

GEOLOGIC SETTING (from LPSET, 1969)

Apollo 11 landed approximately 20 kilometers south-southwest of the crater Sabine D in the southwestern part of Mare Tranquillitatis. The landing site is 41.5 kilometers north-northeast of the eastern promontory of the Kant Plateau, the nearest highland region. Apollo 11 landed approximately 25 kilometers south-southeast of the Surveyor V Spacecraft landing site and 68 kilometers southwest of the crater formed by the Ranger VIII impact.

The southern part of Mare Tranquillitatis is crossed by relatively faint north-northwest trending rays, and prominent secondary craters associated with the crater Theophilus, 420 kilometers southeast of the landing site. About 15 kilometers west of the landing site is a fairly prominent north-northeast trending ray. The crater with which this ray is associated is not definitely known, but it may be Alfraganus, 160 kilometers to the southwest, or Tycho, about 1500 kilometers to the southwest. Neither the north-northeast nor any of the north-northwest trending rays cross the landing site. They are sufficiently close, however, that it is possible that some material from Theophilus, Alfraganus, or Tycho occurs in the vicinity of the lunar module. Other distant craters, especially the crater Moltke which lies 40 kilometers to the southeast, may also be the source of fragments lying near the lunar module. Some potential distant sources of fragments are in the highlands and some in the maria.

A hill of terra material protrudes above the mare surface 52 kilometers east-southeast of the landing site. This suggests that the mare material is very thin in this region, perhaps no more than a few hundred meters thick. Craters more than a kilometer across, such as Sabine D and Sabine E, may have been excavated partly in pre-mare rocks. Pre-mare rock fragments ejected from these craters may occur in the vicinity of the lunar module. The major topographic features in the landing area are large craters a few hundred meters across, four of which are broad subdued features and the fifth is West Crater, located 400 meters east of the landing point. West Crater is a sharp-rimmed, rayed crater about 180 meters in diameter and 30 meters deep with a blocky-ejecta apron extending almost symmetrically outward to a distance of about 250 meters. Rays of blocky ejecta extend further west, probably past the landing site. Near the lunar module, the surface is pock-marked by numerous small craters and strewn with fragmental debris, part of which may have been derived from West Crater. A boulder field north of the lunar module (described by the crew and shown in photographs taken by the crew) is probably part of a blocky ray.

All of the craters in the immediate vicinity of the lunar module have rims and floors of relatively fine-grained material and appear to be excavated entirely in the regolith. A pile of blocks and coarse rubble forms a peak on the floor of the 33-meter crater east of the lunar module but the walls and rim of this crater have the same texture as the regolith elsewhere. West Crater is about 30 meters deep and has a coarse blocky rim.

Among the smaller craters, both sharp raised-rim craters and relatively subdued craters are common. They range in size from a few centimeters to 20 meters. A slightly subdued, raised-rim crater (Armstrong's 70- to 80- foot crater) 33 meters in diameter and

4 meters deep occurs about 60 meters east of the lunar module, and a double crater (Armstrong's doublet), about 12 meters long and 6 meters wide, lies 10 meters southwest of the lunar module and 260° azimuth.

The walls and floors of most of the craters are smooth and uninterrupted by either outcrops or conspicuous stratification. There are rocks present in the 33-meter crater that are larger than any of those seen on the surface in the vicinity of the lunar module. With this exception, there is no apparent correlation between the location of blocks and the smaller craters near the lunar module.

The surface of the mare near the landing site is unusually rough. Television pictures show a greater abundance of coarse fragmental debris than at any of the four Surveyor landing sites on the maria except that of Surveyor I. It is likely that the observed fragments and the samples returned to earth have been derived from varying depths beneath the original mare surface and have had widely different histories of exposure on the lunar surface.

The lunar module footpads penetrated a maximum of 7 to 8 centimeters. The astronaut's boots left prints generally from 3 millimeters to 2 to 3 centimeters deep. As the astronauts walked, they noted that their boot tread was preserved in their footprints, and that angles of 70 degrees were maintained in the print walls. The surface, where disturbed by walking, tended to break into slabs, cracking out as far as 12 to 15 centimeters from the edge of footprints.

The regolith is weak and relatively easily trenched to depths of several centimeters. Surface material was easily dislodged by kicking. Before the lunar module landed, at an altitude somewhat less than 30 meters, dust was observed moving away from the center of the descent-propulsion-system blast.

When the flagpole and drive tubes were pressed into the surface, they penetrated with ease to 10 to 12 centimeters. However, at that depth the regolith was not strong enough to hold the core tubes upright. A hammer was needed to drive them to depths of 15 to 20 centimeters.* At places, rocks were encountered by the scoop and by the various tubes and rods pressed into the subsurface.

Coarse fragments in the vicinity of the lunar module exhibited a wide variety of shapes and were embedded in varying degrees in the fine mat of the regolith (Armstrong, comment). Armstrong took time during the television panorama to point out several rocks west of the television camera, one of which was tabular and standing on edge, protruding 30 centimeters above the surface. During the post mission debriefing, Armstrong described another rock as resembling a distributor cap. When dislodged, the cap was found to be the exposed top of a much larger rock, the buried part of which was much larger and more angular in form. Strewn fields of angular blocks, many more than one-half meter long occur north and west of the lunar module. In general, the rocks collected tended to be rounded on top and flat or angular on the bottom.

**It was subsequently determined that the design of the core bit led to the jamming of material in the core. The bits were subsequently redesigned for greater penetration..*

The strength of rock fragments ranged from friable to hard, and was difficult for the crew in some cases to distinguish aggregates or clods of fine debris from rocks. Armstrong suggested that West Crater was the source for these boulder fields and may be the source for any of the rocks in the immediate vicinity of the lunar module.