Report of Investigations No. 106

REVIEW OF OIL POSSIBILITIES IN HARDING AND BUTTE COUNTIES WITH EMPHASIS ON THE NEWCASTLE SANDSTONE

by Robert A. Schoon, 1972
SOUTH DAKOTA GEOLOGICAL SURVEY

COVER: Indian Signal Hill near Ponca Creek in the extreme south-central part of South Dakota. These cairns or monuments for the most part were constructed by sheepherders at the turn of the century. Perhaps these cairns were monuments to some event in the lonely sheepherder's life, or to mark a particular vantage point from which the herder could watch the sheep with minimum effort, or maybe merely to serve as a source of shade in treeless areas. At any rate they are there, for perhaps a legion of reasons. Cairns, such as that pictured, some as large as five feet in diameter and as high as a man can reach, are even today present in Butte and Harding Counties - the area of this report.

Photo by J. E. Todd, pre 1908

STATE OF SOUTH DAKOTA
Richard Kneip, Governor

SOUTH DAKOTA GEOLOGICAL SURVEY
Duncan J. McGregor, State Geologist

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by

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Science Center
University of South Dakota
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1972

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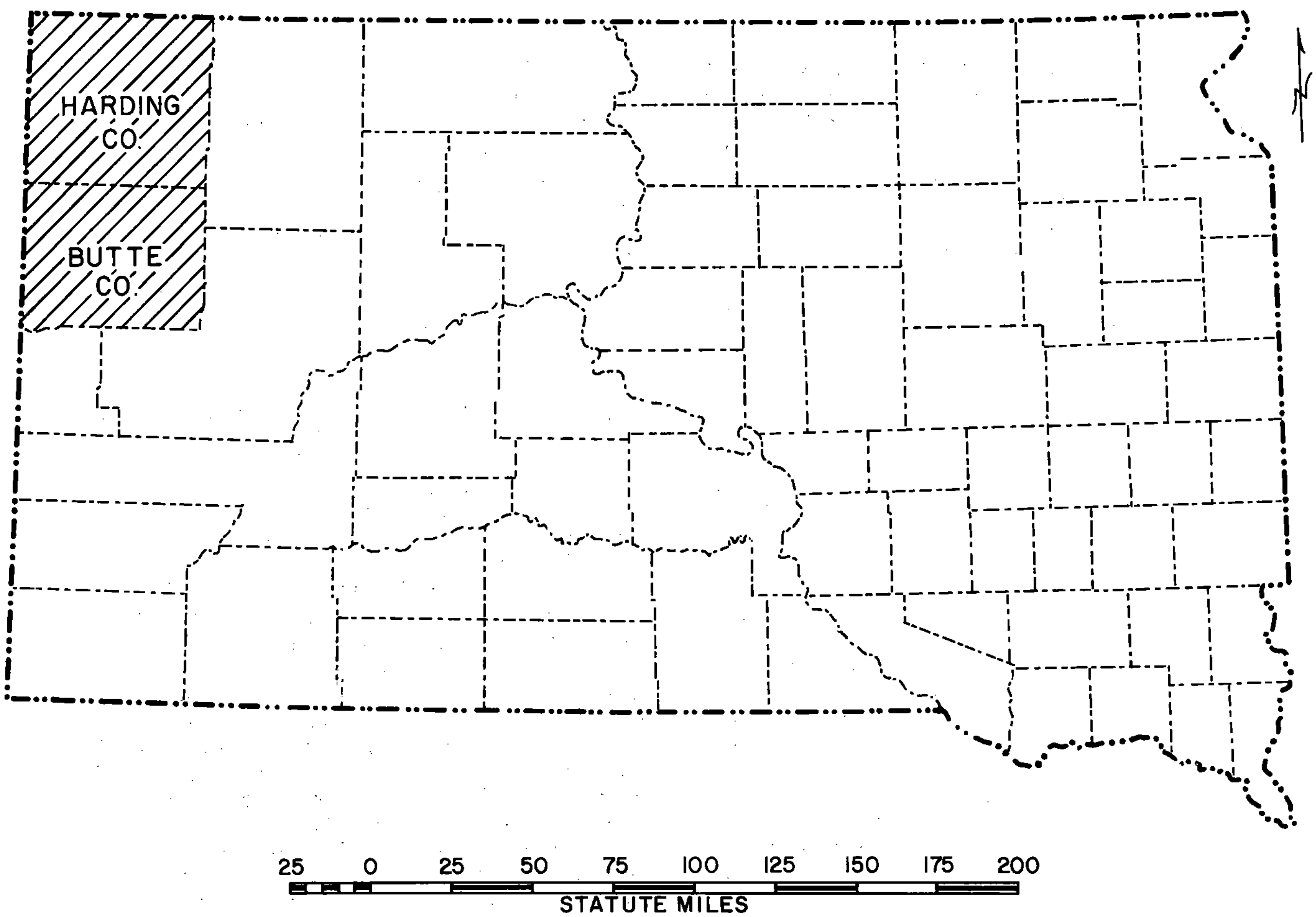


Figure I. Map of South Dakota showing location of Harding and Butte Counties.

PURPOSE

Harding and Butte Counties, situated in the northwestern part of South Dakota (fig. 1) compose an area that has recently undergone a flurry of exploratory test drilling for oil. For the most part, the objective of the drilling programs has been the sandstone that is present between the Mowry Shale (above) and the Skull Creek Shale (below). This sandstone has been identified by various names by different authors. The term one chooses to employ in defining this sandstone is academic and is not instrumental in finding oil per se. However, the origin and mode of deposition of the sandstone, herein referred to as the Newcastle Sandstone, play a vital role in the search for oil. Therefore, the purpose of this report is to set forth some general observations concerning the deposition of the Newcastle Sandstone.

HISTORY OF EXPLORATION

Interest in the Newcastle Sandstone as a potential oil producing unit was sparked as early as March 13, 1918, when the Ohio Oil Company encountered the Wall Creek Sandstone at a depth of 2689 feet. Yield from the well was 80 barrels of oil per day. The well was subsequently deepened to 3665½ feet and penetrated the "main oil sand" or Newcastle Sandstone (Hancock, 1921, p. 116). The finished well yielded at the rate of 1500 barrels of oil during an initial 24 hour test. This was the discovery well of the Lance Creek Oil Field in Wyoming, located about 45 miles southwest of Edgemont, South Dakota.

Subsequent drilling established numerous oil fields progressively northward in Wyoming near the periphery of the Black Hills uplift. However, the productive trend of the Wyoming wells did not have a great impact on drilling activity in northwestern

South Dakota. On June 6, 1967, the Exeter Federal McCarrel No. 33-1 oil test (sec. 33, T. 8 S., R. 54 E.) Powder River County, Montana, recovered 450 feet of water and 2700 feet of free oil on a drillstem test of the Muddy Sandstone. This well was completed with an initial production of 230 barrels of oil per day and proved to be the discovery well of the giant Bell Creek Oil Field. A lease play, based on the results of the discovery well, extended as far east as the Missouri River in South Dakota. Subsequent drilling in South Dakota has generally centered in Harding and Butte Counties.

DEFINITIONS OF UNITS

Four units have been employed in this general study; these are the Mowry Shale, the Newcastle Sandstone, and the upper and the lower Skull Creek Shale. These units appear as drawn in figure 2 and closely correspond with previously defined formational boundaries of earlier authors. The top of the Mowry Shale (fig. 2) has been drawn at the base of a relatively intense gamma-ray reading. As thus defined, the top of the Mowry was used as the datum in constructing a structure map (fig. 3). The base of the Mowry Shale is marked by the Newcastle Sandstone where present. Where the Newcastle Sandstone is not present the base of the Mowry coincides with the top of the upper Skull Creek Shale and is usually marked by a slight increase of resistivity values on the electric log. The Newcastle Sandstone is bounded to a minor extent by the Mowry Shale (above) and to a major extent by the upper Skull Creek Shale (below).

