BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D.C. 20024

B70 04004

SUBJECT: Projected Activities at Science Stations for J Mission Traverse Planning - Case 320

DATE: April 1, 1970

FROM: P. Benjamin

ABSTRACT

A modular approach is taken to the definition of sampling station activities in order to provide a framework within which various modules can be combined to select a sampling strategy for specific stations on a J mission LRV traverse. The times associated with overhead and engineering tasks at a grab sample station (no documentation), a short stop station (no television), and a long stop station (television and scientific instrumentation) are defined. The procedures and times associated with various types of scientific activity are described separately. The times and procedural constraints of traverse scientific instrumentation are not considered. Combination of the scientific activities appropriate to a specific traverse station with the defined overhead should provide sampling station times and thus permit the basic tradeoffs required for traverse design.

Based upon simulation data, the results of Apollo 11 and Apollo 12 experience, and current flight planning estimates, the station times vary from a low of 3 minutes for a grab sample station through 10 or so minutes for a short stop station to a high of 15 minutes, a half hour, or more for a long stop station, depending upon the activities required.

(NASA-CR-110574) PROJECTED ACTIVITIES AT SCIENCE STATIONS FOR J-MISSICN TRAVERSE PLANNING (Bellcomm, Inc.) 13 p

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MEMORANDUM FOR FILE

INTRODUCTION

In order to perform J mission LRV traverse planning it is necessary to define the types and durations of activities which would be undertaken at science stations along the traverse. This memorandum proposes a modular approach to station activity definition in which the operational and engineering overhead costs are defined separately from scientific activities. The nature and duration of the overhead are specified as well as the procedures and times associated with the scientific tasks, as projected from current procedures.

Three types of science stations are considered: a grab sample station, at which samples are obtained without LRV egress; a short stop station, at which no television and minimum traverse scientific instrumentation are used but the LRV is egressed; and a long stop station, including television and traverse scientific instrumentation. This provides a framework within which various modules can be combined to select a sampling strategy for specific traverse stations. Details of traverse scientific instrumentation procedures and constraints are not considered.

GRAB SAMPLE STATION

At some stations only a minimum amount of sampling will be necessary to fulfill the scientific objectives. Other than generalized photography of the area there is no documentation of the samples required, and sample selection is almost random. The timeline for the activities at a grab sample station is shown in Figure 1, and indicates a cost of less than 3 minutes for obtaining 2 grab samples without LRV egress. Additional samples could be obtained at an approximate cost of 30 seconds for each. Appropriate overhead activities, including navigation updating, LRV status reporting, and omni antenna alignment are accommodated.

SHORT STOP STATION

A short stop station includes egress of the LRV, but is designed for minimum overhead, and thus includes no television and minimum use of traverse scientific instrumentation. As envisioned, it would include a few documented samples and similar activities of relatively short duration. As shown in the timeline in Figure 2, such a station has approximately a 3 1/2 minute overhead regardless of the number of samples collected. The details of sample collection procedures are discussed below.

LONG STOP STATION

When extensive investigation of a station is desired a long stop station timeline, similar to that shown in Figure 3, is required. It is assumed that a remote controlled television fixed to the LRV is used. This requires appropriate modifications to LCRU settings and alignment of the high gain antenna. Further, such alignment must be performed after egress and LRV offloading to prevent redistribution of LRV weight from misaligning the antenna. A more detailed discussion of the possible television options and associated constraints is given in Reference 1. The total overhead cost of a long stop station is just under 6 minutes.

DOCUMENTED SAMPLE COLLECTION

In order to establish the context within which a specific sample was obtained a series of five photographs is taken of a documented sample. These provide a detailed record of the exact position and orientation of the sample relative to its surroundings. Documentation may be of an individual sample or of a generalized area from which a number of samples will be collected. The procedures involved in documented sample collection are shown in Figure 4. As with all sampling procedures discussed here, the details shown are adapted from Reference 2.

Based upon simulation data and the results of Apollo 11 and 12 experience, full documentation of one sample, including a reasonable period for sample location and selection, requires about 5 minutes. Once a specific localized area has been documented, only 30 seconds or so are required for each additional sample taken from that area. If it is within the scientific constraints, considerable EVA time can be saved by multiple sampling within a single documented area.

