Beneath and Before the Prairies: Geologic Events Near the Mt. Mitchell Prairie Area of Kansas

By Dort Wakefield, Jr.

Largest known erratic of Sioux Quartzite in Kansas. Located at glacial limit northwest of Dover.

Kansas is a prairie state, part of a vast lowland occupying much of the interior of North America. Glance at a small map of the continent and there it is, a seemingly endless field of grass waving in the ceaseless wind. But do not be misled. Look closer. There are, indeed, featureless flatlands, yet here and there these are interrupted by small areas of more irregular terrain, which on careful study, reveal subtle patterns of knobs, ridges, valleys and hollows – some linear, some circular. And if one is willing to explore just a few feet below the land surface, there is evidence of an even more complicated history during the recent past as well as through more distant times.

At first glance the whole region appears to be changeless, a landscape frozen in time. Discerning eyes can still identify remnants of trails, wagon ruts and campsites left by both explorers and settlers as much as two centuries ago. They remain today but they are disappearing rapidly, mainly through destruction by plowing and other agricultural practices. These vestiges are, however, just modern scratches on landscapes that developed episodically over hundreds of thousands of years.

Activity of Streams

An area extending a few miles south from the Kansas River and the towns of Wamego and Wabaunsee is especially rich in evidence of past geologic changes. Passage of the Kansas-Nebraska Act by Congress in 1854 greatly intensified opposing efforts to legally permit or deny establishment of slavery in the new state of Kansas. Many settlers came to Kansas to provide votes either for or against the proposition. One contingent from New Haven, Connecticut arrived at the site of the village of Wabaunsee in 1855. Construction of the historic Beecher Bible and Rifle Church was completed in 1862.

The landscape around Wabaunsee was then very much as it is today; even minor features show very little change. The Kansas (or Kaw) River flows eastward past the town, carrying water and sediment from as far away as southern Nebraska and northeastern Colorado. Its channel is incised 10 to 15 feet below the slightly uneven valley-floor flat that is comprised partly of floodplain and partly of slightly higher remnants of the first terrace. The entire floor is subject to inundation by the greatest floods, such as those of 1993, 1951, 1903 and 1844.

In general, the channel of the Kansas River is about 600 feet wide during average or high-volume flow, but drought reduces the stream to a few narrow, very shallow, discontinuous threads of water. At such time, the rest of the channel bed is occupied by an ever-changing maze of sand bars that slowly migrate downstream. No detailed study has been made of these features. Are individual sand bars seen one year, actually the very same ones that had been observed the year before? Or are they different?

Unusual concentration of Sioux Quartzite erratics covers a hilltop close to the glacial boundary west of Tower Hill.

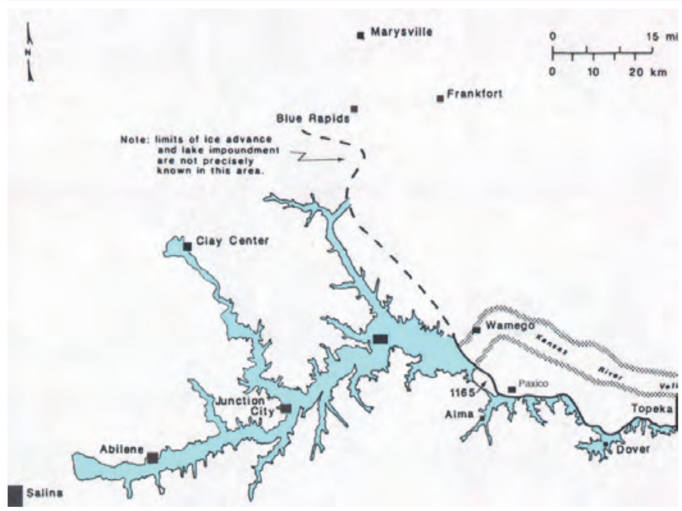
As for most streams that flow through broad valley-floor flats, the Kaw channel has sinuously meandered back and forth from one side of the valley to the other. Maps in the "Atlas of Historical Channel Change of the Kansas River," that was published in 2009, clearly depict channel migrations near Wabaunsee since the mid-1800s. Comparison of old maps shows river positions for eight intervals from 1885 to 2004. Between 1940 and 1952 the channel just west of Wabaunsee increased its meandering and developed an abrupt loop toward the north. Then in the early 1970s, the base of the loop narrowed, and by 2004 was cut through so that the course became straight and two miles shorter. Similar meander cutoffs along the river elsewhere have resulted in a combined shortening of 25 miles of channel length between Junction City and Kansas City since 1850. There was no simultaneous change in the length of the confining bedrock valley. Consequently, the overall gradient has steepened.

