

UNITED STATES
DEPARTMENT OF THE INTERIOR
BRANCH OF ASTROGEOLOGY
GEOLOGICAL SURVEY
Box 1905
Flagstaff, Arizona

August 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

H. J. Moore has pointed out a simple technique for plotting great circles on lunar charts. Such great circles can be constructed by using gnomonic projections (U. S. Navy Hydrographic Charts 1280, 660 A, and misc. 15579) of the earth. Any straight line drawn on a gnomonic projection represents a great circle. The plot of the great circle can be transferred from the gnomonic projection by recovering the latitudes and longitudes and transferring these to polyconic or Mercator projections. Cross sections accompanying 1:1,000,000 lunar geologic maps will be constructed along great circles.

M. H. Carr computed ejection angles and ejection velocities for ray material from the lunar crater Copernicus. The ejection angles were determined from ray "shadows" in Eratosthenes and in the Carpathian Mountains. The angles so determined were all approximately seven degrees for ejection velocities of 1.1 km/sec.

Spencer Titley, WAE, University of Arizona, has completed a preliminary version of the Pitatus quadrangle of the Moon. His telescopic studies were done mainly at the 60-inch McMath Solar Telescope, Kitt Peak National Observatory, Tucson, Arizona.

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R. E. Eggleton has completed dating of exposed craters, and has completed mapping of ray material, in the Montes Rhiphaeus quadrangle of the Moon. Eggleton has begun analysis of about 30 selected Ranger VII photos that cover part of the Rhiphaeus quadrangle, to solve 1:1,000,000 scale geologic mapping problems and provide detailed characterization of 1:1,000,000 scale geologic map units. Additional Ranger VII photos will be useful in this work when completion of photo processing makes them available.

H. H. Schmitt, Flagstaff office, has begun a recompilation of the geology of the Copernicus quadrangle of the Moon, on the newly issued revision of the base map on the Mercator projection, prepared by the Air Force Aeronautical Chart and Information Center. The first edition of this map, on an orthographic projection, by Shoemaker and Hackman, served as the prototype lunar geologic map and although submitted to NASA, was not issued to the public.

D. E. Wilhelms reports that the long awaited Lyot polarimeter has been received from France and will be installed on the 12-inch refracting telescope at Lick Observatory, Mount Hamilton, California.

Harold Masursky reports that comparison of recently mapped large impact structures in Canada and lunar craters indicates that lunar craters larger than 10 miles in diameter will undergo isostatic rebound of crater floors. The lunar crater Taruntius, 40 miles in diameter, closely resembles West Clearwater Lake, New Quebec, 20 miles in diameter; the lunar crater Gassendi, 80 miles in diameter, resembles the Manicouagan-Mouchalagane Lake structure, Quebec, 40 miles in diameter.

During isostatic readjustment the floor resprings, eliminating most of the topographic basin that results from the meteorite impact, the rim blanketed by thick ejecta deposits is depressed, the initially

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formed central peak is preserved (which indicates that the shallowness of the crater is not due to filling and gives an independent estimate of the rigidity of the lunar crust) and lastly, irregular rilles form on the unwarped crater floor.

This hypothesis eliminates the necessity of assuming major filling from external sources of very shallow large Ptolemaeus-type craters. Only enough fill is necessary to cover the central peak; the remainder of the crater is self-filled by the uplifted floor.

Cosmic Chemistry and Petrography

A suite of 10 Ivory Coast tektites have been selected for chemical analyses and other relevant studies from a collection obtained by E. C. T. Chao during his trip to Africa.

Analysis by neutron activation of two individual nickel-iron spherules found in a Philippine tektite (Ortigas Site near Manila, Luzon), several Wabar metallic spherules, and also spherules obtained from the Meteor Crater is in progress. This work is being undertaken in cooperation with Maynard Pro of the Alcohol Tax Unit (I.R.S.) and Capt. Mortimer Cohen of the Armed Forces Radiobiology Institute, Bethesda Naval Hospital.

Crater Investigations

A. H. Chidester reports that six lectures on lunar and terrestrial volcanology and impact geology will be given by visiting lecturers, under the supervision of the Geological Survey training group, and are scheduled for Houston to run concurrently with a lecture series in mineralogy and petrology to be given by the Manned Space Craft Center geologists.

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Both the Manned Space Craft Center and Survey geologists will participate in the field trips; selection and organization of the trips is primarily the responsibility of the Survey geologist. Six field areas have been selected for the second training series: Newberry Crater, Oregon; Valles Caldera, New Mexico; Nevada Test Site; Hawaiian volcanoes; Meteor Crater, Arizona; and Medicine Lake volcanic area, California.

