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INTERIM REPORT - THE LION PROGRAM

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PREFACE

This report has been prepared by Lockheed Electronics Company for the Geophysics Branch of the Lunar and Earth Sciences Division, by Mr. Louis E. Schneider under Action Documentation 3044-AD-03-02 of the NASA Contract NAS 9-5191.

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-INTERIM REPORT
THE LION PROGRAM

INTRODUCTION

At this point in time, when all NASA programs are under review, it seems appropriate to submit an interim report on the LION program. Accordingly, a brief review of lunar observation programs, a summary of operation LION results and recommendations for further study are submitted.

HISTORICAL BACKGROUND

Sightings of transient lunar phenomena have been recorded since 1540. A catalog of nearly six-hundred reports was compiled by Middlehurst, Burley, Moore and Welther and published in 1968 as a NASA Technical Report.

The first coordinated program for lunar observation was developed under a NASA contract in 1964. Operation Moon Blink established the first of ten observation stations utilizing the "blink" device at Port Tobacco, Maryland, in August of that year. The Moon Blink program was supported by both professional and amateur observatories. The network was expanded to include twenty-three observing stations in fifteen states. A conference telephone system provided rapid communication.

This program, monitored by Mrs. Winifred S. Cameron, Goddard Space Flight Center, stimulated interest in lunar transient phenomena. Considerable support was obtained from amateur astronomers in the U.S., and Moon Blink stations were established in England.

Detailed discussions of project Moon Blink and the evaluation of data acquired, are presented in cited references.

In March of 1965, ARGUS, a group of amateur astronomers, and ASTRONET, a network of amateur radio operators, joined to form ARGUS-ASTRONET. The network, managed

by W. R. Calkins and L. C. Bornhurst with headquarters in West Covina, California, now contains about sixty observers who own and operate their own radio stations. The acquisition of data on transient lunar phenomena is one of the objectives of this organization. To date, ARGUS-ASTRONET has logged well over 9,000 hours of lunar observing time. Much of the information obtained is stored on tape and is yet to be evaluated.

The Association of Lunar and Planetary Observers conducted a two year program (1966-1968) of lunar observation. Program ALPO was restricted to the observation of six selected lunar features. A blink device, developed by P. K. Sartory of the British Astronomical Association, was employed in an attempt to determine the degree of enhancement observed.

A report and analysis of phenomena recorded during this program was published in "The Strolling Astronomer" by C. L. Ricker and H. W. Kelsey.

In December of 1968, the Smithsonian Center for Short-Lived Phenomena was requested to contribute communications support to a lunar observation program organized by Barbara Middlehurst and William Chapman. The purpose of this program was to utilize a world-wide network of observers to keep the moon under observation during the Apollo 8 mission. It was hoped that a lunar event reported by an observer on earth could be confirmed by the Apollo 8 crew.

An observing plan was developed by the Smithsonian Center and sent to participating observers. During the alert period, 2100 GMT, December 21 to 2200 GMT, December 25, sixteen observer reports were received. Ten of these were event reports, six were negative reports. A summary of this program was published by the Smithsonian Center on January 5, 1969.

Although the Smithsonian report concludes that this voluntary program had "limited success," it did lead to the establishment of the NASA-funded Lunar International Observers Network.

THE LION PROGRAM

Operation LION, funded by the NASA/MSC, Geophysics Branch, Houston, Texas, was organized in March 1969. Lockheed Electronics Company, Lunar and Earth Sciences Department, Geophysics Section, under NASA Contract NAS 9-5191, was assigned the responsibility to: "Establish and maintain a reporting network for observers around the world with emphasis on periods of Apollo flights." Miss Barbara Middlehurst was retained by LEC on a consulting basis to assist in the performance of this assignment.

The Geophysics Branch contracted with the Smithsonian Center, under NASA Contract 9-9537, to furnish communications support to the LION operation during Apollo missions.

Arrangements were made through the Chief, Mapping Sciences Laboratory, for desk space in the Staff Support Room. Proper channels were established for communications with Apollo Spacecraft -- through the NASA, Room Monitor, and Mission Control Center. Two "hot line" phones were installed for communication with the Smithsonian Center in Cambridge, Massachusetts.

REPORT STATISTICS

The LION network has now operated during three Apollo missions. A LION operations summary and a compilation of reports received by the Smithsonian Center have been published for each mission alert. Therefore, only a brief review of report statistics will be included here.

Although the Apollo 8 program was not part of the NASA-funded LION operation, the data tabulated in Table I includes reports acquired during Apollo 8. From these data, it is apparent that Aristarchus is by far the most "active" lunar feature. Approximately 46% of event reports are for phenomena observed in or near this crater.

Statistics tabulated in Table I also indicate an increase in the number of reports received for each succeeding mission. Weather conditions and the position of the moon from the northern hemisphere, probably account for the slight decrease in number of events reported during Apollo 12.

Approximately sixty-five between-mission reports have been received. Many of these are multiple reports covering periods of observation extending over intervals of from two to nine days. These reports are not included in Table I, which lists only those reports received during LION alerts.

ASSESSMENT OF PROGRAM

It is very difficult to determine the number of observing stations actually contributing observing time to operation LION. If the number of observers who send in reports and/or letters, pictures, etc., is an index to activity, the following estimate may be derived:

During Apollo 8, only 7% of the 125 stations listed sent in reports. There are now 225 stations on the mailing lists; of these, 35 to 38% appear to be active in the program. It is interesting to note that response to questionnaires sent to LION members by the Smithsonian Center also indicates a 35 to 38% participation.

