WESTERN STATES GEOTHERMAL DATABASES CD

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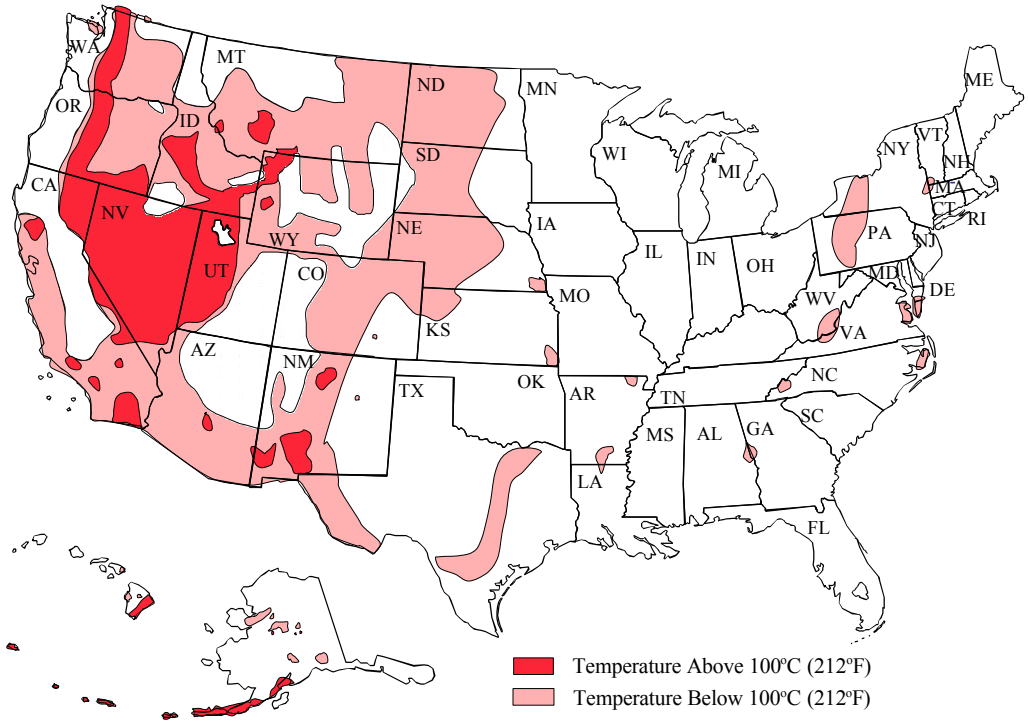

Figure 1. Geothermal Resources Areas of the United States.

INTRODUCTION

Low- and moderate-temperature geothermal resources are widely distributed throughout the western and central U.S. as can be seen in Figure 1. There are also a few low-temperature geothermal resources that occur in the east.

There has been several major efforts in assessing the potential for low-temperature geothermal resources in the U.S. The first major effort in the 1980s included 17 states which resulted in geothermal resource maps, prepared by the National Geophysical Data Center of the National Oceanic and Atmospheric Administration (NOAA), that are still being used today. The latest effort, which included 10 of the 17 original states, was in the early-1990s, and which resulted mainly in individual digital databases of all known geothermal wells and springs for a total of over 9,000 wells and springs. The 10 states were: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, and Washington (Lienau and Ross, 1996).

The state databases that were completed in the 1990s were designed for use on personal computers, and have the capability of being accessed and managed by using readily available commercial spreadsheets. The only problem was the databases were produced in several different formats and no two states were set up in the same format; although, there was a general guideline for the format of the information.

The low-temperature resource assessment completed in 1990s included another task. The task was to complete a statewide study of collocated geothermal resources with the only criteria being a collocated community with a resource temperature above 50ºC (122ºF) and located within 8 km (5 miles) of a community (many of which have <1,000 population). There were 1,723 wells and springs identified with a temperature over 50ºC (122ºF), with 1,469 of them located within 8 km (5 miles) of a community. There were a total of 271 communities identified within the 10 western states.

The oldest, most versatile and most common use of geothermal energy is direct-use applications; although, most people associate geothermal with power generation. Direct-use applications include: greenhouse heating, aquaculture pond and raceway heating, space and district heating, industrial applications such as food processing, and resort and spas. The fastest growing direct-use applications are for greenhouses and aquaculture, which can be seen in Figure 2.

