North Dakota Geological Survey
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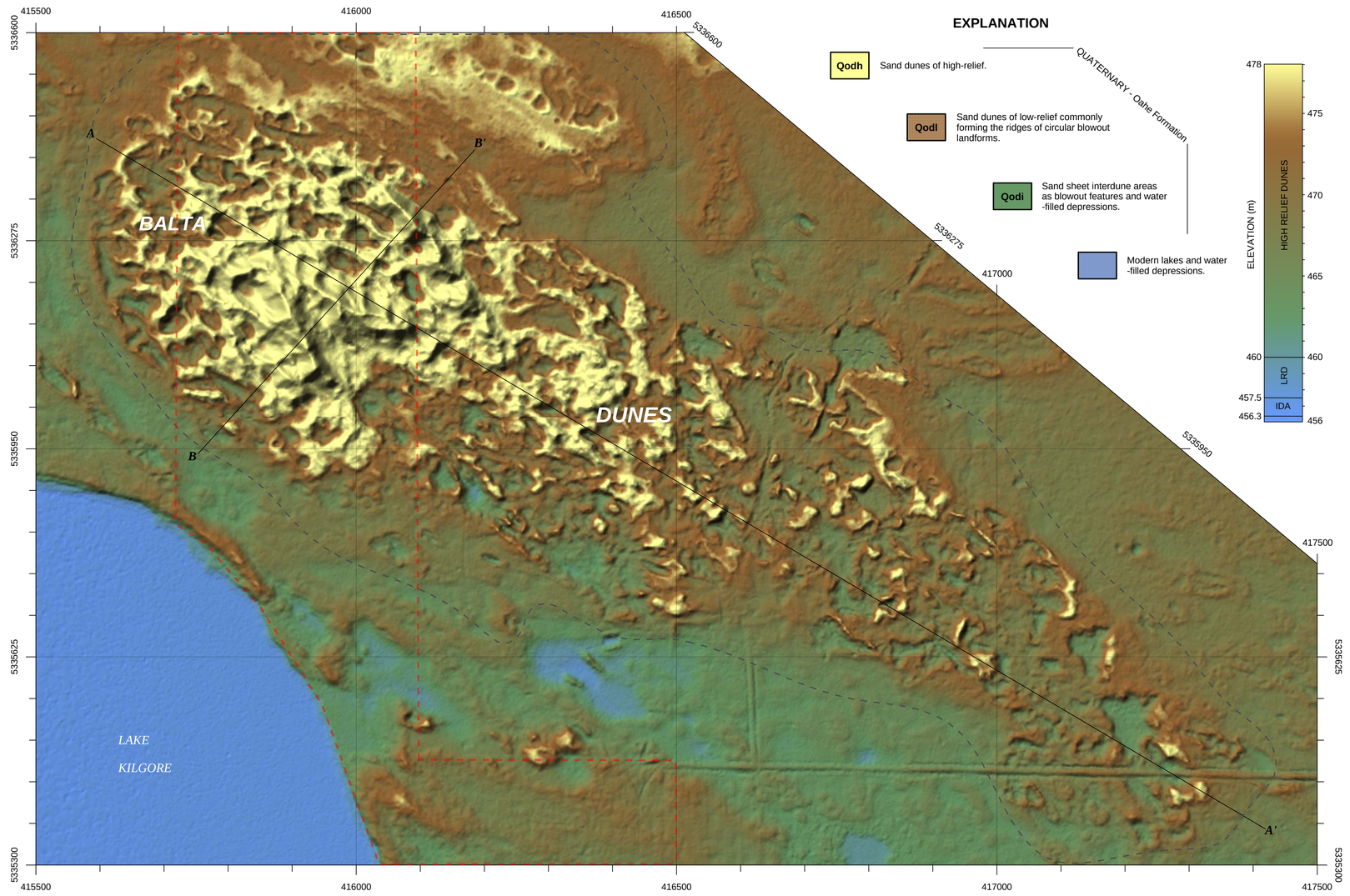
Geomorphology of Dune Sand Resources in Western Pierce County, North Dakota

2016

Fred J. Anderson



EXPLANATION

QUATERNARY - Oahe Formation

Qodh Sand dunes of high-relief.