CORE TUBE COLLECTION

A core tube provides data on subsurface layering and geologic and geochemical changes as a function of depth. The procedures involved in core tube sample collection are shown in Figure 5, and include documentation similar to that for a documented sample. A single core tube collection requires approximately 5 minutes, and the extra depth obtained with a double core tube takes an additional 2 minutes.

TRENCH SAMPLE COLLECTION

The subsurface layering can also be examined and sampled in a trench. Larger and more extensive subsurface samples may be obtained by trenching than by a core tube, and multiple samples are typically taken from various portions of the sides and bottom of the trench.

The procedures associated with this activity are shown in Figure 6. A minimum of 3 minutes is required for the trenching portion of this activity, although as much as 10 minutes may be needed, depending upon soil consistency and depth of trench required. It is followed by area documentation and sampling, as described above, resulting in a total time for trench sample collection in excess of 8 minutes.

MAGNETIC OR GAS ANALYSIS SAMPLE PROCEDURES

The sampling procedures for the magnetic sample and the gas analysis sample are identical, as shown in Figure 7. In both cases, the samples should be obtained away from points of possible contamination (such as the LM or LRV) and are immediately sealed in special containers. For both samples, a variety of documented rocks is obtained. The average duration of the activity, including sample location and selection, is 5 minutes.

POLARIMETRIC EXPERIMENT

A polarizing filter is used on the camera to provide measurements of the photometric properties of fine-grain material and rock fragments, including the undersides of rocks and the disturbed and compressed fine-grain material. Once again, the area is documented by stereo photographs.

As shown in Figure 8, the procedures for this activity require only 4 minutes of one crewman's time. Thus judicious scheduling of this activity can minimize its cost in station time.

OTHER SCIENTIFIC ACTIVITIES

In addition to the activities listed above, several other scientific tasks may be undertaken at sampling stations. Photography of details of the surface material and various small features may be undertaken with the Closeup Stereo Camera. This documentation is performed on a sample-of-opportunity basis at the option of the crewman, and requires approximately 30 seconds per photograph. Documentation of a sampling station is obtained in part by panoramic photography. A full pan sequence requires about 2 minutes. The average times required for the scientific tasks discussed are summarized in Table 1.

As has been stated previously, the time and procedural constraints of traverse scientific instrumentation have not been considered due to the early stage of their development. They will, however, have significant impact not only due to the time required to operate them, but due to location and sequencing constraints. It would be expected that use of specific instruments would cause various stations on the traverse to gain in import due to their value to a given experiment.

CONCLUSION

At this stage in the program definition of the types of activities at science stations and their durations necessarily involves much projection. The projections used here are based upon the best information available at this time, and the sources of the data presented have been indicated wherever possible. The station times shown here vary from a low of 3 minutes for a grab sample station through 10 or so minutes for a short stop station to a high of 15 minutes, a half hour, or more for a long stop station, depending upon the activities required. By using the framework defined in this memorandum and by choosing appropriate modules of scientific activity as a function of specific station requirements on traverses, it should be possible to define sampling station times and thus to perform the basic tradeoffs required for traverse design.

2032-PB-tla

Peter Benjamin
P. Benjamin

Attachments
Figures 1-8
Table 1

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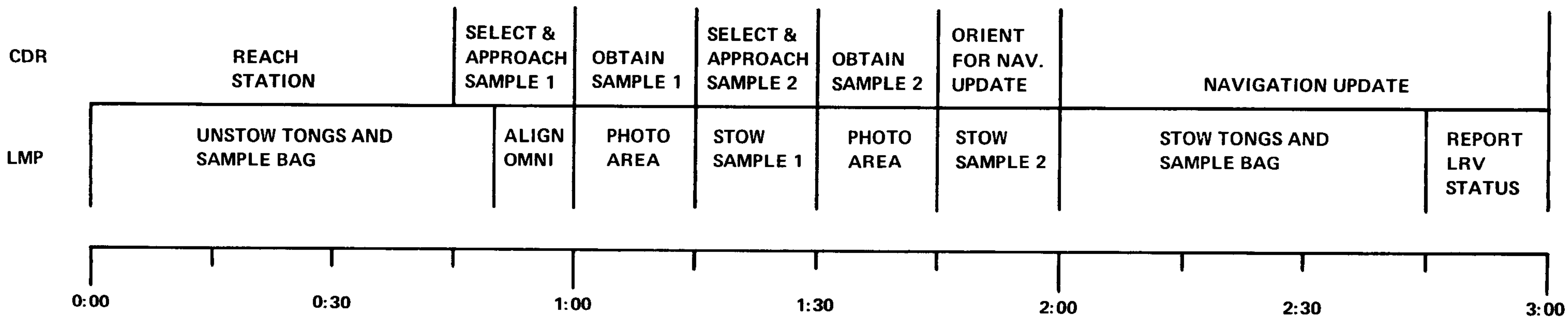
REFERENCES

