TRANSITIONAL DUNE FORMS ON MARS: R.A. De Hon, Department of Geosciences, University of Louisiana at Monroe, Monroe, LA 71209 (rdehon@ulm.edu)

INTRODUCTION. Dune fields are common on Mars. Dunes occupy the floor of large craters, basins, and many valleys (1). A vast sand sea surrounds the north polar layered terrain (2, 3). The outer edges of dune fields transition from continuous sand cover with transverse dunes to clusters of individual dunes. Individual dunes exhibit a variety of forms that reflect sediment supply and wind characteristics (Fig. 1). Forms common to Earth and Mars include simple domes, barchans, and linear dunes (4).

Occurrence. The smallest, sculpted, sand mounds are dome dunes. Martian dome dunes are found on the edge of sand seas in close proximity to, or intermingled with, barchans and short longitudinal dunes in regions with exposed bedrock interdune areas. The typical martian dome dune field is characterized by elliptical mounds 40-100 meter across and less than 30 meters high. Spacing between dunes is on the order of 100-1000 meters. Where dome dunes and barchans are found together, dome dunes are smaller than barchans. Martian barchans are typically greater than 100 meters across and spacing similar to that of dunes on earth (5).

Transitional Dune Forms. Mars dune fields exhibit and array of dunes of varying sizes. Small domes are intermingled with larger barchans and longitudinal dunes. Intermediate-sized dunes appear to represent transitional forms in which simple domes give way to slightly larger *incipient barchans* (fortune cookie dunes) and *wedge-shaped dunes* (Fig. 1). Smaller than barchans, transitional dune forms provide an intermediate step in the progression of dune forms from small domes to larger barchans or linear dunes.

One transitional dune form has been called "fortune cookies" (6), These are incipient barchans which are oval to circular in plan-view with a small, rudimentary slip face on the leeward side of the dune. Horns are not well developed. Incipient barchans are intermediate in size between domes and barchans. They are usually taller than dome dunes.

Another transitional dune form exhibits opposing incipient lateral slip faces that merge to form a downwind tail. These bifacial, *wedge dunes* are larger than dome dunes and are approximately the same size as barchans of the same dune field.

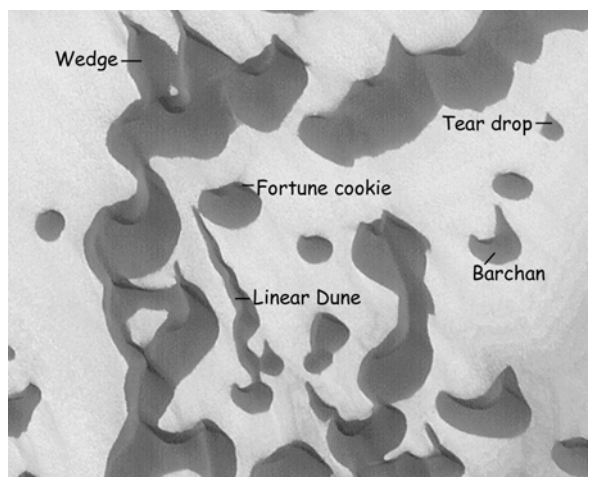

Figure 1. Domes, wedge-shaped or tear drops, linear and barchan dunes with in a single MOC frame (6)

Origin of Transitional Dunes. The development of dunes is governed by the effects of turbulence (7). Flow around

domes while not completely laminar, does not develop flow separation from the bed form. Fortune cookies represent mounds that have grown to sufficient height for the airflow over that top of the dune to develop flow separation and a lee vortex. They are simply the beginning stage of barchan dune formation. Over steepening of the downwind portion of the sand dome leads to the development of an incipient slip face. Flanking airflow that skirts the sides of the dome keeps the incipient horns tucked around the slip face (Fig. 2b). Continued growth develops into a typical barchan (Fig. 2 d).

Wedge dunes represent a transition from dome dunes to linear dunes. The orientation of the dune within fields of barchans suggests that they are formed in the same unidirectional wind regime as the barchans. If the flanking air flow skirting the dome develops flow separation and turbulent flow before the flow over the top, sediment is scoured from either side of the dome and develops opposing slip faces. Sand remove from the sides of the dune are deposited as a lee dune tail as lateral vortices merge downwind (Fig. 2c). Topping flow does not develop, and the dune continues to develop as a linear sand ridge (Fig. 2e).

Conclusion. The transition of dome dunes to larger barchans and linear dunes in a unidirectional wind regime is controlled by the height and width of individual dunes. Once a dome dune reaches a critical height, flow separation initiates a lee slip face, and a incipient barchan dune begins to form. Conversely, if width of the dome creates separation of flanking air flow, the dune tends toward a wedge-shaped or longitudinal form.

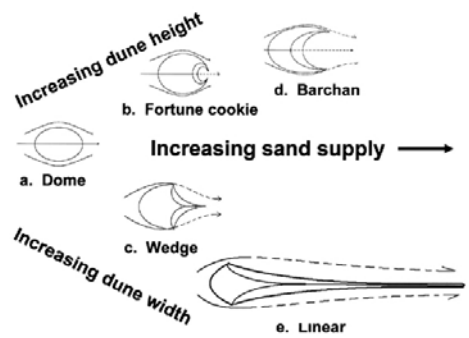

Figure 2. Dune form in a unidirectional wind regime as a function of dune height and width. Solid flow line indicate near laminar flow and dashed flow lines indicate turbulent flow.

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