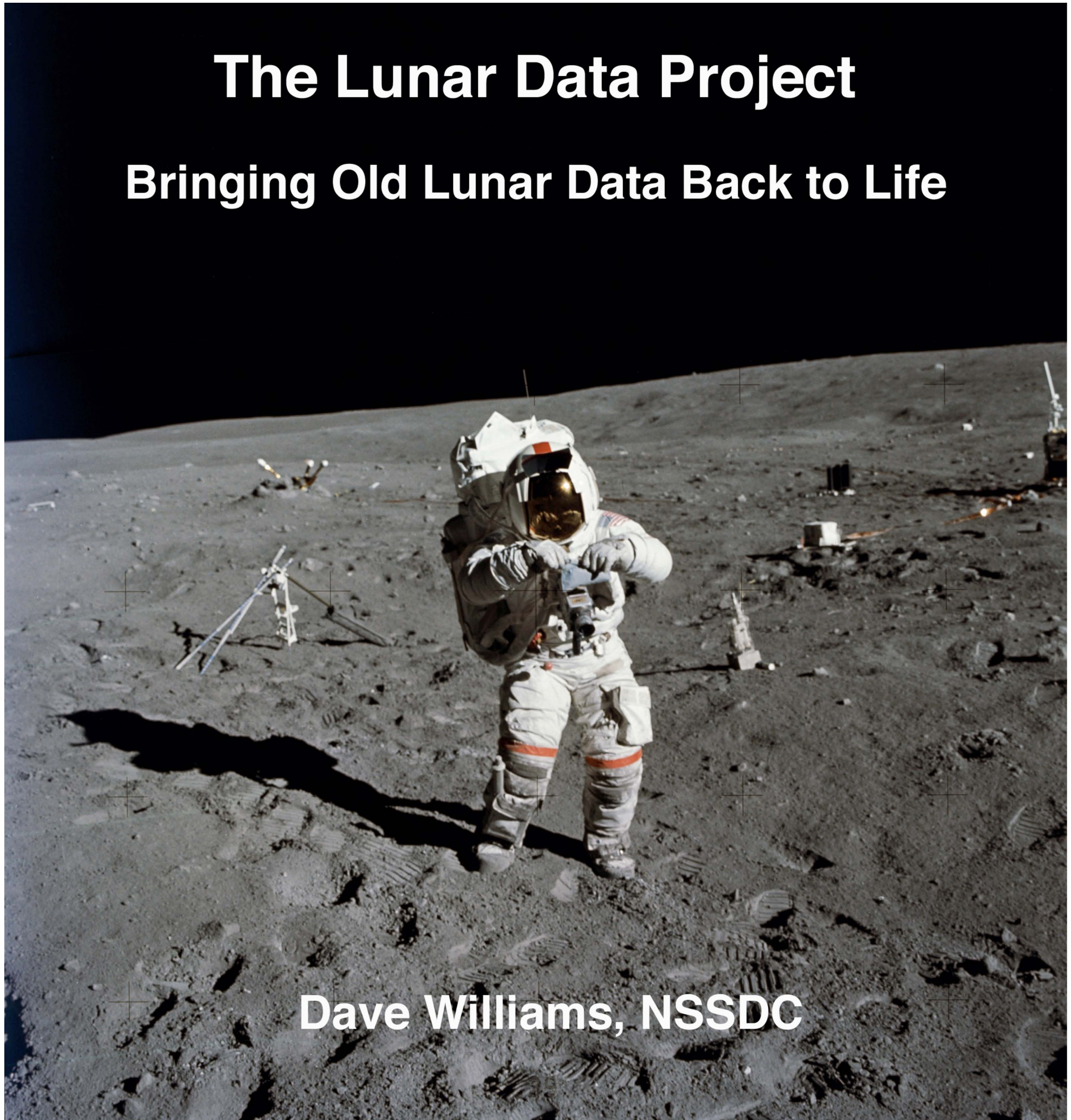
The Lunar Data Project

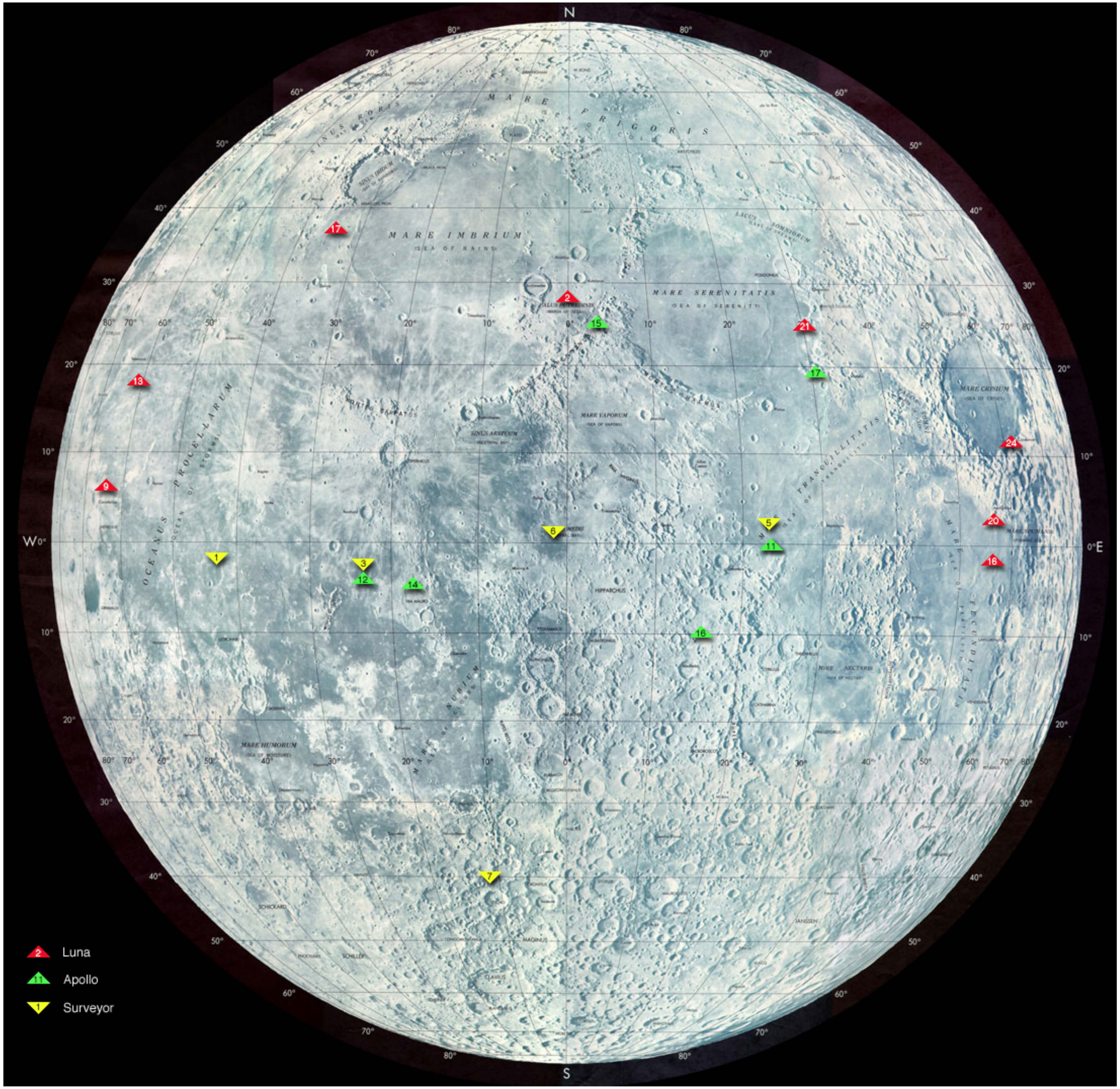
Bringing Old Lunar Data Back to Life



Dave Williams, NSSDC

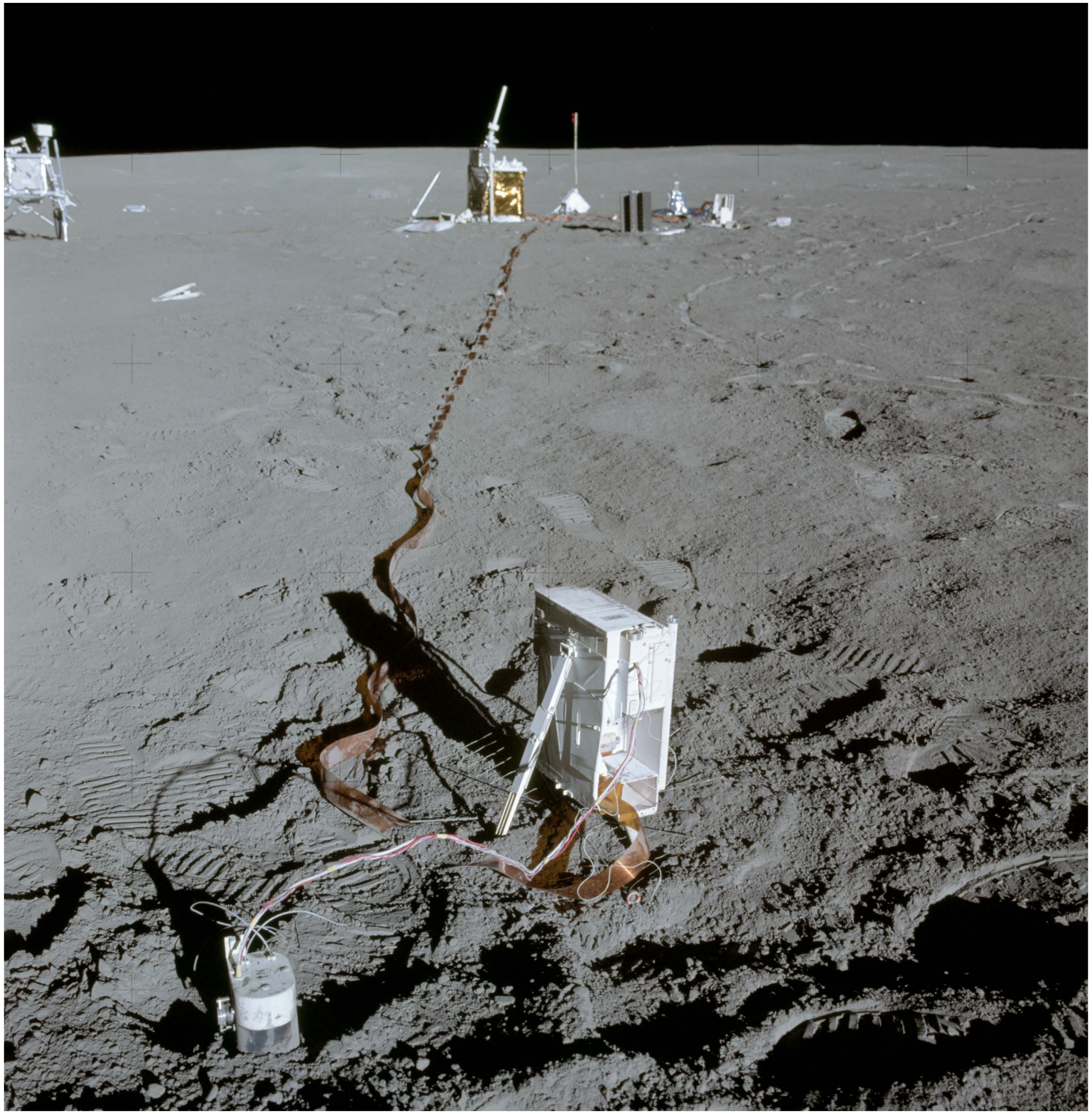
Lunar Data Project

- Ed Grayzeck, Head, NSSDC
- Bruce Milam, P.I.
- Kent Hills
- Allison Lopez
- Danny Hoag
- Jay Friedlander
- Lunar Data Evaluation Team



N
S
W 0°
0° E
MARE FRIGORIS
MARE IMBRIUM
(SEA OF RAINS)
MARE SERENITATIS
MARE CRISIUM
MARE VAPORUM
SINUS AESTUUM
OCEANUS PROCELLARUM
MARE NECTARIS
MARE HUMORUM
MARE NUBIUM
HIPPARCHUS
Luna
Apollo
Surveyor

Apollo Lunar Surface Experiments Package (ALSEP)



Apollo Surface Experiment Packages

Apollo 11 EASEP	7/21/69 - 8/27/69
Apollo 12 ALSEP	11/19/69 - 9/30/77
Apollo 14 ALSEP	2/5/71 - 9/30/77
Apollo 15 ALSEP	7/31/71 - 9/30/77
Apollo 16 ALSEP	4/21/72 - 9/30/77
Apollo 17 ALSEP	12/12/72 - 9/30/77

