

Section A

Traverse Profile for a Hypothetical
Lunar Roving Vehicle Mission

by

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Section A

TRAVERSE PROFILE FOR A HYPOTHETICAL LUNAR ROVING VEHICLE MISSION

Introduction

This report summarizes the preliminary results of on-going studies in the Terrain Analysis, Trafficability, Crater Studies, and Advanced Systems Traverse Research Projects of the U.S. Geological Survey under NASA Contracts W-12,388 and R-09-020-041. The information included herein has been prepared under the auspices of the Science and Traverse Planning Panel for the Lunar Roving Vehicle Study Management Team. It is intended to provide a base line LRV traverse plan from the best currently available supporting data on lunar terrain characteristics and geologic interpretations both of which will critically affect the use and application of roving vehicle concepts in Post-Apollo lunar exploration. It should be made clear that this is a preliminary effort and subsequent revisions should be expected.

Procedure

The traverse profile proposed here is intended to be representative of a wide range of scientific mission objectives and lunar terrain types for an unmanned LRV mission having a map-distance range of 1000 km and a one-year duration. It is not derived from any single area of the Moon but rather it is an assortment of selected sites of scientific interest and terrain types for which data were already available or could be readily obtained for this study. The traverse presents the variety of terrains and sites to be expected in the course of a number

of LRV traverses. The geographic locations from which the data are obtained are not cited except where acknowledgment for the work by other than the author must be made.

This first section of the report attempts to place the hypothetical traverse in a geological context and in a logical sequence of traverse segments alternating with relevant sites of major scientific interest (Table 1). The budgeting of time, distance, and vehicle velocity is dependent on the combined effects of slopes, craters, and blocks based on analyses by H. J. Moore and R. J. Pike of measurable lunar data for broad terrain categories as set forth in the sections following in this report. The primary sources of information on the lunar surface to date are the published and unpublished results from the Ranger, Surveyor, Lunar Orbiter, and Apollo 8 missions. The importance of topographic definition of the lunar surface on both large and small scales has become increasingly evident with the growing demands for definitive mission plans and mobility concept studies (Ulrich, 1968). The primary methods of obtaining such data for this report have been photogrammetry, photoclinometry and shadow measurements.

There are limitations in the accuracy of quantitative data gleaned from spacecraft photography when using photogrammetric, photoclinometric and other measurement techniques. Thus, the data listed here should be considered a current best estimate which will require revision as more information is obtained.

Primary Assumptions

In addition to the constraints imposed by lunar terrain and trafficability estimates, certain basic assumptions concerning LRV traverse concepts must be made on which to base the mission profile. The following assumptions have been generally agreed upon by the Science and Traverse Planning Panel for purposes of the present study:

1. The mission duration is one year, consisting of approximately 4000 hours of lunar daylight. Effective mission operation will continue around the clock throughout each lunar day, except for 1/2 day at each end when sun elevation is less than 7°.
2. The mission profile is for an LRV in the unmanned mode, deployed from a Lunar Payload Module (LPM) at the traverse origin. The LRV will rendezvous with a manned mission at its terminus to deliver samples for return to earth and to provide mobility for one or two astronauts for up to 120 hours of 3-hour sorties, each up to 30 km long. An example of a 3-day manned mission profile is given by Karlstrom, McCauley, and Swann (1968) and a comparison of the gross time allotments for the manned and unmanned missions is shown in Figure 1.
3. The unmanned LRV traverse is 1000 km in map distance consisting of about 50% mare and 50% upland terrain.
4. The traverse is further divided into four general terrain types for which preliminary data are available: smooth mare, rough mare, hummocky upland, and rough upland. Data are also available for large fresh craters such as Tycho, Aristarchus, and Copernicus and are included, on a preliminary basis, for this terrain category.

5. Average velocities of the LRV, on the basis of map distance attainable for the several terrain categories are estimated as follows and in Table 2:

Smooth mare	1.7 kph
Rough mare	1.5 kph
Hummocky upland	1.0 kph
Rough upland	0.5 kph
Large fresh crater	0.3 kph

These velocities are considered reasonable for the LRV operating in a continuous mode. To the extent that they turn out to be pessimistic, they may also be reasonable for the step mode of operation as well.

6. Frequency of stops required to update geographic position and to evaluate hazards and landmarks in areas to be crossed:

Mare--every 0.5 km (total of 1000 stops)

Upland--every 50 m (total of 10,000 stops)

Time for a single, routine LRV stop-and-go including communication delay is estimated to be 40 seconds.

7. Time for shut-down or warm-up procedures before and after lunar night, and use of time and power during lunar night is not determined here. The half day periods when sun is 0.7° above horizon may satisfy the first item.

8. Scientific investigations are to include the following basic group of experiments selected by the Science and Traverse Planning Panel as generally applicable to all unmanned LRV traverses:

- a. Facsimile camera system with the option of small field magnification and stereo capability (in addition to the navigation TV, stabilized to operate continuously on

moving vehicle; both cameras have 360° scan capability.

- b. Samplers for rock core (or fragment) and particulate materials
- c. Sample storage for 400 samples, under 1/2 lb. each
- d. X-ray diffractometer/spectrometer, including sample preparation and introduction
- e. Gravimeter, deployable/retrievable
- f. Magnetometer, continuous reading (if applicable)
- g. Three deployable Remote Geophysical Monitors (passive seismic)

Additional experiments may be added for special application on particular missions. The LRV and its various appendages will provide engineering experiments in soils mechanics that are not charged to science.

9. Scientific operations with respect to time consumption are divided into two categories (Figure 2):

- (a) Major Science sites (Table 1) each of which is allotted 50 hours for local maneuvering and traversing operations (40%), camera scanning for science and general purposes (20%), sample collection (20 samples at 15 minutes each), preparation, insertion, and storage/discard (12 min. each), sample analysis (20 min. each), and 20 gravimeter stations (12 min. each).
- (b) Routine station stops at an average map distance of 0.5 km enroute between major science sites; 360° camera scan (5-10 min.), collection of grab samples (10-15 min.), and a gravity measurement (10-12 min.) comprising 1/2 hour at each station for a total of 2000 stations. Analysis of sample is performed while enroute, and one in every ten collected is retained.

10. The LRV must avoid mature, young, and fresh craters which are two meters across and larger and blocks which are one meter across and larger. The width of the vehicle for purposes of obstacle calculations is two meters.

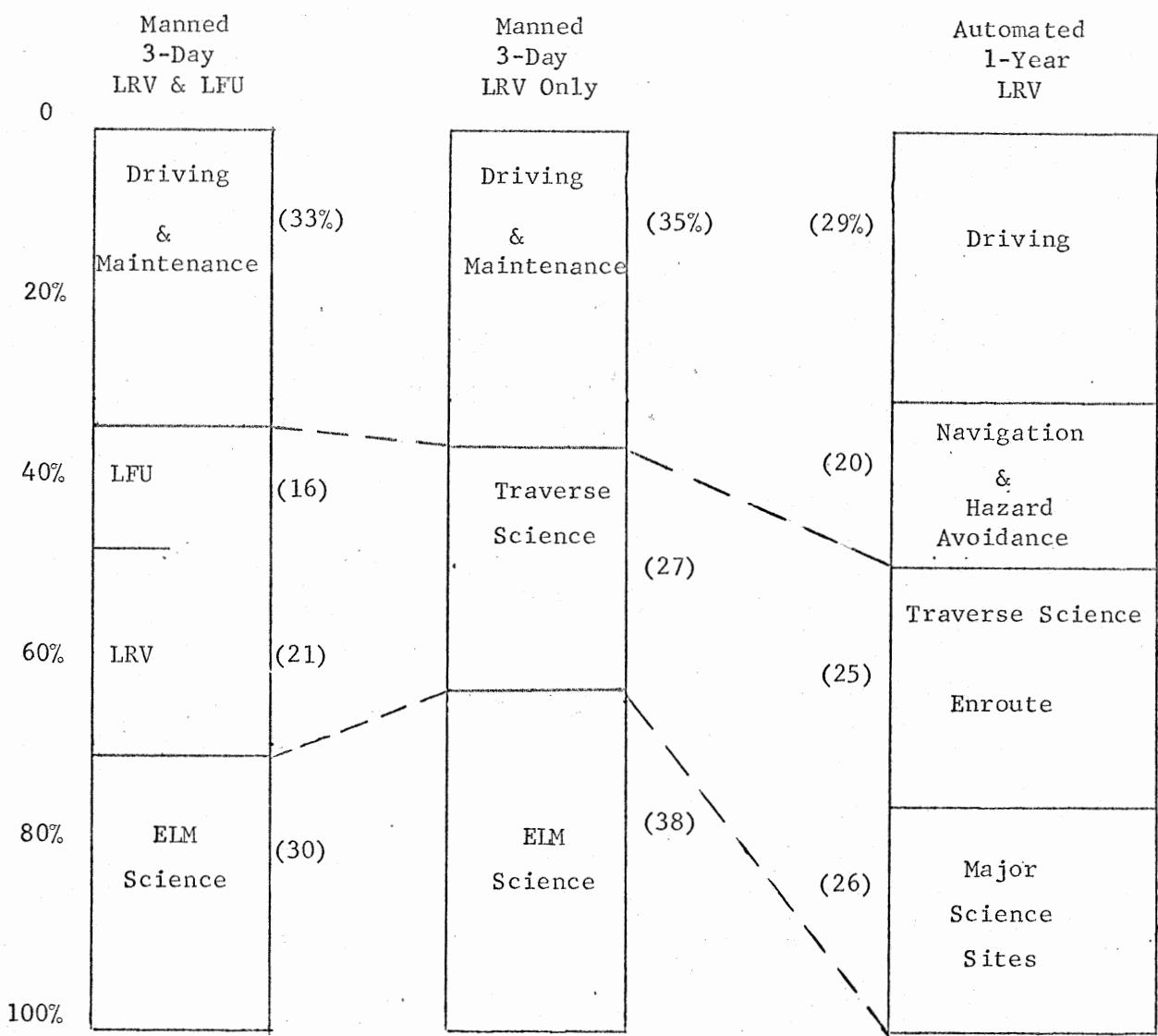


Figure 1.--Comparison of gross time allotment in manned and automated mission concepts.

(Manned mission allotments modified after Karlstrom, McCauley, and Swann (1968))

UNMANNED LRV 1000 KM TRAVERSE		
<u>Hours--1 year traverse</u>		<u>% of operational traverse time</u>
1000	Driving	25
150	Routine stop and start	4
400	Hazard contingencies	10
400	Navigation	10
1000	Routine sampling and geophysics (1/2-km interval)	25
1050	Major science sites (21)	26
<u>4000</u>		<u>100</u>

MAJOR SCIENCE SITE		
<u>Hours at site</u>		<u>% of site time available</u>
20	Maneuvering for vantage points, hazard appraisal and avoidance, sample collection, and local geophysical investigations. (Magnetometry, if applicable, should record continuously while vehicle is operating)	40
10	Facsimile and TV site study	20
5	Sample collection 20--Keep 10	10
4	Sample preparation, presentation to instruments, and storage (or discard)	8
7	Diffractometry and spectrometry	14
<u>4</u>	Gravimetry--20 stations	<u>8</u>
<u>50</u>		<u>100</u>

Figure 2.--Gross budget of time consumption on overall LRV traverse and at individual major science sites.

Table 1.--Major Science Sites

		<u>Sequence in 1000-km Traverse</u>	<u>Terrain Type or equivalent</u>
I. Volcanic sites			
V-1	Lava flow front and top with linear depressions	2	rough mare
V-2	Mare ridge with terrace	5	rough mare
V-3	Caldera or pit crater	14	rough mare- rough upland
V-4	Low lava dome	16	rough mare
V-5	Crater-top dome (or steep-sided dome)	17	hummocky- rough upland
V-6	Maar crater (or chain crater)	18	rough upland
V-7	Dark halo craters and associated rille	20	rough mare- hummocky upland
V-8	Transient phenomenon/thermal anomaly	21	smooth- rough mare
II. Impact crater sites			
I-1	Crater with secondary impacts & blocks	3	rough mare
I-2	Secondary field of small blocky craters and concentric craters in regional ray-covered area	4	rough mare
I-3	Large fresh crater rim	8	large crater
I-4	Normal & inverted stratigraphic succession in wall and rim	9	large crater
I-5	"Ponded" plains on crater rim or wall	10	rough mare
I-6	Floor-wall contact near concentric rille	11	large crater
I-7	Central peaks with block fields and boulder tracks	12	large crater
III. Tectonic/mass wasting sites			
T-1	Smooth regolith at traverse origin	1	smooth mare
T-2	Mare-upland contact and talus slopes	6	smooth mare- rough upland
T-3	Straight rille with fault scarp	7	rough-hummocky upland
T-4	Debris flow	13	large crater
T-5	Mare rille concentric with basin rim	15	rough mare- rough upland
T-6	Sinuous rille with levees	19	rough mare- rough upland

Table 2.--Distance, Velocity, and Time Constraints derived from Sections B, C, and D

Distance and Velocity	Smooth Mare	Rough Mare	Hummocky Upland	Rough Uplands			Fresh Large Crater
				Slopes 25°(5%)	non-negotiable 20°(10%)	15°(20%)	
%increase over map distance due to:					*		
1. Slopes crossed, L_s	0.2	0.4	1.0	1.9	1.7	1.5	3.5
2. Slopes too steep, L_{ts}	--	--	--	2.9	5.7	14.3	14.3
3. Craters, L_c	15.7	16.9	22.4	5.0	5.0	5.0	6.3
4. Blocks, L_b	0.04	0.4	0.4	0.4	0.4	0.4	6.3
5. Blocks and craters, L_{B+C}	15.7	17.5	23.1	5.5	5.5	5.5	13.4
6. Total % increase, L_T	15.9	17.9	24.1	10.3	12.9	21.3	31.2
7. Ground distance travel per unit map distance	1.16	1.18	1.24	1.10	1.13	1.21	1.31
8. Avg. map velocity (kph)	1.7	1.5	1.0	0.5	0.5	0.5	0.3
9. Ground velocity(kph)	1.97	1.77	1.24	0.55	0.56	0.60	0.39
<u>Time Hours per km traverse increment (map distance)</u>							
10. Driving pt-to-pt	.59	.67	1.00	2.00	2.01	2.02	3.36
11. 2 routine sci. stops	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12. Stop & go for science	.02	.02	.02	.02	.02	.02	.02
13. Navigation	.06	.06	.10	.20	.20	.20	.03
Hazard avoidance					*		
14. No. craters & blocks/ km, N_{B+C}	39.1	41.1	41.3	17.5	17.5	17.5	61.1
15. Stop & go @ each	.43	.46	.46	.19	.19	.19	.68
16. Drive around	.08	.10	.19	.10	.10	.09	.34
17. Total stop & go,navigation & hazards	.59	.64	.77	.51	.51	.50	1.07
18. Total traverse & science	2.18	2.31	2.77	3.51	3.52	3.52	5.43
<u>Summation exclusive of Science Sites</u>							
19. Distance [Map: in km [Ground:	250	250	190	150	150	150	125 965
20.	290	295	236	165	170	182	164 1155
21. Time required, hrs.	545	578	526	526	528	528	679 2856
22. % of total time	19	20	18.5	(18)	18.5	(18.5)	24 100
23. % of total distance	25	25.5	20.5	(14)	15	(16)	14 100

*Calculations for rough uplands are based on this column throughout report.

Earth-based mission requirements

The effective use of a complexly instrumented, multipurpose vehicle remotely controlled on the lunar surface clearly places severe requirements on the earth-based control and data handling facility. These requirements should become more clearly defined as the LRV design study progresses. The evolution of a conceptual design for the mission operations center which meets both engineering and scientific needs should parallel that of the LRV.

The hypothetical lunar traverse presented in the following pages is intended partly to illustrate some of the routine demands which will be made on the mission operation center and on the scientific data facility associated with it. Among these are requirements for personnel such as investigators, data handlers, prime vehicle controllers, and operators of remotely controlled scientific instruments. Obvious problems are expected from the simultaneous operation of several vehicle- and instrumented components, the communications time-lags, the power consumption allowable on the vehicle, and the heavy demands from both the scientific and engineering areas on the use of available computers for real-time data handling, decision making, and issuing of commands to the vehicle. In order to operate on a 24-hour basis, four full teams of investigators, data handlers, controllers, and operators will probably be necessary.

All observational data will require real-time interpretative geologic commentary that can be quickly stored and retrieved along with the visual image, as a substitute for observations by an observer aboard the vehicle. Several geophysicists will be required to interpret gravimetry and magnetometry as it is received and plotted; in addition active seismic

data from manned missions will require real-time analysis. Geo-chemists will have to evaluate the textural and analytical data on samples collected in order to select the best working geologic models or hypotheses and as a guide to future sampling. A navigator will be continually responsible for the vehicle's geographic position as well as its elevation, and it will be his job periodically to update the vehicle's navigation system.

Operators or computer-controlled commands with earth overrides will be required for all of the following functions, some of them simultaneously, determined mainly by the scientific mission objectives:

- a. TV pan and tilt and 360° scan
- b. Facsimile camera pan and tilt, 360° scan, and close up of rock and "soil" samples
- c. Sampling of lunar materials
- d. Sample preparation and insertion into analytical instruments
- e. Storage, retrieval, and discarding of selected samples
- f. Deployment, leveling, reading, and retrieval of gravimeter
- g. Ranging to artificial or selected natural reflectors or hazards
- h. Driving the vehicle: starting, accelerating, decelerating, stopping, backing, and turning

Displays in the science data facility based simply on the vehicle-mounted science package described above for the unmanned rendezvous mission should include at least four XY plots driven by telemetry as received from the vehicle: (1) geographic position and heading of the vehicle on a controlled photographic or photogeologic base map,

(2) gravimeter readings with capability of contouring, profiling, and solving 3-point problems for regional gradient, (3) magnetometer data in both XY and profile form as required, and (4) elevation profile of vehicle position continuously along traverse. In addition geochemical displays will be needed to show sample locations, classification, and position in storage unit, tabulated results of elemental and mineralogical compositions with textural characteristics, and off-line plotter displays for comparison of any combination of geochemical data.

