THE ROLE OF WATER AND WIND IN YARDANG FORMATION IN IRAN AND ON MARS. L. Kerber[1] and J. Radebaugh[2], [1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena, CA 91109 (kerber@jpl.nasa.gov). [2]Brigham Young University, S-389 ESC, Provo, UT USA 84602.

Introduction: Yardangs are wind-eroded ridges common in regions of Mars [1] and in the most arid deserts on Earth. Yardangs have also been documented on both Venus [2] and Titan [3]. Landform-scale yardangs are commonly divided into two groups based on size: mega-yardangs (kilometers in length) and meso-yardangs (meters in length [4]). While all yardangs are elongated ridges, the morphology of mega-yardangs and meso-yardangs can differ greatly.

Iran: The Lut Desert of Iran is one of the world's hottest and driest deserts [5]. The western side of the desert is dominated by a fleet of yardangs ~115 km long and ~66 km wide. The Lut Desert's famous mega-yardangs (known as "shahr lut", or "kalut" meaning desert cities or villages [6]) can be up to 60 m high and tens of kilometers long [5]. In planview the Lut mega-yardangs appear to conform to the classic yardang shape: an elongate ridge with a tapered downwind tail. From the ground, however, the flanks of the kalut are not aerodynamically shaped and show no signs of strong wind erosion. Instead wind erosion is visible on the floors of the troughs between the kalut. This mode of formation, achieved through progressive deepening of interyardang "aeolian couloirs" was first described for yardangs fleets in Chad [7]. The flanks of the mega-yardangs are instead coated with a thick (up to a meter or more) carapace of salt-rich clay. This coating is formed through the wetting of the yardang surface by infrequent rains. The rain carries the clays and salts in solution and moves them down the flanks of the yardang, progressively hardening them against further erosion. The mega-yardang flanks are also extensively gullied, and a very shallow groundwater system exists on some ridges whereby rain falling on the top of the enters holes in the carapace and re-emerges towards the bottom of the ridge. This clay carapace forms assymetrically—it is well-developed on the western flanks of the yardangs but not on the eastern flanks, which are characterized by steep cliffs showing original lacustrine bedding planes.

The interyardang, by contrast, is characterized by a combination of migrating sand dunes and an actively eroding surface. These low areas are exposed to abrasion via saltating sand, causing exposed sections of lacustrine sediment to be sculpted into classic meso-yardangs consisting of long ridges with bulbous heads, occasional upwind moats, overhangs, and aerodynamic, tapered tails.

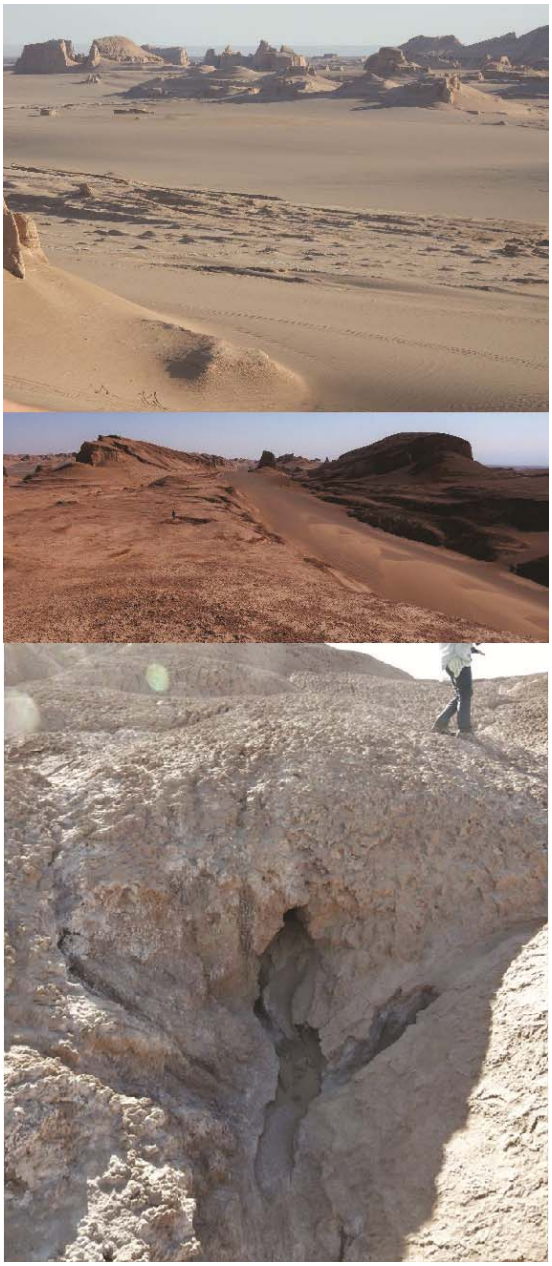

Figure 1. The Lut Desert, Iran. **Top:** Angular, irregularly shaped mega-yardangs (background) and wind-shaped meso-yardangs (middleground). **Middle:** Barchans traveling down an aeolian couloir, or interyardang. **Bottom:** Drainage feature and popcorn-texture carapace covering mega-yardangs.