The top limit of the upper Skull Creek is the base of the Newcastle where present. Where the Newcastle is absent the top of the upper Skull Creek coincides with the base of the Mowry Shale, and the base is arbitrarily placed at the mid-point of a rather persistent silty zone near the middle of the Skull Creek Shale (fig. 2). The lower Skull Creek underlies the upper Skull Creek and includes those sediments that are present downward to the top of the Fall River Sandstone.

STRUCTURE

Although Harding and Butte Counties are located in an area that has been the focus of drilling activity, many block areas remain untested by drilling. Thus, any structural and/or stratigraphic map of the area is highly interpretive.

With the exceptions of the Black Hills uplift and the Williston basin the most prominent structure is the anticline that is situated in Ranges 1 and 2 East, Townships 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, and 22 North (fig. 3). This anticlinal structure plunges north 10° west at an average of 45 feet per mile. The steepest dips are found on the west flank of the structure which may be a northward extension of the Whitewood anticline described by Petsch (1949).

A second structure in Township 10 North, Range 6 East trends north approximately 20° west and is shown in figure 2. Because of the paucity of data this structural interpretation is quite tentative and the configuration may be changed greatly by future drilling. Thickness intervals of the Newcastle Sandstone (fig. 4) show thinning and may suggest slightly elevated areas during Newcastle deposition. Other smaller structures are indicated on the structure map (fig. 3) which are somewhat more conjectural than the two above-mentioned structures.

DEPOSITIONAL HISTORY

The Newcastle Sandstone in South Dakota has long been known to occupy approximately the same time-space interval as the Muddy Sandstone in Montana. Precise lateral limits of these two sandstone units are conjectural due to similar lithology and the paucity of drill hole information. In this report the sandstone at the top of the Skull Creek has been mapped as the eastern-derived Newcastle Sandstone. If the western-derived Muddy Sandstone is at all present in South Dakota it is limited to the western part of the studied area as shown in figure 4.

Many theories have been advanced concerning the deposition of the Newcastle Sandstone. These theories are questioned in view of general observations. For example, Crowley (1951) postulated uplift in the central part of the Black Hills whereby the Precambrian core was exposed and supplied sediments to form the Newcastle. Such an idea is suspect because the Newcastle is the western extension of the lower tongues of the Dakota Sandstone which was derived from an eastern source and not from the Black Hills area.

If the Black Hills were uplifted just prior to Newcastle deposition, the uplift would have had to be of sufficient magnitude to expose the Fall River Sandstone to subaerial erosion because the Fall River is the youngest formation that could have conceivably yielded sand-sized sediments to the Newcastle. Before the Fall River could become a source bed, the Skull Creek Shale would have had to be completely eroded in the central part of the Black Hills. Whether or not this occurred cannot be proved; however, there is no concrete evidence the Skull Creek was subjected to subaerial erosion anywhere in the periphery of the present Black Hills outline (figs. 5 and 6). Thinning of the Skull Creek does occur near the Black Hills area but is no more pronounced than in other localities of the mapped area west of the Dakota Sandstone delta complex (fig. 7).

Most theories suggest the Newcastle consists of near shore, beach and bar deposits developed along the shore of the regressing and subsequently transgressing sea. In localized studies these theories appear valid. However, in nearly all cases, when postulating beach and bar deposits in western South Dakota authors have looked to the area of the Black Hills as a source area of sand and have ignored events that must have occurred in the eastern part of the State which is the logical source of the Newcastle Sandstone.

McGregor and Biggs (1968, fig. 16) maintain the

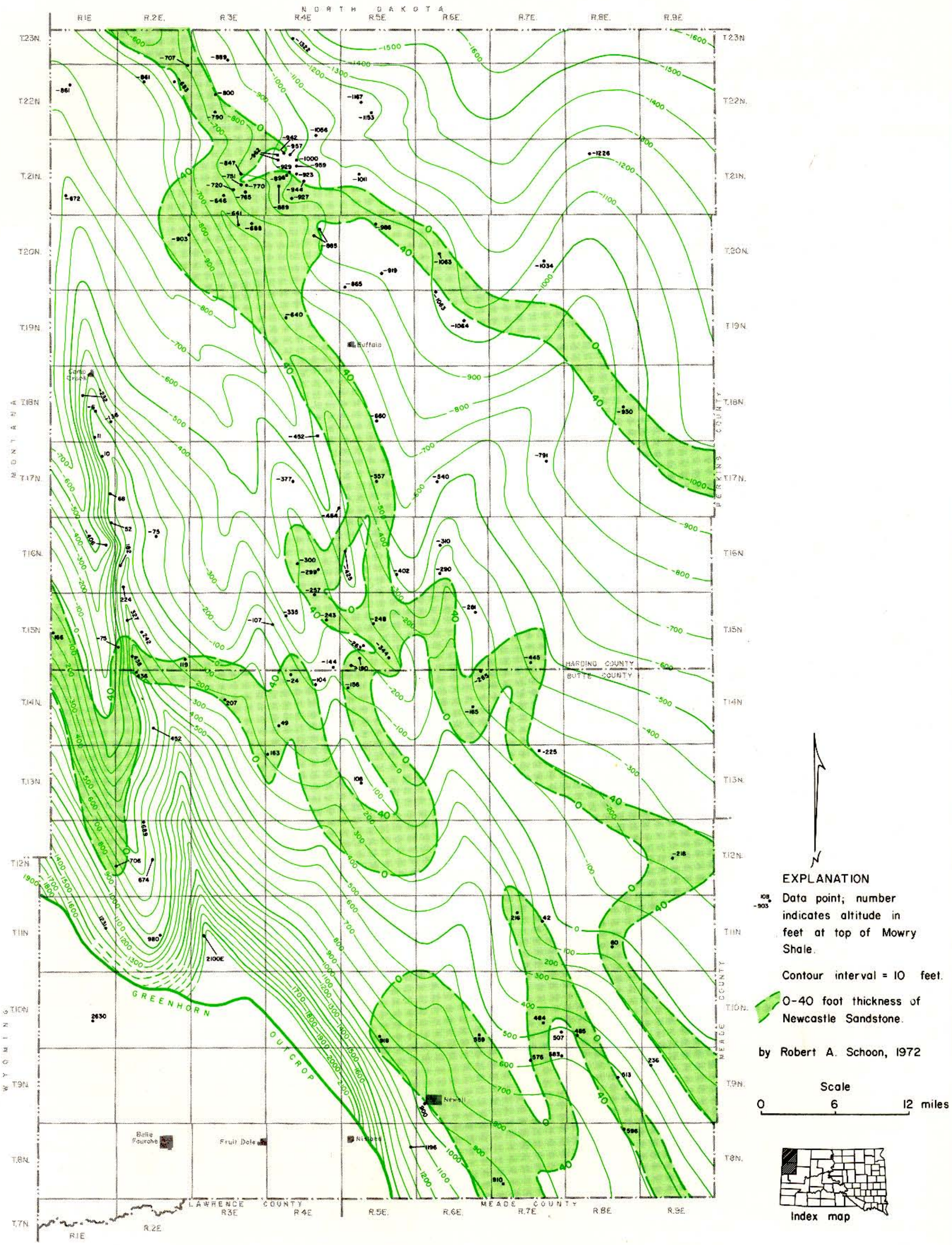


Figure 3. Structure map of Harding and Butte Counties.

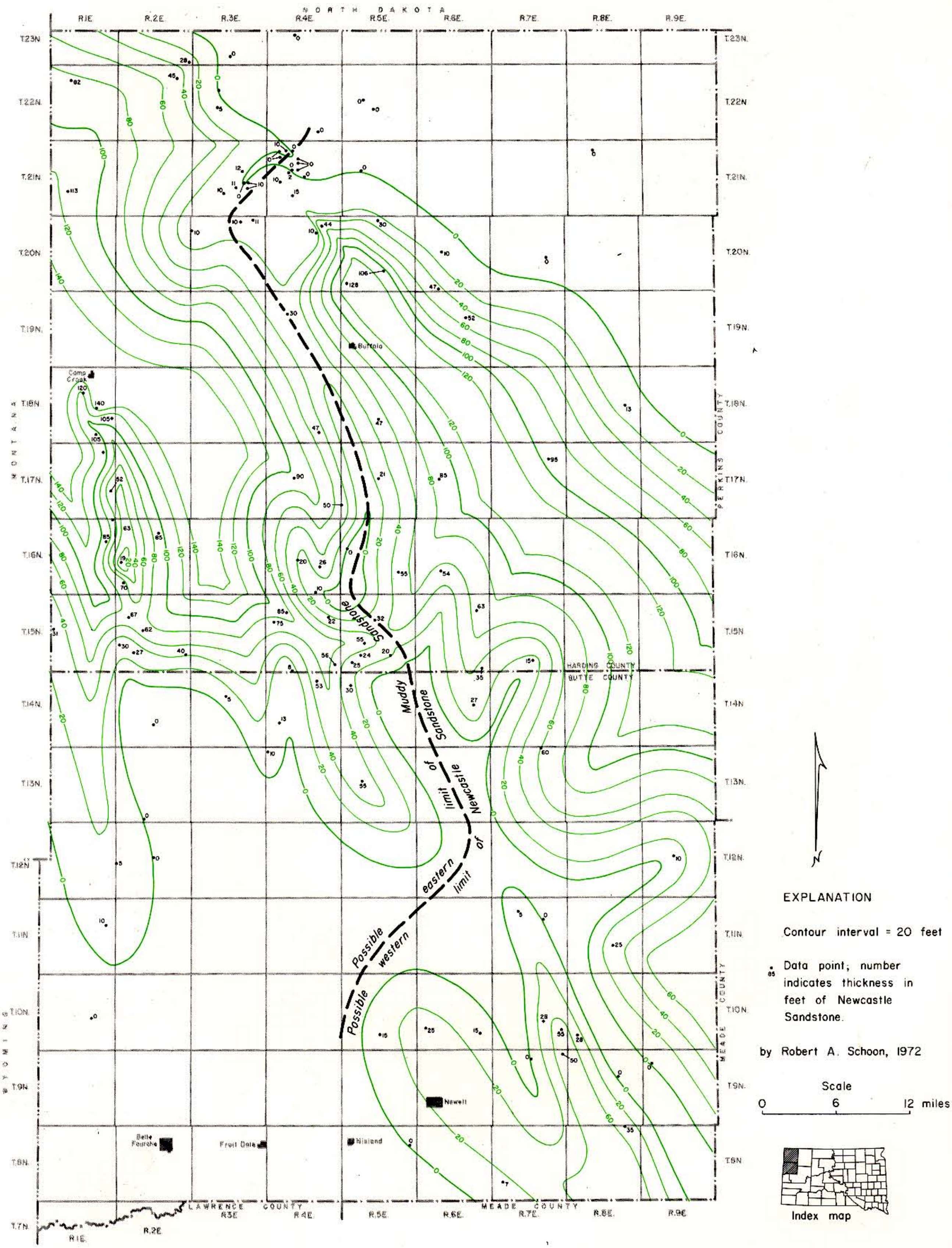


Figure 4. Isopach map of the Newcastle Sandstone in Harding and Butte Counties.

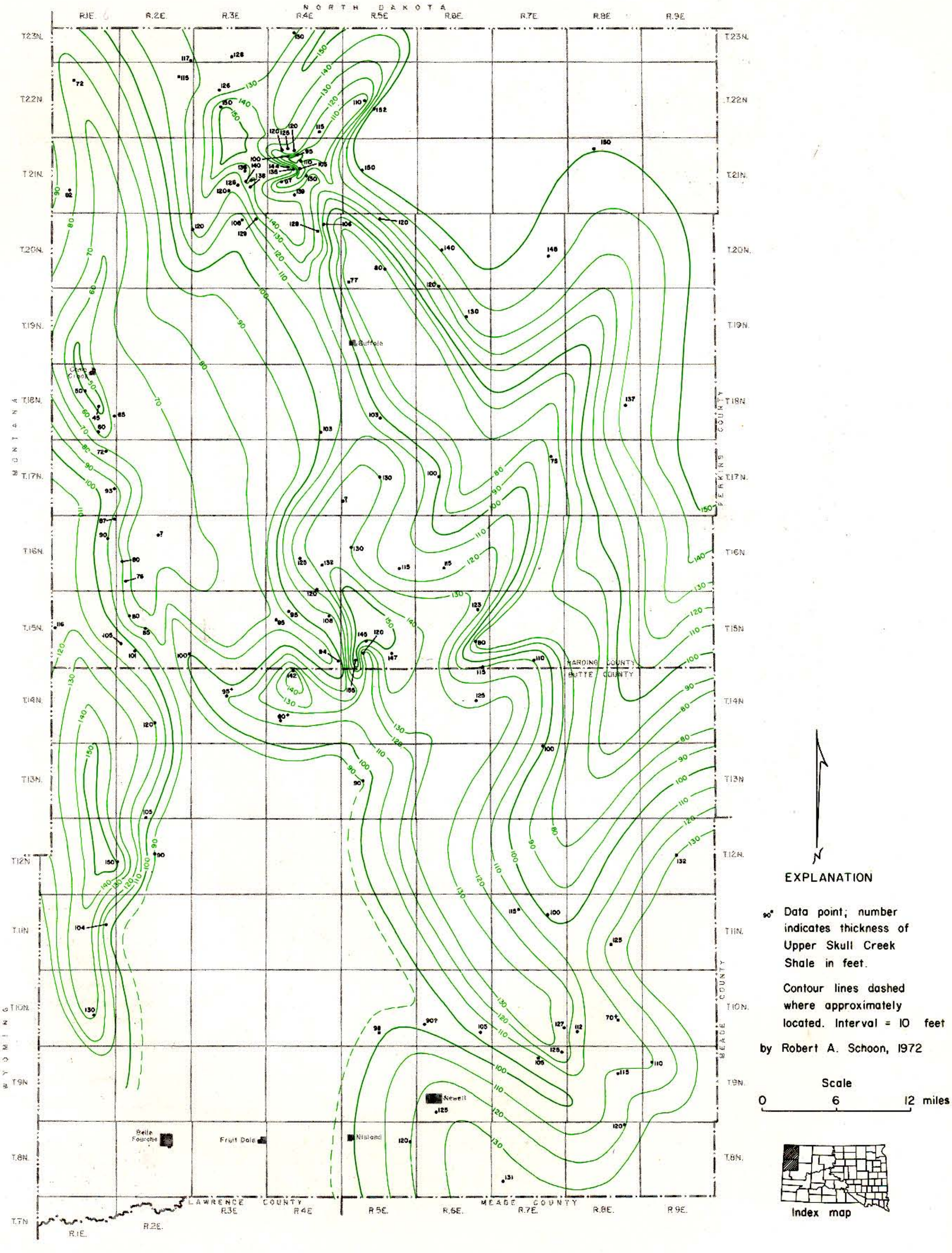


Figure 5. Isopach map of the Upper Skull Creek Shale in Harding and Butte Counties.

