In-Basin Sand a Reality in North Dakota: Eolian Sand in McHenry County Produced for Proppant Use in the Williston Basin

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Introduction

Windblown (eolian) sand from the Denbigh Dunes in central McHenry County is currently being produced for use as natural sand proppant. Recently, the North Dakota Geological Survey characterized sand from the Denbigh Dunes as well as the Hazen-Stanton Dunes for potential use as natural sand proppant with

favorable results (Anderson, 2019a & b). These two sand deposits are the closest to the heart of oil and gas activity in the Williston Basin that, based on current industry trends, have potential for use as proppant, (Fig. 1).



Figure 1. The location of the Denbigh and Hazen-Stanton Dunes in west and north-central North Dakota along with the locations of oil wells waiting on completion in the heart of the four major Bakken oil producing counties in western North Dakota.

Eolian Sand in the Denbigh Dunes

The Denbigh Dunes are located just over 30 miles eastnortheast of Minot in the southern portion of the former glacial lake Souris, which stretched across McHenry County. The high-dune areas (defined as sand deposits with dune heights greater than ten feet) south of the town of Denbigh are being developed for proppant sand by Asgard Resources out of Williston. This is the first known use of in-basin North Dakota sand as proppant in Bakken wells (Fig. 2).



Figure 2. LiDAR map of the high-dunes south of Denbigh in central McHenry County.

Eolian sand deposits in high-dune areas have accumulated in complex, barchanoid, northwest to southeast trending dune fields. The dunes are oriented approximately N 30° W (S 30° E) along the interpreted dominant paleowind direction. These dunes are stabilized with native grasses, trees, and shrubs, and contain occasional blowout exposures (Fig. 3).

These wind blown deposits were likely formed about 7,000 years ago after the drainage of the former glacial lake Souris. At this time, (mid-Holocene) the regional climate was interpreted to be much drier than it is today (Bluemle, 1982).

Current Testing Results

Recently completed sampling and testing of eolian sand from the Denbigh area has yielded sand that ranges from 68-83% quartz with crush-resistance values dominantly between 4,000-6,000 psi (4-6K) (Fig 4).



Figure 3. Aerial drone image of dunes south of Towner in southeastern McHenry County. Dunes similar to these just south of Denbigh are currently being developed as a natural proppant sand resource (Image by Moxness, NDGS).

These sands are medium to very-fine grained with the majority of grain sizes falling in the 40/70 and 70/140 size classes (Fig. 5a & b). Particle shape factors (roundness and sphericity) are consistent at values of 0.6 (40/70) and 0.8 (70/140), which are within the higher-quality ranges recommended by American Petroleum Institute specifications (API, 2018).



Figure 4. Testing locations across the extent of eolian sand areas near Denbigh along with recently reported lab values for quartz content (%) and crush resistance (K-Value). Samples labeled "LAB" are currently undergoing analysis.

b.



Figure 5a & b. Photomicrographs of a) 40/70 and b) 70/140 sand from the Denbigh Dunes. These sands are quartz-dominated with lesser amounts of feldspars, fewer clays, and are essentially devoid of carbonates.

Quartz contents remain consistent between low- and highdune areas whereas crush resistance tends to be slightly higher in high-dune sands. The high-dune sands are presumed to be the more texturally and mineralogically mature due to the natural sizing and sorting effects of the eolian process. Overall, initial results suggest that sands with slightly higher quartz contents (>80%) and resistance to crush (6K) are found in the southern high-dune areas because these sands were transported the furthest.

Initial Resource Estimates

There are as many as 81 distinct areas that contain highdunes located across McHenry County (Fig. 6) identified from previous Survey mapping work (Lemke, 1960; Clayton and others, 1980; Bluemle, 1982; and Lord, 1988). Recently completed eolian sand mapping and resource evaluations determined the high-dune areas directly to the south and to the northeast of Denbigh (Fig. 2) contain a combined 70 million tons of potential proppant sand (Anderson, 2019c). Mapping at the 1:24,000 scale, supplemented with available QL3 LiDAR elevation and resultant 1-m DEM data is being used for initial sand resource evaluation throughout McHenry County and the surrounding areas. This work will likely add potential proppant sand resources to the initial estimates reported here. Exploration has recently been completed across these areas and a comprehensive testing report, including all results, is currently being prepared for completion by the end of 2019.

Selected References

- Anderson, F.J., 2019a, The Potential of the Hazen-Stanton Dunes for use as Natural Sand Proppant: North Dakota Geological Survey Geologic Investigation No. 216, 15 p.
- Anderson, F.J., 2019b, Evaluation of Eolian Sand Deposits in North and South-Central North Dakota for Potential Use as Proppant: North Dakota Geological Survey Report of Investigation No. 123, 32 p.
- Anderson, F.J, 2019c, Eolian Sand Deposits in the Denbigh Quadrangle: North Dakota Geological Survey, 1:24,000 scale eolian sand map.



Figure 6. Locations of high-dune areas containing potential natural sand proppant in McHenry County North Dakota in north-central North Dakota east of Minot.

- API, 2018, Measurement of and Specifications for Proppants Used in Hydraulic Fracturing and Gravel-packing Operations, API Standard 19C, 2nd Ed., August, 2018, 47 p.
- Bluemle, J.P., 1982, Geology of McHenry County, North Dakota: North Dakota Geological Survey Bulletin 74, Part 1, 49 p.
- Clayton, L., Moran, S.R., Bluemle, J.P., and Carlson, C.G., 1980, Geologic Map of North Dakota: U.S. Geological Survey-N.D. Geological Survey, scale 1:500,000.
- Lemke, R.W., 1960, Geology of the Souris River Area: U.S. Geological Survey Professional Paper 325, 135 p.
- Lord, M.L., 1988, Surface Geology of the Souris River Map Area, North Dakota: North Dakota Geological Survey Atlas Series AS-4-A1, scale 1:250,000.