The main mega-yardang fleet ends sharply at its northern boundary, where it is replaced by a dense fleet of large meso-yardangs, ranging from 25 to 250 m long and 20-50 m wide. These yardangs have much less relief than the mega-yardangs. The main differ-

ence between these two areas is the influence of a large salt swamp caused by rivers draining into the Lut from the north. The contours of the flood zone follows the morphologic change between mega-yardangs and meso-yardangs. This is likely because the salt swamp, with its hard surface crusts and near-surface thick, wet, mud prevents the interyardangs from being deepened.

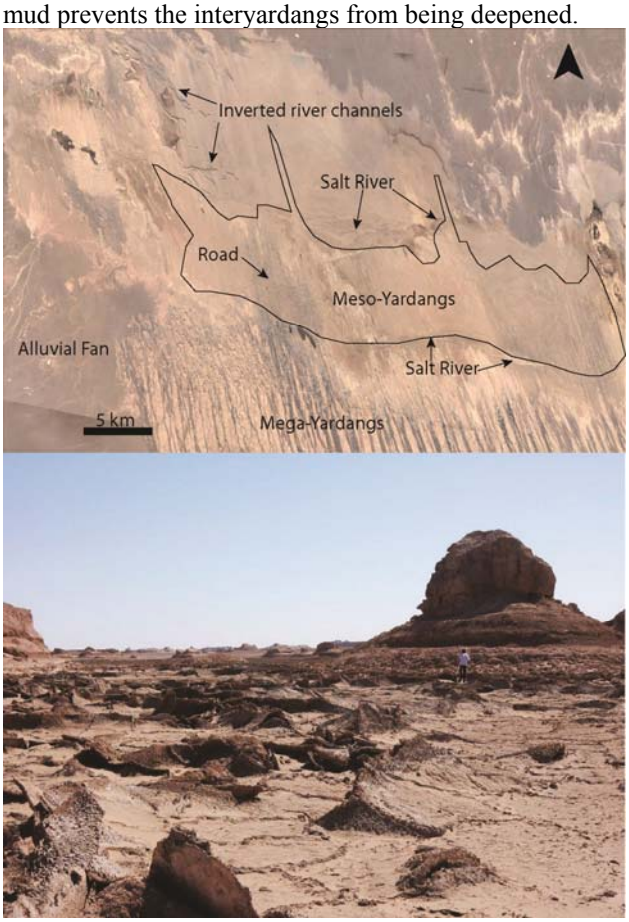

Figure 2. Top: Context for field area in the Lut Desert, Iran. The presence of meso-yardangs is correlated with the presence of a salt swamp. **Bottom:** Salt-related morphologies dominate the interyardangs of this kind of yardang. The yardangs themselves show high-water benches.

Mars: On Mars, major occurrences of yardangs are found in the Medusae Fossae Formation, a large, fine-grained deposit near the Martian equator [e.g., 8]. As in the Lut Desert, different sizes of yardangs with different morphologies are present. Unlike the Lut, whose yardangs are coated with a thick carapace and carved into pluvial gullies, the Martian yardangs generally have faceted flanks characteristic of yardangs untouched by rain (such as the yardangs in Campo de Piedra Pomez, in northern Argentina [9]). While most of the interyardang couloirs in the Lut Desert are filled with sand, this is not usually the case on Mars. On Mars, many have no interyardang sediment at all or have interyardangs filled with transverse aeolian ridges (TARs), which are thought to be gravel ripples [10]. Gravel ripples are also common in the Lut, but the paucity of interyardang sand dunes is more characteristic of a place like Campo de Piedra Pomez [9].

Evidence for the past presence of water is common in some parts of the Medusae Fossae Formation, especially in Aeolis Dorsa, where hundreds of inverted channels have been documented [11]. Alluvial fan textures are also found in limited locations throughout the deposit. Yardangs in fluvial regions of Aeolis Dorsa have similar morphologies to the northern meso-yardangs of the Lut: shorter and lower profile forms that appear embayed at their bases. This morphology could suggest the presence of a salt swamp or periodic flooding at the time of yardang formation.

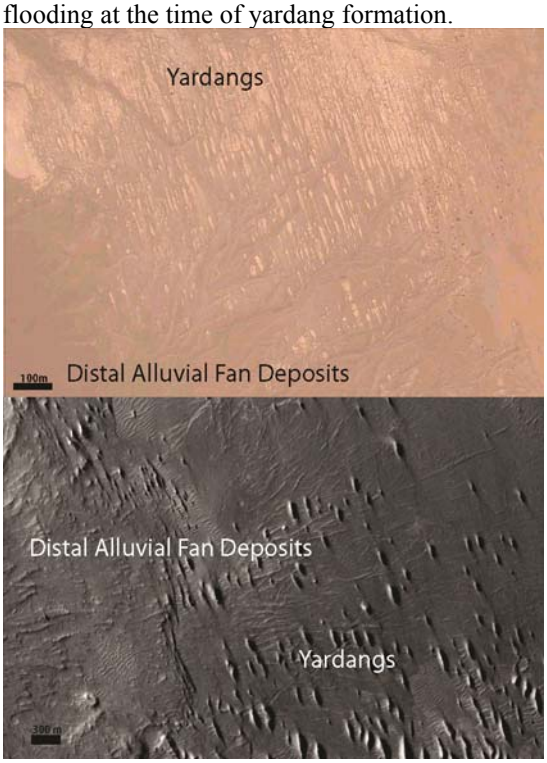

Figure. 3. Alluvial fans and yardangs in Iran and on Mars (P21_009109_179).

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