UNITED STATES
DEPARTMENT OF THE INTERIOR
BRANCH OF ASTROGEOLOGY
GEOLOGICAL SURVEY
Box 1906
Flagstaff, Arizona

March 31, 1964

MEMORANDUM

To: V. R. Wilmarth

From: E. M. Shoemaker

Subject: Monthly Report for Director and Secretary

1. Highlights and Noteworthy Results:

Lunar and Planetary Investigations

The primary and secondary mirrors have been installed in U. S. Geological Survey's 30-inch telescope on Anderson Mesa south of Flagstaff. The telescope has been aligned and preliminary tests have shown that the optical elements of the instrument are of excellent quality.

The telescope is now in operating condition and scheduling of observers will begin in early April.

A preliminary map and report for the Hevelius quadrangle in the western limb area of the Moon have been completed by John F. McCauley. The Imbrian stratigraphy of this region differs considerably from that mapped in the central parts of the lunar disc. Apenninian material can be recognized only in the extreme north and eastern part of the area. The entire western part is overlain by a regional blanket which is related to Mare Orientale. Two new formations have been recognized and employed in the map. They

include the regional blanket itself and a class of craters flooded by Procellarum group material but which are younger than the blanket. This unit is analagous to the Archimedian series as originally defined. The age relationships between the Orientale blanket and the Apenninian blanket are not clear, however, since the nearest exposures are separated by more than 300 kilometers of intervening mare material.

Cosmochemistry and Petrography

M. B. Duke discredited the identification by P. Ramdohr of diamond in the Vaca Muerta and Mincy mesosiderites, thereby saving the necessity of a vast reconsideration of meteorite origin and perhaps even fundamental natural laws. The so-called diamond occurs as euhedral grains up to 70 microns in diameter intergrown with metallic iron and would be best interpreted as formed under equilibrium crystallization. The silicate assemblage of these meteorites includes tridymite and pigeonite, low pressure-high temperature minerals incompatible with diamond. Petrographic and electron probe analysis indicates the mineral is rutile, not previously recognized as a meteoritic mineral.

Space Flight Projects

The Astronaut Training Program in Principles of Terrestrial and Lunar Geology continued in March with two lectures, given jointly by E. D. Jackson and A. H. Chidester, on "Structure and Landforms"; completion of the first field trip, to the Grand Canyon; and a check out trip to West

Texas for geologist team leaders in final preparation for the second field trip.

The field trip to the Grand Canyon was held in two sections, March 4-7 and 11-14. E. McKee, USGS, who had led the geologists in a run-through the week before, conducted the orientation lecture for the first section at the Yavapai point. McKee was unable to attend the second section of the trip, and A. H. Chidester substituted for him in the orientation at Yavapai. Team leaders in the first section were D. E. Wilhelms, E. D. Jackson, D. J. Milton, and A. H. Chidester, of the U. S. Geological Survey; and T. Foss, U. Clanton, and E. King of NASA. In the second section, team leaders were E. D. Jackson, J. F. McCauley, and A. H. Chidester of the U. S. Geological Survey, and T. Foss and U. Clanton of NASA. S. Carpenter and A. Shepard of the Mercury astronauts, Armstrong and See of the second group, and the entire third group of 14 astronauts, participated in the first section. The remaining astronauts--Shirra, Slayton, Grissom, and Cooper, of the Mercury group; and White, Borman, McDivitt, Lovell, Conrad, Young, and Stafford, of the second group--all participated in the second section.

Following the orientation talk at Yavapai, the first day of the trip was spent going down the Kaibab trail to the Phantom Ranch--observing lithologies, facies relations, primary structures, and unconformities; mapping contacts of formations; and working out fault relations. The second day was spent in coming up the Bright Angel trail--observing

particularly structures and lithologies in the Vishnu; the variety of unconformable relations between the Vishnu, the Later Precambrian rocks, and the Paleozoic rocks; faulting in the Precambrian; and the location of contacts between Paleozoic formations.

Both sections of the Grand Canyon trip were highly successful. All the astronauts were extremely enthusiastic, and many expressed a desire for more time in the field. Their rate of progress continues to be very rapid. The readiness with which they grasp geologic principles and geologic methods, and their enthusiasm for field work, has been gratifying.

R. M. Batson has designed a preliminary focus analysis system for use during the operation of the Surveyor spacecraft when it is on the Moon. The same techniques used in focus analysis should be adaptable, with only minor variations for use in topographic mapping the near field around the spacecraft. A preliminary test projector for the focus analyzer has been fabricated and tested, and the instrument shop at Flagstaff is fabricating two prototype models.

E. M. Shoemaker and E. C. Morris met with personnel of Jet Propulsion Laboratory to organize the Television Science Analysis and Command Team (TSAC) which will function as part of the Space Science Analysis and Command Group (SSAC) of the Surveyor Space Flight Operations

Organization. Personnel of the U. S. Geological Survey who are members of the team are. R. M. Batson, photogrammetrist, E. C. Morris, geologist, and D. P. Elston, geologist. The team will meet once every three weeks or bi-weekly as needed for planning and training. The TSAC team will report to E. M. Shoemaker who serves as chairman of the Television Evaluation Team under the SSAC director.