Qodl Sand dunes of low-relief commonly forming the ridges of circular blowout landforms.

Qodi Sand sheet interdune areas as blowout features and water -filled depressions.

Modern lakes and water -filled depressions.

POTENTIAL USES OF SAND RESOURCE
Sand mapped in this area of investigation could potentially find benefical use as a sand resource for general construction and transportation related projects. Additional mineralogical assessment would be needed to identify any potential for highly specialized use. There are approximately 5.5 MCY of sand resource found within this dune area.

STUDY AREA DESCRIPTION
This map is a three-dimensional representation of the land surface geomor -phology of the Balta Dunes located in north-central North Dakota in west -central Pierce County. This is an area of windblown sand that has been swept into a single high-dune complex that tails off towards the southeast, presumably in the direction of maximum wind direction from the northwest.

DUNE GEOMORPHOLOGY
Post-glacial windblown deposits of the Oahe Formation, sourced from glacial Lake Souris to the northwest, are found in west-central Pierce County. These Holocene eolian deposits consist of fine grained sand that has been windswept into a single dune complex which includes flat to planar sheet interdune areas, dunes of low relief, and dunes of high relief. Windblown sands are concentrated in the northwest part of the map area and decrease in height and areal extent towards the southeast. The dunes cover and area of just over one square kilometer (265 acres). Numerous blowout features are found in the northwest surrounding the higher dune area. The prevailing wind direction that has formed these dunes was from the northwest as evidenced from the orientation of stoss slopes towards the northwest, both in high and low-relief dunes, across the landform. These deposits represent the southeastern most extent of eolian sands of the larger Denbigh Dunes area found toward the northwest.

MAPPING ELEMENTS DESCRIPTION
This image map provides an overhead north-south view with an orthographic view face orientation of 90° from the horizontal. Illumination orientation on the map surface is along strike of the dune field from the northwest at 315° with a sun angle of 55° from the horizontal.

VOLUMETRIC ANALYSES OF DUNE SAND RESOURCES

Dunes of High-Relief: 703,908 m³ (920,677 yd³)

Dunes of Low-Relief: 2,121,407 m³ (2,774,386 yd³)

Total Dunes (>457.5 m Elevation): 2,825,315 m³ (3,695,373 yd³)

Sand Sheet Interdune Areas: 1,340,275 m³ (1,753,014 yd³)
(456.3 - 457.5 m elevation)

Total Sand Resource (>456.3 m Elevation): 4,165,590 m³ (5,448,386 yd³)

VOLUME CALCULATION BOUNDARY

DESIGNATED WATERFOWL PRODUCTION AREA

DUNE COMPLEX CHARACTERISTICS
Length: 2,108 m (6,917 ft)
Width: 853 m (2,798 ft)
Height (Maximum): 19.5 m (64 ft)
Perimeter: 5,311 m (17,424 ft)
Area: 1,072,416 m² (11,543,400 ft²)