These basic requirements are only a first cut on the projected needs of a science data facility. Terrestrial experiments combining these and other concepts should permit more precise statements of organizational and hardware requirements for the data facility.

Hypothetical Traverse Mission Profile

The remainder of this section presents the chronological sequence of mission segments in which detailed investigations at individual major science sites (Table 1) are linked together by routine traverse sections across uniform types of lunar terrain. Each science site consists of a brief description of scientific objectives, the allotment of time at the site, and the types of terrain and hazards anticipated. Where data is available, maps and profiles are provided as examples of real lunar features. The tabulated terrain characteristics are also given for each site.

The traverse segments between science sites are presented as data sheets, and when each terrain type is visited for the first time a representative sample of topographic profile is also provided.

Table 3 is a summary of the schedule and cumulative increase of distance, time, and geologic sampling for the entire traverse. For engineering studies and comparative analyses, calculations for any length of traverse and any combination of terrain types and science sites can easily be made by cutting out or rearranging portions of the traverse.

The sequence of science sites, lunar nights, and deployment of Remote Geophysical Monitors in relation to traverse distance and cumulative number of earth days is illustrated in Figure 3. This sequence is based on the traverse presented in the following pages, one of many possible combinations that would be equally logical and feasible from a scientific point of view.

Table 3--Summary of Distance, Time, and Sample Collection Increase on Traverse

Major Traverse Segment	Science Site or Segment	Distance, km.										Time, hrs					
		Mare			Uplands			Science			Cumulative			Geologic			
		Smooth Map	Rough Map	Ground Map	Hummocky Map	Rough Map	Ground Map	Large Crater Map	Ground Map	Sites Ground Distance	Driving Distance	Science	Stop & Go, Navigations Hazards	Cumul. Daylight	Lunar Night Approx.	Collect, Analyze	Retain
Site T-1 0-50 km	50	58						20	20	15	20	15	50	50	20	10	
Site V-1 50-100	50	58						15	78	30	50	30	160	120	20	20	
Site I-1 100-150		50	59					10	93	20	30	20	210	140	30		
Site I-2 150-200		50	59					15	151	30	50	30	320	240	40		
Site V-2 200-300				100	124			10	161	20	30	30	370	260	50		
Site T-2 300-350		50	59					15	200	34	50	32	486	360	60		
Site T-3 350-400		50	62					10	235	20	30	30	536	380	70		
Site I-3 400-450								15	294	34	50	32	652	480	80		
Site I-4 450-500								10	309	20	30	30	702	500	90		
Site T-4 500-550								15	433	100	100	77	979	696	110		
Site I-5 550-600								15	448	20	30	30	1029	720	120		
Site I-6 600-700								15	507	34	50	32	1145	820	130		
Site T-5 700-750								10	517	20	30	30	1195	840	140		
Site V-3 750-800								15	579	50	50	38	1333	940	150		
Site V-5 800-850								5	584	20	30	30	1383	960	160		
Site V-6 850-900								5	589	20	30	30	1433	980	170		
Site T-6 900-950								10	628	101	30	32	1596	1040	176		
Site V-7 950-1000								10	640	20	30	30	1646	1060	186		
Site V-8@ Rendezvous								10	653	20	30	30	1696	1080	196		
								15	712	151	45	48	1940	1170	205		
								7	719	20	30	30	1990	1190	215		
								15	769	40	40	31	2101	1270	223		
								13	782	20	30	30	2151	1290	233		
								10	848	168	50	54	2423	1390	243		
								10	858	20	30	30	2473	17410	253		
								10	971	201	100	51	2825	1610	273		
								15	986	20	30	30	2875	1630	283		
								10	1045	34	50	32	2991	1730	293		
								15	1060	20	30	30	3041	1750	303		
								15	1119	34	50	32	3157	1850	313		
								10	1129	20	30	30	3207	1870	323		
								5	1187	30	50	30	3317	1970	333		
								5	1192	20	30	30	3367	1990	343		
								10	1260	20	30	30	3477	2090	353		
								10	1317	100	50	26	3527	2110	363		
								10	1327	20	30	30	3753	2240	373		
								15	1385	30	50	30	3863	2330	393		
								15	1400	15	20	15	3913*	2350	400		
								---	1641	1575	697	---	---	---	---	---	
								---	1641	1575	697	---	---	---	---	---	

*62 hrs shorter for traverse E → W
62 hrs longer for traverse W → E

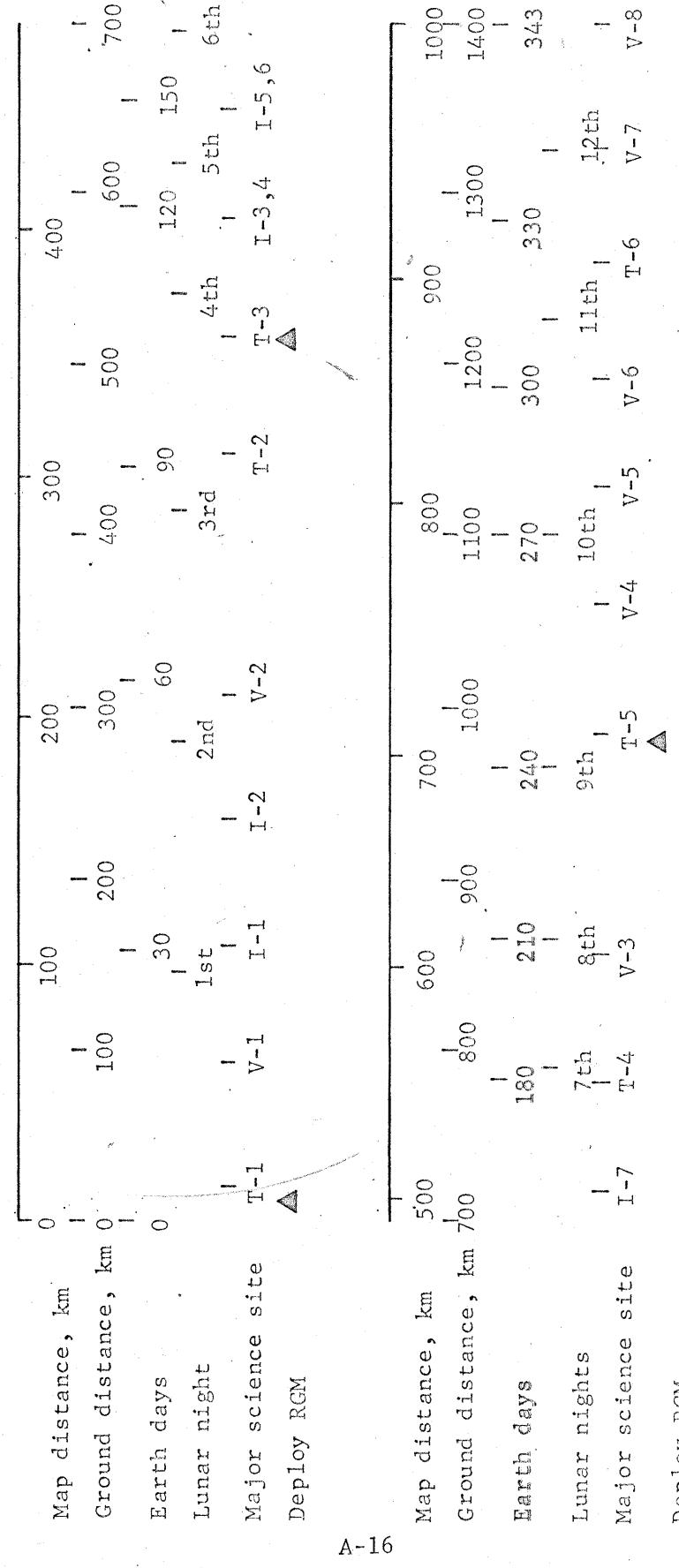


Figure 3. Sequence of science sites and lunar nights in relation to traverse distance and total number of earth days

Definitions of terrain symbols used in Table 2 and in data compilations for each segment of the traverse profile, partly modified from Sections B and E.

- Map distance Distance in km obtained by direct measurement between two points on a map.
- Ground distance True distance in km on the surface between two points which accounts for the statistical irregularities in the surface requiring deviation from a straight, horizontal path.
- Map velocity The map distance divided by the estimated hours required to traverse between two points.
- Ground velocity The true speed in km per hour required to traverse the ground distance so as to achieve the predicted map velocity.
- L_s Percentage of map distance which must be added to get ground distance due to traversing slopes, perpendicular to strike of slope and not allowing for curvature.
- L_{ts} Percentage of map distance which must be added to get ground distance due to slopes too steep to negotiate.
- L_c Percentage of map distance which must be added to get ground distance circumventing craters of mature and younger morphology, 2 m to 2 km in diameter.
- L_b Percentage of map distance which must be added to get ground distance circumventing blocks and boulders, 1 to 30 m in diameter.
- L_{B+C} Percentage of map distance which must be added to get ground distance due to circumvention of craters and boulders.
- L_t Total ground distance increase as percentage of map distance due to the combined effect of slopes, blocks, and craters.
- N_c Number of craters per km of ground distance that must be circumvented (2 m - 2 km in diameter).
- N_b Number of blocks per km of ground distance that must be circumvented (1 m - 30 m in diameter).
- N_{B+C} Number of craters and blocks per km of ground distance that must be circumvented.
- PSD Power spectral density in meters² per cycle per meter; given for frequencies of 0.05 and 0.5 cycles per meter.
- Abs. mean slope---absolute arithmetic mean slope
- Alg. std. deviation---algebraic standard deviation

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Landing of unnamed IM with LRV				
Objectives:	Deployment LRV, check out driving and instrument controls.			
Facsimile and TV scanning for navigation fix, preliminary hazard analysis, and site study.				
Operations	Driving	Science	Other	Five
0	5	10	10	20
1				21
(10)	(3)	(5)	(6)	(1)
Local maneuvering for scientific measurements and sampling.	a. Collection of 20 samples (mostly soils)	b. Prepare and insert into x-ray diffractometer/	c. Diffraction and spectrometry	d. Discard 10 and store 10 samples on basis
				e. Of analytical results
				f. 20 gravimeter readings spaced 2-3 meters apart.
				g. Magnetometer should read continuously while LRV is moving.

NOTES:

- 1) If power permits, items b, c, and d to be performed concurrent with other tasks
- 2) If magnetic data on the moon are valuable for near-surface geological interpretation,

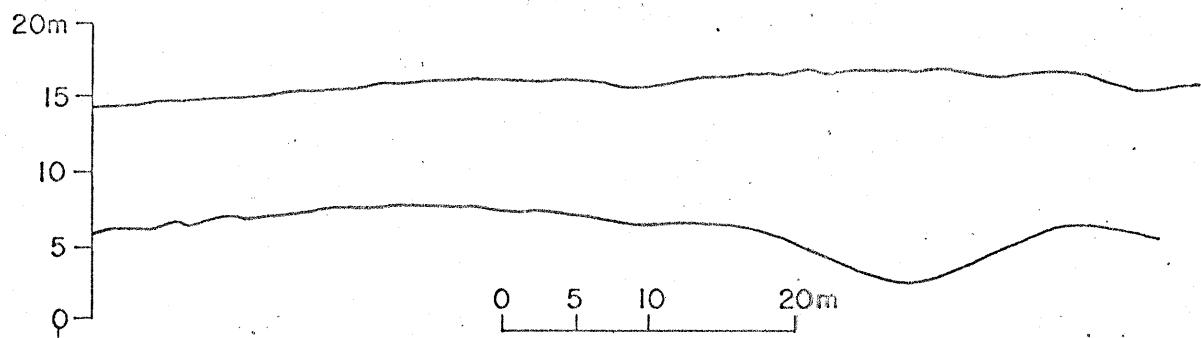
magnetometer should read continuously while

LRV is moving.

Site: T-1 Smooth regolith surface at landing site

Terrain Type or equivalent: smooth mare

Site T-1 Smooth regolith surface



Terrain type: Smooth Mare

L_s	0.2 %	<u>1m</u>	<u>10m</u>	<u>50m</u>
L_{ts}	--	Abs. Mean Slope	2.9°	2.0°
N_B	0.2	Alg. Std. deviation	3.6	2.5
N_C	38.9	Abs. Mean Curvature	0.6	1.0
N_{B+C}	39.1	Alg. Std. deviation	0.8	1.3
L_B	0.04%		<u>Max.</u>	<u>Min.</u>
L_C	15.7 %	PSD@0.05 ($\lambda=20m$):	0.25	0.045
L_{B+C}	15.7 %	PSD@0.5 ($\lambda=2m$):	0.0013	0.00012
L_T	15.9 %			

Terrain type: Smooth Mare

			<u>1m</u>	<u>10m</u>	<u>50m</u>
L _s	0.2 %				
L _{ts}	--	Abs. Mean Slope	2.9°	2.0°	1.4°
N _B	0.2	Alg. Std. deviation	3.6	2.5	1.7
N _C	38.9	Abs. Mean Curvature	0.6	1.0	0.8
N _{B+C}	39.1	Alg. Std. deviation	0.8	1.3	0.9
L _B	0.04%			<u>Max.</u>	<u>Min.</u>
L _C	15.7 %	PSD@0.05 ($\lambda=20m$):	0.25		0.045
L _{B+C}	15.7 %	PSD@0.5 ($\lambda=2m$):	0.0013		0.00012
L _T	15.9 %				

Map distance, this segment: 50 km

Ground distance, this segment: 58 km

Avg. map velocity: 1.7 kph

Ground velocity: 1.97 kph

Driving time: 30 hrs

Routine science each 0.5 km: 50 hrs

Other operations: 30 hrs

Total time, this segment: 110 hrs

Cumulative ground distance to date: 78 km

Cumulative time to date: 160 hrs

Site: V-1 Lava flow front and top with linear depressions

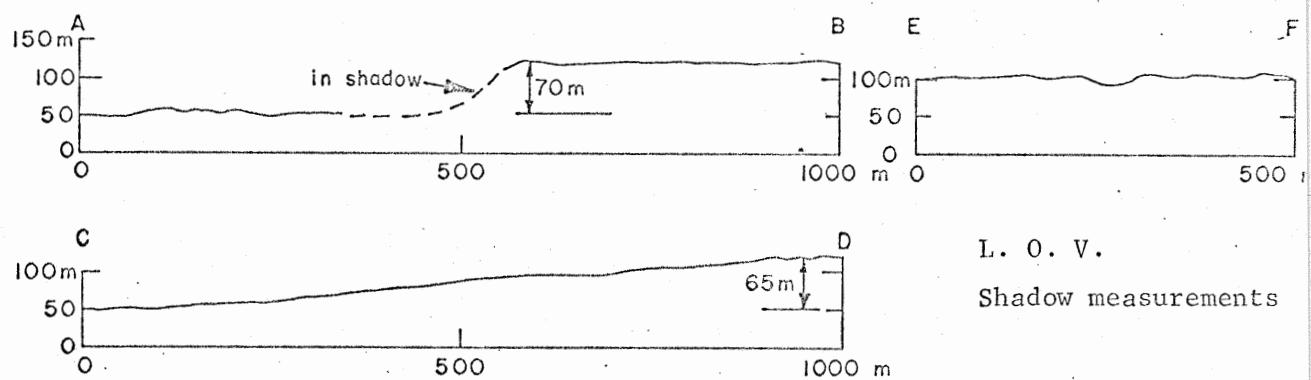
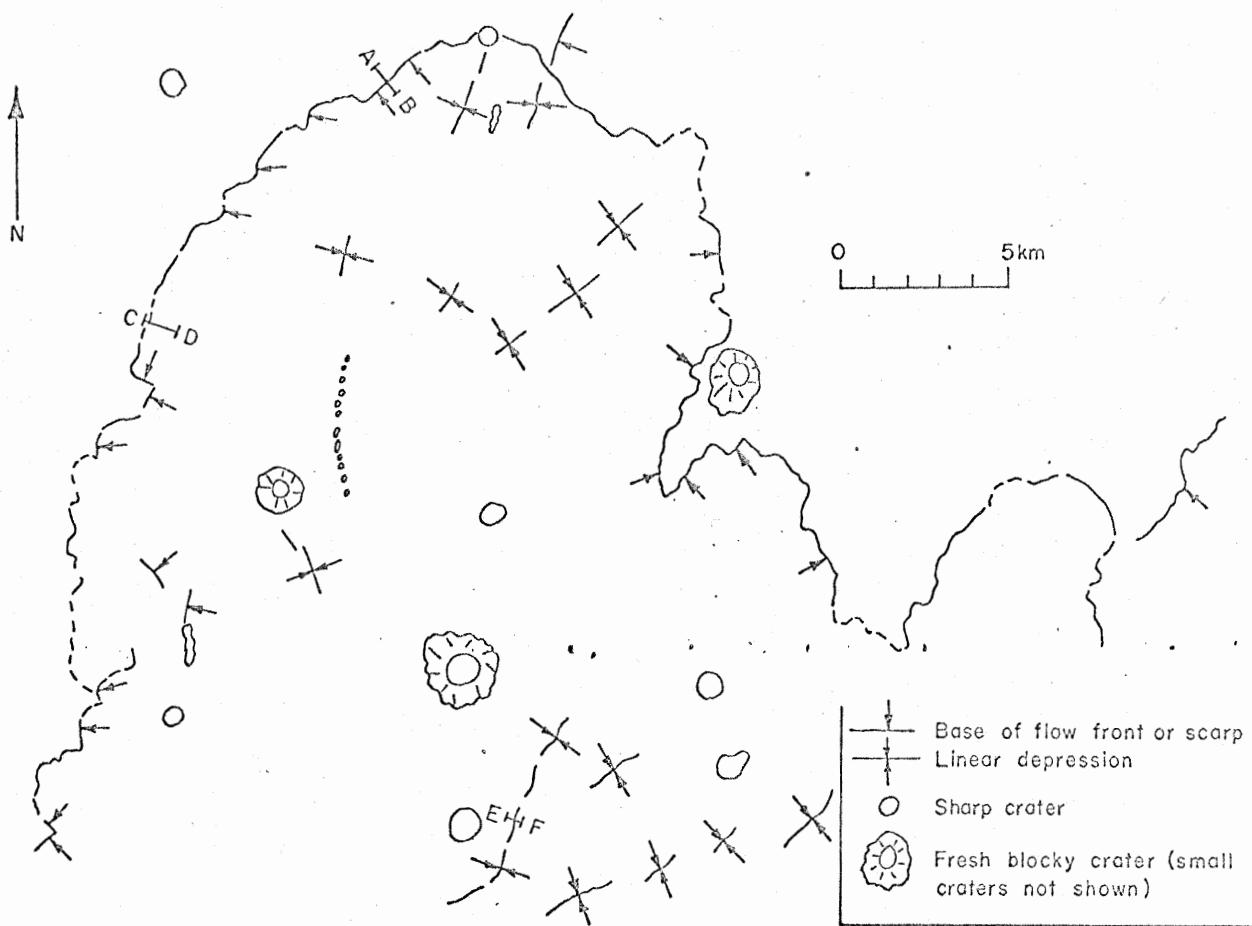
Terrain Type or equivalent: rough mare

Objectives: Composition and history of lava flow and surrounding plains.
Origin of linear depressions:
lava tubes, surface flow channels,
grabens, or other.

