78599 - 198 grams
78595 – 4.2 grams
71527 – 2.2 grams
Ilmenite Basalt

Figure 1: Photos of sides of 78599. Sample is about 8 cm long. Top S73-21391; bottom is S73-21392.

Introduction

78599 is a fine-grained, olivine-microporphyritic ilmenite basalt similar to 71569, 71577 etc. (Warner et al. 1978).

78599 is a rake sample collected as part of a large comprehensive sample at station 8, Apollo 17 (figure 3). 78595 and 71527 appear to have similar modes, textures, pyroxene zoning and chemical compositions. 71527 and 71569 were collected a mile away!

Petrography

78599 has a variolitic groundmass with occasional olivine phenocrysts (figure 5). Ilmenite is acicular and olivine is often embayed. Pyroxene is chemically zoned in a manner similar to 71569 (figure 4).

Detailed mineral analyses can be found in Warner et al. (1976a,b), including armalcolite (table 2).

Mineralogical Mode

	78599	71595	71527
Olivine	4.4	6.5	6.1
Pyroxene	45.4	42.4	46
Plagioclase	28.7	27	26.4
Opaques	16.3	17.9	16.8
Silica	4	5.4	3.7
Meostasis	1.1	0.7	0.7

Figure 2: Photos of 78599. Cube is 1 cm. top S73-21419; bottom S73-21420

Chemistry

Warner et al. (1975) and Rhodes et al. (1976) found that 78599 was similar in composition to 71569 (table 1). Trace element contents indicate 78599 and its companion samples are Type A, ilmenite basalt (figures 7 and 8).

Radiogenic age dating

Nyquist et al. (1976) reported Rb, Sr and $Sr^{87/86}$, but did not report an age. In general the age of Apollo 17 ilmenite basalts is ~3.72 b.y.

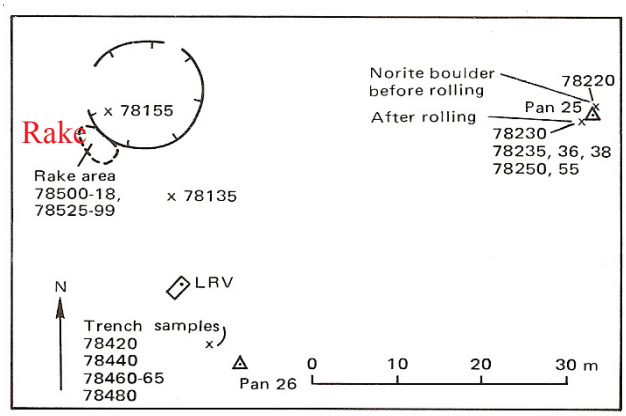
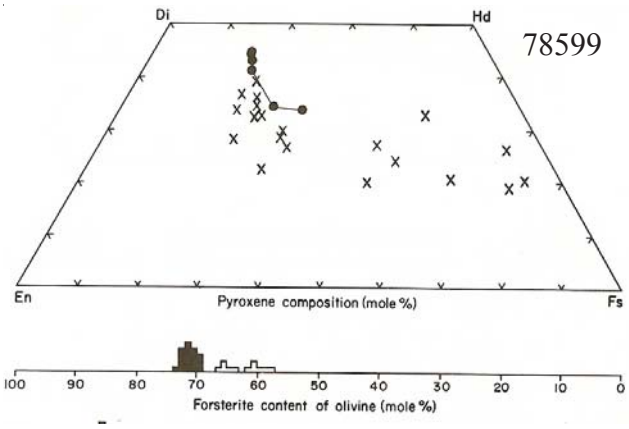
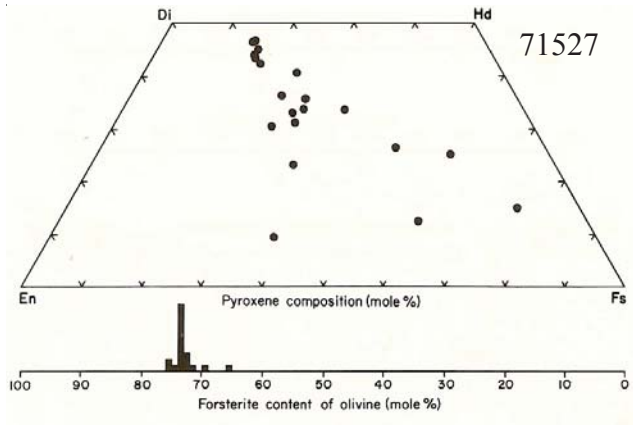


Figure 3: Location of rake sample at station 8, Apollo 17.





