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## Remarkable Prairie Synclinorium

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## REMARKABLE PRAIRIE SYNCLINORIUM.

CHARLES KEYES.

Geotectonics of great plains regions seldom offer very much attraction for structural studies. Large plains are almost universally tracts especially notable for their deep soils. Rock-exposures are few in number and unimportant. There are no marked contrasts of relief. These lowlands are frequently true peneplains the surfaces of which are either still lying near sea level or are but recently raised only slightly above it.

The upper Mississippi basin is just such a region as that postulated. Its surface is so deeply covered by glacial debris, wind-borne loess, and fine soils that the bedrock of entire counties is hardly mapable even approximately. The superficial inequalities are so small, the slopes of the streams so slight, and much of the substructure so soft that rock outcrops are infrequent and give little clue to the attitude of the bedded terranes beneath. Beyond the expressed belief that the strata of the substructure are flat-lying or only slightly inclined mention is seldom made of the regional tectonic features.

Recent years witness a great relief to the difficulties of interpretation of the geologic structures of this region. Numerous deep-wells put down in quest of good water supplies sufficient for municipal purposes indicate clearly the larger features of tectonics. Many of these borings go down distances of 2,000 feet or more. Inasmuch as the principal aquifer of the Iowa region is the St. Peter sandstone deep-borings endeavor to sink to this horizon. By connecting the various boring records along different lines the formations between the St. Peter sandstone and other well known layers are also more or less readily and accurately determined. The resulting sections disclose the fact that there is well-defined flexing that is far from being so simple and so slight as is commonly supposed.

As elucidating some of the broader tectonic features of the prairie region certain of these geologic cross sections are particularly instructive and suggestive. The line of one section connecting two insular outcrops of very old rocks, or pre-Cambrian formations, passes entirely across the western part of

our state. It extends from Sioux Falls, South Dakota, southward or southeastward to the crest of the Ozark dome, in southeast Missouri. This is a section about 600 miles long. From the north end to a point east of Kansas City the section coincides closely with the course of the Missouri river, affording the best surface exposures in all the region. Along this line are an unusual number of deep-wells having good records of the formations penetrated.

This cross section presents the form of a great trough, ending at each extremity in an old mountain ridge. Something of an adequate conception of the grand proportions of this structure is gained from the statement that the middle of the syncline is depressed a distance of more than two miles below the ends. Each of the raised extremities of the section is a part of a notable mountain ridge which in early Mesozoic times trended northeast and southwest across the Upper Mississippi Valley region.

The northern one of these ranges is now designated as the Siouan mountains. Its features are figured forth in a recent paper read before this Academy. The geologic history of this remarkable orogenic elevation is, briefly, this: Since all the Paleozoic formations take part in the arching while the Cretacic rocks do not, it is quite evident that the main movement or uprising occurred in early Mesozoic time. At the beginning of Comanchan deposition (Early Cretacic), when this portion of the continent was a land area, the country was again completely base-leveled, the Siouan arch as well as the lower lands. Upon this even plain, worn out on the bevelled edges of the ancient strata, which was then gradually carried beneath sea-level, sediments were laid down during Mid Cretacic times. These are the deposits which cover the northwestern portion of our state and out of which peeps the crestal remnant of the old arch, called by us the Sioux Quartzite area.

The Siouan mountains were rapid in formation and rapid in their decline. At the time of their highest stage their crests probably stood 3,000 to 4,000 feet above the surrounding country. They were greatly diversified. In the Black Hills, the Ozarks, and the Appalachians of today we find their nearest counterparts.

A similar history obtains for the Ozarks. In early Mesozoic times they too were notable positive features of landscape. As

in the case of the Siouan mountains they were in Comanchan time completely leveled and worn down nearly to the level of the sea. Unlike the instance of the Siouan elevation the Ozark perfectly peneplained area was in Tertiary times again elevated, the summit of the great dome attaining a height above the sea of more than 2,000 feet. This is the elevated region which we see today, modified from its original condition only by the trenching of modern rivers.

To us in Iowa the features of the broad trough and its vast economic consequences concerning our welfare are of first importance.

This great trough is not a simple flexing of strata on a large scale; but a bending of a section already affected by numberless foldings and faultings. It is, therefore, a true synclinorium, and, withal, one of the most typical known.

One of the most notable, as well as one of the most unexpected features connected with this synclinorium is the presence of a number of extensive dislocations. Two of these faults have displacement values of 125 and 350 feet respectively. The lines of fracture have a northeast and southwest direction—parallel to the axial trend of the Siouan and Ozark mountain ridges. These faults appear to be members of a system of sub-equally spaced stratigraphic breaks, 25 miles apart, that traverse nearly, if not quite, the entire width of the state. Since the presence of such a fault-system is foreshadowed indications of other notable faults are made known at the expected intervals. The recognition of these great faults in Iowa where they are wholly unlooked for, explains a host of anomalies concerning the areal distribution of the Paleozoics beneath the deep covering of till that have long puzzled Iowa geologists.

The geologic date of this regular spaced faulting is fixed by a number of circumstances. It appears to be Mid Tertiary, and hence coeval with the last uprising of the Ozark dome. This association of the two events is especially significant in that it immediately supplies an adequate reason for their presence at the points at which they are actually found. In eastern Missouri the orogenic strain seems to have been relieved mainly by a single dislocation; and the famous Cap au Grès fault which intersects the Mississippi river at the mouth of the Illinois river has a throw of more than 1,000 feet. The faulting is, of course, an event long subsequent to those of the Siouan and older Ozark

mountain building. Both the latter and the production of the great synclinorium belong to Early Cretacic, or Comanchan time.

The later physiographic features of the region are also not without great interest. With the planing down of the mountains and the peneplanation of the entire region in Comanchan times the Mid Cretacic deposits were laid down over the old land area not only where they are found outcropping today, in northwestern Iowa and southeastern Missouri but they doubtless once extended unbrokenly over the whole country intervening. This surmise is substantiated by the recent discovery, in Mercer county, Missouri, far beyond the southernmost known extension of the Nishnabotana sandstone in Iowa, of undoubted ledges of typical Dakotan sandrock.

Below the floor of the Cretacic formation, the Comanchan baselevel, more than 2,000 feet of Late Carbonic sediments appear to have been removed from the Iowa area. This section includes besides about 200 feet of the Missourian series, 700 feet of the Oklahoman series, and 1,000 feet of the Cimarronian series.

To the downward bending of the rocks in the great tract between the Siouan and Ozark mountain regions we owe the preservation of our vast stores of mineral fuel. Were it not for this circumstance we would not have within the borders of our state a single workable deposit of coal. Our entire commonwealth would be as barren of coal as now are northeastern Iowa, northern Illinois, Wisconsin and Michigan—vast areas over which the productive coal measures without question originally extended, but which were removed during the prodigious denudation which took place over all this region during Comanchan times.