Estimated Time (hours)

Operation	Driving	Science	Other	Cumulative
Maneuvering using TV camera for vantage points, hazard appraisal and avoidance, sample collection and geophysics traverses on top of flow and off of flow 200 m beyond front. Linear depressions and flow front slopes are special hazards.	20			180
Facsimile camera for site study and sample collection.		10		190
Collection of 20 samples; away from flow, on flow top, at foot of flow front, and from blocks and outcrops where present.		5		195
Sample preparation, analysis, and selection of 10 for return (to be performed concomittant with other tasks when power permits)		11		206
10 gravimeter readings on flow top and 10 off of flow. Commence on outcrop if possible.		4		210

L_s	0.4 %		<u>1m</u>	<u>10m</u>	<u>50m</u>
L_{ts}	--	Abs. Mean Slope	5.3°	3.8°	2.5°
N_B	2	Alg. Std. deviation	6.6	4.7	3.1
N_C	39.1	Abs. Mean Curvature	0.9	1.3	4.1
N_{B+C}	41.1	Alg. Std. deviation	1.3	1.8	5.0
L_B	0.4 %		<u>Max.</u>	<u>Min.</u>	
L_C	16.9 %	PSD@0.05 ($\lambda=20m$):	1.00	0.420	
L_{B+C}	17.5 %	PSD@0.5 ($\lambda=2m$):	0.0035	0.0003	
L_T	17.9 %				



Site V-1 Lava flow front and top with linear depressions
Terrain: rough mare

Segment of original 1000-km traverse: 50-100 km

Terrain type: Smooth Mare

L_s	0.2 %		<u>1m</u>	<u>10m</u>	<u>50m</u>
L_{ts}	--	Abs. Mean Slope	2.9°	2.0°	1.4°
N_B	0.2	Alg. Std. deviation	3.6	2.5	1.7
N_C	38.9	Abs. Mean Curvature	0.6	1.0	0.8
N_{B+C}	39.1	Alg. Std. deviation	0.8	1.3	0.9
L_B	0.04%			<u>Max.</u>	<u>Min.</u>
L_C	15.7 %	PSD@0.05 ($\lambda=20m$):	0.25		0.045
L_{B+C}	15.7 %	PSD@0.5 ($\lambda=2m$):	0.0013		0.00012
L_T	15.9 %				

Map distance, this segment: 50 km

Ground distance, this segment: 58 km

Avg. map velocity: 1.7 kph

Ground velocity: 1.97 kph

Driving time: 30 hrs

Routine science each 0.5 km: 50 hrs

Other operations: 30 hrs

Total time, this segment: 110 hrs

1st lunar night @ 312 hrs for 360-hour period.

Cumulative ground distance to date: 151 km

Cumulative time to date: 320 hrs

Site: I-1 Crater with secondary impacts and blocks

Terrain Type or equivalent: rough mare

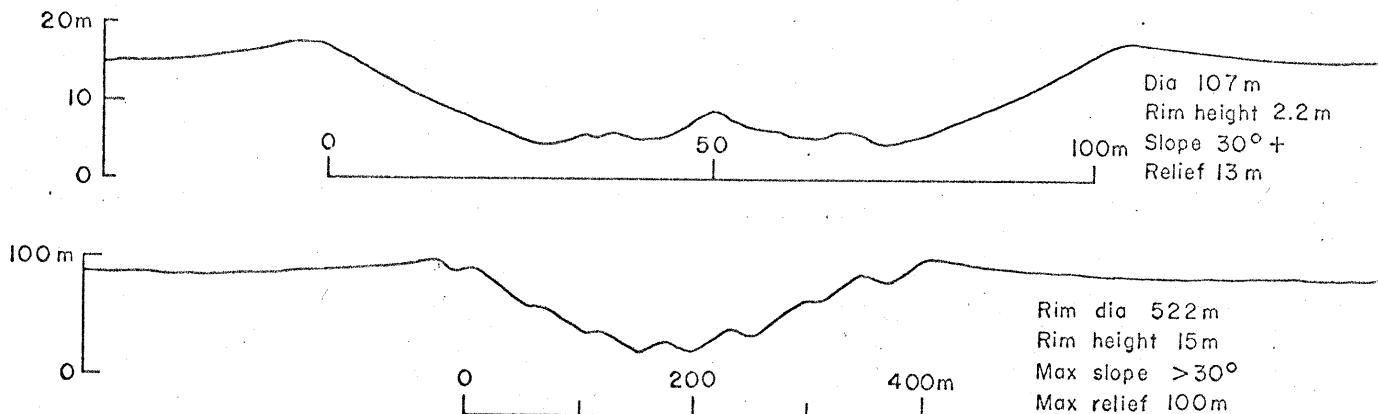
Objectives: to examine blocky ejecta and geophysical evidence of stratigraphy beneath the crater rim and origin of various types of secondary craters

NOTE: Lighting angle will be critical to color and textural interpretation of angular blocks

Estimated Time (hours)

Operation	Driving	Science	Other	Cumulative
Maneuvering using TV camera for vantage points, hazard appraisal and avoidance, sample collection, and geophysics profiles. Blocks are primary hazards. Secondary craters may be assymetric in shape and contain large boulders or blocks.	20			340
Facsimile camera for site study and sample collection.		10		350
Collection of 20 samples from blocks, rim materials, and surrounding plains		5		355
Sample preparation, analysis, and selection of 10 for return		11		366
20 gravimeter readings from rim outward spaced 5 meters apart.		4		370

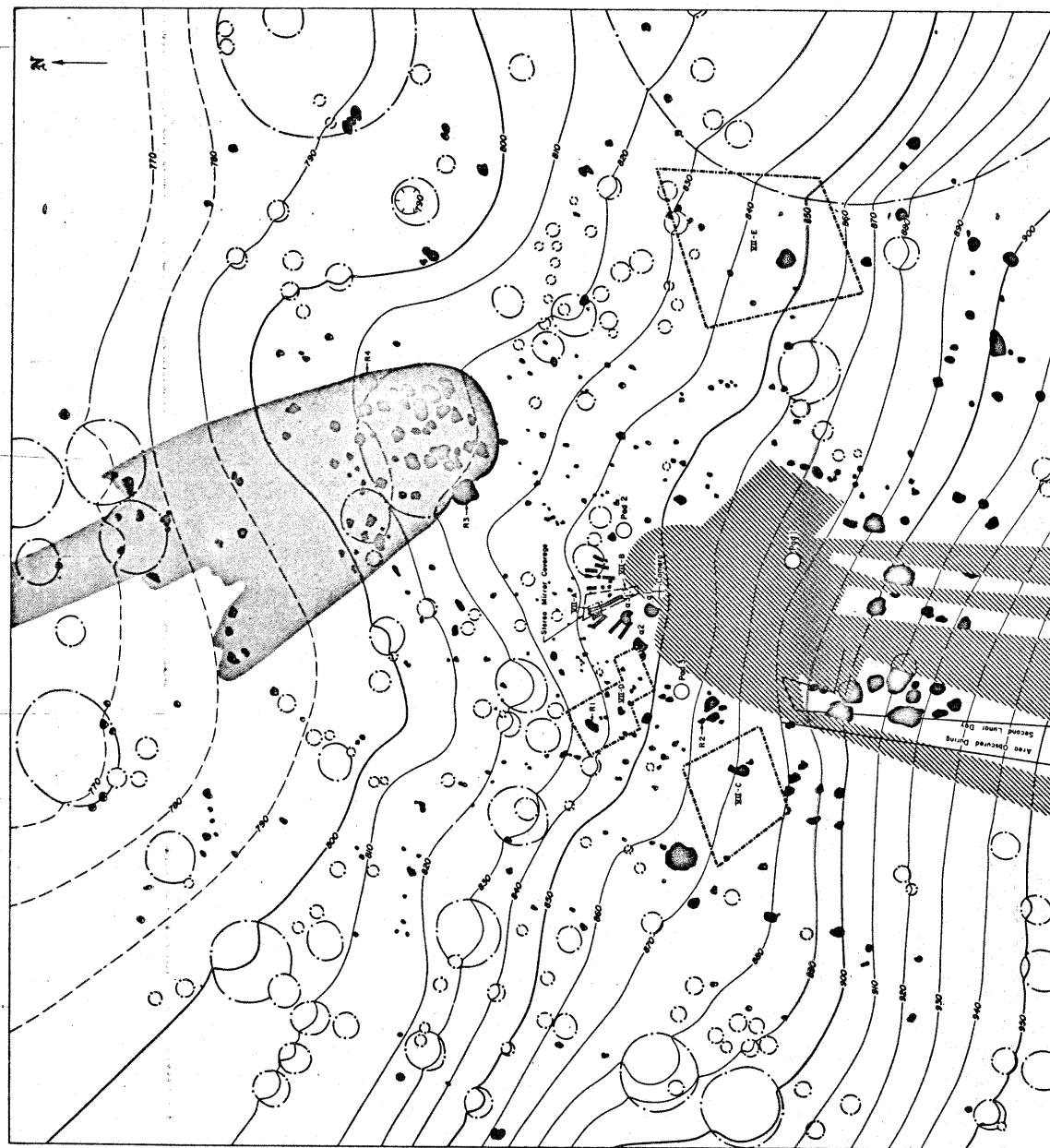
Site I-1 Fresh craters



Shadow measurements (Moore)

Terrain type: Rough Mare

		<u>1m</u>	<u>10m</u>	<u>50m</u>
L _S	0.4 %			
L _{ts}	--	Abs. Mean Slope	5.3°	3.8°
N _B	2	Alg. Std. deviation	6.6	4.7
N _C	39.1	Abs. Mean Curvature	0.9	1.3
N _{B+C}	41.1	Alg. Std. deviation	1.3	1.8
L _B	0.4 %		Max.	Min.
L _C	16.9 %	PSD@0.05 ($\lambda=20m$):	1.00	0.420
L _{B+C}	17.5 %	PSD@0.5 ($\lambda=2m$):	0.0035	0.0003
L _T	17.9 %			



Topographic map of the Surveyor VII landing site (topography)
by R. Jordan.

Site I-1 Secondary blocky craters

(from Shoemaker, et al., 1968)

Site: I-2 Secondary field of small blocky craters
and concentric craters in regional ray-covered area

Terrain Type or equivalent: rough mare

Objectives: to determine variety of composition
in bedrock and the extent to which
depth of over-burden controls the
distribution of blocky craters; also
the origin of concentric craters

Estimated Time (hours)

Operation	Driving	Science	Other	Cumula-tive
Maneuvering. Blocks and small craters are primary hazards	20			506
Facsimile camera, scanning and sample collection.		10		516
Collection of 20 samples of blocks derived from different small craters.		5		521
Sample preparation, analysis, and selection of 10 for return		11		532
20 gravimeter readings starting with concentric crater whose depth to bedrock is known, with spacing about half the depth		4		536

L _s	0.4 %	1m	10m	50m	
L _{ts}	--	Abs. Mean Slope	5.3°	3.8°	2.5°
N _B	2	Alg. Std. deviation	6.6	4.7	3.1
N _C	39.1	Abs. Mean Curvature	0.9	1.3	4.1
N _{B+C}	41.1	Alg. Std. deviation	1.3	1.8	5.0
L _B	0.4 %		Max.	Min.	
L _C	16.9 %	PSD@0.05 ($\lambda=20m$):	1.00	0.420	
L _{B+C}	17.5 %	PSD@0.5 ($\lambda=2m$):	0.0035	0.0003	
L _T	17.9 %				

Segment of original 1000-km traverse: 100-150 km

Terrain type: Rough Mare

		<u>1m</u>	<u>10m</u>	<u>50m</u>
L _s	0.4 %			
L _{ts}	--	Abs. Mean Slope	5.3°	3.8°
N _B	2	Alg. Std. deviation	6.6	4.7
N _C	39.1	Abs. Mean Curvature	0.9	1.3
N _{B+C}	41.1	Alg. Std. deviation	1.3	1.8
L _B	0.4 %			
L _C	16.9 %	PSD@0.05 ($\lambda=20m$):	1.00	0.420
L _{B+C}	17.5 %	PSD@0.5 ($\lambda=2m$):	0.0035	0.0003
L _T	17.9 %			

Map distance, this segment: 50 km

Ground distance, this segment: 59 km

Avg. map velocity: 1.5 kph

Ground velocity: 1.77 kph

Driving time: 34 hrs

Routine science each 0.5 km: 50 hrs

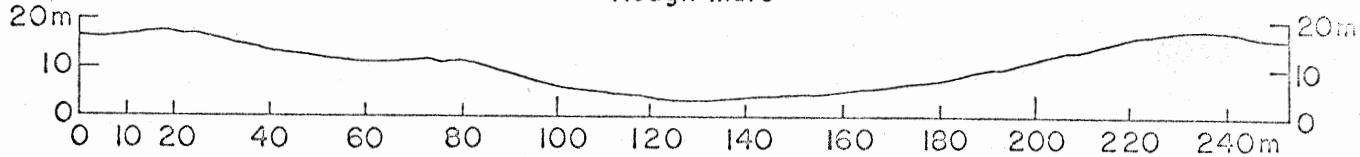
Other operations: 32 hrs

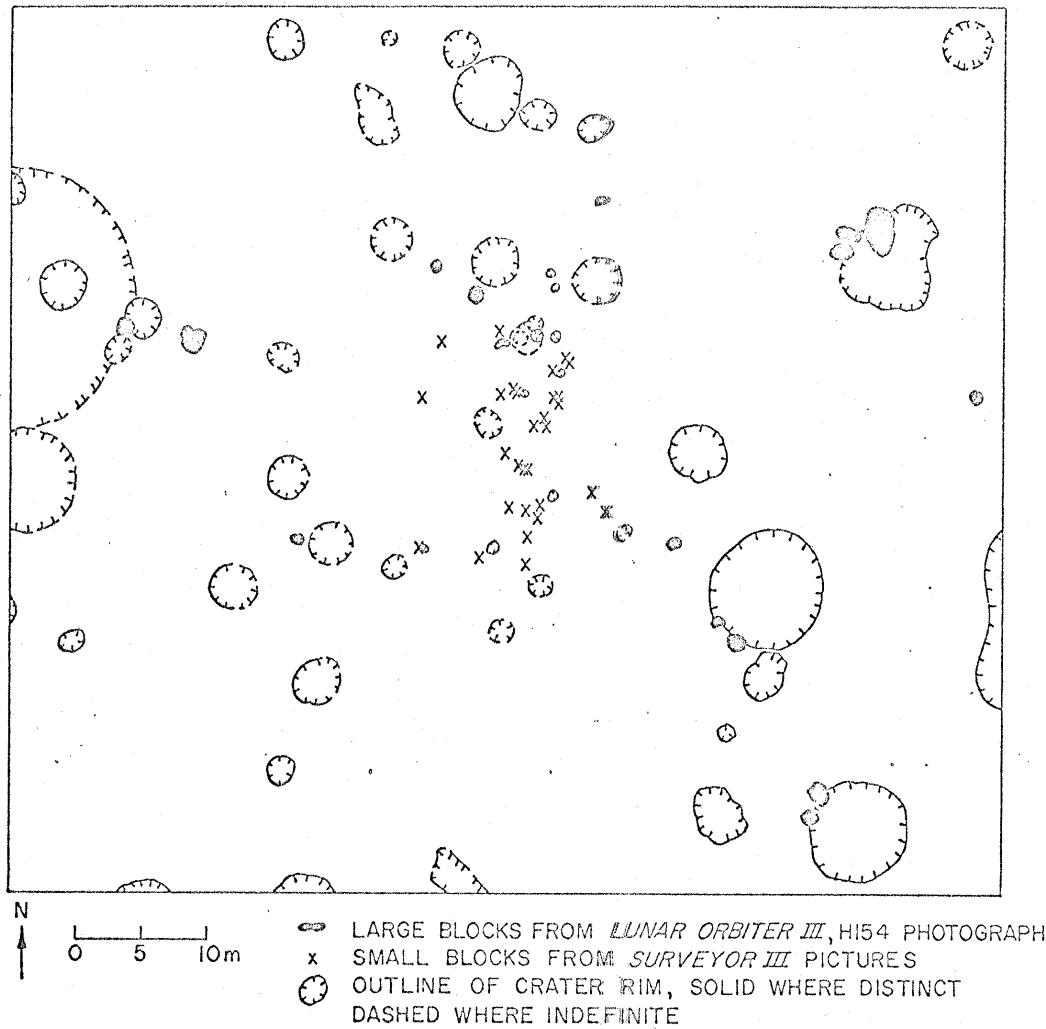
Total time, this segment: 116 hrs

Cumulative ground distance to date: 200 km

Cumulative time to date: 486 hrs

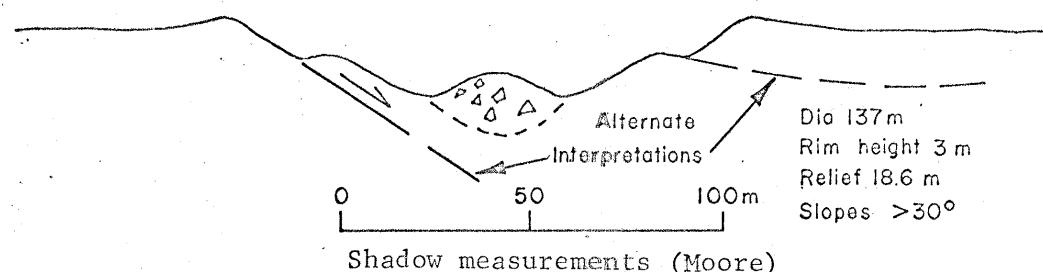
Rough Mare





(Modified from Shoemaker, et al, 1968)

Concentric (double) crater



Site I-2 Secondary field of small blocky craters and concentric craters in regional ray-covered area.