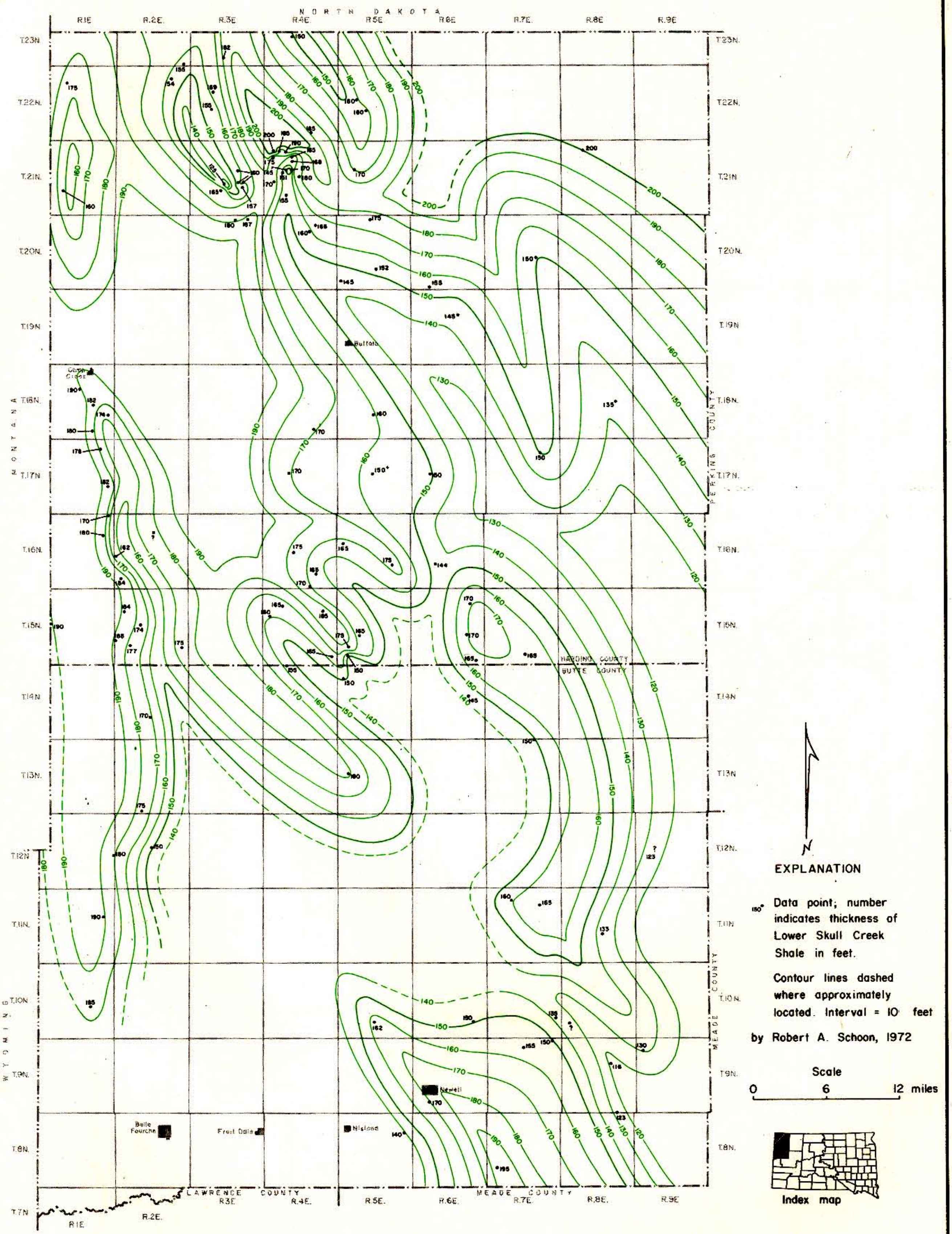


Figure 6. Isopach map of the Lower Skull Creek Shale in Harding and Butte Counties.

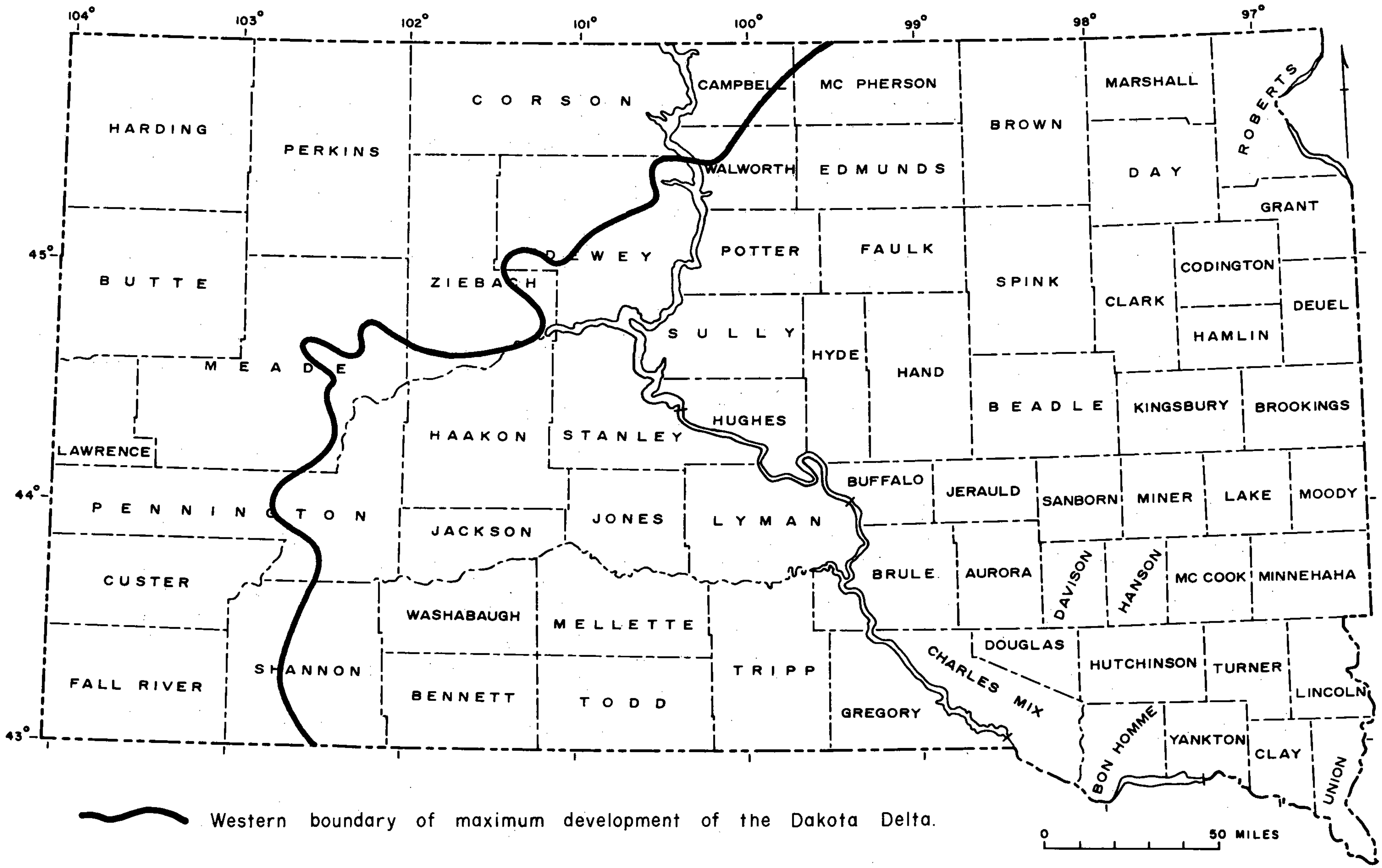


Figure 7. Location of the western boundary of the Dakota Delta.

