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Quarterly Report

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Geothermal Studies in Montana

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State Wide Program

A first draft of the state resource map is nearly complete at scales of 1:500,000 and 1:1,000,000. The bibliography is completed although we are still checking for additional "soft" papers. The dating publication is nearly ready for editing as we are waiting for: (1) five dates from URRI in standard format; and (2) interlibrary loan copies of three (?) papers.

Areal Studies

Appended is Sandra's progress report on work at West Yellowstone. Inventory work has been completed in the Camas and Radersburg areas. Two-thirds of the water samples have been collected at Radersburg; collection of samples around Camas will occur about November 1. Gravity data collection is completed at Camas and some seismic lines have been shot. The Radersburg basin has some but not all of the gravity and seismic data collected at this time. Two days field work remain in the Centennial Valley area.

PROGRESS REPORT

SUBJECT: Geothermal Resource Inventory
West Yellowstone, Montana, Summer 1979

FROM: Sandra Kovacich

TO: John L. Sonderegger, Montana Bureau of Mines and Geology (MBMG)

DATE SUBMITTED: September 27, 1979

OVERVIEW

From the end of May to the end of August 1979, I inventoried 20 springs and 90 wells in and near the city of West Yellowstone, Montana (WY). Of the 110 ground-water sources inventoried, three could be considered warm (above 15°C). All three warm sources were sampled along with an additional six springs and 33 wells. With the aid of Fred Schmidt, 36 water samples were collected in August from these sources. All water samples have been submitted to the MBMG water analysis laboratory for the determination of all major constituents, plus aluminum, lithium, boron, and arsenic.

A gravity and altimeter survey was also conducted in the study area (see map) with many of the points corresponding to inventoried or sampled wells and springs. These data, which were collected by Sunday Oladipo, Dr. Charles Wideman and me, will aid in understanding the stratigraphic and structural nature of the study area. Dr. Wideman is supervising a student who is working on the reduction and analysis of the gravity data now, but a date for the release of that information has not been set.

In addition to the ground-water inventory and sampling, and the gravity altimeter survey, I have gathered data on ground and surface waters and other information from the Gallatin National Forest (USFS) and the Gallatin County Health Department. Other information pertinent to accomplishing the primary goal of locating and characterizing geothermal water in and near West Yellowstone can be obtained from the U.S. Geological Survey (USGS), well drillers who have worked in the area, and from private oil companies and other exploration companies.

This progress report will outline the primary, secondary, and other goals and objectives of this summer's field work with a delineation of the methods employed and the preliminary findings. What has been done and what needs to be done for the successful completion of this study will be discussed.

I. Primary goals and objectives

A. Locate warm springs and wells.

(1) Use maps.
(2) Ask people in the area.
(3) Perform field investigations.

B. Characterize water chemistry for use in model calculations.

(1) Use MBMG data for model calculations.
(2) Use previous investigations for model calculations.

C. Support goal of choosing drilling sites for next year (siting of heat-flow test holes).

(1) Preliminary investigations indicate two areas for a test-hole site.
(2) Geophysical and other data, including sampling and inventory, may indicate other desirable sites.
(3) The socioeconomic and political climate in the West Yellowstone area may preclude any further exploration or geothermal development.

D. Provide data for ground-water report on the West Yellowstone Basin for a reconnsaissance report.

(1) Over 90 wells have been drilled in the city of West Yellowstone (Consisting of ½ mile) but all the water is cold.
(2) An additional 70 or more wells were drilled outside the city of West Yellowstone, however, all but two yield cold water.

E. Assist in compiling and writing geothermal-resource report for the West Yellowstone basin.

(1) Characterize the quality and quantity of geothermal waters (and cooler waters).
(2) Characterize the stratigraphy and structure of aquifer units using selected well logs, geophysical and other information.
(3) Characterize the location and yields of geothermal waters.
(4) Characterize temperature and other nonchemical parameters of thermal water sources.
(5) Characterize public opinion on the development of geothermal resources bordering Yellowstone National Park.
(6) Characterize other relevant data.
(7) Characterize the recharge, discharge and precipitation of area.

