Geothermal Resources of Kansas

1982

Scale 1:500,000
1 centimeter equals 5 kilometers
1 inch equals approximately 8 miles

Contour interval 200 feet
1927 North American datum
Datum is mean sea level
Lambert conformal conic projection based on standard parallels 33° and 45°
Base map supplied by the U.S. Geological Survey

POPULATION KEY

WICHITA	more than 100,000
SALINA	25,000 to 100,000
Leavenworth	5,000 to 25,000
Beloit	2,500 to 5,000
Ellsworth	less than, 2,500

Population indicated by size of letters.

State capital
County seat
City, town, or village
Scheduled service airport

Corporate boundary shown for towns over 5,000 population
Built up area shown for towns over 10,000 population
County boundary

Interstate highway
U.S. highway
State highway
Other principal road

METRIC CONVERSION

1 meter = 3.281 feet
1 kilometer = .621 mile
°Celsius = 5/9 (°Fahrenheit − 32)
°Fahrenheit = 9/5 °Celsius + 32

National wildlife refuge, national historical site, state park
National grassland
Indian reservation
Military reservation

Private land may exist within federal boundaries.

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Map produced by the
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United States Department of Energy
1982

Map available from:
Kansas Geological Survey
1930 Avenue "A", Campus West
The University of Kansas
Lawrence, Kansas 66044

Map produced by Joy A. Ikelman, NGDC/NOAA, and Albert E. Theberge, Jr., Lieutenant Commander, NOAA Corps, Boulder, Colorado, in cooperation with the Earth Science Laboratory/University of Utah Research Institute, Salt Lake City, Utah.

GEOTHERMAL RESOURCES OF KANSAS

Temperature generally increases with depth in the earth. The geothermal gradient is a mathematical expression of that increase. Average geothermal gradient in continental areas is 30°C/km (Smith, 1973). In Kansas, the search for potential geothermal resource areas is currently concentrated in parts of the state where gradients are higher than normal. The U.S. Geological Survey defines low-temperature geothermal resources as those usable concentrations of geothermal energy with temperature less than 100°C, where the geothermal gradient is greater than 25°C/km and the surface temperature of the waters is a minimum of 10°C above mean annual temperature (Reed and Sorey, 1981).

A low-temperature geothermal resource should have an aquifer system with high productivity, and water of acceptable (as defined by various state and engineering standards) chemical quality. Water high in dissolved solids, especially chlorides and sulfates, is corrosive to the metal pipes commonly used in heat exchangers and heat pumps. Water quality of deep aquifers (lower and middle Paleozoic) in western and central Kansas is generally poor or unknown. The quality is generally acceptable in eastern Kansas.

The map, Geothermal Resources of Kansas, shows temperatures measured in 74 wells, all at least 122 m (400 ft) deep. Information posted at each well location includes: total depth logged (m), temperature at that depth (°C), and calculated geothermal gradient (°C/km). Four geothermal resource areas are shown. Dark gray areas in northwestern and southeastern Kansas are delineated following the U.S. Geological Survey criteria for low-temperature resources stated above. Light gray areas of north-central and southwestern Kansas are those where temperatures higher than 75°C may occur in the thick sedimentary section that overlies basement rock.

In the resource area of northwestern Kansas (dark gray), relatively high geothermal gradients may indicate eastward migration of warm waters in the Lower Cretaceous Dakota Group (see Map 5) of the Denver-Julesburg Basin (W.D. Gosnold, Jr., 1981, personal communication). The potential for heat-pump applications using water of the Dakota Group from depths of 500 to 700 m is good. In some areas of northwestern Kansas, the Dakota Group yields potable water. Geothermal gradient measurements in this area were made in the Upper Cretaceous Pierre shale. This formation has low thermal conductivity (Blackwell and others, 1981), which may explain the high gradients.

In southeastern Kansas, the geothermal resources area (dark gray) is in the northwestern part of the Cherokee Basin, where depth to basement rock is 500 to 700 m. The Late Cambrian-Early Ordovician Arbuckle Group is the most likely source of warm (30°-40°C) waters of acceptable chemical quality. Water from the Arbuckle Group is used as the public water supply in much of southeastern Kansas.

