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GEOTHERMAL RESOURCE ASSESSMENT FOR NORTH DAKOTA

Final Report

By
William D. Gosnold, Jr.

April 1984

Work Performed Under Contract No. FC07-79ID12030

University of North Dakota
Grand Forks, North Dakota

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FINAL REPORT

GEOTHERMAL RESOURCE ASSESSMENT FOR NORTH DAKOTA

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TABLE OF CONTENTS

PAGE

LIST OF FIGURES iv

ABSTRACT v

INTRODUCTION 1

SUBSURFACE TEMPERATURES 5

WILLISTON BASIN 9

RESOURCE ESTIMATES 16

ADVECTIVE HEAT FLOW 25

CONCLUSIONS 29

  Methodology 29

  Resources 29

REFERENCES 31

APPENDIX 33

LIST OF FIGURES

FIGURE NO.		PAGE
1	Geologic cross section of the Williston Basin	2
2	Hypothetical temperature-depth curves for the Williston Basin in western North Dakota	4
3	Comparison of geothermal gradients determined by equilibrium temperature measurements and calculated from bottom-hole temperature data	6
4	Comparison of an equilibrium temperature log with two sets of predicted temperatures	10
5	Comparison of an equilibrium temperature log with two sets of predicted temperatures	11
6	Comparison of an equilibrium temperature log with predicted temperatures	12
7	Comparison of an equilibrium temperature log with predicted temperatures	13
8	Grid of heat flow used in calculating subsurface temperatures	15
9	Calculated temperatures on top of the Inyan Kara aquifer	17
10	Calculated temperatures on top of the Madison aquifer . .	18
11	Calculated temperatures on top of the Duperow aquifer . .	19
12	Calculated temperatures on top of the Red River aquifer .	20
13	Mean annual surface temperature from 30 years of NOAA data	21
14	Location map and cross section showing relative positions of five heat flow holes drilled for the advective heat study	28
15	Location key for Appendix tables	34

ABSTRACT

Temperatures in four geothermal aquifers, Inyan Kara (Cretaceous), Mission Canyon (Mississippian), Duperow (Devonian), and Red River (Ordovician) are in the range for low and moderate temperature geothermal resources within an area of about 130,000 km^2 in North Dakota. The accessible resource base is 13,500 x 10^{18} J., which, assuming a recovery factor of 0.001, may represent a greater quantity of recoverable energy than is present in the basin in the form of petroleum.

A synthesis of heat flow, thermal conductivity, and stratigraphic data was found to be significantly more accurate in determining formation temperatures than the use of linear temperature gradients derived from bottom hole temperature data. The thermal structure of the Williston Basin is determined by the thermal conductivities of four principal lithologies: Tertiary silts and sands (1.6 W/m/K), Mesozoic shales (1.2 W/m/K), Paleozoic limestones (3.2 W/m/K), and Paleozoic dolomites (3.5 W/m/K). The stratigraphic placement of these lithologies leads to a complex, multi-component geothermal gradient which precludes use of any single component gradient for accurate determination of subsurface temperatures.

INTRODUCTION

Geothermal resources in the Williston Basin in North Dakota occur as thermal waters in at least four regional aquifers, i.e., the Inyan Kara (Cretaceous), Madison (Mississippian), Duperow (Devonian), and Red River (Ordovician) (Figure 1). These resources are classified as either moderate temperature resources (150° > T > 90°) or low temperature resources (T < 90°) (Muffler & Guffanti, 1979). Any assessment of these resources must establish the temperature, areal extent, thickness, chemical properties, and hydrologic properties of the aquifers. Previous work by Harris et. al., (1980, 1981, 1982) provides information on areal extent, thickness, and water chemistry as well as temperature data recorded in shallow wells, a few heat flow holes, and a large amount of data recorded as bottom hole temperatures (BHT) in oil and gas exploration wells. The temperature data of Harris et. al., (1982) that are relevant to the thermal aquifers are given as linear temperature gradients calculated from the BHT and mean annual surface temperatures. Those data were used in an analysis of low temperature geothermal resources in the United States by the U.S. Geological Survey (Sorey et. al., 1982a); and geothermal resources in North Dakota were estimated for two aquifers, the Madison and the Inyan Kara as 7.5 x 10^{18} J. and 2.3 x $10.^{18}$ J. respectively.

Sorey et al.'s (1983a) estimate of geothermal resources suggests a major new energy resource for North Dakota. However, the BHT data used in the resource estimates gave incorrect predictions of subsurface temperatures and the resource was underestimated by about 50 percent. A fundamental problem was that a two point temperature gradient calculation is inappropriate

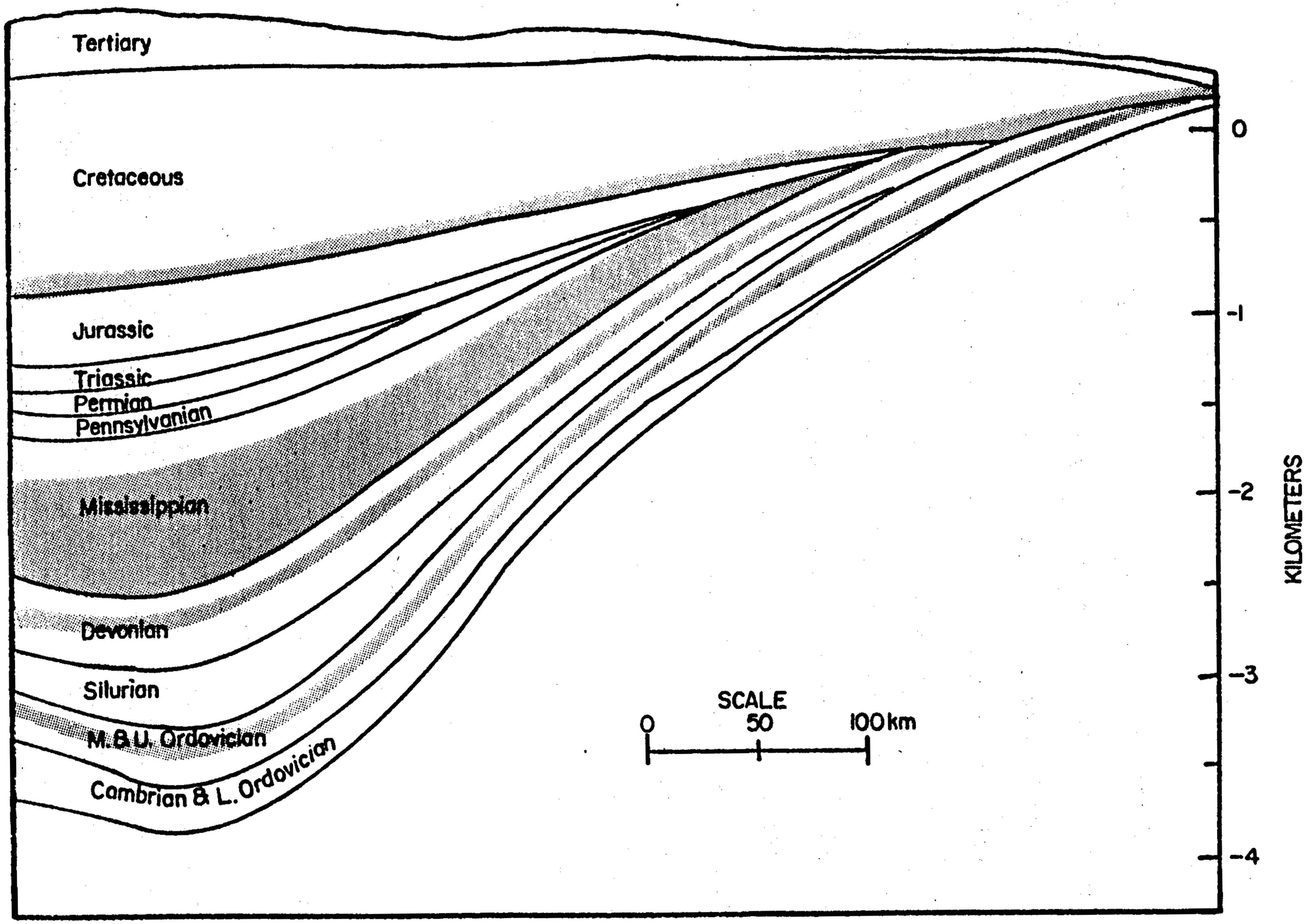


Figure 1. Geologic cross section of the Williston Basin. The approximate positions of the four geothermal aquifers identified in this study are shown by the shaded areas.

for the Williston Basin because there are large differences in thermal conductivity among the four principal rock types in the sedimentary section. These rock types and their estimated average conductivities in S.I. units (W m^1 K^1) are: Tertiary clays, silts, and sands, K = 1.6; Cretaceous shales, K = 1.2; Upper Paleozoic limestones, K = 3.2; Lower Paleozoic dolomites, K = 3.5. Consequently, a typical temperature-depth curve for the Williston Basin is a multi-component curve with slopes differing by as much as a factor of four. Each of the four rock types has a thickness on the order of a kilometer in parts of the basin. A linear temperature gradient based on accurate BHT data from any unit within the basin will give an inaccurate prediction of temperature in any other unit (Figure 2).

Because the thermal structure of the Williston Basin is complex and cannot be represented by linear temperature gradient calculations, the first goal of this project has been to determine accurately the temperatures of the thermal aquifers in the basin. The ultimate goal of this project has been to reassess the resource in the Inyan Kara and Madison aquifers and to extend the resource analysis to include the Duperow and Red River aquifers.

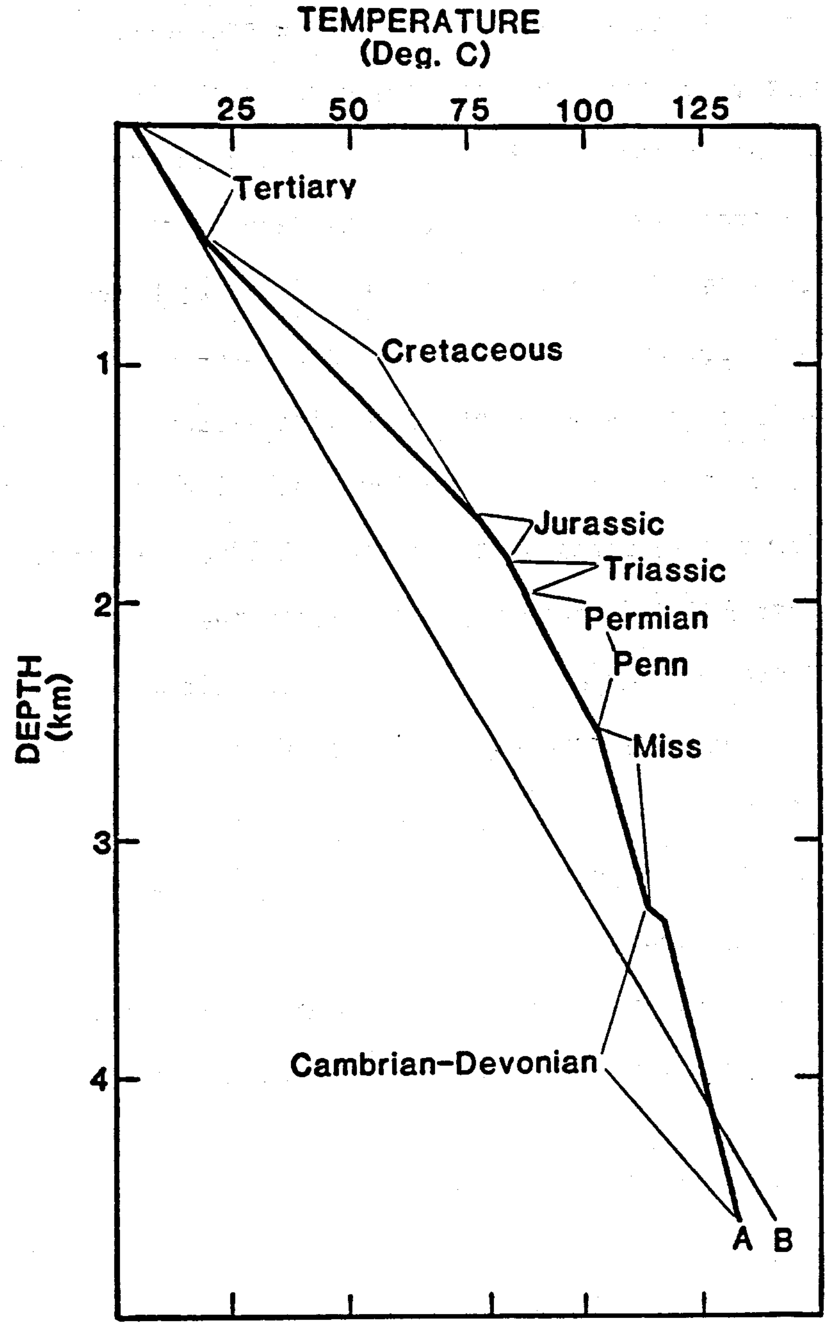


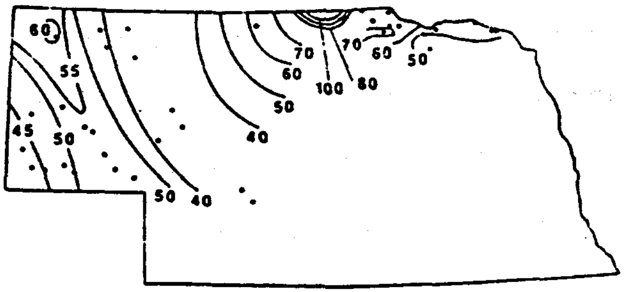
Figure 2. Hypothetical temperature-depth curves for the Williston Basin in western North Dakota. Curve A was calculated from heat flow data. Curve B was calculated from bottom-hole temperature data.

SUBSURFACE TEMPERATURES

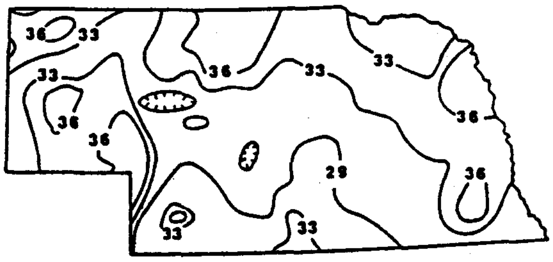
Accurate determination of subsurface temperatures should be the first objective in assessing geothermal resources in sedimentary basins. The methods for determining those temperatures have differed among the various DOE State Coupled Geothermal Resource Assessment Programs. The most commonly used method has been to compile and analyze the bottom hole temperature data from oil and gas wells. Other methods that have been used are direct measurement in deep wells and prediction of temperatures from heat flow data. Because the basic quantity sought in exploration for geothermal resources is heat, establishing the most accurate method for determining subsurface temperatures is crucial in geothermal research.

The accuracy of bottom hole temperatures as predictors of subsurface temperatures was questioned in the introduction. In that discussion, it was assumed that BHT data accurately represent the temperatures of the formations in which they were recorded. Tests of that assumption are available from studies where other methods as well as analysis of BHT data were used to determine subsurface temperatures. For example, Figure 3 shows comparisons between data derived from the geothermal gradient map of North America (A.A.P.G., 1976) and equilibrium temperature data in Nebraska (Gosnold, 1982). The temperature gradients differ by about 10°C/km to 40° C/km and the temperatures differ up to 20°C over the study area. In this case, the equilibrium temperatures are categorically higher than the temperatures extrapolated from the BHT data.

The differences between the temperature data sets are due to the data and to the correction applied to the data. The quality of the data in the



A. Contour map of the geothermal gradient existing above the Dakota Group (Cretaceous) in western and north central Nebraska. The units are °C/km and the contours were drawn on the basis of equilibrium temperatures measured at sites indicated by the dots.



B. The Nebraska portion of the U.S.G.S. Geothermal Gradient Map of North America (A.A.P.G., 1976). The contours were converted from English units to S.I. units and rounded off to the nearest integer.

Figure 3. Comparison of geothermal gradients determined by equilibrium temperature measurements (A) and calculated from bottom-hole temperature data (B). (From Gosnold, 1982).

oil fields in Nebraska is not good. Analysis of bottom hole temperatures recorded in nine different sections in western Nebraska shows that, in some cases, about 20 percent of the temperatures have the same value regardless of depth or time interval between cessation of mud circulation and logging (Gosnold, Eversoll, and Carlson, 1982). In these cases, it is suspected that the BHT is a guess by the logger rather than an actual record. The time of logging is also suspect in most of the data. In a total of 14,000 records, there are fewer than 100 instances in which recorded logging times are not exactly 1 or 2 hours after circulation ceased. The problem with the correction to the BHT data is that it was based on equilibrium temperatures recorded in wells in the Texas Gulf Coast region. The gross lithologies and the thermal properties of the sediments there are not the same as those in the Cretaceous rocks underlying Nebraska. Consequently, the constants in the correction equation (see Wallace et. al., 1979) do not apply to the rocks in Nebraska.

Uncorrected bottom hole temperatures are, as expected, less close to the equilibrium temperature data than the corrected data. This condition also was demonstrated in the Nebraska project where one of the tasks was to produce a contour map of temperature gradients calculated from uncorrected bottom hole temperature data (see Gosnold et al., 1983).

The Denver Basin in Nebraska has a multi-component geothermal gradient curve similar to that in the Williston Basin. The geothermal gradient in the shale-rich Cretaceous section is about 50 K/km due to the low thermal conductivity of the shales, i.e. about 1.2 W/m/K (Sass et. al., 1982; Blackwell et. al., 1981). The gradient in the Paleozoic carbonate section ranges from one-third to one-half of that in the Mesozoic rocks due to the high conductivity of the limestones and dolomites, i.e., about 3.0 W/m/K to

4.5 W/m/K (see Sass et. al., 1981). However, for much of the Denver Basin the BHT data are based on temperatures recorded in the Dakota Group and only one component of the temperature gradient curve influences the data. This observation is most significant. In this case, a two point temperature gradient curve should apply, yet large differences between equilibrium temperatures and BHT data exist. Therefore, BHT data may not accurately represent formation temperatures even for the case of one-component geothermal gradient areas, and use of BHT data in cases where multi-component gradients do influence the data seems wholly inadvisable.

