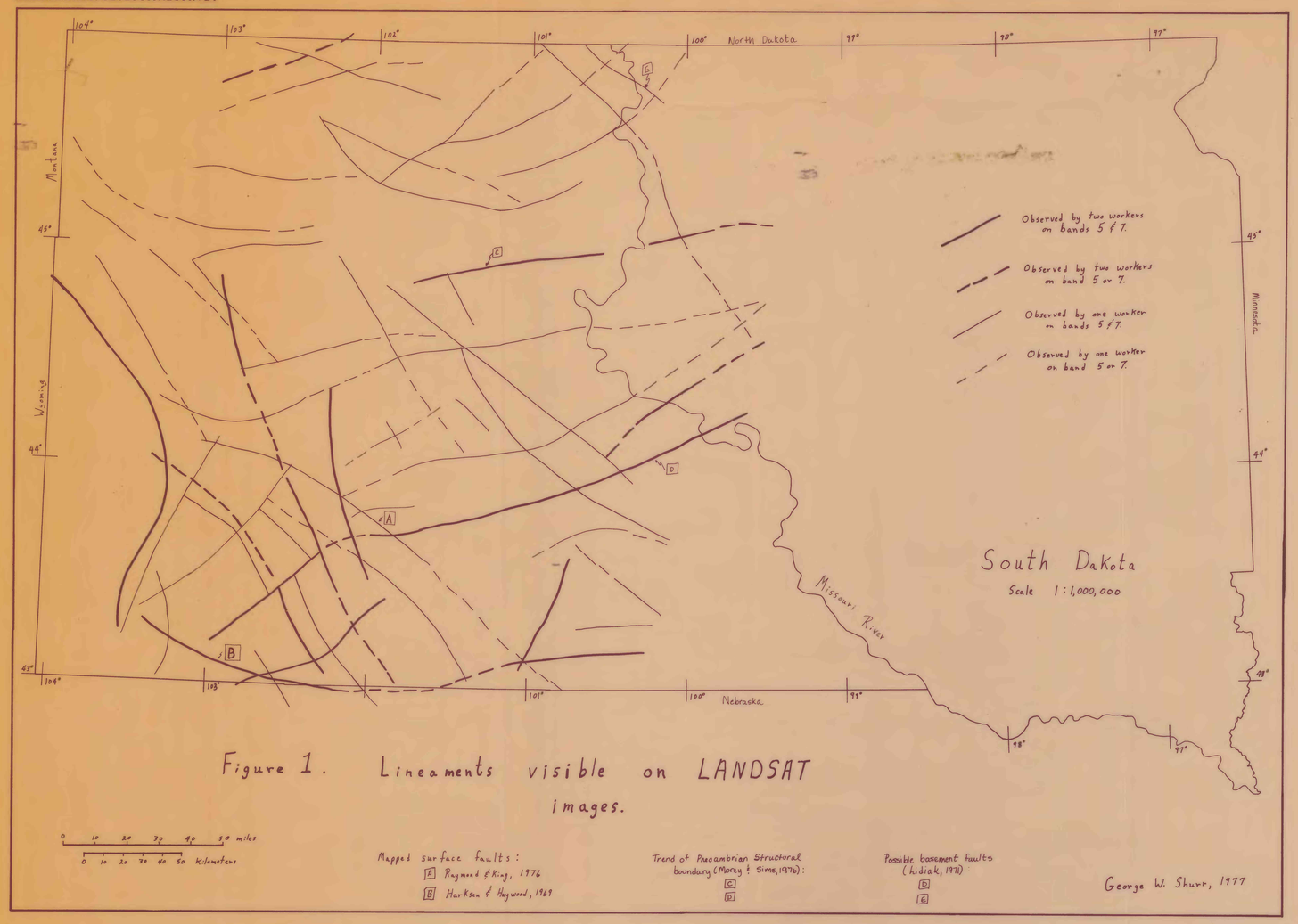

Figure 1. Lineaments visible on LANDSAT images.

LANDSAT LINEAMENTS IN WESTERN SOUTH DAKOTA

By
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U.S. Geological Survey
OPEN FILE REPORT
This map is preliminary and has not been edited or reviewed for conformity with Geological Survey standards or nomenclature.

INTRODUCTION

In South Dakota, oil is currently produced from Paleozoic carbonates in the northwestern corner of the State. There is also potential for hydrocarbon production, particularly shallow biogenic gas, in widespread Cretaceous chalks and sandstones; however, drilling programs have been modest, subsurface information is limited, and the State remains essentially a frontier area. In an area such as this, where subsurface control points are widely separated, lineaments are useful in the construction and interpretation of structural and stratigraphic maps.

TECTONICS

The term lineament is used here as a structural feature, although the exact nature of these features is not known. In the Great Plains, immediately to the north of South Dakota, Thomas (1976) has described a tectonic model which visualizes lineaments as zones of weakness subdividing the crystalline basement into discrete blocks. Paleotectonic movements of the basement blocks influenced sedimentation and hence patterns on stratigraphic maps bear a resemblance to the grid of lineaments bounding the blocks.