2. Secondary goals and objectives

A. Provide data on the location of potable water sources that comply with federal and state standards for fluoride.

B. Provide data on the location of water sources adequate for fire protection in the West Yellowstone area.

C. Provide hydrologic data relevant to the location of a sanitary landfill site near enough to the city of West Yellowstone to be economically feasible and sensible.

   (1) Chemical and other investigations show that the present landfill site (5 mi. north of West Yellowstone) is leaching into the main fork of the Madison River, thence into Hebgen Lake.
   (2) Data compiled by the Health Department and USFS indicate that a suitable landfill site is not available near West Yellowstone (see H. Kringler's report, "Evaluation of Potential Landfill Sites Near West Yellowstone, Montana", p.5).

3. Other goals and objectives

   A. Update MBMG files, well logs, and chemical analyses on the West Yellowstone area.

   B. Compile and present all available ground- and surface-water data including stratigraphy, structure (geophysical), quality, quantity, to the municipal government of West Yellowstone, Montana.

4. Methods employed

   A. Tools used in field:

      (1) Tape and chalk to measure total depths and static water levels.
      (2) Bucket and stopwatch to measure discharges (other methods also employed for spring-discharge measurements).
      (3) Thermometer to measure air and water in degrees centigrade.
      (4) pH tape, digital meter, and expanding scale meter.
      (5) Two specific conductance meters.
      (6) Hach field silica kit.
      (7) Hach field fluoride kit.
      (8) Distilled water.
      (9) Altimeter to measure elevations.
      (10) Gravity meter for geophysical data.
      (11) Forms for recording information.

         a. field notebook
         b. lab cards (filled out but await proofing)
         c. spring inventory forms (my own)
         d. System 2000 forms (to be completed in office)

      (12) Filtration kit for lab sample collection.

   B. Inventory of springs included:

      (1) Location and elevation.

a. The elevations used are those taken by Sunday Oladipo and me in July.
b. Locations are described by Township, Range, and Section (ABCD).

(2) Temperature, pH, specific conductance, silica, and fluoride.
(3) Lab sample collection and subsequent interpretation.

a. 1 liter, raw
b. 1 liter, filtered
c. .250 liter, filtered and acidified (1% HNO_3)

(4) Measured and reported discharges and depths.

a. Some springs were measured with a Gurley meter.
b. Most springs were measured with a bucket and stopwatch.
c. Some springs were measured by method of measuring the time it takes for a small stick to float between two predetermined points and mathematically calculating the discharge with this factor and depth and width factors.

C. Inventory of wells included:

(1) Location and elevation (see spring inventory).
(2) Temperature, pH, specific conductance, silica, and fluoride.
(3) Temperature logging (to be completed).
(4) Lab samples collected (see spring inventory).
(5) Total depth, static water levels, and pumping water levels.

D. Wells and springs were numbered in order of inventory; each source designated WY and a number.

E. Compile and use well-log information.

F. Collect information from previous investigations on geothermal water (e.g., Island Park Geothermal EIS).

G. Collect data from other sources.

H. Maps for plotting data and locating sites.

(1) 15-minute topographic maps: West Yellowstone (1958), Tepee Creek (1958), Hebgen Dam (1950), and Henrys Lake (1964) (all scales 1:62,500 or 1" = 1 mi.).

a. Above maps were used as base maps for geologic and other maps.

b. Map of study area has been photographically enlarged by a factor of 2 by the MBMG drafting department.

(2) Surficial geologic map of the West Yellowstone quad, 1975, by H. A. Waldrop (scale 1:62,500).
(3) Geologic map of the Hebgen Lake-West Yellowstone area, Plate 5 of P.P. 435 (scale 1:62,500).
(4) Gallatin County USFS Day Use Area map.
(5) City of West Yellowstone Plat Map, traced by E. B. Moore 1925 (scale 1" = 300').
(6) Subdivision maps: Lazy Acres, Hebgen Lake Estates 1 and 2, Hebgen Lake Cottage Tracts.
(7) Land ownership maps from Bozeman office.

