Mineralogy of the Hazen-Stanton Dunes

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Interest continues in the development of in-basin sand resources for proppant use in the Williston Basin. At the time of this writing there were two companies looking to develop dune sand resources in the Hazen-Stanton area for local proppant sand use, most likely for wells in the Williston Basin south of Lake Sakakawea.

In order to provide additional baseline geologic data about this area, X-ray diffraction (XRD) mineralogic analysis was recently completed on nine samples collected from the Hazen-Stanton Dunes during the summer of 2019. Unwashed sand samples were submitted to Stim-Lab in Duncan, Oklahoma for bulk sand XRD analysis in order to determine sand mineralogy of in-place dune sand prior to any material handling or processing steps (e.g. screening and washing). Six of the nine samples analyzed were from the northeastern portion of the Hazen Dunes and were concentrated in a one-square-mile (640 acres) area. The remaining three samples were from the northern portions of the Stanton Dunes and were spread across a ten-square-mile area (fig. 1).

This article serves as a supplement to previous proppant sand studies completed by the author for the Hazen-Stanton Dunes where information related to overall sand mineralogy was not available at the time of publication (Anderson, 2019 a & b).

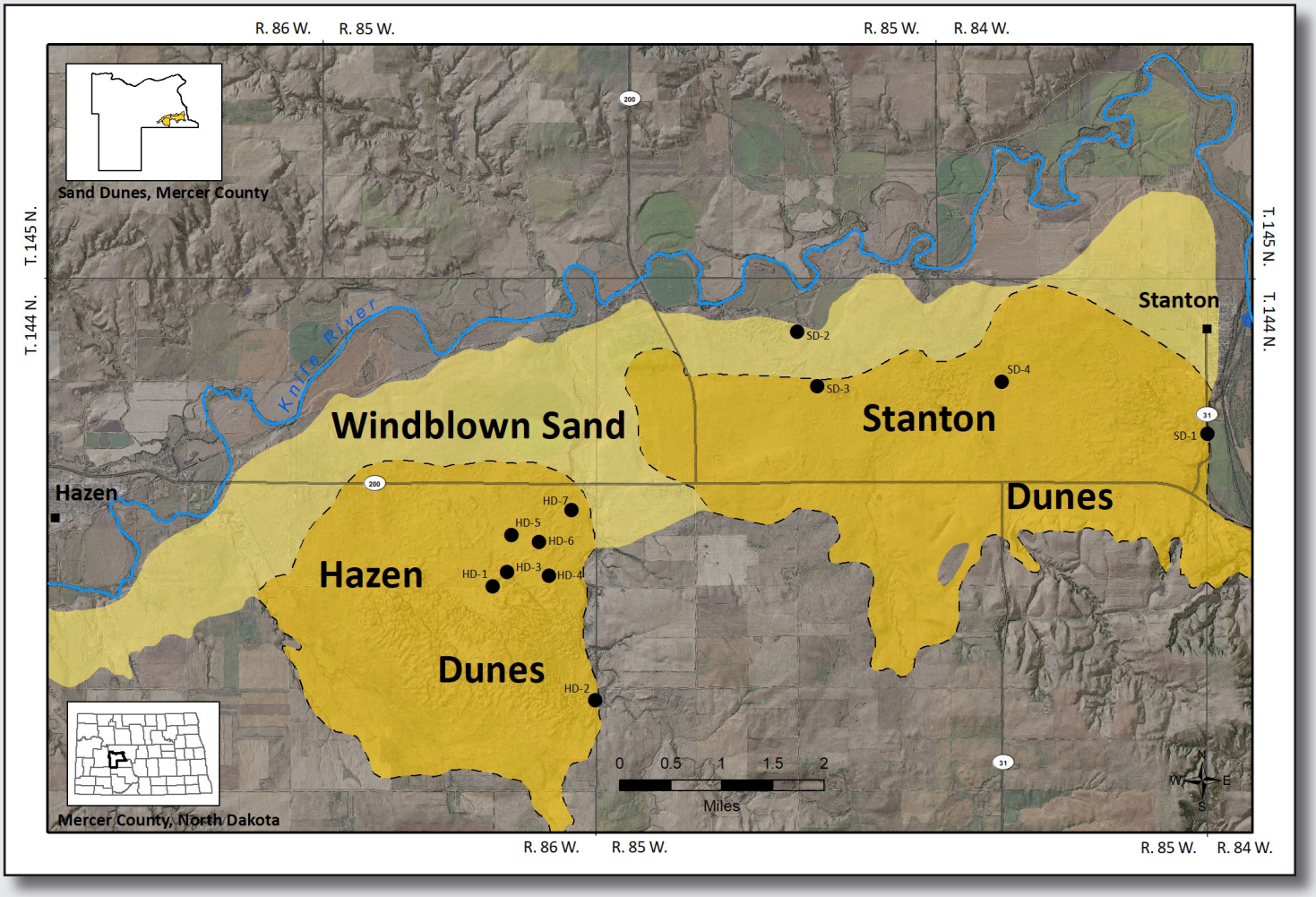

Figure 1. Location of windblown sand samples collected in the Hazen-Stanton Dunes.

