ORIGIN OF THE PRAIRIE COTEAU, NORTHEASTERN SOUTH DAKOTA

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ABSTRACT

The Prairie Coteau is a broad upland in northeastern South Dakota rising several hundred feet above the prairie surface. Inspection of Landsat-1 imagery shows that the topographic form of the edge of the Coteau is similar to the V-shape produced by differential weathering and erosion of a plunging syncline. Detailed drilling in this area lends no support to a bedrock structure, however. Rather, the Coteau is believed to be largely the result of constructional moraines built up where Pleistocene glaciers parted between the James River and Des Moines lobes.

INTRODUCTION

A photogeologic interpretation of the surficial deposits in eastern South Dakota using Landsat-1 imagery was undertaken with emphasis on the effectiveness of locating glacial aquifers (Rahn and Moore, in preparation). During the course of this investigation the striking pattern made by the topographic escarpment along the edge of the Prairie Coteau was observed. This escarpment is particularly visible on the January 2, 1974, snow scene (Fig. 1).

POSSIBLE BEDROCK INFLUENCE

Photogeologists familiar with folded sedimentary rocks would probably associate the V-shaped plan outline of this escarpment with a plunging syncline. Because gently dipping rocks do exist in eastern South Dakota, veneered with hundreds of feet of glacial drift, the possibility exists that the general outline of the Prairie Coteau is preglacial and is caused by bedrock structure. The axis of the syncline would trend almost due north and would plunge slightly to the south.

The possibility of bedrock control of the Prairie Coteau was discussed by Flint (1955), who felt that the Coteau was probably only a topographic divide between the James River Lowland on the west and the Minnesota Red River Lowland to the east against which successive glaciers accented by piling moraines. Flint admitted, however, that more subsurface data were needed before any firm conclusion could be reached. Flint (1955) also agreed with Meinzer (Hall, Meinzer, and Fuller, 1911) who stated that, "It still seems altogether probable that the elevation of the Coteau is to large

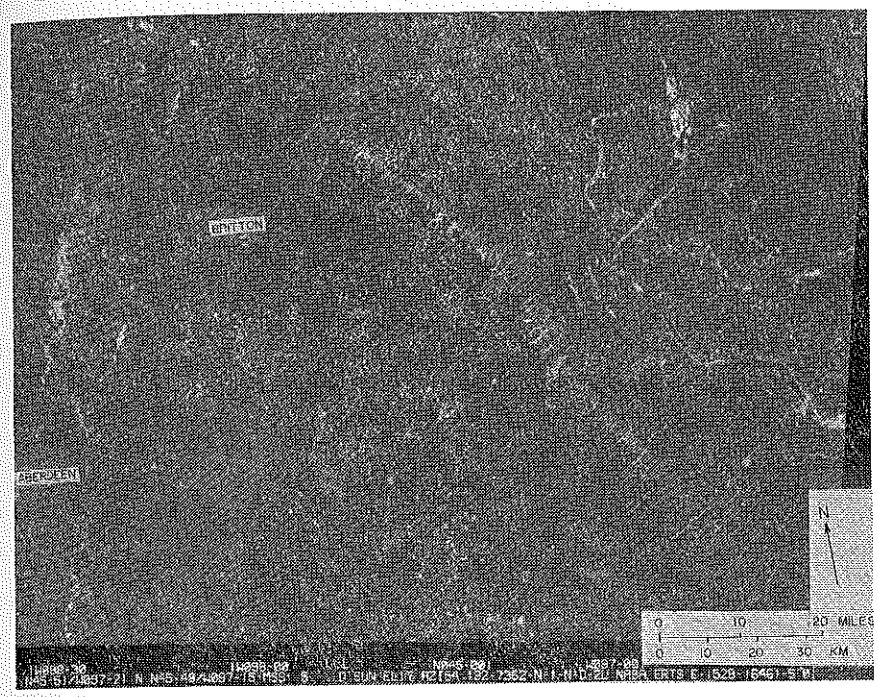

Figure 1. Landsat-1 image of northeastern South Dakota. Band 5, taken on January 2, 1974. Dark and light levels are reversed on this snow-covered scene. Areas covered with snow are dark; the light areas on Fig. 1 are either devoid of snow due to vegetation which emerges through the snow canopy, or are due to topographic irregularities which are accented by the low sun angle. The James River and Sand Lake are visible on the left; Lake Traverse is on the right. The high, northern end of the Prairie Coteau is accentuated by numerous small incised streams.

