Abandoned Channels of the Lower Sheyenne River

Statewide LiDAR coverage offers detailed picture of North Dakota's deglacial history

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The Sheyenne River as we know it today is a relatively small, slow-moving, and unassuming watercourse when not in flood stage; its 591 miles of meanders, the longest course of any river within the state, are a familiar fixture of the southeastern North Dakota landscape. Early in its geologic history, however, the river would have looked very different. Over the course of only a few thousand years, the Sheyenne distributed glacial meltwater, surface runoff, and sediment from North Dakota to the Missouri River, the Mississippi River, the Great Lakes, the Arctic Ocean, and eventually Hudson Bay via various former channels and glacial lake outlets (fig. 1). These early river phases left behind sands and gravels, heavily-utilized today as aggregate and shallow groundwater sources, that may be tens of miles from the modern Sheyenne River. Recently acquired, high-resolution Light Detection and Ranging (LiDAR) data reveals the surface of North Dakota in unprecedented detail, offering not only a clearer picture of its recent geologic history, but increased precision in the characterization of its surficial geologic resources.

In contrast to the unglaciated southwestern portion of the state, where major landscape features have been sculpted by hundreds of thousands of years of mostly gradual erosion, the surface of eastern North Dakota was formed comparatively recently, and much more rapidly. At the close of the Last Glacial Maximum between 18,000 and 14,000 years ago, the southwestern margin of the Laurentide Ice Sheet melted back from the Missouri Coteau and drainageways established themselves over much of east-central North Dakota. Much of the upper Sheyenne River was entrenched before what would become its modern course eastward across Ransom, Richland, and Cass counties was free of the ice that persisted in the Red River Valley. This necessitated multiple ice-marginal courses that carved channels and deposited sands and gravels far beyond the confines of its current valley, shaping the landscape and controlling modern land use in southeastern North Dakota.

Before entrenching its modern channel east of Fort Ransom, the Sheyenne flowed southward along the western edge of glacial ice positioned over much of Ransom and Sargent counties (fig. 2, route 1). Near present-day Oakes, its waters entered glacial Lake Dakota and the James River Valley, before eventually draining to the Missouri River. Imagery produced from LiDAR data clearly shows its well-defined former course (fig. 3), which today is utilized as a surficial aquifer throughout its length and a commercial gravel source near Englevale. This waterway and

Figure 1. Drainage routes of water carried by the Sheyenne River (modern course denoted by heavy blue line) including outlets of Lake Agassiz (hatched area). Blue arrows indicate flow directions (Thorleifson, 1996).

