

# THE BOX BUTTE MEMBER OF THE SHEEP CREEK FORMATION, NEBRASKA.

R. C. CADY.<sup>1</sup>

**ABSTRACT.** Red and green clay with conspicuous white concretions, associated with impure sandstone and, locally, with volcanic ash, have been recognized as a separate lithologic unit in Box Butte County and surrounding areas in western Nebraska. The unit occupies the position in the geologic column of that area between the earliest recognized Pliocene (Ogallala) beds, and the latest known Miocene (Sheep Creek) beds. The unit, called Box Butte, is thought to be a member of the Sheep Creek formation. Most of the material comprising it is probably eolian in origin.

**T**HE lithologic unit for which the name Box Butte is to be proposed was recognized and studied during the summer and early autumn of 1938, in the course of a coöperative investigation of the ground-water resources of Box Butte County, Nebraska, by the Federal Geological Survey and the Conservation and Survey Division, University of Nebraska. Box Butte County is in the panhandle region of western Nebraska, and constitutes a part of the upland divide between the Niobrara and North Platte rivers which lies immediately west of the great sandhills region of central and western Nebraska. Most of Box Butte County lies on the upland plain, but the Niobrara River has eroded a deep valley trending east and west along the northern line of the county. On and near the upper slopes of the Niobrara Valley the Tertiary sediments, including the Box Butte, are best exposed. Snake Creek, a much smaller stream, crosses the southern part of the county in an east-southeast direction. The central and northern part of Box Butte County is underlain by beds of Miocene age to which the Nebraska geologists<sup>2</sup> have given the name Marsland formation. But in about one-half of this area it is covered by beds of the Box Butte unit. Ogallala deposits of Pliocene age are exposed in the eastern part of the county, and cover the Marsland and Box Butte sediments. In the southern part of the county near Snake Creek the Ogallala fills a deep valley that was cut through the Marsland beds. The Sheep

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<sup>2</sup> Schultz, C. B.: The Miocene of Western Nebraska: This Journal, Vol. 35, pp. 441-444, 1938.

Lugn, A. L.: Classification of the Tertiary system in Nebraska: Bull. Geol. Soc. Am., Vol. 50, pp. 1245-1276, 1 pl., 1939.

Creek formation, of which the new Box Butte unit is believed to be the uppermost member, was deposited during the late Miocene, in the interval between the end of the Marsland deposition and the beginning of the Ogallala deposition. The Sheep Creek formation, exclusive of the Box Butte member, fills narrow channels that were eroded into the top of the Marsland in Sioux, Box Butte, and Dawes Counties.

In most exposures in the upland areas of Box Butte County the upper beds assigned to the Marsland formation consist chiefly of massive, limy, sandy silt, alternating with thinner beds of characteristic blocky or lumpy sandstone. Lime impregnations have formed coatings around lumps of the sandstone, or vein-like mazes in the sandstone. On weathering the sandstone tends to disintegrate, leaving the harder, limy material as a resistant ledge or honey-comb mass. The top of the Marsland is a white, limy, slabby caprock as much as five feet thick. It is resistant to erosion. In most exposures the Box Butte member rests upon this caprock.

The Box Butte member consists of three parts. The lowest zone is a red clay, friable when dry, with a mottling of green. White, limy "potato" concretions are scattered through it, commonly in horizontal zones. The concretions have vertical axes as much as six inches in length, whereas they are only three to four inches in cross-section. They are cleanly separated from the matrix, and are so numerous as to give the whole material a white color from a distance. In most exposures this lowest subdivision is from 30 to 40 feet thick. In some localities the middle 15 feet of this basal zone is more silty and less plastic than the upper and lower portions. The red clay of the lower zone of the Box Butte is well exposed near the top of the southern slope of the Niobrara Valley in the northwestern part of Box Butte County. On the upland plain small exposures of it are common in the valleys of the smaller streams.

The middle zone of the Box Butte member consists chiefly of successive layers of brown and green blocky and lumpy clayey or silty sandstone. Most layers are from six inches to as much as two feet thick. As in the Marsland, these sandstones are impregnated with calcareous material, weather into honey-comb ledges, and are similar to those in the Marsland in all other respects.

The top zone of the Box Butte member is similar to the lowest zone, being a clay with white limy "potato" concretions,

but its color is predominantly green, with minor mottlings of red. It also seems slightly more silty. Its whole thickness is not definitely known, but it is probably about 15 feet.

The following section, which is here designated the type section of the Box Butte member, is situated in sec. 27, T. 28 N., R. 49 W.:

- Upper zone— 40 feet — Covered slope, at the top of which the top zone of the Box Butte member can be found by digging through the turf. Part of middle zone may be obscured in this covered slope.
- Middle zone— 25 feet — Lumpy and blocky brown sandstone in beds less than 2 feet thick. At two levels, about 20 and 30 feet above the base of the sandstone, there are two honey-comb limy ledges.
  - 2 feet — Lumpy, brown sandstone that weathers into a honey-comb ledge.
  - 8 feet — Limy, sandy silt, containing thin beds of brown blocky sandstone.
- Lower zone— 30 feet — Red clay with white concretions.

