AN EVALUATION OF GEOTHERMAL RESOURCES IN NEBRASKA

A Proposal Submitted
to
Division of Geothermal Energy
U.S. Department of Energy
by
University of Nebraska
Lincoln, Nebraska 68588

Administrative Units:
Conservation and Survey Division (State Surveys)
Institute of Agriculture and Natural Resources
University of Nebraska-Lincoln
Department of Geography-Geology
University of Nebraska-Omaha

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Research & Graduate Studies

Date

ABSTRACT

Preliminary data from heat flow determinations in Nebraska during 1978 have revealed a significant heat flow anomaly in southeastern Nebraska and a gradual westward increase in heat flow that may extend across the Great Plains to the Rocky Mountains. The data suggest that much of western Nebraska and probably considerable portions of the Great Plains Province including the Dakotas, Wyoming, Kansas, and eastern Colorado may have potential for low-temperature geothermal energy. It is proposed that an in-depth study of Nebraska be conducted to delineate areas of geothermal energy potential. The project will have three interrelated aspects: 1) field data collection of temperature gradients and thermal conductivity analysis, 2) an inventory of file data pertaining to oil well bottom-hole temperature and aquifer temperatures, and 3) a series of shallow and medium depth holes will be drilled and cased to serve as a monitoring data-base for the subsidary information collected.

BACKGROUND

The first contour heat flow map of the U.S. (Roy et al., 1971) shows the transition between the Rocky Mountain heat flow high and the normal-to-low heat flow region of the Interior Lowlands as a narrow boundary that is on the order of a few tens of kilometers wide. Roy et al., (1971) had no data from the Great Plains on which to base their interpretation but they

logically concluded that the Front Range marked the eastern boundary of the Rocky Mountain heat flow province. Subsequent data indicate that heat flow in the plains may be intermediate between that of the Rockies and that of the Interior Lowlands. Consequently Sass et al. (1976) extended the Rocky Mountain heat flow province eastward to include a considerable portion of the Great Plains. Our current study supports the eastern extension of the high heat flow zone. A heat flow trend correlates with increasing elevation toward the west and it is expected that the trend continues across the plains to the Rocky Mountains. Continuation of the trend is expected because of the results of a number of investigations that show a correlation between heat flow and elevation for the oceanic lithosphere (Sclater and Francheteau, 1970; Sclater et al., 1971; Sclater, 1972; Sclater and Parsons, 1976) and for the continental lithosphere (Sclater and Francheteau, 1970; Crough and Thompson, 1976; Pollack and Chapman, 1977; Brott, 1978).

Much of the western portion of Nebraska may be a region of higher than average heat flow and consequently may have potential for low temperature geothermal energy. Reports of high silica-geotemperatures (Swanberg and Morgan, 1978), six high heat flow values from Kansas, South Dakota, and Wyoming (Sass et al., 1976), and high bottom hole temperatures indicated by the AAPG-USGS report (1976) also suggest that Nebraska and other states in the Great Plains may have both low temperature hydrothermal and hot dry rock geothermal potential.

In addition to the regional trends, the project will more thoroughly evaluate any anomalous data. During the current study, temperatures measured in two deep drill holes in southeastern

due to a highly radioactive Precambrian carbonatite body. Semi-quantitative determinations of uranium and thorium in core samples (M. Carlson - unpublished data) indicate that the pluton has a heat production on the order of 20 HFU (10^{-13}cal/cm^3/sec). The surface heat flow is estimated to be about 2.0 HFU (10^{-6}cal/cm^2/sec) on the basis of typical conductivity values for the overlying limestones. No previous heat flow determinations from this area or any other part of Nebraska are reported but measurements in Iowa and Missouri (Combs and Simmons, 1973) suggest that the regional heat flow is on the order of 0.75 HFU to 1.2 HFU.