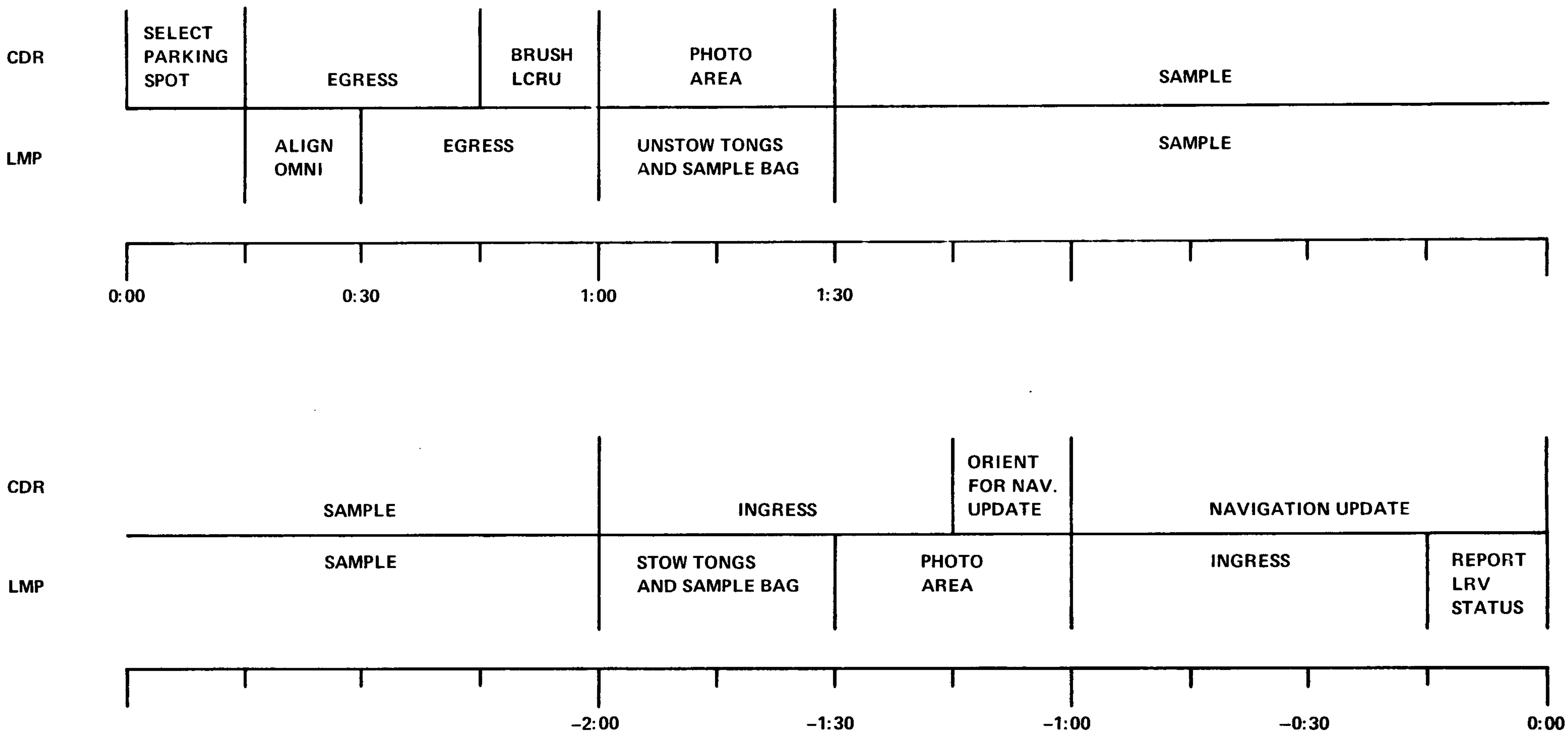
1. J. C. Slaybaugh, "Modular Timeline Elements for Lunar Roving Vehicle Traverse Station Stops," Bellcomm Memorandum for File B70 03072, March 24, 1970.

