

## VIII. PITTED ROCKS AND OTHER VENTIFACTS IN THE WESTERN DESERT

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THE MARINER 9 (1971) and Viking (1976) missions to Mars helped to stimulate a new interest throughout the world in atmospheric processes, particularly the role of wind in shaping terrestrial landforms in arid and semi-arid regions. Mariner 9 images showed that Mars is indeed a desert planet where the wind has been a very important geologic agent (McCauley, 1973). Dune fields comparable in size to the ergs of the Sahara, deflation hollows, fluted cliffs and yardangs are well represented on Mars. Early Viking results, especially those from the Landers, cast doubt on the efficacy of the wind in landscape development on Mars. Because of its extreme aridity and strong winds, the Western Desert of Egypt is surely the best terrestrial desert in which to test the role of wind in sculpturing the surface of Mars.

Common on the aeolian peneplain that lies between Kharga and the Gilf Kebir are small, scattered, severely wind-etched outcrops of the Nubian Series. Most of the Nubian rocks in this region are tough orthoquartzites, rarely with calcium carbonate in the matrix, which are covered with a veneer of dark grey desert varnish. At small scale, these rocks are etched into an array of grooves, projections and irregular shapes that are almost invariably aligned with the prevailing north wind. Even the talus from the many conical hills on the aeolian peneplain is grooved, fluted or etched, mostly along bedding planes.

Particularly resistant rocks in the process of being let down from above by deflation were noted near our campsite of September 29 and 25 km east of Beacon Hill. These forms were given the name 'beheaded sphinxes' because the heads, made up of a thin quartzite layer, have been toppled forward into the wind by undercutting of their prows. These features provide insight into how coarse lag surfaces form in certain desert environments (Plate XIXa).

Just below the notch and the archaeological site in Wadi Bakht (see section III by McHugh), numerous wind-eroded stream cobbles abound, particularly on the surfaces of the older and slightly higher fluvial terraces. The fragile, finely-etched veinlets, bedding planes and windward projections observed could not possibly have been subjected to prior wind erosion; what is now present on their surfaces must postdate the last stages of wadi-cutting. Also of interest is the wide variation in the degree of erosion observed on artefacts at the various archaeological sites visited throughout the desert. As expected, the older artefacts (Acheulean and Mousterian) were the most wind-eroded — frequently fluted and polished by sandblasting. Undisturbed hearthstones of various Nubian lithologies that are Neolithic, or possibly older, show flutes, pits and projections aligned into the prevailing wind.

*Comparisons with Mars*

In terms of Viking Lander interpretations the most significant small erosional features found in the Western Desert are the pitted and fluted quartzites and basalts. Along the slopes of Black Hill, we encountered wind eroded alluvial fan deposits that were so similar in appearance to the views from the Viking Landers

as to be startling (Plate XIXb). The sizes and shapes of the rocks were almost identical with those in the Viking scenes. Depositional tails lay in the lee of most rocks; larger sand drifts occurred locally along with patches of sand on the tops of some of the larger rocks. Many rocks were angular as in the Viking pictures but most were pitted and also fluted to a lesser extent.

Controversy has raged in the geologic literature about the origin of pits and flutes on various types of rocks in arid, semi-arid and humid environments. The general consensus among most American geologists is that they are produced by solution processes and possibly enlarged or modified by wind action. Whitney (1978) has shown that small scale wind vorticity can produce pitted rocks with or without entrained sand particles. Solution effects on the basalts and quartzites exposed in the Western Desert of Egypt must be minimal, based on our knowledge of its present and past climatic conditions.

Some of the most interesting pitted and fluted rocks occur on the top of the Gilf Kebir in let down remnants of cap rock and even on the slabbed surfaces of the Neolithic implement reduction station discovered by McHugh during this expedition. These rocks bear a striking resemblance to many of those seen in the Viking Lander pictures (Plate XIXc and d). Since they consist of rock so tough that it was suitable for implement making by early man, it is doubtful whether solution could have played a significant role in the development of the textures seen. Sand blasting, vorticity and deflation of the worn down particles are more logical explanations.