FIELD DATA COLLECTION/DATA ANALYSIS

A survey study of heat flow in Nebraska is currently being conducted by personnel at the University of Nebraska-Omaha with cooperation from Southern Methodist University in Dallas, Texas and the Conservation and Survey Division of the University of Nebraska-Lincoln. The majority of the study (90%) is funded by a grant from the UNO Faculty Senate Research Committee and the remainder is funded by the Conservation and Survey Division at UNL. Temperature logging equipment was loaned to UNO by SMU and thermal conductivity studies are being conducted by personnel at the SMU Geothermal Laboratory. Temperature gradients were measured in 30 wells that are maintained by CSD for groundwater observation, and drill cuttings from the wells were provided by CSD for thermal conductivity studies. In addition, four new holes drilled by CSD for geologic investigations were cased for

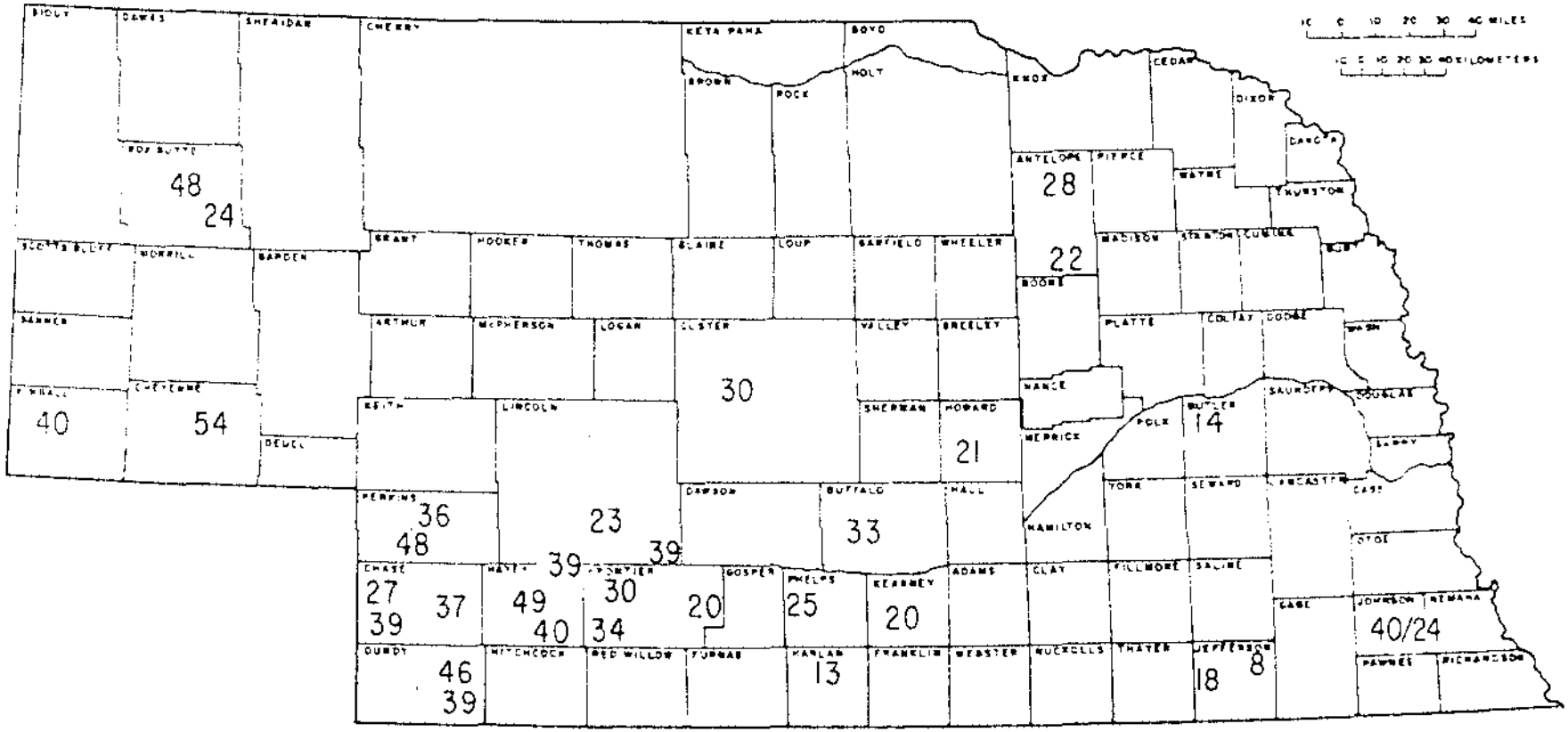


Figure 1. Geothermal gradients measured in Nebraska.

heat flow measurements. To date one of the four heat flow holes has been logged and the remainder are scheduled for logging in 1979. Two deep holes drilled by a mining company were also logged and acquisition of samples of cores from the holes is anticipated in the future.