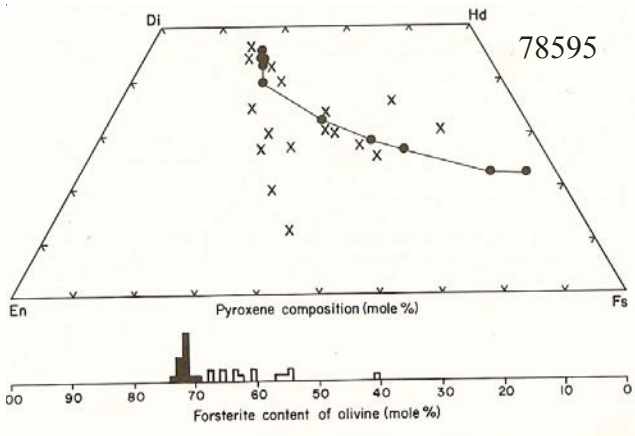
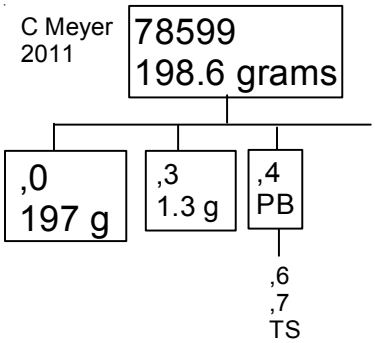


Figure 4: Pyroxene and olivine composition of 78599, 71527 and 78595 (Warner et al. 1978).

Processing

There are 2 thin sections for 78599 and one each for 79595 and 71527.



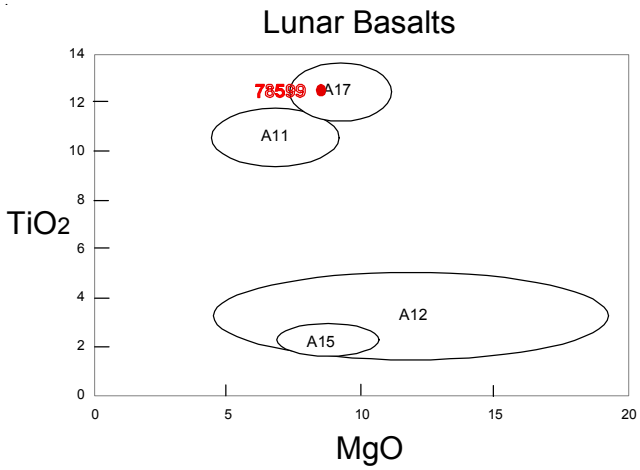


Figure 6: Composition of 78599 comnpared with that of Apollo basalts.

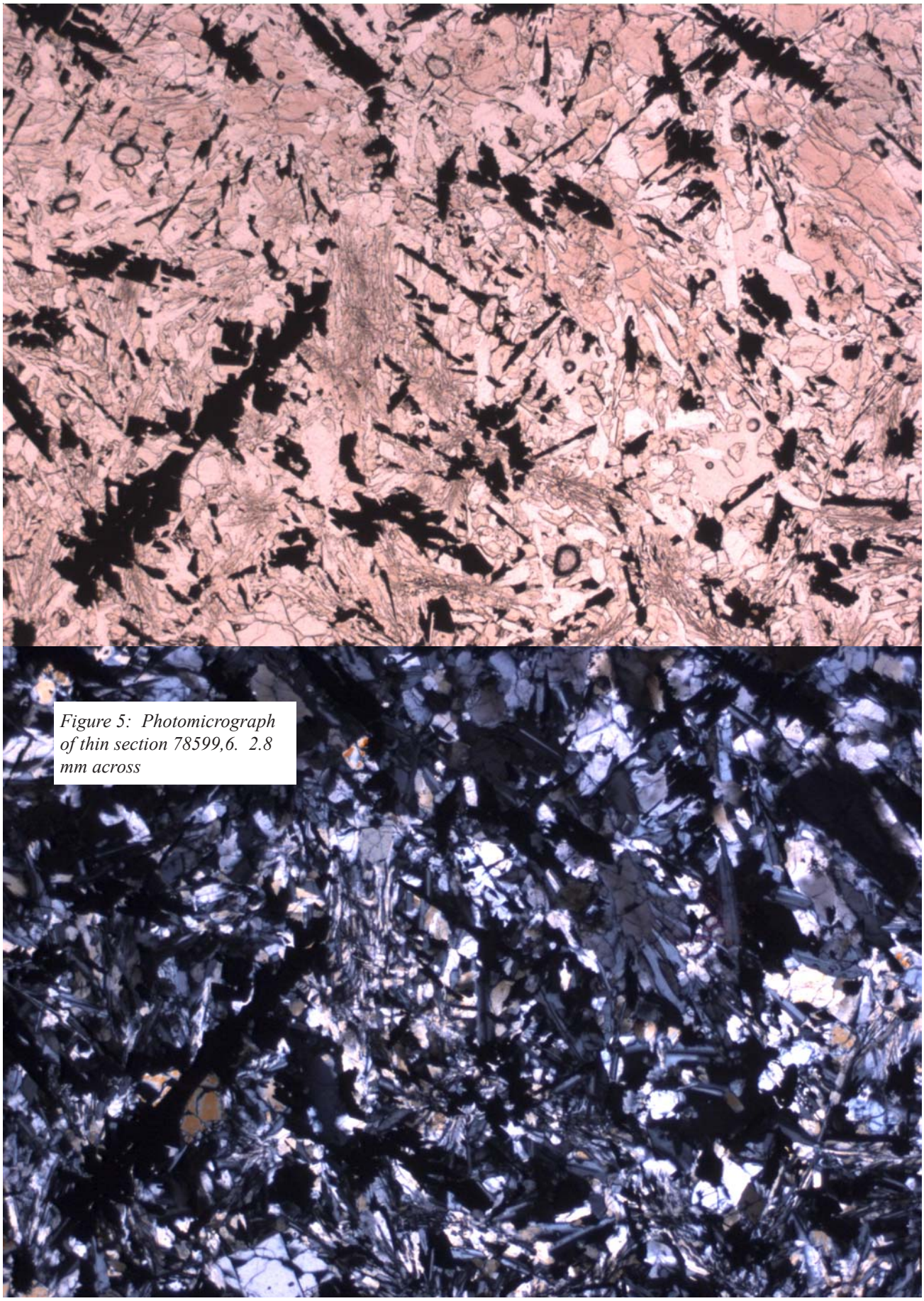


Figure 5: Photomicrograph of thin section 78599,6. 2.8 mm across

Table 1. Chemical composition of 78599.

reference	Rhodes76		Nyquist76		Warner75	
weight						
SiO2 %	38.44	(a)				
TiO2	12.52	(a)			13	(b)
Al2O3	8.67	(a)			9.2	(b)
FeO	19.14	(a)			20.2	(b)
MnO	0.28	(a)			0.234	(b)
MgO	8.47	(a)			7.8	(b)
CaO	10.48	(a)			10.4	(b)
Na2O	0.38	(a)			0.41	(b)
K2O	0.06	(a)			0.076	(b)
P2O5	0.04	(a)				
S %	0.18	(a)				
sum						
Sc ppm	79	(b)			84	(b)
V					130	(b)
Cr	2942	(a)			3421	(b)
Co	18.4	(b)			20.6	(b)
Ni						
Cu						
Zn						
Ga						
Ge ppb						
As						
Se						
Rb	0.71	(c)	0.707	(c)		
Sr	190	(c)	190	(c)		
Y						
Zr						
Nb						
Mo						
Ru						
Rh						
Pd ppb						
Ag ppb						
Cd ppb						
In ppb						
Sn ppb						
Sb ppb						
Te ppb						
Cs ppm						
Ba	83	(c)				
La	6.45	(c)			7.1	(b)
Ce	23.7	(c)			27	(b)
Pr						
Nd	25.8	(c)				
Sm	11	(c)			10.2	(b)
Eu	2.12	(c)			2.2	(b)
Gd	16.6	(c)				
Tb					2.5	(b)
Dy	18.8	(c)			16	(b)
Ho						
Er	11.2	(c)				
Tm						
Yb	10.2	(c)			9.4	(b)
Lu	1.46	(b)			1.6	(b)
Hf	10.1	(b)			9.6	(b)
Ta					2.1	(b)
W ppb						
Re ppb						
Os ppb						
Ir ppb						
Pt ppb						
Au ppb						
Th ppm						
U ppm						

technique: (a) XRF, (b) INAA, (c) IDMS

Table 2. Chemical composition of 78595.