At an exposure in sec. 26, T. 28 N., R. 52 W. the following section may be seen:

- Middle zone— 4 feet — Covered slope.
  - 2 feet — Fresh, gray-white volcanic ash, parts of which are consolidated. It is very similar to the lower, lighter-colored ash in the gully west of Aphelops draw at the Sheep Creek section in Sioux County, west of Box Butte County.
  - 3 feet — Salmon-colored limy silt.
  - 23 feet — Green and gray, lumpy, impure sandstone grading toward bright olive green near top; weathers into honey-comb ledges.
- Lower zone— Red clay with white concretions of the lower division of the Box Butte member.

It will be noted that the ash, which is present in the latter sections, and presumably at the Sheep Creek section in Sioux County, is absent or obscured in the covered slope at the type section.

The exposures of the Box Butte member that show the three zones, or, more specifically, the exposures showing the presence of the Middle sandstone zone, are limited to the northern part of the Box Butte County, where the Niobrara Valley cuts it. Hence, it is believed that the middle zone is local, and does not extend very far south of the Niobrara Valley. Elsewhere the Box Butte member seems to consist wholly of clay with the conspicuous concretions.

Three points of stratigraphic evidence justify the separation of the Box Butte member from the Marsland formation on which it generally rests. (1) The four-foot, limy caprock at the top of the Marsland implies an extended interval of sub-aerial weathering and calcification of a caliche-like nature. (2) In sec. 33, T. 25 N., R. 50 W. on the lower slope of Snake Creek Valley, a remnant of the Box Butte concretion-bearing clay rests upon sediments of the lower part of the Marsland formation, showing the unconformable relation between the Marsland formation and the Box Butte member. (3) In Dawes County northeast of the hamlet of Dunlap, in sec. 33, T. 30 N., R. 47 W., the Box Butte member may be seen to overlie a channel-fill of Sheep Creek sediments. The Sheep Creek channel was cut into the Marsland formation and filled with brick-red silt and sand from which Sheep Creek vertebrate fossils have been taken.<sup>3</sup> At the top of the channel-fill the silt has been cemented with lime, indicating a halt in deposition. The red clay of the lower zone of the Box Butte member rests upon this cemented zone.

There seems no reason to doubt that the Box Butte is definitely younger than the Marsland formation, and indeed, younger than the channel-fill of the Sheep Creek. It is not so easy to determine whether it belongs to the Sheep Creek formation or to the Ogallala, or whether it is a separate formational unit. The final answer must await a careful appraisal of the faunal relations. Stratigraphically there are two opposing lines of evidence. On the one hand, the Box Butte was deposited near the bottom of the ancestral valley of the present Snake Creek. This old valley was cut through the Marsland formation before Ogallala time. Through it the Ogallala sands were

<sup>3</sup> The writer was taken to this outcrop by Grayson Meade, a paleontologist then collecting for the Nebraska State Museum, and by Albert Potter, then a collector for the American Museum of Natural History. Both were familiar with fauna taken from this channel, and are the authority for its age.

later transported, and some were deposited in it. But nowhere does the field evidence indicate that the Box Butte was eroded greatly before it was covered by the Ogallala. This suggests, but does not prove, a close geographic and chronological relation between the Box Butte and Ogallala units. On the other hand, the type of sediment of the Box Butte, particularly the blocky and lumpy sandstone of the middle zone, is very much like that of the Sheep Creek and Marsland formations. The volcanic ash in the Box Butte is similar to an ash in the Sheep Creek of Sioux County. This line of evidence suggests that the Box Butte was deposited under physical conditions approximating those of Marsland and Sheep Creek times. But it does not offer any sure guidance as to whether the Box Butte should be regarded as a member of the Sheep Creek formation or as a formation in its own right.

C. B. Schultz, of the Nebraska State Museum, has informed the writer that vertebrate fossils of Sheep Creek age were taken from the Box Butte sediments during the summer of 1939. M. K. Elias, of the Nebraska Geological Survey, is preparing a memoir on fossil grass seeds of the Tertiary, in which he shows that grass seeds taken from the Box Butte sediments are of Sheep Creek age. It appears, therefore, that these sediments should be regarded as a member of the Sheep Creek formation.

The full geographic distribution of the Box Butte member in western Nebraska is not known, but covers much of the central upland plain of Box Butte County, where it has been mapped; it is also present on the upland divide between the Niobrara and White Rivers to the north of the county. It is a useful horizon marker, especially on the uplands, where sediments of different ages may be of similar type, and where exposures are likely not to be of the best.

The Box Butte member, composed chiefly of clay and silt, and blanketing as it does the rolling pre-Ogallala topography, is probably a loess. The concretions are of the kind that might form in a loess. Evidently late in the Miocene the climate turned more arid. The deposition of loess appears to have been the culmination of the arid cycle and the last event in the Nebraska records before the beginning of the Ogallala cycle of deposition. The lower Ogallala deposits probably indicate a return to wetter climate.