

COMPARATIVE ANALYSIS OF YARDANG MORPHOLOGIES IN CHINA. D. Northrup¹, J. Radebaugh¹, R.D. Lorenz², B. Bishop¹, R.C. Lewis¹ and E. H Christiansen. ¹Brigham Young University, S-389 ESC, Provo, UT USA 84602, ²Johns Hopkins Applied Physics Laboratory, Laurel, MD, USA, northrup.dustin@gmail.com.

Introduction: Relatively straight, elongate ridges that form as wind and other mechanisms erode sediment and rock are known as yardangs [1,2,3,4]. These can be found in many deserts on Earth [1], Mars [5,6], and perhaps Venus [7] and Titan [8]. They generally form in soft sediments such as lakebed clays [10] and volcanic ash [9], but can form in resistant layers [11] or microcrystalline basement rock. Yardangs typically form in regions where there are arid conditions, a lack of vegetation, and a persistent, unidirectional wind, oriented in the direction of the long axis of the yardang [1].

A study of yardang characteristics, including morphologies, lengths, widths, spacings and sinuosity, and other factors may help distinguish similar landforms on planetary surfaces from dunes as well as shed light on the requirements for their formation [6,9]. We describe characteristics of a yardang field on Earth, in China, and discuss how a study of morphology can reveal aspects of the erosional history. We also discuss how our methods may be applied to studies of other yardangs on Earth and other planets.

Yardangs of Western China: Our study area is in the Dunhuang Yardang field of western China, east of the Taklamikan desert. Erodeable lakebed sediments at 40°30' N, 93°06' E form a series of discontinuous, linear features that are highly parallel and generally straight (Fig. 1). Yardangs are oriented N-S in the northern portion of the field and E-W in the eastern portion of the field. There is a set of NE-SW oriented linear dunes between the yardang fields, further evidence of the action of NS and EW winds in the region. Yardangs are generally more discontinuous, longer and more widely spaced in the eastern field than in the northern field.

A closeup view of the upwind margin (Fig 2) reveals a blunt morphology and streamlining of wind blown deposits around the steep hills which may be as much as 40 m high (Fig. 3). A grey limestone gravel lag deposit surrounds the yardangs; the clasts are 0.5-1.0 cm and form large ripples (0.5 m), indicative of high wind speeds or reptation, as seen in gravel ripples in the Altiplano [12].

Yardang Measurement Methods: We made measurements of the yardangs using images acquired from ESRI World Imagery which were taken by the IKONOS satellite. The image resolution is approximately 1 m (Fig. 4). Measurements were made initially on the NE portion of the northern yardang field, and

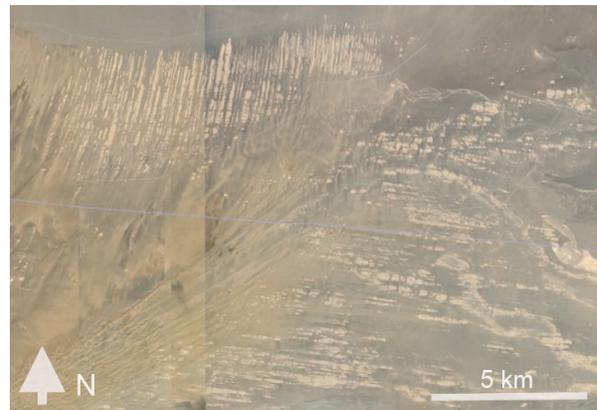


Fig. 1. The Dunhuang Yardang Park, China. Yardangs trend NS and EW, with a set of NE-SW trending linear dunes between them. Fig. 2, Fig. 4 and the study area are at the top center of the image.

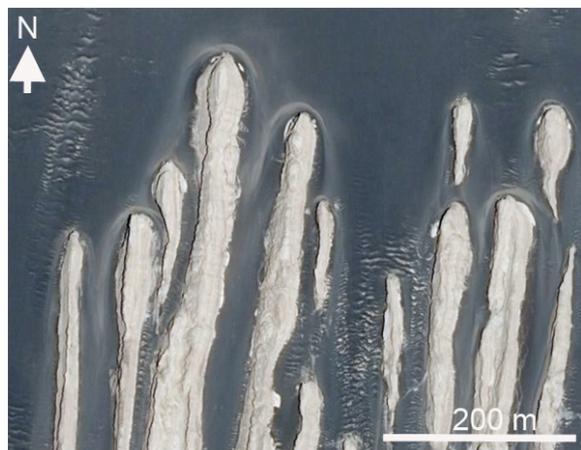


Fig. 2. Dunhuang yardangs are made of light-colored clays while substrate is grey lag gravel with large gravel ripples.

similar methods will be employed across the remaining yardangs in the region.