Note: Land ownership and subdivision maps are not in my possession; rather, I saw them either at USFS office, Gallatin County Courthouse and/or owners themselves showed them to me.

5. Work completed in summer 1979:

A. Field inventory of 110 ground-water sources completed in West Yellowstone area.

B. Lab samples for a total of 42 ground-water sources completed.

(1) Known warm sources sampled except for one on Madison Fork Ranch (owner refused entry).
(2) All sampled sources plotted with total depths but should be replotted.
(3) Water quality analysis sheets completed and submitted to MBMG lab along with samples.
(4) Lab samples await analysis in MBMG lab.

C. Approximately 60 percent of well logs obtained from MBMG files, Helena files, owners, and other sources.

D. Gravity and altimeter surveys completed by Dr. Wideman, Sunday Olidapo, and me.

(1) Elevations have been calculated and used for values on lab cards and for inventoried sources.
(2) Elevations taken with altimeter are accurate to within 10 feet of actual elevations.
(3) Gravity reduction program is in progress; results should be available soon.

E. Aerial photo survey was completed with the help of Dr. Hugh Dresser (06/03/79).

(1) Aerial photos taken with Hasalblad, Canon FX 35mm, and other cameras.
(2) Black and white, color slide (64 ASA and 250 ASA), and color infrared film was used in aerial survey.

F. Springs, artesian flows, topography, and the city of West Yellowstone were photographed during summer.

(1) Color slide film and black and white was exposed in Canon 35mm camera.

(2) Most film awaits development and enlargement, with some problems with self-rolled 64 ASA film.

G. Contact has been made with several agencies and individuals concerned with geothermal and general ground-water inventory and analysis.

(1) I have worked closely with Guy Hanson, Gallatin County USFS employee in charge of surface-water sampling in West Yellowstone area, on locating ground-water sources, measuring springs, and contacting people.
(2) I have met Ralph Meyer, West Yellowstone District Ranger.
(3) I have talked with, and obtained reports containing chemical data, depth to bedrock, and other information pertaining to sanitary landfill conditions, from Harry Kringler of the Gallatin County Health Department.
(4) I have discussed water collection and other related matters with Matt Kramer who collected water samples for biological analysis in the West Yellowstone area.

a. Results from biological testing showed no contamination of ground waters from sewage.
b. Results of this testing showed no contamination from other sources of pollution.
c. Results from previous testing by the Health Department showed fluoride levels that exceed federal and state standards for potable water (federal recommended limit is 1.3 ppm).
d. Field inventory supported findings of excessive fluoride levels.

(5) I have met and talked to Joe Cutter, editor of the newspaper--"The Old Faithful Times".

a. Mr. Cutter has promised his full cooperation.
b. Submitted an article discussing this summer's field work to several newspapers, including "The Old Faithful Times", where it was printed in both the July and August editions.

(6) I have worked with local people such as Allen Lapp, city sanitarian; Bert Fields, pump installer; Glen Goff, pump

installer; Bob Leathead, pump installer; and Verl Andrews, local well driller.

H. I have attended city council meetings on subject of sanitary landfill. Findings of Health Department, EPA, and USFS show no suitable landfill site in West Yellowstone area.

(1) The current landfill site is supposedly leaching concentrations of heavy metals and organics into the main fork of the Madison River, causing eutrophication and other pollution problems in Hebgen Lake and further downstream.

(2) A tentative decision has been made to truck refuse to a cooperative landfill site nearer Ennis, Montana, to be used by the citizens of that city, the city of West Yellowstone, and maybe one or two other nearby cities.

