

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
BRANCH OF ASTROGEOLOGY  
P O Box 1906  
Flagstaff, Arizona

December 31, 1964

MEMORANDUM

TO : V. R. Wilmarth  
FROM : E. M. Shoemaker  
SUBJECT: Monthly Report for Director and Secretary

1. Highlights and Noteworthy Results

Astrogeologic Studies

Lunar and Planetary Investigations

Crater counts made from the Ranger photographs by E. H. Bailey and N. J. Trask agree in detail with counts made by W. Quaide of Ames Research Center. A complex sequence of cratering events and crater destruction is indicated.

Crater Investigations

Harold Masursky, working with Michael Carr and Henry Moore, has devised a hypothesis for the development of lunar crater central peaks. The hypothesis is based on high speed cinematography by Don Gault of Ames Research Center of hypervelocity cratering experiments in rock targets and on field studies of terrestrial craters by Dave Roddy - Flynn Creek, Tennessee, and Michael Dence and Willy Manton - Manicouagan Lake, Ontario. The movies show the development of this peak by violent decompressional uplift of a central column that emerges after the initial cone of ejecta emerges. Supporting evidence at the Flynn Creek crater indicates that the rocks of the central peak are derived from strata that are 900 feet lower than the crater floor.

## Unmanned Lunar Explorations

### Ranger Investigations

Two sets of prime original Ranger VII data were measured on a comparator in Menlo Park by J. D. Alderman and J. L. Derick to determine if the distortion characteristics present are the result of film processing or are due to television distortion of the reticles. The measurements indicate that both film distortion and telemetry distortions are present which will complicate their photogrammetric reduction.

### Surveyor Investigations

Experience gained during Field Test #2 has provided the basis for the generation of the command sequence for the television experiment for Mission A. The sequence of television surveys tentatively agreed upon is as follows:

1. Wide angle panoramic survey.
2. Narrow angle panoramic survey with optimum focus.
3. Narrow angle cartographic survey with fixed focus.
4. Narrow angle colorimetric survey of selected sectors.
5. Narrow angle focus ranging survey for distance determinations.
6. Additional surveys, depending upon the life of the spacecraft, will be carried out to optimize surveys for photometry, colorimetry, cartography and geology.

A satisfactory grid for mosaicing the wide angle photography has been developed. Experiments were made with polar and cylindrical projections and modifications and combinations of each. The grid that proved to be the most useful was a combination of a modified cylindrical projection arranged in polar form. Rapid mosaicing techniques have also been developed during the mosaicing of the field test imagery. These techniques will be used during mission operations.

2. Significant changes in projects:

H. G. Wilshire has started a new project to map and study the geology of the Zuni Salt Lake Maar in northwestern New Mexico.

4. Outside publications reported during the month:

P. R. Brett, Experimental data from the system Cu-Fe-S and their bearing on exsolution textures in ores: *Econ. Geol.*, v. 59, pp. 1241-1269.

P. R. Brett and G. Kullerud, The system Fe-Pb-S: Carnegie Institute, Washington Yearbook 63, pp. 202-204.

J. S. Watkins, Regional Geologic Implications of the Gravity and Magnetic Fields of a part of Eastern Tennessee and Southern Kentucky: Geological Survey Professional Paper 516-A.

6. Scientific meetings attended:

C. H. Roach and S. P. Lassiter were in conference on December 7 with personnel of the Shell Development Company, Houston, Texas, for the purpose of discussing technical difficulties in making exoelectron emission measurements from  $-196^{\circ}\text{C}$  to  $0^{\circ}\text{C}$ .

N. J. Trask conferred with W. Quaide of Ames Research Center to compare crater counts made from the Ranger photography.

R. H. Frost, President of Frost Engineering Development Corporation, conferred with C. H. Roach for the purpose of discussing methods of waterproofing electric strain gages installed in drill holes, and various other problems relating to the in situ measurement of dynamic stress in rocks.

D. J. Milton conferred with Professor C. V. Guidotti, University of California at Davis, on the geologic map of Maine.

Harold Masursky and R. J. Roberts discussed the current drilling program in the Cortez area, Nevada, with Hat Goudy of American Exploration Co. and Paul Filo of the San Francisco office of OME.

