

Reference Material

Appendix 1. Lunar Spaceflights. Successful missions are indicated by an asterisk; dates are Greenwich Mean Time.

Name	Type	Launch date	Completion date†	Chapter described
<u>1958</u>				
Pioneer 0	orbiter	17 Aug.	17 Aug. (E)	2
Pioneer 1	orbiter	11 Oct.	13 Oct. (E)	2
Pioneer 2	orbiter	8 Nov.	8 Nov. (E)	2
Pioneer 3	distant flyby	6 Dec.	7 Dec. (E)	2
<u>1959</u>				
Luna 1	crash lander	2 Jan.	5 Jan. (F)	2
*Pioneer 4	distant flyby	3 Mar.	4 Mar. (F)	2
*Luna 2	crash lander	12 Sep.	13 Sep. (I)	2
*Luna 3	far-side flyby	4 Oct.	7 Oct. (F)	2
Pioneer	orbiter	26 Nov.	26 Nov. (E)	2
<u>1960</u>				
Pioneer	orbiter	25 Sep.	25 Sep. (E)	—
Pioneer	orbiter	15 Dec.	15 Dec. (E)	—
<u>1961</u>				
Ranger 1	test	23 Aug.	23 Aug. (E)	3, 5
Ranger 2	test	18 Nov.	18 Nov. (E)	5
<u>1962</u>				
Ranger 3	crash lander	26 Jan.	28 Jan. (F)	3, 5
Ranger 4	crash lander	23 Apr.	26 Apr. (I)	3, 5
Ranger 5	crash lander	18 Oct.	21 Oct. (F)	3, 5
<u>1963</u>				
Luna	soft lander	4 Jan.	5 Jan. (E)	7
Luna	soft lander	2 Feb.	2 Feb. (E)	7
Luna 4	soft lander	2 Apr.	6 Apr. (F)	7
<u>1964</u>				
Ranger 6	crash lander	30 Jan.	2 Feb. (I)	5
*Ranger 7	crash lander	28 July	31 July (I)	5

Name	Type	Launch date	Completion date†	Chapter described
<u>1965</u>				
*Ranger 8	crash lander	17 Feb.	20 Feb. (I)	5
Kosmos 60	probable lander	12 Mar.	17 Mar. (E)	7
*Ranger 9	crash lander	21 Mar.	24 Mar. (I)	5
Luna 5	soft lander	9 May	12 May (I)	7
Luna 6	soft lander	8 June	11 June (F)	7
*Zond 3	flyby	18 July	20 July (F)	6
Luna 7	soft lander	4 Oct.	7 Oct. (I)	7
Luna 8	soft lander	3 Dec.	6 Dec. (I)	7
<u>1966</u>				
*Luna 9	soft lander	31 Jan.	6 Feb. (T)	7
Kosmos 111	orbiter?	1 Mar.	3 Mar. (E)	—
*Luna 10	orbiter	31 Mar.	30 May (T)	7
*Surveyor 1	soft lander	30 May	7 Jan. 1967 (T)	8
Explorer 33	orbiter	1 July	Earth orbit	—
*Lunar Orbiter 1	orbiter	10 Aug.	13 Sep. (T)	9
*Luna 11	orbiter	24 Aug.	1 Oct. (T)	7
Surveyor 2	soft lander	20 Sep.	22 Sep. (I)	8
*Luna 12	orbiter	22 Oct.	19 Jan. 1967 (T)	7
*Lunar Orbiter 2	orbiter	6 Nov.	6 Dec. (T)	9
*Luna 13	soft lander	21 Dec.	30 Dec. (T)	7
<u>1967</u>				
*Lunar Orbiter 3	orbiter	5 Feb.	2 Mar. (T)	9
*Surveyor 3	soft lander	17 Apr.	4 May (T)	8
*Lunar Orbiter 4	orbiter	4 May	1 June (T)	9
Surveyor 4	soft lander	14 July	17 July (I?)	8
*Explorer 35	distant orbiter	19 July	Feb. 1972 (T)	12
*Lunar Orbiter 5	orbiter	1 Aug.	27 Aug. (T)	9
*Surveyor 5	soft lander	8 Sep.	17 Dec. (T)	8
*Surveyor 6	soft lander	7 Nov.	14 Dec. (T)	8

