# PRECAMBRIAN BASEMENT ROCKS OF SOUTH DAKOTA [1]

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## INTRODUCTION

During the past 100 years many hundreds of wells have been drilled through the sedimentary section and into the Precambrian rocks which make up the foundation or "basement" of South Dakota; as much as 10,000 feet of sedimentary rocks have been deposited on this basement. Unfortunately the geologic records of most of these wells will never be known; only about 210 water wells and oil tests drilled in the State have good records of the Precambrian that they penetrated.

Some wells, especially oil tests, were drilled many feet into the Precambrian in the search and hope for oil. When the sponsors became frustrated and financially spent, the holes were abandoned and oil was sought in more favorable areas. More prudent oil operators abandoned hope upon encountering the Precambrian "suitcase sandstone," so called because when knowledgeable drillers hit the basement they knew they should quit the hole, pack up their suitcases and move on to a new location.

Why, then, is it desirable to study Precambrian if there is no hope for oil in the rocks making up the basement? It is difficult to answer this question without first reviewing some of the facts we know about the Precambrian.

## SURFACE OF PRECAMBRIAN BASEMENT ROCKS

In general the surface of the basement in South Dakota slopes from east to west across the State. It is over 1500 feet above sea level on the Sioux Ridge in eastern South Dakota and drops gradually to the northwest into the Williston basin to an elevation of less than 6,500 feet below sea level. The slope of the basement on the west side of the basin is much more abrupt, rising from the bottom to over 7,000 feet above sea level in the Black Hills, a maximum relief of nearly 13,000 feet.

The surface is actually much more rugged and irregular than is shown on the map (Fig 1). The 1000-foot contour line in the eastern part of the State most nearly indicates the irregularity on the basement surface because there are more control points here than in western South Dakota.

[1]Publication authorized by the South Dakota Geological Survey.