Those observers who are known to have contributed their time and efforts to operation LION are listed in Appendix I.

The initial stage of operation LION has been highly successful. An excellent network of observers is on the alert for all Apollo missions; a very efficient communications system has been established; and, a large number of reports of lunar observations has been acquired. The primary objective of this program may or may not have been achieved. It is not certain that the area reported by the Apollo 11 crew to be "considerably more illuminated than the surrounding area" was indeed the same phenomenon reported as a transient event by earth

observers. More concrete evidence is required before it can be unequivocally stated that the same transient event has been sighted by astronauts and earth observers. A diffraction grating for attachment to the Hasselblad camera could provide the means for substantiating reported events. The proposal to provide such an attachment has been approved, and work is in progress. It is hoped that Apollo 13 will be equipped to obtain spectral evidence of any unusual lunar phenomena.

The second objective of operation LION, "to determine the cause of lunar events" is as far from attainment as it was at the beginning of the program.

Data acquired by the LION operation, and all previous programs, are subject to statistical evaluation only. Such a study should be made, and the method has been discussed. Mrs. W. S. Cameron has completed a statistical evaluation of approximately eight-hundred transient events and will publish the results in the near future. She has offered her assistance and advice on a similar evaluation of LION reports. Mr. W. R. Calkins has offered the support of ARGUS-ASTRONET to any effort to evaluate LION data. This offer includes all reports acquired by ARGUS-ASTRONET during the past five years, assistance with computer programming, and possibly computer time.

It is evident that a study of all available lunar event reports would be most interesting and informative. It is also apparent that a statistical evaluation of such a large quantity of data could be done most efficiently and economically by computer program.

A careful statistical study will no doubt indicate some interesting correlations between transient events and certain interrelations of the Sun-Earth-Moon system. The study will indicate patterns or relationships upon which to focus attention. It will not resolve the question as to the cause or nature of transient phenomena. Such a study can be used to focus photometric, spectrometric and similar techniques upon restricted targets during specific times. From data acquired by these studies, the answers to specific questions may be derived.

RECOMMENDATIONS

It is strongly recommended that:

1. A cooperative statistical study of all available TLP reports be undertaken, utilizing the combined efforts of ARGUS-ASTRONET, Mrs. W. S. Cameron and the LION program.
2. The results of this study be applied to the development of a lunar observation program employing photometric, spectrometric and similar techniques, to obtain physical data on selected lunar areas for scientific evaluation.
3. The observer network be expanded to include more professional observatories where spectrograms and photographs can be obtained.
4. A closer relationship be developed between the management of the lunar event study program and Apollo crews to develop the interest and cooperation necessary to obtain maximum assistance from astronauts in acquiring photographic and observational data.

This program could resolve the ambiguity and uncertainty as to the validity of transient lunar phenomena.

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TABLE I

Apollo 8 - 12
Report Statistics

Lunar Feature	Reports for Apollo Missions					Reports Confirmed by 2 or more Observers				
	8	10	11	12	Total	8	10	11	12	Total
Alphonsus			1	2	3				2	2
Arago/Sinas			1		1					
Argæus				1	1					
Aristarchus	7	22	41	15	85	1	5	7	1	14
Aristoteles				1	1					
Atlas		1	1		2					
Baillaud			1		1					
Biela		1			1					
Biot			1		1					
Birt				1	1					
Bouger		1			1					
Cauchy			1		1					
Censorinus		1	1	4	6					
Chevalier A				1	1					
Copernicus				2	2					
Dionysius				2	2					
Eratosthenes				2	2					
Euclides				1	1					
Eudoxus			1	1	2					
Gassendi				4	4					
Goldschmidt				1	1					
Grimaldi	1		5		6					
Guericke	1				1					
Harpalus		2			2					
Janssen			1		1					
Kepler			1	2	3					
Krafft			1		1					
Lambert				1	1					

TABLE I (Continued)

Apollo 8 - 12 Report Statistics

Lunar Feature	Reports for Apollo Missions					Reports Confirmed by 2 or more Observers				
	8	10	11	12	Total	8	10	11	12	Total
Landsberg				1	1					
Langrenus			1		1					
Manilius			1		1					
Manzinus		1	1		2					
Maskelyne		1	1	1	3					
Maurolycus			1		1					
Mayer T.				1	1					
Menelaus			1	3	4					
Moretus			1		1					
Pickering	1				1					
Pierce			2		2					
Piton				1	1					
Posidonius		1			1					
Proclus			2	2	4					
Ptolemaeus				1	1					
Rabi Levi		1			1					
Ross D		2		2	4					
Theophilus			5		5					
Yerkes			1		1					
Caucasus Mts.				1	1					
Southern Cusp			1		1					
Schroter's Valley				1	1					
Mare Crisium			2		2					
M Serenitatus				1	1					
M Tranquilitatis			3	1	4					
50N, 45W				1	1					
60S, 80W				1	1					

TABLE I (Continued)

Apollo 8 - 12 Report Statistics

Lunar Feature	Reports for Apollo Missions					Reports Confirmed by 2 or more Observers				
	8	10	11	12	Total	8	10	11	12	Total
2° N, 27° E			1		1					
5° N, 8° W			1		1					
12° N, 8° W			1		1					
TOTAL	10	34	83	59	186	1	5	8	3	17
Negative Reports	6	60	151	137	354					

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