Name	Type	Launch date	Completion date†	Chapter described
<u>1968</u>				
*Surveyor 7	soft lander	7 Jan.	21 Feb. (T)	8
Zond 4	test	2 Mar.	?	10
Luna 14	orbiter	7 Apr.	?	13
*Zond 5	flyby	14 Sep.	21 Sep. (L)	10
*Zond 6	flyby	10 Nov.	17 Nov. (L)	10
*Apollo 8	manned orbiter	21 Dec.	27 Dec. (L)	10
<u>1969</u>				
*Apollo 10	manned orbiter	18 May	26 May (L)	10
Luna 15	sampler or rover	13 July	21 July (I)	11
*Apollo 11	manned lander	16 July	24 July (L)	11
*Zond 7	flyby	8 Aug.	14 Aug. (L)	13
Kosmos 300	sampler or rover	23 Sep.	27 Sep. (E)	—
Kosmos 305	sampler or rover	22 Oct.	22 Oct. (E)	—
*Apollo 12	manned lander	14 Nov.	24 Nov. (L)	12
<u>1970</u>				
Apollo 13	manned lander	11 Apr.	17 Apr. (L)	13
*Luna 16	sample returner	12 Sep.	24 Sep. (L)	13
*Zond 8	flyby	20 Oct.	27 Oct. (L)	13
*Luna 17	Lunokhod 1 rover	10 Nov.	Oct. 1971 (T)	13
<u>1971</u>				
*Apollo 14	manned lander	31 Jan.	9 Feb. (L)	14
*Apollo 15	manned lander	26 July	7 Aug. (L)	15
Luna 18	sample returner	2 Sep.	11 Sep. (I)	16
*Luna 19	orbiter	28 Sep.	Oct. 1972 (T)	16
<u>1972</u>				
*Luna 20	sample returner	14 Feb.	25 Feb. (L)	16
*Apollo 16	manned lander	16 Apr.	27 Apr. (L)	16
*Apollo 17	manned lander	7 Dec.	19 Dec. (L)	17

Name	Type	Launch date	Completion date†	Chapter described
<hr/> 1973 <hr/>				
*Luna 21	Lunokhod 2 rover	8 Jan.	June? (T)	13, 18
*Mariner 10	flyby	3 Nov.	5 Nov. (F)‡	18
<hr/> 1974 <hr/>				
*Luna 22	orbiter	29 May	Sep. 1975 (T)	—
Luna 23	sample returner	28 Oct.	9 Nov. (T)	—
<hr/> 1975 <hr/>				
Luna	sample returner?	16 Oct.	16 Oct. (E)	—
<hr/> 1976 <hr/>				
*Luna 24	sample returner	9 Aug.	23 Aug. (L)	18

*Successful mission.

†Completion refers to launch failure or Earth-atmosphere reentry (E), lunar flyby (F), lunar impact (I), successful landing or splashdown on Earth (L), or cessation of principal data transmission (T).

‡Mariner 10's photographic lunar flyby was incidental to its Venus-Mercury mission.

Appendix 2. Science Experiments Carried by Apollo Missions.

Experiment	Apollo						
	11	12	13 *	14	15	16	17
Orbital (CSM)							
Multispectral photography		X					
Gamma-ray spectrometer					X	X	
x-ray fluorescence spectrometer					X	X	
Alpha-particle spectrometer					X	X	
s-band transponder (gravity)		X	X	X	X	X	X
Bistatic radar				X	X	X	
Mass spectrometer (atmosphere)					X	X	
Ultraviolet photography (Earth and Moon)				X	X	X	
Ultraviolet spectrometer (atmosphere)							X
Infrared scanning radiometer							X
Radar sounder							X
Laser altimeter					X	X	X
Number revolutions					74	64	75
Time in orbit (hours)					145.5	125.6	147.8
Hasselblad photography (no. frames)	760	795	112	758	2,350	1,060	1,170
Metric (mapping) photography (no. frames)					3,375	2,514	2,350
Panoramic photography (no. frames)					1,570	1,415	1,580
Orbital (subsattellite)							
Plasmas and energetic particles					X	X	
Magnetometer					X	X	
s-band transponder (gravity)					X	X	
Data return (months)					6	1	
ALSEP							
Passive seismic	X	X	X	X	X	X	
Active seismic				X		X	

