

Choosing the last two lunar landing sites

With Descartes favored for Apollo 16, scientists have to decide options for 17

Only three manned lunar landings are left in the Apollo program. Apollo 15 is scheduled to land at the Hadley/Apenine site July 30. Because of time and budget constraints, planning for Apollo 16 mission in March of 1972 is already under way. Scientific instruments are going through the lengthy production and qualification tests, and the Apollo 16 crew was chosen in March. The final selection of the landing site remains.

Last week officials of the National Aeronautics and Space Administration met again with geologists and other scientists to reevaluate the sites chosen to date and the candidate sites for the last two landings. In contention are the Davy crater chain, Marius Hills (or an alternate, Littrow), Descartes crater area, Tycho crater rim and a dark horse candidate, the Alphonsus crater. In the air is spicy scientific debate over the relative merits of each. Where the men land, and the variety and types of samples they return to earth, may well determine whether scientists, in this decade or even the next, will be able to unravel the complicated history of the moon and its relationship to the earth and the rest of the solar system.

The biggest controversy is between cosmologists and planetologists. The cosmologists are not particularly interested in the growth of the moon itself; they want to go to sites that have the oldest lunar material in order to fit the moon into the evolution of the solar system. The planetologists, in contrast, would like sites having a variety of samples of several stages of the moon's development.

A working chronology of the moon's formation and evolution has been established. The chronology begins at a date unknown, but thought to be between 4.5 billion or 5 billion years ago.

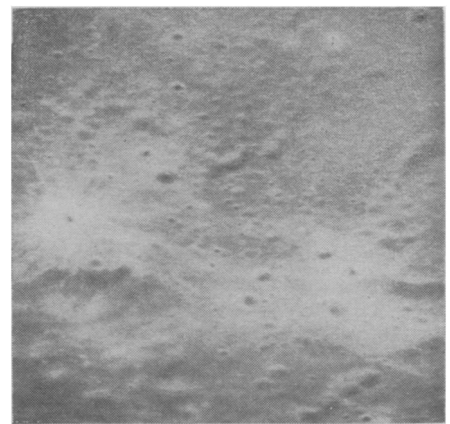


Landing sites and candidates: Vital key to uncovering the moon's history.

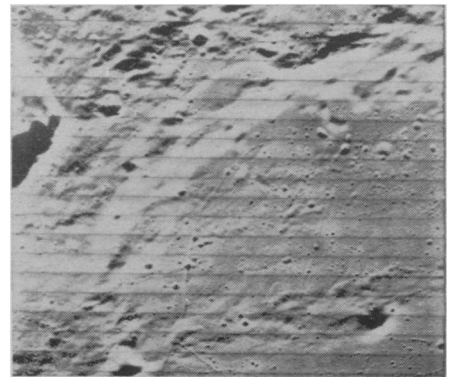
The origin of the moon is also unknown, although the front-running theory is that the moon was "built" by rapid accretion (other theories include capture and fission). During this early history, called Pre-Imbrian, the unsculptured primitive moon was largely mountainous, cratered, with virtually no lowlands. How these mountains were formed, by cold accretion or by melting and upwelling from below, is also an unknown. The next major event was the formation of the large circular basins on the near side of the moon. This period ends with the formation of the largest and perhaps youngest basin, Mare Imbrium. The duration of the basin-forming time is unknown, but through crater counting and stratigraphic analyses scientists believe the oldest mare is Serenitatis, followed by Nectaris, then Humorum, then Crisium and finally Imbrium.

After the Imbrian event, geologists believe there was a period of highland filling. Then came the lava flooding of the circular basins and flooding of areas of low topography, also called maria. Scientists do have a handle on part of this period. The Sea of Tranquility was flooded about 3.7 billion years ago; the Ocean of Storms, about 3.4 billion years ago; the western part of the Ocean of Storms, later yet. The youngest mare events are associated with two sites—Littrow and Marius Hills. Three cratering periods characterize the most recent history of the moon: Eratosthenian, Copernican and Post-Copernican.

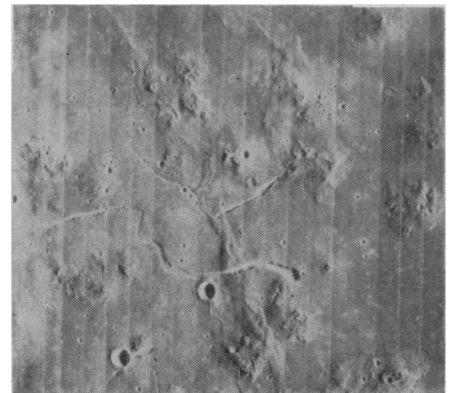
To date, scientists have studied material from three maria: Mare Tranquillitatis, Oceanus Procellarum and Mare Fecunditatis. The Apollo 14 Fra Mauro samples were the first from one of 10 types of highland areas. Although only examined briefly by NASA scientists before distribution to the world scien-



Descartes: Probable Apollo 16 site.



Alphonsus: A possible compromise.



Marius Hills: In close contention.

tific community for thorough analyses, the material appears to be what was expected: ejecta blanket from Mare Imbrium.

From the upcoming Hadley/Apen- nine site, scientists hope to get samples of a rille, of basin fill, of volcanic features and of secondary craters. Most important, however, would be samples of the Apennine Mountain front itself, which could date the event that formed the Imbrium basin and created the mountains. The cream would be Pre-Imbrian samples, exposed by a fault that formed the Apennine Mountain escarpment.