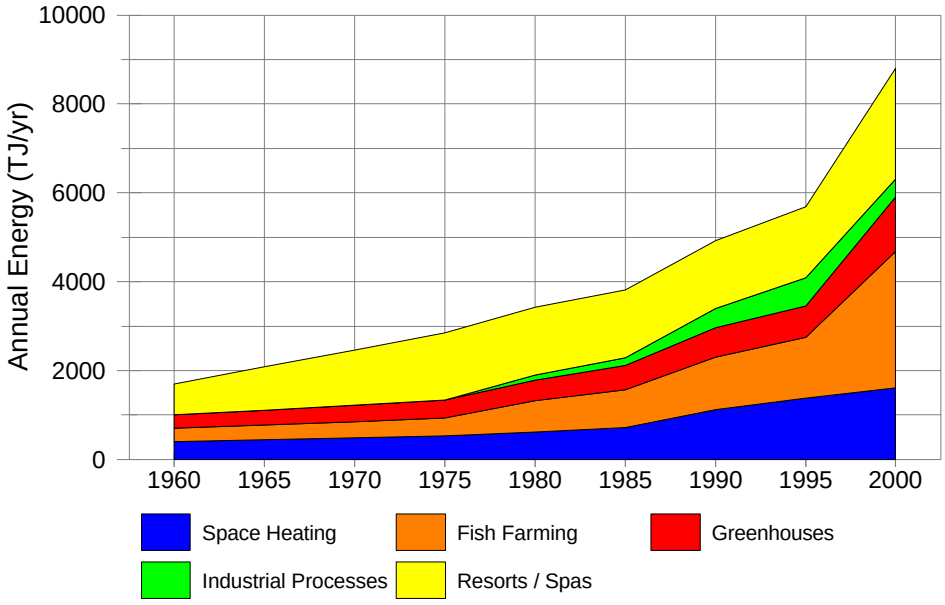

Figure 2. U.S. geothermal direct-use growth.

The Geo-Heat Center was recently tasked through a contract with the Department of Energy to complete a state resource database, including collocated communities, for six more states in the west. These states are: Alaska, Nebraska, North Dakota, South Dakota, Texas and Wyoming. The Geo-Heat Center was further tasked to include the original state databases into a standard format for ease of use. Research for the databases included finding reports and other information on wells and springs for those states, and also to ask knowledgeable people in those states where to obtain additional information.

The reports of the original state teams and the new information from the additional six states documents a total of 11,775 wells and springs in the databases with the new states producing 2,731 more entries. The number of collocated sites increased to 404 from the previous 271 for the 10 states. The total of wells and springs with a temperature over 50°C (122°F) went from 1723 to 2211, which is an increase of 28%. A summary of the numbers by state is shown in Table 1. All of this information is available on a CD, as described below.

WESTERN STATES GEOTHERMAL DATABASES CD

The Geothermal State Resources CD can contain up to five databases for the 16 states as stated above. The five databases are:

1. *Well and Springs* - Which contains all the known wells and spring for that state with a temperature typically > 20°C (68°F);

2. *Chemistry* - This database contains the most common fluid chemistry for the sites listed in the *Wells and Springs* database. There are a couple states where no chemistry information was available (Texas and Nebraska);

3. *Other Information* - This database contains additional information found in the original databases but did not fit in the original two categories;

4. *Direct-Use Sites* - This database contains known locations of existing direct-use sites for each state. The states of Arkansas, Georgia, Hawaii, New York and Virginia are also included since they all have direct-use; and

5. *Collocated Sites* - Contains information on population centers located with 8 km (5 miles) of a known resource with a temperature above 50°C (122°F).

The databases are available in three different formats for use over a wide range of spreadsheets and database programs. The three formats are listed below.

1. QuattroPro 8 extension *.wb3
2. Microsoft Excel 97 extension *.xls
3. Comma delimited Text extension *.csv

Background information on each state database can be found in the "Information" file. This file includes where the information was obtained, summary of each database included for the state (such as how may entries in the wells and springs database), a listing or the column headings for each database, and which of the column headings has no information for that state.

There are two more white paper files that may be available for each state. The first one is the original state team report for the 10 original states. Seven of the original reports are available online at the website DOE Information Bridge

Table 1 Summary of the Western States Geothermal Databases

	Number of Wells and Springs	Number of Chemistry Entries	Number of Collocated Communities	Number of Direct-Use Sites
Original Databases				
Arizona	1,251	2,491	14	12
California	989	683	70	100
Colorado	168	443	15	39
Idaho	1,555	620	51	73
Montana	292	288	18	34
Nevada	455	365	30	330
New Mexico	361	823	12	13
Oregon	2,195	208	32	628
Utah	964	885	23	17
Washington	814	195	6	6
Subtotal	**9,044**	**7,001**	**271**	**1,252**
New Databases				
Alaska	238	242	17	14
Nebraska	87	0	9	0
North Dakota	128	139	1	0
South Dakota	821	4	58	6
Texas	1,101	0	43	3
Wyoming	356	182	5	21
Subtotal	**2,731**	**567**	**133**	**44**
TOTAL	**11,775**	**7,568**	**404**	**1,296**

<http://www.osti.gov/bridge/>. As the other state reports become available they will also be placed on the CD. The second white paper file contains a listing of references that provides more information for each state.

To be able to view these white paper files, you must be able to view an Adobe PDF file. If a person does not have the program Adobe Reader or similar program to read the white papers files, the installation files have been included on the CD in the directory Adobe. The files are available for both Windows and Mac computers.