J. D. Alderman and J. L. Derick and R. E. Altenhofen (JPL) visited Bendix Systems Division in Detroit, Michigan, to discuss applicability of the AP-2 plotter to analysis of Ranger, Surveyor and Lunar Orbiter photography.

J. F. McCauley visited H. S. Johnson, Jr., State Geologist of South Carolina to discuss the origin of and to study from the air the "Carolina Bays", December 16, 1964.

7. Talks or papers presented at meetings:

- E. M. Shoemaker "Fine structure of the Moon's surface - a preliminary model", Philosophical Society of Washington, Washington D. C.
- Harold Masursky "Lunar geology", Le Conte Club, Menlo Park, California.
- H. H. Schmitt "Branch of Astrogeology and Manned Lunar Exploration", Prescott Rotary Club, Prescott, Arizona, December 11, 1964.
- " " "Branch of Astrogeology and Manned Lunar Exploration", Silver City Rotary Club, Silver City, New Mexico, December 29, 1964.
- J. F. McCauley "The stratigraphy of the Moon", Duke University, Society of the Sigma Xi, Durham, North Carolina, December 14, 1964.
- " " "The geological exploration of the Moon", University of North Carolina, Graduate Student-Staff Seminar, Chapel Hill, North Carolina, December 14, 1964.
- " " "The geological exploration of the Moon", University of South Carolina, Graduate Student-Staff Seminar, Columbia, South Carolina, December 15, 1964.
- " " "Lunar terrain analysis", Marshall Space Flight Center, Aero-Astrodynamic Laboratory Group, Huntsville, Alabama, December 17, 1964.
- L. C. Rowan "Preliminary analysis of Ranger VII photography", Sedona Gem and Mineral Club, Sedona, Arizona, December 8, 1964.

## 8. Visitors

### Visitor

Vance Kennedy, USGS  
Denver, Colorado

Carlos Ferreira  
Brazilian Geological Survey  
Rio de Janeiro, Brazil

C. W. Henderson, NASA,  
Washington; D. A. Beattie,  
NASA, Washington; R. J.  
Allenby, NASA, Washington;  
R. P. Bryson, NASA, Washington;  
Dale Ruth, Herman Gierow,  
Marshall Space Flight Center,  
Huntsville; J. E. Dornbach,  
J. M. Eggleston, L. N.  
McMillion, Manned Space Flight  
Center, Houston.

Max Bender, Bendix Systems,  
Ann Arbor, Michigan

Herbert Reich, Northrop  
Space Laboratories, Hawthorne,  
California

### Visited and Purpose

Frank Cuttitta to discuss application  
of semi-micro and micro x-ray  
fluorescence techniques to water  
analyses.

Frank Cuttitta to discuss micro-  
analytical techniques.

E. M. Shoemaker, D. P. Elston,  
J. F. McCauley, H. H. Schmitt,  
P. T. Barosh, H. A. Pohn,  
W. A. Roberts, R. H. Barnett,  
Y. Yamamoto, G. A. Swann,  
to discuss the Program Review.

D. P. Elston, H. H. Schmitt,  
Y. Yamamoto, L. C. Rowan,  
J. D. Alderman, R. M. Batson,  
J. H. Whitcomb, to discuss  
MLEI current and future operations.

H. H. Schmitt, D. P. Elston,  
L. C. Rowan, R. M. Batson,  
R. H. Barnett, W. A. Mason,  
H. E. Holt, conferred and showed films  
on their space simulation labora-  
tories and a lunar rover.

D. Rea, Brian O'Leary,  
Dept. of Astronomy,  
University of California

J. F. McCauley to discuss Mars  
Orbiter

T. H. Bird, J. J. Rennilson, of  
Jet Propulsion Laboratories,  
Pasadena, California; R. E.  
Altenhofen, USGS, Menlo  
Park, California

E. Morris

Mort Price, General Motors  
Defense Research Laboratories,  
Santa Barbara, California

P. J. Barosh, Test areas for the  
mobile geologic laboratory.

## General Information:

### Astrogeologic Studies

#### Crater Investigations

C. H. Roach, D. A. Baldwin, and J. G. McGrath are developing lined-cavity shaped charges to be used for in situ cratering experiments under impact conditions.