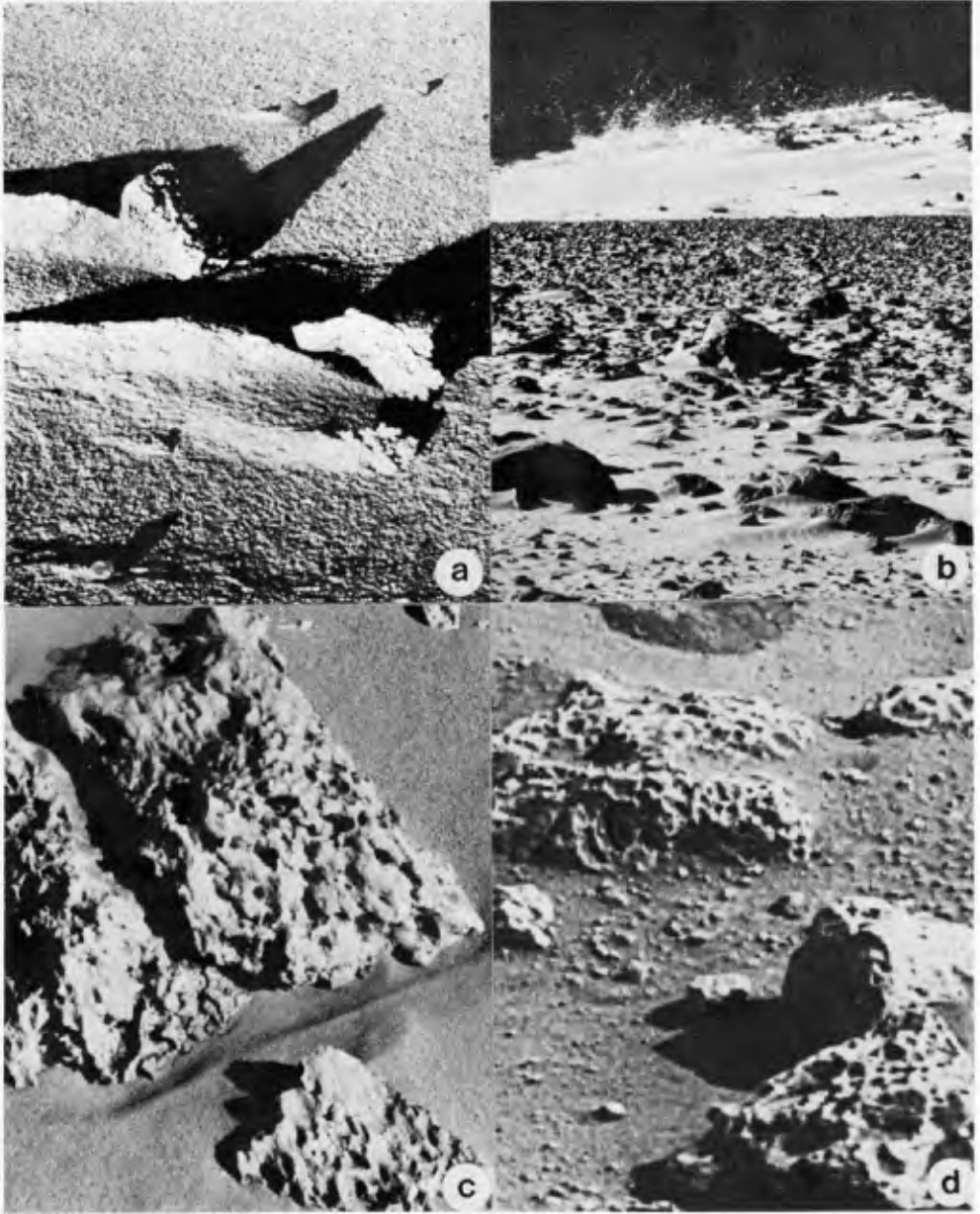
An even more revealing example of pit formation by wind was discovered along the north side of the west end of Wadi Mashi, where remnants of a basaltic intrusive form a large, rounded hill. Talus fragments including blocks of basalt columns are extensively pitted and the surfaces on the tops of the fragments are partly filled with fine yellowish sand. At first glance, one might ascribe these pits to the presence of vesicles in the basalt. However, when broken open, these rocks proved to be massive, with only a small percentage of olivine grains to mar their internal uniformity. In this almost rainless desert, it appears almost certain that these are wind vortex pits. Chemical weathering may have initiated the pitting process — relative humidity in excess of 25 per cent and light dews are known to occur from time to time during the night. Vorticity and the development of small aeolian 'pot holes' is then responsible for the enlargement of the pits and the present surface texture of the rocks.

These preliminary observations in the most arid desert on Earth, where wind erosion has dominated the land for thousands and perhaps millions of years, raise the issue as to whether the terrain seen by the Viking Landers is as little eroded as was at first reported. Dense fine-grained rocks such as basalts and even orthoquartzites can become pitted and fluted in hyperarid environments even without sand — the dust in the air is sufficient. This raises the question as to whether the pits seen by the Viking Landers are vesicles or vortex pits.

#### References

- McCauley, J. F. 1973 Mariner 9 evidence for wind erosion in the equatorial and mid-latitude regions of Mars. *J. Geophys. Res.* 78, 20: 4123-37.
- Whitney, M. J. 1978 The role of vorticity in developing lineation by wind erosion. *Geol. Soc. Amer.* 89: 1-18.

PLATE XIX



(a) Small yardangs of quartzite blocks; (b) deflated alluvial fan on the slopes of Black Hill, similar to Viking Lander photographs of Mars; (c) pitted orthoquartzite of the Gulf Kebir; (d) pitted rocks in the Viking Lander 2 site