Preliminary results from a survey heat flow study of Nebraska indicate that geothermal gradients range from 10°C/km to 30°C/km in the eastern part of the state and are on the order of 40°C/km to 50°C/km in the west.

The results of the preliminary reconnaissance study indicates that geothermal information of potential application value exists. If field equipment and laboratory instrumentation is readily available, this data collection will continue. Efforts will be made to locate existing wells where conditions are appropriate for measurement. Contacts will be established with ongoing well drilling activity for program cooperation. There facilities will also be utilized to interpret heat flow and obtain thermal conductivity measurements for the wells in the monitoring study.

INVENTORY OF FILE DATA

Over 13,000 deep tests have been drilled in Nebraska in search of oil and gas. For many of these wells, geophysical logs were run which usually contain a notation as to bottom-hole-temperature. This information will be extracted for as many wells as is feasible and encoded together with other pertinent data. Programs will be devised which can retrieve the information in a variety of tabular formats or as computer generated maps.

Other basic files will be searched for information pertaining to aquifer temperature and water quality. The resulting data display will indicate the location, depth and expected temperatures of potential hydrothermal reservoirs. Specific sites may be indicated for more detailed investigation.

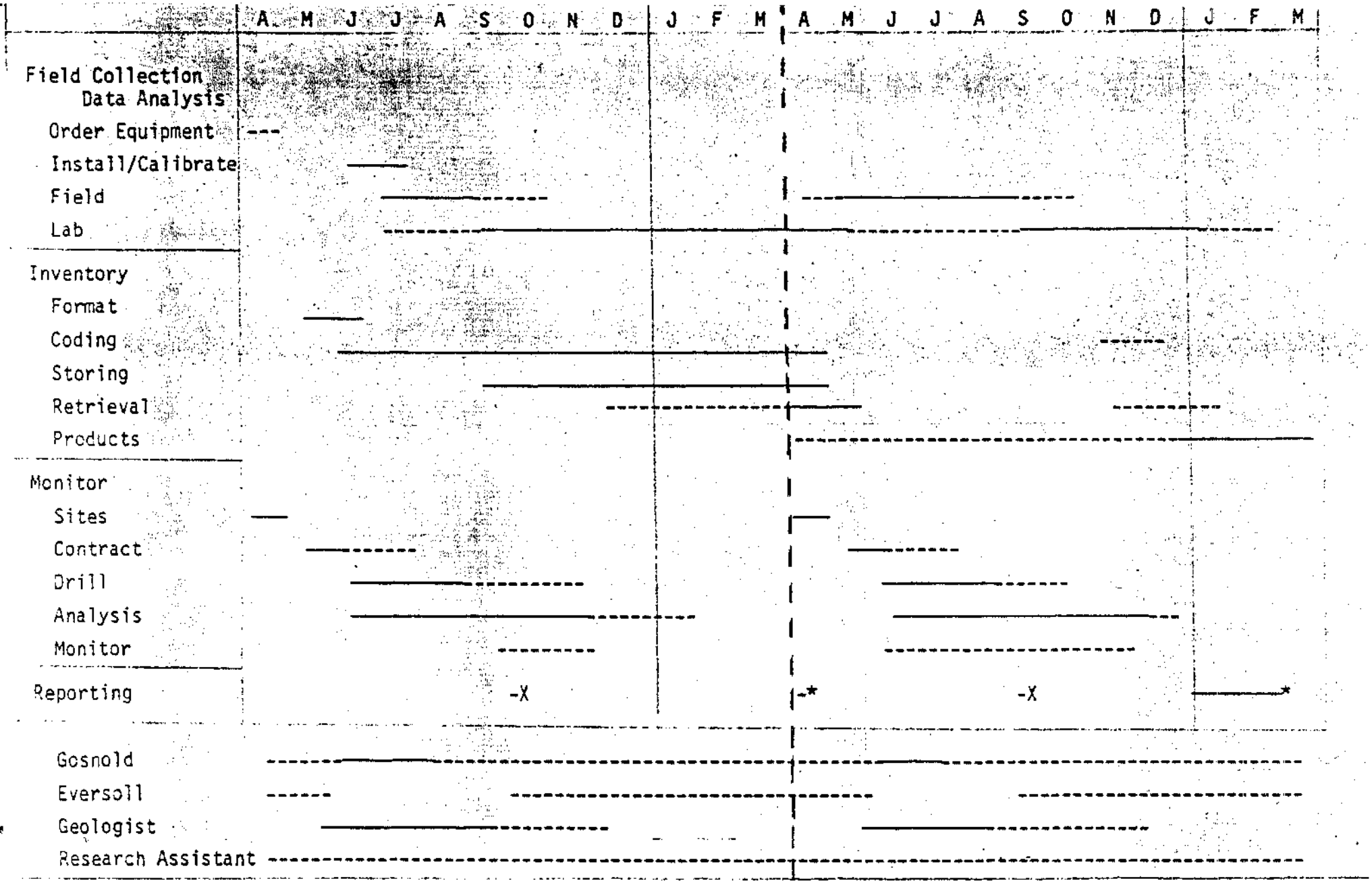
MONITORING NETWORK

Although available drill holes give reasonable indications of temperature variations, it is important to have a network of stabilized measurements. Current data indicate that a series of shallow drill holes, averaging about 500 feet (150 meters) in depth will provide adequate heat flow data. It is proposed to drill approximately 30 such holes although the availability of other data will control the exact number and location. If funds are available, either as a part of this project or from other sources, a deep test would be particularly interesting.