Table 1. XRD mineralogy of windblown sand from the Hazen-Stanton Dunes.

XRD Mineralogy	Sample No.	Quartz	Plagioclase	K-Feldspar	Feldspars (Total)	Calcite	Dolomite	Carbonates (Total)	Illite	Illite/ Smectite	Chlorite	Kaolinite	Clays (Total)	Micas	Hornblende	Pyrite	Iron Oxides
Hazen Dunes	HD-1	58	14	9	23	--	--	--	3	1	1	2	7	3	9	--	--
	HD-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	HD-3	68	12	11	23	--	--	--	3	1	tr.	2	6	3	--	--	--
	HD-4	70	10	9	19	--	--	--	3	1	tr.	2	6	5	--	--	--
	HD-5	62	15	11	26	--	--	--	4	1	tr.	2	7	5	--	--	--
	HD-6	71	10	9	19	tr.	--	tr.	4	1	tr.	1	6	4	--	--	--
	HD-7	67	12	11	23	--	--	--	3	1	tr.	2	6	4	--	--	--
Stanton Dunes	SD-1	66	12	9	21	--	--	--	4	2	1	2	9	4	--	--	--
	SD-2	73	10	10	20	--	--	--	2	1	tr.	1	4	3	--	--	--
	SD-3	73	10	7	17	--	--	--	3	1	tr.	2	6	4	--	--	--
	SD-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

- mineral phase not detected tr. = trace NA = Not Analyzed

DUNE SAND MINERALOGY

Mineralogical analysis revealed 14 major minerals that fall into four main mineral groups consisting of quartz, feldspars, clays, and other minor minerals (table 1). Quartz was the most abundant mineral, followed by much lower percentages of minerals in the feldspar group, and very small percentages of clays (fig. 2). Only a trace amount of carbonate was found in one of the samples tested. Generally, windblown sands in North Dakota tend to be devoid of carbonates. The absence of carbonates is likely due to these dunes being very porous and permeable and repetitively washed by meteoric waters (i.e. seasonal precipitation) at the surface.

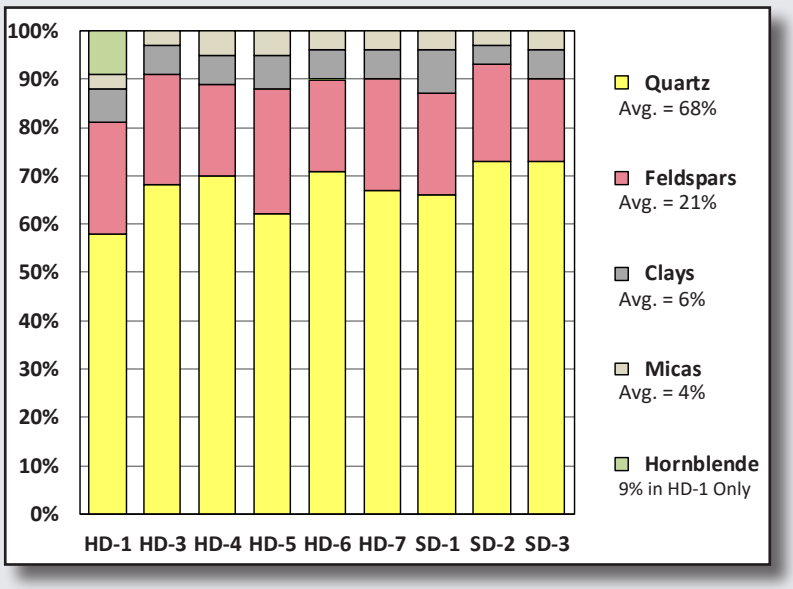

Figure 2. Generalized mineralogy of sand from the Hazen-Stanton Dunes.

QUARTZ

Quartz is the dominant mineral in North Dakota windblown sands based on recent testing data collected from windblown deposits in central and western North Dakota. Typically, quartz ranges from 52 to 76% with an average (n=50) of 68%. Quartz contents in the Hazen-Stanton dunes ranged from 58 to 73% with an average (n=9) of 68% (fig. 3).

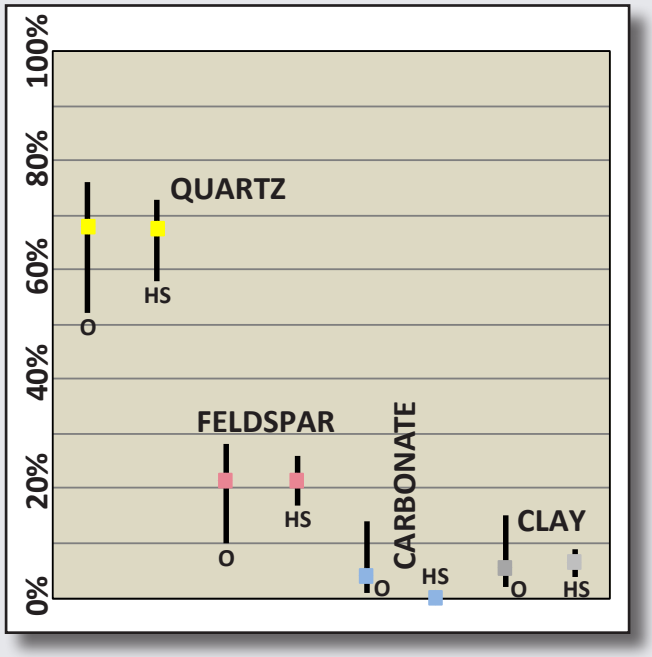

Figure 3. Comparison of the ranges of major mineral composition from the Hazen-Stanton Dunes (HS) with other windblown sand deposits in North Dakota (O). Colored squares represent the average values for each major mineral group.

