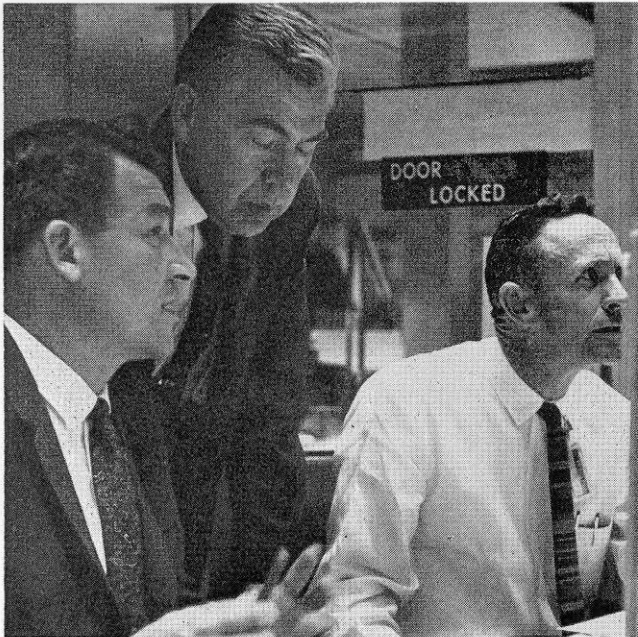
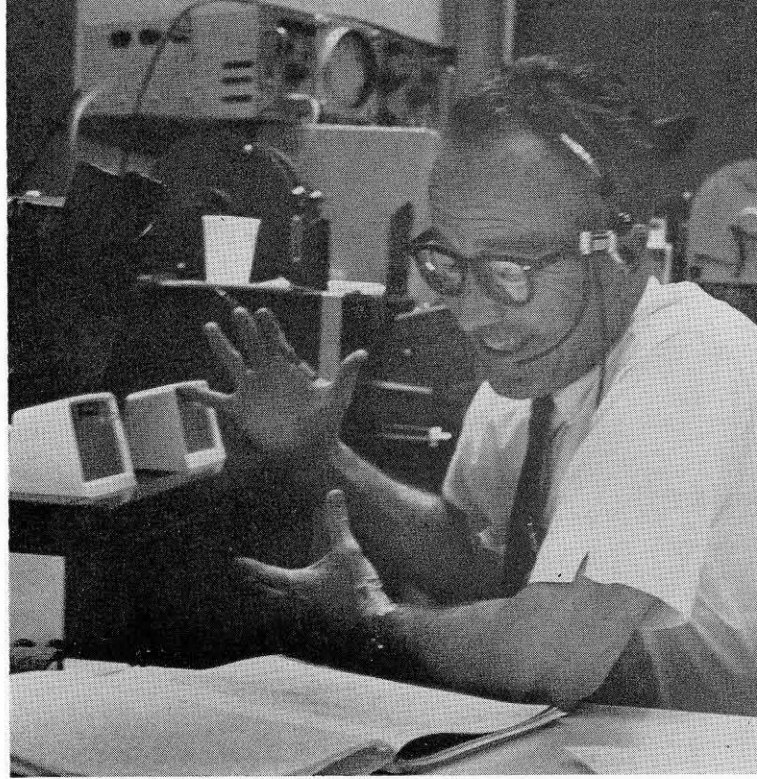
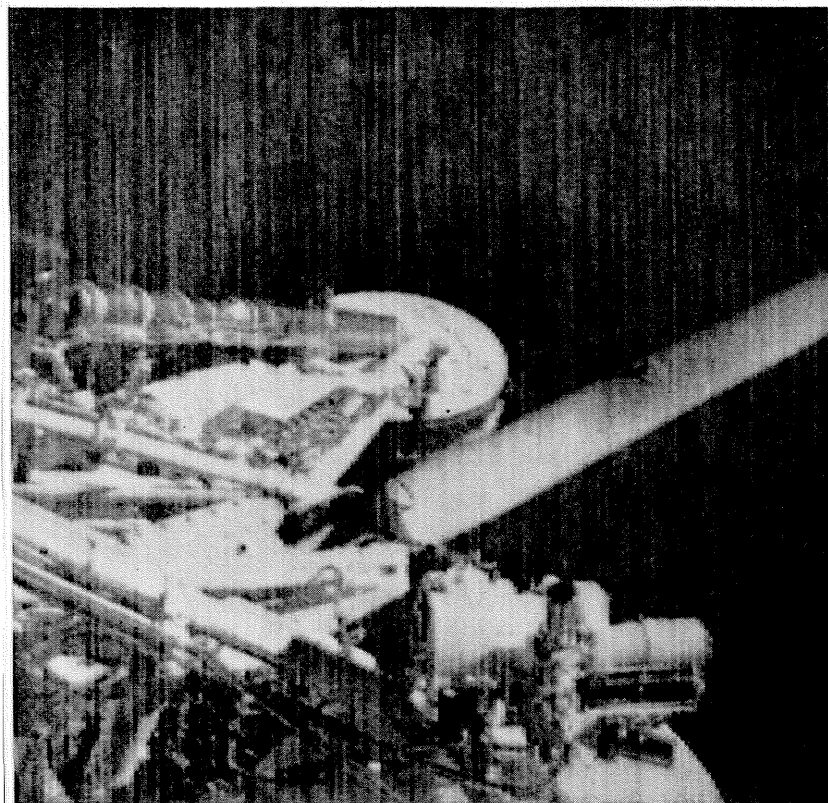


