70139

High-Ti Mare Basalt
3.16 g, 2 x 1.4 x 0.8 cm

INTRODUCTION

70139 (see Fig. 1 of 70138) was described as a brownish-gray, medium-grained high-Ti mare basalt, containing ~2% vugs (Apollo 17 Lunar Sample Information Catalog, 1973). No zap pits are present. One face is darkened with smeared out and pulverized ilmenite. It was collected from the "Geophone Rock", 50 m south of the ALSEP central station.

PETROGRAPHY AND MINERAL CHEMISTRY

This basalt was described as plagioclase-poikilitic by Neal et al. (1989). Ilmenite (0.1-1 mm) is subhedral-euhedral and blocky in appearance, occurring in both clinopyroxene (0.12-0.86 mm) and plagioclase (0.24-4 mm). Olivine is present either as cores in pyroxenes or as pyroxene-free inclusions in plagioclase. No armalcolite is present. Chromite and rutile exsolution lamellae (both c 0.005 mm) occur in ilmenite. Native Fe, troilite, and silica occur as interstitial phases. Modally, 70139 is comprised of: 35.8% pyroxene; 41.6% plagioclase; 15.8% ilmenite; 2.4% native Fe and troilite; 1,9% silica; 2.5% olivine. Chromite and rutile are present in trace amounts.

Olivines are generally unzoned, but range in composition from Fo_{55} to Fo_{69}. Plagioclase exhibits limited zonation (An_{81-88}) although rare examples contain An_{71}. The rims of the plagioclase are always more sodic. Pyroxene compositions range from pigeonite to titan-augite, each exhibiting Fe enrichment trends (Fig. 1). Cr_2O_3 contents decrease with progressive Fe enrichment, and AI/Ti ratios are constant at ~2. The MG# of ilmenite ranges from 10-23.

WHOLE-ROCK CHEMISTRY

70139 (Table 1) is a Type B Apollo 17 high-Ti mare basalt (Neal et al., 1990), using the classification of Rhodes et al. (1976) and Warner et al. (1979). The REE pattern (Fig. 2) is LREE-depleted, typical of the Apollo 17 basalt suite, with a slight convex-upwards profile. The MREE reach ~30 times chondritic values. A negative Eu anomaly is present $(Eu/Eu^*]_N = 0.70)$. Neal et al. (1990) used the whole-rock composition of 70139,4 in a comprehensive study of Apollo 17 high-Ti basalt petrogenesis. These authors defined two groups of Type B basalts - B1 and 132, on the basis of whole-rock chemistry. Each group is generated by fractional crystallization of observed phenocryst phases. 70139,4 is a Type B1 Apollo 17 high-Ti basalt, which was generated after 50% fractional crystallization.

ISOTOPES

Rb-Sr and Sm-Nd isotopic data has been reported by Paces et al. (1991) for 70139,6 whole-rocks (Tables 2 and 3) and mineral separates (Tables 4 and 5). They reported internal isochrons giving a best-estimate age for 70139 of 3.71 ± 0.12 Ga.

PROCESSING

There is approximately 2.60 g of 70139,0 remaining, of the original 3.16 g. About 0.55 g was used for the INA analysis and 0.01 g for thin section 70139,3.