Most of the drilling and casing activity will be by contractural service. However, if conditions warrent, certain key sites may be installed by Conservation and Survey equipment.

For most holes less than 500 feet deep plastic casing (PVC) can be utilized. Deeper installation will require steel pipe. Periodic measurements of temperature gradients will be made until the holes have stabilized.

Both field and laboratory descriptions will be made of the materials penetrated during drilling. Whenever possible, geophysical logs will be run on the holes to further determine the geologic and hydrologic conditions at each site. This information will aid in the selection of samples to be analyzed in the thermal conductivity laboratory. Full documentation of these wells will provide a consistent data base for interpretation of the geothermal characteristics of Nebraska.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Field Collection
Data Analysis
Order Equipment
Install/Calibrate
Field
Lab
Inventory
Format
Coding
Storing
Retrieval
Products
Monitor
Sites
Contract
Drill
Analysis
Monitor
Reporting
-X
-*
-X
Gosnold
Eversoll
Geologist
Research Assistant
X Semiannual report
* Annual report
Fulltime commitment
Partial time commitment

BUDGET

Wages	First Year	Second Year	Total
Principal Investigator (Gosnold)	6,700	7,300	14,000
Research Asst (UNO)	2,940	3,150	6,090
Research Asst (UNL)	12,000	13,000	25,000
Field Technicial (UNL)	3,000	3,300	6,300
Total	24,640	26,750	51,390
Benefits (14%)	3,450	3,750	7,200
Operations (Publication, Computer)	2,000	3,000	5,000
Contractural Services (Drilling)	25,000	20,000	45,000
Expendable Supplies	2,000	1,000	3,000
Travel	6,000	7,000	13,000
Equipment			
Thermal Conductivity	5,000		5,000
Temperature Logging	5,000		5,000
Total Direct	73,090	61,500	134,590
Indirect Cost			
UNO (55% Wages)	5,300	5,750	11,050
UNL (59% Wages)	8,850	9,620	18,470
Total	14,150	15,370	29,520
Total Budget	87,240	76,870	164,110