SURVEYOR TO THE MOON

On June 1, 1966, a 596-pound package of space hardware gently bumped down on the surface of the moon and proceeded to send 10,338 excellent pictures of the lunar landscape back to Caltech's Jet Propulsion Laboratory. The flawless performance of Surveyor I came as a surprise to the people who had worked so long on the project. They had frankly expected to have several unsuccessful—or only partly successful—flights before the system worked perfectly. As a result of the model mission of the spacecraft, JPL and NASA officials now say that the Surveyor program is about one year ahead of where it was expected to be at this time.

A long, tense wait at Caltech's Jet Propulsion Laboratory—then jubilation as Surveyor I makes a perfect soft landing on the moon.





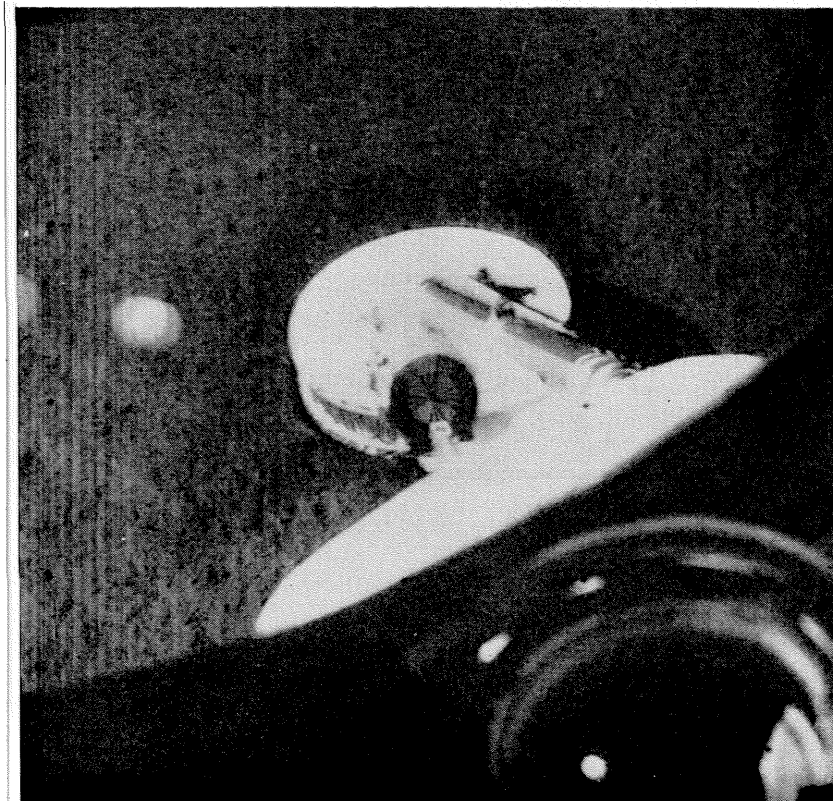
Touchdown! Surveyor's first picture from the moon, received at 11:52 p.m. PDT June 1, was immediately flashed on home television screens. It shows one of the spacecraft's landing legs, its foot pad, an antenna boom, and the top of a helium container.

Surveyor is the most complex unmanned space program yet attempted by the United States. Its bull's-eye soft landing on the moon (the first ever) has given a big boost to the Apollo program, which will use essentially the same technique to land men on the moon. Even more important, the photographs that Surveyor has sent back show that the ground in the region of the landing site, at least, is strong enough to support the weight of an Apollo landing craft—and that of a man walking on the surface as well.