reference	Warner75	
weight		
SiO2 %		
TiO2	12.8	(a)
Al2O3	9	(a)
FeO	19.9	(a)
MnO	0.253	(a)
MgO	9.1	(a)
CaO	11	(a)
Na2O	0.387	(a)
K2O	0.063	(a)
P2O5		
S %		
sum		
Sc ppm	86	(a)
V	121	(a)
Cr	3031	(a)
Co	20.5	(a)
Ni		
Cu		
Zn		
Ga		
Ge ppb		
As		
Se		
Rb		
Sr		
Y		
Zr		
Nb		
Mo		
Ru		
Rh		
Pd ppb		
Ag ppb		
Cd ppb		
In ppb		
Sn ppb		
Sb ppb		
Te ppb		
Cs ppm		
Ba		
La	7.5	(a)
Ce		
Pr		
Nd		
Sm	10.5	(a)
Eu	2.05	(a)
Gd		
Tb		
Dy	16	(a)
Ho		
Er		
Tm		
Yb	9.9	(a)
Lu	1.4	(a)
Hf		
Ta		
W ppb		
Re ppb		
Os ppb		
Ir ppb		
Pt ppb		
Au ppb		
Th ppm		
U ppm		

technique: (a) INAA

Table 3. Chemical composition of 71527.

reference	Murali77	
weight		
SiO2 %		
TiO2	12.8	(a)
Al2O3	9.1	(a)
FeO	19.3	(a)
MnO	0.255	(a)
MgO	10	(a)
CaO	10.1	(a)
Na2O	0.42	(a)
K2O	0.066	(a)
P2O5		
S %		
sum		
Sc ppm	77	(a)
V	100	(a)
Cr	2791	(a)
Co	17	(a)
Ni		
Cu		
Zn		
Ga		
Ge ppb		
As		
Se		
Rb		
Sr		
Y		
Zr		
Nb		
Mo		
Ru		
Rh		
Pd ppb		
Ag ppb		
Cd ppb		
In ppb		
Sn ppb		
Sb ppb		
Te ppb		
Cs ppm		
Ba		
La	6.4	(a)
Ce	26	(a)
Pr		
Nd		
Sm	10.9	(a)
Eu	2.05	(a)
Gd		(a)
Tb	2.8	(a)
Dy	17	(a)
Ho		
Er		
Tm		
Yb	9.7	(a)
Lu	1.23	(a)
Hf	9.1	(a)
Ta	1.8	(a)
W ppb		
Re ppb		
Os ppb		
Ir ppb		
Pt ppb		
Au ppb		
Th ppm		
U ppm		

technique: (a) INAA

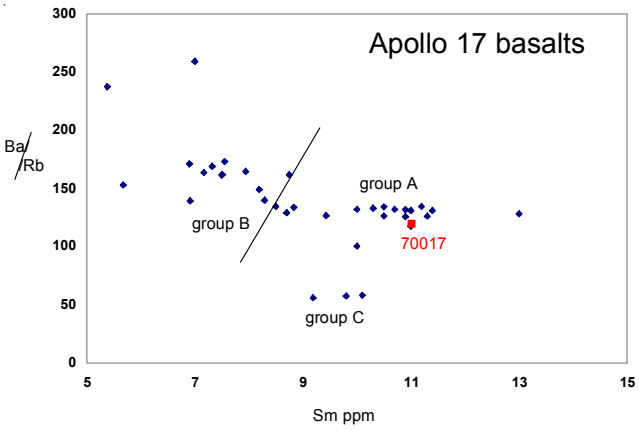


Figure 7: Trace element characteristics of Apollo 17 basalts with 78599 shown.

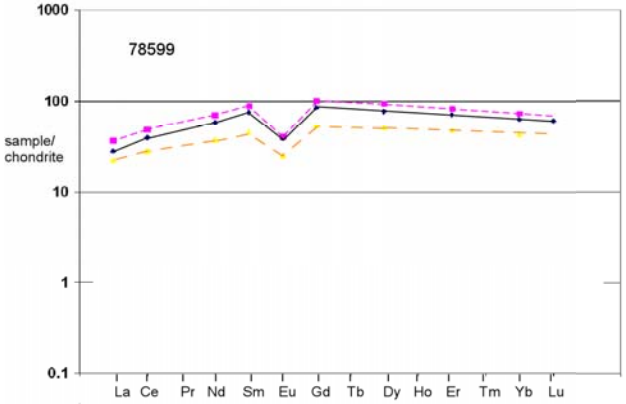


Figure 8: Normalized rare-earth-element diagram for 78599 compared with A and B types of Apollo 17 basalt.