An alternate method for determining subsurface temperatures is to use a synthesis of heat flow, thermal conductivity, and stratigraphic data. This method is a direct approach to determining subsurface temperatures because it addresses the fundamental variables in the thermal structure of the crust, i.e., heat flow and thermal conductivity. This method was used in the geothermal resource assessment of Nebraska (Gosnold and Eversoll, 1982; 1983) and its accuracy proved to be excellent. Subsequent measurement of temperatures in nine wells at depths ranging from 1.2 km to 1.8 km in the Denver Basin have found actual temperatures to be within 2 degrees of the predicted temperatures.

WILLISTON BASIN

At least four geothermal aquifers lie within the Williston Basin. Accurate determination of their temperatures was the first objective in assessing the total geothermal resource. Because of its better accuracy, the method of synthesis of heat flow and stratigraphy was used in this analysis of the Williston Basin. Consequently, one of the significant results of this study is that it provides another comparison between the BHT and heat flow synthesis methods for assessing geothermal resources.

The data for the Williston Basin include heat flow data from previous studies (Blackwell, 1969; Combs and Simmons, 1973; Scattolini, 1977) and stratigraphic data summarized in the previous geothermal studies in North Dakota (Harris et. al., 1982). Thermal conductivities of rocks at heat flow sites were used as a basis for estimating regional conductivities for gross lithologies. Although thermal conductivity of a specific unit may differ from site to site, the range of variation for one rock type is small compared to the difference in conductivities for different rock types characteristic of the Williston Basin. For example, the range in conductivity for the Paleozoic shales in Kansas is about 0.3 W/m/K (Blackwell et al., 1981b), the difference in conductivity between the Pierre shale and the Madison limestone is about 2.0 W/m/K. The thermal conductivities used for the analysis are included in the Appendix. An accuracy control for the range of thermal conductivities used is obtained by comparing the predicted temperature-depth plot with the actual temperature logs taken at nearby sites. Comparisons for four deep-well temperature logs are given in Figures 4 through 7.

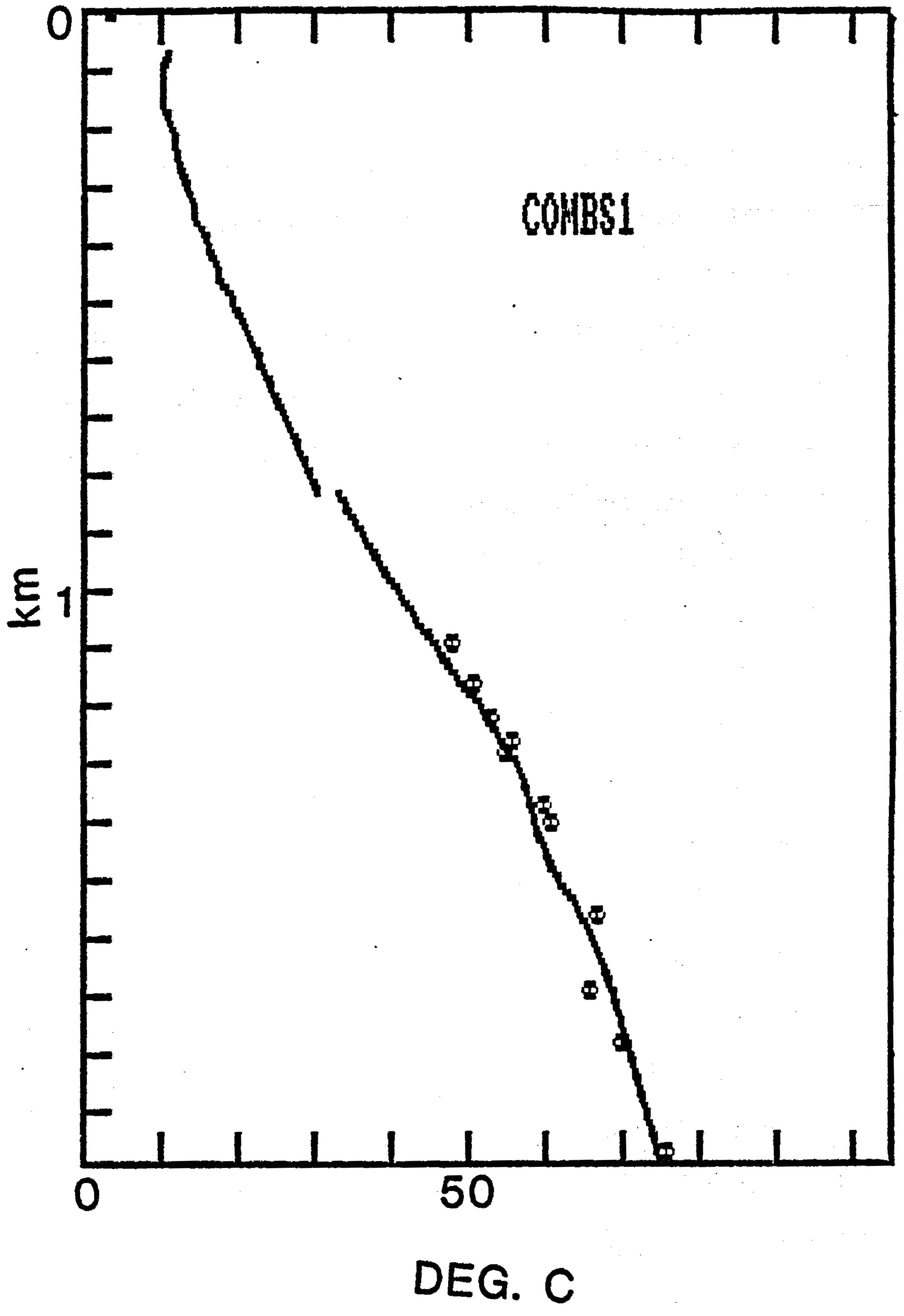


Figure 4. Comparison of an equilibrium temperature log (small dots) with two sets of predicted temperatures (large dots). Temperature-depth log is from Combs (1970).

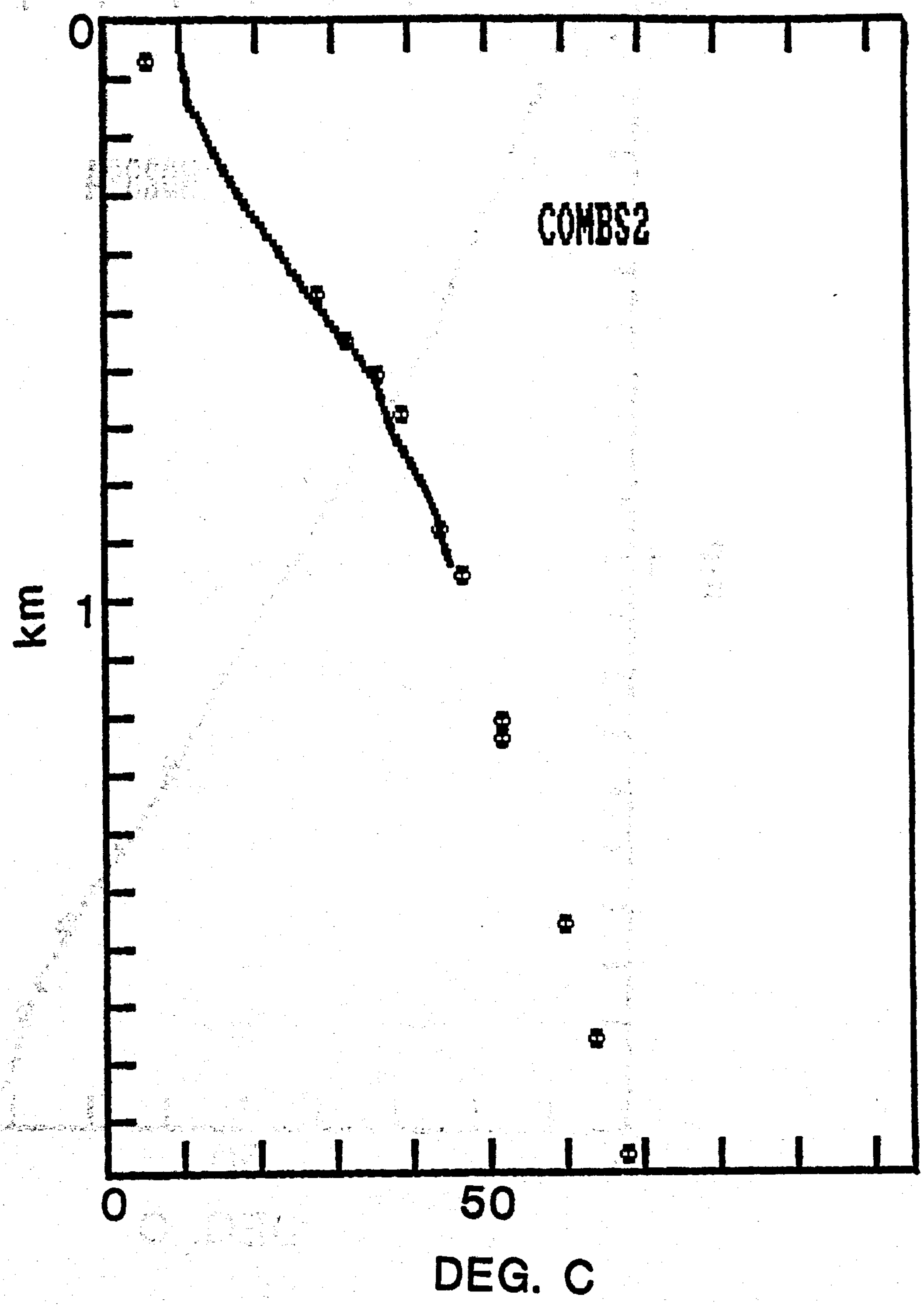


Figure 5. Comparison of an equilibrium temperature log (small dots) with two sets of predicted temperatures (large dots). Temperature-depth log is from Combs (1970).

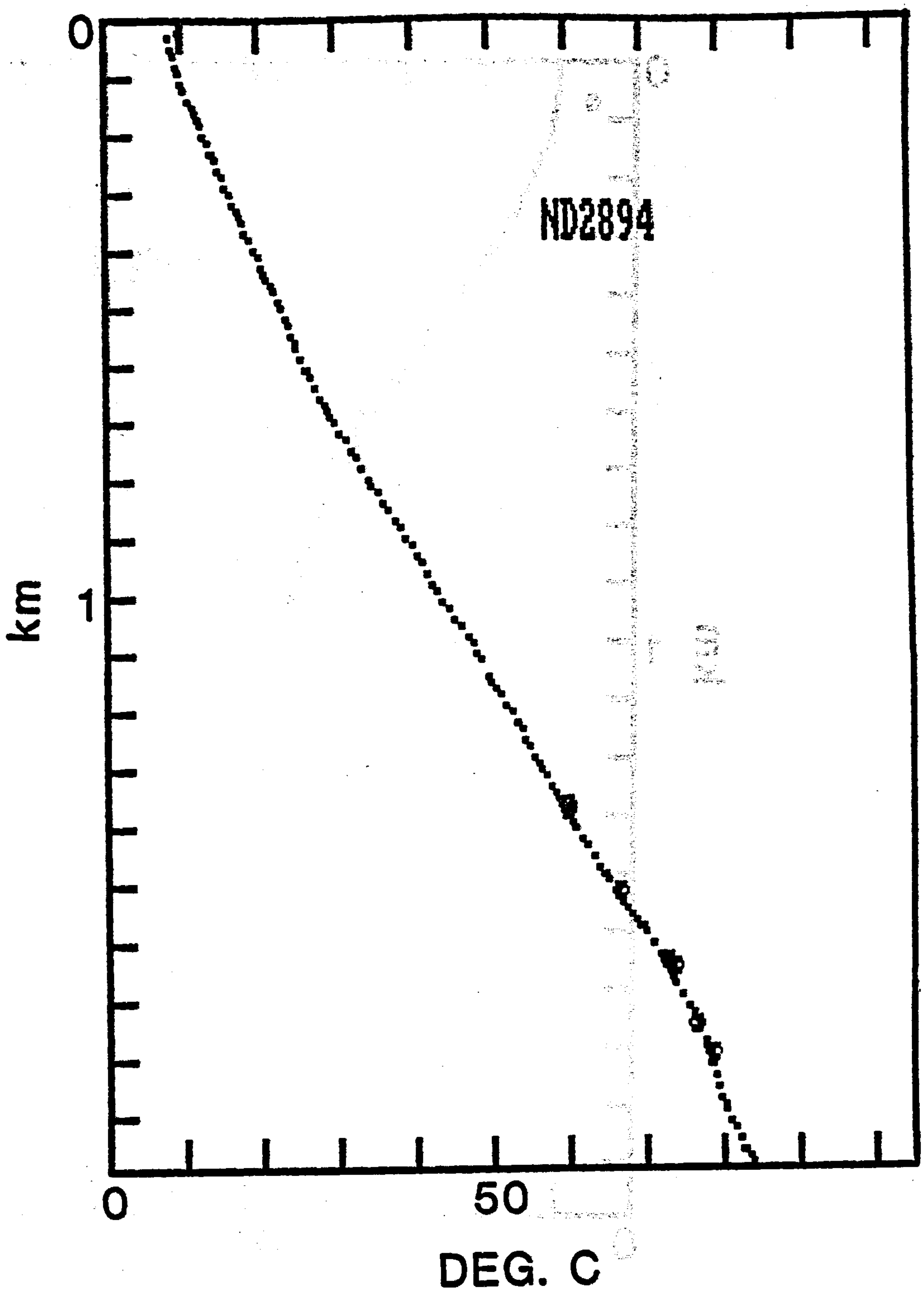


Figure 6. Comparison of an equilibrium temperature log (small dots) with predicted temperatures (large dots). Temperature-depth log is from Scattolini (1977).

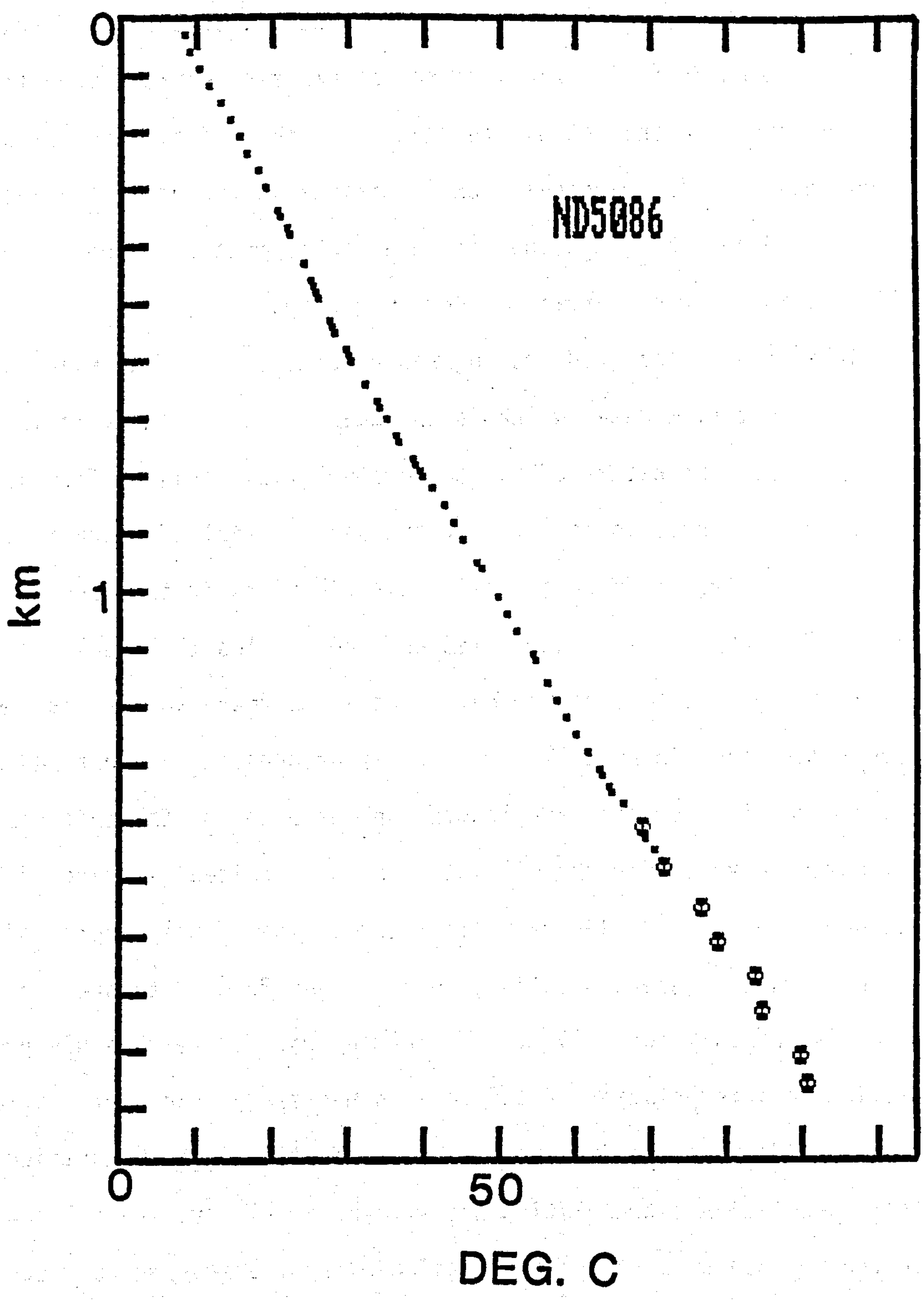


Figure 7. Comparison of an equilibrium temperature log (small dots) with predicted temperatures (large dots). Temperature-depth log is from Scattolini (1977).

In the application of this method in the Nebraska study, stratigraphic data were taken from electric logs for a number of sites within the resource area. However, in this study, the data were taken from a set of structure contour maps of the principal rock formations in the Williston Basin (Harris et. al., 1982). These maps permitted establishment of a regularly spaced grid of points for subsurface temperature computations.

Selection of the grid spacing was determined from the spacing of available heat flow data, which is the quantity most likely to vary from site to site. The nature of the temperature field arising from a radioactive basement source is essentially the same as that of a gravitational field arising from different density distributions in the basement (Simmons, 1967). The simple half-width rules and depth rules that apply to gravity data also apply to temperature data, and it is reasonable to assume that lateral variation in heat flow due to differences in basement radioactivity should have its shortest wave lengths on the order of the thickness of the sedimentary cover. For the Williston Basin, the ideal spacing of heat flow data would be on the order of 4 kilometers. The actual spacing of data from previous studies (see Scattolini, 1977) ranges from 10 to greater than 100 km and is commonly about 40 km. To form a grid for temperature projections, speculative interpolation of the data is necessary. However, extrapolation of these widely spaced data to a dense grid of 4 km is unjustified; and the least speculative extrapolation seems to be a grid spacing of about 40 km. For the purpose of portrayal on available maps, a spacing corresponding to 4 townships, i.e., 24 miles (38.6 km) was adopted. The smoothed heat flow grid is given in Figure 8.