In the deeper portions of the Hugoton Embayment of the Anadarko Basin (light gray area in southwestern Kansas), the sedimentary section is 2.5 to 3 km thick. Although there is good prospect of obtaining 75°C water at depths of approximately 2.5 km in the lower Paleozoic formations, the water is of marginal chemical quality. The cost of drilling a deep exploratory geothermal well in this area would be high and, because there is little industry here, the outlook for geothermal development is poor. However, heat could be extracted from brines produced with petroleum.

In north-central Kansas, a geothermal resources area (light gray) is coincident with the subsurface occurrence of the Precambrian Rice Formation (Bickford and others, 1979). Based on drilling data in Kansas and outcrop data in Minnesota, the Rice Formation is arkosic sandstone with interbedded shale (Scott, 1966). Unpublished seismic data available at the Kansas Geological Survey indicate that the Rice Formation is from zero to 3 km thick. The composition and thickness of the Rice Formation suggest that it may have an abundance of water. The temperature in the deeper parts of the Rice Formation reaches 75° to 100°C, based on extrapolation of reasonable gradients. The hatched central part of this light gray area contains up to 4 km of Precambrian basalts beneath the Paleozoic sediments. These basalts could contain substantial volumes of warm (75° to 100°C) water. However, the chemical quality of water in both the Rice Formation and the basalts is unknown.

There is a possibility that other areas in the state may have low-temperature geothermal resources, but with the data presently available, such areas cannot be delineated.

For information on water quality of aquifers in Kansas, contact the Kansas Geological Survey's Geohydrology Section or the U.S. Geological Survey Water Resources Division, both at Lawrence, Kansas 66044.

THERMAL WELLS

Depth (m)
Temperature (°C)
Gradient (°C/km)

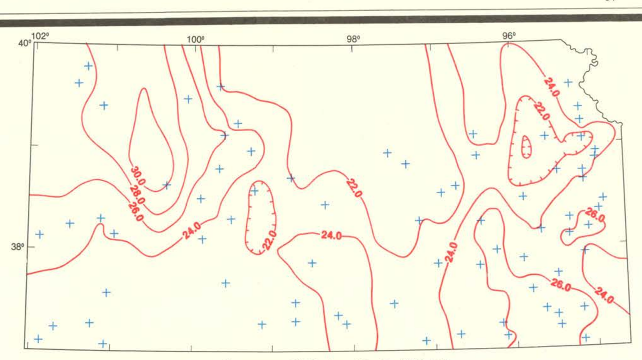
THERMAL WATERS

Dark gray. Area most favorable for discovery and development of low-temperature (lower than 100°C) geothermal resources, defined on the basis of above-normal geothermal gradients, bottom-hole temperatures, and the known or inferred presence of extensive thermal aquifers. Thermal aquifers most favorable for development are the Dakota Group in northwestern Kansas and the Arbuckle Group in southeastern Kansas.

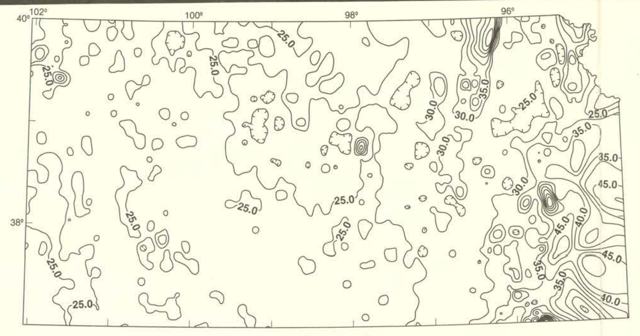
Light gray. Areas of north-central and southwestern Kansas where temperatures higher than 75°C may occur at depths between 2.0 and 3.0 kilometers in the thick sedimentary section overlying basement rock.

Hatched light gray. Area where up to 4 km of Precambrian basalt flows underlie the sedimentary sequence. Although these may contain waters from 75° to 100°C, the geothermal potential of these areas has not yet been assessed.

