Reports of Planetary Geology Program, 1978–1979
The nearly level surface of the Western Desert of Egypt is broken in places by hills, which include inselbergs, volcanic cones and yardangs. Yardangs and inselbergs are the most spectacular erosional landforms in the Western Desert. In contrast to inselbergs, which require escarpments of considerable relief for their formation, yardangs are hills or hillocks, which are streamlined by the wind. Their occurrence does not require the presence (or former presence) of an escarpment, and their world-wide distribution (McCauley and others, 1977) shows that they are restricted to the most arid deserts, where wind erosion predominates over water erosion in moulding the landscape. Yardangs are eroded in soft and hard rocks by a combination of wind and blown sand. The most obvious prerequisites for their existence are strong, unidirectional or reversing winds, and great fetch over barren but continuous rock exposures or slightly consolidated sediments. In the southern part of the Western Desert, these conditions are met on the limestone plateau between Assiut and the Kharga depression, on the floor of the Kharga depression, and wherever lacustrine or sebkha deposits occur. The critical morphological criteria in distinguishing a yardang from an inselberg are that it is streamlined, and its length greatly exceeds its width—by a ratio of 3:1 or more, whereas most inselbergs are irregular and equant.

One of the largest fields of small yardangs in easily erodible lacustrine deposits occupies the floor of the Kharga depression between Kharga and Jebel El Ghennima to the east. It is easily accessible along the paved highway leading to Assiut, a few kilometers north of Kharga. The lacustrine deposits consist of brownish sand and clays that unconformably overlie harder and older rocks. They are furrowed by wind and sand into a multitude of elongated hummocks, which are 4-5 meters high, a few meters wide, and tens of meters long (Beadnell, 1909, p. 111). The rate at which the lacustrine deposits are deflated varies from layer to layer according to slight differences in resistance to weathering and erosion. Degree of cementation, and bedding and jointing patterns are among the controlling factors of rock resistance to wind erosion. The resulting landform, as sculptured by wind, strikes the imagination and is known under a variety of highly evocative names such as mud lion, recumbent lion, sitting sphinx, and sphinx hill. The hummocks are separated by long and shallow depressions or couloirs, which bear no morphological evidence of fluvial erosion. The long axes of both hummocks and couloirs are parallel to the direction of the prevailing northerly wind. Fields of well developed mud lions also occur south of Kharga, particularly near el Ramah on the Kharga-Baris road (Embabi, 1972).

Besides wind-eroded mud lions, yardangs eroded out of the much more resistant "Nubian" sandstone also occur within the Kharga depression. They were first sighted and photographed during our flight from Cairo to Kharga, but there was no time to study them on the ground. The plateau which extends between the Kharga depression and the valley of the Nile River is underlain by limestone. This limestone was previously reported to be furrowed by the wind into a very rough surface that was called "kharafish" (Beadnell, 1909, p. 35). "Kharafish" topography as originally described consists of innumerable sharp-ridged hillocks separated by troughs which are partly buried with sand. Hillocks and troughs lie parallel to the direction of prevailing winds. This type of terrain was
considered by Gautier (1935, p. 112-113) to be similar to that in western China, where yardangs were first described by Hedin (1905), but the general impression left by these early explorers was that these wind erosion forms were small-scale features. In the flights to and from Kharga, we realized that the "kharafish" topography only represents a small part of a far more extensive field of large-scale yardangs. This field of streamlined hills and intervening furrows (couloirs) is approximately 150 kms long and at least tens of kilometers wide. The innumerable hillocks reported by Beadnell (1909) are only the smaller of the yardangs which are sculptured out of the Thebes limestone of early Eocene age; countless numbers of larger yardangs, which occur either as isolated hills or in clusters, are hundreds of meters long and tens of meters high.

The irregular tops of the larger yardangs in this field are mantled by a gray-pink residual material, which resembles the terra-rossa so commonly found on limestone terrain in much of the Mediterranean region farther north. Terra-rossa extends downward into cracks and irregular cavities within the limestone. The upper part of the Thebes limestone—that part which is furrowed by the wind—is silicified, and it is unusually hard and resistant. Siliceous concretions—the "melons" of British geologists—are common erosional remnants on the wind-swept surface of the "kharafish" terrain. The chemical weathering implied by terra-rossa, silification, and solution features such as interconnecting cavities suggests that a humid climate prevailed over the region for a long time during the Cenozoic era, prior to Quaternary or older onset of extreme aridity.

The smaller streamlined rock exposures typical of the "kharafish" terrain are intensely fluted both to windward and to leeward, and also on the side slopes. They resemble artichoke heads or the prows of heavy ships, with the stem or the prow pointing into the wind. The wind-fluted and polished crystalline limestone glistens in the sun to a height of several meters above the couloirs, which are choked with ripples of abrading sand and granules. Unlike sharp-crested keel-shaped yardangs that we have seen in other deserts, these are frequently flat-topped and retain some of the original weathered surface on the Thebes limestone. Thus, these yardangs are less mature than the sharp-crested variety, and the tops mark a surface against which the depth of wind erosion can be estimated. A detailed study of this extraordinarily large yardang field will lead to a better understanding of the extensive yardang fields seen on Mars on the recently acquired Viking Orbiter images (Ward, in press).

References:


