MONTANA BUREAU OF MINES AND GEOLOGY
A Department of Montana College of Mineral Science and Technology

Hydrogeologic Map HM 4
Geothermal Resources of Montana
Sonderegger and Bergantino, 1981

Geothermal Resources of Montana

Compiled by
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1981

Low-Temperature Geothermal Waters

Existing knowledge does not permit the inference that thermal water will be found everywhere within the gray areas, nor do the boundaries represent precise knowledge of the areal extent of geothermal systems or aquifers.

Bounded darker gray. Areas where discovery and development of additional sources of low-temperature (less than 100ºC) water for direct heat application are highly probable. Areas are defined on the basis of thermal springs and/or thermal wells, plus geohydrologic settings generally favorable for recovery of thermal water at depths of less than 1000 meters.

Unbounded lighter gray. *West of the 109th meridian:* Areas which, because of their geologic history and similarity to areas with known thermal systems, are expected to contain geothermal resources suitable for direct heat applications, in addition to the depicted wells and springs. The primary exploration targets are valley fill sedimentary units (less than 1000 meters in depth) receiving water from deeper basement sources. North of Garrison the area is significantly expanded to maintain private data confidentiality. *East of the 109th meridian:* Area without thermal springs or shallow thermal wells, but which contains the Madison Group and deeper aquifers with water temperatures of 60ºC (140ºF) or greater (modified from U.S. Geological Survey Open-File Report 81-629). In much of the area wells must be deeper than 2000 meters. Holes of opportunity may be economically viable; however, corrosiveness or salinity of the water and/or limited well yield caused by low aquifer permeability or cementing of casing may impede utilization of this resource. Most successful wells have been located near structural highs. Potential users of this resource are advised to contact the Montana Bureau of Mines and Geology for information about specific areas.

Heat Flow

▲70 Heat flow in milliwatts/m²
1 milliwatt/m² = 0.024 Heat Flow Unit (HFU)
See Sass, J.H., and Lachenbruch, A.H., 1979, Heat flow and conduction-dominated thermal regimes, *in* Muffler, L.J.P., ed., Assessment of geothermal resources of the United States-1978: U.S. Geological Survey Circular 790.

Thermal Springs

- Surface temperature ≤ 50ºC
- Surface temperature > 50ºC

Thermal Wells

- Surface temperature ≤ 50ºC
- Surface temperature > 50ºC

* Recently obtained well information, not listed in accompanying tables

Temperature, ºCelsius	Flow, liters/minute (L/min)
Total Dissolved Solids, milligrams/liter (mg/L)	Producing Depth, meters

Known Geothermal Resources Area (KGRA) as designated by the U.S. Department of Interior. Name in red lettering

Indian Reservation

National Forest

National Park, National Wilderness Area, National Wildlife Refuge

Private lands may exist within federal boundaries

Metric Conversion Factors

1 liter = 0.2642 gallon
1 meter = 3.281 feet
1 milligram/liter = 1 part per million
ºCelsius = 5/9 (ºFahrenheit − 32)
ºFahrenheit = 9/5 ºCelsius + 32
1 kilometer = 0.621 mile

State capital
County seat
City, town, or village
Scheduled service airport
Built-up areas shown for towns over 5,000 population

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

POPULATION KEY
GREAT FALLS .... more than 50,000
MISSOULA .... 10,000 to 50,000
Lewistown .... 2,500 to 10,000
Fort Benton .... 1,000 to 2,500
Stanford .... less than 1,000
Population indicated by size of letters

SCALE 1:1,000,000
1 centimeter equals 10 kilometers
1 inch equals approximately 16 miles

Contour interval 500 feet
Datum is mean sea level
1927 North American Datum
Lambert conformal conic projection based on standard parallels 33º and 45º

Map produced by David M. Clark, NOAA/NGSDC, and Ronald H. Smith, Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado/NOAA, Boulder, Colorado, in cooperation with the Earth Science Laboratory/University of Utah Research Institute, Salt Lake City, Utah

Digital thermal well and spring data available from GEOTHERM Project, U.S. Geological Survey, 345 Middlefield Road, MS84, Menlo Park, California 94025

Base map data is reduced from 1:500,000 scale topographic map of Montana (U.S. Geological Survey, 1965)

Data for thermal springs and most thermal wells in Montana are in the accompanying tables. For additional information about the geothermal resources of Montana contact the Montana Bureau of Mines and Geology. Published literature is listed in
Rautio, S.A., and Sonderegger, J.L., 1980, Annotated bibliography of the geothermal resources of Montana: Montana Bureau of Mines and Geology Bulletin 110, 25 p

Map available free of charge from: Montana Bureau of Mines and Geology, Montana College of Mineral Science and Technology, Butte Montana 59701

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