Muddy Sandstone (Newcastle of South Dakota) is a complex assemblage of nearshore and channel sand deposits derived from a southeasterly direction. In the same publication (figs. 17, 18, 19, and 20) the Skull Creek Shale varies in thickness between 120 and 180 feet. However, closer to the outcrop area and the central part of the Black Hills in South Dakota, the Shell No. 23-23 Johnson oil test (sec. 23, T. 10 N., R. 1 E.) penetrated approximately 300 feet of Skull Creek Shale (fig. 2). The increased thickness of the Skull Creek Shale in a southeastward direction from the Bell Creek Oil Field appears to refute the existence of a nearby source area for Newcastle sediments as drawn by McGregor and Biggs in figure 16 of their report.

Consider also that it is not probable that the 130-foot interval of Newcastle sediments (Hunt No. 1 State, sec. 23, T. 18 N., R. 1 E.) represents filling of a 130-foot channel that was cut by subaerial erosion leaving a 225-foot interval of Skull Creek Shale and 48 miles south (Shell No. 23-23 Johnson oil test), in the direction of a proposed source area, the Newcastle is absent and 310 feet of Skull Creek Shale remains after proposed subaerial erosion. Also, approximately 135 miles in a southeasterly direction from the Hunt No. 1 State oil test (toward the Newcastle source area), the Phillips No. 1 State oil test (sec. 20, T. 11 N., R. 23 E.) penetrated 220 feet of the Skull Creek Shale. In other words, between these points the proposed erosional surface at the top of the Skull Creek Shale had a vertical deviation of 5 feet from the sea floor at the end of Skull Creek time. This amounts to an erosional profile that sloped to the west-northwest at the rate of less than half an inch per mile greater than the Skull Creek sea floor. If deposition of the Newcastle Sandstone was caused by the regression and transgression of a Cretaceous sea the movement must have been very rapid. So rapid, in fact, that subaerial erosion removed only 5 feet of easily eroded shale from the area of the Phillips No. 1 State oil test while the sea regressed 135 miles westward and transgressed 135 miles eastward.

Baker (1962) also suggests the Skull Creek Shale was subjected to subaerial erosion. On page 161 of his report he states, "The depositional history of the Newcastle Formation is summarized as follows: 1) abrupt regression terminating the deposition of Skull Creek Shale, 2) a period of subaerial exposure of the Skull Creek Shale with resulting erosion of at least 50 feet of the shale and development of a valley-like erosional depression . . . " Baker's theory also appears valid in his area of study; however, when regional aspects of Newcastle deposition are considered it must be remembered that proposed subaerial erosion of the Skull Creek began at the water's edge and the cumulative effects of this erosion would increase greatly in an eastward direction.

In reality, early Cretaceous geologic history in South Dakota can be described as a rather monotonous continuation of a single event. Depositional basins subsided in relation to sea level. Initially, continental sediments were deposited on a pre-Cretaceous erosion surface. The Cretaceous sea encroached the western portion of the State and marine sandstone was deposited on the existing continental sands and clays. According to Waage (1959) the Lakota sediments represent the continental sediments, the Fuson represents the transition from continental to marine sedimentation, and the marine sandstone constitutes the Fall River Formation. This normal sequence of events continued with the marine deposition of the Skull Creek Shale. The Skull Creek sea encroached as far east as the eastern one-fifth of the State and south as far as the southern border of the eastern one-third of the State. There is no evidence that the Skull Creek sea advanced beyond these limits nor is there evidence that the Skull Creek Shale was truncated by subaerial erosion within these limits. Thus far in the early Cretaceous Period in South Dakota a single event is recorded. The early Cretaceous sea came in from the north and spread southeastward.

Events succeeding the maximum transgression of the Skull Creek sea are not as well known. Dominant opinion of geologists suggests that the Skull Creek sea receded as far west as the western periphery of the present Black Hills area and triggered the deposition of the lower sandstone tongues of the Dakota Formation; i.e., the Newcastle Sandstone. However, information from data in the eastern part of the State does not confirm this theory. The Skull Creek Shale thins perceptibly towards the east, but it can be demonstrated that this thinning occurs at the base and the top (fig. 2). This does not indicate a transgressing-regressing sea in the sense that a change in sea level occurred, but simply suggests a lessening of sea transport energy (wave action and ocean currents) in relation to supply of sediments available for transport. In the latter case a change in sea level is not required, nor is subaerial erosion mandatory to logically explain the thinning of Skull Creek Shale and subsequent deposition of the Dakota Formation. The feather edge of the Skull Creek Shale which is believed to closely approximate the sodium chloride and sodium sulfate water type boundary in the Dakota Formation (Schoon, 1969, fig. 4) marks the point at which the supply of sediments available for transport exceeded the transporting capacity of the sea. As the Skull Creek sea became static the delta building process began at the feather edge of the Skull Creek Shale and proceeded westward to the western boundary of coalesced Dakota sands (fig. 7).

Westward migration of the Skull Creek seashore was accomplished by shoreline accretion and not by a physical lowering of sea level. As this delta building process continued and the vertical dimension increased, the gradient of the sea floor was also increased. Increasing of the sea floor gradient enhanced the carrying capacity of turbidity currents derived from sediment-laden, cold, fresh water streams and rivers discharging into the sea. Configuration of the paths of these turbidity or density currents was governed by the lower elevations of the sea bottom. Depressions on the sea bottom were filled to surrounding levels causing the course of these currents to be shifted to lower elevations elsewhere until these lower elevations also became aggraded. Sediments deposited by this type of turbidity current are sinuous in plan view and appear as channel-like deposits of the Newcastle Sandstone (fig. 2).

Another type of density or turbidity current is described by Kuenen (1952) in his report concerning the Grand Banks turbidity current. This type of current is energized by potential energy (in the form of unstable deposits) which is triggered by naturally occurring phenomena such as earth tremors. The sediments in the main Dakota delta are 350 feet thick in the central and 450 feet thick in the south-central part of the State. At the time of deposition this delta almost certainly constituted a relatively unstable mass. Thus, mild earthquakes, such as do occur in the central part of the State, triggered slides in the deltaic sediments. These slides, similar to but possibly smaller in scale than that described by Kuenen, assumed a liquid-like property and were launched as a turbulent turbidity current.