FELDSPARS

Feldspars are the most common mineral group found in rocks and are commonly the weathering products of older igneous and metamorphic rocks. Feldspar content in the Hazen-Stanton deposits ranged from a minimum of 17% to a maximum of 26% with an average (n=9) of 21%.

CARBONATES

Similar to other windblown deposits found across the state, the Hazen-Stanton Dunes have little to no carbonate present. This is likely due to the highly permeable nature of the sand and its repeated washing from meteoric waters. This is a favorable characteristic as low amounts of acid reactivity are desirable in natural sand proppants. High amounts of chemical reactivity (i.e. acid solubility) would result in undesirable chemical reactions occurring in the borehole and significant volume loss of proppant solids.

CLAYS

Overall clay content was low, ranging from a minimum of 4% to a maximum of 9% with an average (n=9) of 6%. Clay minerals detected included illite, kaolinite, and smectite.

OTHER MINERALS

Micas (undifferentiated) were also reported in these sands at low amounts between 3 and 5%.

DISCUSSION

The mineralogy of windblown sand from the Hazen-Stanton dunes appears favorable for future use as natural

sand proppant based on current industry requirements (figs. 4 and 5). Relatively high quartz content within unprocessed sand along with low clay content and only trace amounts of carbonates should make these deposits a potentially attractive in-basin proppant sand alternative. Appropriate proppant sand processing steps, such as washing and sizing, has been shown to lead to an increase in quartz content and reduction in overall clay content as compared to sand in place.

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, Central North Dakota's Eolian Sands Evaluated as Potential Natural Proppant Sand Alternative, North Dakota Geological Survey, Geo News, v. 46, no. 2, pp. 10-12.

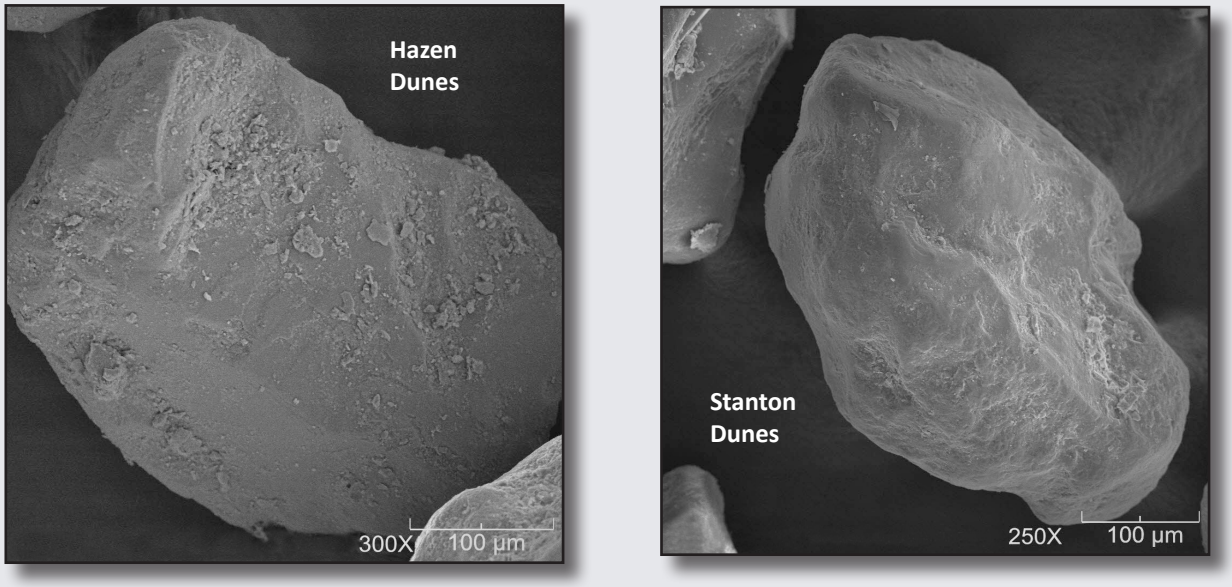

Figure 4. Scanning electron microscopy (SEM) scans of individual quartz grains from the Hazen-Stanton Dunes. Subdued conchoidal fracturing, a characteristic of quartz mineralogy, can be seen on each of the sand grains.

Figure 5. 3D LiDAR surface model of windblown sand in eastern Mercer County, North Dakota. Areas of prominent dunes, with relief commonly of 30 feet or more, can be found in the western, central, and eastern part of this area just west of Stanton.