Segment of original 1000-km traverse: 150-200 km

Terrain type: Rough Mare

L_s	0.4 %		<u>1m</u>	<u>10m</u>	<u>50m</u>
L_{ts}	--	Abs. Mean Slope	5.3°	3.8°	2.5°
N_B	2	Alg. Std. deviation	6.6	4.7	3.1
N_C	39.1	Abs. Mean Curvature	0.9	1.3	4.1
N_{B+C}	41.1	Alg. Std. deviation	1.3	1.8	5.0
L_B	0.4 %			<u>Max.</u>	<u>Min.</u>
L_C	16.9 %	PSD@0.05 ($\lambda=20m$):	1.00		0.420
L_{B+C}	17.5 %	PSD@0.5 ($\lambda=2m$):	0.0035		0.0003
L_T	17.9 %				

Map distance, this segment: 50 km

Ground distance, this segment: 59 km

Avg. map velocity: 1.5 kph

Ground velocity: 1.77 kph

Driving time: 34 hrs

Routine science each 0.5 km: 50 hrs

Other operations: 32 hrs

Total time, this segment: 116 hrs

2nd lunar night @ 624 hrs for 360-hour period

Cumulative ground distance to date: 294 km

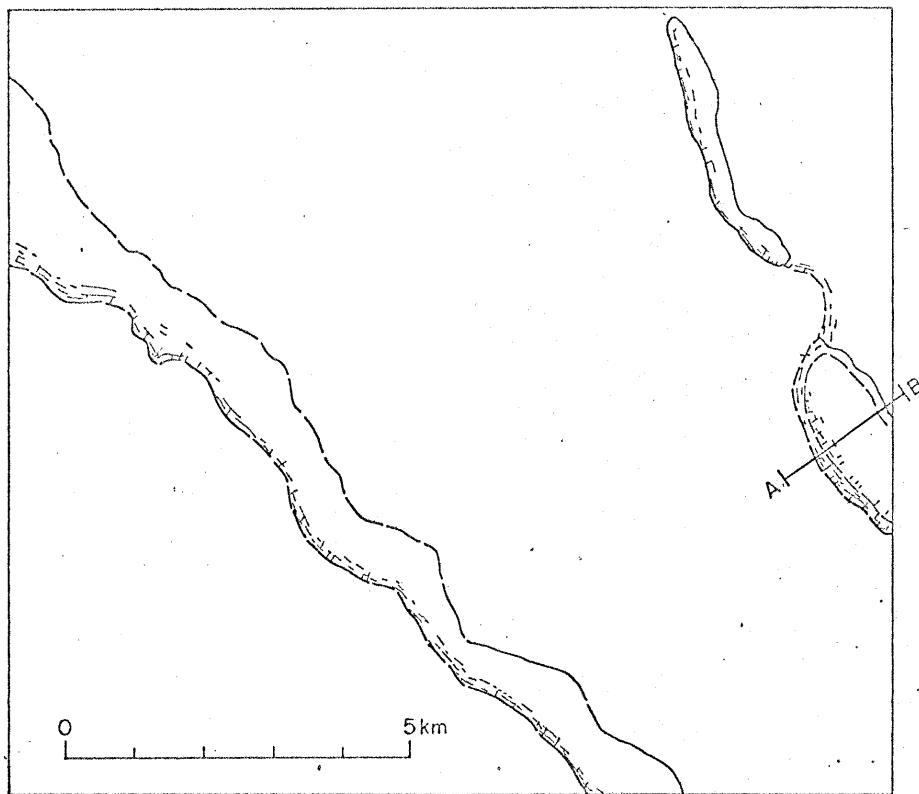
Cumulative time to date: 652 hrs

Site: V-2 Mare ridge with terrace

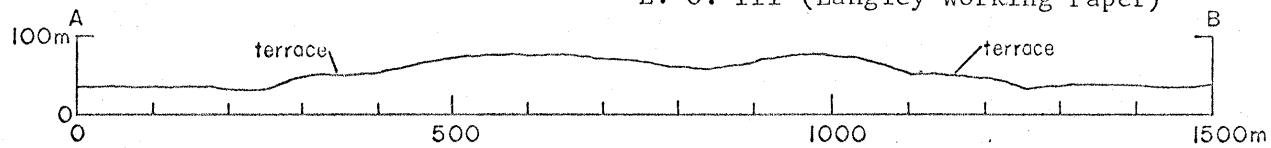
Terrain Type or equivalent: rough mare

Objectives: to analyze the possible mechanisms by which mare ridges are emplaced and the nature of post-emplacement processes

Operation	Estimated Time (hours)			
	Driving	Science	Other	Cumulative
Maneuvering along ridge-mare contact, along terrace, and across ridge. Locally steep, possibly unstable slopes are primary hazards.	20			672
Facsimile camera scanning and sample selection.		10		682
Collection of 20 samples from blocks and soil on ridge top, on terrace surface, and along ridge-mare contact		5		687
Sample preparation, analysis, and selection of 10 for return		11		698
20 gravimeter stations across ridge if terrain corrections are feasible; otherwise take readings at least 500 m away from ridge.		4		702



L. O. III (Langley Working Paper)



Site V-2 Mare ridge with terrace

Terrain type: Rough Mare

L_s 0.4 %

	1m	10m	50m
--	----	-----	-----

L_{ts} -- Abs. Mean Slope 5.3° 3.8° 2.5°

N_B 2 Alg. Std. deviation 6.6 4.7 3.1

N_C 39.1 Abs. Mean Curvature 0.9 1.3 4.1

N_{B+C} 41.1 Alg. Std. deviation 1.3 1.8 5.0

L_B 0.4 %

	Max.	Min.
--	------	------

L_C 16.9 % PSD@0.05 ($\lambda=20m$): 1.00 0.420

L_{B+C} 17.5 % PSD@0.5 ($\lambda=2m$): 0.0035 0.0003

L_T 17.9 %

Segment of original 1000-km traverse: 200-300 km

Terrain type: Hummocky Upland

L _s	1.0 %		1m	10m	50m
L _{ts}	--	Abs. Mean Slope	8.2°	5.8°	3.9°
N _B	2	Alg. Std. deviation	10.2	7.2	4.8
N _C	39.3	Abs. Mean Curvature	0.8	2.4	1.5
N _{B+C}	41.3	Alg. Std. deviation	1.2	2.9	1.9
L _B	0.4 %			Max.	Min.
L _C	22.4 %	PSD@0.05 ($\lambda=20m$):	0.34	0.075	
L _{B+C}	23.1 %	PSD@0.5 ($\lambda=2m$):	0.0021	0.000013	
L _T	24.1 %				

Map distance, this segment: 100 km

Ground distance, this segment: 124 km

Avg. map velocity: 1.0 kph

Ground velocity: 1.24 kph

Driving time: 100 hrs

Routine science each 0.5 km: 100 hrs

Other operations: 77 hrs

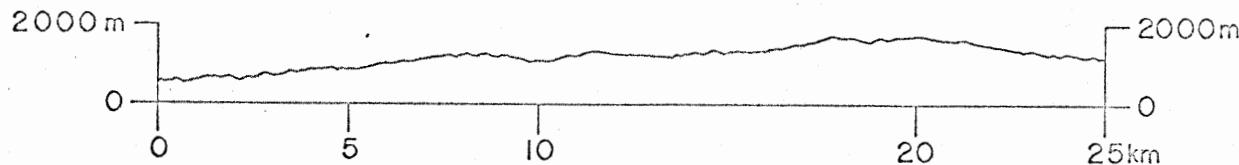
Total time, this segment: 277 hrs

3rd lunar night @ 936 hrs for 360-hour period

Cumulative ground distance to date: 433 km

Cumulative time to date: 979 hrs.

Hummocky Upland



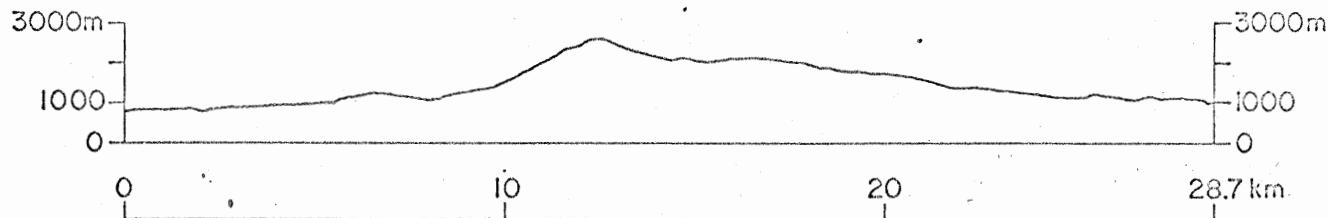
Site: T-2 Mare-uplands contact and talus slopes

Terrain Type or equivalent: smooth mare-rough upland

Objectives: Comparative study of composition and geologic processes in adjacent mare and upland areas

Operation	Estimated Time (hours)			
	Driving	Science	Other	Cumulative
Maneuvering along base of upland slopes for sampling and possible access route up onto upland. Loose talus slopes and abundant blocks are primary hazards.	20			999
Facsimile camera for scanning and detailed textural analysis of fresh blocks and boulders		8		1007
TV and Facsimile camera for landmark study and navigation			2	1009
Collection of 20 samples from mare & upland (or from blocks at foot of talus slopes)		5		1014
Sample preparation, analysis, and selection of 10 for return		11		1025
20 gravimeter stations, probably on mare		4		1029

Site I-2 Mare-uplands contact



Apollo 8 farside, photogrammetry (Wu, 1969)

Terrain type: Smooth Mare - Rough Upland

L_s	0.2 - 1.7 %		<u>1m</u>	<u>10m</u>	<u>50m</u>
L_{ts}	0 - 5.7 %	Abs. Mean Slope	2.9 - 11.0°	2.0 - 7.7°	1.4 - 5.2°
N_B	0.2 - 2	Alg. Std. deviation	3.6 - 13.7	2.5 - 9.6	1.7 - 6.5
N_C	15.5 - 38.9	Abs. Mean Curvature	0.6 - 2.0	1.0 - 2.7	0.8 - 3.8
N_{B+C}	17.5 - 39.1	Alg. Std. deviation	0.8 - 3.1	1.3 - 3.4	0.9 - 3.4
L_B	0.04 - 0.4 %		<u>Max.</u>	<u>Min.</u>	
L_C	5.0 - 15.7 %	PSD@0.05 ($\lambda=20m$):	0.25 - 0.50	0.045 - 0.200	
L_{B+C}	5.5 - 15.7 %	PSD@0.5 ($\lambda=2m$):	$13 \pm 80 \times 10^{-4}$	$1.2 - 4 \times 10^{-4}$	
L_T	12.9 - 15.9 %				

Segment of original 1000-km traverse: 300-350 km

Terrain type: Rough Mare

		<u>1m</u>	<u>10m</u>	<u>50m</u>
L _s	0.4 %			
L _{ts}	--	Abs. Mean Slope	5.3°	3.8°
N _B	2	Alg. Std. deviation	6.6	4.7
N _C	39.1	Abs. Mean Curvature	0.9	1.3
N _{B+C}	41.1	Alg. Std. deviation	1.3	1.8
L _B	0.4 %			
L _C	16.9 %	PSD@0.05 ($\lambda=20m$):	1.00	0.420
L _{B+C}	17.5 %	PSD@0.5 ($\lambda=2m$):	0.0035	0.0003
L _T	17.9 %			

Map distance, this segment: 50 km

Ground distance, this segment: 59 km

Avg. map velocity: 1.5 kph

Ground velocity: 1.77 kph

Driving time: 34 hrs

Routine science each 0.5 km: 50 hrs

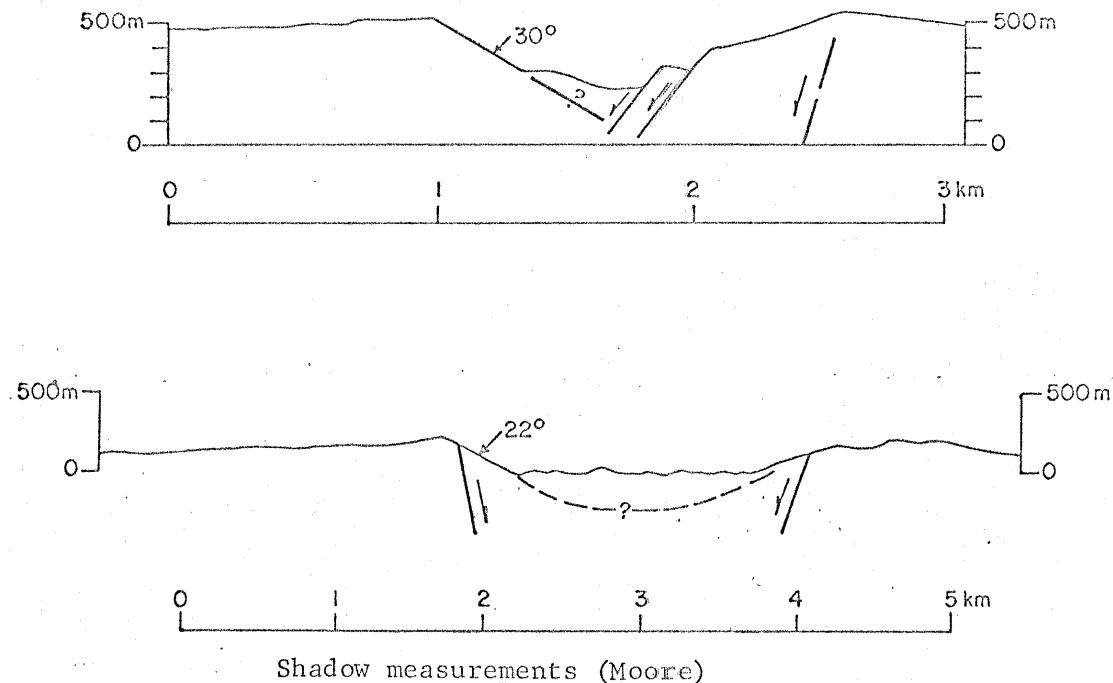
Other operations: 32 hrs

Total time, this segment: 116 hrs

Cumulative ground distance to date: 507 km

Cumulative time to date: 1145 hrs

Site:	T-3	Straight rillie with faults scarsps	Terrain Type or equivalent:	Rough-to-hummocky upland	Objectives:	To investigate top, floor, and wall of straight rillie and establish whether origin is volcanic, structural, erosional, or some combination.	Estimated Time (hours)	Operation	Cumula-tive time	
								Driving	Science	Other
1165			Maneuvering along upper edges and floor of rillie	20						hazards.
1166			Deploy 2nd Remote Geophysical Monitor	1						
1176			Fascimile camera scanning of scarsps and floor	10						
1181			Collection of 20 samples from above and below fault scarsps, blocks at base, and rillie floor.	5						
1191			Sample preparation, analysis, and selection of 10 for return.	10						
1195			10 gravimeter stations on upland surface above scarp and 10 on rillie floor, spaced 5-10 meters apart.	4						



Site T-3 Straight rille with fault scarps

Terrain type: Rough-Hummocky Upland

L_s	$1.0 - 1.7\%$	<u>1m</u>	<u>10m</u>	<u>50m</u>
L_{ts}	$0 - 5.7\%$	Abs. Mean Slope	$8.2 - 11.0^\circ$	$5.8 - 7.7^\circ$
N_B	2	Alg. Std. deviation	$10.0 - 13.7$	$7.2 - 9.6$
N_C	$15.5 - 39.3$	Abs. Mean Curvature	$0.8 - 2.0$	$2.4 - 2.7$
N_{B+C}	$17.5 - 41.3$	Alg. Std. deviation	$1.2 - 3.1$	$2.9 - 3.1$
L_B	0.4%		<u>Max.</u>	<u>Min.</u>
L_C	$5.0 - 22.4\%$	PSD@0.05 ($\lambda=20m$):	$0.34 - 0.50$	$0.075 - 0.200$
L_{B+C}	$5.5 - 23.1\%$	PSD@0.5 ($\lambda=2m$):	$21 - 80 \times 10^{-4}$	$0.13 - 4 \times 10^{-4}$
L_T	$12.9 - 24.1\%$			

Segment of original 1000-km traverse: 350-400 km

Terrain type: Hummocky Upland

Ls	1.0 %		<u>1m</u>	<u>10m</u>	<u>50m</u>
L _{ts}	--	Abs. Mean Slope	8.2°	5.8°	3.9°
N _B	2	Alg. Std. deviation	10.2	7.2	4.8
N _C	39.3	Abs. Mean Curvature	0.8	2.4	1.5
N _{B+C}	41.3	Alg. Std. deviation	1.2	2.9	1.9
L _B	0.4 %			<u>Max.</u>	<u>Min.</u>
L _C	22.4 %	PSD@0.05 ($\lambda=20m$):	0.34	0.075	
L _{B+C}	23.1 %	PSD@0.5 ($\lambda=2m$):	0.0021	0.000013	
L _T	24.1 %				