Table 2: Armalcolite in 78599 (Warner et al. 1976).

TiO2	70.8	7.5	71.8	71.7	70
Al2O3	1.79	1.81	1.69	1.74	1.7
Cr2O3	1.84	2.09	1.56	1.46	2.18
FeO	16	16.4	16.6	16.7	16.8
MgO	7.6	7.6	6.6	7.2	7.3
CaO	0.49	0.51	0.33	0.68	0.31

References for 78599

Brown G.M., Peckett A., Emeleus C.H., Phillips R. and Pinsent R.H. (1975a) Petrology and mineralogy of Apollo 17 mare basalts. *Proc. 6th Lunar Sci. Conf.* 1-13.

Butler P. (1973) **Lunar Sample Information Catalog Apollo 17.** Lunar Receiving Laboratory. MSC 03211 Curator's Catalog. pp. 447.

Gibson E.K., Usselman T.M. and Morris R.V. (1976a) Sulfur in the Apollo 17 basalts and their source regions. *Proc. 7th Lunar Sci. Conf.* 1491-1505.

LSPET (1973) Apollo 17 lunar samples: Chemical and petrographic description. *Science* **182**, 659-672.

LSPET (1973) Preliminary Examination of lunar samples. Apollo 17 Preliminary Science Rpt. NASA SP-330. 7-1 – 7-46.

Muehlberger et al. (1973) Documentation and environment of the Apollo 17 samples: A preliminary report. Astrogeology 71 322 pp superceeded by Astrogeolgy 73 (1975) and by Wolfe et al. (1981)

Muehlberger W.R. and many others (1973) Preliminary Geological Investigation of the Apollo 17 Landing Site. *In* **Apollo 17 Preliminary Science Report.** NASA SP-330.

Neal C.R. and Taylor L.A. (1993) Catalog of Apollo 17 rocks. Vol. 2 Basalts

Nyquist L.E., Bansal B.M. and Wiesmann H. (1976a) Sr isotopic constraints on the petrogenesis of Apollo 17 mare basalts. *Proc. 7th Lunar Sci. Conf.* 1507-1528.

Rhodes J.M., Hubbard N.J., Wiesmann H., Rodgers K.V., Brannon J.C. and Bansal B.M. (1976a) Chemistry, classification, and petrogenesis of Apollo 17 mare basalts. *Proc. 7th Lunar Sci. Conf.* 1467-1489.

Warner R.D., Keil K., Prinz M., Laul J.C., Murali A.V. and Schmitt R.A. (1975b) Mineralogy, petrology, and chemistry of mare basalts from Apollo 17 rake samples. *Proc. 6th Lunar Sci. Conf.* 193-220.

Warner R.D., Warren R.G., Mansker W.L., Berkley J.L. and Keil K. (1976a) Electron microprobe analyses of olivine, pyroxene and plagioclase from Apollo 17 rake sample mare basalts. Spec. Publ. # 15, UNM Institute of Meteoritics, Albuquerque. 158 pp.

Warner R.D., Berkley J.L., Mansker W.L., Warren R.G. and Keil K. (1976b) Electron microprobe analyses of spinel, Fe-Ti oxides and metal from Apollo 17 rake sample mare basalts. Spec. Publ. #16, UNM Institute of Meteoritics, Albuquerque. 114 pp.

Warner R.D., Keil K., Nehru C.E. and Taylor G.J. (1978) Catalogue of Apollo 17 rake samples from Stations la, 2, 7, and 8. Spec. Publ. #18, UNM Institute of Meteoritics, Albuquerque. 88 pp.

Warner R.D., Nehru C.E. and Keil K. (1978g) Opaque oxide mineral crystallization in lunar high-titanium basalts. *Am. Mineral.* **68**, 1209-1224.

Wolfe E.W., Bailey N.G., Lucchitta B.K., Muehlberger W.R., Scott D.H., Sutton R.L and Wilshire H.G. (1981) The geologic investigation of the Taurus-Littrow Valley: Apollo 17 Landing Site. US Geol. Survey Prof. Paper, 1080, pp. 280.