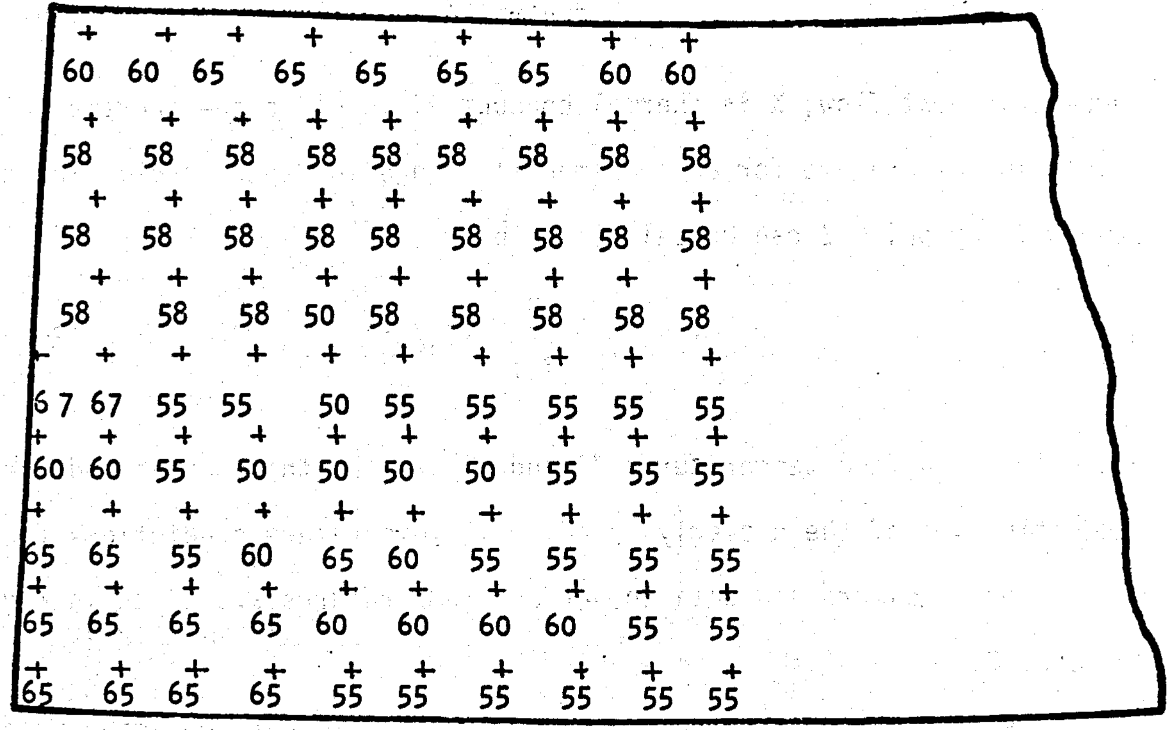


Figure 8. Grid of heat flow used in calculating subsurface temperatures.

RESOURCE ESTIMATES

Temperatures on top of each of the aquifers were projected for each point in the 9 x 10 grid using the simple equation for one dimensional heat flow

$$Q = K(dT/dZ) \qquad \text{(Eq. 1)}$$

where Q is heat flow, K is thermal conductivity, dT is the incremental change in temperature for an incremental change in depth of dZ. The temperature at any point Z can be calculated by

$$T = To + \sum_{i=1}^{n} Zi(Q/Ki) \qquad \text{(Eq. 2)}$$

where To is surface temperature, Zi and Ki are the thicknesses and thermal conductivities of the n overlying layers. Temperature predictions for each of the four aquifers and data on surface temperatures are given in Figures 9 through 13.

Estimates of the mean accessible resource base were obtained using the method of Sorey et. al. (1983b), i.e.,

$$qR = p\ c\ a\ d\ (t - tr) \qquad \text{(Eq. 3)}$$

where qR is the accessible resource base, pc is the volumetric specific heat of the rock plus water, a is the reservoir area, d is the reservoir thickness, t is the reservoir temperature and tr is 15°C. This method gives an optimistic estimate for the resource base because of the large temperature drop that is used. However, each use of geothermal waters may require different amounts of heat extraction, and heat exchanger characteristics vary widely

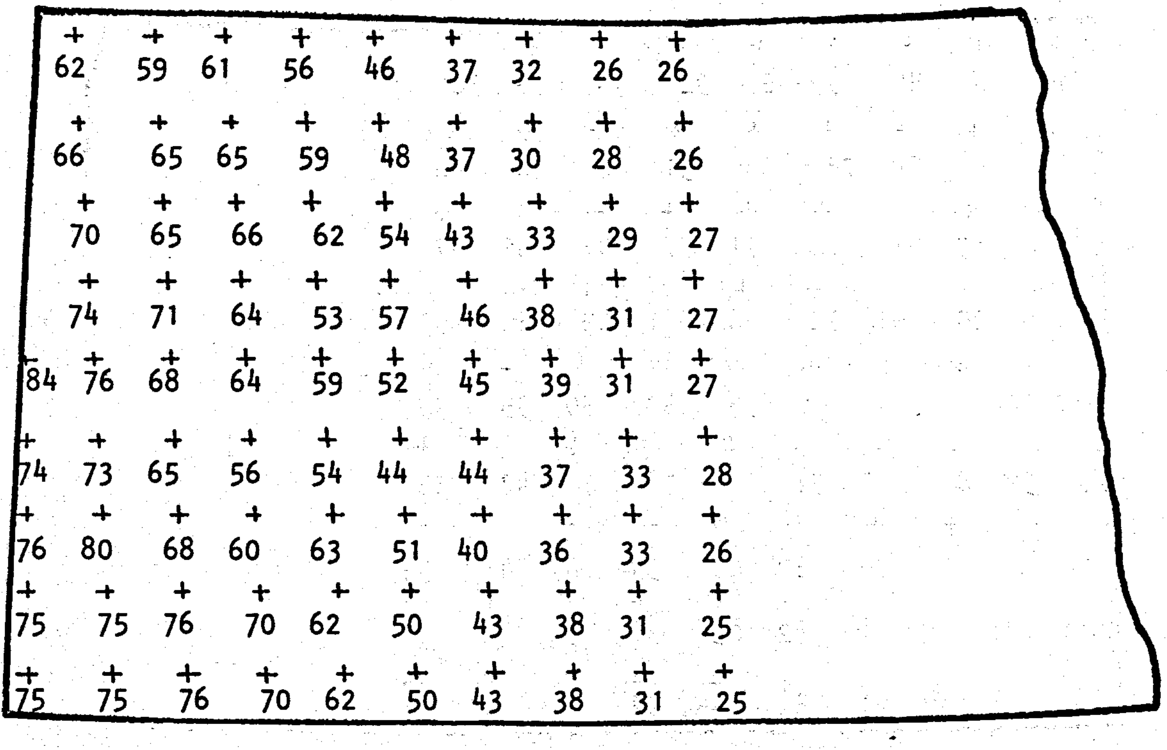


Figure 9. Calculated temperatures on top of the Inyan Kara aquifer.

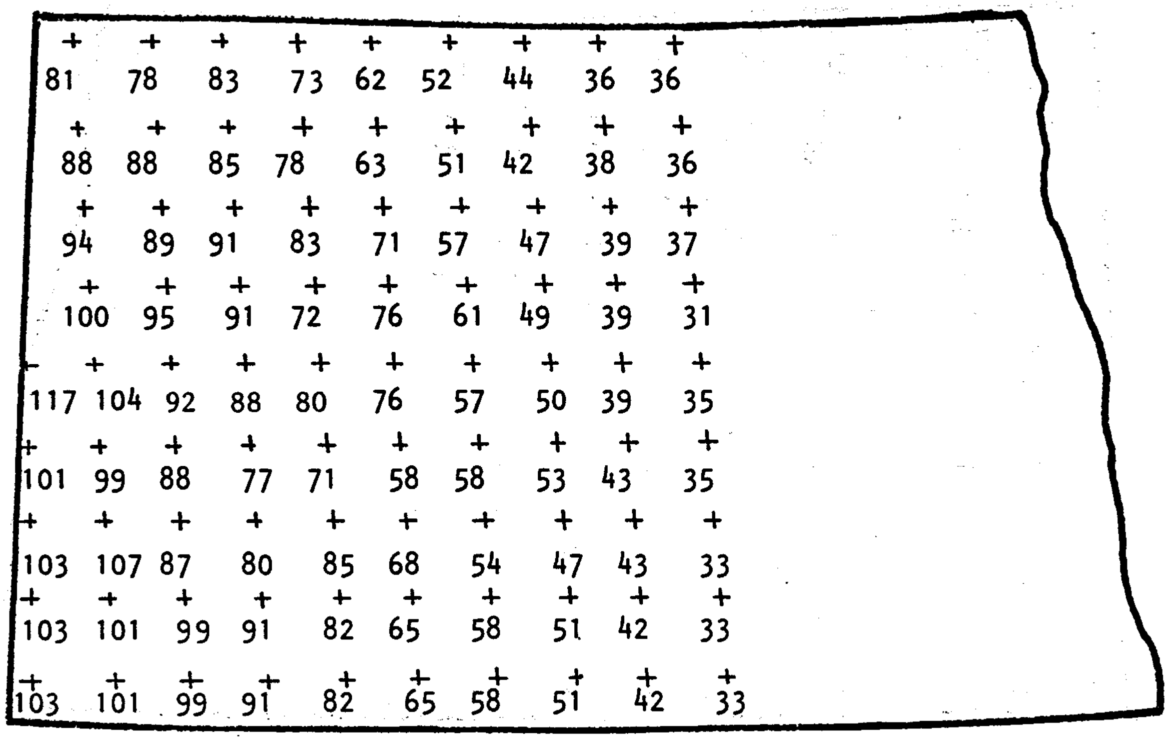


Figure 10. Calculated temperatures on top of the Madison aquifer.

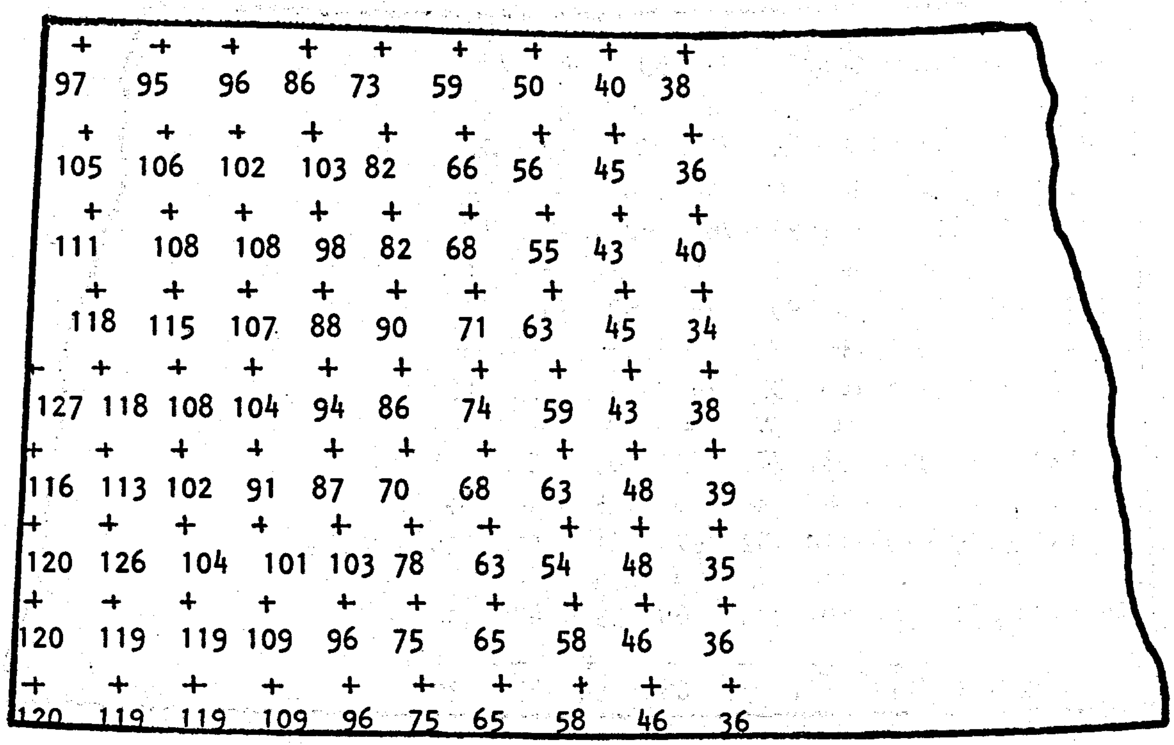


Figure 11. Calculated temperatures on top of the Duperow aquifer.

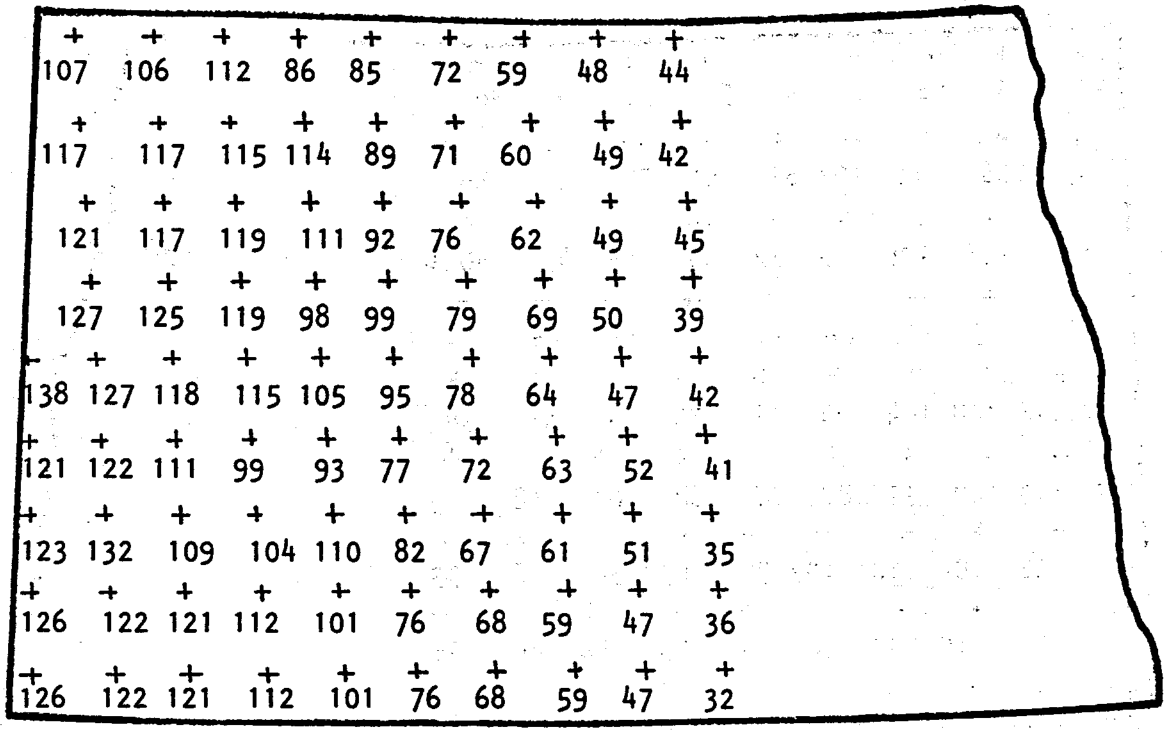


Figure 12. Calculated temperatures on top of the Red River aquifer.

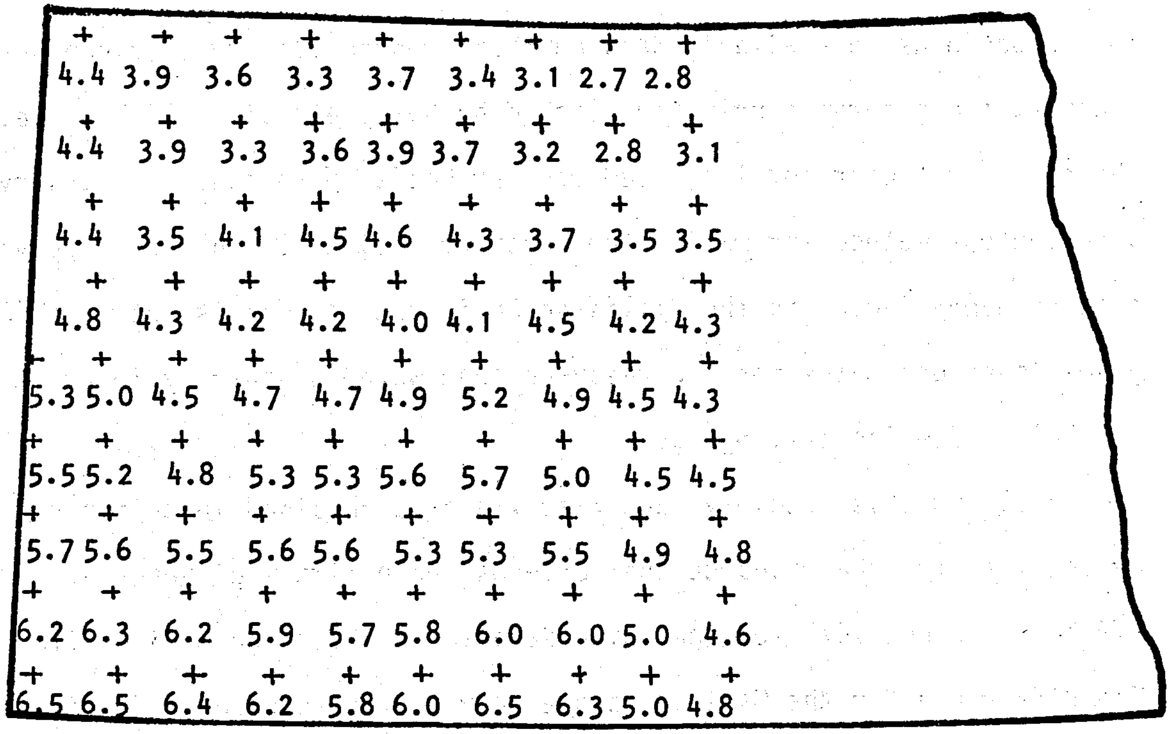


Figure 13. Mean annual surface temperature from 30 years of NOAA data.

among different types and in different applications. Therefore, it may be better to specify a specific reference temperature for purpose of resource estimation and let the potential user make additional estimates based on the data and his particular needs.

