FINAL REPORT

for

GRANT NSG - 07013

entitled

A SHORT COURSE IN LUNAR GEOLOGY FOR EARTH-SCIENCE INSTRUCTORS

conducted by

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A SHORT COURSE IN LUNAR GEOLOGY FOR EARTH-SCIENCE INSTRUCTORS*

This grant had three initial objectives: 1) to develop a short course in lunar geology, 2) to hold the short course and 3) to conduct a follow-up survey of the results. A fourth objective was added: to design and construct a display in Lunar Geology at Foothill College, Space Science Center. A no-cost extension was requested and granted to add the fourth objective in order to make effective use of the funds that remained after the course was conducted. Each objective is stated and discussed in terms of its fulfillment.

OBJECTIVE 1. To develop a four-day short course in lunar geology.

Drawing on space scientists at NASA-Ames and the U. S. Geological Survey, Astrogeology Branch at Menlo Park, California, the short course was organized (Table 1) to provide the participants with fundamental knowledge in lunar geology. Each speaker used a combination of lecture, slides, and open discussion to put his topic across to the individual. The number of participants was limited to 25 in order to promote free discussion.

Each speaker prepared a written summary of his presentation, which was combined with reprints of related papers and other handouts and assembled as a Resource Notebook for retention by each participant. Extra copies of the Resource Notebook were distributed to NASA field center Public Affairs Offices.

After the course, the notebook was edited and reassembled for publication as NASA TM X-62,359 A Primer in Lunar Geology (Greeley and Schultz, 1974) and is available through the NASA Scientific and Technical Information Facility, Box 33, College Park, Maryland 20740.

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* The NASA Technical Officer for this Grant was Robert Bryson, Lunar Programs Office, NASA Headquarters, Washington, D. C. 20546

TABLE 1
SCHEDULE FOR THE COURSE
SHORT COURSE IN LUNAR GEOLOGY

APRIL 25, 1974

8:30	Registration, introduction, objectives of the course.
9:30	The Solar System (with emphasis on terrestrial planets) (Dr. D. Black, NASA).
10:45	Coffee.
11:00	Meteorites and lunar samples (Dr. T. Bunch, NASA).
12:15	Lunch.
1:30	Lunar photo exercise, introduction to selenography (Dr. P. Schultz, NASA).
3:15	Coffee.
3:30	Laboratory cratering experiments.
5:30	Break for dinner.
7:30	Keg session: Data acquisition - a review of manned and unmanned lunar missions (Dr. R. Greeley, Univ. Santa Clara). Film: Shoot the Moon.

APRIL 26, 1974

8:00	Impact cratering, introduction (D. E. Gault, NASA).
9:45	Coffee.
10:00	Lunar basins and mascons (Dr. K. Howard, USGS).
12:00	Lunch.
1:00	Principles of extraterrestrial geological mapping (Dr. J. Guest, Univ. of London Observatory).
2:45	Coffee.
3:00	Lunar photogeologic mapping exercise.
5:00	Break for dinner.
7:30	Keg session: Sources of teaching materials (G. Hull, NASA). Film: Apollo Lunar Landing.

APRIL 27, 1974

8:00	Volcanism as a planetary process (Dr. R. Greeley, Univ. Santa Clara).
9:45	Coffee.
10:00	Geology of the Apollo landing sites (Dr. W. Quaide, NASA).
12:00	Lunch.
1:00	Geophysical characteristics of the Moon (Dr. C. Parkin, Univ. Santa Clara).
3:00	Coffee.
3:15	Teaching methods for lunar geology (Dr. R. Greeley, Univ. Santa Clara).
5:00	End of session.
6:30	Banquet at Dinah's Shack, 4269 El Camino Real, Palo Alto. Lecture: "The Geology of Mars" (Dr. M. Carr, USGS).

APRIL 28, 1974

8:15	Tour of NASA-Ames 1. NASA orientation. 2. Benefits and "spin-off" of the Space Program. 3. Airborne Sciences, flight line. 4. Hypervelocity impact facility. 5. Planetology wind tunnel facility. 6. Lunar sample orientation and geochemical facilities.
12:00	Closing remarks.

OBJECTIVE 2. Presentation of Lunar Geology Short Course.

Announcements of the short course and applications for attendance were sent to all (100) community colleges in California. Fifty-two applications were received (Appendix I), from which 22 were accepted (Appendix II) as sponsored (expenses paid) participants.

