

Geology

The recommended exploration program for follow-on missions should provide the data for a detailed analysis of the geologic history of the moon and the major processes that have acted upon the surface and interior.

In the early Apollo missions, the major objective should be studies of the fine structure of the moon as revealed by study of the surface, mainly in the maria or plains areas, which appear to be surfaces formed by deposition and modified by post-depositional processes of several kinds. These areas include not only the marias, or lunar "seas," but also the plain-like features of certain upland regions.

In the limited time available for geological investigation on these missions, the primary question should be the nature and origin of the material underlying these plains. Specifically, the question is whether they are composed of lava flows and range from solid rock to rock froth; or whether they are ash or granular material pulverized by explosions of various types.

Another important question will be the nature and rate of the extremely slow processes that have operated on the moon's surface.

To obtain early answers to these questions, the explorers should gather lunar samples with the use of simple hand tools and should undertake lunar traverses. Immediately after the first Apollo landings, a systematic program of geologic mapping should be carried out with the use of data from manned missions in lunar orbit, preferably over the moon's poles for complete coverage.

The orbiting spacecraft should be capable of carrying and distributing lunar surface probes that would make measurements for calibrating remote sensors, characterize the fine geological features of the local area, and emplace scientific instruments.

In the lunar surface missions of the first 5 years following the initial Apollo landings, the geological objective should be to test detailed theories of the nature of the three major types of lunar terrain—the maria or lunar "seas," the cratered highlands, and a presumed thermally active crater such as Alphonsus.

In the latter half of the decade, the objective should be to obtain a broad regional integrated picture of the surface geology and crustal structure of the moon, by means of a series of traverses along the equatorial belt.

Geochemistry

The return to earth of lunar samples for analysis, the most important scientific objective of Apollo, has particular application to geochemistry. Seven objectives of geochemistry investigations on the returned samples have been recommended. These are (1) to compare the composition of the earth and the moon in terms of bulk chemistry and the ratios of certain elements and isotopes; (2) to compare the time scale of events in the moon's history with that of the earth's history; (3) to determine the evolution of the moon by establishing the relative ages of major events in its history; (4) to establish whether there is evidence of chemical differentiation on the moon or whether it has remained essentially unchanged since it was originally formed; (5) to establish the gross composition of the lunar surface as a whole; (6) to establish the relative roles played by internal and external processes in shaping the present surface topography; and (7) to determine whether the moon should be surveyed more exhaustively for resources, such as water, oxygen and energy sources, which would simplify lunar phase supplying and enable it to be used as a staging area for planetary exploration.

Analysis of lunar samples returned to earth should include determination of the abundance of elements, evidence of gas formation, separation of metallic phases, isotope investigations and other tests where suitable.

As it becomes possible for the explorer to spend longer times on the moon, field selection of samples will be necessary and some tests should be done on the moon, particularly of materials that may be altered by return to earth. Analytical devices should be carried to extend the power of the observer on the lunar surface to differentiate materials that are virtually similar and make an optimum selection of samples to be returned to earth for detailed examination.

Geophysics

The lunar surface experiment packages to be carried on the early Apollo missions represent a major opportunity for performing geophysical research. The packages should include the following instruments: magnetometer, heat flow probe, passive seismometer, active seismometer, lunar atmosphere detector, micrometeorite detectors and, if weight permits, a gravimeter.