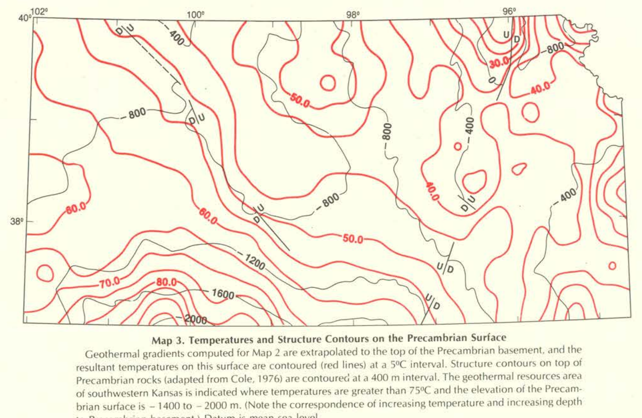
Note. Existing knowledge does not in general permit the inference that thermal waters may be found everywhere within the depicted areas, nor do the boundaries represent certain knowledge of the areal extent of the geothermal systems.



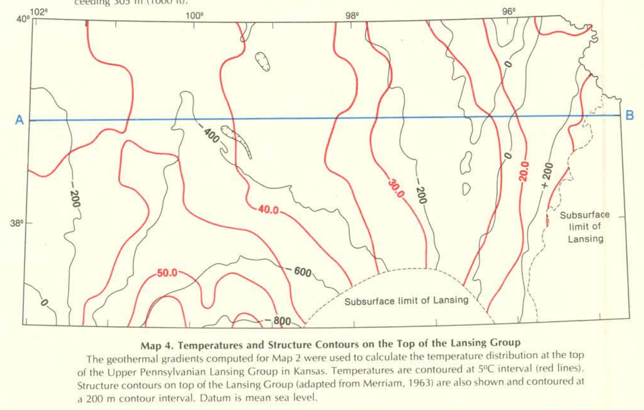
Map 1. Temperature Distribution at Depth of 300 Meters
Temperature 300 m below ground surface. Data from 74 wells logged to depths of 122 m or deeper during 1980 and 1981. Well locations indicated by +. Contour interval is 2°C.



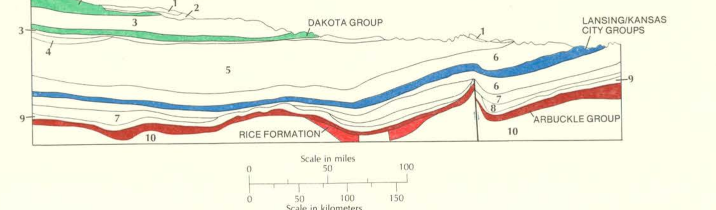
Map 2. Geothermal Gradient Map
Geothermal gradients computed from 42,348 bottom-hole temperatures obtained from oil and gas well logs available at the Kansas Geological Survey. Average geothermal gradient for each township was calculated and these gradients then contoured at 5°C/km interval. Gradients were computed only for wells with depths exceeding 305 m (1000 ft).



Map 3. Temperatures and Structure Contours on the Precambrian Surface
Geothermal gradients computed for Map 2 are extrapolated to the top of the Precambrian basement, and the resultant temperatures on this surface are contoured (red lines) at a 5°C interval. Structure contours on top of Precambrian rocks (adapted from Cole, 1976) are contoured at a 400 m interval. The geothermal resources area of southwestern Kansas is indicated where temperatures are greater than 75°C and the elevation of the Precambrian surface is − 1400 to − 2000 m. (Note the correspondence of increasing temperature and increasing depth to Precambrian basement.) Datum is mean sea level.



Map 4. Temperatures and Structure Contours on the Top of the Lansing Group
The geothermal gradients computed for Map 2 were used to calculate the temperature distribution at the top of the Upper Pennsylvanian Lansing Group in Kansas. Temperatures are contoured at 5°C interval (red lines). Structure contours on top of the Lansing Group (adapted from Merriam, 1963) are also shown and contoured at a 200 m contour interval. Datum is mean sea level.



Map 5. Geologic Cross Section along A-B on Map 4
The cross section extends along line A-B (see Map 4), west-east across Kansas. Formation, group, and system boundaries are generalized. System coding is as follows:

1. Quaternary
2. Tertiary
3. Cretaceous
4. Jurassic
5. Permian
6. Pennsylvanian
7. Mississippian
8. Silurian-Devonian
9. Cambrian-Ordovician
10. Precambrian

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