 Mission Report, 1973, NASA Tech. Publ, JSC-07904.
(2) Chao, E.C.T., and Minkin, J.A., 1974, Lunar Science V, p. 112-114. Lunar Science Inst., Houston.
(3) Chao, E.C.T., and Minkin, J.A., 1974, Lunar Science V, p. 109-111. Lunar Science Inst., Houston.
(4) Morgan, John W., Ganapathy, R., Higuchi, Hideo, and Anders, Edward, 1974, Lunar Science V, p. 526-528 and abstract submitted to Soviet-American Conf. on Cosmochemistry of the Moon and Planets, Moscow, 4-8 June 1974.
(5) Tatsumoto, M., Nunes, P.D., Knight, R.J., and Unruh, D.M., 1974, Lunar Science V, p. 774-776. Lunar Science Inst., Houston.

STATION 7 BOULDER CONSORTIUM STUDY

The International Consortium

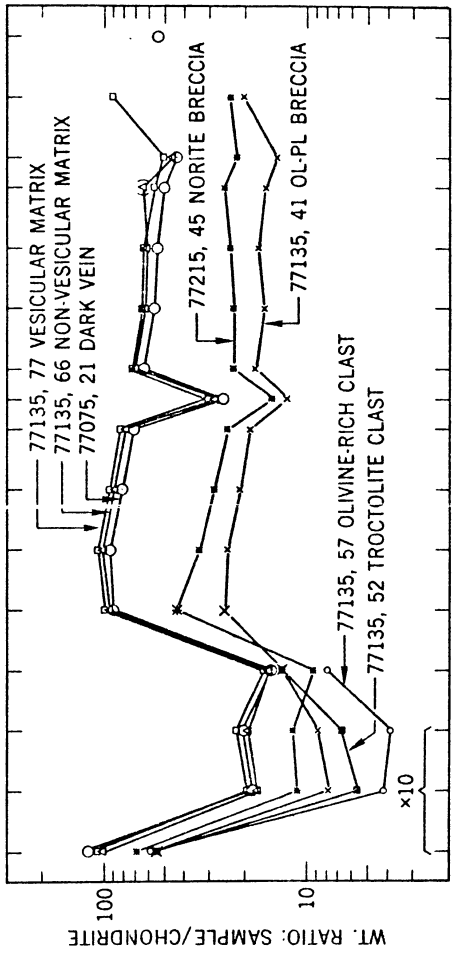

Figure 1. LITHOPHILE TRACE ELEMENT ABUNDANCES IN CONSORTIA SAMPLES, STATION 7 BOULDER

Table 1. Major elemental composition of station 7 boulder consortium samples in wt. percent*

	77135,77 ves. matrix	77135,66 less ves. matrix	77115,9-1 matrix	77075,21 black veinlet	77135,41 recryst. clast	77215,45 off-white clast
SiO_2	46.3	45.3	46.9	46.4	45.3	51.3
TiO_2	1.48	1.72	1.16	1.38	0.43	0.32
Al_2O_3	18.39	18.03	19.6	18.17	25.13	15.06
FeO	9.48	9.56	7.8	9.31	5.98	10.07
MnO	0.11	0.11	n.d.	0.11	0.06	0.16
MgO	12.19	13.38	10.3	12.57	8.59	12.56
CaO	10.96	10.64	11.9	10.55	13.95	8.96
Na_2O	0.65	0.61	0.83	0.65	0.40	0.43
K_2O	0.23**	0.22**	0.35	0.23**	0.095**	0.14**
P_2O_5	0.28	0.28	n.d.	0.26	0.10	0.11
Cr_2O_3	0.18	0.18	0.12	0.17	0.13	0.32
S	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Total	100.25	100.03	99.	99.80	130.165	99.43

*All analyses are by atomic absorption, analyst David Nava, except electron microprobe expanded beam analysis of 77115,9-1 by Jean A. Minkin
**Analysts John Philpotts et al.

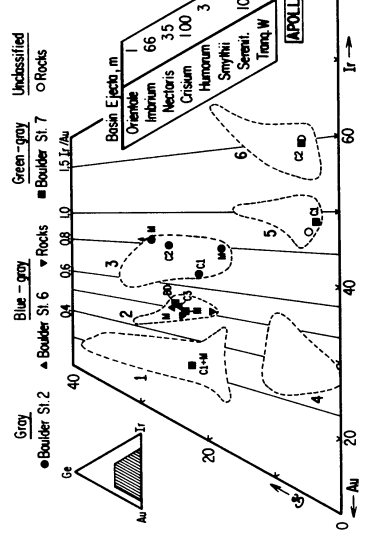

Figure 2. Grouping of boulder consortium samples in terms of meteoritic components. Square symbol: C1+M=matrix with clast; M=matrix; BD=black dike or vein; C1=troctolitic breccia clast; C2=troctolitic anorthosite clast.