Map distance, this segment: 50 km

Ground distance, this segment: 62 km

Avg. map velocity: 1.0 kph

Ground velocity: 1.24 kph

Driving time: 50 hrs

Routine science each 0.5 km: 50 hrs

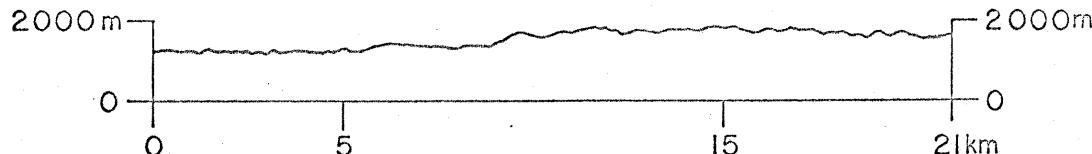
Other operations: 38 hrs

Total time, this segment: 138 hrs

4th lunar night @ 1248 for 360-hour period

Cumulative ground distance to date: 579 km

Cumulative time to date: 1333 hrs



Apollo 8 farside, photogrammetry (Wu, 1969)

Site: I-3 Large fresh crater rim

Terrain Type or equivalent: rough upland

Objectives: to examine changes in composition
of surface materials and nature
of geophysical gradients radial to
a large fresh crater

Estimate Time (hours)

Operation	Driving	Science	Other	Cumulative
Maneuvering along a path generally radial to crater for sampling and geophysical measurements. Frequent slope reversals, limited horizon, and large blocks are principal hazards.	20			1353
Façsimile camera scans from high vantage points observing transition from secondary crater fields and radial ejecta to thicker hummocky ejecta.		10		1363
Collection of 20 samples progressively across rim units including blocks of ejecta.		5		1368
Sample preparation, analysis, and selection of 10 for return		11		1379
20 gravimeter stations at 0.25 km intervals		4		1383

L_s 1.7 % 1m 10m 50m

L_{ts} 5.7 % Abs. Mean Slope 11.0° 7.7° 5.2°

N_B 2 Alg. Std. deviation 13.7 9.6 6.5

N_C 15.5 Abs. Mean Curvature 2.0 2.7 3.8

N_{B+C} 17.5 Alg. Std. deviation 3.1 3.4 3.4

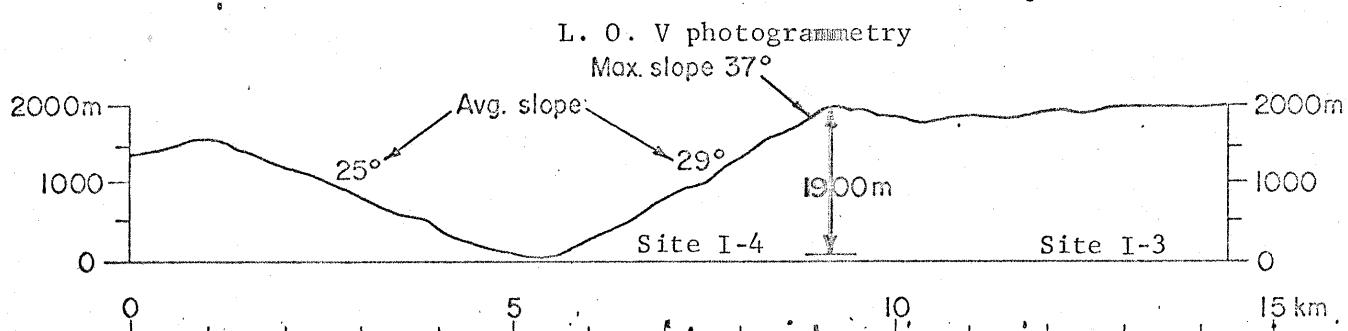
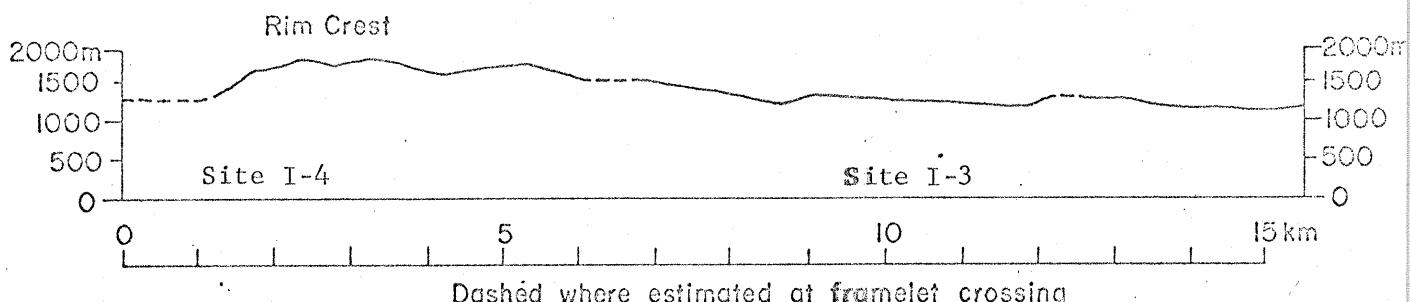
L_B 0.4 % Max. Min.

L_C 5.0 % PSD@0.05 ($\lambda=20m$): 0.50 0.200

L_{B+C} 5.5 % PSD@0.5 ($\lambda=2m$): 0.0080 0.0004

L_T 12.9 %

Cumula- tive Time	Estimated Time (hours)	Operational			
		Driving	Science	Other	Drive
1403	20				Maneuvering to cross overturned hummocky rim
1413	10				Fascimile camera for scanning steeper slopes in search of coherent bedrock. TV camera to point-to-point navigation to reach best access down crater wall. Investigate "tree bark" textures and blocks progressively across rim and wall.
1418	5				Collection of 20 samples from larger outcrops and blocks of 10 for return.
1429	11				Sample preparation, analyses, and selection
1433	4				20 gravimeter stations on hummocky rim if terrain corrections are feasible.



Apollo 8 farside photogrammetry (S. Wu, 1969)

Sites I-3 and I-4 Large fresh crater rim and wall

Terrain type: Fresh Large Crater

L_s 3.5 %*

1m

10m

500m

L_{ts} 14.3 %*

Abs. Mean Slope

Rough upland

10°+*

N_B 31.7

Alg. Std. deviation

gives best available estimates.

12°+*

N_C 29.4

Abs. Mean Curvature

N_{B+C} 61.1

Alg. Std. deviation

L_B 6.3 %

Max.

Min.

L_C 6.3 %

PSD@0.05 ($\lambda=20m$):

2.2*

0.50*

L_{B+C} 13.4 %

PSD@0.5 ($\lambda=2m$):

0.018*

0.008*

L_T 31.2 %

* Insufficient data. Best guess.

Segment of original 1000-km traverse: 400-450 km

Terrain type: Fresh Large Crater

Ls	3.5 %*		<u>1m</u>	<u>10m</u>	<u>500m</u>
L _{ts}	14.3 %*	Abs. Mean Slope	Rough upland	10°+*	
N _B	31.7	Alg. Std. deviation	gives best		12°+*
N _C	29.4	Abs. Mean Curvature	available.		
N _{B+C}	61.1	Alg. Std. deviation	estimates.		
L _B	6.3 %				
L _C	6.3 %	PSD@0.05 ($\lambda=20m$):	Max.	Min.	
L _{B+C}	13.4 %	PSD@0.5 ($\lambda=2m$):	2.2*	0.50*	
L _T	31.2 %	* Insufficient data. Best guess.	0.018*	0.008*	

Map distance, this segment: 30 km

Ground distance, this segment: 39 km

Avg. map velocity: 0.3 kph

Ground velocity: 0.39kph

Driving time: 101 hrs

Routine science each 0.5 km: 30 hrs

Other operations: 32 hrs

Total time, this segment: 163 hrs

5th lunar night @ 1560 hrs for 360-hr period

Cumulative ground distance to date: 628 km

Cumulative time to date: 1596 hrs

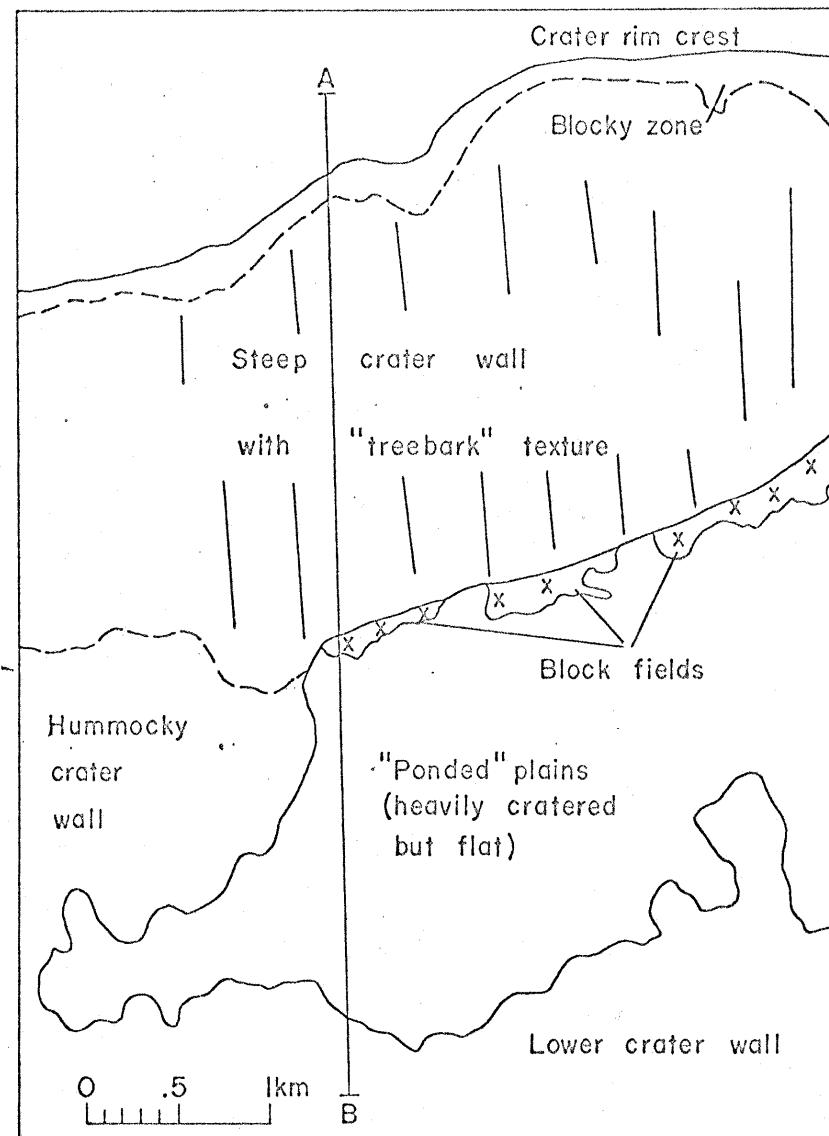
Site: I-5 "Ponded" plains on crater rim or wall

Terrain Type or equivalent: rough mare (= upland plains)

Objectives: to compare with adjacent rim or wall materials of crater and with similar mare plains units elsewhere. Test steep slopes with "tree bark" texture for stability

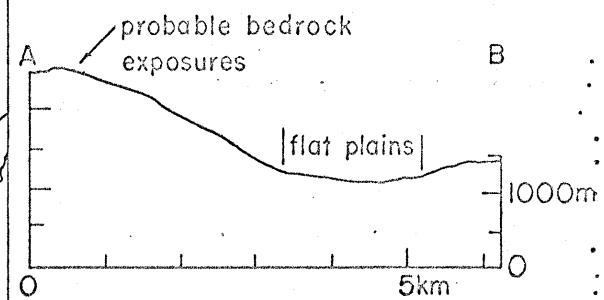
Operation	Estimated Time (hours)			
	Driving	Science	Other	Cumulative
Maneuvering across typical upland plains materials (such as Cayley or Apennine formations in local topographic lows). 10 km map distance enroute to Site I-6. Craters are primary hazards; blocks occur at foot of steep adjacent crater wall slopes	20			1616
Facsimile and TV camera scan. Examine slopes with "tree bark" texture.		10		1626
Collection of 20 samples from plains material and from blocks at base of steep adjacent slopes.		5		1631
Sample preparation, analysis, and selection of 10 for return.		11		1642
20 gravimeter stations at 100 m intervals if terrain corrections are feasible.		4		1646

L _s	0.4 %		1m	10m	50m
L _{ts}	--	Abs. Mean Slope	5.3°	3.8°	2.5°
N _B	2	Alg. Std. deviation	6.6	4.7	3.1
N _C	39.1	Abs. Mean Curvature	0.9	1.3	4.1
N _{B+C}	41.1	Alg. Std. deviation	1.3	1.8	5.0
L _B	0.4 %		Max.	Min.	
L _C	16.9 %	PSD@0.05 ($\lambda=20m$):	1.00	0.420	
L _{B+C}	17.5 %	PSD@0.5 ($\lambda=2m$):	0.0035	0.0003	
L _T	17.9 %				



Site I-5 "Ponded" plains on crater wall terrain

Terrain: rough mare



L. O. V., photogrammetry

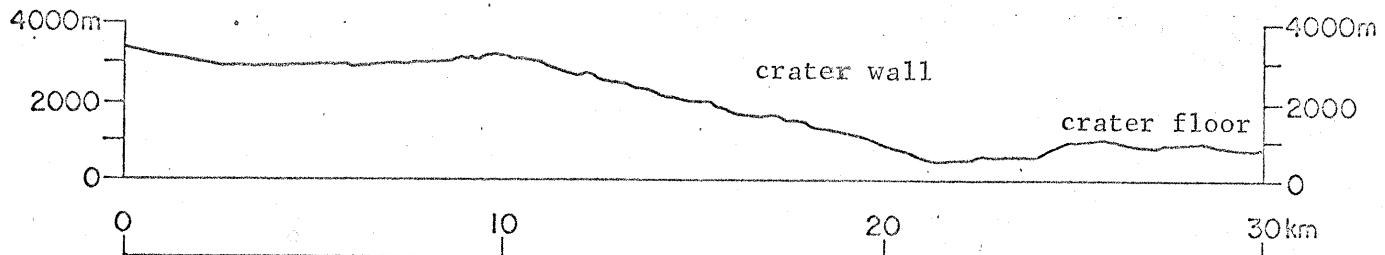
Site: I-6 Floor-wall contact near concentric rilles

Terrain Type or equivalent: large crater

Objectives: to examine relation of crater floor to wall and of concentric rille to each of these; whether processes are primarily structural or volcanic

Operation	Estimated Time (hours)			
	Driving	Science	Other	Cumulative
Maneuvering down side slope of lower crater wall for observation and sampling. 10 km map distance onto crater floor. Steep unstable slopes and blocks at base of slopes are principal hazards.	20			1666
Facsimile camera and TV scanning of fresh crater wall from above and below and of rille walls and floor.		10		1676
Collection of 20 samples from crater wall, floor, rille margins and floor, and blocks at base of slopes		5		1681
Preparation, analysis, and selection of 10 samples for return.		11		1692
20 gravity stations, several km away from crater wall; 10 at 100 m intervals across crater floor and 10 in floor of rille		4		1696

Site I-6 Floor-wall contact



Apollo 8 farside, photogrammetry (Wu, 1969)

Terrain type: Fresh Large Crater

L_s	3.5 %*	<u>1m</u>	<u>10m</u>	<u>500m</u>
L_{ts}	14.3 %*	Abs. Mean Slope	Rough upland	$10^\circ \pm *$
N_B	31.7	Alg. Std. deviation	gives best available estimates.	$12^\circ \pm *$
N_C	29.4	Abs. Mean Curvature		
N_{B+C}	61.1	Alg. Std. deviation		
L_B	6.3 %		<u>Max.</u>	<u>Min.</u>
L_C	6.3 %	PSD@0.05 ($\lambda=20m$):	2.2*	0.50*
L_{B+C}	13.4 %	PSD@0.5 ($\lambda=2m$):	0.018*	0.008*
L_T	31.2 %			

* Insufficient data. Best guess.

Segment of original 1000-km traverse: 450-500

Terrain type: Fresh Large Crater

Ls	3.5 %*		<u>1m</u>	<u>10m</u>	<u>500m</u>
L _{ts}	14.3 %*	Abs. Mean Slope	Rough upland	10°+*	
N _B	31.7	Alg. Std. deviation	gives best		12°+*
N _C	29.4	Abs. Mean Curvature	available		
N _{B+C}	61.1	Alg. Std. deviation	estimates.		
L _B	6.3 %				
L _C	6.3 %	PSD@0.05 ($\lambda=20m$):	Max.	Min.	
L _{B+O}	13.4 %	PSD@0.5 ($\lambda=2m$):	2.2*	0.50*	
L _T	31.2 %	* Insufficient data. Best guess.	0.018*	0.008*	

Map distance, this segment: 45 km

Ground distance, this segment: 59 km

Avg. map velocity: 0.3 kph

Ground velocity: 0.39 kph

Driving time: 151 hrs

Routine science each 0.5 km: 45 hrs

Other operations: 48 hrs

Total time, this segment: 244 hrs

6th lunar night @ 1872 hrs for 360-hr period.