extent caused by older formations." Drill data by the South Dakota Geological Survey show that this statement is not accurate inasmuch as the difference in elevation between the Coteau and Lowland is about 400 feet, whereas the difference in elevation between the bedrock in these two areas is only about 100 feet (Fig. 2). Drill data indicates that the elevation of the Pierre Shale is rarely above 1,400 feet above sea level, whereas the elevation of the Coteau is well over 2,000 feet above sea level. Thus, the contrast in elevation is believed to be due largely to morainal deposits, not bedrock elevations. The present writer believes: (1) that Flint's statement that the Coteau is not a bedrock structure (resistant bed) is true, but

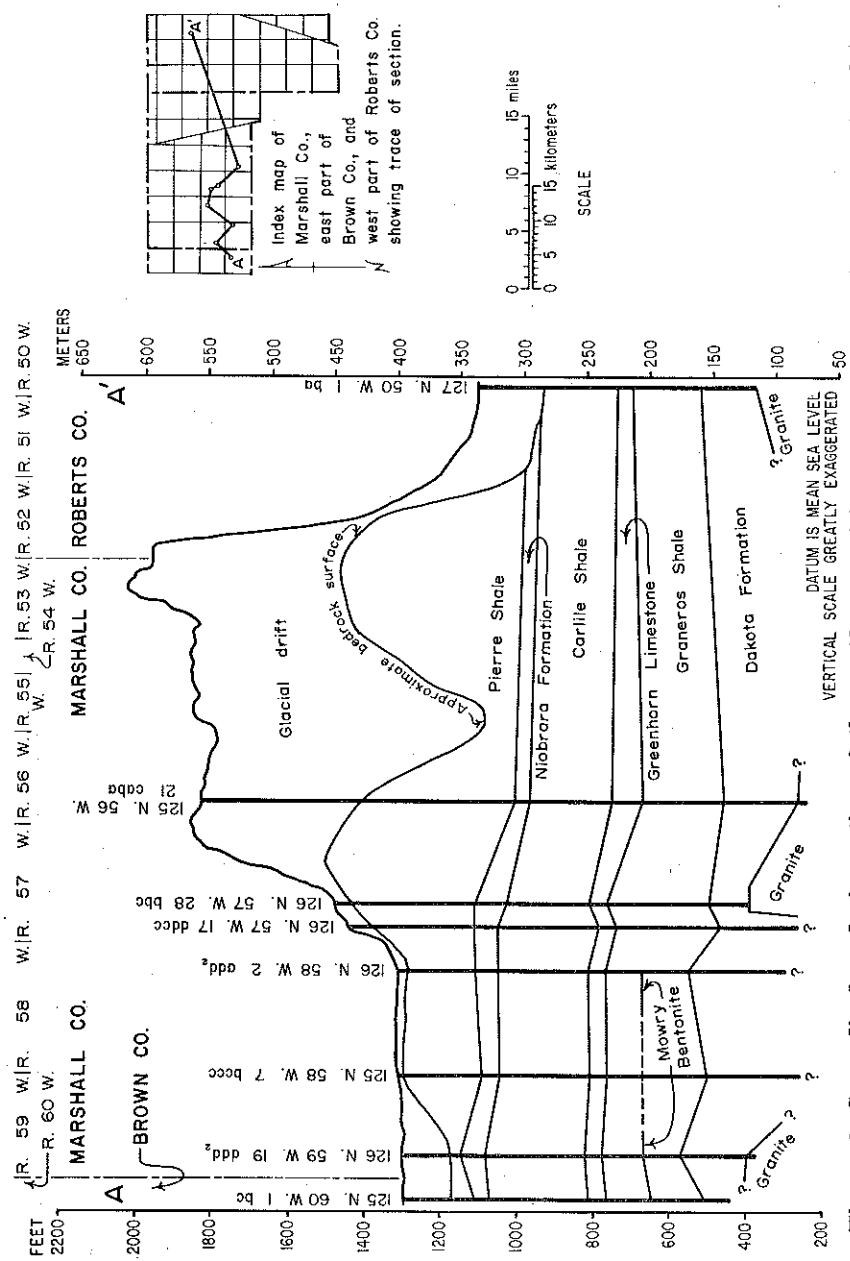

Figure 2. Generalized geologic section of the northern Prairie Coteau (from Koch, 1975, p. 12). The valley shown in the Pierre shale under Range 55 West may not exist.

