GEOLOGY OF THE APENNINE FRONT--APOLLO 15 LANDING SITE

The Apennine front, bordering the Imbrium Basin on the southwest, largely comprises two major mountains at the Apollo 15 site--Mount Hadley and Hadley Delta. These two mountains rise steeply 3-5 km above the mare surface. According to pre-mission interpretations (Ref. 1), the front massifs are considered to consist of impact breccias from the Serenitatis basin that overlie a complex of impact breccias from still older basins and craters. Faulting related to the Imbrium impact occurred along lines both radial and concentric to the Imbrium Basin and produced the present-day arc of block faulted mountains.

Surface material on the front at stations 2, 6, 6a, and 7 consists of relatively fine-grained cratered regolith that probably contains debris derived from deeper layers and from the nearby mare, as well as some exotic material from distant meteorite impacts. It may include not only pre-Imbrian massif material, but also Imbrium ejecta, either deposited directly in the sampled areas by the Imbrium impact or subsequently transported downslope by mass wasting.

About 80 percent of the fragments collected are breccias. The remainder are crystalline rocks including some of the distinctive mare type basalts, and glass fragments. The breccias contain variable amounts of feldspathic and basaltic clasts and mineral grains, and glass fragments. The indurated breccias, unlike the Apollo 14 breccias, are notable for the scarcity of clasts of older breccias. They may represent materials from relatively deep levels, either ejected derived from some large craters and basins that excavated bedrock prior to the Imbrium impact or bedrock brecciated and uplifted by the Imbrium event itself.

Well developed systems of lineaments, suggestive of fractures and/or compositional layers were observed by the crew and recorded by surface and orbital photographs of Mount Hadley and Hadley Delta. Previous orbital and surface photographs have also shown sets of lineaments with preferred orientations--predominantly northwest, north, and northeast. This so-called lunar grid has been observed under very restricted lighting conditions, generally low sun with illumination from either the east or the west, which suggests that some of the lineaments may be illusions created by low angle illumination of randomly irregular surfaces. Experiments with small scale models (Howard and Larsen, 1972) show that oblique illumination on randomly irregular surfaces produces systematic sets of apparent lineaments that resemble some of those seen at the Hadley site.
Statistical analyses of lineaments recorded from orbit over a range of sun positions at the Hadley site show similar predominant trends on slopes with different orientations. On most of the studied slopes, major north and northeast lineament trends intersect in obtuse angles that are approximately bisected by the sun line. The lineaments have no consistent relationship to the slope such as gravitational effects might be expected to produce, nor do they vary systematically as slope attitudes vary relative to the sun line. Apparently the lineaments represent either real directional features of the lunar surface, or, if they are illusions of oblique lighting on an irregular surface, they are sensitive only to the lighting direction and not to the orientation of the slope on which they occur. If real, they may represent closely spaced repetitive geologic structures, such as layering or regional fracture patterns projected through the regolith to the surface.

Locally, lineament trends are related to distinct topographic features and are less equivocally interpreted as geologic structures. At Silver Spur prominent northeast and northwest trending lineaments may be directly related to steeply dipping geologic structures with distinctive topographic expression.

If either of the prominent north or northeast trends represents bedrock structure, that structure is more likely to be regional fracturing propagated through the regolith than to be a surface expression of compositional layering. The extensive areal distribution of the pattern and its azimuthal consistency regardless of slope orientation would suggest, if real, that it represents a regional set of nearly vertical conjugate fractures.

References and notes


3. This work done under NASA contract number T-65253-G.