Cumulative ground distance to date: 712 km

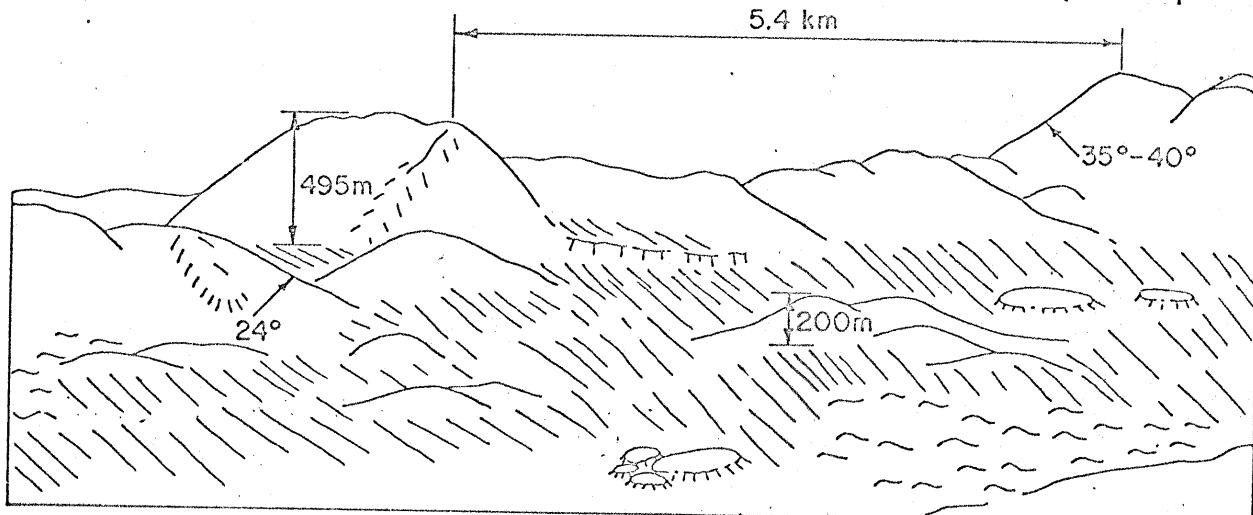
Cumulative time to date: 1940 hrs

Site: I-7 Central peak in large crater floor

Terrain Type or equivalent: Large crater

Objectives: to determine origin of central peaks; whether volcanic, rebounded structures from depth, or other. Possible samples of deep-seated rocks

Operation	Estimated Time (hours)			
	Driving	Science	Other	Cumulative
Maneuvering around base of rugged hills on crater floor to observe and sample variety of materials present in blocks and soils, and if possible, traversing lower hills. Hazards are blocks, abrupt steep slopes and many reversals, limited horizon, and possibly unstable slopes.	20			1960
Facsimile camera and TV scanning and close study of fresh blocks and boulders.		14		1974
Collection, preparation, and analysis of 20 samples; selection of 10 for return.		16		1990
(Gravity experiment deleted due to large uncertainty in terrain corrections)				



Site I-7 Central peaks with block fields and boulder tracks

Terrain: fresh crater

L. O. II, oblique profile; L. O. V, shadow measurements

Segment of original 1000-km traverse: 500-550 km

Terrain type: Hummocky Upland

		<u>1m</u>	<u>10m</u>	<u>50m</u>
L _s	1.0 %			
L _{ts}	--	Abs. Mean Slope	8.2°	5.8°
N _B	2	Alg. Std. deviation	10.2	7.2
N _C	39.3	Abs. Mean Curvature	0.8	2.4
N _{B+C}	41.3	Alg. Std. deviation	1.2	2.9
L _B	0.4 %			
L _C	22.4 %	PSD@0.05 ($\lambda=20m$):	0.34	0.075
L _{B+C}	23.1 %	PSD@0.5 ($\lambda=2m$):	0.0021	0.000013
L _T	24.1 %			

Map distance, this segment: 40 km

Ground distance, this segment: 50 km

Avg. map velocity: 1.0 kph

Ground velocity: 1.24 kph

Driving time: 40 hrs

Routine science each 0.5 km: 40 hrs

Other operations: 31 hrs

Total time, this segment: 111 hrs

Cumulative ground distance to date: 769 km

Cumulative time to date: 2101 hrs

Site: T-4 Debris flow

Terrain Type or equivalent: Large crater

Objectives: to investigate mechanisms of flow from close-up examination of surface materials and fine structures that characterize them; to exit from large crater

Operation	Estimated Time (hours)			
	Driving	Science	Other	Cumulative
Maneuvering up and/or across slopes of debris flow which is least steep part of crater wall (or uplands front). Sample collection and observation are most important. Hazards are blocks, small scale roughness, and possibly unstable slopes	20			2121
Facsimile camera and TV scanning for optimum traverse route and for samples, and small scale surface textures.		14		2135
Collection, preparation, and analysis of 20 samples; selection of 10 for return		16		2151
(Gravity experiment deleted due to large uncertainty in terrain corrections)				

L_s 3.5 %*

1m 10m 500m

L_{ts} 14.3 %*

Abs. Mean Slope

Rough upland

10°**

N_B 31.7

Alg. Std. deviation

gives best available estimates.

12°**

N_C 29.4

Abs. Mean Curvature

gives best available estimates.

N_{B+C} 61.1

Alg. Std. deviation

Max. Min.

L_B 6.3 %

PSD@0.05 ($\lambda=20m$):

2.2* 0.50*

L_C 6.3 %

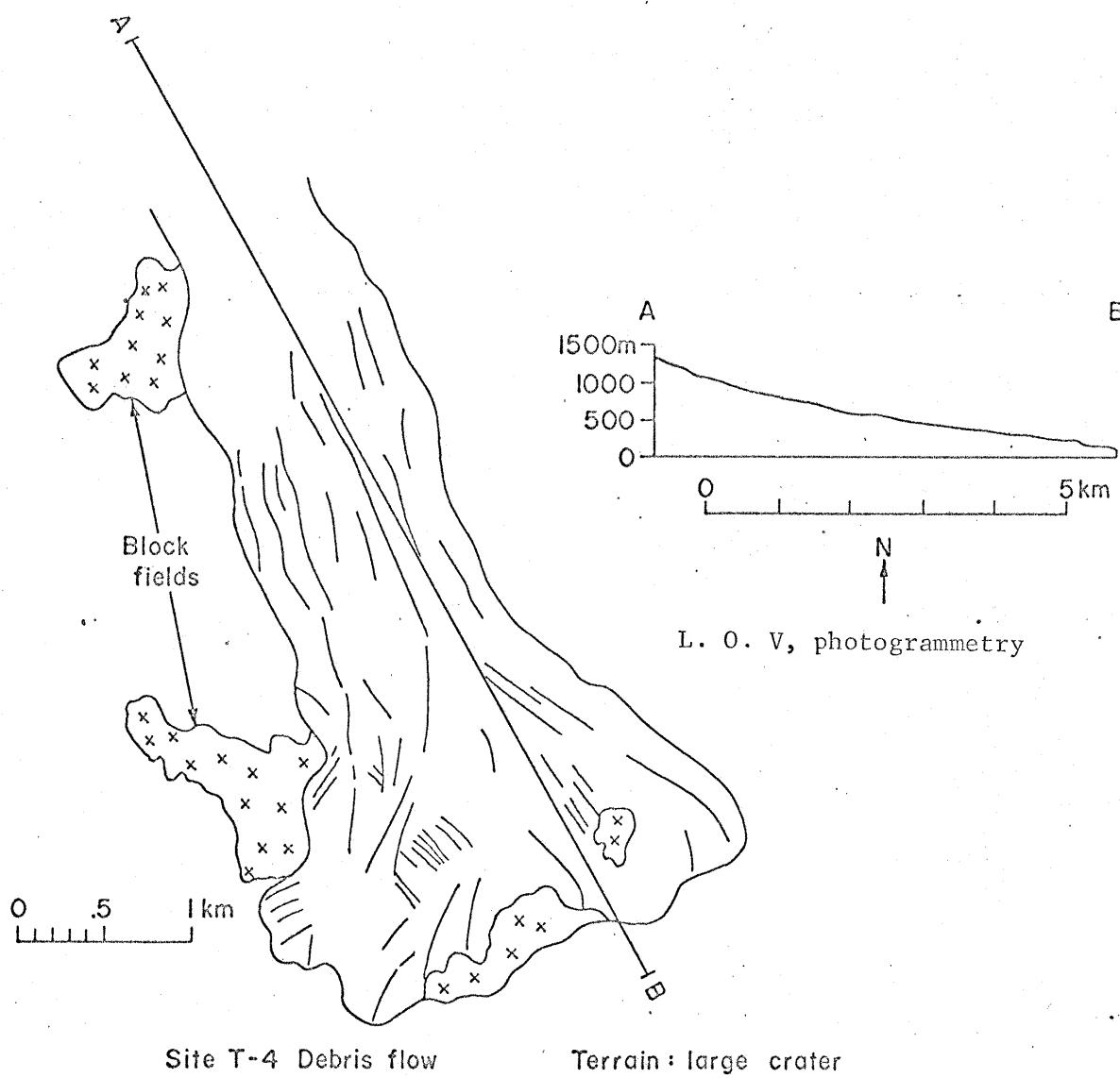
PSD@0.5 ($\lambda=2m$):

0.018* 0.008*

L_{B+C} 13.4 %

* Insufficient data. Best guess.

L_T 31.2 %



Site T-4 Debris flow

Terrain: large crater

Segment of original 1000-km traverse: 550-600 km

Terrain type: Fresh Large Crater

Ls	3.5 %*	1m	10m	500m
L _{ts}	14.3 %*	Abs. Mean Slope	Rough upland	10°+*
N _B	31.7	Alg. Std. deviation	gives best	12°+*
N _C	29.4	Abs. Mean Curvature	available.	
N _{B+C}	61.1	Alg. Std. deviation	estimates.	
L _B	6.3 %			
L _C	6.3 %	PSD@0.05 ($\lambda=20m$):	Max.	Min.
L _{B+C}	13.4 %	PSD@0.5 ($\lambda=2m$):	2.2*	0.50*
L _T	31.2 %	* Insufficient data. Best guess.	0.018*	0.008*

Map distance, this segment: 50 km

Ground distance, this segment: 66 km

Avg. map velocity: 0.3 kph

Ground velocity: 0.39 kph

Driving time: 168 hrs

Routine science each 0.5 km: 50 hrs

Other operations: 54 hrs

Total time, this segment: 272 hrs

7th lunar night @ 2184 hrs for 360-hr period

Cumulative ground distance to date: 848 km

Cumulative time to date: 2423 hrs

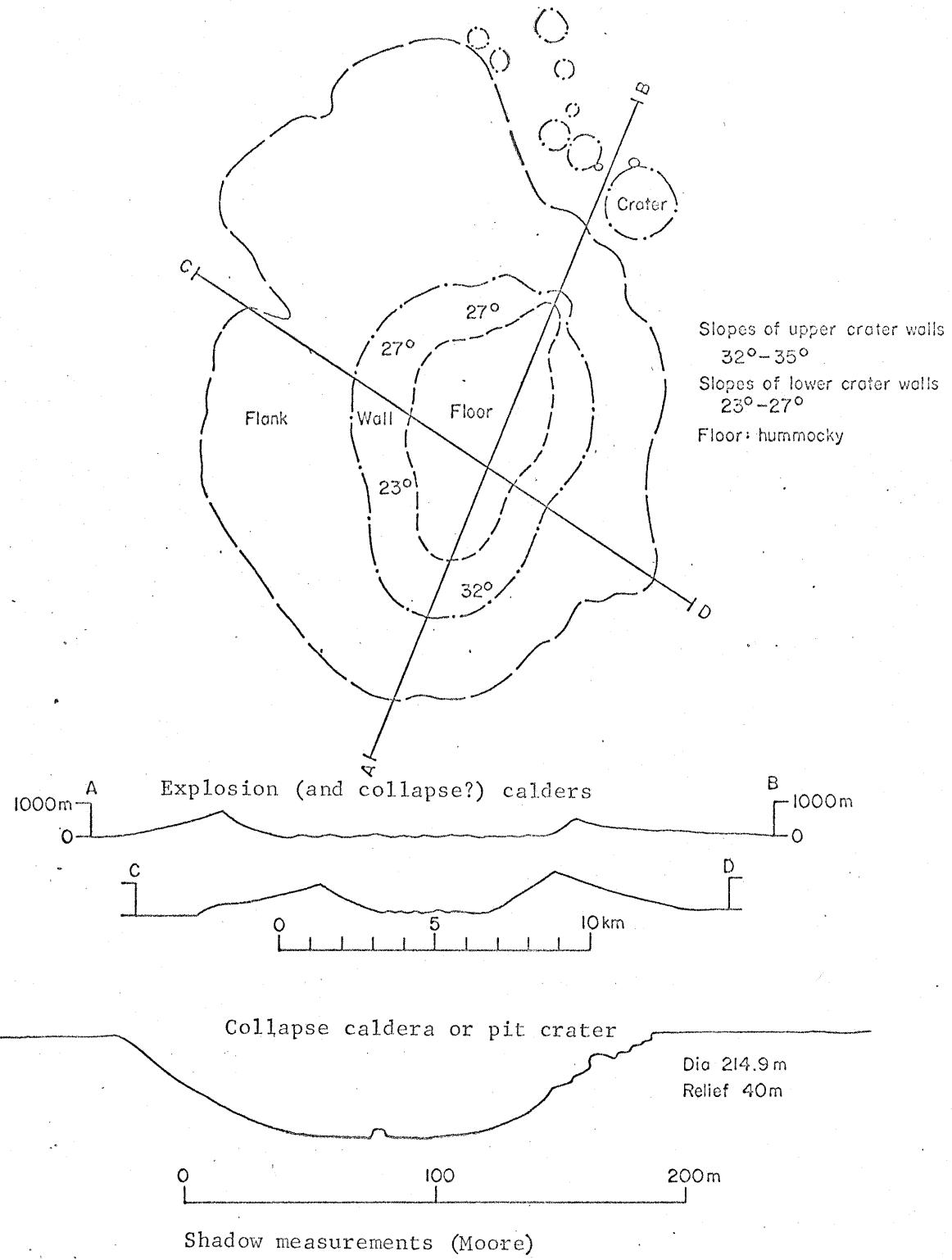
Site: V-3 Caldera or pit crater

Terrain Type or equivalent: Rough mare-rough upland

Objectives: to determine degree of explosion, collapse, and mass wasting as processes in formation and modification of low-rimmed volcanic craters

Operation	Estimated Time (hours)			
	Driving	Science	Other	Cumulative
Maneuvering around rim to observe and sample ejecta if present and to find access to crater floor. Principal hazards are abrupt steep slope segments and large blocks.	20			2443
Facsimile camera and TV scanning for blocks, bombs, and outcrops and for access to crater floor		10		2453
Collection, preparation, and analysis of 20 samples; selection of 10 for return		16		2469
20 gravity recordings spaced at 100-200 m on crater rim, away from crest. Floor will likely be inaccessible for terrain corrections of gravity stations.		4		2473

L_s	0.4 - 1.7 %	<u>1m</u>	<u>10m</u>	<u>50m</u>
L_{ts}	0 - 5.7 %	Abs. Mean Slope	5.3 - 11.0°	3.8 - 7.7°
N_B	2	Alg. Std. deviation	6.6 - 13.7	4.7 - 9.6
N_C	15.5 - 39.1	Abs. Mean Curvature	0.9 - 2.0	1.3 - 2.7
N_{B+C}	17.5 - 41.1	Alg. Std. deviation	1.3 - 3.1	1.8 - 3.4
L_B	0.4 %		Max.	Min.
L_C	5.0 - 16.9 %	PSD@0.05 ($\lambda=20m$):	0.50 - 1.00	0.200 - 0.420
		PSD@0.5 ($\lambda=2m$):	$35 - 80 \times 10^{-4}$	$3 - 4 \times 10^{-4}$
L_{B+C}	5.5 - 17.5 %			
L_T	12.9 - 17.9 %			



Site V-3 Caldera and pit crater

Terrain: Rough mare-rough upland

Segment of original 1000-km traverse: 600-700 km

Terrain type: Rough Upland

		<u>1m</u>	<u>10m</u>	<u>50m</u>
L _s	1.7 %			
L _{ts}	5.7 %	Abs. Mean Slope	11.0°	7.7°
N _B	2	Alg. Std. deviation	13.7	9.6
N _C	15.5	Abs. Mean Curvature	2.0	2.7
N _{B+C}	17.5	Alg. Std. deviation	3.1	3.4
L _B	0.4 %		<u>Max.</u>	<u>Min.</u>
L _C	5.0 %	PSD@0.05 ($\lambda=20m$):	0.50	0.200
L _{B+C}	5.5 %	PSD@0.5 ($\lambda=2m$):	0.0080	0.0004
L _T	12.9 %			

Map distance, this segment: 100 km

Ground distance, this segment: 113 km

Avg. map velocity: 0.5 kph

Ground velocity: 0.56 kph

Driving time: 201 hrs

Routine science each 0.5 km: 100 hrs

Other operations: 51 hrs

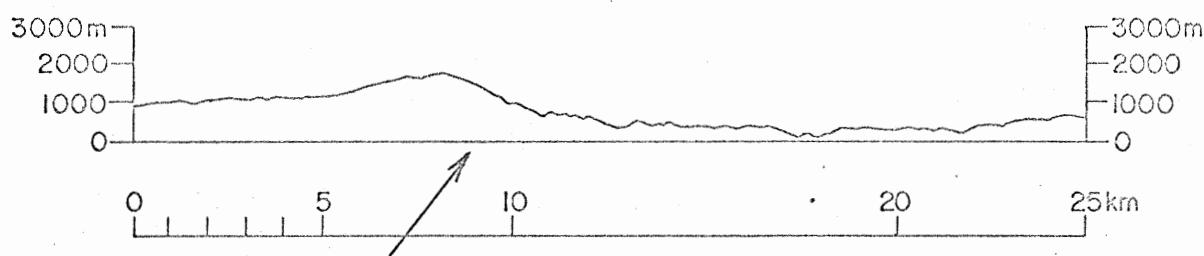
Total time, this segment: 352 hrs

8th and 9th lunar nights @ 2496 and 2808 hrs for 360-hr periods

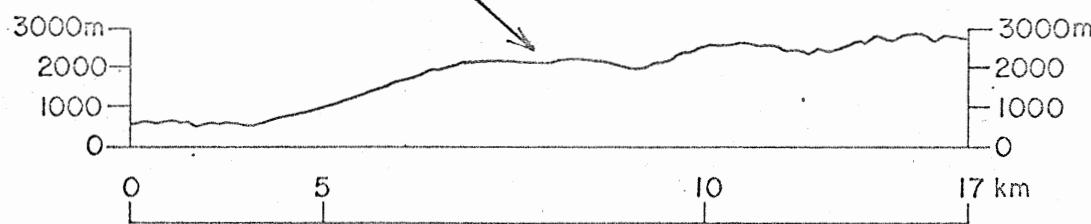
Cumulative ground distance to date: 971 km

Cumulative time to date: 2825 hrs

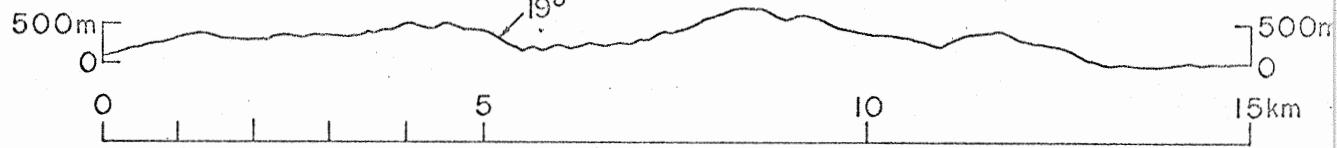
Rough Uplands



Apollo 8 farside, photogrammetry (Wu, 1969)