Central Station and RTG

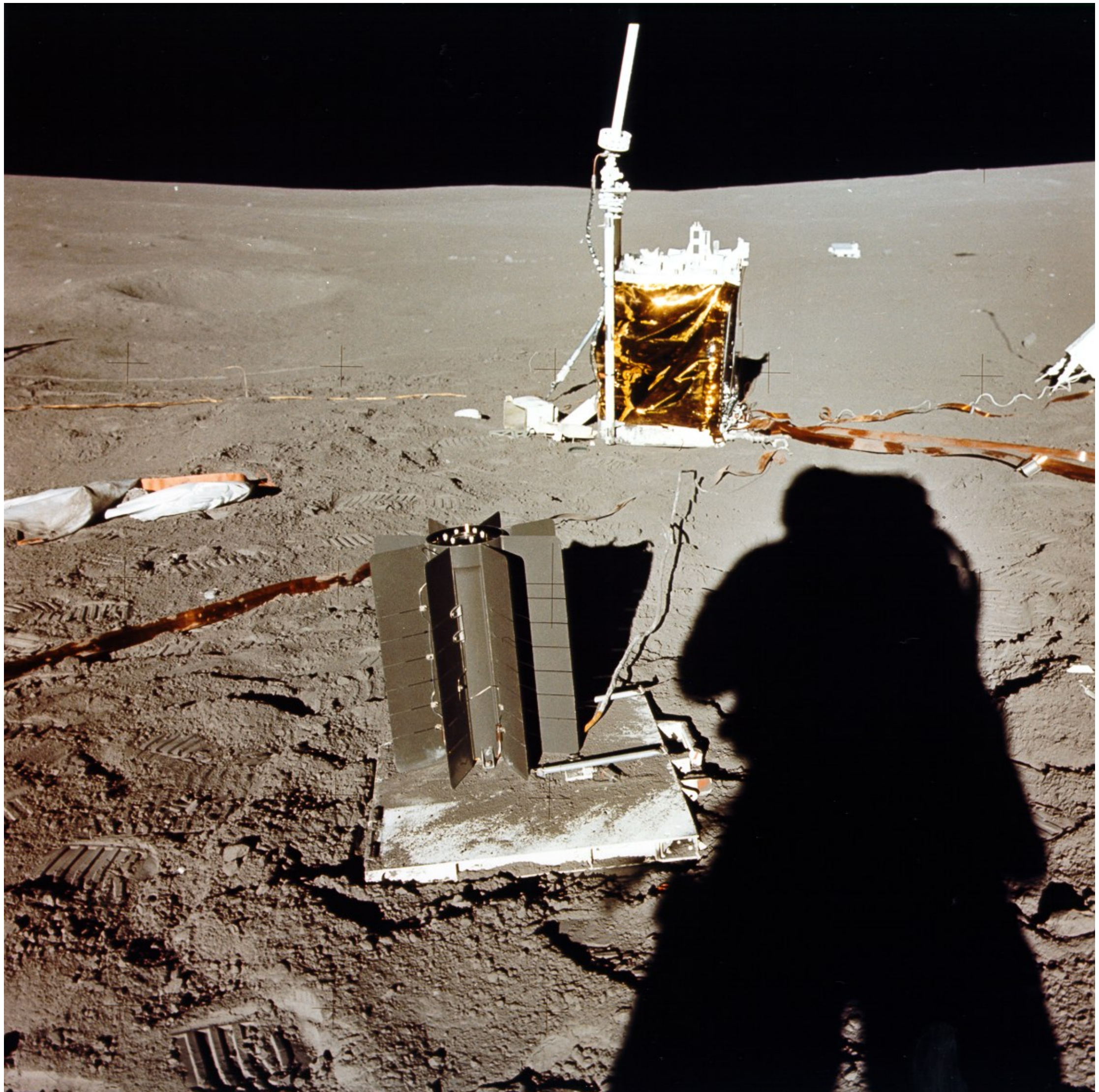


Table 5-14. Lunar Surface Experiments for which NSSDC has Data

Experiment	Mission					
	Apollo 11	Apollo 12	Apollo 14	Apollo 15	Apollo 16	Apollo 17
Lunar Field Geology	X	X	X	X	X	X
Soil Mechanics	X	X	X	X	X	X
Passive Seismic	X	X*	X*	X*	X*	
Active Seismic			X		X	
Seismic Profiling						X*
Laser Ranging Retroreflector	X*		X*	X*		
Surface Magnetometer and Portable Magnetometer		X		X	X*	
Heat Flow				X		X*
Traverse Gravimeter						X
Surface Electrical Properties						X
Neutron Probe						X
Suprathermal Ion Detector		X	X	X*		
Cold Cathode Ion Gage			X	X*		
Charged Particle Lunar Environment			X*			
Atmospheric Composition						X
Solar Wind Spectrometer		X		X		
Cosmic Ray					X	X
Far UV Camera/Spectrograph					X	
Lunar Dust Detector			X	X		

*Actively returning data as of January 26, 1977.

Rationale For Restoring Data

- Avoid Repeating Experiments
- Use New Data Analysis Techniques and Hardware
- Explore Environmental Hazards
- Help Define Safe Landing Sites

Lunar Data Evaluation Team

Figure 4 – The Lunar Data Evaluation Team (L to R) Gregory Leptoukh, Dave Rubincam, Paul Lowman, Will Webster (not pictured: Patrick Taylor) reviewed the data held at the NSSDC for relevance to future lunar exploration.

