Chapter 16

BOULDER TRACKS ON HILLSLOPES IN SOUTHWEST EGYPT AND SIMILAR FEATURES ON THE MOON

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ABSTRACT

Tracks of mass wasted boulders are examined on the slope of a steep hill 3 km east of Peter and Paul in the southwestern desert of Egypt. The hill is what remains of a volcanic neck of trachytes and basal conglomerates. The hill is surrounded by an apron of debris in which the tracks are grooved. One 2 m boulder left a straight trail and its motion appears to have been smooth. It continued to slide on the level surface surrounding the debris apron for about 5 m, perhaps lubricated by the fine sand that covers this surface. Another boulder left a chain of depressions suggesting that it bounced as it moved downslope. This boulder appears to have disintegrated just before reaching the level ground. Erosional products from previous wetter climatic conditions appear to have been completely washed away in this region, where eolian conditions predominate. The motion of boulders downslope seems to be basically controlled by gravity, or mass wasting. The resulting features are analogous to those on the Moon. Boulder tracks in southwestern Egypt are compared to those on walls of lunar craters such as Hyginus, and mountain slopes such as the massifs at the Apollo 17 landing site. On the Moon, boulder tracks occur as straight or curved depressions with sharp parallel borders, or as chains of depressions. The similarity of the tracks left by mass-wasted boulders in the two places attests to the extremely dry conditions in southwest Egypt. From this correlation it is speculated that similar tracks will be observed on martian hillslopes, when those are revealed by high resolution photographs.

BOULDER TRACKS ON TRACHYTE HILL

On the way from the Gilf Kebir to Gebel Uweinat, a hill about 3 km east of Peter and Paul was examined (Fig. 16.1). Like many other hills in the region, this one is composed of volcanic rock and rises steeply from the otherwise flat terrain of Paleozoic sandstones. The hills are composed of either trachyte or basalt. The trachyte hills form piles about 30 m high on the average, but may reach heights of up to 80 m.

Figure 16.1 Enlargement of Landsat image (E-1131-08141) showing four trachyte hills in southwest Egypt. The two hills in the center are known as Peter and Paul; the 3 km long hill to the east (right) is illustrated in Figure 16.2.

Fluvial landforms in the Gilf Kebir and Uweinat region, in the form of wadis and small catchment basins, attest to wet conditions in the past. However, today the whole area appears to be completely enveloped in an extremely dry climate that is characterized by an eolian regime. In fact, this area is part of the driest region on Earth, where the incident solar radiation is capable of evaporating 200-times the amount of rainfall (Henning and Flohn, 1977).

The desert surfaces on which the volcanic hills occur appear to have eradicated the climatic history of the area. Results of water erosion in previous episodes appear to have been completely blown away. Today each hill is skirted by an apron of rock rubble, which is most likely due to both gravity-induced mass wasting and wind erosion.

The unnamed hill east of Peter and Paul typifies the locality. It stands approximately 25 m above the plain. The upper half is composed of trachyte with characteristic jointing that gives it a columnar, steep-sided appearance. The lower half is composed of a mixture of trachyte and basal conglomerate with a distinct apron of debris (Fig. 16.2a).

As shown in Figure 16.2a, the area beyond the apron does not show remains of the hill's erosional products. These are concentrated only in the debris apron, beyond which an eolian sand sheet thinly covers the rock surface. Mass wasting caused by gravity and wind action is clearly visible on the hillslopes. Large boulders are dislodged from the very steep walls of the trachyte mass. As these boulders land on the apron of debris surrounding the basal conglomerate their downward motion leaves trails behind.

In one case, the approximately 2 m fallen boulder left a nearly straight trail with a sharp rim (Fig. 16.2b). Only one slight bend is