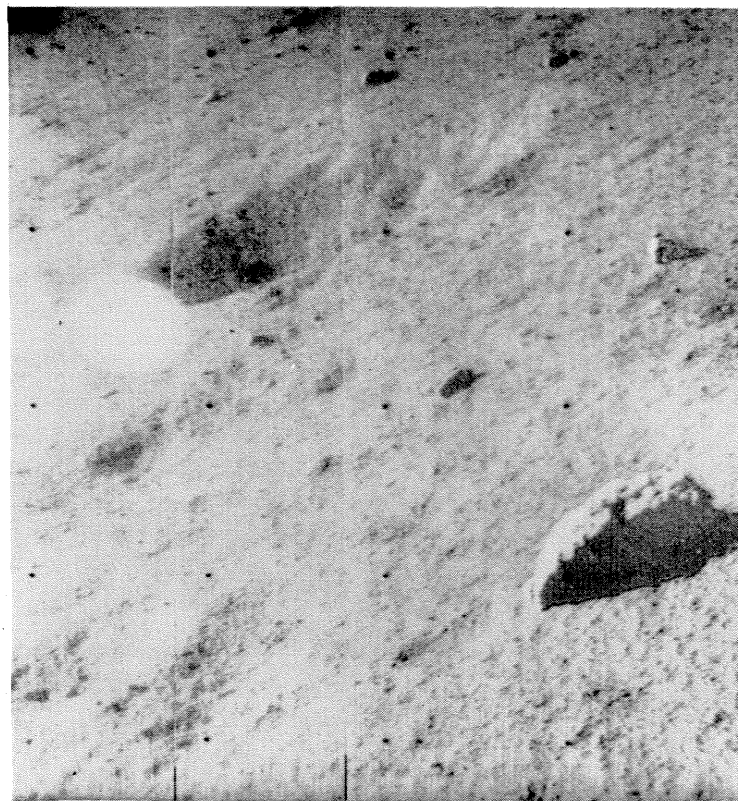
JPL and NASA scientists are now working with other moon experts to evaluate the data received from Surveyor. Since there are more than 10,000 pictures, the job will take some time, but even after a first brief look at the pictures, the scientists have been able to draw some tentative conclusions about the lunar environment.

Preliminary results

The lunar surface around the landing site is a debris-strewn field, with particles ranging in size from 1/50 of an inch to large clods of "soil" and hard boulders many feet across. Some of these larger particles may have been ejected when craters were formed long ago and far



A landing foot resting on the surface shows that the landing site—on the floor of the crater Flamsteed in the Ocean of Storms—is strong enough to support the weight of an Apollo landing craft.



This view shows a large rock, several smaller rocks, and a crater about a yard deep in the surface layer. The grid of black dots is part of the television tube; the bright spots are reflections of the sun.

away from the landing site, perhaps even on the other side of the moon.

According to one scientist, the scene on earth most resembling Surveyor's landing site is the area around the Sudan nuclear crater in Yucca Flats, Nevada, which is believed to closely resemble a typical impact crater on the moon.

Although the actual ground surface is quite flat at the landing site, the numerous large boulders nearby are large enough to have spoiled the soft-landing if the spacecraft had come down a few hundreds yards away.

Pictures from the Soviet Union's Luna 9 (*Engineering and Science*, February 1966) gave the impression that the smaller objects on the surface were all rocks, but Surveyor indicates that at least some of them are lumps of soil.

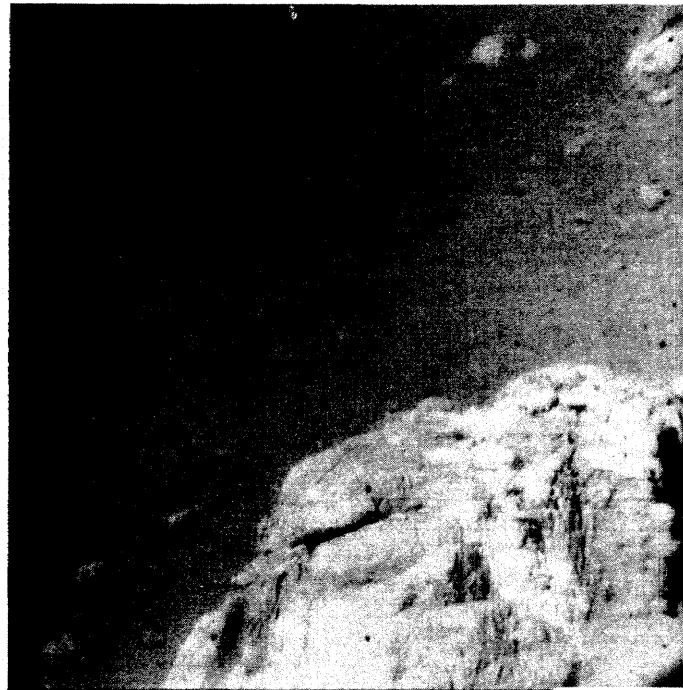
The actual surface on which Surveyor landed is definitely smoother than that on which Luna 9 came down.