Apollo Lunar Data Sets Recommended for Restoration

Lunar Data	Media	Priority	Effort	Apollo Mission
SIDE Mass Analyzer	Mag. Tapes	High	Low	12, 14, 15
SIDE Total Ion Energy	Mag. Tapes	High	Low	12, 14, 15
Charged Particle Environment	Mag. Tapes	High	Low	14
Solar Wind Spectrometer	Mag. Tapes	High	Low	12, 15
Cold Cathode Ion Gauge	Microfilm	High	Medium	14, 15
Subsatellite Lunar Part.	Mag. Tapes	Medium	Low	15, 16
SIDE PI Raw Data	Mag. Tapes	Medium	Medium	12, 14, 15
SIDE Hard Copy Plots	Hard Copy	Medium	Medium	12, 14, 15
Soil Mechanics	Microfilm	Medium	Medium	15, 16
Dust Detector	Microfilm	Medium	High	12, 14, 15
ALSEP Work Tapes	Mag. Tapes	Medium	Medium	12, 14, 15, 16, 17
Alpha Particle Spectrometer	Mag. Tapes	Low	Low	15, 16
Far UV Spectrometer	Mag. Tapes	Low	Low	17
Lunar Passive Seismic	Mag. Tapes	Low	High	12, 14, 15, 16
Apollo Panoramic Camera	Film	Low	High	15, 16, 17

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New events discovered in the Apollo lunar seismic data

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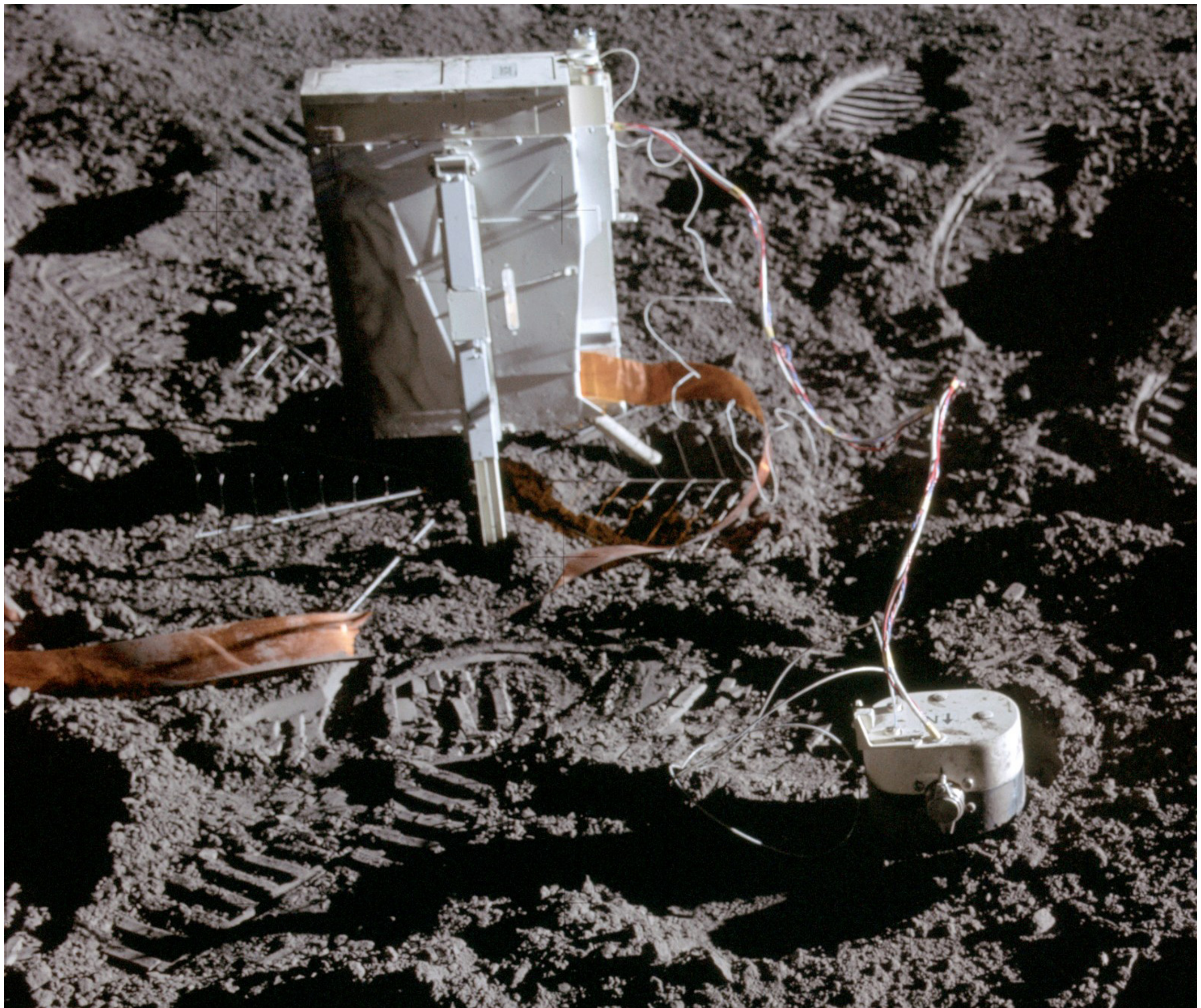
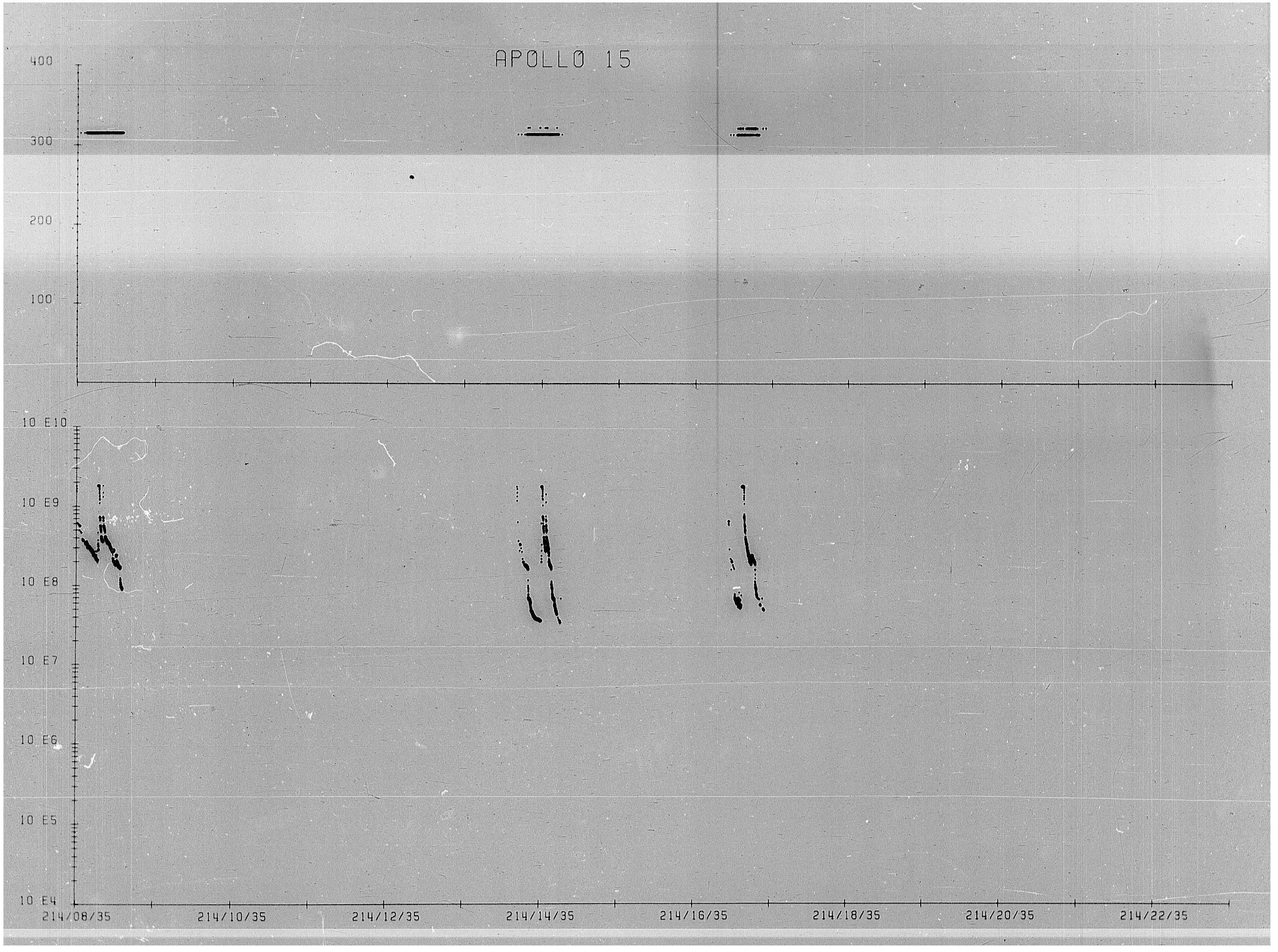
[1] We use modern seismological data processing tools to revisit the Apollo lunar seismic data set with the goal of extending and further characterizing the existing catalog of deep moonquakes.