According to Rusnak and Nesteroff (1964) sediments deposited by this type of current are commonly cross-bedded, well-sorted, and graded coarse at the base to fine at the top. Organic debris; i.e., wood fragments, leaves, and grasses such as ordinarily occur in deltaic sediments remain in the liquid mass and are redeposited hundreds of miles basinward. This gives rise to the phenomenon of near shore sediments enclosed in marine sediments. This type of turbidity current deposits sediment over a wide lateral area, is less governed by submarine topography, and is responsible for the sheet-like distribution of parts of the Newcastle Sandstone in Harding and Butte Counties (fig. 2). In areas where the turbidity currents were not present clay-sized particles were incorporated into the Skull Creek Shale. The end result of these processes was the vertical and horizontal migration of the Newcastle Sandstone in the upper part of the Skull Creek Shale. This vertical migration of the Newcastle has been wrongly interpreted by geologists as indicative of subaerial erosion of the Skull Creek. The Newcastle Sandstone is, as McGregor and Biggs, (p. 1881) speculate, associated with facies changes within the Skull Creek Shale. Rather than being deposited in channels subaerially eroded in the Skull Creek, the Newcastle is in large part enclosed by and is contemporary with the upper Skull Creek Shale. The upper Skull Creek and associated Newcastle sediments represent infilling of the Skull Creek sea. Due either to a decrease of transport energy, a decrease of sand-sized sediments available for transport, or renewed southward and eastward advance of the sea, Newcastle deposition ceased and the finer-grained Mowry Shale was deposited in a subsiding basin.

MAP INTERPRETATIONS

The questionable 140-foot thickness interval of the lower Skull Creek (fig. 6) indicates thinning towards the Black Hills. However, the 140-foot interval is also present along the eastern border of the area. Thus, all one can surmise at this time is that the two areas received approximately 140 feet of lower Skull Creek sediments and the histories of the two areas are nearly identical.

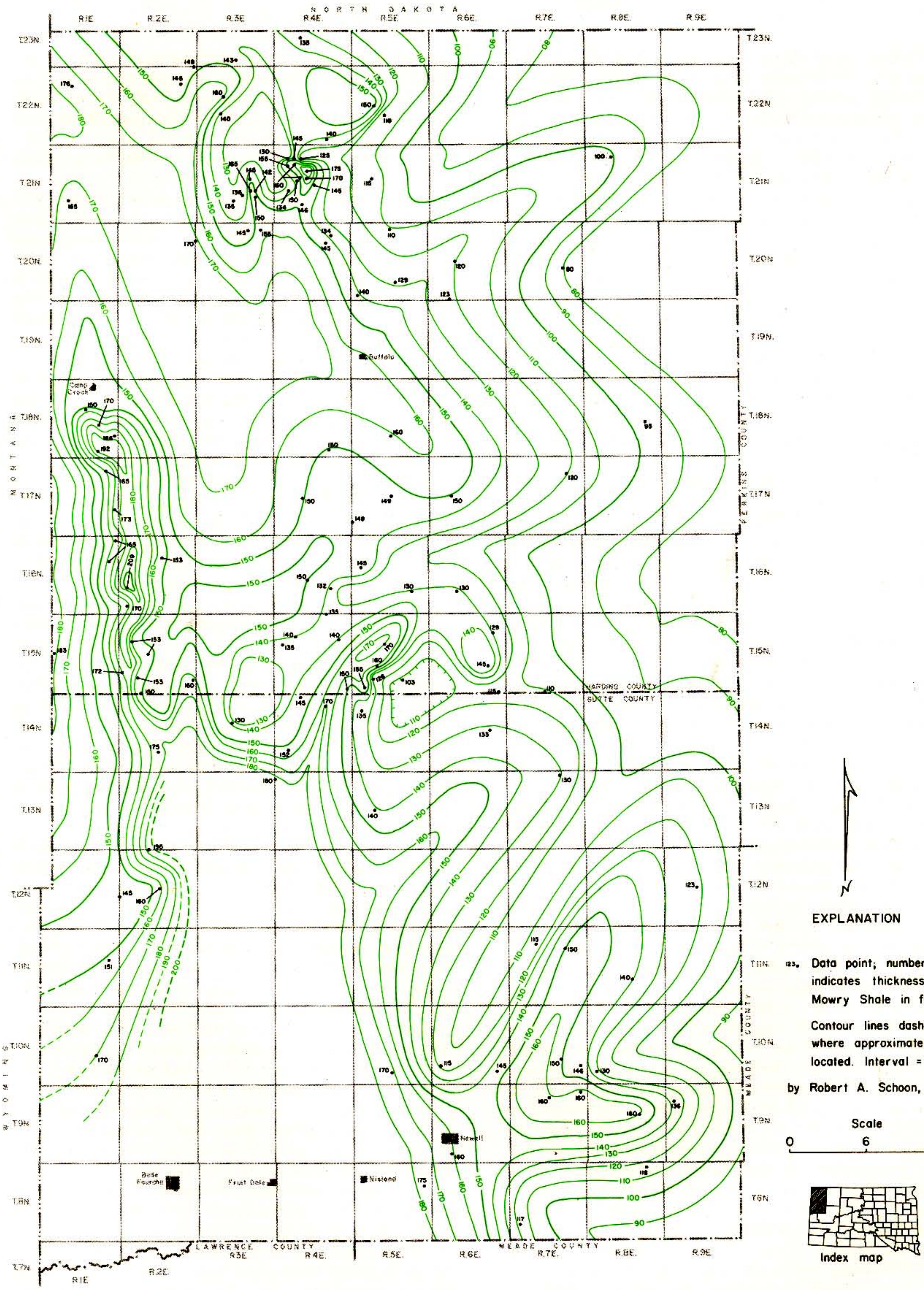
Along the western boundary of the area under discussion, the 190-foot thickness interval is developed over an extensive north-south area. The thick interval extends southward to a point that is at least 6 miles south of the present Greenhorn Limestone outcrop. This probably does not indicate erosion during early Skull Creek time because it is doubtful the silt marker (datum in fig. 2) at the top of the lower Skull Creek would be consistently present over a wide horizontal area in such a restricted vertical range. Rather, the area of thicker lower Skull Creek sediments indicates continuous downwarping in a synclinal area that is situated between the large anticlinal structure in the western part of the mapped area and parallels the anticline believed to exist in the extreme eastern portion of Wyoming and Montana.

The configuration of the thickness intervals of the upper Skull Creek (fig. 5) coincides quite closely with the thickness interval of the underlying lower Skull Creek (fig. 6) and suggests that the deposition of the Skull Creek Shale continued with little or no interruptions. Thicknesses vary gradually over horizontal distances and generally appear to thin over positive structures.

The isopach map of the Newcastle Sandstone (fig. 4) indicates that sediments thin over positive areas similar to the upper and lower Skull Creek Shale. This suggests that present structures were evolving during early Skull Creek to Newcastle time and loss of vertical section does not represent subaerial erosion. Previous authors have suggested that the fine-grained nature of the Newcastle is due to the fine-grained nature of the source rock (i.e., the Fall River Sandstone) and is not a function of transport velocity. However, from figures 5 and 6 one cannot state that the Fall River was eroded from the central portion of the Black Hills uplift prior to the Newcastle deposition because the Skull Creek Shale is everywhere present between the Newcastle and Fall River Sandstones. In figure 2, wells No. 5, No. 7, No. 8, and No. 9, the Newcastle is composed of medium-grained, subrounded, friable, quartz sandstone near the base of the unit. This deviation from the normal fine-grained nature of the Newcastle merely suggests the presence of ocean currents with varying transport capabilities.

From figure 2 of this report, it is seen that the top of the Mowry Shale has been drawn at the base of a unit that exhibits an increase in resistivity values on the electric log. The interval to represent the Mowry was selected to serve as a convenient mappable rock unit that overlies the Newcastle Sandstone.