The lineaments shown for western South Dakota (fig. 1) were mapped on Landsat images by two workers. An uncorrected mosaic was compiled from the seven scenes shown on figure 2. Unenhanced images in bands 5 and 7 were employed. A ranking of the importance of individual lineaments is provided by comparing the maps of two workers. Lineaments seen by both interpreters on both bands 5 and 7 are ranked as most important; those seen by both workers on 5 or 7 are less important; and those seen by one worker on 5 or 7 are least important. The lineaments shown in figure 1 seem to have expression in the vertical-intensity magnetic map of South Dakota (Petsch, 1967). Lineaments were not mapped in the crystalline core of the Black Hills, although many were visible on the images.

Surface mapping is not extensive in the region, but in at least two locations (A & B, fig. 1), geologic maps show faults which correspond with lineaments. Several major lineaments (C & D, fig. 1) seem to be on-trend with a structural boundary between Precambrian terranes in the basement (Morey & Sims, 1976). In addition, a basement fault has been postulated by Lidiak (1971) near the lineaments shown at locations D & E, figure 1.

STRATIGRAPHY

The grid of lineaments seems to correspond with patterns visible on stratigraphic maps. A map of the maximum westward extent of chalk tongues in the Niobrara Formation is shown in figure 3. Facies lines on this map were drawn with the aid of the lineaments mapped from satellite images. The maximum eastward extent of a shale tongue separating units in the Dakota Sandstone is shown in figure 4. The facies line on this map was drawn by Schoon (1971) without prior knowledge of the lineaments and yet there is remarkable correspondence. The stratigraphic units illustrated in both of these examples are horizons with good potential for shallow biogenic gas.

CONCLUSION

Lineaments are easily mapped with Landsat images and are useful in the exploration for hydrocarbons. As structural features, lineaments may mark the location of structural traps and zones of fracture porosity. However, subtle paleotectonic aspects of lineaments may be even more important than obvious structural significancies. Movements on basement blocks could have influenced migration of fluids and controlled the deposition of source beds of reservoir rocks. Thus, a grid of lineaments may provide valuable insights into stratigraphic geometries.

ACKNOWLEDGMENTS

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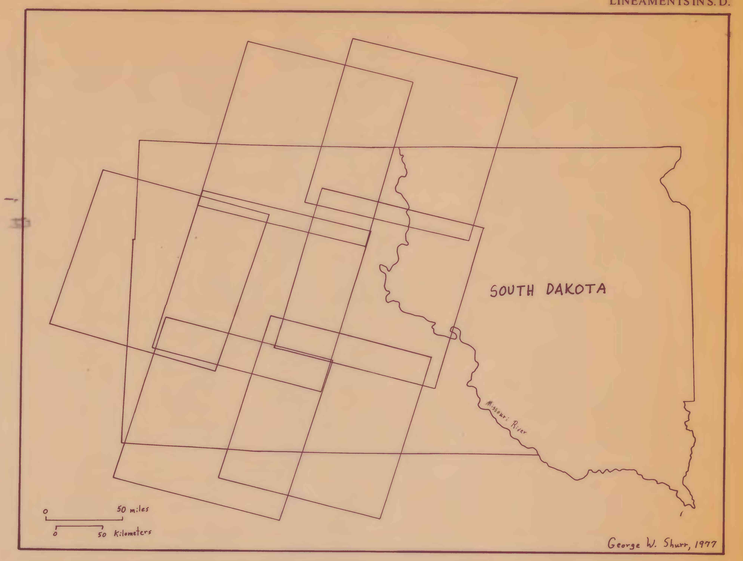

Figure 2. Images employed in mapping lineaments.

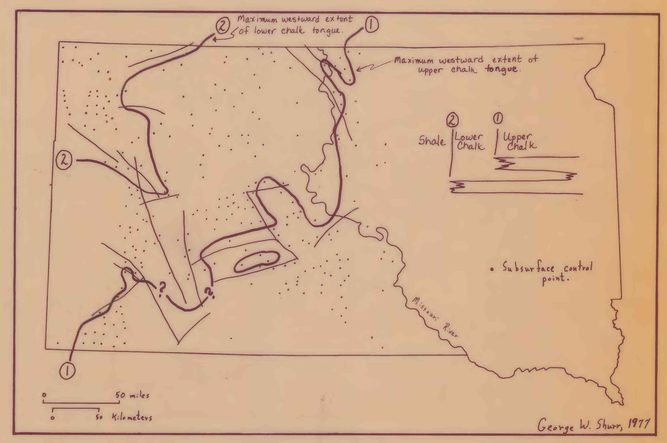

Figure 3. Lineament control of facies in the Niobrara Formation.

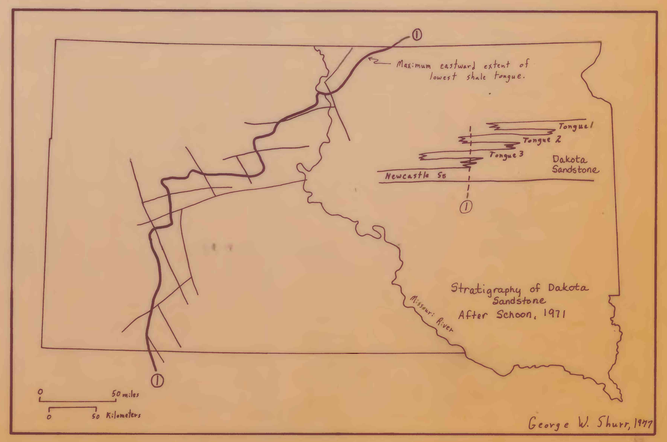

Figure 4. Lineament control of facies in the Dakota Sandstone