Over somewhat longer periods of time this channel has sequentially occupied all parts of the floodplain from one bluff to the other. As the bank is eroded on the outside of a curve and old sediment is carried away downstream, deposition of an equivalent quantity of new sediment coming from upstream fills in on the opposing side. In this way the floodplain surface is being continuously regraded through geologic time, measured in hundreds to thousands of years.

> Nature is a vast tablet, inscribed with signs, each of which has its own significancy, and becomes poetry in the mind when read; and geology is simply the key by which myriads of these signs, hitherto indecipherable, can be unlocked and perused, and thus a new province added to the poetical domain.
> — Hugh Miller

The channel has at one time or another meandered across every part of the floodplain and has then moved away. This has led some observers to propose that the channel and its stream were at one time as wide as the entire valley-floor flat. That is a great misapprehension. Channel width is determined by the volume of water and sediment delivered from upstream, plus local geologic history and the nature of the materials through which the channel is cutting. A proposal that the Kansas River per se was once three miles across cannot be supported by factual observations.

Sometimes lateral channel erosion will expose in the bank an ancient soil that had formed directly beneath an earlier floodplain surface, but subsequently became buried by later sedimentation. The actual time of formation of that soil can usually be determined by analysis of the quantity of radioactive carbon present in



Kaw Lake, impounded by maximum ice sheet advance, drained eastward through a spillway at 1,165 feet elevation south of Tower Hill.

enclosed organic matter. The amount of radiocarbon in the buried soil decreases at a known rate as soon as organisms die.

If the floor of a valley is being raised by net addition of sediment over the years, the surface, which is the top of the most recent deposition, will be flat and nearly featureless. But on the other hand, if there is a prolonged episode of net erosion, the stream will cut a deeper channel at a lower elevation. Once a new equilibrium has been established, whatever remains of the former floodplain becomes a step or terrace above the new stream level. As erosion continues, that terrace will be progressively dissected by tributary streams of all sizes and evidence of the change will gradually disappear.

A very prominent example of such a terrace is present south of Wamego. Kansas State Highway 99 traverses the Kaw floodplain south from the bridge. The presence of sand pits west of the highway attests to the depositional origin of the landform. At a point two and a half miles south of the river there is a steep rise to another nearly flat surface. That is a terrace, a prominent remnant of a former floodplain that once extended across most of the width of the valley when the river was flowing something like 40 feet above its present elevation and was located close to Wamego. For some as yet unknown reason the river began to cut down. At the end of that episode, the Kaw channel lay at the base of the scarp that crosses Highway 99. Then it migrated back north horizontally to its present position adjacent to downtown Wamego, and formed the present floodplain as it went.