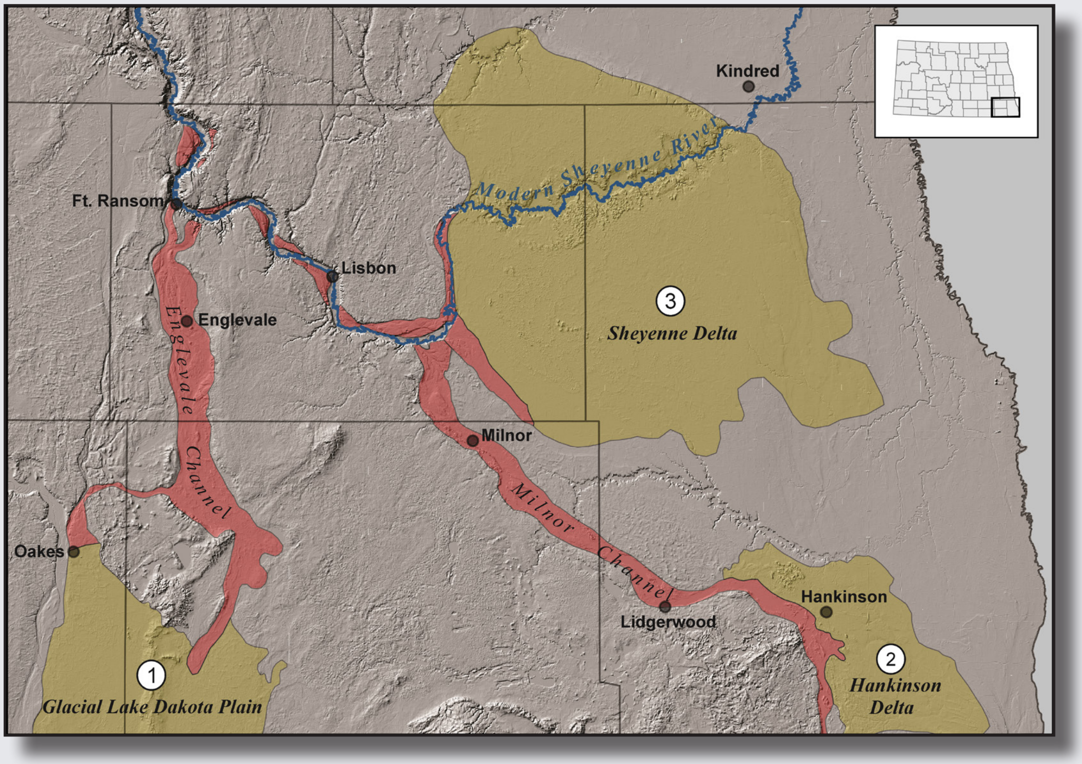

Figure 2. Surficial sand and gravel (red) and sand (yellow) deposits associated with early phases of the lower Sheyenne River in southeastern North Dakota. Numbers represent drainage routes to (1) glacial Lake Dakota and south through the James River Valley, (2) the southern Lake Agassiz basin and southeast through the Minnesota River Valley, and (3) the Lockhart phase of Lake Agassiz and its outlets to the Arctic Ocean, Great Lakes, and Hudson Bay. Sand and gravel extents adapted from Clayton (1980).

the early James River are the source of significant sand and silt deposits southeast of Oakes that were deposited in the short-lived glacial Lake Dakota.

As glacial ice receded eastward, the Sheyenne abandoned its Englevale route for lower elevations around the margins of the Red River Valley (fig. 2, route 2). The Milnor Channel carried meltwater around, and likely over, glacial ice through Milnor, Lidgerwood, and Hankinson, carving a spillway southeast to the Minnesota River Valley and eventually the Mississippi River (Baker, 1966; Matsch, 1983). This stage of the Sheyenne may have been the primary tributary to the incipient Lake Agassiz, depositing large volumes of sand near Hankinson.

The highest-volume phase of the river came as ice began rapidly melting from north-

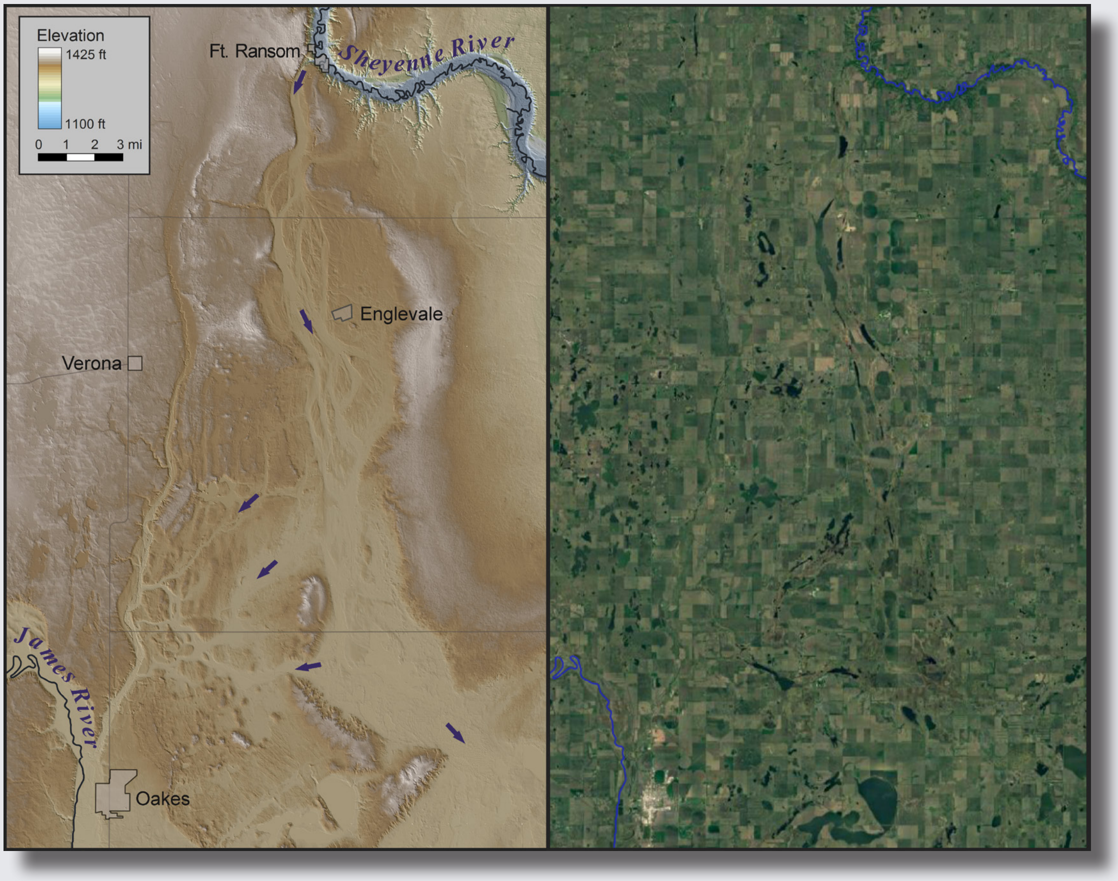

Figure 3. Shaded relief map generated from LiDAR data (left) of a braided stream channel carved by a former course of the Sheyenne River. Blue arrows indicate former flow directions. Channel expression on aerial imagery (right) is interrupted by varied land use.