Yardang length was measured as a straight line from one end to the other through the center of the yardang, which can be seen as light-colored sediments in Figs 1, 2 and 4. Yardang spacing was obtained by measuring from the line running through the center of the yardang perpendicular to the line running through the adjacent yardang, in three separate places along each yardang. These were averaged to obtain the average spacing between each yardang. Sinuosity of the yardangs was obtained by drawing a curve along the



Fig. 3. Dunhuang yardang study area viewed from the north (winds blow to the south). Low gravel ripples are apparent in the foreground.

yardang crest and then ratioing this curve to the length of the straight line measurements.

Yardang Measurement Results, NE Dunhuang Yardang Field: Yardang length in the NE field ranged from 340 m to 2120 m, with an average length of 1260 m from the start of the yardang to its final termination with a SD of 560 m. The yardang spacing ranged from 52 m to 377 m, with an average spacing of 131 m and SD of 67 m. The sinuosity ranged from 1.00 to 1.06 with an average sinuosity of 1.01 and SD of 0.01.

Discussion: The yardangs in the NE portion of the Dunhuang yardang field display a great deal of variability in length and a very low degree of sinuosity. They have moderately variable spacings, are relatively

continuous along their lengths, with a high yardang density per area. Variability in length could result from a regional change in materials available for yardang formation. The low value for sinuosity corroborates their generally straight appearance. By comparison, the yardangs in the southeastern portion of the field trend east-west, display a large degree of discontinuity in yardang material along their lengths, and have a low yardang density per area in comparison with the northern field. This may have resulted when winds changed direction from east-west to north-south, which exposed the yardangs to cross-feature erosion. Further analysis is expected to yield a greater understanding of yardang morphology and their formative processes. This work may also be used to help distinguish between yardangs and dunes on other celestial bodies.

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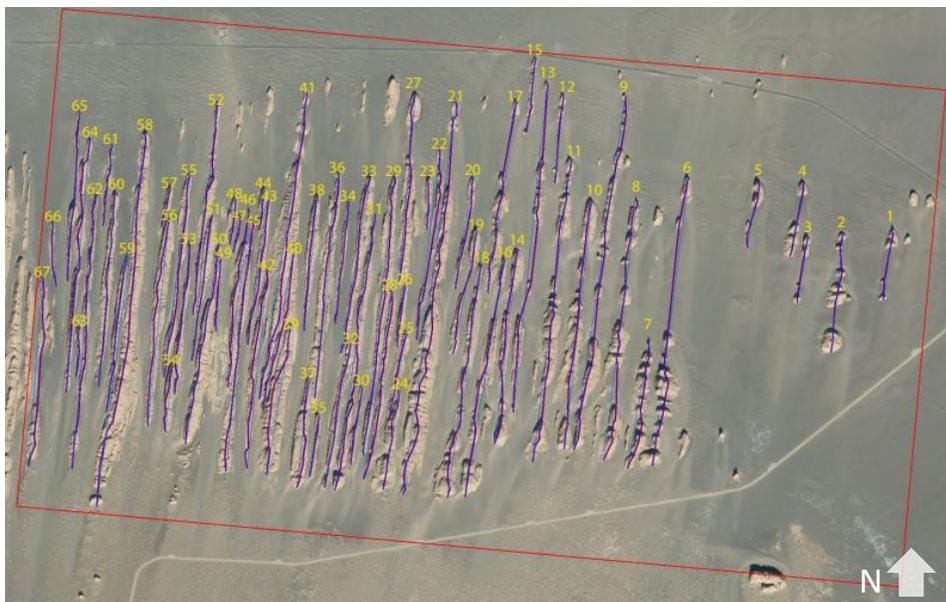


Fig. 4. Measurements of yardangs in the NE portion of the Dunhuang Yardang Field. Lines show the trace along each yardang length, to compare with a straight, end-to-end segment to determine sinuosity.