6. Work to be completed on the West Yellowstone project.

A. All information pertinent to the primary and other goals of this study should be obtained.

(1) Contact should be made with the USGS to obtain information on wells that are being monitored for helium, radon, or other gases/elements in the West Yellowstone area.

a. Information on helium levels may be obtained from W. P. Doering of USGS.
b. Information on well depths and strata may be clarified for two wells (West Yellowstone City railroad well, and the Deep Well ranch artesian well) monitored by the USGS.

(2) Any other information available from the USGS should be obtained on the West Yellowstone area.
(3) A printout from the federal computer data system (STORET) should be obtained as soon as possible.
(4) Drillers who apparently have not filed well logs for the West Yellowstone area should be contacted (e.g., Martin, of Black Foot Drilling).
(5) Any well logs not in our files should be obtained from Water Rights in Helena or from the drillers themselves.
(6) Island Park EIS researchers should be contacted for information pertaining to the Madison Fork Ranch and to correlate MBMG data with theirs.

B. With all available data that can be obtained, System 2000 forms should be filled out (this task is partially completed).

(1) Field data were put into chart form for convenience.
(2) Tom Patton's new computer form may be used in addition to System 2000 and other forms.

C. Decisions must be made as to form (charts, graphs, maps, photos) in which information should be presented.

(1) Decisions must be made as to what maps to use (scale, etc.) and what information should be plotted.

a. Should information be plotted on mylar overlays initially and then the information transferred to a map(s)?
b. Should information be charted on one map overlay or several?
c. Possible map-related problems exist because most maps are 20 or more years old, and were compiled prior to the 1959 earthquake and before the recent logging activities in the area.

(2) Decisions must be made concerning the general format of the geothermal report.
(3) A system of codes must be developed.

a. Well-numbering system has already been explained in this outline (WY #).
b. Stratigraphic codes are those developed by the USGS, correlated to P.P. 435, Plate 5, but the surficial deposit map of Waldrop (1975) has different codes for the alluvium and other deposits.
c. Codes should be developed to distinguish deep wells from shallower wells.
d. Codes should be developed to distinguish wells that finish in bedrock from those that finish in sediments.
e. Codes should be developed to distinguish warm from cold ground-water sources.
f. Codes should be developed to distinguish high-silica from low-silica sources.
g. Codes should be developed to distinguish high-fluoride from low-fluoride sources.
h. Codes should be developed for any other features that may be mapped.

D. So far it has been decided to draw up a ground-water table map and to key gravity and altimeter surveys to water level and other information.

F. Field values for silica, fluoride, pH, and SC, should be checked against lab values and any necessary corrections made.

G. A final report on the geothermal resource potential of the West Yellowstone area will be the result of field and office work.

(1) All geological and other characteristics should be delineated for the area.
(2) This outline will serve as a partial basis for the final report.

H. If time, money, and initiative permit, all information available on the quality, quantity, location, and yield of water sources, should be reported to the people who reside in and near West Yellowstone, Montana.

(1) Information of this nature will be important for the people in the area of West Yellowstone for planning and general purposes.
(2) Information should be presented in both written or oral form.

CONCLUSIONS

In general, the people in and near the city of West Yellowstone regard the development of geothermal energy with suspicion but were cooperative for the most part. Because the town depends upon tourism for its livelihood, any development that may effect Old Faithful and other geyser activity in the park is regarded by the residents as a threat to their businesses. The socioeconomic and political atmosphere of the area therefore may preclude any geothermal development near enough to Yellowstone National Park to have a possible detrimental effect on its geothermal features. This is especially true for large-scale use of hot water for the generation of electricity, although the city needs additional energy to meet present and future energy demands.

Preliminary investigations and conclusions regarding the geothermal resource potential of the area indicate that hot water does exist in the study area but the temperatures and yields of sources may not be adequate for economical development at this time. However, high-yield warm-water sources may, in fact, exist that have not been tapped. For this reason, heat-flow test wells may be sited in areas near known warm sources to discover if a larger source than is apparent does exist. If the decision is made to site such test holes in spite of public opinion (which might change), two areas seem high in potential. The two areas that seem to have the highest geothermal resource potential are lightly traced on the study area may accompanying this report.