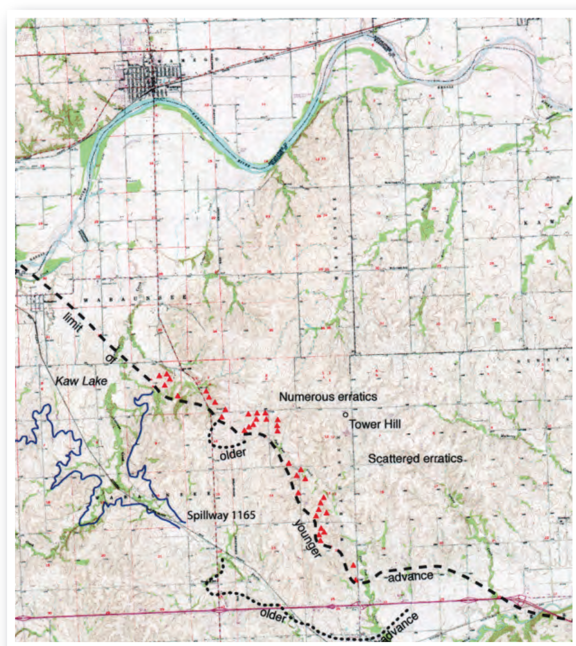
No date has been established for this channel down-cutting and migration. It preceded the earliest mapping of the area, but was not a long time before. The scarp crossed by Highway 99 has been only slightly eroded by small gullies, even though that steep surface is presumably underlain by easily erodible sand. Erosion has just begun. Drilling on that high surface would probably produce samples that could yield a radiocarbon age date. Just as a guess unsupported by any scientific study, the upper terrace surface might be 5,000 year old.

Long-term Episodic Glaciation

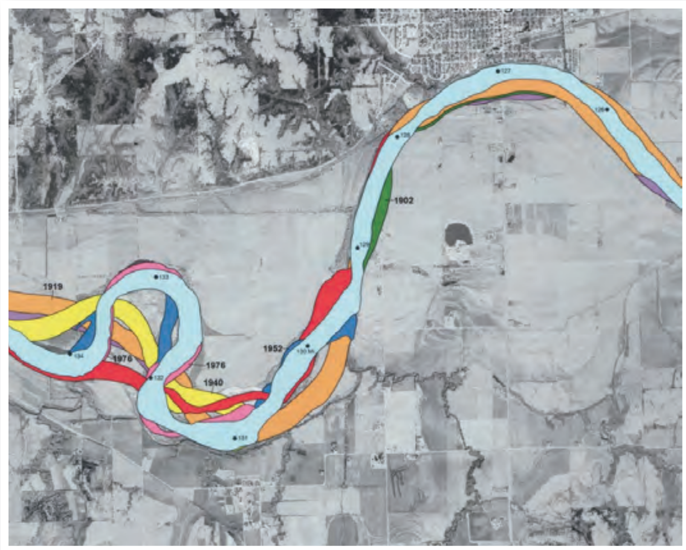
The preceding paragraphs have described evidence that permitted compilation of a fairly complex geological history for an area near Wabaunsee and Wamego during the past 200 or so years. There is no compelling reason to suppose that earlier times were less active. However, if we extend our attention back from 200 years to one or two million years, traces are found of several other geological events.

Approximately six and a half miles southeast of the Wamego bridge and three miles southeast of Mt. Mitchell Heritage Prairie Preserve is Tower Hill, a feature colloquially named for the communication tower located there. Because this is the highest elevation in a large area, excellent views are provided. Seen is a varied landscape of hills and valleys that contrasts sharply with the Kaw Valley floodplain previously described. The terrain is different and so is the geologic history that produced it.

When approaching Tower Hill, even a casual observer might notice loose boulders of a distinct purplish-pink color scattered along the roadside and in adjacent grasslands. Some rest on the surface of the underlying near-white limestone bedrock, some on the superficial soil. Quick inspection reveals that almost every one is composed of quartzite, a metamorphic rock formed by re-compaction and re-crystallization of an ancient silica-rich sedimentary sandstone and conglomerate. This is not present as bedrock anywhere in Kansas. In fact, it is well known that this rock occurs at the Earth's surface only in southwestern Minnesota, plus a bit in adjacent southeastern South Dakota, and a very small area in northwestern Iowa. It is officially called the Sioux Quartzite and is of Precambrian age. This small area must have been the source of the boulders on Tower Hill; no other source is known to exist. Loose pieces of rock resting on bedrock of a distinctly



Southern limits of "younger" and "older" glacial advances in the vicinity of Tower Hill. Eastern end and controlling spillway of Kaw Lake to left.