Experiment	Apollo						
	11	12	13 *	14	15	16	17
Magnetometer (stationary)		X			X	X	
Solar wind spectrometer		X			X		
Suprathermal ion detector (ionosphere)		X		X	X		
Heat flow			X		X	X	X
Charged particles (environment)			X	X			
Cold cathode gage (atmosphere)		X	X	X	X		
Lunar ejecta and meteorites							X
Mass spectrometer (atmosphere)							X
Surface gravimeter (stationary)							X
Dust detector	X	X		X	X		
Non-ALSEP surface							
Soil mechanics	X	X	X	X	X	X	X
Solar wind composition	X	X	X	X	X	X	
Portable magnetometer				X		X	
Laser ranging retroreflector	X			X	X		
Cosmic ray detectors						X	X
Far UV camera/spectrograph (space)						X	
Seismic profiling							X
Traverse gravimeter							X
Neutron probe							X
Surface electrical properties							X
Closeup photography (pairs)	17	15		17½			
Hasselblad photography (no. frames)	325	583		417	1,150	1,774	2,200
Time on Moon (hours)	22	32		33	67	71	75
Number EVAs	1	2		2	3	3	3
Duration EVAs (hours)	2.4	7.5		9.4	18.6	20.2	22.1
Total traverse length (km)	0.25	2.0		3.3	27.9	27.0	35.0
Sample weight (kg)	22	34		43	77	96	110

*Apollo 13 did not reach the lunar surface.

Appendix 3. Progress toward Scientific Objectives at Time of Apollo 17 Site Selection (between Apollos 15 and 16).

Objective	Apollo					
	11	12	14	15	16	17
Early lunar history	—	m	m	M?	?	E
Old crustal and interior materials	—	—	—	M?	?	E
Major basins (>250 km) and mascons	m	m	M	M	—	E
Highland crustal evolution	—	—	m	M	M	E
Mare fillings	M	M	—	M	—	D
Large craters (>40 km) and their products	—	m	—	—	—	E
Postmare internal history	m	M	—	M	?	E
Regolith evolution	M	M	m	M	M?	D
Regolith interactions with extralunar environment	M	m	m	M	M?	D
Present interior, physical, and chemical state	m	m	M	M	M?	E
Lunar heterogeneity	—	m	M	m	?	E

Source: From memorandum prepared for Noel W. Hinners by William R. Muehlberger and Leon T. Silver, dated 30 November 1971.

Abbreviations: M = major contribution; m = significant but limited contribution; E = essential; D = desirable but less urgent.

Appendix 4. Geologic Periods and Notable Events in Lunar History
(after Wilhelms 1987).

Approximate time (aeons ago)	Event
4.5	Accretion of Moon in Earth orbit.
4.5–4.2 (?)	Differentiation of crust and mantle; plutonism, volcanism, and impact mixing and melting.
4.2(?)	Crustal solidification and formation of oldest preserved impact basins.
4.2–3.92	Formation of at least 30 pre-Nectarian basins.
3.92	Nectaris basin impact, beginning Nectarian Period.
3.92–3.84	Formation of 10 more Nectarian basins, including Serenitatis and Crisium.
3.84	Imbrium basin impact, marking Nectarian-Imbrian period boundary; eruption of oldest dated intact mare lava flows.
3.8	Formation of last large basin (Orientale), marking Early Imbrian-Late Imbrian epoch boundary.
3.8–3.2	Eruption of most voluminous mare lavas and pyroclastics; continued though diminished impact cratering.
3.2	Imbrian-Eratosthenian period boundary.
3.2–1.1	Continued mare volcanism and impact cratering.
1.1	Eratosthenian-Copernican period boundary.
0.81	Copernicus impact; approximate time of last mare eruptions.
0.11	Tycho impact.