H. J. Moore, Reuben Kachadoorian (Branch of Alaskan Studies), and H. G. Wilshire have completed a report on missile impact craters at the White Sand Missile Range, New Mexico.

Studies by D. J. Milton and Paul de Carli (Stanford Research Institute) suggest that both coesite and stishovite are formed during shock by way of a transient amorphous phase with six-fold coordination; the pressure and abundance of crystalline shock phases in the final product depends on the nature of decay of the pressure pulse. Formation of coesite requires a long pressure pulse such as occurs during a major cratering event and is not found in samples shocked by explosive-loading laboratory techniques.

D. J. Milton has found the stress pattern used by E. M. Shoemaker to explain the ray system around the lunar crater Copernicus requires modification for applicability to the rays that Milton and F. C. Michel mapped around one of the Henbury craters in Australia, suggesting that the overpressure decreased more rapidly with distance from point of impact at the Henbury crater. This relation is in line with the current tendency to use a higher scaling constant for cratering events than has been used previously.

C. H. Roach and G. R. Johnson, in cooperation with Donald Doran (Stanford Research Institute) have found that small specimens

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of Yule marble shocked to peak pressures of about 10 kilobars did not have their natural thermoluminescence noticeably modified. By exposing shocked and unshocked specimens to short wave ultraviolet radiations for two hours, the shocked specimens were found to have a significantly lower level of irradiation-induced thermoluminescence than did the equivalent unshocked specimens.

Space Flight Studies

The field testing of the Aeronautics Lunar Facsimile Capsule was commenced in the middle part of August. The initial test is being conducted concurrently with the HAC system on the Bonito Lava Flow test site and is under the auspices of Jet Propulsion Laboratory representative Roy Brereton, in cooperation with the Branch of Astrogeology.

Two fixed base camera positions are being used requiring three scans. Of prime concern is the vertical base separation of 0.5 meters that will give a good insight into the penetration capability into shadowed areas, indications being that a vertical base reduces occultation problems.

A portion of the field is controlled vertically and horizontally to allow the camera to be field calibrated and at the same time to assist in the determination of photogrammetric potential.

Spheres of known dimension are placed at selected points and specific tests will be made to analyze the possibility that targets of such a nature may be used to complement the rare analytical spatial recovery of the prospective centers.

The tests will be completed in early September and the results should be known approximately in early October.

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The In Situ project received a new seismic truck from GeoSpace, Inc., of Houston, Texas, on August 14. The unit includes a 24-channel amplifier, 28-channel FM tape recorder, oscillograph and associated equipment. The instrument is mounted on a 4-wheel drive Dodge truck capable of negotiating much of the rough volcanic terrain where the project investigations are being conducted. Addition of this instrument greatly enhances our capabilities, both in increased speed and field work and quality of recorded data.

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2. Significant Changes

The Aeroneutronics Division of Philco Corporation, under a fixed contract with Jet Propulsion Laboratory, has removed the Lunar Facsimile Capsule from Government funds in order to perform field tests that will determine the photogrammetric potential of the system in terms of resolution stereoscopic accuracy, calibration of system, guidance capability, both stereo and monoscopic, photometric properties and photo interpretation of field.

Inclement weather, the simultaneous running of two independent tests (HAC), minor equipment problems, and refurbishment of the facsimile system have resulted in a drastic revision of the initial scheduling which will result in data less desirable than those initially anticipated, but of sufficient quality and quantity to more than satisfy the requirements.

The Branch of Astrogeology, not having at its disposal state-of-the-art instrumentation that appears to have the capacity to handle the facsimile photography, has made arrangements with Wild and Ziess to make systematic tests on the various scans.

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3. New Projects

The lunar scientific photo laboratory, Flagstaff, Arizona, is organizing a file set of the Ranger VII photographs. A sample work set will be printed and available to interested personnel by mid-September.

Time and motion studies of geophysical survey operations have begun using a Worden Master gravimeter. Time and motion studies will be expanded to include seismic refraction surveys, magnetometer surveys, radiation surveys, and other geophysical techniques which might be of value during lunar exploration.

Howard Pohn and Kenneth Watson, Flagstaff Office, have begun a photometric analysis of the new Ranger VII lunar photography.

Don Ryan, WAE, Lehigh University, has begun study of the Langrenus quadrangle of the Moon at the Flagstaff Office.

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5. Personnel

Houston, Texas

Dale Jackson has left the astronaut training program to resume duties with Field Geochemistry and Petrology in Menlo Park, California.

A. H. Chidester has relocated from Houston to the Flagstaff, Arizona, Branch of Astrogeology where he will assume the duties of coordinator for the Survey program in geological training for the astronauts.