Present and former courses of the Kansas River near Wamego and Wabaunsee. Numbers next to channel segments are dates of source maps. Small numbers within channels are river miles from Kansas City.

different type and origin, as in this case, are termed erratics. They may also be called indicator rocks if some aspect of their composition clearly indicates their source or origin. Size of these fragments depends on the type of rock the glacier is attacking and the spacing of weak near-surface fractures and joints. In general, a glacier has the power to dislodge any loose rock encountered.

Present distribution of Sioux Quartzite boulders in the general vicinity of Tower Hill appears to bear no relationship to local topography. They are not concentrated on the floors of small valleys, not on hilltops, nor on slopes that face in any specific direction. However, there is in this area a clear, though irregular, linear boundary beyond which no Sioux boulders occur farther south. Here is a situation that demands an explanation.

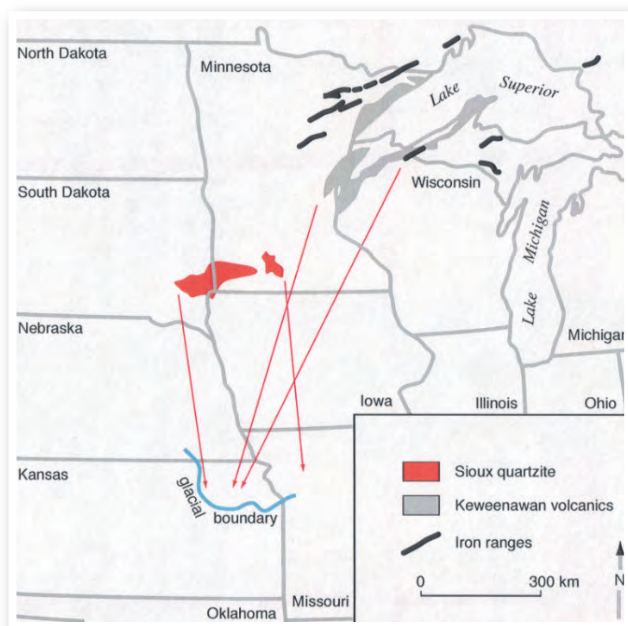
There has been no river to carry them southward some 400 miles from the Minnesota outcrops. There is no slope down which they could have slid. The only scientifically reasonable explanation is that during the era of the Pleistocene Glaciation masses of Sioux Quartzite were picked up by the over-riding Laurentide Ice Sheet and carried southward to its terminal position in northern Kansas. The irregular linear boundary of boulder occurrences is thus interpreted as marking the southern-most limit of advance of the ice sheet. That rocky boundary can easily be followed from west of Wamego, thence easterly along the general line of Highway I-70 to Topeka, Lawrence and Kansas City. On Tower Hill the boundary lies a few hundred feet down the south-facing slope.

Initial ideas about a former time of colder climate accompanied by regional development of numerous mountain glaciers and vast ice sheets on surrounding plains began to be expressed in Europe by the 1860s. (Note: that was just when the Beecher Bible and Rifle Church was established in Wabaunsee.) Evidence of the former presence of ice sheets in the American interior, including northeastern Kansas, was recognized in the 1870s. However, even after 150 years of investigation, there is much more that can be learned from further detailed studies of glacial deposits in northeastern Kansas.

If the preceding interpretations are correct, then we know the origin of the Sioux Quartzite boulders on Tower Hill as well as on Mt. Mitchell. They came from the southwestern Minnesota region and were transported to the area by a prehistoric ice sheet. This scenario has been bolstered by discovery, mainly in the vicinity of Topeka, of fragments of other indicator rocks such as agates and native copper from the Keweenaw Peninsula of Upper Michigan, and iron ore from the western end of Lake Superior. All identifiable erratics signify ice flow from the north or north-northeast. We also know that at least some rock fragments found in northeastern Kansas have been carried approximately 350 miles, and a few may have come as far as 700 miles without being ground up and destroyed within the conveying glacier.