2. R. J. Koppa, "Preliminary Apollo 13 Lunar Surface Procedures," Lunar Surface Operations Office, MSC, January 30, 1970.



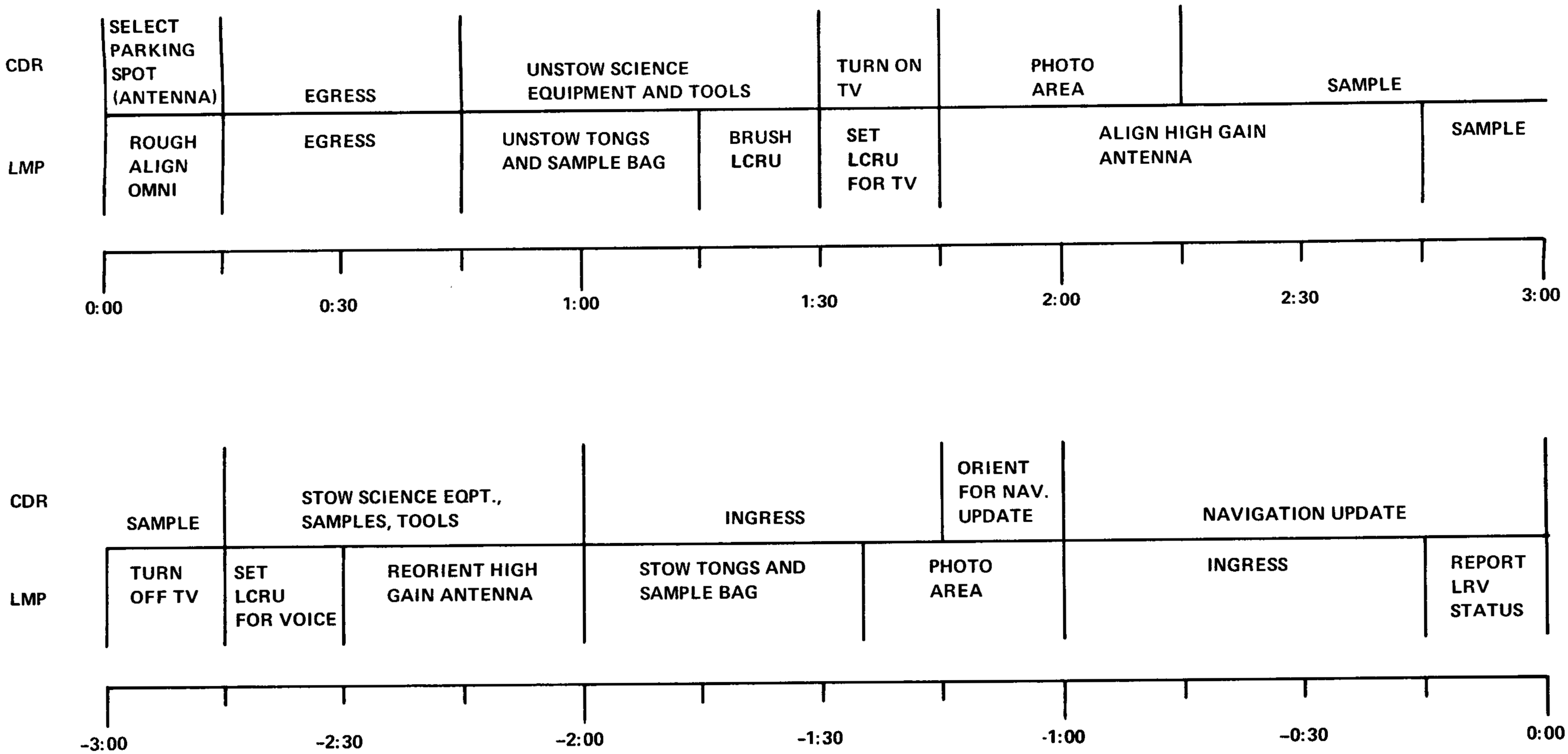
NOTE: ADD 30 SEC. FOR EACH ADDITIONAL SAMPLE DESIRED