In a post-landing experiment, the attitude control thrusters near the base of the spacecraft's legs were fired at the ground while the camera was trained on the ground underneath. Apparently the jets of nitrogen gas (less than one-pound thrust) produced no movement of material on the ground.

Surveyor's feet sank only a little way into the material on the moon's surface, indicating that if there is a dust layer, it is either relatively hard or fairly shallow.

Had there been a lot of loose dust on the lunar surface, it would have adhered to the surfaces of the spacecraft. The normally shiny, heat-reflecting surfaces would then have begun to heat abnormally in the sunlight. Temperature sensors on the spacecraft have not detected any abnormal temperature rise, indicating that the surfaces are still clean.

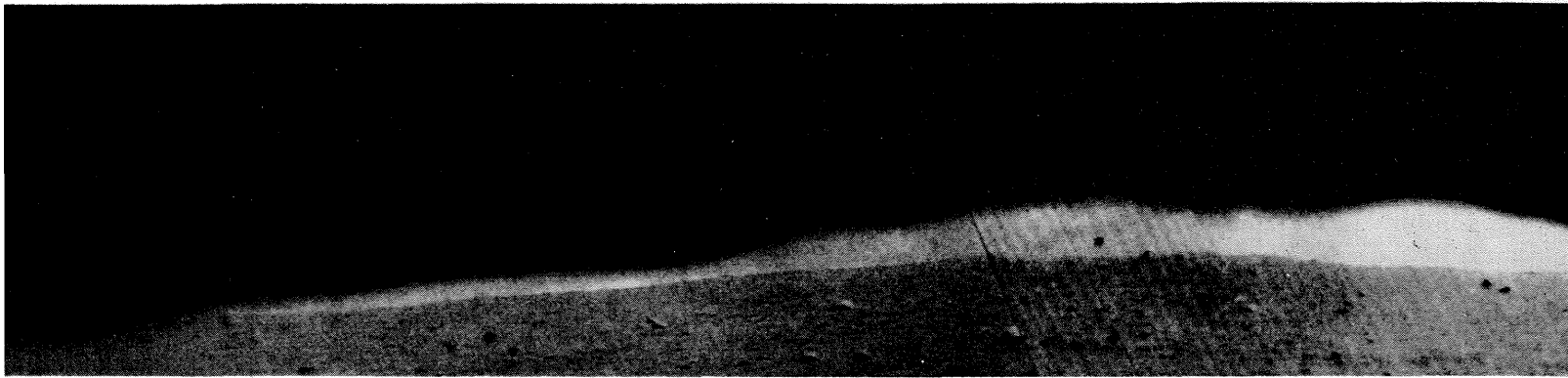
Although the gas jet produced no apparent movement, the surface material is nevertheless probably not as cohesive as had been expected by some people, because "rays" of soil were thrown out by the relatively gentle impact of Surveyor's feet. These rays are similar to the long rays that can be seen stretching out from



The surface of this rock (about 18 inches long) is eroded or abraded, probably by bombardment of fine particles. The rock also shows evidence, in its slaty cleavage, of having undergone plastic flow of the type produced by conditions of strong shock.

large craters on the moon, except that they are darker than the surface material on which they lie; this is just the opposite of the older rays, which are lighter. The significance of this difference in color is not known.

One rock on the lunar surface is speckled with dark spots, which are actually cavities. These indicate that it was once molten; the holes are the remnants of bubbles. Either lunar vulcanism or shock melting (from impact) could have produced the features.



Only the top of a small, ghostly mountain range about 12 miles from the spacecraft shows above the lunar horizon, which is probably less than a mile away. The

portion that can be seen is a little less than 8 miles long and rises 500 feet above the near horizon. It is part of the nearly buried crater in which Surveyor landed.

As the two-week lunar day ended on June 14, Surveyor took pictures of its own lengthened shadow, the corona of the sun, and of one of the spacecraft's landing feet illuminated by sunlight reflected from the earth. Finally, before it was shut down for the duration of the two-week night, Surveyor was commanded to move its solar panel and high-gain antenna to a horizontal position. If the batteries have frozen and the spacecraft cannot be reactivated

when sunlight again appears, the panel and antenna will be in position to cast a long shadow. This summer another U.S. spacecraft, the Lunar Orbiter, is scheduled to make a photographic survey as it flies around the moon. When it passes over the crater Flamsteed, it may be able to spot Surveyor by its shadow, permitting a valuable correlation of the findings of the two explorers that are paving the way for man's eventual landing on the moon.

The boulders strewn over this field probably came from the crater whose outer rim can be seen along the horizon. Those boulders in the upper left may be one or two

yards across. Had the spacecraft hit one of them during landing, it could have tipped or even broken apart. The distance to the horizon is several hundred yards.