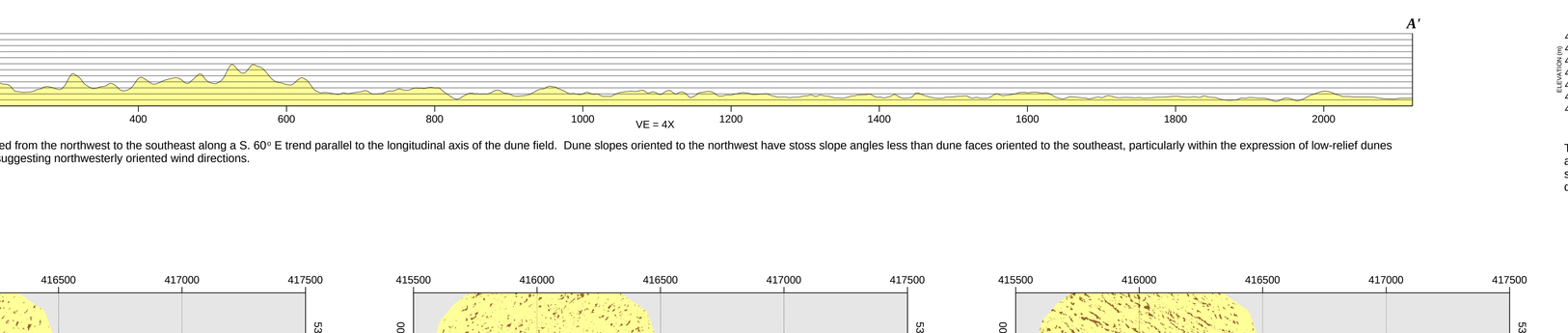
SCALE 1:4,000

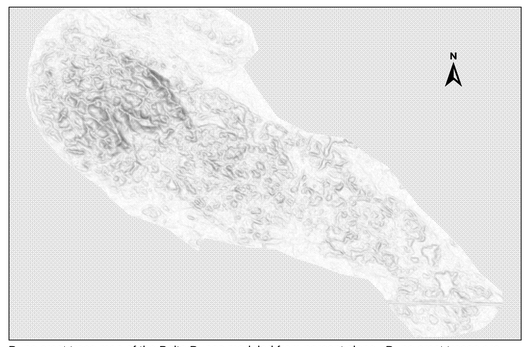
100 50 0 100 200 300 400
METERS

ELEVATION DATA SOURCE
NRCS\USFWS\NDSWC\USACE 2010 James River Basin LiDARCollect - Phase I
North American Vertical Datum of 1988.

HORIZONTAL CONTROL
Universal Transverse Mercator Zone 14

LOCATION OF MAP AREA
The Balta Dunes are located primarily in the SE 1/4 of Sec. 11 and the SW 1/4 of Sec. 12, T. 154 N., R. 74 W., in west-central Pierce County.



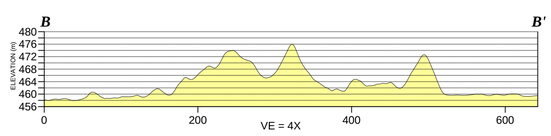


Dune crest trace map of the Balta Dunes modeled from percent slope. Dune crest traces are readily discernable, particularly in the high dunes area in the northwest portion of the dune field.

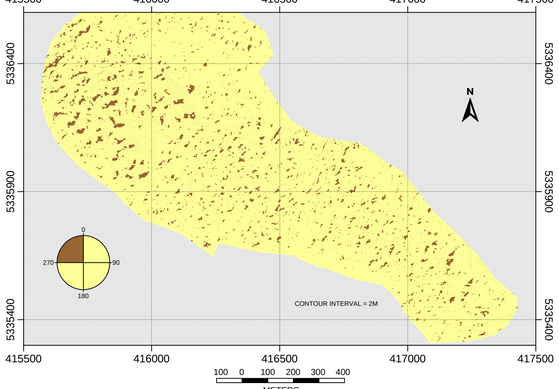
TOPOGRAPHIC DUNE PROFILE *A - A'*

Topographic section A - A' is oriented from the northwest to the southeast along a S. 60° E trend parallel to the longitudinal axis of the dune field. Dune slopes oriented to the northwest have stoss slope angles less than dune faces oriented to the southeast, particularly within the expression of low-relief dunes southeast of the high-dunes area, suggesting northwesterly oriented wind directions.