#### Cosmic Chemistry and Petrology

P. R. Brett examined a suspected iron meteorite from a drill hole from Elizabeth Lake, California, and found it to be artificial (probably drill rod).

P. R. Brett began, with J. J. Fahey, a search for diamond in graphite-rich portions of the Ries and Bosumtwi impactites.

On November 30, 1964, Isidore Adler, Frank Cuttitta, Francis Flanagan, Harry J. Rose, Jr., and Leonard Shapiro, members of the Geologic Division X-ray Spectroscopy Unit, were awarded a Presidential Citation in special recognition of an outstanding contribution to greater economy and improvement in Government operations during the tenth anniversary year of the Federal incentive awards program.

### Unmanned Lunar Explorations

#### Surveyor Investigations

A General Electrodynamics slow scan television system has been obtained for use on Field Test #3. The imagery obtained from GEC television system, when adapted to the proper optical components, will simulate closely the imagery that will be obtained from the Surveyor camera.

L. C. Rowan and A. H. Chidester started mapping Altai Scarp Quadrangle.

## Terrain Analysis

Photometric slope analysis of the western portion of the Mare Tranquillitatis has been initiated using the Lick-Herbig photograph ECD-36.

## Manned Lunar Exploration Studies

### Lunar Geophysical Methods Investigations

R. A. Loney has been engaged in the study of specimens and thin sections from the Mono Craters, California, area; R. H. Godson and the field crew are analyzing data obtained during the Mono Craters trip, reviewing data previously recorded in the Flagstaff area, and preparing field equipment for field work in the Mojave Desert and a future astronaut training trip at the Nevada Test Site.

J. H. Whitcomb and J. Cl. DeBremaecker have been studying methods of shear wave propagation and developing digital analytical procedures.

### Manned Lunar Explorations Investigations

Work conducted during December by the Manned Lunar Exploration Investigations primarily involved compilation and analysis of data for use in the preparation of the semi-annual written and film reports. The reports will cover studies and activities of the following projects: 1) Lunar Field Geological Methods, 2) Lunar Field Geophysical Methods, and 3) Lunar Field Surveying Methods.

Approximately three days' field work was conducted early in December for the development of lunar geological mapping methods and for the establishment of geologic control in the Castle Butte area of the Navajo Indian Reservation. The reduction of data on field geological operations obtained in the buttes area during October and November and data on geological surveying and field methods obtained in the Flagstaff area during July, August, and September were also carried out. A written report of these data and their significance to lunar exploration is being prepared for inclusion in the semi-annual

report which is scheduled for transmittal January 15. Film clips of standard field operations have been selected, and narrations prepared for a brief film documentary report that is to accompany the semi-annual report.

The analysis of time and motion data on geophysical field operations is being carried out for presentation in the semi-annual report. The analysis has been divided into seven categories, which include: 1) the times required for individual operations, 2) motions required for individual operations, 3) operator experience, 4) operator fatigue, 5) difficulty of terrain, 6) quality of data, and 7) usefulness of data. Data is available on gravity meter, magnetometer, and portable seismic operations. These operations have been documented on film, and selected film clips will be presented in a film report.

Surveying operations in December included the reduction of surveying control obtained at the Moses Rock Diatreme, Utah, and the reduction of time and motion data of standard surveying operations. The analysis and presentation of the time and motion data will accompany the forthcoming semi-annual report. A brief film report of standard surveying operations with narrative has been prepared. The mount for the theodolite and ranging laser for use in a four-wheel drive cross-country vehicle has been fabricated by the Branch instrument shop. The ranging laser, which has not yet been received, is reported to have been shipped from Fort Monmouth December 23. After check-out by electronics personnel of the Branch, the laser will be turned over to the surveying group. Operations to test methods of theodolite and ranging laser surveying from a mobile vehicle are scheduled for January.