In addition to the 22 sponsored participants, representatives from the Lunar Science Institute, Houston, Texas, and from the Educational Programs Office of NASA-Ames attended the course.

The course was held April 25 - 28, 1974, at NASA-Ames Research Center, cohosted by the University of Santa Clara and NASA-Ames, Educational Programs Office.

In addition to the scientific presentations, sessions included suggestions for incorporating planetology in Earth-science curricula and discussion of the educational resources that are available from NASA and other organizations. Laboratory exercises were held for the participants as a means of both educating them and as working examples of exercises which could be used in their classes. These and other exercises are given in Greeley and Schultz (1974).

OBJECTIVE 3. To conduct a follow-up survey of short course participants.

PART A: Immediate response (last day of course)

After the course, an evaluation form (Appendix III) was filled out by each participant. Summarizing from the results of this evaluation, most of the participants best liked the opportunity to learn directly from active research scientists; they least liked the long periods of sitting (i.e., the program should have had more opportunity for the participants to move around). All of the participants indicated their intention to incorporate

TABLE 2

SUMMARY OF RATING FOR THE LEVEL OF INSTRUCTION BY TOPIC
(INDICATED BY NUMBER OF RESPONSES)

	Too Low	Just Right	Too High
Solar System		19	4
Meteorites		19	4
Selenology	3	20	
Cratering	1	18	4
Lunar Basins	2	21	
Geological Mapping	1	21	1
Volcanism		23	
Apollo	7	14	2
Geophysics	8	7	4

aspects of lunar geology into their present courses; about one-fourth indicated an intention to initiate either formal courses in planetology, or short courses through their community affairs program. In general, the participants felt that the course was well organized and that the speakers were effective. Table 2 shows the rating of the various topics on the program.

Most of the participants indicated a willingness to have paid their own way to the course, although most felt that their home institution should have met their expenses if they had not been supported by NASA.

PART B: Survey One Year Later

In early Spring, 1975, a follow-up survey of the participants was conducted in order to assess the "long-term" effect of the short course. Of the 22 earth-science instructors who attended the course, contact was made with 21. The following is a tabulation of the responses made to specific questions:

1. How has the information gained from the short course been applied?

Classroom	16	
Seminars	4	
Short Course	0	
Other	a) Formal course in planetology	4
	b) Display	1

2. Approximately how many class hours are now spent in lunar geology? 5.3 (ave.)
   What increase (decrease) does this represent with respect to class time prior to the short course? 3.9 (ave.)
   How many hours in planetary geology? 3.2 (ave.) Increase of 2.1 (ave.)

3. Which, if any, laboratory exercises (performed in the short course or described in the handout) have been used?

a)	Selenology	1
b)	Cratering	4
c)	Mapping	2
d)	None yet, but planned	6

4. Which course materials have you used in the classroom?

Geographic maps	5
Geologic maps	11
Topographic maps	6
NASA brochures	5
NASA posters	6
Reprints	1
Photographs	12

Which generated the greatest interest? Photographs

5. Were any additional course materials ordered for the classroom? 9
for personal use? 7

What were they? Photographs (mostly)

Were there any problems in ordering these materials? no

6. Do you feel there is a need for a similar short course in geology extended to other terrestrial planets? yes - 15

Similarly, is there a need for a short course that includes the rest of the Solar System? yes - 11 no - 1

OBJECTIVE 4. Design and construct a display in lunar geology.

A wall-panel display about 7½ feet high and 16 feet long was designed to acquaint the viewer with the elementary facts of lunar geology. The exhibit consists of Lunar Orbiter photographs, LAC charts and the Geologic Map of the Frontside of the Moon. The display was constructed on contract and permanently installed at the Space Science Center of Foothill College. Foothill is a community college with an enrollment of 21,000 students.

RESULTS

The tangible results of this program can be summarized as:

1. Development of a short course curriculum that can be used as a core for similar programs by other institutions. In May, 1975, The Lunar Science Institute used our material and outline to conduct a lunar geology short course and, although the specific program was modified to better fit the resources of the Houston area, the basic program was modelled on the Santa Clara short course. Both investigators (Ronald Greeley and Peter Schultz) consulted for LSI to help organize and conduct their program.

2. Instruction and sufficient motivation for the participants to increase their instruction in lunar and planetary geology by more than 50%. Twenty percent initiated formal courses in planetology and approximately 20 percent held special seminars in lunar geology.

3. Publication of a 574 page "Primer in Lunar Geology" from material assembled for the short course was another result of the short course. Copies are available for interested parties from NASA-Ames. Cost of the printing was borne by Ames Research Center.

In summary, we believe that the short course was successful and effective in meeting its objectives. Much of the success must be attributed to the involvement of many lunar investigators who contributed their time to serve as instructors. One of the comments most frequently heard from the participants was that they liked very much the opportunity to hear from and talk to the scientists engaged in the lunar program.

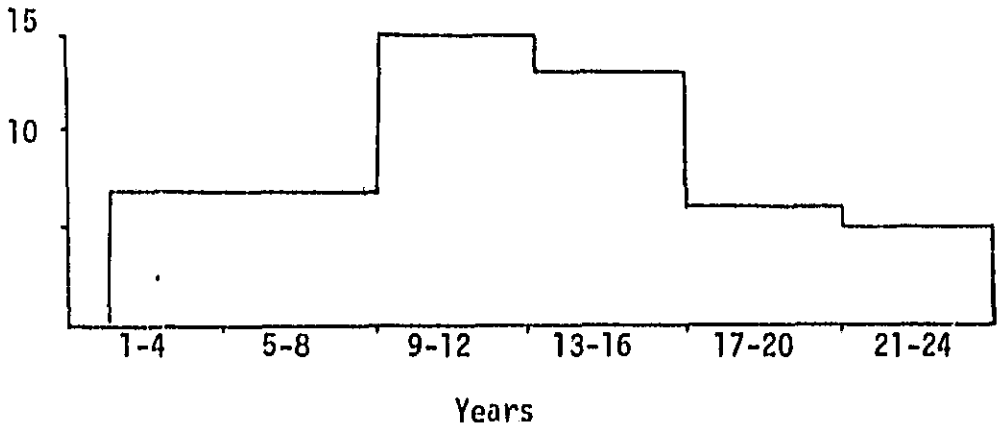
Reference

Greeley, R. and Schultz, P., editors, 1974. A Primer in Lunar Geology: NASA TM X-62,359.

APPENDIX I

SUMMARY OF THE APPLICANTS TO THE SHORT COURSE

1. Years of teaching experience:



2. Education:

Bachelor's degree	6%
Master's degree	79%
PhD	15%

Those teachers with a Bachelor's or Master's degree had the following backgrounds:

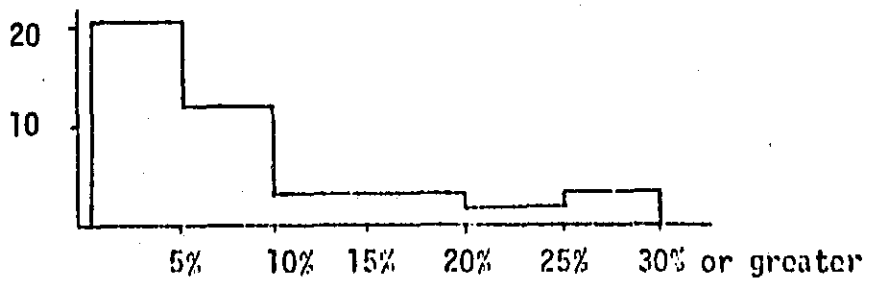
1. Geology (including geophysics, geochemistry, and geography)	32
2. Natural or Earth Science	3
3. Physical Science	3
4. Education	2
5. Astronomy	1
6. Meteorology	1
7. Biology	1
8. Electronics	1

Those teachers with a PhD degree included:

1. Geology	6
2. Earth Science	1
3. Astrophysics	1

3. Previous instruction in lunar or planetary geology: 85% had none; 15% had either a short course or a course while in school.

4. Percentage of time spent in classroom on lunar or planetary studies:



APPENDIX II
SHORT COURSE IN LUNAR GEOLOGY
LIST OF PARTICIPANTS

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APPENDIX III

POST COURSE EVALUATION

(Immediately after the course)

1. What did you like best about the course?

2. What did you like least about the course?

3. What did you expect from the course, but did not receive?

4. Explain briefly and frankly what you expect to do with the information and material gained from this short course.

5. Do you believe the speakers were generally effective? Yes____ No____

   Would you have preferred to have had only one or two instructors? Yes____ No____

   Were any of the presentations of little or no value to you? If so, which _____

6. Please rate (from YOUR point of view) the level of instruction for each presentation.

	Too Low	Just right	Too high	Way over my head!	
Solar System					
Meteorites					
Selenology					
Cratering					
Lunar Basins					
Geologic Mapping					
Volcanism					
Apollo Landing Sites					
Geophysics					