THE PUZZLE OF LINEAR DUNES ON PLANETS. H. Tsoar, Department of Geography and Environmental Development, Brn Gurion University of the Negev, Beer Sheva, 84105, Israel. tsoar@bgu.ac.il

The term "linear" or "longitudinal" dunes describes more than one type of dune. In my lecture I will cover what we do and do not know about these dunes. While all linear dunes possess one common characteristic of elongation, they have different shapes and mechanisms of formation and elongation.

McKee [1] differentiated between basic or simple linear dune forms and compound or complex linear forms. The former consists of individual dune forms which are spatially separated from the adjacent dunes. These dunes can also be either convoluted or rectilinear. The mechanism of convoluted seif dunes was studied in the field [2], [3], [4], and by modeling [5]. From its primary formation, the seif dune is affected by two wind directions coming obliquely from both sides of its slopes, at angles of 90^o to 120^o between the two wind directions. Each wind is separated and diverted along the lee slope after reattachment of the separated flow, to blow parallel to the crest-line in a down-dune direction. This process is known as the *flow diversion model*.

The rectilinear dunes are divided between vegetated linear dunes (VLDs) and unvegetated rectilinear dunes. The first is the most widespread dune type that exists in many deserts of the world (mostly in the Australian deserts and the Kalahari). Vegetated-linear dunes are low with rounded profiles. They range in height from a few meters up to dozens of meters. Vegetated-linear dunes may run in parallel for scores of kilometers. Vegetated linear dunes were formed in Late Pleistocene, which had a climate characterized by higher wind power. However, the processes of formation and elongation of VLDs, which are partly or fully vegetated, are not well understood because all contemporary VLDs are stable. It is assumed that vegetation cover is the main reason for VLD formation. It is proposed that VLDs were formed under conditions that prevailed during the Pleistocene but are not present today. Those ancient conditions are characterized by higher wind power and lower rainfall that can reduce, but not completely destroy, vegetation cover, leading to the formation of big nebkhas with lee dunes behind them. The lee dunes connect to the nebkha in front of it, forming one elongated linear vegetated dune. Accordingly, VLDs develop by elongation of lee dunes formed at the downwind side of the nebkhas [6].

The unvegetated rectilinear dunes are found around the north polar region of Mars. On Earth, these dunes are only found at the Qaidam Basin in western China [7]. It is hypothesized that they were also created by the formation of lee dunes when the lee side of a dune (barchan for instance) was cemented. This indurated dune acts as an obstacle that causes a three-dimensional horseshoe vortex and the formation of a lee dune. Once the lee dune is indurated, the process is repeated, and eventually leads to the formation of an elongated rectilinear dune. There are some similarities between the formation of VLDs and unvegetated rectilinear dunes. For example, both are formed by the creation of lee dunes.

Compound and complex linear dunes are wide and high linear megadunes. The first consists of two or more simple linear dunes which have coalesced and are superimposed on the linear megadune. The complex linear dune is composed of two or more non-linear simple dune types which have coalesced and are superimposed on the linear megadune. When we examine aerial low-resolution photographs or satellite images, the small simple superimposed dunes cannot be discerned. That may give the impression that the compound and complex dunes are simple forms. It is plausible that the vast linear dunes on Titan are compound and/or complex forms.

References:

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