6. Conclusions

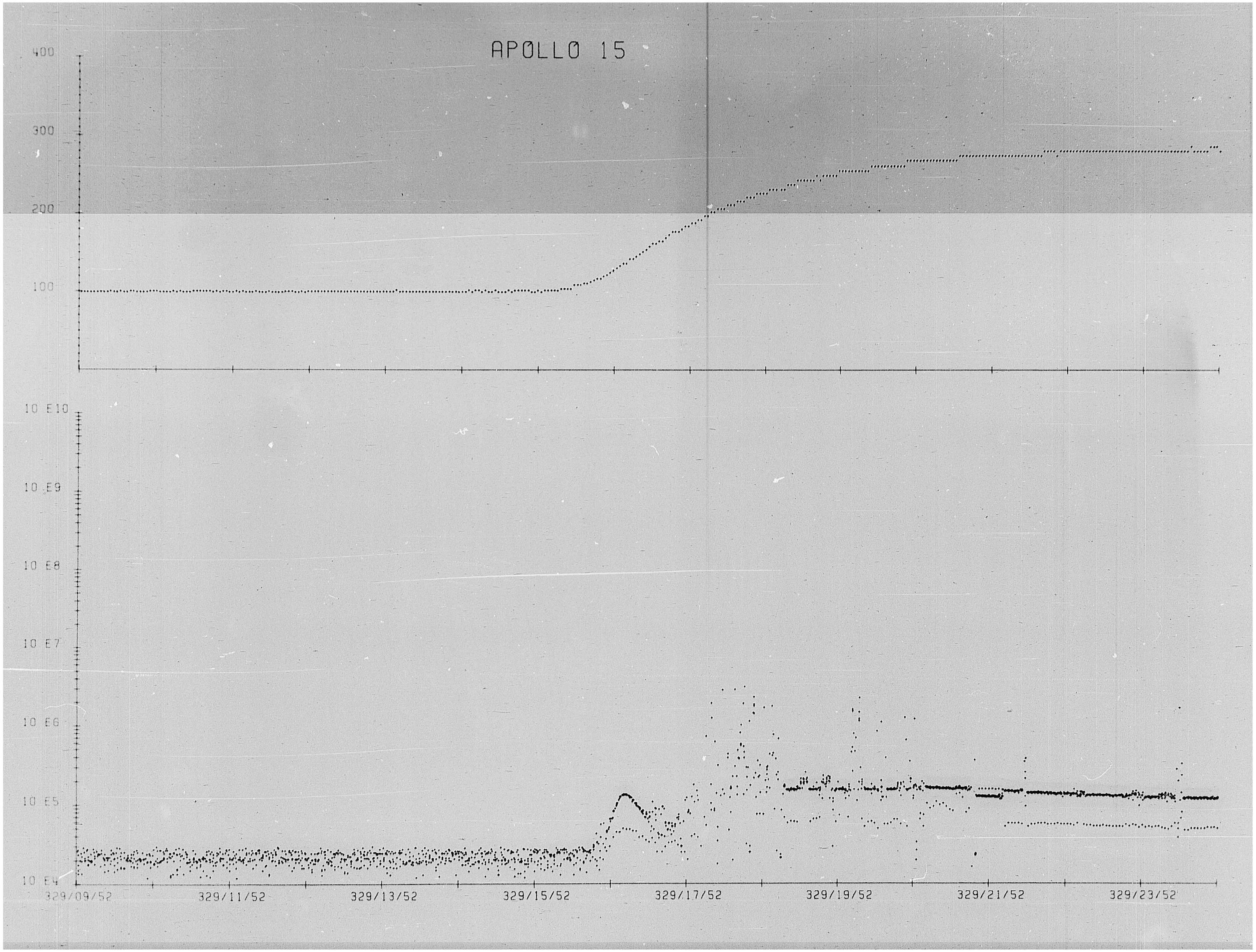
[48] Analysis of the continuous event data has proven to be fruitful. Although previous studies did a remarkable job of identifying events by visual rather than automatic means, our comprehensive event search has shown the analysis of the continuous Apollo lunar seismic data to be worthwhile, as additional events are readily detectable using cross-correlation methods. Furthermore, modern computing capabilities have proven essential for obtaining reliable results, as lunar seismograms are of limited quality compared to terrestrial seismograms. The extensive data processing described in section 2 is essential to our results.

Cold Cathode Ion Gage (CCIG)





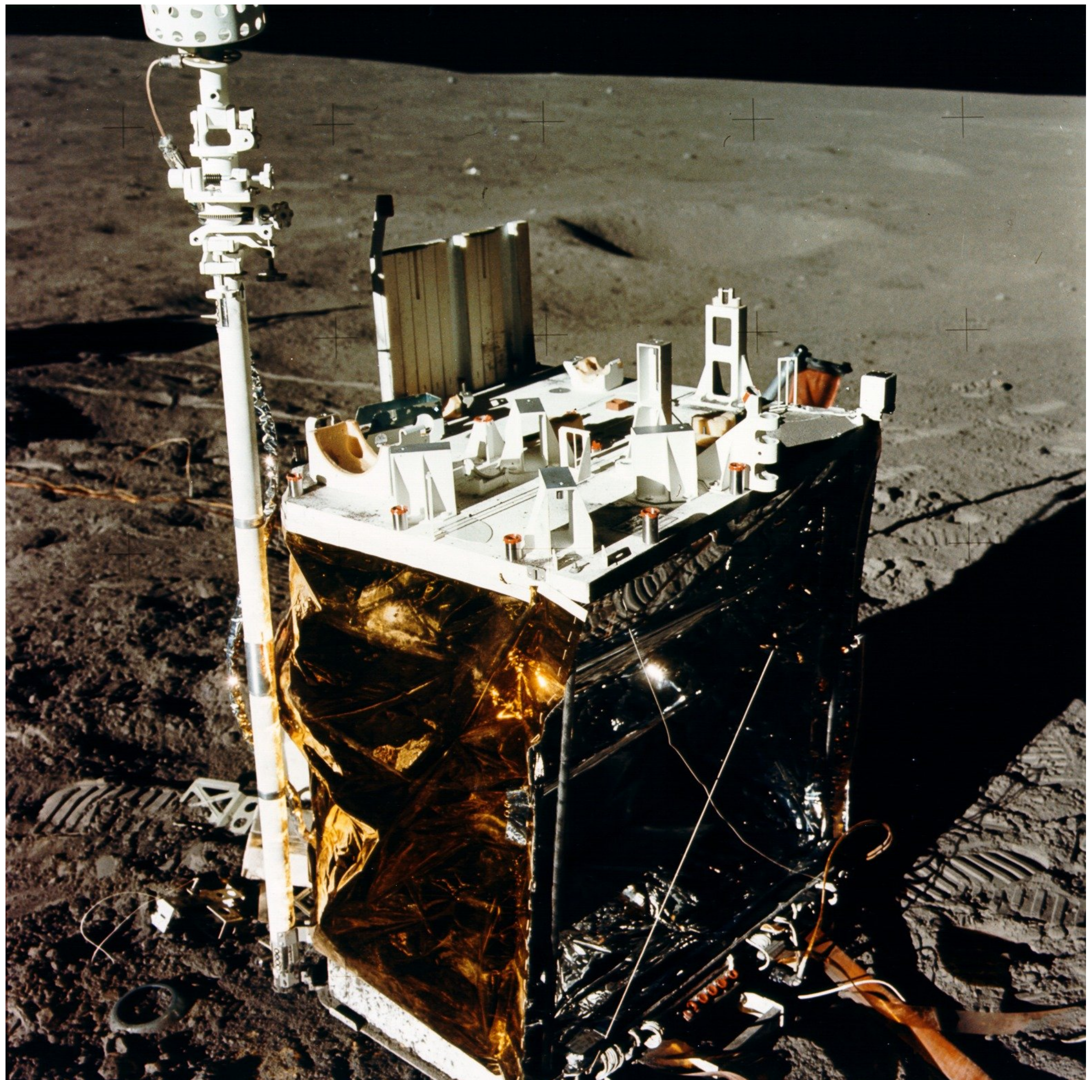
APOLLO 15
400
300
200
100
10 E10
10 E9
10 E8
10 E7
10 E6
10 E5
10 E4
214/08/35
214/10/35
214/12/35
214/14/35
214/16/35
214/18/35
214/20/35
214/22/35



APOLLO 15
400
300
200
100
10 E10
10 E9
10 E8
10 E7
10 E6
10 E5
10 E4
329/09/52
329/11/52
329/13/52
329/15/52
329/17/52
329/19/52
329/21/52
329/23/52

Lunar Dust Detector

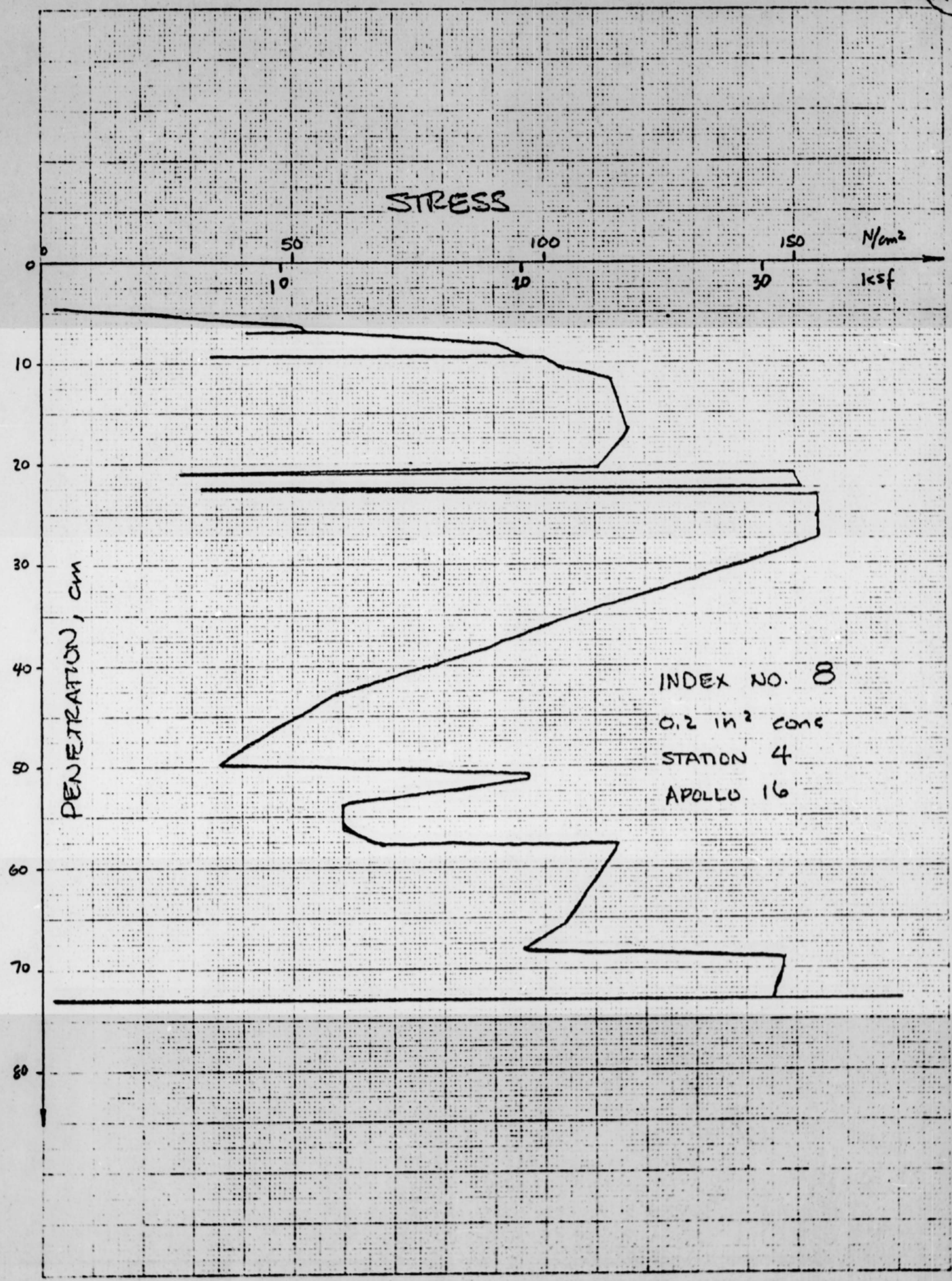
Dust, Thermal, and Radiation Engineering Measurements Package



