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J. E. Todd

indefinite distance. Inside this margin the land nowhere rises higher than the margin, and it is here and there sprinkled with northern boulders, often in patches, especially on the higher levels. The divide between the Moreau and Grand rivers has an altitude of about 2,300 feet. Most of the surface is of Cretaceous clays, and is much eroded, the alternating layers of hard and soft material, producing an interesting topography, studded here and there with high, flat-topped buttes.

The course of the marginal ridge south of the Moreau is in line with some high clay buttes on the east side of the Missouri, just above the mouth of the Little Cheyenne, which are known as Welland Buttes. They are strewn with a thin layer of boulders, and are the west end of a high divide separating the Little Cheyenne and Swan Lake Creek. Crossing this divide is a well preserved ancient channel, more than 400 feet above the Missouri, and there are traces of an old terrace along the Missouri, near the Welland Buttes, at about the same level.

Putting these things together, we come with some confidence to this conclusion: Fox Ridge, with its eastern extension, the Welland Buttes and the high land southwest of Bowdle and west of Faulkton, once formed the divide between the Cheyenne and Moreau rivers, when they flowed through to the James river valley. When the great ice sheet came down the latter valley during the glacial period, and occupied the outermost terminal moraine, there was for a time a great lake formed north of this Fox ridge divide. It was deep enough to float ice-floes and probably bergs from the edge of the ice sheet further north. These formed a bouldery beach along the margin, particularly along the southern side. Of the two outlets indicated, the western one cut down more rapidly, and formed part of the course of the Missouri. As erosion proceeded the bouldery margin became a ridge, because it yielded less rapidly to degradation than the soft clays and loose sands adjacent.

For this glacial lake we propse the name Lake Arikaree, after the Indian tribe whose home formerly occupied a considerable portion of its area.

STRIATION OF ROCKS BY RIVER ICE.

BY J. E. TODD.

Though it is commonly admitted by geologists, that both land-ice and floating-ice are capable of striating rocks, when armed with erratics; careful discriminations seem to be largely neglected. The question, whether river-ice was ever the active agent in scratching rocks, had been raised in the writer's mind several years since by a few observations in Dakota. Diligent search at several seemingly favorable localities had given only negative evidence, until this past season, when two or three observations seem to demonstrate the fact that such is not very infrequently the case.

In this abstract there is room but for the clearest example.

Three miles above Grand Tower, Illinois, there is a hard even-topped stratum of dark lime-stone, jutting out from the eastern bank for several yards, and dipping at a slight angle toward the bank. The steep face resting upon it and extending further up-stream is covered with large sandstone boulders. The dip of the rocks

is 4-6 degrees E. N. E. The principal seams of the rock are N. 10°-12° E. The surface, which was quite generally planed and striated, was 10 feet wide, on an average, and 60-75 feet long. The direction of most of the striæ was S. 10°-11° W., and of a few, S. 18° W. The striated surface reached from the water level up to two or three feet above. A small patch toward the southern end of the area was scratched in a direction, S. 56° E. The striæ were, if anything, more strictly parallel than in most glacial striæ. They were short, being rarely more than three inches long. This was mainly due, it would seem, to the much-cracked and nodular character of the rock. One other peculiarity of the stone affected the form of the markings. Scattered through it were numerous black grains like iron oxide. These usually headed the narrow ridges between the striæ. The striæ were mostly fine, rarely more than an eighth of an inch across. As if to leave no doubt concerning the cause, a long, deep, horizontal scratch, about four feet long and as high above the ledge just described, was found on the nearly vertical face of a large sandstone boulder. This was in the same general direction as the striæ below.

The reasons for referring these phenomena to river-ice are briefly, as follows:

1. Their recency, as indicated by their appearance and their location where water and weather would obliterate them in a short time.

2. Their parallelism with the present channel of the river.

3. Their occurrence outside of the recognized limit of glacial action.

Other localities where similar phenomena have been found which are reasonably referred to the same origin, are as follows:

Running Water, S. D., a little above landing, S. 73 E., "Chalkstone," few feet above low-water.

Sioux Falls, S. D., a few rods east of Cascade Mills, N. 57 W., Red Quartzite, few feet above low-water.

Wellington, Mo., a few rods N. W. of depot, S. 45, 61 and 73 E., Limestone, few feet above low-water.

Grand Tower, Ill., 3 miles up R. R. from depot, S. 10 and 18 W., Limestone, few feet above low-water.

Cape Girardeau, Mo., at landing, S. 10 to 35 E., Limestone, few feet above low-water.

All these directions are magnetic.

Besides these, we would provisionally refer to the same cause striæ reported by Dr. C. A. White as found near low water at Omaha, Neb. [Geol. Iowa, Vol. I. p. 95]; some reported by Prof. S. T. Trowbridge, from the vicinity of Glasgow, Mo., and some reported by Prof. J. W. Spencer, as occurring at St. Louis, at low water mark.

It seems not unreasonable to suppose that this same influence was even more efficient when the rivers were flowing at higher levels, with stronger currents and when erratics were more abundant and ice cakes larger and more abundant, as must have often been the case during the Glacial epoch.

It is no doubt true that ledges are often exposed long to the ice action of rivers without being striated. The conditions producing the effect may not yet be fully understood, but the following seem to be some of them.

1. The localities most favorable, seem to be on the outside of a bend, or near a strong current, near low water mark, and below a point where silicious erratics are abundant at the water level.

2. The dynamical conditions necessary are probably a sudden breaking up of the ice before it is rotted by thawing, while it still adheres firmly to the shore, and when there is a flood to wield it.