If the Fra Mauro and Apennine sites do not yield the oldest lunar material, another gap will be left. And scientists would like to land at the sites of very young events both in the maria and the highlands, as well as in areas that look volcanic.

Marius Hills and Littrow could fill out the picture of the maria, since they are both young sites (after maria flooding). Marius Hills, northwest of the crater, has a series of domes and cones. It is in Oceanus Procellarum. The domes and cones are on a plateau atop a major ridge system that runs for about 1,200 miles. Some features of the site appear volcanic.

Littrow, on the southeast edge of the Serenitatis basin, is covered with some of the darkest and perhaps youngest material on the moon. In addition it has young-looking ridges of wrinkled or ropy features.

Tycho crater is alluring (SN: 9/19/ 70, p. 247) because it is probably the youngest major impact crater on the moon and is in the oldest area.

The sites in or near the central highlands could possibly yield very old material, plus other information. The Davy crater chain is northwest of the crater Alphonsus on the western side of the central highlands. This puzzling chain of 30 small craters extends about 40 miles (some believe the chain is of volcanic origin). Nearly half the craters are on the floor of Davy Y itself. Some think these chain craters resemble dia- tremes on earth—vents from deep- seated material.

The Descartes site is also in the cen- tral highlands near the apex of the largest topographic feature on the moon. The site could contain several events of Imbrian origin, but pools of highland filling are also an attraction. The landing site, between two bright halo craters, would afford samples of these upwelling pools. It would also perhaps allow samples of Imbrian structure, of mare material and of hilly, grooved and furrowed material.

Alphonsus, the dark horse site, is on the west side of the highlands bordering on Mare Nubium and south of

Davy chain. A ridge dissects the crater bottom. On the ridge is a mound, or small mountain. On the "floor" of the crater are dark halo craters and rilles. On the ledges of the rim of the crater can be seen dark areas that could be lava pools. Cutting across part of the crater rim is material from Mare Im- brium.

LAKE RUDOLF FOSSILS

Two distinct hominids?



National Geographic Society

Richard Leakey: Sorting out the past.

A decade ago anthropologist Louis S. B. Leakey and his wife Mary dis- covered at Olduvai Gorge in Tanzania the skull of what was believed to be the world's earliest antecedent to true man. This ape-like creature, *Australo- pithecus*, lived in Africa almost 2 mil- lion years ago. The find by the Leakeys was a monumental step in the search for man's past.

Following in the footsteps of his famed parents, Richard E. F. Leakey is making equally important contribu- tions to the history of early man. In 1969 he discovered on the eastern shore of Lake Rudolf in Kenya an *Australopithecus* skull believed to be 850,000 years older than the one found by his parents. This and his subsequent finds in 1970 have pushed the history of early man back to at least 4 million years. Another find in the Lake Rudolf area, reported earlier this year, has extended the date for *Australopithecus* back to 5.5 million years (SN: 2/27/ 71, p. 141).

In the May 28 NATURE Richard Leakey describes 16 hominid specimens (skulls and limbs) and "the view that two distinct hominids—*Australopithe- cus* and *Homo*—lived contemporane- ously in the Lower Pleistocene" in the Lake Rudolf area of East Africa.

Previously, researchers have con- cluded that there were two forms of *Australopithecus*, robust and gracile,

A NASA announcement of the Apollo 16 site is expected within the next few weeks. More than likely the decision will go to Descartes. Then if Hadley/ Apennine does not yield the oldest ma- terial, Alphonsus could be the com- promise Apollo 17 site. Some bets, however, are being placed on Marius Hills. □

and that the gracile form was ancestor- al to *Homo* in the Lower Pleistocene. Richard Leakey, basing his conclusions on East Rudolf specimens, feels that this concept "requires careful reexamina- tion." Three specimens of *Homo* were taken from levels that also yielded both sizes of *Australopithecus*—indicating, he says, that they existed at the same time. Leakey further points out that the two types or sizes of *Australopithe- cus* may actually be different sexes of the same species. This sexual dimor- phism is especially obvious in large primates such as gorillas, chimps and baboons.

If the two sizes of australopithecine are actually the same species, and if they did live at the same time as *Homo*, there is little probability that *Austra- lopithecus* was ancestor to *Homo*. This theory, however, has not been widely accepted. Other workers in the field point out that some sites have yielded only one type or size. They feel it is unlikely that only one sex would be preserved at these sites.

These theories are based on cranial material—the relative sizes of the skulls and teeth. Leakey, however, also has postcranial material to show that *Homo* and *Australopithecus* are two "quite separate and distinct early Pleistocene hominids." Detailed study of the bone fragments, with particular emphasis on functional aspects, should help answer some of the taxonomic questions. So far, the specimens do seem to repre- sent two distinct forms. Those attrib- uted to *Homo* indicate an upright bipedal hominid. The rest, presumably *Australopithecus*, suggest a form of lo- comotion that was not entirely upright or bipedal. "The Rudolf australopithe- cines," explains Leakey, "may have been close to the 'knuckle-walkers' con- dition, not unlike the extant African apes."

As research continues on the Rudolf finds (two other studies on the East Rudolf Basin appear in the same issue of NATURE) Leakey's hypotheses may or may not be proved. But his work and his finds, like those of his parents, are important and will eventually lead to a fuller knowledge of man's early history. □