70138

High-Ti Marc Basalt
3.66 g, 2 x 1.3 x 1 cm

INTRODUCTION

70138 has been described as a brownish-gray, medium-grained, high-Ti mare basalt (Fig. 1), containing ~5% vugs and one slickensided face with smeared out and pulverized ilmenite (Apollo 17 Lunar Sample Information Catalog, 1973). No zap pits are present. This sample was collected from the "Geophone Rock", 50 m south of the ALSEP central station.

PETROGRAPHY AND MINERAL CHEMISTRY

Thin section 70138,3 was studied by Neal et al. (1989), who described this sample as a plagioclase-poikilitic, high-Ti mare basalt (see 70135). Modal analysis of 70138 showed: 49.7% clinopyroxene; 22.2% plagioclase; 3% olivine; 21.1% ilmenite; 1 % native Fe and troilite; and 3% armalcolite, with trace amounts of rutile and chromite, present mainly as exsolution lamellae (both <0.005 mm) in ilmenite. Olivine is present either as cores to clinopyroxenes, or as inclusions in plagioclase, where the olivine has no pyroxene rim.

Armalcolite is present as ilmenite-free inclusions in pyroxene and plagioclase.

Olivine compositions range in Fo content from 48 to 69. However, individual grains are homogeneous. Plagioclase exhibits little variation (An84_89), but the rims are usually more sodic. Pyroxenes range from titan-augites to pigeonites, with both varieties exhibiting Fe enrichment (Fig. 2), An unusual feature of this basalt is that core-to-rim zoning in the largest clino-pyroxenes trend toward pigeonite from titan-augite. This is probably a result of olivine resorption. Cr_2O_3 decreases with Fe enrichment and Al/Ti ratios are constant at ~2. Ilmenite exhibits a large range in MG# (5-23), whereas armalcolite exhibits little variation (MG# = 43-45).

WHOLE-ROCK CHEMISTRY

70138 (Table 1) is a Type A high-Ti mare basalt (Neal et al., 1990), on the basis of the classification used by Rhodes et al. (1976) and Warner et al. (1979). The REE pattern is LREE-depleted and convex-upward, with a negative Eu anomaly (Fig. 3 and Table 1) with $(Eu/Eu^*]_N$ = 0.62. The MREE reach ~40-45 times chondritic values. Neal et al. (1990) have used the whole-rock composition of 70138 to refine previous petrogenetic models and formulate a new one for the Type A Apollo 17 high-Ti basalts. This model involved up to 80% fractional crystallization of observed phenocryst phases, although the majority of Type A high-Ti basalts are generated after 40% fractional crystallization.

ISOTOPES

Rb-Sr and Sm-Nd isotopic data for 70138,7 was reported by Paces et al. (1991) (Tables 2 and 3). These analyses were part of a larger study aimed at the isotopic characterization of the Apollo 17 high-Ti basalts.

PROCESSING

There is 2.89 g of 70138,0 remaining. Approximately 0.75 g was irradiated for INA analysis, and a further 0.01 g was used in the preparation of thin section 70138,3.

Figure 1: Hand specimen photograph of 70135, 70137, 70138, and 70139.

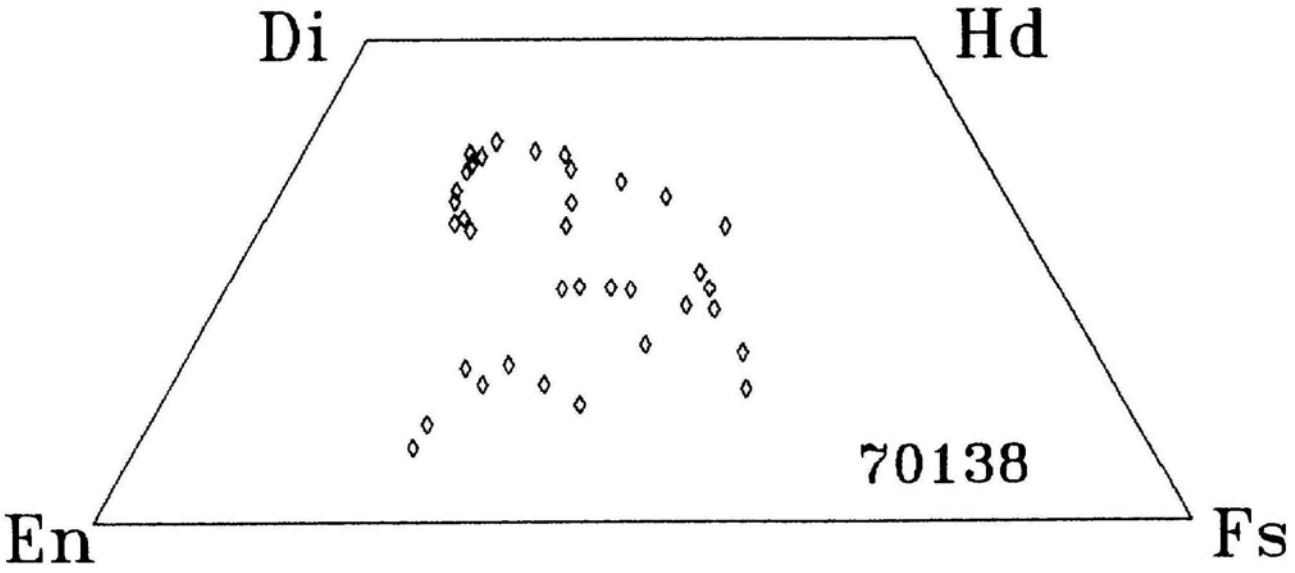

Figure 2: Pyroxene compositions of 70138 represented on a pyroxene quadrilateral.