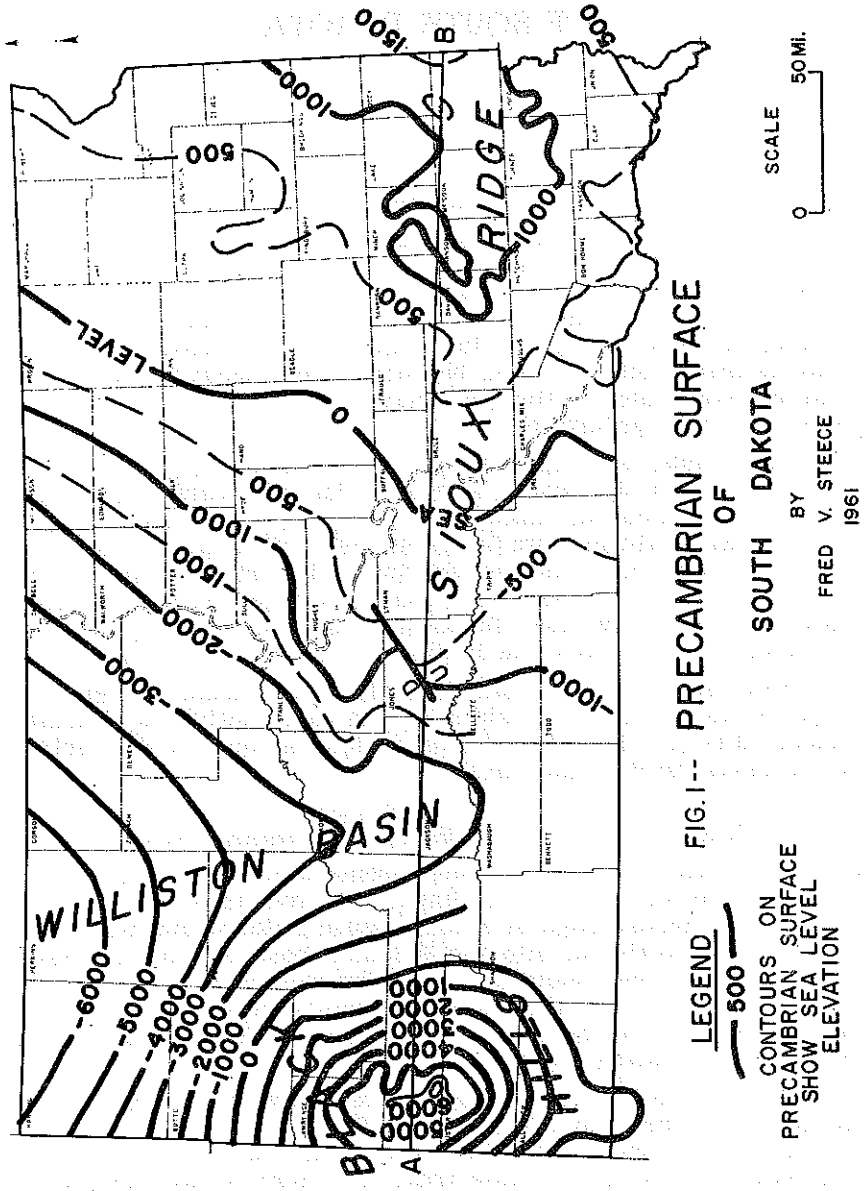


FIG. 1-- PRECAMBRIAN SURFACE OF SOUTH DAKOTA BY FRED V. STEECE 1961



## COMPOSITION OF PRECAMBRIAN BASEMENT ROCKS

The Precambrian basement is made up of a wide variety of rocks. Probably the most uniform single rock formation is the Sioux Quartzite which maintains its character over a distance of 250 miles, from southwestern Minnesota to Haakon County in central South Dakota (Fig. 2). Although the term quartzite implies that the rock is metamorphic, it is not. The Sioux Quartzite is an orthoquartzite, that is, a sandstone which has been thoroughly and tightly cemented with silica. The term quartzite is used here only because it is well established in the literature. The rock might better be termed a formation for it consists not only of orthoquartzite but also of interbedded claystones and siltstones known as Pipestone or Catlinite, and beds of coarse conglomerate at its base. The quartzite of the Sioux crops out extensively in the eastern part of the State. The entire Sioux Formation has been estimated by Baldwin (1949) to be about 5000 feet thick.

The area of the Sioux Formation is surrounded and underlain by a vast region of granite, which current studies show to be similar to the granite that crops out at Milbank, and is older than the Sioux Formation. This is commonly biotite granite characterized by pink to salmon-colored microcline.

Interspersed throughout the granite area are metamorphic rocks, chiefly schists, which may well record an early Precambrian mountain building.

Extrusive rocks, mainly porphyrys, are present in the granite area and near the northern edge of the Sioux area. It is possible that these rocks resulted from the crustal warpings which deformed the Sioux Formation.

The Black Hills is composed of a complicated sequence of early Precambrian metamorphic rocks complexly folded and faulted by ancient mountain building forces, and granitic rocks which intrude them.

Magnetitic gabbro is present in the Sioux area and is the granite area of southeastern South Dakota.

The hypothetical relationships of these rocks are shown in the cross-section, Figure 3.

## ECONOMIC IMPORTANCE OF PRECAMBRIAN ROCKS

The tremendous economic value of the Precambrian rocks of the Black Hills is well known. Many minerals including gold have made these rocks an important part of the economy of South Dakota. Likewise, in Eastern South Dakota the Precambrian rocks have contributed to the State's economy as structural and ornamental stone.