It is probably a general public impression that during the maximum glaciations of North America, ice covered all of the land from the Atlantic coast westward to the Rocky Mountain Front, and from the North Pole southward to some vague line that crosses the middle of the continent, and all ice that actually reached Kansas really came from northern Canada. Well, yes and no.

As studies progress, new evidence points to more and more complexities – a characteristic so often true in research. Ice indeed was continuous for the entire north-to-south span. However, glacial ice is formed by compressive re-crystallization of snow which in turn, might sometimes have come from local storms. This means that some of the ice that had at one time covered Wamego



Glacial transport of indicator rock types brought erratics to northeastern Kansas.

may really have formed from snow that had fallen nearby and had been adsorbed into the mass of ice that actually did come from Canada.

If an observer could have stood on Tower Hill, let us just say vaguely one million years ago, and looked toward the north, he would have seen the Kansas River Valley appearing very similar to the view today. But a few miles farther north there would have been the advancing front of the ice sheet. As decades or centuries passed, the ice would have moved forward, downhill, until it reached the ancestral river in the bottom of its valley.

Then what? Glacial ice "flows" only in response to a pressure gradient. In this example, a pressure differential or push from the north must have been great enough to overcome resistance exerted by any impeding landscape features and also resistance to internal deformation of the ice itself.

There is no way that the advancing glacier could have over-topped Tower Hill, as the presence of Sioux Quartzite erratics on its summit demonstrates actually happened, unless and until the Kaw Valley had been completely filled by ice. In fact, a southward pressure gradient must have been established all the way across that void. So, the elevation of the ice surface north of the valley must have been built up 100 to 200 or more feet higher than the bedrock summit of Tower Hill to the south. The presence of boulders on and even slightly south of Tower Hill shows that these relationships were achieved. Tower Hill now rises almost exactly 300 feet higher than Wamego. So it is reasonable to estimate that at maximum glaciation the ice was between 400 and 500 feet thick on top of the town site.

One final local consequence of the advance of the ice sheet to Tower Hill must be mentioned. As the ice front crossed the ancestral Kansas River, it at once became a huge dam that extended northwestward from Tower Hill to the present location of Wabaunsee, and from there to St. George and into the hilly terrain beyond. Runoff from precipitation in the western headwaters of the entire Kaw drainage basin continued its pre-glacial flow eastward, but no significant quantity could pass that blockage, and consequently, impoundment of a lake began collecting water from rain and melting snow. The elevation of its surface rose, and the head of inundation extended farther and farther upstream to the west, ultimately reaching nearly to the present location of Salina. At last overflow began through a small notch in the high ridge on the south side of the basin. Water could then escape eastward along the front of the ice sheet. A small pond was impounded wherever the glacier front formed a local dam across the mouth of a tributary stream that flowed northward toward the ice-filled river valley.

Even though most people express at least a casual interest in chronological knowledge, few pertinent facts are available for this report. During the last century it was taught that the Pleistocene Epoch, or Great Ice Age, began one million years ago. Recent discoveries in east-central Missouri clearly demonstrate that advances of continental ice sheets occurred there at least two million years ago.

At present, it is impossible to identify a reliable age for the glacier's advance onto Tower Hill. A broad guess might be in the vicinity of 700,000 years. However, it must be noted that very small exposures north of the summit of Tower Hill, and in a house excavation to the west, reveal the presence of a glacial deposit that is much older than the surface unit that is filled with Sioux Quartzite boulders. It is characterized by the presence of rotten, iron-stained boulders of several types of granite. Its age may exceed a million years. These two glacial deposits record the farthest advances of ice sheet southwestward across North America.

> Apart from its healthful mental training as a branch of ordinary education, geology as an open-air pursuit affords an admirable training in habits of observation...(it) sets before us problems of the highest interest regarding the history of the ground beneath our feet, and thus gives a new charm to scenery which may be already replete with attractions.
> — Sir Archibald Geikie

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