Upland Hills



Max. overall slopes 19–22°

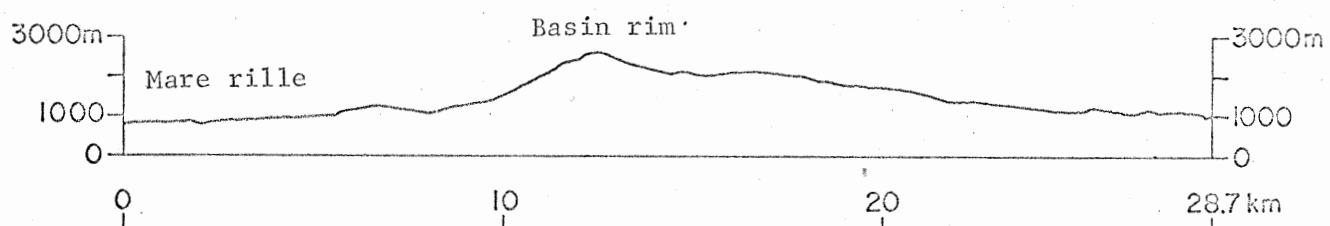
Shadow measurements (Moore)

Site: T-5 Mare rilles concentric with basin rim

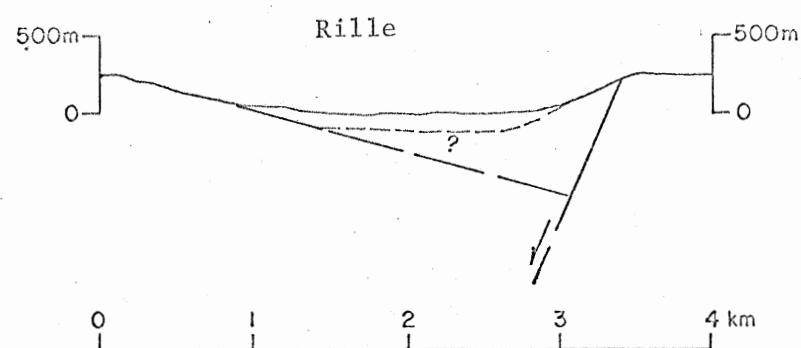
Terrain Type or equivalent: Rough mare--rough upland

Objectives: to examine structure of concentric rilles and establish relationship to nearby highland rim.
Compare with earlier rille sites I-6 and T-3

Operation	Estimated Time (hours)			
	Driving	Science	Other	Cumulative
Maneuvering between basin rim and rilles and down into rilles to examine walls visually and floor geophysically. Principal hazards are craters on mare and steep slopes and blocks at mare contacts with rilles and upland.	20			2845
Deploy 3rd Remote Geophysical Monitor on uniform mare surface.		1		2846
Facsimile and TV scanning of steep slopes for stratigraphic correlation and close ups for sample collection		10		2856
Collection, preparation, and analysis of 20 samples; select 10		15		2871
20 gravimeter stations at 5-10 m intervals: 10 on rille floor and 10 on mare surface		4		2875



Apollo 8 farside, photogrammetry (Wu, 1969)



Shadow measurements (Moore)

Site T-5 Mare rille concentric with basin rim.

Segment of original 1000-km traverse: 700-750 km

Terrain type: Rough Mare

			<u>1m</u>	<u>10m</u>	<u>50m</u>
L _s	0.4 %				
L _{ts}	--	Abs. Mean Slope	5.3°	3.8°	2.5°
N _B	2	Alg. Std. deviation	6.6	4.7	3.1
N _C	39.1	Abs. Mean Curvature	0.9	1.3	4.1
N _{B+C}	41.1	Alg. Std. deviation	1.3	1.8	5.0
L _B	0.4 %			<u>Max.</u>	<u>Min.</u>
L _C	16.9 %	PSD@0.05 ($\lambda=20m$):	1.00		0.420
L _{B+C}	17.5 %	PSD@0.5 ($\lambda=2m$):	0.0035		0.0003
L _T	17.9 %				

Map distance, this segment: 50 km

Ground distance, this segment: 59 km

Avg. map velocity: 1.5 kph.

Ground velocity: 1.77 kph

Driving time: 34 hrs

Routine science each 0.5 km: 50 hrs

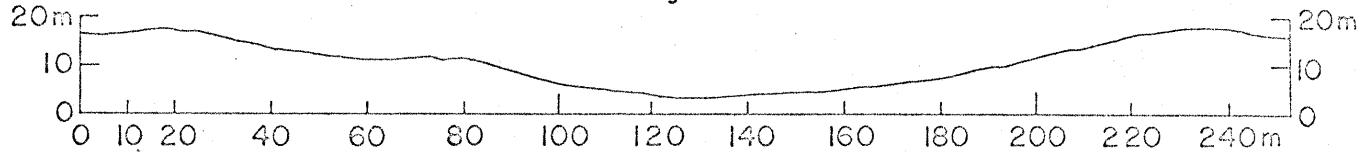
Other operations: 32 hrs

Total time, this segment: 116 hrs

Cumulative ground distance to date: 1045 km

Cumulative time to date: 2991 hrs

Rough Mare



Site: V-4 Low lava dome

Terrain Type or equivalent: Rough mare

Objectives: to investigate volcanic materials and processes of flat-top dome as related to differentiation of magmas and in comparison with other volcanic features

Operation	Estimated Time (hours)			
	Driving	Science	Other	Cumulative
Maneuvering from mare terrain around and, if possible, onto top of lava dome for sampling and geophysical investigation. Craters and locally steep slopes on dome sides are main hazards.	20			3011
Facsimile camera and TV viewing of mare-dome contact and of dome's upper surface; particularly looking for outcrops, blocks		10		3021
Collection, preparation, and analysis of 20 samples; selection of 10 for return		16		3037
10 gravity stations on mare 1.5 km from base of dome and 10 on top of dome spaced at 100-200 meters.		4		3041

Segment of original 1000-km traverse: 750-800 km

Terrain type: Rough Mare

		<u>1m</u>	<u>10m</u>	<u>50m</u>
L _s	0.4 %			
L _{ts}	--	Abs. Mean Slope	5.3°	3.8°
N _B	2	Alg. Std. deviation	6.6	4.7
N _C	39.1	Abs. Mean Curvature	0.9	1.3
N _{B+C}	41.1	Alg. Std. deviation	1.3	1.8
L _B	0.4 %		<u>Max.</u>	<u>Min.</u>
L _C	16.9 %	PSD@0.05 ($\lambda=20m$):	1.00	0.420
L _{B+C}	17.5 %	PSD@0.5 ($\lambda=2m$):	0.0035	0.0003
L _T	17.9 %			

Map distance, this segment: 50 km

Ground distance, this segment: 59 km

Avg. map velocity: 1.5 kph

Ground velocity: 1.77 kph

Driving time: 34 hrs

Routine science each 0.5 km: 50 hrs

Other operations: 32 hrs

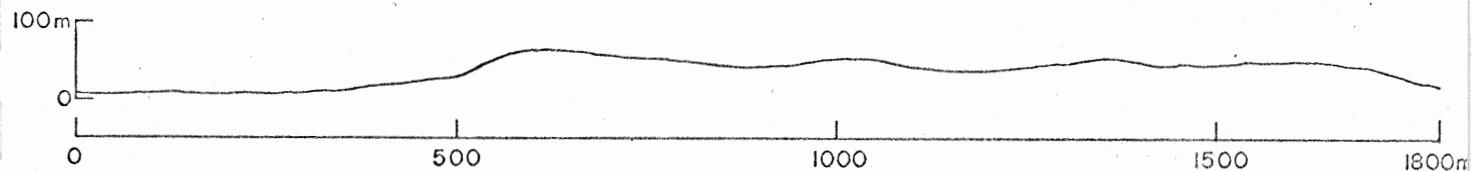
Total time, this segment: 116 hrs

10th lunar night @ 3120 hrs for 360-hr period

Cumulative ground distance to date: 1119 km

Cumulative time to date: 3157 hrs

Site V-4 Low lava dome



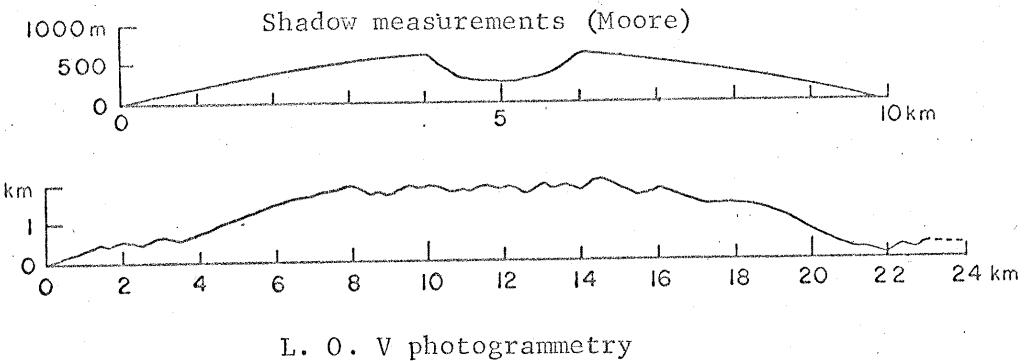
Site: V-5 Crater-top dome (or steep-sided dome)

Terrain Type or equivalent: Hummocky-to-rough upland

Objectives: to investigate evidence for volcanism and magmatic differentiation in dome-forming processes

Operation	Estimated Time (hours)			
	Driving	Science	Other	Cumulative
Maneuvering from mare around and, if possible, onto moderate-to-steep-walled dome. Locally steep slopes, craters, and blocks are primary hazards	20			3177
Facsimile camera and TV scanning of close up surface to determine changes in rock type, surface characteristics, or increasing hazards.		10		3187
Collection, preparation, and analysis of 20 samples; selection of 10 for return.		16		3203
Gravity stations on top of dome at 0.5 km intervals, if terrain corrections are feasible.		4		3207

Site V-5 Crater-top dome (or steep-sided dome)



Terrain type: Hummocky-Rough Upland

		<u>1m</u>	<u>10m</u>	<u>50m</u>	
L_s	1.0 - 1.7 %				
L_{ts}	0 - 5.7 %	Abs. Mean Slope	8.2 - 11.0°	5.8 - 7.7°	3.9 - 5.2°
N_B	2	Alg. Std. deviation	10.0 - 13.7	7.2 - 9.6	4.8 - 6.5
N_C	15.5 - 39.3	Abs. Mean Curvature	0.8 - 2.0	2.4 - 2.7	1.5 - 3.8
N_{B+C}	17.5 - 41.3	Alg. Std. deviation	1.2 - 3.1	2.9 - 3.1	1.9 - 3.4
L_B	0.4 %		<u>Max.</u>	<u>Min.</u>	
L_C	5.0 - 22.4 %	PSD@0.05 ($\lambda=20m$):	0.34 - 0.50	0.075 - 0.200	
L_{B+C}	5.5 - 23.1 %	PSD@0.5 ($\lambda=2m$):	$21 - 80 \times 10^{-4}$	$0.13 - 4 \times 10^{-4}$	
L_T	12.9 - 24.1 %				

Segment of original 1000-km traverse: 800-850

Terrain type: Smooth Mare

Ls	0.2 %		<u>1m</u>	<u>10m</u>	<u>50m</u>
L _{ts}	--	Abs. Mean Slope	2.9°	2.0°	1.4°
N _B	0.2	Alg. Std. deviation	3.6	2.5	1.7
N _C	38.9	Abs. Mean Curvature	0.6	1.0	0.8
N _{B+C}	39.1	Alg. Std. deviation	0.8	1.3	0.9
L _B	0.04%			<u>Max.</u>	<u>Min.</u>
L _C	15.7 %	PSD@0.05 ($\lambda=20m$):	0.25		0.045
L _{B+C}	15.7 %	PSD@0.5 ($\lambda=2m$):	0.0013		0.00012
L _T	15.9 %				

Map distance, this segment: 50 km

Ground distance, this segment: 58 km

Avg. map velocity: 1.7 kph

Ground velocity: 1.97 kph

Driving time: 30 hrs

Routine science each 0.5 km: 50 hrs

Other operations: 30 hrs

Total time, this segment: 110 hrs

Cumulative ground distance to date: 1187 km

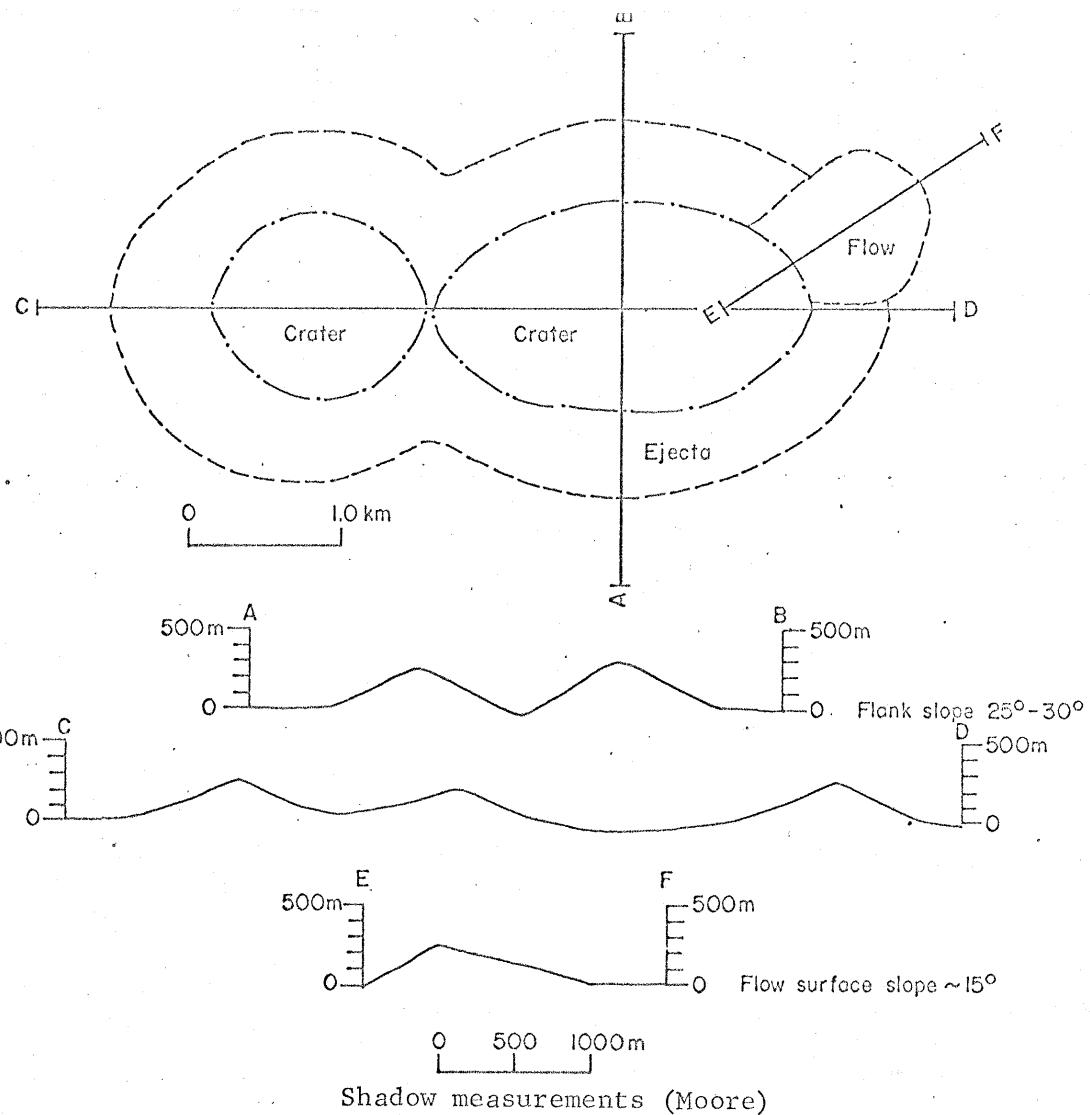
Cumulative time to date: 3317 hrs

Site: V-6 Maar or chain crater

Terrain Type or equivalent: Rough upland

Objectives: to investigate a complex class of crater thought to be volcanic in origin and primarily explosive in mechanism. Possible samples of deep-seated rocks

Operation	Estimated Time (hours)			
	Driving	Science	Other	Cumulative
Traversing around flank of low-to-moderate rim crater to examine variety of material in ejecta and to look for access into interior. Steep slopes are main hazard.	20			3337
Facsimile camera and TV observation of inner and outer crater slopes and closeups of rim material for exotic inclusions of deep-seated material.		10		3347
Collection, preparation, and analysis of 20 samples; selection of 10 for return.		16		3363
20 gravity stations across crater and onto smooth mare at 0.5 km intervals, if terrain corrections are feasible. Otherwise, conduct experiment at 50 m spacing on mare, at least 1 km from crater.		4		3367



Shadow measurements (Moore)

Site V-6 Maar or chain crater

Terrain type: Rough Upland

		<u>1m</u>	<u>10m</u>	<u>50m</u>
L _s	1.7 %			
L _{ts}	5.7 %	Abs. Mean Slope	11.0°	7.7°
N _B	2	Alg. Std. deviation	13.7	9.6
N _C	15.5	Abs. Mean Curvature	2.0	2.7
N _{B+C}	17.5	Alg. Std. deviation	3.1	3.4
L _B	0.4 %		Max.	Min.
L _C	5.0 %	PSD@0.05 ($\lambda=20m$):	0.50	0.200
L _{B+C}	5.5 %	PSD@0.5 ($\lambda=2m$):	0.0080	0.0004
L _T	12.9 %			