Flagstaff, Arizona

Congratulations and best wishes to Pete Krauss (computer programming) and Sandra Carraway, on their marriage, August 15, 1964.

The following personnel entered on duty in Flagstaff during the month of August:

Clark, Lanny L., Electronic Maintenance Technician (Computer), August 3, 1964.

Hassemer, Jerry H., Civil Engineering Technician, August 11, 1964.

Holt, Henry E., Geologist (General), August 13, 1964.

Lee, Thomas J. W., III, Photographer, August 14, 1964.

Mason, William A., Electronic Engineer, August 5, 1964.

Roberts, Wayne A., Geologist, August 14, 1964.

Smith, Lula M., Clerk Typist, August 18, 1964.

Snyder, Carl W., Electronic Development Technician (Inst.), August 1, 1964.

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6. Conferences and scientific meetings attended at home or abroad.

E. M. Shoemaker held a two-day coordinators' conference to review the fiscal 1965 program and personnel.

All Branch of Astrogeology Lunar Mappers attended a lunar stratigraphy conference in Flagstaff, Arizona, August 6-8th.

C. H. Roach attended a conference on application of solid state techniques for detection of shock events in rocks at the U. S. Naval Radiological Defense Laboratory in San Francisco on August 3-4.

Howard Pohn and Peter Krauss conferred with Don Willingham of Jet Propulsion Laboratory for the purpose of obtaining two sets of the Ranger VII negatives and the accompanying data.

Eugene Phillippi and Ray Barnett, in cooperation with Jet Propulsion Laboratory personnel, J. D. Alderman, H. H. Schmitt, R. Novatny, and J. S. Watkins, visited NASA, Washington, D. C., to discuss Apollo Molab Studies.

Eugene Phillippi and Ray Barnett conferred with Manned Spacecraft Center, Houston, personnel regarding Gemini and Apollo communications and television.

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8. Visitors

<u>Visitors</u>	<u>Visited and Purpose</u>
Harry Berberian Atomic Defense & Space Group Phoenix, Arizona	D. P. Elston to discuss electronic systems applicable to Molab studies.
Vernon B. Morris, Jr. James D. Frye J. J. Wild Systems Division Westinghouse Defense & Space Center Baltimore, Maryland	
Messrs. Stuhlinger, Downy, de Freese, Hale, Weber, & Keller George Marshall Space Flight Center Huntsville, Alabama	E. M. Shoemaker to discuss post-Apollo planning.
Kenneth MacLeish Carolyn Patterson Robert Magis Pierre Mion National Geographic Society Washington, D. C.	E. M. Shoemaker and R. E. Eggleton to discuss National Geographic's article on the Ranger VII photographs.
Phillip Oetking Graduate Research Institute of the Southwest Dallas, Texas	Howard Pohn to discuss recent lunar research.
Philip Nekitin Stanford Research Institute Menlo Park, California	D. J. Milton to discuss plans for locating the lost Port Orford, Oregon, meteorite.
A. P. Bennison Sinclair Oil Company Tulsa, Oklahoma	D. J. Milton to discuss recent lunar investigations.

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Visitors, continued

John Larimer
Lehigh University
Bethlehem, Pennsylvania

J. D. Ryan regarding experimental studies of mineral systems important in meteorites.

Dr. Stuhlinger and others
NASA
Huntsville, Alabama

R. E. Eggleton to discuss Ranger VII photos.

Mr. Beattie
NASA
Washington, D. C.

W. I. Manton
Bernard Price Institute
Johannesburg, So. Africa

R. E. Eggleton and Branch geologists regarding the Vredefort structure and was escorted on a tour of Meteor Crater, Arizona.

William LeCroix
Manned Space Flight
Center
Houston, Texas

J. S. Watkins to discuss the In Situ project.

Sheldon Breiner
Varian Associates
Palo Alto, California

J. S. Watkins to discuss the possible utilization of rubidium vapor and proton magnetometers in the In Situ and Apollo geophysical studies.

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General Information

A. H. Chidester spent eight days in early August in the field checking in the Rowe, Mass-Vt quadrangle.

Frank Cuttitta and E. C. T. Chao reviewed the manuscript "Some alkali and titania analyses of tektites before and after G-1 precision monitoring", by D. B. Tatlock, for submission to *Geochim. et Cosmochim. Acta*.

Frank Cuttitta reviewed "Electrical resistivity and viscosity of tektite glass", by P. Wirtz. This manuscript is being revised for publication in *Nature*, and will also be included in the *Astrogeologic Studies* annual progress report.

Apollo studies equipping and planning are requiring a major effort on the part of the Electronics group. Survey field tests in progress at the Bonito Lava Flow; Rover Imaging system in progress at the Bonito Lava Flow.