ALSEP LUNAR DUST DETECTOR

DAYS	HR	MIN	SECS	SUN ELEVATION ANGLE DEG	AX01 DEG. C	AX03 DEG. C	AX04 UN-CORRECTED MV	AX05 UN-CORRECTED MV	AX06 UN-CORRECTED MV	AX04 CORRECTED MV	AX05 CORRECTED MV	AX06 CORRECTED MV
179	11	53	8.079	60.02	74.12	64.71	44.34	38.77	42.34	44.54	40.78	42.73
179	11	54	2.415	60.01	75.62	63.24	44.34	38.77	42.34	44.53	40.67	42.71
179	11	54	56.751	60.01	74.12	63.24	44.34	39.41	42.34	44.54	41.45	42.73
179	11	55	51.088	60.01	74.12	63.24	43.71	38.77	42.34	43.90	40.78	42.73
179	11	56	45.424	60.00	74.12	63.24	44.34	38.77	42.34	44.54	40.78	42.73
179	11	57	39.761	60.00	74.12	63.24	44.34	38.77	42.34	44.54	40.78	42.73
179	11	58	34.098	59.99	74.12	63.24	44.34	38.77	42.34	44.54	40.78	42.73
179	11	59	28.434	59.99	74.12	63.24	44.34	38.77	42.34	44.54	40.78	42.73
179	12	0	22.771	59.99	74.12	63.24	44.34	38.77	42.34	44.54	40.78	42.73
179	12	1	17.107	59.98	74.12	63.24	44.34	38.77	42.34	44.54	40.78	42.73
179	12	2	11.444	59.98	74.12	63.24	44.34	38.77	42.34	44.54	40.78	42.73
179	12	3	5.781	59.97	74.12	63.24	43.71	38.77	42.34	43.90	40.78	42.73
179	12	4	.118	59.97	74.12	63.24	44.34	38.77	42.34	44.54	40.78	42.73
179	12	4	54.454	59.97	74.12	63.24	43.71	38.77	42.34	43.90	40.78	42.73
179	12	5	48.790	59.96	74.12	63.24	44.34	38.77	42.34	44.54	40.78	42.73
179	12	6	43.127	59.96	74.12	63.24	44.34	38.77	42.34	44.54	40.78	42.73
179	12	7	37.463	59.95	74.12	63.24	44.34	38.77	42.34	44.54	40.78	42.73
179	12	8	31.800	59.95	74.12	63.24	44.34	38.77	42.34	44.54	40.78	42.73
179	12	9	26.138	59.95	74.12	63.24	44.34	38.77	42.34	44.54	40.78	42.73
179	12	10	20.473	59.94	75.62	63.24	43.71	38.77	42.34	43.89	40.67	42.71
179	12	11	14.811	59.94	74.12	64.71	44.34	38.77	42.34	44.54	40.78	42.73
179	12	12	9.146	59.93	75.62	63.24	43.71	38.77	42.34	43.89	40.67	42.71
179	12	13	3.483	59.93	74.12	63.24	43.71	38.77	42.34	43.90	40.78	42.73
179	12	13	57.819	59.93	74.12	63.24	44.34	39.41	42.34	44.54	41.45	42.73
179	12	14	52.156	59.92	74.12	64.71	44.34	38.77	42.34	44.54	40.78	42.73
179	12	15	46.493	59.92	74.12	64.71	44.34	38.77	42.34	44.54	40.78	42.73
179	12	16	40.829	59.91	74.12	63.24	44.34	38.77	42.34	44.54	40.78	42.73
179	12	17	35.167	59.91	74.12	64.71	44.34	38.77	42.34	44.54	40.78	42.73
179	12	18	29.503	59.91	74.12	63.24	44.34	38.77	42.34	44.54	40.78	42.73

Soil Mechanics


STRESS
N/cm²
0
50
100
150
10
20
30
ksf
0
10
20
30
40
50
60
70
80
PENETRATION, cm
INDEX NO. 8
0.2 in² cone
STATION 4
APOLLO 16

APOLLO 16

(B-3)