Segment of original 1000-km traverse: 850-900

Terrain type: Smooth Mare

Ls	0.2 %		<u>1m</u>	<u>10m</u>	<u>50m</u>
L _{ts}	--	Abs. Mean Slope	2.9°	2.0°	1.4°
N _B	0.2	Alg. Std. deviation	3.6	2.5	1.7
N _C	38.9	Abs. Mean Curvature	0.6	1.0	0.8
N _{B+C}	39.1	Alg. Std. deviation	0.8	1.3	0.9
L _B	0.04%			<u>Max.</u>	<u>Min.</u>
L _C	15.7 %	PSD@0.05 ($\lambda=20m$):	0.25	0.045	
L _{B+C}	15.7 %	PSD@0.5 ($\lambda=2m$):	0.0013	0.00012	
L _T	15.9 %				

Map distance, this segment: 50 km

Ground distance, this segment: 58 km

Avg. map velocity: 1.7 kph

Ground velocity: 1.97 kph

Driving time: 30 hrs

Routine science each 0.5 km: 50 hrs

Other operations: 30 hrs

Total time, this segment: 110 hrs

11th lunar night @ 3432 for 360-hr period

Cumulative ground distance to date: 1250 km

Cumulative time to date: 3477 hrs

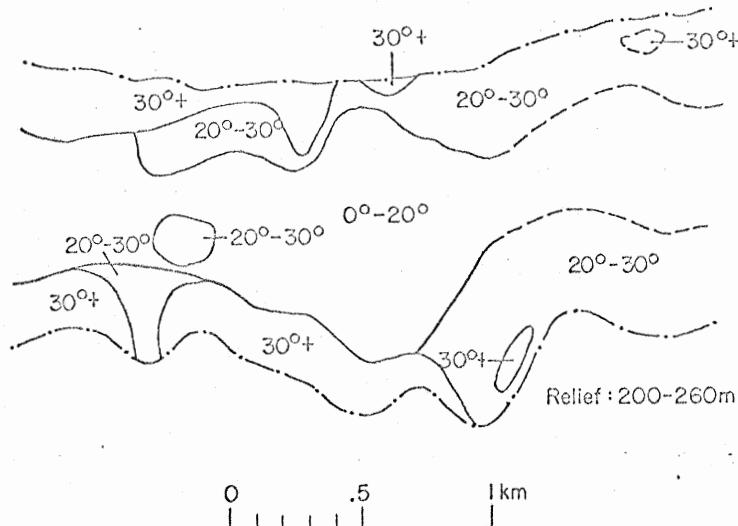
Site: T-6 Sinuous rille

Terrain Type or equivalent: Rough mare

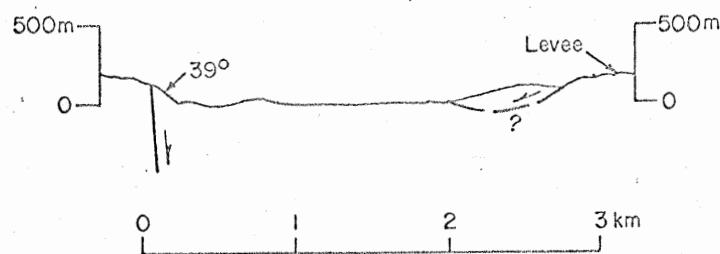
Objectives: to determine origin of meandering patterns and nature of floor wall, and rim (levee), if present; whether volcanic constructional, erosional, or structural. Compare with other rille sites I-6, T-3, and T-5

Estimated Time (hours)

Operation	Driving	Science	Other	Cumulative
Maneuvering along mare rille contact to search for levees, down into rille where access is possible, and along floor. Primary hazards are craters, steep slopes of rille walls, and blocks at base of slopes	20			3497
Facsimile and TV camera scanning and close ups at sample localities		10		3507
Collection of 20 samples from mare, rille walls, levees, and floor		5		3512
Preparation, analysis, and selection of 10 samples		11		3523
20 gravimeter stations at 5-10 m intervals: 10 on mare and 10 on rille floor		4		3527



Slope map and shadow measurements (Moore)



Site T-6 Sinuous rille with levees

Terrain type: Rough Mare

		<u>1m</u>	<u>10m</u>	<u>50m</u>
L _s	0.4 %			
L _{ts}	--	Abs. Mean Slope	5.3°	3.8°
N _B	2	Alg. Std. deviation	6.6	4.7
N _C	39.1	Abs. Mean Curvature	0.9	1.3
N _{B+C}	41.1	Alg. Std. deviation	1.3	1.8
L _B	0.4 %			
L _C	16.9 %	PSD@0.05 ($\lambda=20m$):	1.00	0.420
L _{B+C}	17.5 %	PSD@0.5 ($\lambda=2m$):	0.0035	0.0003
L _T	17.9 %			

Segment of original 1000-km traverse: 900-950 km

Terrain type: Rough Upland

Ls	1.7 %		1m	10m	50m
L _{ts}	5.7 %	Abs. Mean Slope	11.0°	7.7°	5.2°
N _B	2	Alg. Std. deviation	13.7	9.6	6.5
N _C	15.5	Abs. Mean Curvature	2.0	2.7	3.8
N _{B+C}	17.5	Alg. Std. deviation	3.1	3.4	3.4
L _B	0.4 %		Max.	Min.	
L _C	5.0 %	PSD@0.05 ($\lambda=20m$):	0.50	0.200	
L _{B+C}	5.5 %	PSD@0.5 ($\lambda=2m$):	0.0080	0.0004	
L _T	12.9 %				

Map distance, this segment: 50 km

Ground distance, this segment: 57 km

Avg. map velocity: 0.5 kph

Ground velocity: 0.56 kph

Driving time: 100 hrs

Routine science each 0.5 km: 50 hrs

Other operations: 26 hrs

Total time, this segment: 176 hrs

Cumulative ground distance to date: 1317 km

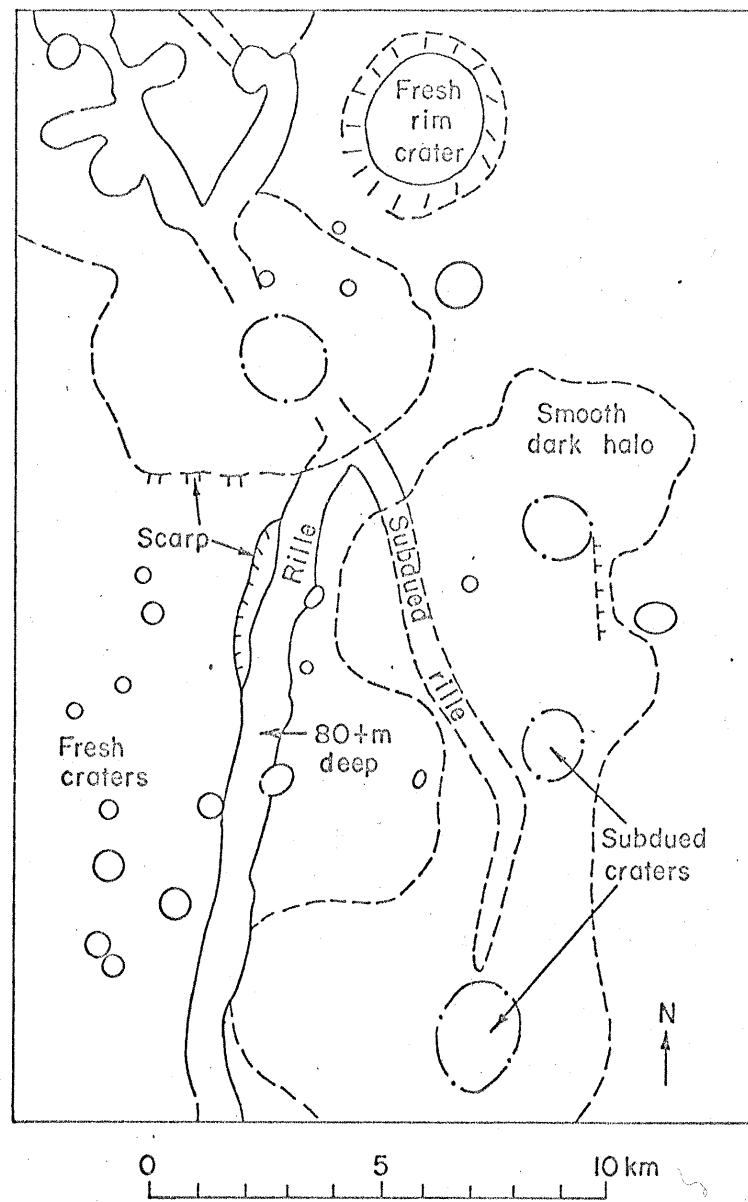
Cumulative time to date: 3703 hrs

Site: V-7 Dark halo craters and associated rille

Terrain Type or equivalent: Rough mare-hummocky upland

Objectives: to examine the nature of dark low-rim crater and rille material apparently of volcanic origin, blanketing surrounding area

Operation	Estimated Time (hours)			
	Driving	Science	Other	Cumulative
Maneuvering over smooth gentle slopes to sample material around craters and in adjoining rilles; traversing from crater across partly filled rille to fresh, sharp rille. Dark smooth surfaces may have low bearing capacities and no cohesion.	20			3723
Facsimile camera and TV viewing of surface materials, particularly for blocks, bombs, or outcrops.		10		3733
Collection of 20 samples		5		3738
20 gravity stations spaced 5-10 m apart, commencing at outcrop if possible.		4		3742
At commencement of 12th lunar night: Preparation, analysis, and selection of 10 samples for return.		11		3753
Shutdown for lunar night	No time estimate			
L _s 0.4 - 1.0 %	<u>1m</u> <u>10m</u> <u>50m</u>			
L _{ts} --	Abs. Mean Slope	5.3 - 8.2°	3.8 - 5.8°	2.5 - 3.9°
N _B 2	Alg. Std. deviation	6.6 - 10.2	4.7 - 7.2	3.1 - 4.8
N _C 39.1 - 39.3	Abs. Mean Curvature	0.9 - 0.8	1.3 - 2.4	1.5 - 4.1
N _{B+C} 41.1 - 41.3	Alg. Std. deviation	1.2 - 1.3	1.8 - 2.9	1.9 - 5.0
L _B 0.4 %	<u>Max.</u> <u>Min.</u>			
L _C 16.9 - 22.4 %	PSD@0.05 ($\lambda=20m$):	0.34 - 1.00	0.075 - 0.420	
L _{B+C} 17.5 - 23.1 %	PSD@0.5 ($\lambda=2m$):	21 - 35 $\times 10^{-4}$	0.013 - 3 $\times 10^{-4}$	
L _T 17.9 - 24.1 %				



Site V-7 Dark halo craters and associated rille

Terrain: Rough mare - hummocky upland

Ranger IX, shadow measurements

Segment of original 1000-km traverse: 950-1000 km

Terrain type: Smooth Mare

		<u>1m</u>	<u>10m</u>	<u>50m</u>
L _s	0.2 %			
L _{ts}	--	Abs. Mean Slope	2.9°	2.0°
N _B	0.2	Alg. Std. deviation	3.6	2.5
N _C	38.9	Abs. Mean Curvature	0.6	1.0
N _{B+C}	39.1	Alg. Std. deviation	0.8	1.3
L _B	0.04%		<u>Max.</u>	<u>Min.</u>
L _C	15.7 %	PSD@0.05 ($\lambda=20m$):	0.25	0.045
L _{B+C}	15.7 %	PSD@0.5 ($\lambda=2m$):	0.0013	0.00012
L _T	15.9 %			

Map distance, this segment: 50 km

Ground distance, this segment: 58 km

Avg. map velocity: 1.7 kph

Ground velocity: 1.97 kph

Driving time: 30 hrs

Routine science each 0.5 km: 50 hrs

Other operations: 30 hrs

Total time, this segment: 110 hrs

Cumulative ground distance to date: 1385 km

Cumulative time to date: 3863 hrs

Site: V-8 Transient phenomenon/thermal anomaly

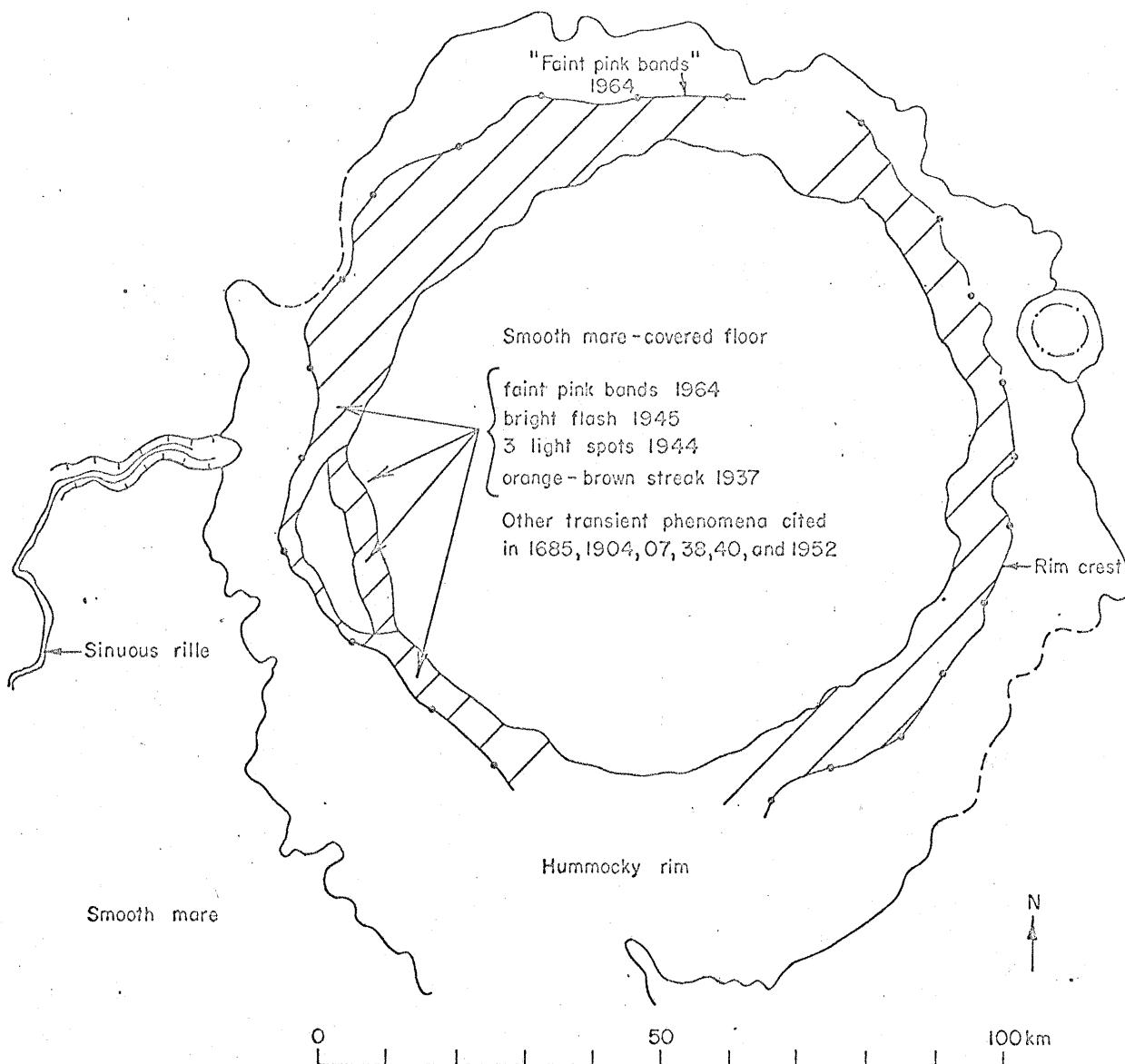
Terrain Type or equivalent: Smooth-to-rough mare

Objectives: To investigate source of thermal anomaly and, if possible, area of active volcanism; to rendezvous with manned mission and deliver lunar samples.

Estimated Time (hours)

Operation	Driving	Science	Other	Cumulative
Maneuvering primarily to reach manned landed LM, but also to locate, study, and collect samples of rock units which may be very young. Primary hazards are craters, blocks, and possibly near-surface volcanic cavities.	15			3878
Collection of 15 samples; preparation, analysis, and selection of 7 for return		12		3890
40 gravimeter stations at 100 m intervals beyond range of manned mission		8		3898
Landing site evaluation. Navigation and homing on rendezvous point. Facsimile camera and TV camera scanning to confirm position celestially and by prominent landmarks. Traverse ends with manned landing.			15	3913

<u>L_s</u>	<u>0.2 - 0.4 %</u>	<u>1m</u>	<u>10m</u>	<u>50m</u>
<u>L_{ts}</u>	<u>--</u>	<u>Abs. Mean Slope</u>	<u>2.9 - 5.3°</u>	<u>2.0 - 3.8°</u>
<u>N_B</u>	<u>0.2 - 2</u>	<u>Alg. Std. deviation</u>	<u>3.6 - 6.6</u>	<u>2.5 - 4.7</u>
<u>N_C</u>	<u>38.9 - 39.1</u>	<u>Abs. Mean Curvature</u>	<u>0.6 - 0.9</u>	<u>1.0 - 1.3</u>
<u>N_{B+C}</u>	<u>39.1 - 41.1</u>	<u>Alg. Std. deviation</u>	<u>0.8 - 1.3</u>	<u>1.3 - 1.8</u>
<u>L_B</u>	<u>0.04 - 0.4 %</u>		<u>Max.</u>	<u>Min.</u>
<u>L_C</u>	<u>15.7 - 16.9 %</u>	<u>PSD@0.05 ($\lambda=20m$):</u>	<u>0.25 - 1.00</u>	<u>0.045 - 0.420</u>
<u>L_{B+C}</u>	<u>15.7 - 17.5 %</u>	<u>PSD@0.5 ($\lambda=2m$):</u>	<u>$13 - 35 \times 10^{-4}$</u>	<u>$1.2 - 3 \times 10^{-4}$</u>
<u>L_T</u>	<u>15.9 - 17.9 %</u>			



Map modified after preliminary geology map, LAC-I2 (Schleicher & M'Gonigle)
 Transient phenomena from Middlehurst and Burley (1966)

Site V-8 Transient phenomena/thermal anomaly

Terrain: Smooth-to-rough mare