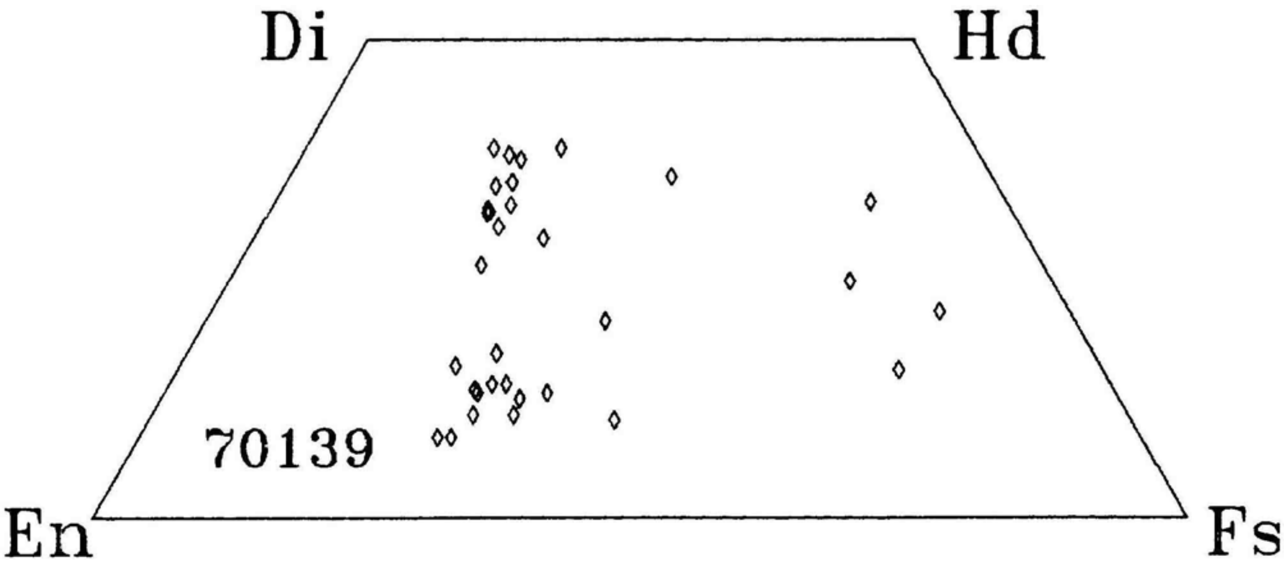

Figure 1: Pyroxene compositions of 70139 represented on a pyroxene quadrilateral.

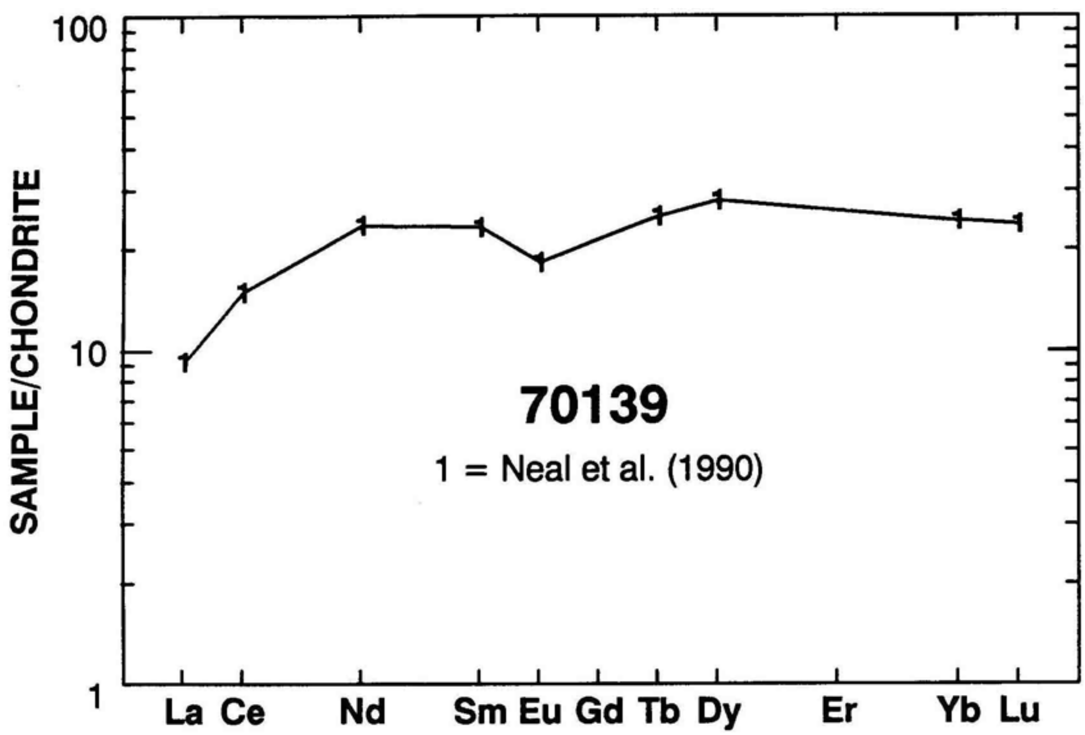

Figure 2: Chondrite-normalized rare-earth element profile of 70139.

Table 1: Whole-rock composition of 70139.4.
Data from Neal et al. (1990).

	70139,4		70139,4
SiO_2 (wt%)		Cu	
TiO_2	13.1	Ni	31
Al_2O_3	8.32	Co	26.2
Cr_2O_3	0.557	V	143
FeO	17.6	Sc	79.9
MnO	0.232	La	3.05
MgO	9.6	Ce	13
CaO	10.0	Nd	15
Na_2O	0.36	Sm	4.78
K_2O	0.04	Eu	1.42
P_2O_5		Gd	
S		Tb	1.47
Nb (ppm)		Dy	9.7
Zr	160	Er	
Hf	5.65	Yb	5.40
Ta	1.16	Lu	0.81
U	0.05	Ga	
Th	0.28	F	
W		Cl	
Y		C	
Sr	180	N	
Rb		H	
Li		He	
Ba	67	Ge (ppb)	
Cs	0.02	Ir	
Be		Au	
Zn		Ru	
Pb		Os	

Analysis by INAA.