The recoverable resource can be calculated from the accessible resource base by considering the hydrologic properties of the aquifers. The general approach of Sorey et. al. (1983b) could be applied to the different aquifers in the basin using available data on their respective hydrologic properties. However, the general conclusion reached by Sorey et. al. (1983b), i.e., that the recovery factor for large sedimentary basis approaches 0.001, serves as a convenient method for making the resource estimate. In fact, applying this recovery factor to the Williston Basin data of Harris, et al (1981) gives lower estimates for the resource than were obtained by Sorey et. al. (1983a). (See Table 7, pg. 59).

Applying this recovery factor to the data obtained in this study gives an estimate for the resource that exceeds the estimate of Sorey et. al. (1983a) by about 107% for the Inyan Kara and 25% for the Madison (Table 1). The difference for the Madison is due only to the temperature differences used in the calculations. The difference for the Inyan Kara is due to temperature differences and to the size of the area included in the estimate. The extent of the resource area can be calculated by applying the criterion of Reed (1983), i.e., that a resource must have a temperature exceeding Tr; where

$$Tr = T10 + Z(25) \qquad \text{(Eq. 4)}$$

T10 is mean annual surface temperature plus 10°C, and Z is depth to resource. The Inyan Kara underlies Cretaceous shales that have a thermal conductivity

TABLE 1

	Mean Temperature	Maximum Temp. °C	Minimum Temp. °C	Reservoir Area (Km^2)	Reservoir Thickness (Km)	Mean Accessible Resource Base (10^{18} J.)
Inyan Kara	51	84	25	128,000	0.091	1,100
Madison	69	117	31	128,000	0.366	6,600
Duperow	81	127	34	128,000	0.100	2,200
Red River	87	138	35	128,000	0.150	3,600
TOTAL ACCESSIBLE RESOURCE BASE						13,500

on the order of 1.2 W/m/K. Assuming that the mean heat flow in the basin is 55 mW/m^2 (See Figure 8), the minimum depth at which the Inyan Kara becomes a resource can be calculated by setting Equation 2 equal to Equation 4 and solving for Z. For the conditions given above, this depth is 720 meters.

ADVECTIVE HEAT FLOW

One of the goals of this study was to attempt to quantify advective heat flow components on the eastern side of the basin. Previous theoretical studies (Smith and Chapman, 1983; Domenico and Palciauskas, 1983; Kilty and Chapman, 1980) and empirical studies (Morgan et. al., 1981; Brott et. al., 1981; Gosnold, 1982, 1983, 1984; Gosnold and Eversoll; 1981, 1982) indicate that significant thermal anomalies are produced by large scale regional ground water flow in sedimentary basins. In general terms, positive and negative heat flow components correlate with the sense of the vertical component of regional aquifer flow and may be recognized in detailed heat flow work. Eastward groundwater flow in the Great Plains is driven by the sloping potentiometric surface of the Plains (Hitchon, 1969) and causes heat flow anomalies on the order of 20 mW/m^2 in the Denver Basin and 50 mW/m^2 in the Kennedy Basin (Gosnold, 1983).

Regional groundwater flow in the Williston Basin is northeast (Downey, 1982) and involves at least the four major aquifers included in this resource analysis. Our approach to this phase of the study was determined by the available drilling funds which were sufficient for a total of 2,500 feet of drilling. We had to choose between drilling one deep hole that would penetrate at least one of the aquifers or to drill several holes into the Pierre shale on a profile paralleling the direction of water flow. The theory of the single hole approach is that the difference in heat flow above and below a flowing aquifer is the advective component. In the profile approach, heat flow is expected to increase eastward, i.e., in the updip flow direction; and the advective heat flow and water flow can be calculated from the data.

However, there are problems with both approaches. In order to accurately make these heat flow determinations, it is necessary to obtain either core samples or good drill cuttings for thermal conductivity measurements. Unfortunately, none of the formations overlying the uppermost aquifer, the Inyan Kara, are suitable for thermal conductivity measurements because they are shales (see Blackwell et. al., 1981a, 1981b). The first formation below the Inyan Kara that is suitable for conductivity measurements is the Madison limestone. However, it is too much deeper to be drilled and sampled by cuttings with the funds available. Consequently, the single hole option was precluded. The profile approach has the same problem with conductivity measurements, however, the only formation in question is the Pierre shale. The variation in thermal conductivity within a single formation such as the Pierre shale is unknown. The previously mentioned range of variation for Paleozoic shales in Kansas, i.e., 0.3 W/m/K (Blackwell et. al., 1981b), could generate a noise level on the order of 10 mW/m^2. This is a minimum noise level that could be expected assuming there is no variation in heat flow from the radioactive basement along the profile. Obviously, the combination of uncertainties in the conductivity and basement radioactive heat generation is a strong argument against the profile method. The conclusions reached from these considerations are: 1) The best method to determine advective heat flow is to drill deep holes through the aquifer. 2) The funds available were not sufficient to drill a deep hole. 3) More information that would be useful in the geothermal study could be gained by drilling five shallow holes than by drilling one deep hole. Consequently, five heat flow holes were drilled along a profile that parallels the direction of ground water flow in the eastern margin of the basin (Figure 14). The data from these holes is immediately useful for estimates of the geothermal resource because it adds to our heat flow data. In the future, we can obtain deep temperature gradient logs in holes of opportunity. Then we may be able to integrate the data and determine advective heat flow.

Table 2

Heat Flow Data

Well Name	Location Twp Rg Sec	Depth (m)	Gradient K/km	Conductivity W/m/K	Heat Flow mW/m2
LANDA	162 78 36ABB	70-95	39.5±0.1	1.2 (EST)	47.4±2
GLENBURN	159 82 36CCC	140-209	43.1±0.2	1.2 (EST)	51.7±2
MINOT N.	157 83 1AAA	235-270	40.3±0.2	1.2 (EST)	48.4±2
MINOT S.	157 84 36DCD	300-335	36.1±0.2	1.2 (EST)	43.3±2
SOURIS	163 78 36BBB	TD 100 M	(Well destroyed by farm machinery)		

Thermal conductivity estimate from Sass and Galanis (1983).

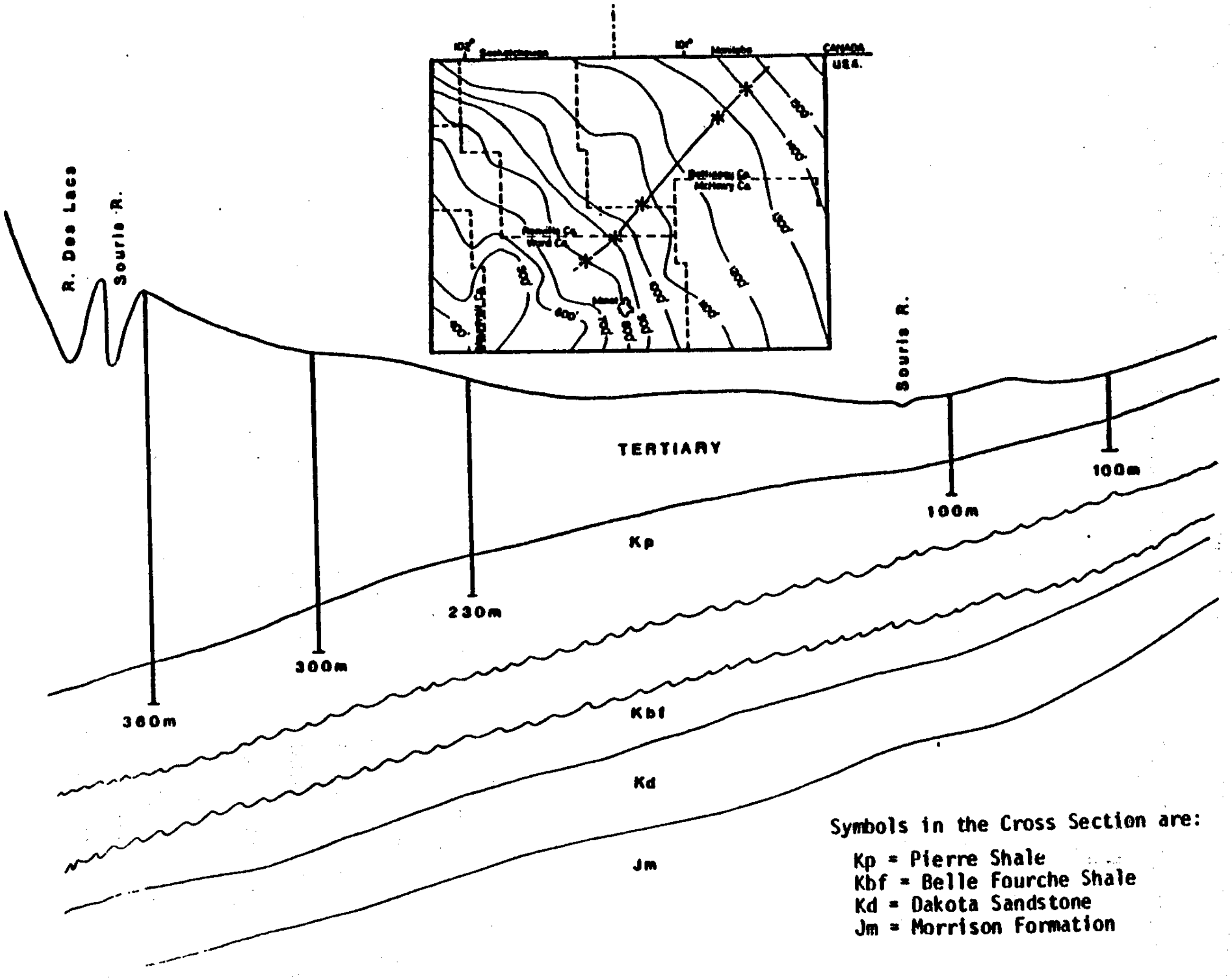


Figure 14. Location map and cross section showing relative positions of five heat flow holes drilled for the advective heat flow study. The drill hole sites are indicated by asterisks on the inset map. Contours on the inset map are structure contours on top of the Pierre shale.

CONCLUSIONS

Methodology

The method of estimating subsurface temperatures used in this study is significantly more accurate than is the use of BHT data. Application of the heat flow synthesis method in this study relied on the assumption that thermal conductivities do not vary over the study area. This assumption is not entirely correct. Formation conductivities do vary throughout the basin, but the variation is significantly less than the differences in conductivities between formations. Consequently, errors in calculated subsurface temperatures due to variation in formation conductivities are significantly less than errors that result from applying linear gradients extrapolated from BHT data.

The heat flow synthesis method would be best applied where actual conductivities are measured at each grid point. In most sedimentary basins this condition can be met. Most state geological surveys maintain drill core repositories or libraries, and numerous samples are available for thermal conductivity analyses. It is suggested that a cooperative effort between the state surveys and the geothermal laboratories at several universities and the U.S.G.S. could lead to accurate temperature analyses of most sedimentary basins. It is recommended that this type of project be a major component of any future federal geothermal program.

Resources

This assessment of geothermal resources in the Inyan Kara, Madison, Duperow, and Red River aquifers places the accessible resource base in North Dakota at 13,500 x 10^{18} J. Assuming an estimated recovery factor of 0.001

for geothermal waters and that a barrel of petroleum contains 6.07×10^9 J., the recoverable geothermal resource contained within four aquifers in North Dakota is equivalent to the energy contained in 2.22×10^9 barrels of petroleum. A surprising result of this study is that the quantity of geothermal energy in the Williston Basin may exceed the energy that is present in the form of oil. The potential impact of this energy resource on the industrial climate of North Dakota should be explored in depth.

Technology for utilization of the geothermal resource directly as a heat source and for refrigeration has developed to an economical stage. Electric power generation with binary systems is not yet economical (Gene Culver, personal communication), but it will be in the future, as the cost of conventional power generation rises. When exploited using both production and reinjection wells, this large energy resource is almost non-depletable and is non-polluting. Some possible uses for the resource are: electric power supply, direct heating supply, lignite drying, grain drying, electric rail systems, vegetable crops in geothermally heated green houses, and fish farming.

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APPENDIX

Tables of Temperatures, Formation Thickness, Depth to Formation Top, and Thermal Conductivity used in the Geothermal Resource Assessment. No tables were generated for Township 130N because the stratigraphic data were inadequate.

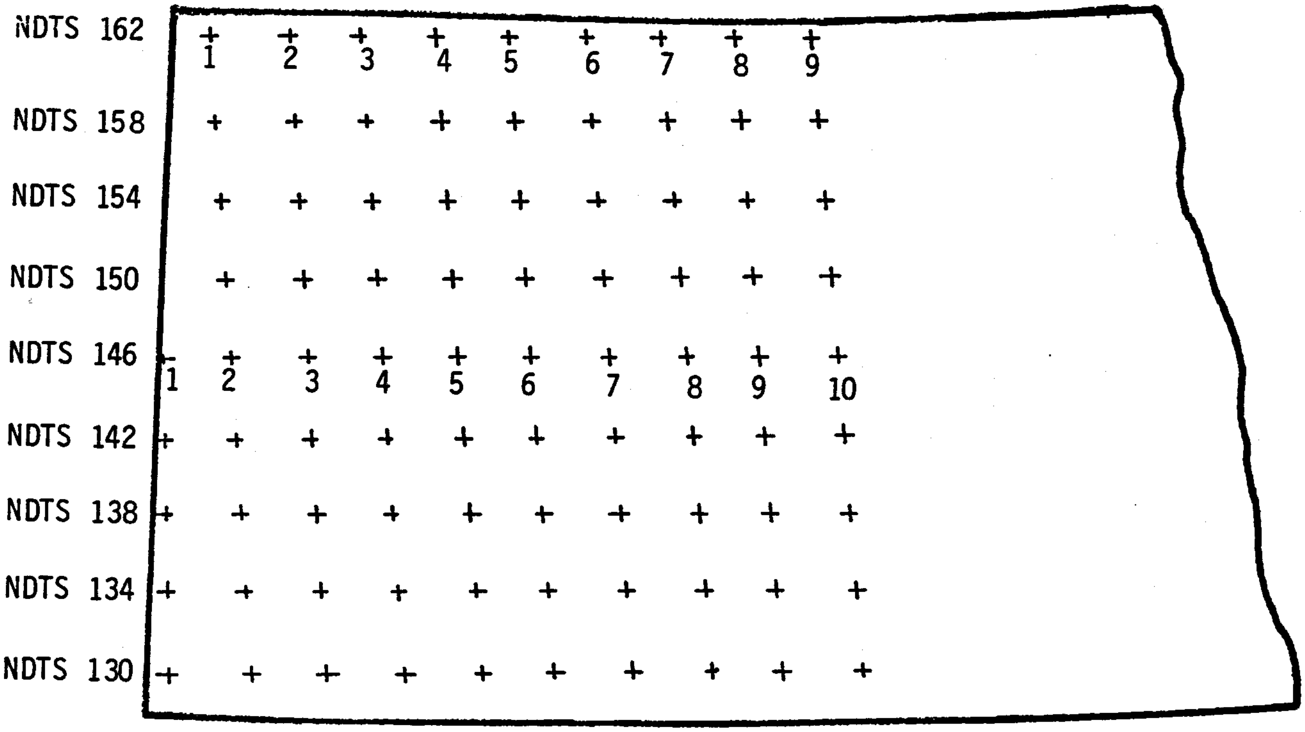

Figure 15. Location Key for Appendix Tables.