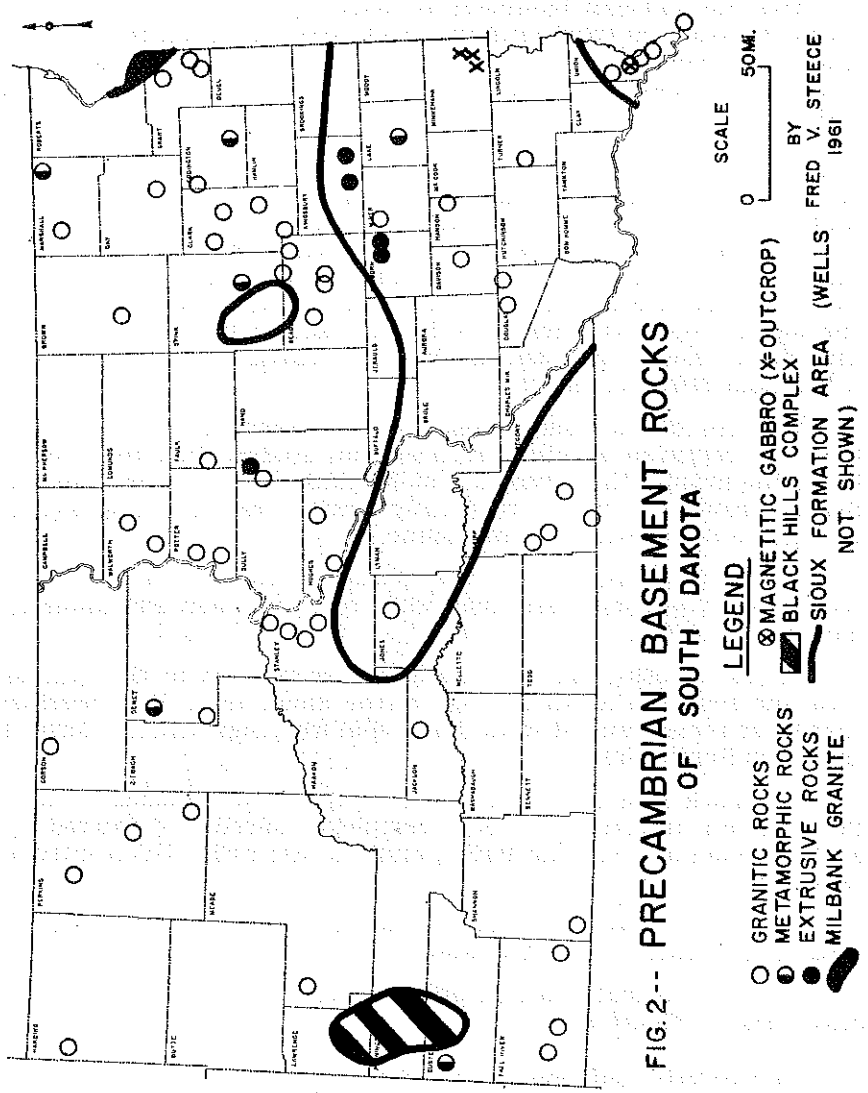


FIG. 2-- PRECAMBRIAN BASEMENT ROCKS OF SOUTH DAKOTA



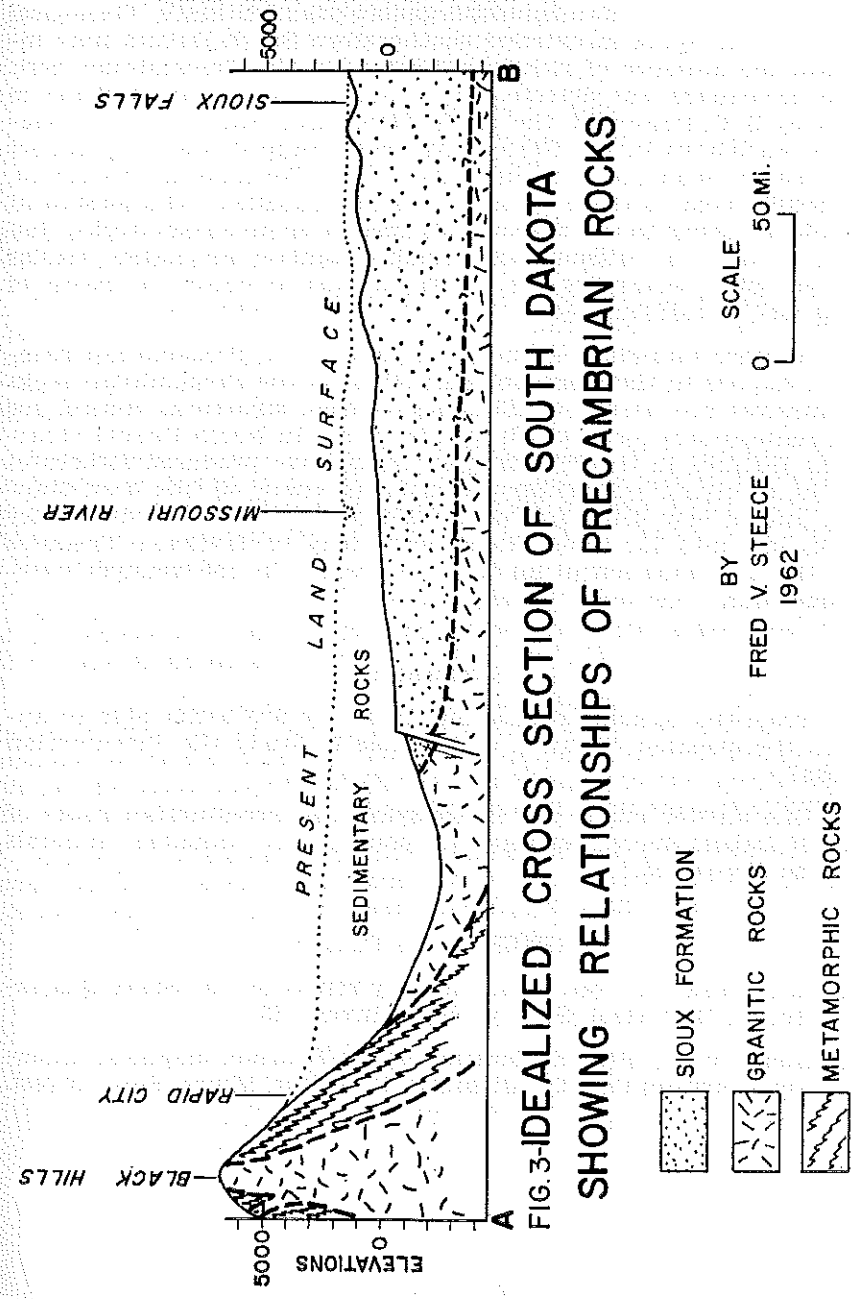


FIG. 3-IDEALIZED CROSS SECTION OF SOUTH DAKOTA SHOWING RELATIONSHIPS OF PRECAMBRIAN ROCKS

A recent find of magnetitic gabbro by the State Geological Survey near Spink in extreme southeastern South Dakota may indicate the presence of rich iron deposits in the Precambrian here. The occurrence was detected by a magnetometer survey made in 1961 by B. C. Petsch of the State Geological Survey. Other magnetic anomalies in the State have been mapped and may reflect potentially economic iron deposits in the Precambrian basement, although most of these have not yet been drilled. The gabbro at Spink is buried beneath about 800 feet of sedimentary rocks, but iron deposits in Missouri expressing magnetic anomalies similar to the Spink occurrence are known to exist at depths in excess of 1600 feet (McMillan, 1946).

Another important economic aspect of the Precambrian basement applies to the seach for oil. Whereas the Precambrian rocks themselves are barren of oil, they provide structural control for the sedimentary rocks which overlie them. In North Dakota structural features in the Precambrian rocks have produced structures in the overlying sedimentary formations where oil has been trapped and is now being produced. Where the younger sedimentary rocks lap onto the Sioux Ridge there may be favorable localities for the accumulation of oil if oil is present in the younger overlying rocks.

## SUMMARY

From the forgoing discussion, then, we are better able to answer the question "Why is it desirable to study the Precambrian rocks?"

One answer might be "In studying the Precambrian rocks of South Dakota more deposits of economically valuable minerals will be discovered."

## REFERENCES CITED

Baldwin, Brewster, 1949, A preliminary report on the Sioux Quartzite: S. Dak. Geol. Survey, Rept. Invest. 63.

McMillan, W. D., 1946, Exploration of the Bourbon magnetic anomaly, Crawford County, Missouri: U. S. Bur. Mines, Rept. Invest. 3961.