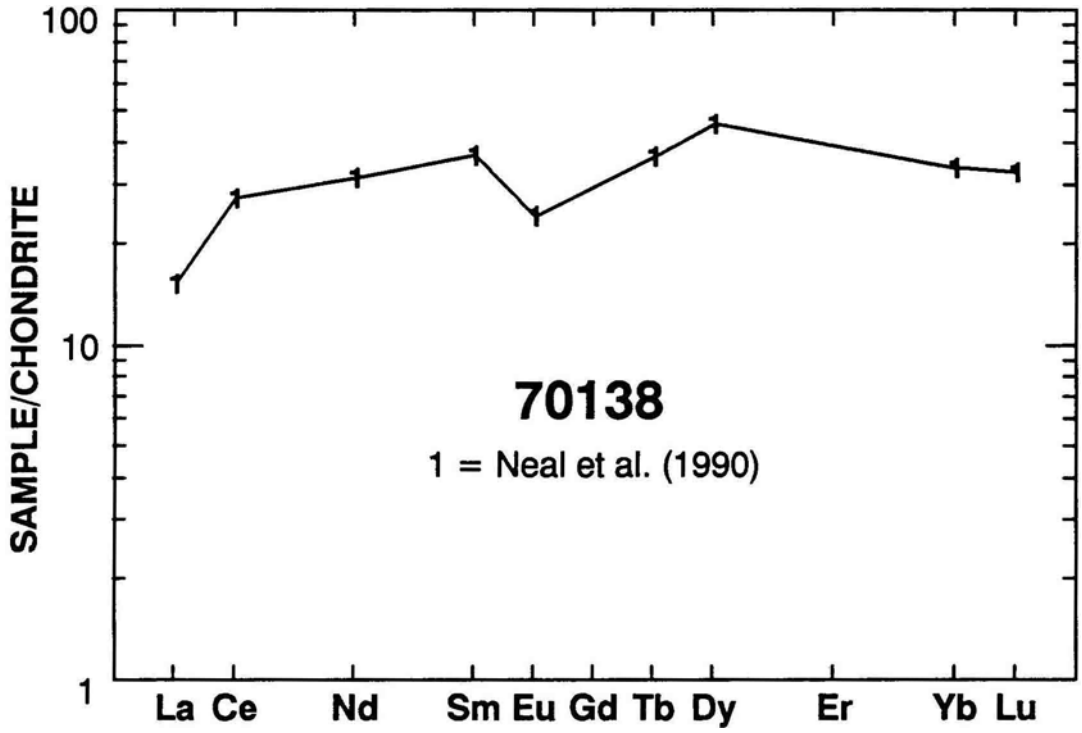

Figure 3: Chondrite- normalized rare-earth element profile of 70138.

Table 1: Whole-rock composition of 70138,4.
Data from Neal et al. (1990).

	70138,4		70138,4
SiO_2 (wt%)		Cu	
TiO_2	12.5	Ni	4
Al_2O_3	8.49	Co	19.8
Cr_2O_3	0.501	V	134
FeO	17.9	Sc	77
MnO	0.237	La	5.05
MgO	8.2	Ce	24
CaO	9.5	Nd	20
Na_2O	0.39	Sm	7.56
K_2O	0.05	Eu	1.88
P_2O_5		Gd	
S		Tb	2.13
Nb (ppm)		Dy	15.8
Zr	230	Er	
Hf	7.29	Yb	7.49
Ta	1.57	Lu	1.12
U	0.17	Ga	
Th		F	
W		Cl	
Y		C	
Sr	170	N	
Rb		H	
Li		He	
Ba	65	Ge (ppb)	
Cs	0.11	Ir	
Be		Au	
Zn		Ru	
Pb		Os	

Analysis by INAA.

Table 2: Rb-Sr isotopic data for 70138,7.
Data from Paces et at. (1991).

Rb (ppm)	0.647
Sr (ppm)	182
$^{87}Rb/^{86}Sr$	0.001020 ± 10
$^{87}Sr/^{86}Sr$	0.699793 ± 14
I(Sr)[a]	0.699235 ± 20
T_{LUNI}[b] (Ga)	5.2

[a]Initial Sr isotopic ratios calculated at 3.75 Ga using ^{87}Rb decay constant = 1.42×10^{-11} yr^{-1}.

[b]Model age relative to I(Sr) = LUNI = 0.69903 (Nyquist et al., 1974; Shih et al., 1986).

$T_{LUNI} = 1/\lambda * \ln[((^{87}Sr/^{86}Sr - 0.69903)/^{87}Rb/^{86}Sr) + 1]$.

Table 3: Sm-Nd isotopic data for 70138,7.
Data from Paces et al. (1991).

Sm (ppm)	11.5
Nd (ppm)	27.8
$^{147}Sm/^{144}Nd$	0.24990 ± 50
$^{143}Nd/^{144}Nd$	0.514277 ± 10
I(Nd)[a]	0.508072 ± 22
$\varepsilon_{Nd}(t)$[b]	6.3 ± 0.4
T_{CHUR}[c] (Ga)	4.6

[a]Initial Nd isotopic ratios calculated at 3.75 Ga using ^{147}Sm decay constant = $6.54 \times 10^{-12} yr^{-1}$.

[b]Initial ε_{Nd} calculated at 3.75 Ga using present-day chondritic values of $^{143}Nd/^{144}Nd = 0.512638$ and $^{147}Sm/^{144}Nd = 0.1967$.

[c]Model age relative to CHUR reservoir using present-day chondritic values listed above.

$T_{CHUR} = 1/\lambda * \ln[((^{143}Nd/^{144}Nd - 0.512638)/(^{147}Sm/^{144}Nd - 0.1967) + 1]$.