NDTS162 1

SURFACE TEMP = 4.4 Deg. C ELEVATION = 671 m HEAT FLOW = 60 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	16	800	351	1.2
TOP OF GREENHORN =	56	90	1151	1.2
TOP OF MOWRY =	61	110	1241	1.2
TOP OF INYAN KARA =	66	100	1351	1.6
TOP OF JURASSIC =	70	340	1451	2.8
TOP OF SPEARFISH =	77	155	1791	3.1
TOP OF MINNEKAHTA =	80	0	1946	2.8
TOP OF MINNELUSA =	80	0	1946	3.2
TOP OF MISSISSIPPIAN =	80	555	1946	3
TOP OF BAKKEN =	91	120	2501	1.5
TOP OF DUPEROW =	96	450	2621	3.5
TOP OF INTERLAKE =	104	220	3071	3.5
TOP OF RED RIVER =	108	880	3291	3.5
TOP OF DEADWOOD =	123	150	4171	3.5
TOP OF PRECAMBRIAN =	125	0	4321	3.5

NDTS162   2

SURFACE TEMP = 3.9 Deg. C   ELEVATION = 610 m   HEAT FLOW = 60 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	3		0	1.7
TOP OF PIERRE =	16	740	360	1.2
TOP OF GREENHORN =	53	80	1100	1.2
TOP OF MOWRY =	57	110	1180	1.2
TOP OF INYAN KARA =	63	105	1290	1.6
TOP OF JURASSIC =	67	325	1395	2.8
TOP OF SPEARFISH =	74	180	1720	3.1
TOP OF MINNEKAHTA =	77	0	1900	2.8
TOP OF MINNELUSA =	77	0	1900	3.2
TOP OF MISSISSIPPIAN =	77	530	1900	3
TOP OF BAKKEN =	88	160	2430	1.5
TOP OF DUPEROW =	94	420	2590	3.5
TOP OF INTERLAKE =	101	320	3010	3.5
TOP OF RED RIVER =	107	730	3330	3.5
TOP OF DEADWOOD =	119	130	4060	3.5
TOP OF PRECAMBRIAN =	121	0	4190	3.5

NDTS162 3

SURFACE TEMP = 3.6 Deg. C ELEVATION = 610 m HEAT FLOW = 65 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	3		0	1.7
TOP OF PIERRE =	18	705	395	1.2
TOP OF GREENHORN =	56	50	1100	1.2
TOP OF MOWRY =	59	110	1150	1.2
TOP OF INYAN KARA =	65	140	1260	1.6
TOP OF JURASSIC =	71	370	1400	2.8
TOP OF SPEARFISH =	79	40	1770	3.1
TOP OF MINNEKAHTA =	80	0	1810	2.8
TOP OF MINNELUSA =	80	0	1810	3.2
TOP OF MISSISSIPPIAN =	80	580	1810	3
TOP OF BAKKEN =	93	20	2390	1.5
TOP OF DUPEROW =	94	700	2410	3.5
TOP OF INTERLAKE =	107	310	3110	3.5
TOP OF RED RIVER =	112	570	3420	3.5
TOP OF DEADWOOD =	123	120	3990	3.5
TOP OF PRECAMBRIAN =	125	0	4110	3.5

NDTS162 4

SURFACE TEMP = 3.3 Deg. C ELEVATION = 594 m HEAT FLOW = 65 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	3		0	1.7
TOP OF PIERRE =	15	660	324	1.2
TOP OF GREENHORN =	51	60	984	1.2
TOP OF MOWRY =	54	90	1044	1.2
TOP OF INYAN KARA =	59	100	1134	1.6
TOP OF JURASSIC =	63	285	1234	2.8
TOP OF SPEARFISH =	70	85	1519	3.1
TOP OF MINNEKAHTA =	72	0	1604	2.8
TOP OF MINNELUSA =	72	0	1604	3.2
TOP OF MISSISSIPPIAN =	72	570	1604	3
TOP OF BAKKEN =	84	20	2174	1.5
TOP OF DUPEROW =	85	380	2194	3.5
TOP OF INTERLAKE =	92	220	2574	3.5
TOP OF RED RIVER =	96	200	2794	3.5
TOP OF DEADWOOD =	100	50	2994	3.5
TOP OF PRECAMBRIAN =	101	0	3044	3.5

NDTS162 5

SURFACE TEMP = 3.7 Deg. C ELEVATION = 518 m HEAT FLOW = 65 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	3		0	1.7
TOP OF PIERRE =	11	535	203	1.2
TOP OF GREENHORN =	40	105	738	1.2
TOP OF MOWRY =	46	80	843	1.2
TOP OF INYAN KARA =	50	110	923	1.6
TOP OF JURASSIC =	54	245	1033	2.8
TOP OF SPEARFISH =	60	65	1278	3.1
TOP OF MINNEKAHTA =	61	0	1343	2.8
TOP OF MINNELUSA =	61	0	1343	3.2
TOP OF MISSISSIPPIAN =	61	425	1343	3
TOP OF BAKKEN =	71	50	1768	1.5
TOP OF DUPEROW =	73	500	1818	3.5
TOP OF INTERLAKE =	82	230	2318	3.5
TOP OF RED RIVER =	86	190	2548	3.5
TOP OF DEADWOOD =	90	40	2738	3.5
TOP OF PRECAMBRIAN =	91	0	2778	3.5

NDTS162 6

SURFACE TEMP = 3.4 Deg. C ELEVATION = 457 m HEAT FLOW = 65 mW m*-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m*-1 K*-1
SURFACE =	3		0	1.7
TOP OF PIERRE =	7	470	107	1.2
TOP OF GREENHORN =	32	75	577	1.2
TOP OF MOWRY =	37	75	652	1.2
TOP OF INYAN KARA =	41	90	727	1.6
TOP OF JURASSIC =	44	240	817	2.8
TOP OF SPEARFISH =	50	50	1057	3.1
TOP OF MINNEKAHTA =	51	0	1107	2.8
TOP OF MINNELUSA =	51	0	1107	3.2
TOP OF MISSISSIPPIAN =	51	330	1107	3
TOP OF BAKKEN =	58	20	1437	1.5
TOP OF DUPEROW =	59	400	1457	3.5
TOP OF INTERLAKE =	66	380	1857	3.5
TOP OF RED RIVER =	73	30	2237	3.5
TOP OF DEADWOOD =	74	30	2267	3.5
TOP OF PRECAMBRIAN =	74	0	2297	3.5

NDTS162 7

SURFACE TEMP = 3.1 Deg. C ELEVATION = 457 m HEAT FLOW = 65 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	3		0	1.7
TOP OF PIERRE =	5	395	72	1.2
TOP OF GREENHORN =	27	80	467	1.2
TOP OF MOWRY =	31	65	547	1.2
TOP OF INYAN KARA =	35	70	612	1.6
TOP OF JURASSIC =	37	200	682	2.8
TOP OF SPEARFISH =	42	75	882	3.1
TOP OF MINNEKAHTA =	44	0	957	2.8
TOP OF MINNELUSA =	44	0	957	3.2
TOP OF MISSISSIPPIAN =	44	250	957	3
TOP OF BAKKEN =	49	30	1207	1.5
TOP OF DUPEROW =	50	320	1237	3.5
TOP OF INTERLAKE =	56	200	1557	3.5
TOP OF RED RIVER =	60	200	1757	3.5
TOP OF DEADWOOD =	64	20	1957	3.5
TOP OF PRECAMBRIAN =	64	0	1977	3.5

NDTS162 8

SURFACE TEMP = 2.7 Deg. C ELEVATION = 457 m HEAT FLOW = 60 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	2		0	1.7
TOP OF PIERRE =	4	390	37	1.2
TOP OF GREENHORN =	23	80	427	1.2
TOP OF MOWRY =	27	40	507	1.2
TOP OF INYAN KARA =	29	105	547	1.6
TOP OF JURASSIC =	33	130	652	2.8
TOP OF SPEARFISH =	36	25	782	3.1
TOP OF MINNEKAHTA =	36	0	807	2.8
TOP OF MINNELUSA =	36	0	807	3.2
TOP OF MISSISSIPPIAN =	36	180	807	3
TOP OF BAKKEN =	40	20	987	1.5
TOP OF DUPEROW =	41	350	1007	3.5
TOP OF INTERLAKE =	47	200	1357	3.5
TOP OF RED RIVER =	50	250	1557	3.5
TOP OF DEADWOOD =	54	20	1807	3.5
TOP OF PRECAMBRIAN =	55	0	1827	3.5

NDTS162 9

SURFACE TEMP = 2.8 Deg. C ELEVATION = 500 m HEAT FLOW = 60 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	2		0	1.7
TOP OF PIERRE =	2	410	0	1.2
TOP OF GREENHORN =	23	90	410	1.2
TOP OF MOWRY =	27	30	500	1.2
TOP OF INYAN KARA =	29	90	530	1.6
TOP OF JURASSIC =	32	130	620	2.8
TOP OF SPEARFISH =	35	100	750	3.1
TOP OF MINNEKAHTA =	37	0	850	2.8
TOP OF MINNELUSA =	37	0	850	3.2
TOP OF MISSISSIPPIAN =	37	30	850	3
TOP OF BAKKEN =	37	35	880	1.5
TOP OF DUPEROW =	39	95	915	3.5
TOP OF INTERLAKE =	41	290	1010	3.5
TOP OF RED RIVER =	45	450	1300	3.5
TOP OF DEADWOOD =	53	50	1750	3.5
TOP OF PRECAMBRIAN =	54	0	1800	3.5

NDTS158 1

SURFACE TEMP = 4 Deg. C ELEVATION = 655 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	20	800	475	1.2
TOP OF GREENHORN =	58	110	1275	1.2
TOP OF MOWRY =	64	130	1385	1.2
TOP OF INYAN KARA =	70	120	1515	1.6
TOP OF JURASSIC =	74	320	1635	2.8
TOP OF SPEARFISH =	81	310	1955	3.1
TOP OF MINNEKAHTA =	87	0	2265	2.8
TOP OF MINNELUSA =	87	0	2265	3.2
TOP OF MISSISSIPPIAN =	87	640	2265	3
TOP OF BAKKEN =	99	150	2905	1.5
TOP OF DUPEROW =	105	400	3055	3.5
TOP OF INTERLAKE =	112	390	3455	3.5
TOP OF RED RIVER =	118	390	3845	3.5
TOP OF DEADWOOD =	124	150	4235	3.5
TOP OF PRECAMBRIAN =	127	0	4385	3.5

NDTS158   2

SURFACE TEMP = 3.9 Deg. C   ELEVATION = 700 m   HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	3		0	1.7
TOP OF PIERRE =	21	760	520	1.2
TOP OF GREENHORN =	58	120	1280	1.2
TOP OF MOWRY =	64	110	1400	1.2
TOP OF INYAN KARA =	69	110	1510	1.6
TOP OF JURASSIC =	73	330	1620	2.8
TOP OF SPEARFISH =	80	370	1950	3.1
TOP OF MINNEKAHTA =	87	0	2320	2.8
TOP OF MINNELUSA =	87	0	2320	3.2
TOP OF MISSISSIPPIAN =	87	610	2320	3
TOP OF BAKKEN =	99	170	2930	1.5
TOP OF DUPEROW =	105	420	3100	3.5
TOP OF INTERLAKE =	112	390	3520	3.5
TOP OF RED RIVER =	119	370	3910	3.5
TOP OF DEADWOOD =	125	120	4280	3.5
TOP OF PRECAMBRIAN =	127	0	4400	3.5

NDTS158   3

SURFACE TEMP = 3.3 Deg. C   ELEVATION = 700 m   HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	3		0	1.7
TOP OF PIERRE =	21	770	530	1.2
TOP OF GREENHORN =	58	110	1300	1.2
TOP OF MOWRY =	63	100	1410	1.2
TOP OF INYAN KARA =	68	100	1510	1.6
TOP OF JURASSIC =	72	310	1610	2.8
TOP OF SPEARFISH =	78	290	1920	3.1
TOP OF MINNEKAHTA =	84	0	2210	2.8
TOP OF MINNELUSA =	84	0	2210	3.2
TOP OF MISSISSIPPIAN =	84	690	2210	3
TOP OF BAKKEN =	97	100	2900	1.5
TOP OF DUPEROW =	101	500	3000	3.5
TOP OF INTERLAKE =	109	400	3500	3.5
TOP OF RED RIVER =	116	290	3900	3.5
TOP OF DEADWOOD =	121	80	4190	3.5
TOP OF PRECAMBRIAN =	122	0	4270	3.5

NDTS158 4

SURFACE TEMP = 3.6 Deg. C ELEVATION = 700 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	3		0	1.7
TOP OF PIERRE =	21	675	525	1.2
TOP OF GREENHORN =	54	95	1200	1.2
TOP OF MOWRY =	58	95	1295	1.2
TOP OF INYAN KARA =	63	120	1390	1.6
TOP OF JURASSIC =	67	280	1510	2.8
TOP OF SPEARFISH =	73	210	1790	3.1
TOP OF MINNEKAHTA =	77	0	2000	2.8
TOP OF MINNELUSA =	77	0	2000	3.2
TOP OF MISSISSIPPIAN =	77	540	2000	3
TOP OF BAKKEN =	87	410	2540	1.5
TOP OF DUPEROW =	103	250	2950	3.5
TOP OF INTERLAKE =	107	500	3200	3.5
TOP OF RED RIVER =	116	200	3700	3.5
TOP OF DEADWOOD =	119	50	3900	3.5
TOP OF PRECAMBRIAN =	120	0	3950	3.5

NDTS158 5

SURFACE TEMP = 3.9 Deg. C ELEVATION = 552 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	3		0	1.7
TOP OF PIERRE =	14	595	307	1.2
TOP OF GREENHORN =	43	100	902	1.2
TOP OF MOWRY =	47	100	1002	1.2
TOP OF INYAN KARA =	52	100	1102	1.6
TOP OF JURASSIC =	56	250	1202	2.8
TOP OF SPEARFISH =	61	90	1452	3.1
TOP OF MINNEKAHTA =	63	0	1542	2.8
TOP OF MINNELUSA =	63	0	1542	3.2
TOP OF MISSISSIPPIAN =	63	400	1542	3
TOP OF BAKKEN =	71	310	1942	1.5
TOP OF DUPEROW =	83	250	2252	3.5
TOP OF INTERLAKE =	87	230	2502	3.5
TOP OF RED RIVER =	90	120	2732	3.5
TOP OF DEADWOOD =	92	40	2852	3.5
TOP OF PRECAMBRIAN =	93	0	2892	3.5

NDTS158 6

SURFACE TEMP = 3.7 Deg. C ELEVATION = 466 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	3		0	1.7
TOP OF PIERRE =	8	505	141	1.2
TOP OF GREENHORN =	32	85	646	1.2
TOP OF MOWRY =	37	85	731	1.2
TOP OF INYAN KARA =	41	100	816	1.6
TOP OF JURASSIC =	44	225	916	2.8
TOP OF SPEARFISH =	49	100	1141	3.1
TOP OF MINNEKAHTA =	51	0	1241	2.8
TOP OF MINNELUSA =	51	0	1241	3.2
TOP OF MISSISSIPPIAN =	51	405	1241	3
TOP OF BAKKEN =	59	200	1646	1.5
TOP OF DUPEROW =	66	200	1846	3.5
TOP OF INTERLAKE =	70	200	2046	3.5
TOP OF RED RIVER =	73	200	2246	3.5
TOP OF DEADWOOD =	76	40	2446	3.5
TOP OF PRECAMBRIAN =	77	0	2486	3.5

NDTS158 7

SURFACE TEMP = 3.2 Deg. C ELEVATION = 427 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	3		0	1.7
TOP OF PIERRE =	4	475	42	1.2
TOP OF GREENHORN =	27	60	517	1.2
TOP OF MOWRY =	30	60	577	1.2
TOP OF INYAN KARA =	33	80	637	1.6
TOP OF JURASSIC =	36	210	717	2.8
TOP OF SPEARFISH =	40	75	927	3.1
TOP OF MINNEKAHTA =	42	0	1002	2.8
TOP OF MINNELUSA =	42	0	1002	3.2
TOP OF MISSISSIPPIAN =	42	305	1002	3
TOP OF BAKKEN =	47	220	1307	1.5
TOP OF DUPEROW =	56	200	1527	3.5
TOP OF INTERLAKE =	59	110	1727	3.5
TOP OF RED RIVER =	61	210	1837	3.5
TOP OF DEADWOOD =	65	20	2047	3.5
TOP OF PRECAMBRIAN =	65	0	2067	3.5

NDTS158 8

SURFACE TEMP = 2.8 Deg. C ELEVATION = 457 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	2		0	1.7
TOP OF PIERRE =	4	420	37	1.2
TOP OF GREENHORN =	24	80	457	1.2
TOP OF MOWRY =	28	60	537	1.2
TOP OF INYAN KARA =	31	60	597	1.6
TOP OF JURASSIC =	33	200	657	2.8
TOP OF SPEARFISH =	37	50	857	3.1
TOP OF MINNEKAHTA =	38	0	907	2.8
TOP OF MINNELUSA =	38	0	907	3.2
TOP OF MISSISSIPPIAN =	38	160	907	3
TOP OF BAKKEN =	41	110	1067	1.5
TOP OF DUPEROW =	45	90	1177	3.5
TOP OF INTERLAKE =	47	180	1267	3.5
TOP OF RED RIVER =	50	430	1447	3.5
TOP OF DEADWOOD =	57	20	1877	3.5
TOP OF PRECAMBRIAN =	57	0	1897	3.5

NDTS158 9

SURFACE TEMP = 3.1 Deg. C ELEVATION = 500 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	3		0	1.7
TOP OF PIERRE =	3	410	0	1.2
TOP OF GREENHORN =	22	90	410	1.2
TOP OF MOWRY =	27	50	500	1.2
TOP OF INYAN KARA =	29	60	550	1.6
TOP OF JURASSIC =	31	140	610	2.8
TOP OF SPEARFISH =	34	120	750	3.1
TOP OF MINNEKAHTA =	37	0	870	2.8
TOP OF MINNELUSA =	37	0	870	3.2
TOP OF MISSISSIPPIAN =	37	10	870	3
TOP OF BAKKEN =	37	10	880	1.5
TOP OF DUPEROW =	37	190	890	3.5
TOP OF INTERLAKE =	40	200	1080	3.5
TOP OF RED RIVER =	44	370	1280	3.5
TOP OF DEADWOOD =	50	50	1650	3.5
TOP OF PRECAMBRIAN =	51	0	1700	3.5

NDTS154 1

SURFACE TEMP = 4 Deg. C ELEVATION = 610 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	22	820	530	1.2
TOP OF GREENHORN =	61	120	1350	1.2
TOP OF MOWRY =	67	140	1470	1.2
TOP OF INYAN KARA =	74	140	1610	1.6
TOP OF JURASSIC =	79	300	1750	2.8
TOP OF SPEARFISH =	85	110	2050	3.1
TOP OF MINNEKAHTA =	87	75	2160	2.8
TOP OF MINNELUSA =	89	225	2235	3.2
TOP OF MISSISSIPPIAN =	93	750	2460	3
TOP OF BAKKEN =	107	80	3210	1.5
TOP OF DUPEROW =	110	340	3290	3.5
TOP OF INTERLAKE =	116	400	3630	3.5
TOP OF RED RIVER =	123	200	4030	3.5
TOP OF DEADWOOD =	126	230	4230	3.5
TOP OF PRECAMBRIAN =	130	0	4460	3.5

NDTS154 2

SURFACE TEMP = 3.5 Deg. C ELEVATION = 564 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	3		0	1.7
TOP OF PIERRE =	15	720	344	1.2
TOP OF GREENHORN =	50	280	1064	1.2
TOP OF MOWRY =	63	120	1344	1.2
TOP OF INYAN KARA =	69	90	1464	1.6
TOP OF JURASSIC =	72	270	1554	2.8
TOP OF SPEARFISH =	78	140	1824	3.1
TOP OF MINNEKAHTA =	80	10	1964	2.8
TOP OF MINNELUSA =	81	370	1974	3.2
TOP OF MISSISSIPPIAN =	87	820	2344	3
TOP OF BAKKEN =	103	100	3164	1.5
TOP OF DUPEROW =	107	280	3264	3.5
TOP OF INTERLAKE =	112	390	3544	3.5
TOP OF RED RIVER =	118	230	3934	3.5
TOP OF DEADWOOD =	122	220	4164	3.5
TOP OF PRECAMBRIAN =	126	0	4384	3.5

NDTS154 3

SURFACE TEMP = 4.1 Deg. C ELEVATION = 732 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	22	790	532	1.2
TOP OF GREENHORN =	60	115	1322	1.2
TOP OF MOWRY =	65	100	1437	1.2
TOP OF INYAN KARA =	70	115	1537	1.6
TOP OF JURASSIC =	74	300	1652	2.8
TOP OF SPEARFISH =	81	130	1952	3.1
TOP OF MINNEKAHTA =	83	100	2082	2.8
TOP OF MINNELUSA =	85	250	2182	3.2
TOP OF MISSISSIPPIAN =	90	700	2432	3
TOP OF BAKKEN =	103	100	3132	1.5
TOP OF DUPEROW =	107	460	3232	3.5
TOP OF INTERLAKE =	115	340	3692	3.5
TOP OF RED RIVER =	120	330	4032	3.5
TOP OF DEADWOOD =	126	220	4362	3.5
TOP OF PRECAMBRIAN =	130	0	4582	3.5

