INTRODUCTION

Seif dunes, a sinuous variety of longitudinal sand dunes, are one of the many types of eolian landforms found in Mongolia’s windy Gobi Desert. Located within the southeastern Dornogovi province, the Tavan Har field site is situated at latitude 44° 7’ 38” N and longitude 109° 38’ 56” E. The site is host to a large meteor crater blasted into Proterozoic (?) metamorphic rocks. Here, peaks of the eroded Tavan Har crater rim act like a snow fence to cause deposition of sand downwind, resulting in more than 20 sub-parallel, sharp-crested seif dunes draping eastward off the crater (figure 1). By mapping and measuring aspects of these dunes, we were able to ascertain the locality of the proximal sand supply, and the wind conditions, velocities, and directions necessary to cause the dunes’ formation.

Methods

Landsat satellite imagery and air photos were initially used for selection of research site. Field data was then collected with a focus on the determining factors of dune dynamics and morphology, primarily wind regime and grain size. GPS surveying was conducted by using a Trimble GeoXT GPS receiver integrated with ESRI ArcPad software to map the sampled portions of the dune field. Spatial coordinates of the crest and perimeter of each dune were used to create dune profiles showing shapes, lengths, widths, and elevations. Elevations and GPS locations were also recorded for points of slip face changes, with slope angles measured with an inclinometer. Dune orientations were determined by sighting the median crest azimuth from dune top to bottom.

Information on depositional environments was gathered from samples and observation of meteorological conditions and other eolian features. Azimuths of daily dominant wind directions were taken at midpoints of each dune, with annual wind information augmented by the wind energy resource atlas of Mongolia (Elliot et al. 2001). Mechanical grain size analysis was performed on four, 200g samples of crest sand, with the purpose of using results to infer local wind velocities needed for sand transport and deposition. (This correlation between grain diameter and threshold velocity is based on Bagnold’s...
In order to determine the extent of lateral dune migration, distances were measured from the dune perimeters to edges of remnant, organic rich cross-beds (figure 2). Along the rim of the crater, azimuths and locations were recorded for sub-parallel, sand-abraded grooves found in 33 outcrops of green schist (figure 3).

RESULTS

Each individual dune, approximately 1 km long, decreases in size and elevation as it winds eastward to a low narrow “tail” that seasonally shifts north and south by approximately 10 m (figure 4). Maximum heights of 10 m and widths of 35 m occur near the seifs’ upwind or westward ends in the wind shadows of peaks along the crest of the eroded meteor crater. Daily observations show the multiple slip faces of each dune shift from north to south in time and space, with steep (35°) slopes opposite gentle (10-20°) slopes. Results from mechanical grain size analysis of crest sands reveal the majority of the well-sorted sand grains to be approximately 2.5 phi units (0.177 mm), thus classifying them as fine sand.

After averaging crest orientations of 16 dunes, it was found that the dunes run sub-parallel to one another at approximately S74°E (figure 5). This data is remarkably similar to that of the crater rim’s sand-abraded grooves, which average S81°E (figure 6).

DISCUSSION

Results of this study suggest that moderate winds are fairly common in this region, and are of high enough velocities to significantly alter the landscape. By comparing average grain size results with Bagnold’s curve (1941) of threshold and impact velocities, it was concluded that winds speeds of approximately 4 m/s are necessary to initiate sand movement.
along the dunes. Such findings correspond to regional observations by Elliot et al. 2001, who noted similar wind speeds in this province six months of the year.

Analogous results of orientations of dunes and sand-abraded grooves strongly indicate they are concordant with the approximate mean annual wind direction of S80°E. Two possible wind regimes account for this resultant orientation, as these dune-forming conditions could consist of either: 1) a dominant unimodal westerly wind with minor modifying north and south seasonal winds necessary to preserve the dunes’ characteristically sinuous shape, or (2) semi-oblique bimodal wind directions from the northwest and southwest which converge in a net direction parallel to the crest line. Both wind models are supported by Landsat satellite imagery which shows large areas of unconsolidated sediment 5-15 km to the west and northwest of the dune site: westerly winds transport the sand from this source area (via surface creep and saltation) and deposit it on the leeward side of the crater as wind speed diminishes.

As little is known today about the kinematics of seif dune morphology, this study is unique in that it provides an assessment of both dune characteristics and the environmental conditions essential for dune formation and preservation. Much information can be ascertained in the future by examining dune characteristics at other seif fields.

REFERENCES CITED