WHAT EACH STAT DATABASE CONTAINS

The *Wells and Springs* databases are available in both SI (site-a) and US (site-b) units. The column headings for this database are:

a. Site ID - Corresponds to the other databases Chemistry and Other for easy reference between them
b. Site Name - Name given to the well or spring in the original databases
c. Type - well, spring or other (for example, California lists several types of wells)
d. Latitude
e. Longitude
f. County
g. Quad - Some states listed Quadrangle information which represents Township N/S and Range E/W. Some of the states used both references.
h. Township - Part of the legal land description which includes columns h, i, j, k, l
i. North or South - Part of the legal land description which includes columns h, i, j, k, l
j. Range - Part of the legal land description which includes columns h, i, j, k, l
k. East or West - Part of the legal land description which includes columns h, i, j, k, l
l. Section - Part of the legal land description which includes columns h, i, j, k, l
m. Quarter Section - further defines the location of the well or spring.
n. Depth
o. Temperature
p. Flow
q. TDS - Total Dissolved Solids
r. Chemistry - if there is available chemistry in the chemistry database (yes or no).

The *Chemistry* database has information on the more commonly reported chemistry entries in the original databases. The column headings are:

a. Site ID - Corresponds to the other databases Chemistry and Other for easy reference between them
b. Date Sampled - Corresponds to the date the sample was taken as reported in the databases. Some wells and springs have more than one chemistry entry.
c. Sample Name - Some of the chemistry entries were given identifying names
d. Site Name - Name given to the well or spring in the original databases

e. Type - well, spring or other (for example, California lists several types of wells)
f. Latitude
g. Longitude
h. Temperature - reported in Degrees C
i. TDS - Total Dissolved Solids
j. Field pH
k. Lab pH
l. Field Conductivity
m. Na - Sodium (milligrams per liter, mg/L)
n. K - Potassium (milligrams per liter, mg/L)
o. Ca - Calcium (milligrams per liter, mg/L)
p. Mg - Magnesium (milligrams per liter, mg/L)
q. Fe - Iron (milligrams per liter, mg/L)
r. Sr - Strontium (milligrams per liter, mg/L)
s. Li - Lithium (milligrams per liter, mg/L)
t. B - Boron (milligrams per liter, mg/L)
u. SiO_2 - Silica (milligrams per liter, mg/L)
v. HCO_3 - Bicarbonate (milligrams per liter, mg/L)
w. SO_4 - Sulfate (milligrams per liter, mg/L)
x. Cl - Chlorine (milligrams per liter, mg/L)
y. F - Fluoride (milligrams per liter, mg/L)
z. As - Arsenic (milligrams per liter, mg/L)
aa. Calc TDS - Calculated Total Dissolved Solids
bb. Br - Bromide (milligrams per liter, mg/L)
cc. NO_3 - Nitrate
dd. NA + K

The *Other* database contains additional information that was not included in the *Wells and Springs* database or the *Chemistry* database. This information was either not consistently reported in all the state databases or was newly discovered in the development of the newer state databases. Some examples of column headings are drilling date, well status, reference, and SWL (static water level).

The *Collocated* databases were developed using the *Wells and Springs* databases. The criteria for being a collocated community is a geothermal resource with a temperature of at least 50°C (122°F) and located within 8 km (5 miles) of a community. The column headings for this database are:

a. State
b. City
c. County
d. Latitude
e. Longitude
f. Resource Temp., °C
g. Resource Temp., °F.
h. # of wells listed
i. Typical depth, m - average for the wells listed
j. Typical Depth, ft - average for the wells listed
k. Flow, L/min - total flow for all the wells listed
l. Flow, gpm - total flow for all wells listed
m. TDS (Total Dissolved Solids) - highest value reported
n. Current Use
o. HDD - Heating degree days
p. Design Temp. - used for designing building heating systems
q. Remarks - This sometimes listed the wells associated with the collocated community.

The *Direct-Use* database contains known direct-use applications located in the U.S.; although, we believe there are a significant number of projects utilizing geothermal energy that are not included in this database. The direct-use applications are: district heating, space heating, aquaculture, greenhouses, industrial, snow melting, resorts/pools and agriculture applications. The column headings for this database are:

a. State
b. Site - name of the business
c. Location -
d. Application - which of the direct-use application it is
e. Temp, °F
f. Temp, °C
g. Flow, gpm
h. Flow, L/min
i. Capacity, 10^6 Btu/hr
j. Capacity, MWt
k. Energy Use, 10^9 Btu/yr
l. Energy Use, GWh/yr
m. Energy Use, 10^{12} TJ/yr
n. Load Factor, [annual load / (capacity x 860)]
o. Contact
p. Address
q. Zip code
r. Phone number

HOW TO OBTAIN THIS INFORMATION

The databases, which can be obtained in part or as a whole set on a CD, are available through the Geo-Heat Center. The cost for information for one state is $10 and for all 16 of the western states is $25. To obtain a copy of the CD, contact the Geo-Heat Center by phone (541-885-1750), fax (541-885-1754), email (geoheat@oit.edu), or mail (Geo-Heat Center, 3201 Campus Drive, Klamath Falls, OR 97601).

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