NDTS154   4

SURFACE TEMP = 4.5 Deg. C   ELEVATION = 640 m   HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	20	720	460	1.2
TOP OF GREENHORN =	54	130	1180	1.2
TOP OF MOWRY =	61	120	1310	1.2
TOP OF INYAN KARA =	67	105	1430	1.6
TOP OF JURASSIC =	70	305	1535	2.8
TOP OF SPEARFISH =	77	150	1840	3.1
TOP OF MINNEKAHTA =	80	0	1990	2.8
TOP OF MINNELUSA =	80	150	1990	3.2
TOP OF MISSISSIPPIAN =	82	690	2140	3
TOP OF BAKKEN =	96	60	2830	1.5
TOP OF DUPEROW =	98	520	2890	3.5
TOP OF INTERLAKE =	107	430	3410	3.5
TOP OF RED RIVER =	114	180	3840	3.5
TOP OF DEADWOOD =	117	186	4020	3.5
TOP OF PRECAMBRIAN =	120	0	4206	3.5

NDTS154 5

SURFACE TEMP = 4.6 Deg. C ELEVATION = 640 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	19	625	435	1.2
TOP OF GREENHORN =	49	110	1060	1.2
TOP OF MOWRY =	54	95	1170	1.2
TOP OF INYAN KARA =	59	100	1265	1.6
TOP OF JURASSIC =	63	275	1365	2.8
TOP OF SPEARFISH =	68	175	1640	3.1
TOP OF MINNEKAHTA =	72	0	1815	2.8
TOP OF MINNELUSA =	72	0	1815	3.2
TOP OF MISSISSIPPIAN =	72	475	1815	3
TOP OF BAKKEN =	81	60	2290	1.5
TOP OF DUPEROW =	83	390	2350	3.5
TOP OF INTERLAKE =	90	300	2740	3.5
TOP OF RED RIVER =	95	250	3040	3.5
TOP OF DEADWOOD =	99	120	3290	3.5
TOP OF PRECAMBRIAN =	101	0	3410	3.5

NDTS154 6

SURFACE TEMP = 4.3 Deg. C ELEVATION = 503 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	11	555	198	1.2
TOP OF GREENHORN =	37	110	753	1.2
TOP OF MOWRY =	43	90	863	1.2
TOP OF INYAN KARA =	47	90	953	1.6
TOP OF JURASSIC =	50	260	1043	2.8
TOP OF SPEARFISH =	56	100	1303	3.1
TOP OF MINNEKAHTA =	58	0	1403	2.8
TOP OF MINNELUSA =	58	0	1403	3.2
TOP OF MISSISSIPPIAN =	58	400	1403	3
TOP OF BAKKEN =	65	80	1803	1.5
TOP OF DUPEROW =	68	320	1883	3.5
TOP OF INTERLAKE =	74	280	2203	3.5
TOP OF RED RIVER =	78	100	2483	3.5
TOP OF DEADWOOD =	80	76	2583	3.5
TOP OF PRECAMBRIAN =	81	0	2659	3.5

NDTS154 7

SURFACE TEMP = 3.7 Deg. C ELEVATION = 457 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	3		0	1.7
TOP OF PIERRE =	7	450	102	1.2
TOP OF GREENHORN =	28	115	552	1.2
TOP OF MOWRY =	34	65	667	1.2
TOP OF INYAN KARA =	37	100	732	1.6
TOP OF JURASSIC =	41	195	832	2.8
TOP OF SPEARFISH =	45	130	1027	3.1
TOP OF MINNEKAHTA =	47	0	1157	2.8
TOP OF MINNELUSA =	47	0	1157	3.2
TOP OF MISSISSIPPIAN =	47	350	1157	3
TOP OF BAKKEN =	54	50	1507	1.5
TOP OF DUPEROW =	56	220	1557	3.5
TOP OF INTERLAKE =	60	250	1777	3.5
TOP OF RED RIVER =	64	150	2027	3.5
TOP OF DEADWOOD =	66	30	2177	3.5
TOP OF PRECAMBRIAN =	67	0	2207	3.5

NDTS154 8

SURFACE TEMP = 3.5 Deg. C ELEVATION = 457 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	3		0	1.7
TOP OF PIERRE =	5	390	62	1.2
TOP OF GREENHORN =	24	95	452	1.2
TOP OF MOWRY =	29	75	547	1.2
TOP OF INYAN KARA =	32	85	622	1.6
TOP OF JURASSIC =	35	150	707	2.8
TOP OF SPEARFISH =	38	75	857	3.1
TOP OF MINNEKAHTA =	40	0	932	2.8
TOP OF MINNELUSA =	40	0	932	3.2
TOP OF MISSISSIPPIAN =	40	225	932	3
TOP OF BAKKEN =	44	20	1157	1.5
TOP OF DUPEROW =	45	180	1177	3.5
TOP OF INTERLAKE =	48	200	1357	3.5
TOP OF RED RIVER =	51	280	1557	3.5
TOP OF DEADWOOD =	56	20	1837	3.5
TOP OF PRECAMBRIAN =	56	0	1857	3.5

NDTS154 9

SURFACE TEMP = 3.5 Deg. C ELEVATION = 500 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	3		0	1.7
TOP OF PIERRE =	3	450	0	1.2
TOP OF GREENHORN =	25	60	450	1.2
TOP OF MOWRY =	28	60	510	1.2
TOP OF INYAN KARA =	31	70	570	1.6
TOP OF JURASSIC =	33	210	640	2.8
TOP OF SPEARFISH =	37	0	850	3.1
TOP OF MINNEKAHTA =	37	0	850	2.8
TOP OF MINNELUSA =	37	0	850	3.2
TOP OF MISSISSIPPIAN =	37	50	850	3
TOP OF BAKKEN =	38	50	900	1.5
TOP OF DUPEROW =	40	250	950	3.5
TOP OF INTERLAKE =	44	120	1200	3.5
TOP OF RED RIVER =	46	280	1320	3.5
TOP OF DEADWOOD =	51	50	1600	3.5
TOP OF PRECAMBRIAN =	52	0	1650	3.5

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                             NDTS150       1

SURFACE TEMP =  4.8  Deg. C    ELEVATION =  732 m     HEAT FLOW =  58 mW m°-2

                         TEMPERATURE      THICKNESS        DEPTH    CONDUCTIVITY
                          DEGREES C                        METERS   W m°-1 K°-1

SURFACE  =                    4                            0            1.7
TOP OF PIERRE =               26             850           632          1.2
TOP OF GREENHORN  =           67             110           1482         1.2
TOP OF MOWRY  =               72             140           1592         1.2
TOP OF INYAN KARA =           79             140           1732         1.6
TOP OF JURASSIC  =            84             310           1872         2.8
TOP OF SPEARFISH =            91             150           2182         3.1
TOP OF MINNEKAHTA =           93             90            2332         2.8
TOP OF MINNELUSA =            95             210           2422         3.2
TOP OF MISSISSIPPIAN =        99             700           2632         3
TOP OF BAKKEN =               113            150           3332         1.5
TOP OF DUPEROW =              118            270           3482         3.5
TOP OF INTERLAKE =            123            380           3752         3.5
TOP OF RED RIVER =            129            100           4132         3.5
TOP OF DEADWOOD =             131            260           4232         3.5
TOP OF PRECAMBRIAN =          135            0             4492         3.5
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NDTS150 2

SURFACE TEMP = 4.3 Deg. C ELEVATION = 686 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	20	840	486	1.2
TOP OF GREENHORN =	61	160	1326	1.2
TOP OF MOWRY =	69	140	1486	1.2
TOP OF INYAN KARA =	75	185	1626	1.6
TOP OF JURASSIC =	82	185	1811	2.8
TOP OF SPEARFISH =	86	180	1996	3.1
TOP OF MINNEKAHTA =	89	100	2176	2.8
TOP OF MINNELUSA =	91	260	2276	3.2
TOP OF MISSISSIPPIAN =	96	750	2536	3
TOP OF BAKKEN =	111	150	3286	1.5
TOP OF DUPEROW =	116	300	3436	3.5
TOP OF INTERLAKE =	121	410	3736	3.5
TOP OF RED RIVER =	128	170	4146	3.5
TOP OF DEADWOOD =	131	260	4316	3.5
TOP OF PRECAMBRIAN =	135	0	4576	3.5

NDTS150 3

SURFACE TEMP = 4.2 Deg. C ELEVATION = 610 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	18	790	430	1.2
TOP OF GREENHORN =	57	160	1220	1.2
TOP OF MOWRY =	64	90	1380	1.2
TOP OF INYAN KARA =	69	130	1470	1.6
TOP OF JURASSIC =	73	285	1600	2.8
TOP OF SPEARFISH =	79	155	1885	3.1
TOP OF MINNEKAHTA =	82	95	2040	2.8
TOP OF MINNELUSA =	84	325	2135	3.2
TOP OF MISSISSIPPIAN =	90	630	2460	3
TOP OF BAKKEN =	102	120	3090	1.5
TOP OF DUPEROW =	107	430	3210	3.5
TOP OF INTERLAKE =	114	380	3640	3.5
TOP OF RED RIVER =	120	190	4020	3.5
TOP OF DEADWOOD =	123	250	4210	3.5
TOP OF PRECAMBRIAN =	128	0	4460	3.5

NDTS150 4

SURFACE TEMP = 4.2 Deg. C ELEVATION = 610 m HEAT FLOW = 50 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	17	710	450	1.2
TOP OF GREENHORN =	47	160	1160	1.2
TOP OF MOWRY =	53	100	1320	1.2
TOP OF INYAN KARA =	57	115	1420	1.6
TOP OF JURASSIC =	61	285	1535	2.8
TOP OF SPEARFISH =	66	80	1820	3.1
TOP OF MINNEKAHTA =	67	300	1900	2.8
TOP OF MINNELUSA =	73	0	2200	3.2
TOP OF MISSISSIPPIAN =	73	660	2200	3
TOP OF BAKKEN =	84	150	2860	1.5
TOP OF DUPEROW =	89	380	3010	3.5
TOP OF INTERLAKE =	94	420	3390	3.5
TOP OF RED RIVER =	100	200	3810	3.5
TOP OF DEADWOOD =	103	170	4010	3.5
TOP OF PRECAMBRIAN =	105	0	4180	3.5

NDTS150 5

SURFACE TEMP = 4 Deg. C ELEVATION = 640 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	19	600	440	1.2
TOP OF GREENHORN =	48	160	1040	1.2
TOP OF MOWRY =	55	120	1200	1.2
TOP OF INYAN KARA =	61	110	1320	1.6
TOP OF JURASSIC =	65	270	1430	2.8
TOP OF SPEARFISH =	71	115	1700	3.1
TOP OF MINNEKAHTA =	73	0	1815	2.8
TOP OF MINNELUSA =	73	125	1815	3.2
TOP OF MISSISSIPPIAN =	75	600	1940	3
TOP OF BAKKEN =	87	100	2540	1.5
TOP OF DUPEROW =	91	380	2640	3.5
TOP OF INTERLAKE =	97	220	3020	3.5
TOP OF RED RIVER =	100	400	3240	3.5
TOP OF DEADWOOD =	107	100	3640	3.5
TOP OF PRECAMBRIAN =	109	0	3740	3.5

NDTS150 6

SURFACE TEMP = 4.1 Deg. C ELEVATION = 610 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	14	565	305	1.2
TOP OF GREENHORN =	41	90	870	1.2
TOP OF MOWRY =	46	100	960	1.2
TOP OF INYAN KARA =	50	100	1060	1.6
TOP OF JURASSIC =	54	240	1160	2.8
TOP OF SPEARFISH =	59	110	1400	3.1
TOP OF MINNEKAHTA =	61	0	1510	2.8
TOP OF MINNELUSA =	61	0	1510	3.2
TOP OF MISSISSIPPIAN =	61	450	1510	3
TOP OF BAKKEN =	70	50	1960	1.5
TOP OF DUPEROW =	72	350	2010	3.5
TOP OF INTERLAKE =	78	220	2360	3.5
TOP OF RED RIVER =	81	40	2580	3.5
TOP OF DEADWOOD =	82	190	2620	3.5
TOP OF PRECAMBRIAN =	85	0	2810	3.5

NDTS150 7

SURFACE TEMP = 4.5 Deg. C ELEVATION = 518 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	9	560	158	1.2
TOP OF GREENHORN =	36	5	718	1.2
TOP OF MOWRY =	37	115	723	1.2
TOP OF INYAN KARA =	42	100	838	1.6
TOP OF JURASSIC =	46	170	938	2.8
TOP OF SPEARFISH =	49	100	1108	3.1
TOP OF MINNEKAHTA =	51	0	1208	2.8
TOP OF MINNELUSA =	51	0	1208	3.2
TOP OF MISSISSIPPIAN =	51	310	1208	3
TOP OF BAKKEN =	57	200	1518	1.5
TOP OF DUPEROW =	65	280	1718	3.5
TOP OF INTERLAKE =	70	130	1998	3.5
TOP OF RED RIVER =	72	10	2128	3.5
TOP OF DEADWOOD =	72	55	2138	3.5
TOP OF PRECAMBRIAN =	73	0	2193	3.5

NDTS150 8

SURFACE TEMP = 4.2 Deg. C ELEVATION = 489 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	7	425	89	1.2
TOP OF GREENHORN =	27	95	514	1.2
TOP OF MOWRY =	32	60	609	1.2
TOP OF INYAN KARA =	35	40	669	1.6
TOP OF JURASSIC =	36	160	709	2.8
TOP OF SPEARFISH =	40	70	869	3.1
TOP OF MINNEKAHTA =	41	0	939	2.8
TOP OF MINNELUSA =	41	0	939	3.2
TOP OF MISSISSIPPIAN =	41	230	939	3
TOP OF BAKKEN =	45	40	1169	1.5
TOP OF DUPEROW =	47	280	1209	3.5
TOP OF INTERLAKE =	51	100	1489	3.5
TOP OF RED RIVER =	53	200	1589	3.5
TOP OF DEADWOOD =	56	30	1789	3.5
TOP OF PRECAMBRIAN =	57	0	1819	3.5

NDTS150 9

SURFACE TEMP = 4.3 Deg. C ELEVATION = 500 m HEAT FLOW = 58 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	19	70	460	1.2
TOP OF GREENHORN =	23	70	530	1.2
TOP OF MOWRY =	26	95	600	1.2
TOP OF INYAN KARA =	31	135	695	1.6
TOP OF JURASSIC =	36	0	830	2.8
TOP OF SPEARFISH =	36	0	830	3.1
TOP OF MINNEKAHTA =	36	0	830	2.8
TOP OF MINNELUSA =	36	0	830	3.2
TOP OF MISSISSIPPIAN =	36	100	830	3
TOP OF BAKKEN =	38	20	930	1.5
TOP OF DUPEROW =	38	200	950	3.5
TOP OF INTERLAKE =	42	140	1150	3.5
TOP OF RED RIVER =	44	210	1290	3.5
TOP OF DEADWOOD =	48	50	1500	3.5
TOP OF PRECAMBRIAN =	48	0	1550	3.5

NDTS146 1

SURFACE TEMP = 5.3 Deg. C ELEVATION = 762 m HEAT FLOW = 67 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	27	860	552	1.2
TOP OF GREENHORN =	75	140	1412	1.2
TOP OF MOWRY =	82	120	1552	1.2
TOP OF INYAN KARA =	89	140	1672	1.6
TOP OF JURASSIC =	95	325	1812	2.8
TOP OF SPEARFISH =	103	115	2137	3.1
TOP OF MINNEKAHTA =	105	100	2252	2.8
TOP OF MINNELUSA =	108	360	2352	3.2
TOP OF MISSISSIPPIAN =	115	550	2712	3
TOP OF BAKKEN =	127	-20	3262	1.5
TOP OF DUPEROW =	127	320	3242	3.5
TOP OF INTERLAKE =	133	300	3562	3.5
TOP OF RED RIVER =	138	200	3862	3.5
TOP OF DEADWOOD =	142	270	4062	3.5
TOP OF PRECAMBRIAN =	147	0	4332	3.5

NDTS146 2

SURFACE TEMP = 5 Deg. C ELEVATION = 792 m HEAT FLOW = 67 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	30	840	642	1.2
TOP OF GREENHORN =	77	130	1482	1.2
TOP OF MOWRY =	84	115	1612	1.2
TOP OF INYAN KARA =	90	135	1727	1.6
TOP OF JURASSIC =	96	310	1862	2.8
TOP OF SPEARFISH =	103	160	2172	3.1
TOP OF MINNEKAHTA =	107	90	2332	2.8
TOP OF MINNELUSA =	109	280	2422	3.2
TOP OF MISSISSIPPIAN =	115	670	2702	3
TOP OF BAKKEN =	130	40	3372	1.5
TOP OF DUPEROW =	132	360	3412	3.5
TOP OF INTERLAKE =	139	230	3772	3.5
TOP OF RED RIVER =	143	190	4002	3.5
TOP OF DEADWOOD =	147	280	4192	3.5
TOP OF PRECAMBRIAN =	152	0	4472	3.5

NDTS146 3

SURFACE TEMP = 4.5 Deg. C ELEVATION = 732 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	25	765	642	1.2
TOP OF GREENHORN =	60	165	1407	1.2
TOP OF MOWRY =	67	120	1572	1.2
TOP OF INYAN KARA =	73	90	1692	1.6
TOP OF JURASSIC =	76	320	1782	2.8
TOP OF SPEARFISH =	82	120	2102	3.1
TOP OF MINNEKAHTA =	84	120	2222	2.8
TOP OF MINNELUSA =	87	280	2342	3.2
TOP OF MISSISSIPPIAN =	92	710	2622	3
TOP OF BAKKEN =	105	100	3332	1.5
TOP OF DUPEROW =	108	310	3432	3.5
TOP OF INTERLAKE =	113	390	3742	3.5
TOP OF RED RIVER =	119	170	4132	3.5
TOP OF DEADWOOD =	122	240	4302	3.5
TOP OF PRECAMBRIAN =	126	0	4542	3.5