Table 2: Rb-Sr isotopic data for 70139,6.
Data from Paces et al. (1991) [two analyses].

Rb (ppm)	0.281	0.282
Sr (ppm)	146	146
$^{87}Rb/^{86}Sr$	0.005515 ± 55	0.005542 ± 55
$^{87}Sr/^{86}Sr$	0.699511 ± 14	0.699518 ± 17
I(Sr)[a]	0.699214 ± 17	0.699220 ± 20
T_{LUNI}[b] (Ga)	6.0	6.0

[a]Initial Sr isotopic ratios calculated at 3.69 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 70139,6.
Data from Paces et al. (1991) [two analyses].

Sm (ppm)	5.30	5.38
Nd (ppm)	12.3	12.4
$^{147}Sm/^{144}Nd$	0.26021 ± 52	0.26234 ± 52
$^{143}Nd/^{144}Nd$	0.514547 ± 11	0.514605 ± 15
I(Nd)[a]	0.508191 ± 24	0.507197 ± 28
$\varepsilon_{Nd}(t)$[b]	7.0 ± 0.5	7.2 ± 0.5
T_{CHUR}[c] (Ga)	4.5	4.5

[a]Initial Nd isotopic ratios calculated at 3.69 Ga using ^{147}Sm decay constant = $6.54 \times 10^{-12} yr^{-1}$.

[b]Initial ε_{Nd} calculated at 3.69 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.

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

Table 4: Rh-Sr analyses for whole-rocks and mineral separates from 70139,6.
Data from Paces et al. (1991).

	Rb (ppm)	Sr (ppm)	$^{87}Rb/^{86}Sr^{a}$	$^{87}Sr/^{86}Sr^{b}$
WR1	0.281	146	0.005515±55	0.699511±14
WR2	0.282	146	0.005543±55	0.699518±17
F Plg	0.0886	514	0.004956±20	0.699244±27
Ilm	0.313	23.1	0.03903±39	0.701312±31
Px	0.143	30.2	0.01364±14	0.699922±32
Mag[c]	0.478	87.9	0.01564±16	0.700013±28
NMag[c]	0.0882	270	0.000939±18	0.699297±25

[a]Uncertainties reported for parent/daughter ratios reflect the magnitude of the blank correction, mass spectrometer precision, and corrections for the quality of spiking.

[b]Normalized to $^{86}Sr/^{88}Sr = 0.1194$. Quoted errors include 2-sigma run precision for whole-rock analyses plus an additional uncertainty of 0.00001 (2-sigma) reflecting corrections for fractionation and spike contributions in total-spiked mineral separates.

[c]Non-pure mineral separates consisting of predominantly "nonmagnetic" plagioclase and pyroxene in NMag and "magnetic" pyroxene and ilmenite in Mag.

Table 5: Sm-Nd analyses for whole-rocks and mineral separates from 70139,6.
Data from Paces et al. (1991).

	Sm (ppm)	Nd (ppm)	$^{147}Sm/^{144}Nd^{a}$	$^{143}Nd/^{144}Nd^{b}$
WR1	5.30	12.3	0.26021±52	0.514547±11
WR2	5.38	12.4	0.26234±52	0.514605±15
F Plg				
Ilm	3.49	8.54	0.24726±49	0.514230±23
Px	4.85	9.72	0.3020±15	0.515571±29
Mag[c]	9.17	21.5	0.2574±26	0.514457±25
NMag[c]	1.82	3.89	0.28250±56	0.515098±26

[a]Uncertainties reported for parent/daughter ratios reflect the magnitude of the blank correction, mass spectrometer precision, and corrections for the quality of spiking.

[b]Normalized to $^{146}Nd/^{144}Nd = 0.7219$. Quoted errors include 2-sigma run precision for whole-rock analyses plus an additional uncertainty of 0.00001 (2-sigma) reflecting corrections for fractionation and spike contributions in total-spiked mineral separates. Nd was measured as the metal ion.

[c]Non-pure mineral separates consisting of predominantly "nonmagnetic" plagioclase and pyroxene in NMag and "magnetic" pyroxene and ilmenite in Mag.