The isopach of the Mowry Shale (fig. 8) shows thickened sediments over present anticlinal structures and perceptible thickening towards the Black Hills uplift. From the northeast corner of the mapped area the Mowry shows an increase in thickness to the



EXPLANATION

123. Data point; number indicates thickness of Mowry Shale in feet.

Contour lines dashed where approximately located. Interval = 10 feet

by Robert A. Schoon, 1972

Scale

0 6 12 miles

Figure 8. Isopach map of the Mowry Shale in Harding and Butte Counties.

western boundary. In general, the thickness lines suggest western subsidence during Mowry time, and previous positive areas subsided at a faster rate than surrounding areas. Whether this subsidence was of sufficient magnitude to allow connection with colder seas or a colder climate ensued is not known. However, the term Mowry as used in this report is believed to be in large part equivalent to the Shell Creek Shale of Wyoming (see Eicker, 1962, p. 73, and Curry, 1962, p. 119). According to Curry (1962, p. 123), "The siliceous glass sponges in the Shell Creek member suggest that the Shell Creek seas were cold . . . " Thus, it is quite possible denser, colder sea water reduced the transport capabilities of the turbidity currents that deposited the Newcastle Sandstone and resulted in deposition of the finer-grained Mowry Shale. The isopach map of the Mowry-Lower Skull Creek Shale (fig. 9) interval indicates that overall movement of present positive structures was positive during early Cretaceous time.

OIL POSSIBILITIES OF THE STUDIED AREA

A report of the Camp Crook Well, scouted by Dr. E. P. Rothrock, indicates that a small amount of gas was produced from a depth of 1400 feet. Rothrock speculated the source of the gas was from the Eagle Sandstone at this location (NE SE sec. 3, T. 18 N., R. 1 E.). An unofficial report indicates that gas was also obtained at a depth of 1200 to 1500 feet from a well located in NW SW sec. 7, T. 23 N., R. 3 E. Both of the foregoing reports were secured from local residents. If the reports are accurate, any well drilled on the crest of structures should be watched carefully at shallow depths.

Figure 3 of this report is a structural contour map of the area under discussion. Superimposed on this structure map is the 0 to 40 foot thickness interval of the Newcastle Sandstone which identifies the area most apt to contain updip pinch outs. This thickness of Newcastle sediments corresponds to the Newcastle Sandstone development that is found in many of the oil fields near the western periphery of the Black Hills. If the Newcastle was deposited by means of density or turbidity currents it is probable the zero isopach line marks the area that received contemporaneous shale sediments. Thus, the area near the zero isopach line would be an excellent area to explore for oil because the pinch outs would be relatively continuous and would logically parallel the trends of existing structures.

Thus far the Newcastle Sandstone of the Dakota Formation has yielded only shows of dry gas in western and central South Dakota. This does not condemn the Newcastle as a hydrocarbon prospect in the area north and northeast of the present Black Hills outline. East of the axis of the Williston basin oil may have escaped from the Newcastle after deposition prior to and after the Black Hills uplift (Laramide Revolution). However, any oil present in the Newcastle in the area under discussion just prior to the Laramide Revolution may well be trapped by sandstone wedging updip towards the Black Hills.

Possible trapping mechanisms also occur in the area of thicker Newcastle. For example, figure 2 illustrates possible trapping conditions. Permeability barriers to the migration of oil almost certainly exist in many localities of the mapped area. Accurate definition of these traps awaits a greater density of test drilling in the area.

Structural conditions favorable for the accumulation of hydrocarbons exist in the area. Here again, drilling density is sufficient to establish general trends but is insufficient to map local highs which probably exist. Examination of well logs indicates that strutural closure increases with depth; therefore, deeper potential zones should be considered when drilling is being carried out on a Cretaceous high.

The Newcastle Sandstone crops out only sporadically around the periphery of the Black Hills and these outcrops are too thin and tight to receive large amounts of surface runoff. Thus, it appears doubtful that hydrodynamic traps exist in the Newcastle in the mapped area.

Older Cretaceous rocks (Inyan Kara Group) may receive greater amounts of surface runoff in the outcrop area and hydrodynamic traps may be present. Stratigraphic trapping mechanisms in these older Cretaceous sandstones are not believed to be as numerous as in the Newcastle Sandstone.

Oil potential of Paleozoic rock units (fig. 10) are not well known. Many shows have been reported from the upper Red River Formation which produces oil at the Buffalo Field and Yellow Hair Field in Harding County. By virtue of the foregoing the Red River must be considered the most promising oil producing unit in the mapped area. Drilling depths of up to 9100 feet and logistics are problems which have hampered exploration of this potential producing unit. The Red River underlies all of the mapped area and should be an objective of any oil test drilled on a structurally high area.

Fewer oil shows have been reported from rocks of Mississippian age in the area. These Mississippian rocks do yield oil in Montana and North Dakota and should be considered potential reservoirs in Harding and Butte Counties. Progressively older units of these rocks subcrop in a direction approaching the Black Hills uplift (fig. 10). Structural and/or stratigraphic traps are distinct possibilities in Mississippian rocks which underlie the entire mapped area.

The Permo-Pennsylvanian Minnelusa Formation which has been subdivided into seven units (Condra, *et al*, 1940; Agatston, 1954; McCauley, 1956; this report, fig. 10) may be termed the potential oil producing "sleeper" of the entire stratigraphic section in the mapped area. These rock units have varied lithologies and consist of dolomite, sandstone, shale, and anhydrite. Similar to the Cretaceous Mowry to Fall River interval, the Minnelusa thickens perceptibly towards the Black Hills. For instance, the Hunt No. 1 "C" State oil test (NE NW sec. 23, T. 18 N., R. 1 E.) penetrated 575 feet (5120-5695) of these Permo-Pennsylvanian sediments (fig. 10). Farther south, the Pure No. 1 Government oil test (SW SW sec. 27, T. 14 N., R. 2 E.) encountered 600