NDTS146 4

SURFACE TEMP = 4.7 Deg. C ELEVATION = 670 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	22	790	560	1.2
TOP OF GREENHORN =	59	120	1350	1.2
TOP OF MOWRY =	64	105	1470	1.2
TOP OF INYAN KARA =	69	105	1575	1.6
TOP OF JURASSIC =	72	295	1680	2.8
TOP OF SPEARFISH =	78	105	1975	3.1
TOP OF MINNEKAHTA =	80	115	2080	2.8
TOP OF MINNELUSA =	82	300	2195	3.2
TOP OF MISSISSIPPIAN =	88	675	2495	3
TOP OF BAKKEN =	100	120	3170	1.5
TOP OF DUPEROW =	104	380	3290	3.5
TOP OF INTERLAKE =	110	400	3670	3.5
TOP OF RED RIVER =	117	110	4070	3.5
TOP OF DEADWOOD =	118	170	4180	3.5
TOP OF PRECAMBRIAN =	121	0	4350	3.5

NDTS146 5

SURFACE TEMP = 4.7 Deg. C ELEVATION = 640 m HEAT FLOW = 50 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	21	705	555	1.2
TOP OF GREENHORN =	50	105	1260	1.2
TOP OF MOWRY =	54	100	1365	1.2
TOP OF INYAN KARA =	58	100	1465	1.6
TOP OF JURASSIC =	62	300	1565	2.8
TOP OF SPEARFISH =	67	145	1865	3.1
TOP OF MINNEKAHTA =	69	0	2010	2.8
TOP OF MINNELUSA =	69	255	2010	3.2
TOP OF MISSISSIPPIAN =	73	675	2265	3
TOP OF BAKKEN =	84	50	2940	1.5
TOP OF DUPEROW =	86	370	2990	3.5
TOP OF INTERLAKE =	91	400	3360	3.5
TOP OF RED RIVER =	97	280	3760	3.5
TOP OF DEADWOOD =	101	110	4040	3.5
TOP OF PRECAMBRIAN =	103	0	4150	3.5

NDTS146 6

SURFACE TEMP = 4.9 Deg. C ELEVATION = 610 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	18	680	430	1.2
TOP OF GREENHORN =	49	50	1110	1.2
TOP OF MOWRY =	52	115	1160	1.2
TOP OF INYAN KARA =	57	105	1275	1.6
TOP OF JURASSIC =	61	255	1380	2.8
TOP OF SPEARFISH =	66	165	1635	3.1
TOP OF MINNEKAHTA =	69	0	1800	2.8
TOP OF MINNELUSA =	69	435	1800	3.2
TOP OF MISSISSIPPIAN =	76	175	2235	3
TOP OF BAKKEN =	79	200	2410	1.5
TOP OF DUPEROW =	87	400	2610	3.5
TOP OF INTERLAKE =	93	200	3010	3.5
TOP OF RED RIVER =	96	200	3210	3.5
TOP OF DEADWOOD =	99	90	3410	3.5
TOP OF PRECAMBRIAN =	101	0	3500	3.5

NDTS146 7

SURFACE TEMP = 5.2 Deg. C ELEVATION = 579 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	13	560	269	1.2
TOP OF GREENHORN =	39	60	829	1.2
TOP OF MOWRY =	42	175	889	1.2
TOP OF INYAN KARA =	50	65	1064	1.6
TOP OF JURASSIC =	52	240	1129	2.8
TOP OF SPEARFISH =	57	60	1369	3.1
TOP OF MINNEKAHTA =	58	0	1429	2.8
TOP OF MINNELUSA =	58	60	1429	3.2
TOP OF MISSISSIPPIAN =	59	430	1489	3
TOP OF BAKKEN =	67	240	1919	1.5
TOP OF DUPEROW =	76	220	2159	3.5
TOP OF INTERLAKE =	79	100	2379	3.5
TOP OF RED RIVER =	81	200	2479	3.5
TOP OF DEADWOOD =	84	60	2679	3.5
TOP OF PRECAMBRIAN =	85	0	2739	3.5

NDTS146 8

SURFACE TEMP = 4.9 Deg. C ELEVATION = 518 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	9	580	133	1.2
TOP OF GREENHORN =	35	95	713	1.2
TOP OF MOWRY =	40	90	808	1.2
TOP OF INYAN KARA =	44	50	898	1.6
TOP OF JURASSIC =	45	210	948	2.8
TOP OF SPEARFISH =	50	135	1158	3.1
TOP OF MINNEKAHTA =	52	0	1293	2.8
TOP OF MINNELUSA =	52	0	1293	3.2
TOP OF MISSISSIPPIAN =	52	425	1293	3
TOP OF BAKKEN =	60	30	1718	1.5
TOP OF DUPEROW =	61	170	1748	3.5
TOP OF INTERLAKE =	64	200	1918	3.5
TOP OF RED RIVER =	67	200	2118	3.5
TOP OF DEADWOOD =	70	50	2318	3.5
TOP OF PRECAMBRIAN =	71	0	2368	3.5

NDTS146 9

SURFACE TEMP = 4.5 Deg. C ELEVATION = 518 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	7	470	88	1.2
TOP OF GREENHORN =	28	105	558	1.2
TOP OF MOWRY =	33	40	663	1.2
TOP OF INYAN KARA =	35	95	703	1.6
TOP OF JURASSIC =	38	110	798	2.8
TOP OF SPEARFISH =	40	85	908	3.1
TOP OF MINNEKAHTA =	42	0	993	2.8
TOP OF MINNELUSA =	42	0	993	3.2
TOP OF MISSISSIPPIAN =	42	105	993	3
TOP OF BAKKEN =	44	45	1098	1.5
TOP OF DUPEROW =	46	175	1143	3.5
TOP OF INTERLAKE =	48	150	1318	3.5
TOP OF RED RIVER =	51	220	1468	3.5
TOP OF DEADWOOD =	54	20	1688	3.5
TOP OF PRECAMBRIAN =	54	0	1708	3.5

NDTS146 10

SURFACE TEMP = 4.3 Deg. C ELEVATION = 500 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	4	460	0	1.2
TOP OF GREENHORN =	25	80	460	1.2
TOP OF MOWRY =	29	70	540	1.2
TOP OF INYAN KARA =	32	95	610	1.6
TOP OF JURASSIC =	35	125	705	2.8
TOP OF SPEARFISH =	37	0	830	3.1
TOP OF MINNEKAHTA =	37	0	830	2.8
TOP OF MINNELUSA =	37	0	830	3.2
TOP OF MISSISSIPPIAN =	37	90	830	3
TOP OF BAKKEN =	39	30	920	1.5
TOP OF DUPEROW =	40	200	950	3.5
TOP OF INTERLAKE =	43	150	1150	3.5
TOP OF RED RIVER =	46	200	1300	3.5
TOP OF DEADWOOD =	49	50	1500	3.5
TOP OF PRECAMBRIAN =	50	0	1550	3.5

NDTS142 1

SURFACE TEMP = 5 Deg. C ELEVATION = 823 m HEAT FLOW = 60 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	23	830	533	1.2
TOP OF GREENHORN =	65	150	1363	1.2
TOP OF MOWRY =	72	130	1513	1.2
TOP OF INYAN KARA =	79	145	1643	1.6
TOP OF JURASSIC =	84	295	1788	2.8
TOP OF SPEARFISH =	91	130	2083	3.1
TOP OF MINNEKAHTA =	93	100	2213	2.8
TOP OF MINNELUSA =	95	260	2313	3.2
TOP OF MISSISSIPPIAN =	100	550	2573	3
TOP OF BAKKEN =	111	130	3123	1.5
TOP OF DUPEROW =	116	150	3253	3.5
TOP OF INTERLAKE =	119	200	3403	3.5
TOP OF RED RIVER =	122	200	3603	3.5
TOP OF DEADWOOD =	126	270	3803	3.5
TOP OF PRECAMBRIAN =	130	0	4073	3.5

NDTS142 2

SURFACE TEMP = 5.2 Deg. C ELEVATION = 762 m HEAT FLOW = 60 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	23	840	532	1.2
TOP OF GREENHORN =	65	140	1372	1.2
TOP OF MOWRY =	72	120	1512	1.2
TOP OF INYAN KARA =	78	105	1632	1.6
TOP OF JURASSIC =	82	300	1737	2.8
TOP OF SPEARFISH =	89	165	2037	3.1
TOP OF MINNEKAHTA =	92	100	2202	2.8
TOP OF MINNELUSA =	94	260	2302	3.2
TOP OF MISSISSIPPIAN =	99	640	2562	3
TOP OF BAKKEN =	112	40	3202	1.5
TOP OF DUPEROW =	113	320	3242	3.5
TOP OF INTERLAKE =	119	250	3562	3.5
TOP OF RED RIVER =	123	170	3812	3.5
TOP OF DEADWOOD =	126	270	3982	3.5
TOP OF PRECAMBRIAN =	131	0	4252	3.5

NDTS142 3

SURFACE TEMP = 4.8 Deg. C ELEVATION = 655 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	21	780	505	1.2
TOP OF GREENHORN =	56	165	1285	1.2
TOP OF MOWRY =	64	130	1450	1.2
TOP OF INYAN KARA =	70	100	1580	1.6
TOP OF JURASSIC =	73	295	1680	2.8
TOP OF SPEARFISH =	79	110	1975	3.1
TOP OF MINNEKAHTA =	81	95	2085	2.8
TOP OF MINNELUSA =	83	300	2180	3.2
TOP OF MISSISSIPPIAN =	88	625	2480	3
TOP OF BAKKEN =	100	70	3105	1.5
TOP OF DUPEROW =	102	320	3175	3.5
TOP OF INTERLAKE =	107	330	3495	3.5
TOP OF RED RIVER =	112	240	3825	3.5
TOP OF DEADWOOD =	116	274	4065	3.5
TOP OF PRECAMBRIAN =	120	0	4339	3.5

NDTS142 4

SURFACE TEMP = 5.3 Deg. C ELEVATION = 625 m HEAT FLOW = 50 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	18	790	455	1.2
TOP OF GREENHORN =	51	145	1245	1.2
TOP OF MOWRY =	57	110	1390	1.2
TOP OF INYAN KARA =	62	100	1500	1.6
TOP OF JURASSIC =	65	270	1600	2.8
TOP OF SPEARFISH =	70	75	1870	3.1
TOP OF MINNEKAHTA =	71	90	1945	2.8
TOP OF MINNELUSA =	72	330	2035	3.2
TOP OF MISSISSIPPIAN =	78	580	2365	3
TOP OF BAKKEN =	87	160	2945	1.5
TOP OF DUPEROW =	93	240	3105	3.5
TOP OF INTERLAKE =	96	380	3345	3.5
TOP OF RED RIVER =	102	220	3725	3.5
TOP OF DEADWOOD =	105	230	3945	3.5
TOP OF PRECAMBRIAN =	108	0	4175	3.5

NDTS142 5

SURFACE TEMP = 5.3 Deg. C ELEVATION = 671 m HEAT FLOW = 50 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	21	650	556	1.2
TOP OF GREENHORN =	48	135	1206	1.2
TOP OF MOWRY =	54	125	1341	1.2
TOP OF INYAN KARA =	59	105	1466	1.6
TOP OF JURASSIC =	62	230	1571	2.8
TOP OF SPEARFISH =	66	80	1801	3.1
TOP OF MINNEKAHTA =	68	15	1881	2.8
TOP OF MINNELUSA =	68	265	1896	3.2
TOP OF MISSISSIPPIAN =	72	610	2161	3
TOP OF BAKKEN =	82	200	2771	1.5
TOP OF DUPEROW =	89	200	2971	3.5
TOP OF INTERLAKE =	92	320	3171	3.5
TOP OF RED RIVER =	96	30	3491	3.5
TOP OF DEADWOOD =	97	170	3521	3.5
TOP OF PRECAMBRIAN =	99	0	3691	3.5

NDTS142 6

SURFACE TEMP = 5.6 Deg. C ELEVATION = 579 m HEAT FLOW = 50 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	16	590	369	1.2
TOP OF GREENHORN =	41	115	959	1.2
TOP OF MOWRY =	45	95	1074	1.2
TOP OF INYAN KARA =	49	90	1169	1.6
TOP OF JURASSIC =	52	225	1259	2.8
TOP OF SPEARFISH =	56	5	1484	3.1
TOP OF MINNEKAHTA =	56	50	1489	2.8
TOP OF MINNELUSA =	57	220	1539	3.2
TOP OF MISSISSIPPIAN =	61	520	1759	3
TOP OF BAKKEN =	69	100	2279	1.5
TOP OF DUPEROW =	73	200	2379	3.5
TOP OF INTERLAKE =	75	400	2579	3.5
TOP OF RED RIVER =	81	50	2979	3.5
TOP OF DEADWOOD =	82	120	3029	3.5
TOP OF PRECAMBRIAN =	84	0	3149	3.5

NDTS142 7

SURFACE TEMP = 5.7 Deg. C ELEVATION = 590 m HEAT FLOW = 50 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	14	550	300	1.2
TOP OF GREENHORN =	37	130	850	1.2
TOP OF MOWRY =	42	80	980	1.2
TOP OF INYAN KARA =	46	150	1060	1.6
TOP OF JURASSIC =	50	140	1210	2.8
TOP OF SPEARFISH =	53	0	1350	3.1
TOP OF MINNEKAHTA =	53	0	1350	2.8
TOP OF MINNELUSA =	53	215	1350	3.2
TOP OF MISSISSIPPIAN =	56	325	1565	3
TOP OF BAKKEN =	62	120	1890	1.5
TOP OF DUPEROW =	66	280	2010	3.5
TOP OF INTERLAKE =	70	10	2290	3.5
TOP OF RED RIVER =	70	90	2300	3.5
TOP OF DEADWOOD =	71	110	2390	3.5
TOP OF PRECAMBRIAN =	73	0	2500	3.5

NDTS142 8

SURFACE TEMP = 5 Deg. C ELEVATION = 549 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	9	490	149	1.2
TOP OF GREENHORN =	32	120	639	1.2
TOP OF MOWRY =	37	95	759	1.2
TOP OF INYAN KARA =	42	45	854	1.6
TOP OF JURASSIC =	43	425	899	2.8
TOP OF SPEARFISH =	52	0	1324	3.1
TOP OF MINNEKAHTA =	52	0	1324	2.8
TOP OF MINNELUSA =	52	0	1324	3.2
TOP OF MISSISSIPPIAN =	52	295	1324	3
TOP OF BAKKEN =	57	130	1619	1.5
TOP OF DUPEROW =	62	5	1749	3.5
TOP OF INTERLAKE =	62	5	1754	3.5
TOP OF RED RIVER =	62	270	1759	3.5
TOP OF DEADWOOD =	66	80	2029	3.5
TOP OF PRECAMBRIAN =	67	0	2109	3.5

NDTS142 9

SURFACE TEMP = 4.5 Deg. C ELEVATION = 550 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	7	490	100	1.2
TOP OF GREENHORN =	30	80	590	1.2
TOP OF MOWRY =	33	80	670	1.2
TOP OF INYAN KARA =	37	55	750	1.6
TOP OF JURASSIC =	39	245	805	2.8
TOP OF SPEARFISH =	44	0	1050	3.1
TOP OF MINNEKAHTA =	44	0	1050	2.8
TOP OF MINNELUSA =	44	0	1050	3.2
TOP OF MISSISSIPPIAN =	44	200	1050	3
TOP OF BAKKEN =	47	50	1250	1.5
TOP OF DUPEROW =	49	250	1300	3.5
TOP OF INTERLAKE =	53	1	1550	3.5
TOP OF RED RIVER =	53	179	1551	3.5
TOP OF DEADWOOD =	56	60	1730	3.5
TOP OF PRECAMBRIAN =	57	0	1790	3.5

NDTS142 10

SURFACE TEMP = 4.5 Deg. C ELEVATION = 500 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	4	450	0	1.2
TOP OF GREENHORN =	25	90	450	1.2
TOP OF MOWRY =	29	80	540	1.2
TOP OF INYAN KARA =	32	80	620	1.6
TOP OF JURASSIC =	35	120	700	2.8
TOP OF SPEARFISH =	38	0	820	3.1
TOP OF MINNEKAHTA =	38	0	820	2.8
TOP OF MINNELUSA =	38	0	820	3.2
TOP OF MISSISSIPPIAN =	38	120	820	3
TOP OF BAKKEN =	40	60	940	1.5
TOP OF DUPEROW =	42	130	1000	3.5
TOP OF INTERLAKE =	44	0	1130	3.5
TOP OF RED RIVER =	44	220	1130	3.5
TOP OF DEADWOOD =	47	50	1350	3.5
TOP OF PRECAMBRIAN =	48	0	1400	3.5

NDTS138 1

SURFACE TEMP = 5.7 Deg. C ELEVATION = 823 m HEAT FLOW = 65 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	21	870	403	1.2
TOP OF GREENHORN =	68	145	1273	1.2
TOP OF MOWRY =	76	105	1418	1.2
TOP OF INYAN KARA =	81	130	1523	1.6
TOP OF JURASSIC =	87	280	1653	2.8
TOP OF SPEARFISH =	93	180	1933	3.1
TOP OF MINNEKAHTA =	97	90	2113	2.8
TOP OF MINNELUSA =	99	220	2203	3.2
TOP OF MISSISSIPPIAN =	103	580	2423	3
TOP OF BAKKEN =	116	120	3003	1.5
TOP OF DUPEROW =	121	10	3123	3.5
TOP OF INTERLAKE =	121	190	3133	3.5
TOP OF RED RIVER =	125	400	3323	3.5
TOP OF DEADWOOD =	132	260	3723	3.5
TOP OF PRECAMBRIAN =	137	0	3983	3.5

NDTS138 2

SURFACE TEMP = 5.6 Deg. C ELEVATION = 823 m HEAT FLOW = 65 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	25	840	533	1.2
TOP OF GREENHORN =	71	160	1373	1.2
TOP OF MOWRY =	80	105	1533	1.2
TOP OF INYAN KARA =	85	105	1638	1.6
TOP OF JURASSIC =	90	280	1743	2.8
TOP OF SPEARFISH =	96	175	2023	3.1
TOP OF MINNEKAHTA =	100	75	2198	2.8
TOP OF MINNELUSA =	102	250	2273	3.2
TOP OF MISSISSIPPIAN =	107	500	2523	3
TOP OF BAKKEN =	117	220	3023	1.5
TOP OF DUPEROW =	127	170	3243	3.5
TOP OF INTERLAKE =	130	210	3413	3.5
TOP OF RED RIVER =	134	80	3623	3.5
TOP OF DEADWOOD =	135	265	3703	3.5
TOP OF PRECAMBRIAN =	140	0	3968	3.5