FIGURE 1—GRAB SAMPLE STATION
(NO DOCUMENTATION)



NOTE: SEE SAMPLING PROCEDURES FOR DOCUMENTED SAMPLING

FIGURE 2–SHORT STOP STATION
(NO TELEVISION)



NOTE: SEE SAMPLING PROCEDURES

FIGURE 3—LONG STOP STATION
(REMOTE CONTROL FIXED TELEVISION)

LMP	CDR
PLACE TOOLS	PLACE GNOMON UP SUN OF SAMPLE
PHOTO SAMPLE IN CONTEXT	
	TAKE STEREO PAIR (CROSS SUN)
PHOTO SAMPLE (DOWN SUN)	
	COLLECT SAMPLE & DESCRIBE
DEPLOY SAMPLE BAG	
	PLACE SAMPLE IN BAG
SEAL BAG AND REPORT NUMBER	
	PHOTO SITE (CROSS SUN)
STOW SAMPLE	

FIGURE 4 - TYPICAL DOCUMENTED SAMPLE PROCEDURES
(5 MIN)

LMP	CDR
PLACE TOOLS	PLACE GNOMON UP SUN OF SAMPLING POSITION
ASSEMBLE CORE TUBE AND HANDLE	OBTAIN HAMMER
REPORT TUBE NUMBER	
HOLD CORE TUBE	DRIVE CORE TUBE
REMOVE CORE TUBE	PHOTO TUBE AREA IN CONTEXT
CAP CORE TUBE	
	TAKE STEREO PAIR (CROSS SUN)
REMOVE HANDLE	

FIGURE 5 - TYPICAL CORE TUBE SAMPLE PROCEDURES
(5 MIN)

LMP

PLACE TOOLS

ASSEMBLE SHOVEL

DIG TRENCH 10° OFF
DOWN SUN

CDR

PLACE GNOMON UP SUN OF SAMPLING POSITION

TAKE STEREO PAIR (CROSS SUN)

PROCEED AS WITH DOCUMENTED SAMPLE; SAMPLE FILL BOTTOM, SIDES OF TRENCH

FIGURE 6 - TYPICAL TRENCH SAMPLE PROCEDURES
(8 MIN)

LMP	CDR
PLACE TOOLS	PLACE GNOMON (UP SUN)
PHOTO SAMPLE (DOWN SUN)	TAKE STEREO PAIR (CROSS SUN)
OBTAIN SAMPLE CONTAINER	COLLECT SAMPLE & DESCRIBE
OPEN CONTAINER	
REMOVE SEAL PROTECTOR	PLACE SAMPLE IN CONTAINER
CLOSE AND SEAL CONTAINER	PHOTO SITE (CROSS SUN)

FIGURE 7 - TYPICAL MAGNETIC OR GAS ANALYSIS SAMPLE PROCEDURES (5 MIN)

LMP	CDR
	LOCATE ROCKS - OVERTURN ONE & PLACE GNOMON
	KICK UP SURFACE BY ROCK 1 PHOTO DOWN SUN AT 5 FT & 10° PHASE ANGLE
	ATTACH POLAR FILTER
	OVERTURN ROCK & KICK UP SURFACE
	12 PHOTOS DOWN SUN 5 FT AT 80°, 100°, 120°, 140° PHASE ANGLE
	MOVE TO 90° SUN ANGLE

FIGURE 8 - POLARIMETRIC EXPERIMENT
(4 MIN)

TABLE 1

SAMPLING STATION SCIENTIFIC ACTIVITIES

SCIENTIFIC ACTIVITY	(CDR AND LMP) AVERAGE DURATION (MIN.)
Documented Sample Collection	5
Core Tube Sample Collection	
Single	5
Double	7
Trench Sample Collection	8
Magnetic or Gas Analysis Sample	5
Polarimetric Experiment	4 (one man)
Panoramic Photography	2 (one man)
Closeup Stereo Camera	30 sec (one man)

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