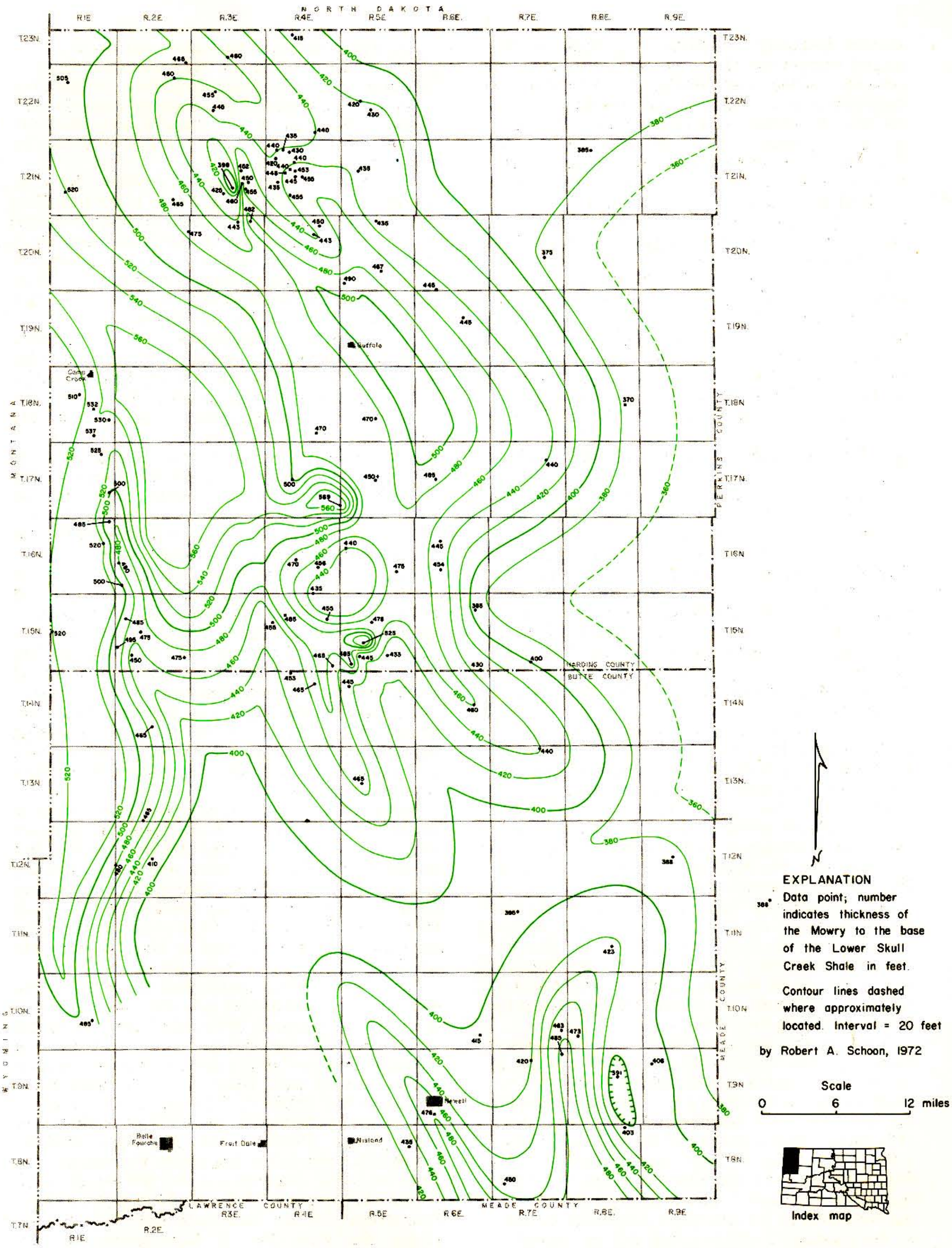


Figure 9. Isopach map of the Mowry to the base of the Lower Skull Creek Shale in Harding and Butte Counties.

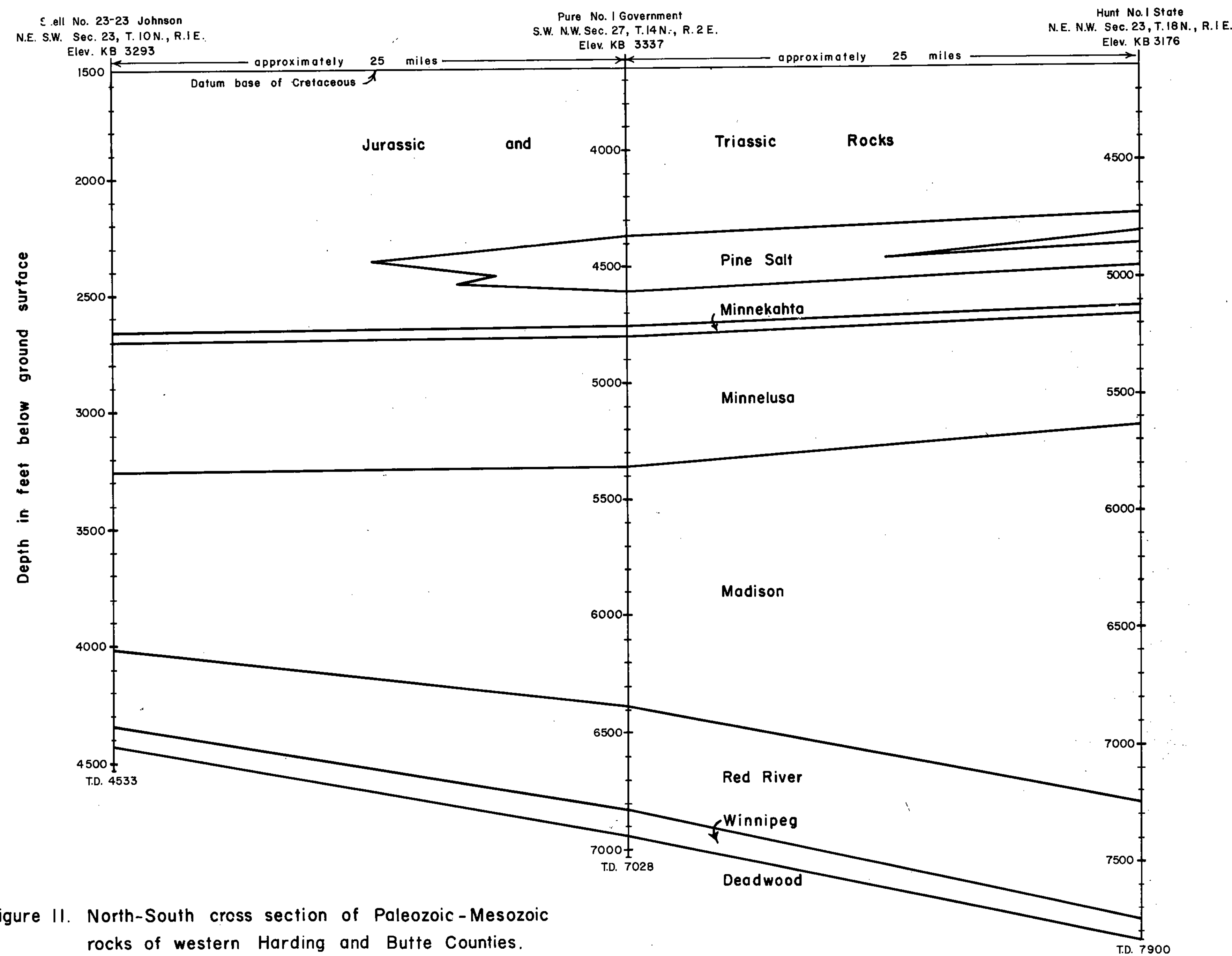


Figure 11. North-South cross section of Paleozoic-Mesozoic rocks of western Harding and Butte Counties.

feet (4750-5350) of Minnelusa sediments. The same interval is 605 feet thick (2650-3255) at the Shell No. 23-23 Johnson oil test NE SW sec. 23, T. 10 N., R. 1 E.). Only one oil show was reported from the Permo-Pennsylvanian interval in these oil tests and that was from 2815 to 2830 feet in the Shell No. 23-23 Johnson test. However, a number of shows in tight sandstone in the upper part of the Minnelusa have been reported from oil tests drilled in the northern Black Hills area. Bona fide shows have been reported from the Fairbank (basal Pennsylvanian sand) in the South Dakota portion of the Williston basin and in the Barker Dome Oil Field, Custer County, production is from the Hayden subdivision of the Minnelusa.

Triassic rocks have been barren of reported oil shows in the mapped area with one possible exception. The well-site geologist at the Northern Ordinance No. 1 Government oil test (SE SE sec. 32, T. 15 N., R. 2 E.) entered the following note on the sample log: "4500-70 dark oil on pits and gas bubbling-no sand in samples." In conjunction with the foregoing, E. P. Rothrock, then South Dakota State Geologist, wrote the Oil and Gas Board, "Some gas was burning at the well but since this is officially a stratigraphic test I could not ask for the log or drilling records and have no information on this gas." At the time of Rothrock's visit to the well, the drill pipe had been twisted off at 5502 feet and the operators were preparing to whipstock at 3600 feet. The two reports coincide and if correct the reported oil and gas show was present at the base of the Pine Salt unit (see fig. 11). Available records do not indicate if the interval was tested. Officially reported oil shows from the Jurassic rocks in the mapped area do not exist in the files of the South Dakota Geological Survey.

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