5. Personnel

Daniel J. Milton and Gordon A. Swann joined the Houston project in March.

E. C. T. Chao safely emerged from the Ivory Coast, where tektites are still elusive, and arrived in the Nordlingen Ries to further sample impact metamorphosed rocks. Work in the Rieskessel was hampered by an unseasonable snow cover, but Chao was able to find a few promising specimens (several hundred pounds) for laboratory study.

Arthur O. Beall, Jr., Physical Science Technician entered on duty at Menlo Park to assist in fragmentation studies in the hypervelocity impact program and map compilations for the Lunar Terrain Study.

The following personnel entered on duty in Flagstaff in March:

Earl F. Kiernan, Electronics Engineer, March 13, 1964
David W. Dodgen, Optical Physicist, March 17, 1964
Valerie J. Way, Physical Science Technician, March 23, 1964

6. Conferences and Scientific Meetings Attended at Home or Abroad:

A field conference for geologist team leaders in final preparation for the second field trip--to be held in the Marathon Basin-Big Bend area in West Texas--was held March 26-29. Participating geologists were G. A. Swann, D. J. Milton, D. E. Wilhelms, M. F. Kane, E. D. Jackson, and A. H. Chidester of the U. S. Geological Survey; E. King, U. Clanton, and T. Foss of NASA; and P. Flawn and W. Muehlberger of the University of Texas, who are the consulting experts on the area and who will serve also as team leaders.

Russell Wahmann, Cartographer and Coordinator for Technical Support and Patricia L. Marshall, Cartographic Draftsman, visited the Branch of Technical Illustrations, Field Office, Menlo Park, California, for the purpose of coordination of color separation processes of U. S. Geological Survey geologic maps of the Moon.

E. M. Shoemaker, J. F. McCauley, E. C. Phillippi, and R. M. Batson attended the final bi-monthly report on the Surveyor Lunar Roving Vehicle at the Jet Propulsion Laboratory March 9 and 10.

E. M. Shoemaker, E. C. Morris, J. F. McCauley, R. M. Batson, K. Watson, and E. C. Phillippi visited Aeronutronics engineers, J. S. Hanrahan, D. M. Tompkins, and W. Hostetler and their staff engineers to discuss the facsimile system developed for the Ranger spacecraft.

E. D. Jackson visited Aaron Waters, University of California at Santa Barbara, to discuss possible astronaut field trip to Newberry Crater, Oregon.

7. Talks or Papers Presented at Meetings

Donald P. Elston	"Astrogeological research of the U. S. Geological Survey" Physical Sciences Division Arizona College Association Arizona State University Tempe, Arizona
H. J. Moore	"Mapping the Moon" Los Altos High School Science Seminar Group Los Altos, California
M. B. Duke	"The Basaltic Meteorites, just breaking the surface of a meteorite parent body" Geological Society of Washington

8. Visitors

Visitors	Visited and Purpose
Joe Goldstein Massachusetts Institute of Technology	M. B. Duke to discuss metallography of mesosiderites.
Richard Kelliger (not specified)	H. J. Moore to discuss hypervelocity impact craters.
A. A. Tyer Lockheed, Sunnyvale, California	Harold Masursky to discuss radar mapping.
Robert Radabaugh and Harold Swanson New Jersey Zinc Company	C. H. Roach and G. R. Johnson to discuss applicability of thermoluminescence and other solid state properties to ore exploration
Paul Lowman Donald Beattie NASA Headquarters Washington, D. C.	E. M. Shoemaker, D. P. Elston J. F. McCauley, E. C. Morris R. H. Barnett, E. C. Phillippi, K. Watson, and R. M. Batson for the purpose of discussing post-Apollo mission planning.
Vincent J. Schaefer Director of Research Atmospheric Sciences Research Center State University of New York Schenectady, New York	E. M. Shoemaker for the purpose of discussing summer projects for students at Museum of Northern Arizona
R. G. Eisenhardt R. J. Curran Bendix Systems Division Ann Arbor, Michigan	E. M. Shoemaker, J. F. McCauley, E. C. Phillippi for the purpose of discussing the photogrammetric mission of the Surveyor Lunar Roving Vehicle
W. B. Foster Manned Space Sciences Division Office of Space Sciences and Applications, NASA	E. D. Jackson, U. S. Geological Survey on astronaut training program

V. C. Fryklund Manned Space Sciences Division Office of Space Sciences & Applications, NASA Washington, D. C.	Second section Grand Canyon field trip, status of field training program
R. F. Fudali Bellcomm, Inc.	E. D. Jackson, Terrain quantification studies

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General Information

Lunar and Planetary Investigations

Porter Irwin visually observed what appeared to be an almost complete "natural bridge" in the Apennine Mountains Region of the Moon on the 12 inch and 36 inch refractors at Lick Observatory. The arch is about 10 km across and is apparently a better example of this type of feature than the well-known O'Neill's bridge near Mare Crisium on the east limb of the Moon. The true nature of the observed feature remains a puzzle.

Space Flight Projects

Stereophotography from a simulated Surveyor spacecraft located at a test site east of Flagstaff has been partially assembled into flat mosaics. A new projection for assembling the flat mosaics was developed during this work. Experiments are also underway for developing techniques for assembling spherical mosaics.