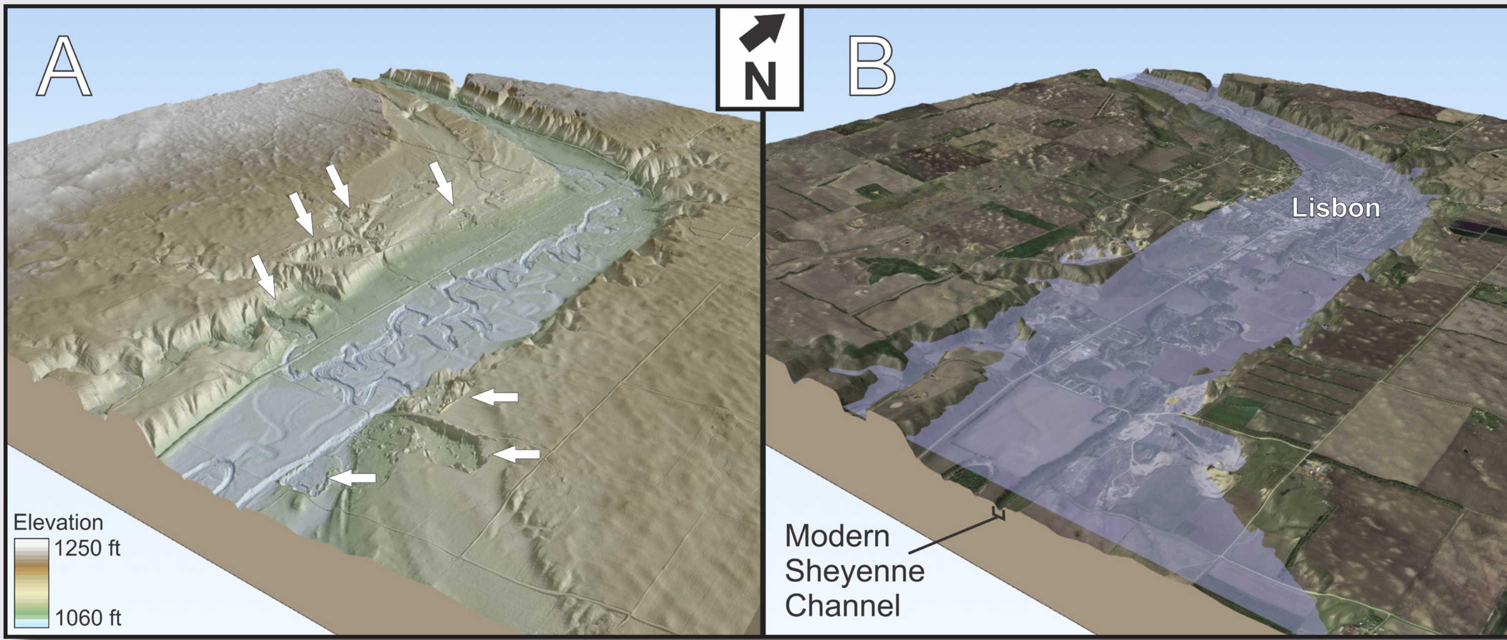

Figure 4. Three-dimensional surface models generated from LiDAR data of the Sheyenne River Valley at Lisbon. (A) Shaded relief image with commercial gravel pits (white arrows) indicated on high river terraces. (B) Aerial imagery overlay with an early, high-flow stage modeled at 1140 feet of elevation.

eastern North Dakota, marking the onset of the Lockhart phase of Lake Agassiz when the lake occupied the southern Red River Valley. Large volumes of glacial meltwater, likely including catastrophic drainages from glacial lakes in north-central parts of the state, caused deep trenching of the meltwater channel and deposited a massive fan delta in Lake Agassiz (fig. 2, route 3,) (Brophy and Bluemle, 1983). This phase of the river saw the emplacement of important commercial gravel deposits along terraces in the Lisbon area that today are utilized in infrastructure along the Red River, where there are few economic gravel resources. The Sheyenne River today is a comparative trickle to the high-flow phases at the end of the last glacial period (fig. 4).

Geologic mapping of regional deposits like the sands and gravels associated with former Sheyenne channels has long relied on aerial photography to interpret landscapes at a regional level, adding context to often widely-spaced field data. While aerial photographs continue to be an invaluable tool, more subtle geomorphic expressions can be obscured by forest cover or variations in land use (fig. 3), requiring approximated unit boundaries or additional field validation. The availability of statewide, high-resolution LiDAR data provides a bare-earth picture of North Dakota that is being utilized by the NDGS's 1:24,000-scale Surface Mapping program (Maike, 2017). The digitization of the state's surface in three dimensions has already facilitated the quantification of sand and gravel resources (Anderson, 2016). Tools like LiDAR serve not only to accurately delineate geologic units present at the surface, but also paint a vivid picture of North Dakota's complex geologic history. Understanding both is integral to best identify and characterize the state's resources.

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