A TERRESTRIAL ANALOG FOR TRANSVERSE AEOLIAN RIDGES ON MARS IN THE LUT DESERT OF IRAN.

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Introduction: Transverse Aeolian Ridges (TARs) are known to be bright small-scaled distinct morphological features with narrow transverse dimensions found mostly in the equatorial regions of Mars (Figure 1), although they occur throughout the mid-latitudes of both hemispheres [1, 2]. The origin of TARs is still unknown; they could have formed either as small sand dunes or large ripples. However they come in a variety of different settings, crest morphologies, patterns and populations [3]. One of the most common and distinctive characteristics of TARs in comparison to other aeolian features is their symmetric profile, typically with a triangular cross-sectional shape [4].

There are several hypothesis about their formation and sediment source [2, 5]. TARs are inactive and still thought to be unique to Mars [6] although recent studies introduce some terrestrial analogues for them [7, 8]. The lack of abundant Earth analogs still prevent us from studying them appropriately. The current study is intended to introduce one of the best analogs to date for TARs, in a unique desert in Iran (Fig. 1).

Figure 1. The morphological similarities of TARs on Mars to the Lut Desert on Earth is apparent when viewed at the same scale. Left, TARs in Toro crater, HiRISE (ESP_025067_1970). Right, Google Earth view of TAR-like features in the Lut desert of Iran.

Site Location and Setting: The new TAR terrestrial analog site is located in the hyper-arid Lut Desert (Dasht-e Lut) in southeast Iran, within an area of about 80,000 km^2 that is located between 29° 30' N to 30° 49' N latitude, and 57° 47' E to 59° 53' E longitude (Fig. 2). The two most remarkable features in the Lut Desert are first, the deposition site at the eastern side of the basin, which is a low plain covered with salt flats and containing some of the world's tallest sand dunes, reaching heights of 300 m [9], and second, the wind abrasion in the western part of the desert that has produced huge mega-yardangs up to 80 m tall and 120 km long, aligned in a NW-SE direction. The mega-yardangs developed in Pleistocene basin fill deposits (silty clays, gypsiferous sands), with an estimated thickness of 135–200 m [10].

Moderate Resolution Imaging Spectro-radiometer (MODIS) Climate Model Grid (CMG) shows that the Lut Desert was the hottest area on Earth in the years 2004 to 2009, with a temperature up to 70°C [11]. Annual rainfall in this desert is <10 mm based on weather station data. Based on wind records during the 1970–2013 period from the closest weather station (northwest of the study area), the mean annual wind speed is 6 m/s. Strong winds in this area occur in April, with an average speed of 9.35 m/s.

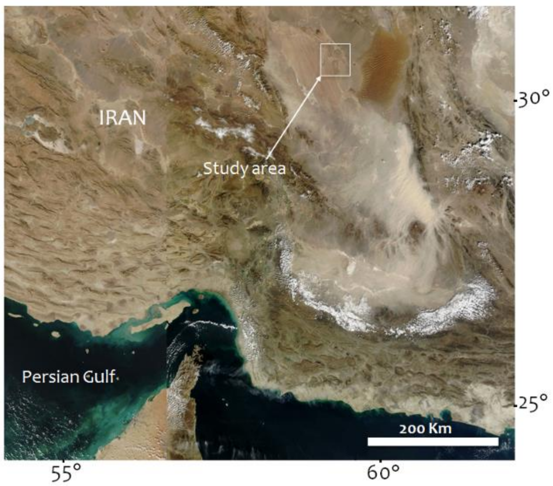

Figure 2. Location of the TAR-like features in the Lut desert of Iran (MODIS image / NASA)

Results and Discussion: Primary remote sensing analysis and photoclinometric measurements of the basic morphometric characteristics of the Lut Desert's TAR-like features (particularly feature height) were extracted by using shadow length in an ArcGIS environment. Results show that the TAR-like features are not taller than 4 m, with the majority being between 0.3 and 2 meters in height. The TAR features range in width and length from 1 to 30 and 7 to 300 meters, respectively. Wider and longer landforms are located mainly in the central part of the study area where there is a lower amount of surface roughness, which means that they can be found directly on the bedrock.

Barchan-like TARs are crescent-shaped, like their namesake dunes, but the crescent TARs are much shorter than most barchan dunes. The majority of TARs displaying >200 meters in crest length occur on the central (flat) planar area.

Visual evaluation of available ground photos from the Lut Desert (Fig. 3) reveal that the surface sediment is coarse (i.e., much coarser than sand), although from the limited examples available we cannot define specifically what the median grain size is across the entire study area. Previous studies suggest that the surface particle size on Martian TARs is mostly in coarse sand to gravel size range. In some regions in the Lut Desert, cobble-sized alluvium or salt deposits present in between TAR-like features are recognizable from ground photos (Fig. 3).

Figure 3. Study area in the Lut Desert of Iran, showing approximate height of the features in comparison to a vehicle, which suggests a height of >1 m for some features in the region (image: Mehrdad Ghazvinian, 2014).

The enigmatic TAR-like aeolian bedforms in the Lut Desert of Iran have the same horizontal length scale as TARs on Mars (Fig. 1). The majority of TAR-like features occur on Quaternary sand sheet and alluvial fan deposits which are surrounded by salt-rich terrains. The features are located in a lowland that is <200 meters above sea level, and they are also found in corridors between nearby yardangs, the same situation as observed for some TARs on Mars. The TAR-like features in Iran seem to be old landforms relative to their neighboring aeolian and fluvial features. Juxtaposition of different aeolian features in this area helps for better studying and evolution of TAR-like features in general, and comparing them to Mars using the same regional settings. More studies need to be done for getting information about the formational processes of the TAR-like features in the Lut Desert.

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