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(ABSTRACTS)

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THE FORMATION AND MOTION OF DUNES AND SAND SEAS

by

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SUMMARY

Particulate material in the desert originates from the disintegration of rock by both mechanical and chemical weathering. This disintegration exposes the particles to the agents of erosion, which in turn loosen more particles from the rock.

Wind is the major agent of erosion and deposition in the desert. The wind hurles the finest particles into the atmosphere as dust. The largest particles remain behind and armor the surface protecting it from further erosion by the wind. Medium-sized particles are winnowed away and deposited downwind, as sand sheets and sand dunes. This paper summarizes dune shapes and accumulations, their rates of movement and methods of stabilization.

Sand accumulations occur in a large number of forms, which makes them hard to classify. However, generally speaking, sand-sized grains accumulate in the form of sand sheets with rippled, undulated surfaces or as free dunes and obstacle-related dunes. Free dunes, which are by far the most abundant, can be isolated simple forms, coalesced compound groups, or complex accumulations. The basic geometric forms of dunes are linear (longitudinal and self dunes), crescentic (barchans and parabolic dunes), and domical (including pyramidal and star dunes). All types of dunes may be active, semi-fixed or fixed by vegetatio

Dune shapes vary considerably in different areas and often in the same locality; little is known about the causes of such variation in form. A large number of dunes is commonly referred to as a dune field, which is here arbitrarily limited to less than 2,000 km². Described examples of dune fields include the Algodones field in southern California, the Vallecito dune field of Argentina, and the Turfan dune field in northwestern China.

Larger accumulations of sand dunes are known as sand seas because of the repetitive nature of dune forms, much like waves on the sea surface. Detailed knowledge of the texture and morphology of these sand seas was made possible through the interpretation of photographs and images taken from space. For example, data from Meteosat allow the recognition of general sand movement patterns in all of the Sahara. On the other hand, Landsat images and photographs taken on manned space missions allow the mapping of dune accumulations such as the Great Sand Sea in the Western Desert of Egypt or the Takla Makan Desert in northwestern China.

The motion of dunes is fueled by the wind and depends on its direction and velocity. The rate of advance also depends on the size of the dune. For example, crescentic dunes in the Kharga depression in the central part of the Western Desert of Egypt move at the varying rates of 20 to 100 meters per year; the smallest dunes are the fastest moving.

The motion of dunes may have devastating effects on human settlement in the desert. Because of this, numerous attempts have been made in various deserts to halt the advance of sand dunes. Stabilization methods include the utilization of vegetation by seeding the dunes and by planting trees on the wind or lee sides. Other methods utilize erection of hay fences to limit the saltation of sand grains as has been employed in Egypt, India and China. Still other methods include the spraying of the sand surface by crude oil, as has been successfully tried in Iran and Saudi Arabia, or by chemicals that bind the sand grains on the uppermost surfaces of the dunes.