UNIVERSITY OF CALIFORNIA
Soil Mechanics Laboratory

APOLLO 16 - LSRP | Date 11 & 12 MAY 1972

FLIGHT UNIT (S/N 2004) | Lunar Penetration Data Reduction

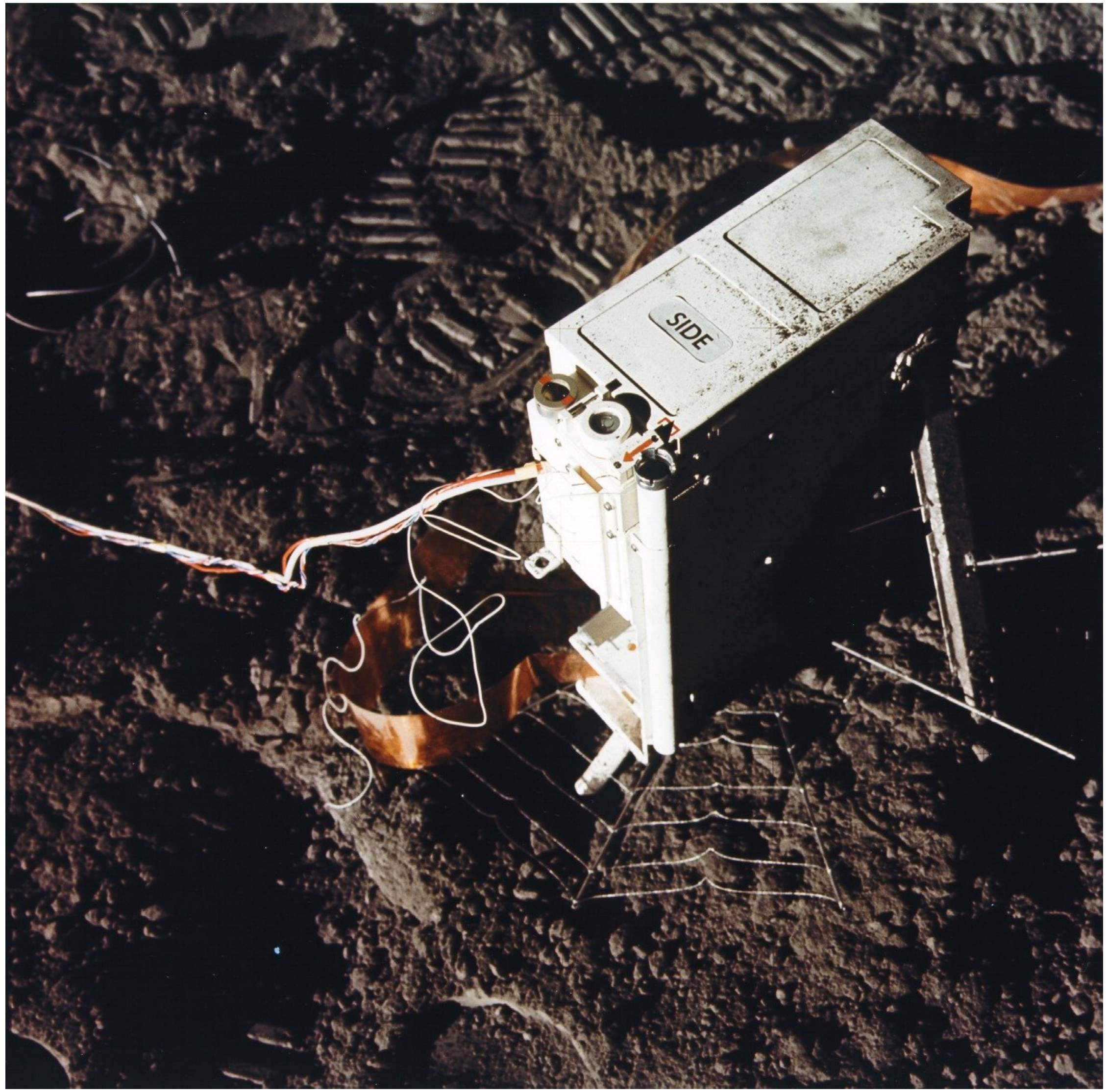
LUNAR DRUM (S/N 2008) | Index No. 5 Page No. 1

$0.5\ in^2$ cone = $3.2258\ cm^2$

DRUM LOAD ∡ deg-min	DRUM LOAD ∡ degrees (→ x .5542 →)	DRUM CIRCUMF. DEFLECTION mm.	LOAD newtons (from calib. curve)	STRESS newton/cm^2		INITIAL / FINAL DRUM DEPTH cm	Δ DRUM DEPTH READING cm. (→ x 31.3 →)	ACTUAL PENETR. DEPTH cm.	
0°00'	0.00	0.00	0.0	0.0		89.77	0.00	0.00	
0°00'	0.00	0.00*	3.5	1.1		89.88	0.11	3.4	
2°50'	2.83	1.57	23.8	7.4		89.89	0.12	3.8	
5°14'	5.23	2.90	41.0	12.7		89.94	0.17	5.3	
6°55'	6.92	3.84	53.0	16.4		89.[illegible]	0.17	5.3	
9°05'	9.08	5.03	68.7	21.3		[illegible]	0.19	6.0	
9°20'	9.33	5.17	70.3	21.8		90.00	0.23	7.2	
5°40'	5.67	3.14	44.0	13.6		90.00	0.23	7.2	
9°41'	9.68	5.36	72.8	22.6		90.01	0.24	7.5	
14°38'	14.63	8.11	109.0	33.8		90.11	0.34	10.6	
15°02'	15.03	8.33	111.7	34.6		90.16	0.39	12.2	
9°38'	9.63	5.34	72.6	22.5		90.16	0.39	12.2	
16°35'	16.52	9.19	122.7	38.0		90.16	0.39	12.2	
18°33'	18.55	10.28	137.0	42.5		90.21	0.44	13.8	
18°49'	18.82	10.43	138.8	43.0		90.25	0.48	15.0	
8°49'	8.82	4.[illegible]	67.0	19.8		90.25	0.48	15.0	
20°00'	20.00	[illegible].08	147.3	45.7		90.25	0.48	15.0	
21°19'	21.32	11.82	157.0	48.7		90.29	0.52	16.3	
8°15'	8.25	4.57	62.5	19.4		90.29	0.52	16.3	
23°24'	23.40	12.97	172.0	53.3		90.29	0.52	16.3	

TREADWELL & MORIWAKI

Suprathermal Ion Detector Experiment



Lunar Exploration Enabling Database

At the end of this effort we will have 20 to 30 data sets in digital, machine-readable formats.

Data, in CDF, will be made available online in a Lunar Exploration Enabling Database (LEED) at NSSDC.

Data will be put into PDS format and archived with PDS for the widest possible distribution.

Future Work

- Further data sets to be added, put online and archived with PDS. (Proposal pending - Pat Taylor)
- Digitization of Apollo orbital photography for use in determining landing sites. (Proposal in early development)