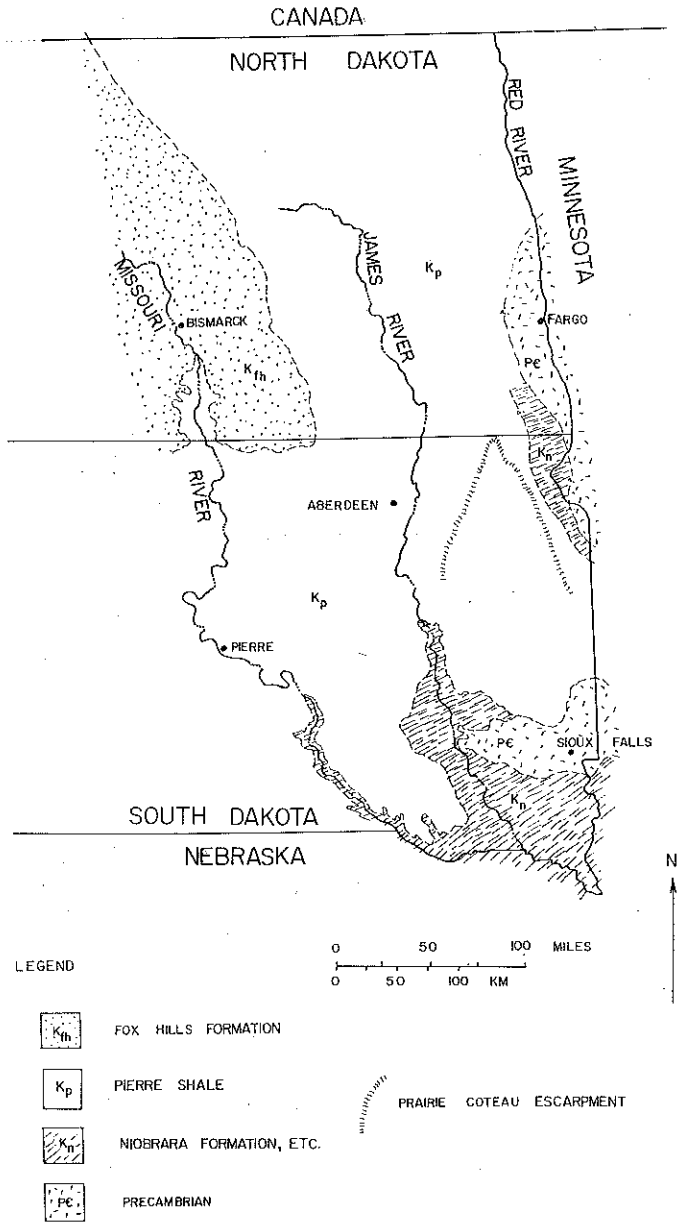

Figure 3. Simplified bedrock geologic map of eastern South Dakota and North Dakota. Compiled from numerous sources. The Niobrara Formation shown also includes the underlying Carlile, Greenhorn, Graneros and Dakota Formations at some places. The outline of the Prairie Coteau as identified on Landsat-1 imagery is shown.

(2) that the elevation of the Coteau is largely caused by deposition of moraines, and not, as Flint states, caused by a bedrock high.

The general sequence and dating of glacial events in the northern Great Plains is described by Lempke, et al. (1965). Figure 2 is a geologic cross-section across Marshall County, including parts of Brown and Roberts Counties in northeastern South Dakota. This section was determined after a detailed study of the geology and hydrology of Marshall County (Koch, 1975). The section and other data presented by Koch (1975) shows that although the glacial drift is thicker under the Coteau than surrounding Lowlands, the bedrock does stand slightly higher under the Plateau. The Coteau area apparently was a small interfluve area in preglacial time. The bedrock is the Pierre Shale, which is almost horizontally bedded. Thus, based on abundant drill-hole data there appears to be no grounds for structural control of the Coteau, such as a syncline. In addition, there appears to be no ridge-forming sediments in the Pierre Shale capable of making the escarpment shown in Figure 1. According to Lee Clayton of the North Dakota Geological Survey (personal communication), part of the Pierre Shale (the Odanah Member) contains hard siliceous shale which locally forms a cliff, but studies in North Dakota show that the Missouri Coteau escarpment cuts across this bedrock unit as well as other formational contacts, and thus the present topography seems to be glacially derived.

Figure 3 shows the general geology of eastern South Dakota and North Dakota. The Pierre Shale-Niobrara Formation contact east of the Prairie Coteau is shown. This contact appears to trend north into North Dakota. If the Prairie Coteau is indeed a plunging syncline, the contact should swing around and come back down on the west side of the Prairie Coteau. Unfortunately there is too much glacial drift to determine the bedrock contacts with certainty, but limited evidence from test drilling to date suggests that the contact does not swing around.

CONCLUSION

The present writer agrees with Flint (1955) and other geologists who argue that the Prairie Coteau is the result of successive glaciers plastering moraines against the side of a small topographic interstream divide. The two lobes of late Wisconsin ice, the westerly James Lobe and the easterly Des Moines Lobe, parted at this divide. As the ice spread to the south, lateral and other moraines were dumped on its sides, perhaps like mudflow or lava levees build against channel sides. Johnson (1970) describes the mathematical similarities between the rheological properties of mud, lava, and ice, and shows how levees may be formed by all these viscous slurries where a rigid plug exists in the center of the flowing mass.

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