GENESIS OF PARTICULATE MATERIAL IN TERRESTRIAL DESERTS AND APPLICATIONS TO MARS. Farouk El-Baz, National Air and Space Museum, Smithsonian Institution, Washington, DC 20560.

In this paper it is suggested that contrary to widespread belief, particulate materials in terrestrial deserts are formed basically during wet climatic periods. During dry conditions particulate materials are transported or redistributed by the action of wind. Negligible amounts of particulate materials are formed by wind erosion as compared to those produced by water erosion. Such distinct roles of fluvial and eolian processes in the generation and redistribution of particulate materials in terrestrial deserts may be applicable to Mars as well.

Cursory observation of the distribution of sand seas in the world indicates that sand accumulations occur in basins or low topographic areas. Examples include the sand fields of the Simpson in Australia, the Taklimakan, Gurvanmorigut and Turpan in China, the Rajasthan and Thar in India and Pakistan, the Dasht-e-Lut in Iran, the Great Erqs and Murzuk in the Sahara, the Vallescito and Marayes in Argentina, and the Algodones in California.

Most of these basins are nearly circular or elongate in shape (1; Fig. 1). Some of them are surrounded by high mountains, and most of these show relict drainage leading to the sand fields. This suggests that the sands that fill the basins were produced by fluvial action and deposited in the low areas. Such sand deposits may be 150 meters thick, such as in the Rajasthan of northwest India. In the latter case eolian activity appears to have affected only the uppermost horizons where parabolic dunes occur over a thick layer of sand. These dunes are partly stabilized by natural vegetation.

In hyperarid deserts, where there is no vegetation, the wind appears to have been a more effective terrain sculptor. Such is the case of the Great Sand Sea, which was so named by the German explorer Gerhard Rolf who futilely attempted to cross it in 1874 (2). The part of the Great Sand Sea in the Western Desert of Egypt covers 72,000 km² (3). However, several additional arms of the sand sea may also be considered part of this desert.

![Fig. 1. Large dune fields in world deserts (Cooke and Warren, 1973, p. 230). (Figure published courtesy of University of California Press.)](image-url)
including the sand fields of Sitra (2,100 km²), El-Qusṣ Abu Said (800 km²) and Uweinat (31,500 km²), giving a total of 106,400 km².

The Great Sand Sea begins in the northern part of the Western Desert just south of El-Diffa plateau. It continues southward for 600 km before the dunes are deflected by the Gilf Kebir plateau and associated highs. In its northern part there are few sand-free areas. Numerous 2-10 km long crested linear and sinuous dunes arise from a blanket of sand. The distance between the crests of these dunes is usually less than one kilometer (4).

In the southern part of the Great Sand Sea, large and gently sloping whaleback dunes abound. These are usually over 20-70 km long and 2-5 km wide. They are often separated by essentially sand-free corridors several kilometers in width. Bagnold (1,5) noted that these dunes are usually overlain by crested linear dunes or seifs. He correctly recognized that the latter move along the spines of the relatively static whalebacks. This led him to the conclusion that the whaleback dunes became so large that they no longer could move, and thus, were rendered static by their own bulkiness (4).

However, the situation is better explained if we assume that the whaleback dunes are static remnants of nearly flat (fluvial) deposits of sand that were eroded by the wind. In this model for the formation of whalebacks, sand, over 100 m in thickness, is deposited during fluvial periods in a low basin. During dry periods the sand is moved by the wind which creates the crested dunes of the northern part of the Great Sand Sea. In the southern part, at the edge of the basin where the sand deposit is thinner, the wind more easily erodes the sand and creates the nearly parallel corridors leaving the whaleback ridges. These remain static except for the loss of sand which forms the sharp crested dunes.

Such a genetic model may also be applicable to dunes and dune-like forms on Mars. Particulate material appears to be concentrated in martian basins; the Hellas basin is considered a source area of many martian dust storms, and dune fields abound in a low area of the north polar plains, inside Vallis Marineris and within large craters. Furthermore, yardang-like ridges in the equatorial region of Mars may have formed in a similar way as the whaleback ridges of the Great Sand Sea. Particulate materials may have been initially deposited in low areas and later reshaped by wind action.

References