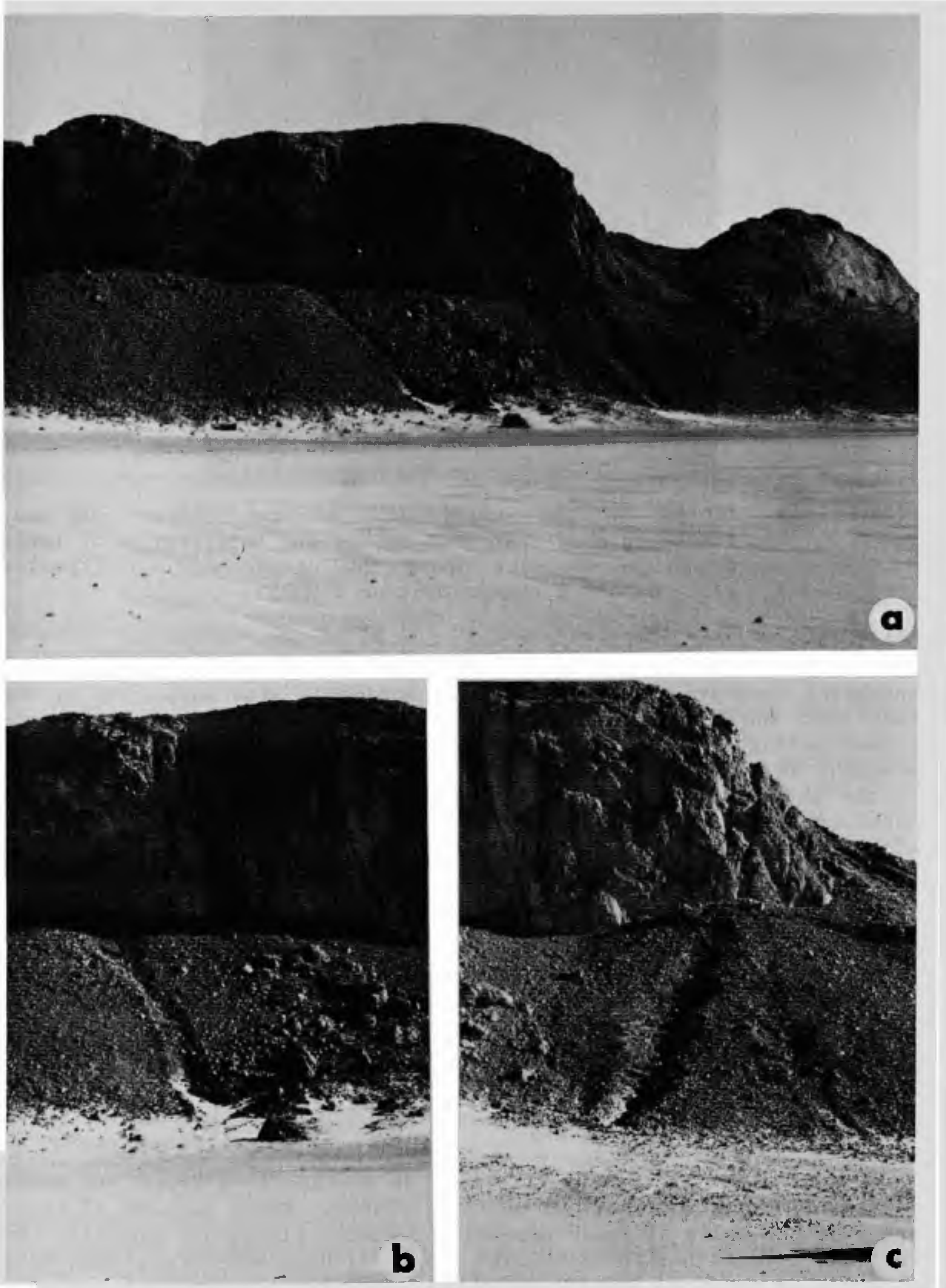

Figure 16.2 Photographs of a hillslope showing the vertical jointing in the upper part and the apron of debris in the lower half (a), with a straight boulder track (b) and one that is made of a chain of depressions (c).

Figure 16.3 Blocks on the south wall of the crater Hyginus, including many that have rolled and left trails of their downslope movement along the crater wall. Framelet width is 440 m (Lunar Orbiter V H-95).

noticeable in this boulder track, suggesting a reasonably fast and unimpeded downward motion. The rapid motion is also supported by the fact that the boulder did not settle at the break in slope; it continued moving until coming to rest some 5 m away from the hill. The movement on the level plain may have been lubricated by the fine sand on the surface. As will be discussed below, some boulders that moved downslope on the Moon also continued to move away from the break in slope onto the level lunar terrain, perhaps also lubricated by the fine lunar dust.

A second prominent track on the same (north) side of the hill shows distinctly different morphology (Fig. 16.2c). In this case, the track is made of a chain of depressions, suggesting that the boulder had bounced on the surface as it made its way downslope. However, in this case, no boulder can be found at the end of the track. Only small pieces of rock remain. This suggests that the boulder disintegrated before reaching the level ground.

BOULDER TRACKS ON LUNAR SLOPES

The boulder tracks on hillslopes in southwestern Egypt are reminiscent of those photographed on lunar slopes. Large numbers of these occur on the walls of fresh appearing craters, rilles and massifs. By far, the largest number of boulder tracks is displayed along the walls of Hyginus crater at 7°40'N, 6°20'E. Most of these tracks are in the form of chains of small depressions; some are up to 1 km long. In most cases the boulder is clearly visible at the end of the slope, in other cases the boulder appears to have disintegrated into small pieces (Fig. 16.3), similar to the track on the trachyte hill in

Figure 16.4 Photograph taken by the Apollo 17 astronauts of boulder tracks on the slopes of the North Massif. The larger boulders are approximately 15 m in diameter (AS17-144-21991).

southwestern Egypt. Tracks in the Hyginus walls and also on the walls of Rima Hadley are depicted in Kosofsky and El-Baz (1970).

Other occurrences of boulder tracks on lunar hillslopes are those investigated and photographed by the Apollo 17 astronauts in the Taurus-Littrow landing site at 20°10'N, 30°45'E. The astronauts observed that the tracks led from outcrops high on the slopes to large boulders near their bases (Fig. 16.4). They also observed that "once a boulder is jarred loose and begins to roll, only a decrease in slope or the disintegration of the boulder will stop it.

"The tracks are made up of chains of small depressions. These chains are generally straight; however, gradual curves were noted in some instances. Not all tracks are exactly perpendicular to the contours, and, in some cases, the tracks curve noticeably.

"Most boulders stopped rolling at least a few tens of meters before reaching the base of the massif slope. However, two large boulders in the crater Nansen moved across the base of the slope and up the other side of the crater for several tens of meters" (Schmitt and Cernan, 1973, p. 5-17).

The use of boulder tracks to find the original location of the boulder was helpful in constructing the stratigraphy of the Apollo 17 site, and the origin of the returned samples. Details of the utilization of the tracks is discussed by Muehlberger and others (1973).

The morphological similarity between the tracks observed on hillslopes in southwestern Egypt and those photographed on the Moon attests to the very dry conditions prevailing today in the Egyptian desert. This leads to the speculation that similar features may exist on hillslopes on Mars. Confirmation of this will have to wait acquisition of high resolution photographs of martian scarps.

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