NDTS138 3

SURFACE TEMP = 5.5 Deg. C ELEVATION = 732 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	22	790	537	1.2
TOP OF GREENHORN =	59	215	1327	1.2
TOP OF MOWRY =	68	100	1542	1.2
TOP OF INYAN KARA =	73	95	1642	1.6
TOP OF JURASSIC =	76	220	1737	2.8
TOP OF SPEARFISH =	81	120	1957	3.1
TOP OF MINNEKAHTA =	83	75	2077	2.8
TOP OF MINNELUSA =	84	280	2152	3.2
TOP OF MISSISSIPPIAN =	89	500	2432	3
TOP OF BAKKEN =	98	220	2932	1.5
TOP OF DUPEROW =	106	160	3152	3.5
TOP OF INTERLAKE =	109	220	3312	3.5
TOP OF RED RIVER =	112	300	3532	3.5
TOP OF DEADWOOD =	117	240	3832	3.5
TOP OF PRECAMBRIAN =	121	0	4072	3.5

NDTS138 4

SURFACE TEMP = 5.6 Deg. C ELEVATION = 701 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	21	745	506	1.2
TOP OF GREENHORN =	56	120	1251	1.2
TOP OF MOWRY =	61	105	1371	1.2
TOP OF INYAN KARA =	66	95	1476	1.6
TOP OF JURASSIC =	69	280	1571	2.8
TOP OF SPEARFISH =	75	55	1851	3.1
TOP OF MINNEKAHTA =	76	25	1906	2.8
TOP OF MINNELUSA =	76	295	1931	3.2
TOP OF MISSISSIPPIAN =	81	425	2226	3
TOP OF BAKKEN =	89	350	2651	1.5
TOP OF DUPEROW =	102	80	3001	3.5
TOP OF INTERLAKE =	103	200	3081	3.5
TOP OF RED RIVER =	106	440	3281	3.5
TOP OF DEADWOOD =	113	230	3721	3.5
TOP OF PRECAMBRIAN =	117	0	3951	3.5

NDTS138 5

SURFACE TEMP = 5.6 Deg. C ELEVATION = 690 m HEAT FLOW = 65 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	24	645	485	1.2
TOP OF GREENHORN =	59	100	1130	1.2
TOP OF MOWRY =	64	90	1230	1.2
TOP OF INYAN KARA =	69	145	1320	1.6
TOP OF JURASSIC =	75	235	1465	2.8
TOP OF SPEARFISH =	80	20	1700	3.1
TOP OF MINNEKAHTA =	81	70	1720	2.8
TOP OF MINNELUSA =	82	200	1790	3.2
TOP OF MISSISSIPPIAN =	86	560	1990	3
TOP OF BAKKEN =	98	140	2550	1.5
TOP OF DUPEROW =	105	200	2690	3.5
TOP OF INTERLAKE =	108	230	2890	3.5
TOP OF RED RIVER =	113	250	3120	3.5
TOP OF DEADWOOD =	117	200	3370	3.5
TOP OF PRECAMBRIAN =	121	0	3570	3.5

NDTS138 6

SURFACE TEMP = 5.3 Deg. C ELEVATION = 594 m HEAT FLOW = 60 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	16	580	324	1.2
TOP OF GREENHORN =	45	130	904	1.2
TOP OF MOWRY =	52	85	1034	1.2
TOP OF INYAN KARA =	56	70	1119	1.6
TOP OF JURASSIC =	59	245	1189	2.8
TOP OF SPEARFISH =	64	1	1434	3.1
TOP OF MINNEKAHTA =	64	1	1435	2.8
TOP OF MINNELUSA =	64	233	1436	3.2
TOP OF MISSISSIPPIAN =	68	325	1669	3
TOP OF BAKKEN =	75	100	1994	1.5
TOP OF DUPEROW =	79	100	2094	3.5
TOP OF INTERLAKE =	80	200	2194	3.5
TOP OF RED RIVER =	84	200	2394	3.5
TOP OF DEADWOOD =	87	160	2594	3.5
TOP OF PRECAMBRIAN =	90	0	2754	3.5

NDTS138 7

SURFACE TEMP = 5.3 Deg. C ELEVATION = 549 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	12	565	209	1.2
TOP OF GREENHORN =	37	55	774	1.2
TOP OF MOWRY =	40	125	829	1.2
TOP OF INYAN KARA =	46	45	954	1.6
TOP OF JURASSIC =	47	200	999	2.8
TOP OF SPEARFISH =	51	0	1199	3.1
TOP OF MINNEKAHTA =	51	0	1199	2.8
TOP OF MINNELUSA =	51	250	1199	3.2
TOP OF MISSISSIPPIAN =	55	320	1449	3
TOP OF BAKKEN =	61	100	1769	1.5
TOP OF DUPEROW =	65	80	1869	3.5
TOP OF INTERLAKE =	66	200	1949	3.5
TOP OF RED RIVER =	69	90	2149	3.5
TOP OF DEADWOOD =	71	120	2239	3.5
TOP OF PRECAMBRIAN =	73	0	2359	3.5

NDTS138 8

SURFACE TEMP = 5.5 Deg. C ELEVATION = 564 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	10	485	159	1.2
TOP OF GREENHORN =	32	100	644	1.2
TOP OF MOWRY =	37	90	744	1.2
TOP OF INYAN KARA =	41	50	834	1.6
TOP OF JURASSIC =	43	270	884	2.8
TOP OF SPEARFISH =	48	0	1154	3.1
TOP OF MINNEKAHTA =	48	0	1154	2.8
TOP OF MINNELUSA =	48	0	1154	3.2
TOP OF MISSISSIPPIAN =	48	490	1154	3
TOP OF BAKKEN =	57	120	1644	1.5
TOP OF DUPEROW =	61	50	1764	3.5
TOP OF INTERLAKE =	62	100	1814	3.5
TOP OF RED RIVER =	64	30	1914	3.5
TOP OF DEADWOOD =	64	70	1944	3.5
TOP OF PRECAMBRIAN =	65	0	2014	3.5

NDTS138 9

SURFACE TEMP = 4.9 Deg. C ELEVATION = 570 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	8	470	120	1.2
TOP OF GREENHORN =	30	100	590	1.2
TOP OF MOWRY =	34	85	690	1.2
TOP OF INYAN KARA =	38	10	775	1.6
TOP OF JURASSIC =	39	260	785	2.8
TOP OF SPEARFISH =	44	0	1045	3.1
TOP OF MINNEKAHTA =	44	0	1045	2.8
TOP OF MINNELUSA =	44	0	1045	3.2
TOP OF MISSISSIPPIAN =	44	245	1045	3
TOP OF BAKKEN =	48	30	1290	1.5
TOP OF DUPEROW =	49	100	1320	3.5
TOP OF INTERLAKE =	51	150	1420	3.5
TOP OF RED RIVER =	53	220	1570	3.5
TOP OF DEADWOOD =	57	80	1790	3.5
TOP OF PRECAMBRIAN =	58	0	1870	3.5

NDTS138 10

SURFACE TEMP = 4.8 Deg. C ELEVATION = 500 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	4	390	0	1.2
TOP OF GREENHORN =	22	100	390	1.2
TOP OF MOWRY =	27	95	490	1.2
TOP OF INYAN KARA =	31	65	585	1.6
TOP OF JURASSIC =	33	130	650	2.8
TOP OF SPEARFISH =	36	0	780	3.1
TOP OF MINNEKAHTA =	36	0	780	2.8
TOP OF MINNELUSA =	36	0	780	3.2
TOP OF MISSISSIPPIAN =	36	100	780	3
TOP OF BAKKEN =	38	10	880	1.5
TOP OF DUPEROW =	38	10	890	3.5
TOP OF INTERLAKE =	38	0	900	3.5
TOP OF RED RIVER =	38	250	900	3.5
TOP OF DEADWOOD =	42	50	1150	3.5
TOP OF PRECAMBRIAN =	43	0	1200	3.5

NDTS134 1

SURFACE TEMP = 6.2 Deg. C ELEVATION = 945 m HEAT FLOW = 65 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	6		0	1.7
TOP OF PIERRE =	17	850	295	1.2
TOP OF GREENHORN =	63	225	1145	1.2
TOP OF MOWRY =	75	115	1370	1.2
TOP OF INYAN KARA =	81	160	1485	1.6
TOP OF JURASSIC =	88	310	1645	2.8
TOP OF SPEARFISH =	95	140	1955	3.1
TOP OF MINNEKAHTA =	98	50	2095	2.8
TOP OF MINNELUSA =	99	200	2145	3.2
TOP OF MISSISSIPPIAN =	103	400	2345	3
TOP OF BAKKEN =	112	200	2745	1.5
TOP OF DUPEROW =	121	10	2945	3.5
TOP OF INTERLAKE =	121	340	2955	3.5
TOP OF RED RIVER =	127	50	3295	3.5
TOP OF DEADWOOD =	128	240	3345	3.5
TOP OF PRECAMBRIAN =	133	0	3585	3.5

NDTS134 2

SURFACE TEMP = 6.3 Deg. C ELEVATION = 823 m HEAT FLOW = 65 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	6		0	1.7
TOP OF PIERRE =	22	810	433	1.2
TOP OF GREENHORN =	66	170	1243	1.2
TOP OF MOWRY =	75	110	1413	1.2
TOP OF INYAN KARA =	81	100	1523	1.6
TOP OF JURASSIC =	85	270	1623	2.8
TOP OF SPEARFISH =	92	180	1893	3.1
TOP OF MINNEKAHTA =	96	50	2073	2.8
TOP OF MINNELUSA =	97	250	2123	3.2
TOP OF MISSISSIPPIAN =	102	450	2373	3
TOP OF BAKKEN =	111	200	2823	1.5
TOP OF DUPEROW =	120	100	3023	3.5
TOP OF INTERLAKE =	122	100	3123	3.5
TOP OF RED RIVER =	124	400	3223	3.5
TOP OF DEADWOOD =	131	230	3623	3.5
TOP OF PRECAMBRIAN =	136	0	3853	3.5

NDTS134 3

SURFACE TEMP = 6.2 Deg. C ELEVATION = 792 m HEAT FLOW = 65 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	6		0	1.7
TOP OF PIERRE =	25	780	492	1.2
TOP OF GREENHORN =	67	170	1272	1.2
TOP OF MOWRY =	76	110	1442	1.2
TOP OF INYAN KARA =	82	90	1552	1.6
TOP OF JURASSIC =	86	240	1642	2.8
TOP OF SPEARFISH =	91	110	1882	3.1
TOP OF MINNEKAHTA =	93	50	1992	2.8
TOP OF MINNELUSA =	95	275	2042	3.2
TOP OF MISSISSIPPIAN =	100	555	2317	3
TOP OF BAKKEN =	112	210	2872	1.5
TOP OF DUPEROW =	121	90	3082	3.5
TOP OF INTERLAKE =	123	40	3172	3.5
TOP OF RED RIVER =	124	410	3212	3.5
TOP OF DEADWOOD =	131	220	3622	3.5
TOP OF PRECAMBRIAN =	135	0	3842	3.5

NDTS134 4

SURFACE TEMP = 5.9 Deg. C ELEVATION = 762 m HEAT FLOW = 65 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	23	727	465	1.2
TOP OF GREENHORN =	63	140	1192	1.2
TOP OF MOWRY =	70	105	1332	1.2
TOP OF INYAN KARA =	76	75	1437	1.6
TOP OF JURASSIC =	79	250	1512	2.8
TOP OF SPEARFISH =	85	50	1762	3.1
TOP OF MINNEKAHTA =	86	50	1812	2.8
TOP OF MINNELUSA =	87	250	1862	3.2
TOP OF MISSISSIPPIAN =	92	450	2112	3
TOP OF BAKKEN =	102	200	2562	1.5
TOP OF DUPEROW =	110	10	2762	3.5
TOP OF INTERLAKE =	111	190	2772	3.5
TOP OF RED RIVER =	114	400	2962	3.5
TOP OF DEADWOOD =	122	190	3362	3.5
TOP OF PRECAMBRIAN =	125	0	3552	3.5

NDTS134 5

SURFACE TEMP = 5.7 Deg. C ELEVATION = 701 m HEAT FLOW = 60 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	18	660	351	1.2
TOP OF GREENHORN =	51	160	1011	1.2
TOP OF MOWRY =	59	90	1171	1.2
TOP OF INYAN KARA =	63	80	1261	1.6
TOP OF JURASSIC =	66	240	1341	2.8
TOP OF SPEARFISH =	71	10	1581	3.1
TOP OF MINNEKAHTA =	71	60	1591	2.8
TOP OF MINNELUSA =	73	240	1651	3.2
TOP OF MISSISSIPPIAN =	77	510	1891	3
TOP OF BAKKEN =	87	80	2401	1.5
TOP OF DUPEROW =	91	10	2481	3.5
TOP OF INTERLAKE =	91	280	2491	3.5
TOP OF RED RIVER =	96	30	2771	3.5
TOP OF DEADWOOD =	96	170	2801	3.5
TOP OF PRECAMBRIAN =	99	0	2971	3.5

NDTS134 6

SURFACE TEMP = 5.8 Deg. C ELEVATION = 701 m HEAT FLOW = 60 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	16	580	301	1.2
TOP OF GREENHORN =	45	120	881	1.2
TOP OF MOWRY =	51	90	1001	1.2
TOP OF INYAN KARA =	55	90	1091	1.6
TOP OF JURASSIC =	59	190	1181	2.8
TOP OF SPEARFISH =	63	0	1371	3.1
TOP OF MINNEKAHTA =	63	20	1371	2.8
TOP OF MINNELUSA =	63	210	1391	3.2
TOP OF MISSISSIPPIAN =	67	450	1601	3
TOP OF BAKKEN =	76	30	2051	1.5
TOP OF DUPEROW =	77	10	2081	3.5
TOP OF INTERLAKE =	78	110	2091	3.5
TOP OF RED RIVER =	79	280	2201	3.5
TOP OF DEADWOOD =	84	160	2481	3.5
TOP OF PRECAMBRIAN =	87	0	2641	3.5

NDTS134 7

SURFACE TEMP = 6 Deg. C ELEVATION = 610 m HEAT FLOW = 60 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	6		0	1.7
TOP OF PIERRE =	14	475	240	1.2
TOP OF GREENHORN =	38	145	715	1.2
TOP OF MOWRY =	45	80	860	1.2
TOP OF INYAN KARA =	49	45	940	1.6
TOP OF JURASSIC =	51	185	985	2.8
TOP OF SPEARFISH =	55	0	1170	3.1
TOP OF MINNEKAHTA =	55	0	1170	2.8
TOP OF MINNELUSA =	55	290	1170	3.2
TOP OF MISSISSIPPIAN =	60	330	1460	3
TOP OF BAKKEN =	67	20	1790	1.5
TOP OF DUPEROW =	67	100	1810	3.5
TOP OF INTERLAKE =	69	120	1910	3.5
TOP OF RED RIVER =	71	200	2030	3.5
TOP OF DEADWOOD =	75	140	2230	3.5
TOP OF PRECAMBRIAN =	77	0	2370	3.5

NDTS134 8

SURFACE TEMP = 6 Deg. C ELEVATION = 610 m HEAT FLOW = 60 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	6		0	1.7
TOP OF PIERRE =	12	465	190	1.2
TOP OF GREENHORN =	35	165	655	1.2
TOP OF MOWRY =	44	0	820	1.2
TOP OF INYAN KARA =	44	70	820	1.6
TOP OF JURASSIC =	46	295	890	2.8
TOP OF SPEARFISH =	53	0	1185	3.1
TOP OF MINNEKAHTA =	53	0	1185	2.8
TOP OF MINNELUSA =	53	0	1185	3.2
TOP OF MISSISSIPPIAN =	53	305	1185	3
TOP OF BAKKEN =	59	20	1490	1.5
TOP OF DUPEROW =	60	30	1510	3.5
TOP OF INTERLAKE =	60	50	1540	3.5
TOP OF RED RIVER =	61	220	1590	3.5
TOP OF DEADWOOD =	65	110	1810	3.5
TOP OF PRECAMBRIAN =	67	0	1920	3.5

NDTS134 9

SURFACE TEMP = 5 Deg. C ELEVATION = 610 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	5		0	1.7
TOP OF PIERRE =	9	420	140	1.2
TOP OF GREENHORN =	28	110	560	1.2
TOP OF MOWRY =	33	65	670	1.2
TOP OF INYAN KARA =	36	65	735	1.6
TOP OF JURASSIC =	39	260	800	2.8
TOP OF SPEARFISH =	44	0	1060	3.1
TOP OF MINNEKAHTA =	44	0	1060	2.8
TOP OF MINNELUSA =	44	0	1060	3.2
TOP OF MISSISSIPPIAN =	44	150	1060	3
TOP OF BAKKEN =	46	20	1210	1.5
TOP OF DUPEROW =	47	80	1230	3.5
TOP OF INTERLAKE =	48	20	1310	3.5
TOP OF RED RIVER =	49	180	1330	3.5
TOP OF DEADWOOD =	52	80	1510	3.5
TOP OF PRECAMBRIAN =	53	0	1590	3.5

NDTS134 10

SURFACE TEMP = 4.6 Deg. C ELEVATION = 500 m HEAT FLOW = 55 mW m°-2

	TEMPERATURE DEGREES C	THICKNESS	DEPTH METERS	CONDUCTIVITY W m°-1 K°-1
SURFACE =	4		0	1.7
TOP OF PIERRE =	4	385	0	1.2
TOP OF GREENHORN =	22	110	385	1.2
TOP OF MOWRY =	27	55	495	1.2
TOP OF INYAN KARA =	29	80	550	1.6
TOP OF JURASSIC =	32	170	630	2.8
TOP OF SPEARFISH =	35	0	800	3.1
TOP OF MINNEKAHTA =	35	0	800	2.8
TOP OF MINNELUSA =	35	0	800	3.2
TOP OF MISSISSIPPIAN =	35	50	800	3
TOP OF BAKKEN =	36	50	850	1.5
TOP OF DUPEROW =	38	0	900	3.5
TOP OF INTERLAKE =	38	0	900	3.5
TOP OF RED RIVER =	38	210	900	3.5
TOP OF DEADWOOD =	41	50	1110	3.5
TOP OF PRECAMBRIAN =	42	0	1160	3.5

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