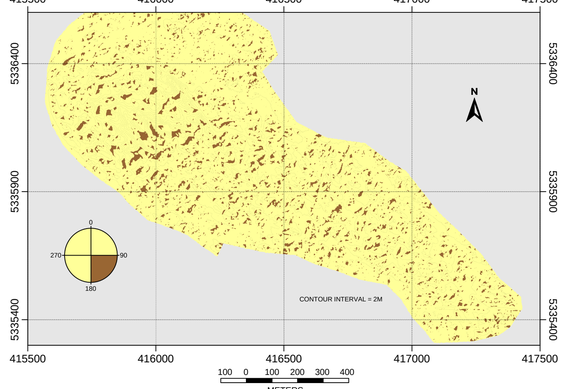
TOPOGRAPHIC DUNE PROFILE *B - B'*



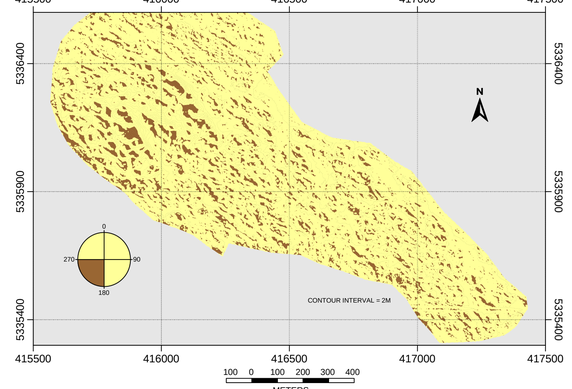
Topographic section B - B' is oriented from the southwest to the northeast along a N. 40° E trend approximately perpendicular to the longitudinal axis of the dune field. Dune slopes oriented to the southwest have slope angles less than dune faces oriented to the northwest suggesting W-NW dominant wind directions.



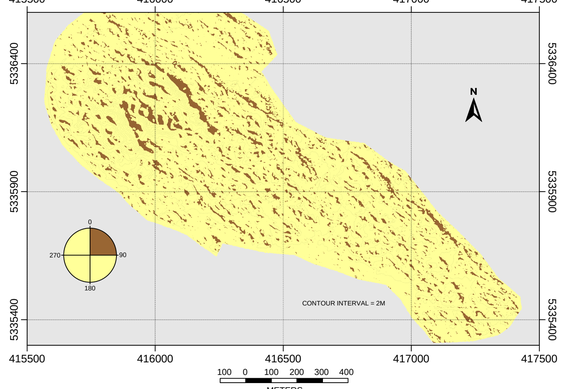
Slope aspect map illustrating the areas within the Balta dune field where the orientation of maximum slope occurs between 270° and 0°.



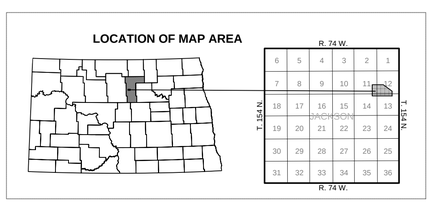
Slope aspect map illustrating the areas within the Balta dune field where the orientation of maximum slope occurs between 90° and 180°.



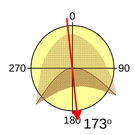
Slope aspect map illustrating the areas within the Balta dune field where the orientation of maximum slope occurs between 180° and 270°.



Slope aspect map illustrating the areas within the Balta dune field where the orientation of maximum slope occurs between 0° and 90°.

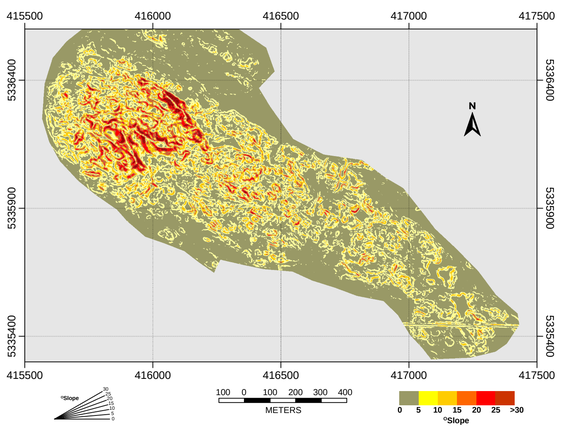


MEAN SLOPE ASPECT ORIENTATION



S. 7° E.

The mean slope aspect direction is the average direction of steepest slope and can be considered as a proxy indicator for dominant wind direction. For the Balta Dunes this would indicate a dominant wind direction from the NW to the SE at a direction of S. 7° E. as determined from the statistical analysis of over 2x10⁶ slope aspect values calculated from the LiDAR modeled surface.



Topographic slope map of the Balta Dunes in west-central Pierce County, North Dakota. High degrees of slope (or steepness), shown here in degrees, are the areas where the rate of change in elevation per horizontal distance is greatest. Areas where where gentle slopes are shown generally indicate areas on the windward side of a dune. Conversely, areas with steeper slopes generally indicate the lee side of the dune where deposition of the dune form is or was occurring. Orientation of lunate features within the low-relief dunes morphology also suggest dominant wind directions from the north-northwest.

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