## Central North Dakota's Eolian Sands Evaluated as Potential Natural Proppant Sand Alternative

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Sampling and testing work completed by the North Dakota Geological Survey (NDGS) in conjunction with EOG Resources in 2018-2019 has revealed that deposits of eolian (windblown) sand in the Hazen-Stanton area (fig. 1) may be viable sources of natural proppant sand. The Hazen-Stanton Dunes cover an estimated 34 square miles and are geologically young, presumed to be active during the mid-Holocene, sometime between 8,500 and 4,500 years ago (Reiten, 2006) and the late Holocene around 1,000 years ago as indicated by optical dating techniques (Halfen and Johnson, 2013). These sands are presumed to be sourced from the alluvial sediments and exposed sedimentary bedrock present throughout the Knife River Valley. X-ray diffraction analysis of a sand sample from the Hazen high-dunes shows a quartz percentage of 77%, with no carbonates and little clay (fig. 2). Gradational distributions are dominantly in the medium to very-fine grained sand range (50/140), with crush resistance values ranging from 4K to 6K (~4,000-6,000 psi).



**Figure 1.** View to the northwest across the Hazen high-dunes. These dunes are vegetation-stabilized with occasional blowout exposures in high-dune areas where dunes commonly reach heights of 40 feet.



a. Hazen Dunes

**Figure 2.** Sand monolayer photomicrograph (30x) of eolian sands from the Hazen Dunes (a.) and the Stanton Dunes (b.). The similarity in textural and mineralogical composition can be observed along with the roundness and angularity of individual sand grains. Quartz grains tend to be clear to opaque, dark-colored grains may be feldspars, detrital lignite, or sand grains from the weathering of igneous and metamorphic rocks.



b. Stanton Dunes



**Figure 3.** Schematic representation of the topographical expression of windblown sands in the Hazen-Stanton area. This topographic profile would be representative of a section drawn from north to south across the Hazen Dunes.





The windblown sands in this area are fine to very-fine grained, pale-brown sands that occur as vegetation-stabilized-low-relief (<10-ft) and high-relief (>10-ft) dunes. In addition to tabular sheets sands found between the dune areas (fig. 3).

The dunes in the Hazen-Stanton area commonly range from 10 to 40 feet in height (fig. 4). Some are as high as 60 feet or more in the high-dune areas (fig. 5). Longitudinal dunes oriented from northeast to southwest make up most of the dune field with blowout exposures common within individual dunes (fig. 6).

The Hazen high-dunes cover a nine-square-mile-area and contain an estimated 134 million tons of sand, as determined from LiDARbased volumetric assessments. Preliminary estimates suggest the Hazen-Stanton area may contain as much as one billion tons of sand with potentially favorable characteristics for use as a local alternative natural sand proppant. Sand (and gravel) resource production in North Dakota is not regulated at the state level. Individual counties and local jurisdictions (e.g. townships) currently provide authority over this process.

Geologic investigations for the 2019 - 2021 biennium will continue to characterize eolian sand deposits, primarily from the western part of the state, as well as additional windblown sand deposits in central and eastern North Dakota. Sandstone bedrock in southwestern and south-central North Dakota will also continue to be investigated for additional proppant and industrial sand uses. Planned investigations will be consistent with earlier proppant sand studies completed by the NDGS (Anderson, 2011, 2018, and 2019).



**Figure 5.** 3D LiDAR surface model (view to the south of N.D. HWY 200) across the Hazen high-dunes southeast of Hazen. The orientation of the dune crests from southwest to northeast suggest paleo wind-transport directions from the northwest.



**Figure 6.** Sand dune blowout exposure in the Hazen high dunes (Google Earth image). These exposures can be difficult to stabilize from continued wind erosion.

## References -

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