Title MSC's Plans for Lunar Exploration

1 6 Selenology

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Until there has been a successful landing of a vehicle on the lunar surface, advances in Selenology (the study of the Moon - its surface features, rock types, structure, thermal properties, luminescence and magnetic and gravity character) will depend upon indirect measurements. These are made either by the study of energy returned from the surface of the Moon in the form of electromagnetic waves, such as radio, radar, infrared, ultraviolet, and visible light waves or through the study of simulated laboratory models. The interpretation of these model studies as well as interpretations of reflected and emitted electromagnetic waves from the surface of the Moon as measured on Earth have quite often led to diametrically opposed views by scientists with equally valid backgrounds. The divergence of opinions will most probably be maintained until instruments and man have landed successfully on the lunar surface, to measure directly the physical properties of the Moon and return samples to the Earth.

General areas where agreement on the Moon has been reached are those dealing with the macro-features, its physical size, and orbital parameters. The Moon has 1/81.366 the mass of the Earth, a mean radius of 3476.0 kilometers and a density of 3.3402 gm/cm^3. Apogee of its orbit is 406,732 kilometers, perigee is 364,397 kilometers and mean distance from the Earth 384,402 $\pm$ 2 Km. Some of the more noticeable macro-

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features are the craters, rilles, mountains, Maria, and continental areas. Craters which are very numerous range in size up to 140 miles in diameter and to as much as 16,000 feet deep with walls up to 8,000 feet above the surrounding terrain. Mountain chains are present with some peaks as high as 30,000 feet above the general Mare surfaces. Many fractures and rills, some up to 200 miles long and several miles wide are apparent on the lunar surface. Forty per cent of the visible surface of the Moon is covered by large dark areas called Maria. These areas contain considerably fewer craters than the bulk of the Moon's surface and are therefore considered to be geologically younger than the remaining sixty per cent which is lighter colored and very densely cratered. These areas are called the continents.

The Space Environment Division of the Manned Spacecraft Center at Houston, Texas has been intensively working on plans for manned lunar experimentation and exploration. The purpose of the lunar surface mission will be twofold. First, to collect engineering data that will be useful on future missions to the Moon and second, to make those scientific measurements that will add the most useful data to man's knowledge of the Universe in which he lives.

In the Fall of 1962 the lunar - orbit - rendezvous method was chosen as the technique for manned lunar

landing missions. A three stage spacecraft and a crew of three will go to the vicinity of the Moon. Two of the three men land at a preselected site on the lunar surface, while the third will remain in orbit about the Moon. For the first four missions to the Moon, only one member of the crew will leave the Lunar Excursion Module (LEM) at any given time. On the first two of these missions, about four man-hours will be allowed on the lunar surface. After the fourth mission, stay times may be extended to one week and both astronauts may be allowed to leave the landing vehicle at one time. On these missions the weight of scientific equipment landed on the surface of the Moon will be about 215 pounds and scientific payload returned to Earth will be about 80 pounds.

After the scientific and engineering work has been performed, the two astronauts and the payload in the LEM will launch from the Moon in such a manner that it may rendezvous with the Apollo Command-Service Module orbiting about the Moon. After rendezvous, the astronauts will transfer the payload to the Command Module and all will return to the Earth.

In order to plan for detailed exploration and topographic mapping of the lunar surface while still assisting in defining the lunar surface environment for landing missions, the Manned Spacecraft Center in the Spring of 1963 sent a request for proposals to

industry and research foundations for a study to determine the most effective methods of conducting manned lunar reconnaissance. A study of probes to determine surface composition will also be investigated as part of this mission. The reconnaissance mission is to take place using either a modification of the LEM or with a module designed specifically for reconnaissance to replace the Lunar Excursion Module. Cameras will be carried that will be capable of photographing selected small areas of special interest with high resolution (on the order of 1 foot resolution). Areas photographed by this camera will be those appearing to be most suitable for landing sites or those which may possess special scientific interest. Other cameras will be carried that will be capable of obtaining photographs of smaller scale suitable for making topographic and photo-geologic maps.

As payload permits, other types of remote sensing equipment will be carried. These may include radar to study the depth of dust and roughness of the surface, infrared and ultraviolet spectrometers for possible compositional determination and empirical delineation of geologic formations, and others. Probes released from orbit will be retrofired, so as to land as near as possible to acceptable landing sites. The probes will measure bearing strength, dust thickness and surface roughness thus verifying the suitability of the

area selected as a recommended landing site.

In the summer of 1963, the MSC instituted studies for a comprehensive analysis of the experiments, measurements and geologic studies that should be made on the lunar surface. The results of this study will be used to assist in determining what equipment must be designed for use by the astronauts on the lunar surface, what experiments should be made, and in what sequence they should be performed on the various missions.

In the 215 pounds of scientific equipment that will be landed on the Moon there will be instruments that will be set up in an optimum location, calibrated by the astronaut, and then left to transmit to Earth, geophysical information on the properties of the Moon's interior, the characteristics of the lunar surface, the flux of micrometeorites and ejecta, the intensity of various electromagnetic radiations in the vicinity of the Moon, and other information.

Other equipment carried to the Moon will be that required to map and photograph the geological formations, collect geological samples, perform chemical and mineralogical analyses, and precisely locate selenodetic control points.

The 80 pounds of scientific payload returned to Earth will consist largely of film, notes, geologic samples, and sample containers.

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Detailed planning at MSC for manned lunar exploration is presently confined to programmed Apollo missions. Interim exploration plans for longer stay lunar missions and permanent bases are now in the exploratory and investigation stage.