THE GEOTHERMAL MAP OF CALIFORNIA

Susan F. Hodgson
California Department of Conservation
Division of Oil, Gas and Geothermal Resources
Sacramento, CA

The new "Geothermal Map of California," drawn at a scale of 1:1,500,000, is the most comprehensive geothermal map every made of the state. Digitally produced with a PC-based geographic information system, the map was created by the Division of Oil, Gas and Geothermal Resources, and the California Geological Survey, under the California Department of Conservation.

The map includes digital layers for a wide range of geothermal data, including boundaries of Known Geothermal Resource Areas from the U.S. Bureau of Land Management; commercial, low-temperature geothermal projects from the Geo-Heat Center, Oregon Institute of Technology (see the illustration); thermal springs and low-temperature geothermal wells from the California Geological Survey; geothermal fields, power plants and high-temperature production wells, and plugged and abandoned wells from the California Division of Oil, Gas and Geothermal Resources; and electrical generation data from the California Energy Commission.

It is interesting to see where all the geothermal features lie. Although the state's best-known volcanoes–Mt. Shasta and Mt. Lassen–are in the northernmost area, the geothermal resources in general–both developed and underdeveloped–are more scattered. The shaded relief map overlying the large state map shows where they occur in respect to the mountain ranges and valleys. Mostly, the resources are found in the border area surrounding the central Great Valley, leaving much of the state without any geothermal features whatsoever.

Another fact becomes clear. Except for thermal springs, most geothermal features on the map are clustered to such a degree that five inset maps and an additional small, state map are needed to illustrate them. The small state map includes low-temperature wells and low-temperature projects, such as aquaculture, district heating, greenhouses, industrial uses, resorts and pools, and space heating.

A black and white version of the small, state map showing direct-use applications, was drawn for this article. Although this version is in black and white as opposed to color, a look will illustrate how often the low-temperature projects and low-temperature wells are found together. Even though the Geo-Heat Center's list of California's low-temperature geothermal projects had not been updated in several years, a sample of 99 was used. It is clear that several projects and project types often exist at a single site.

On the following page is a list of direct-use sites in California extracted from the back of the map sheet. Additional information on direct-use sites in California can be obtained from the Geo-Heat Center website: http://geoheat.oit.edu.

The thermal springs in the state–there are 299–are dispersed more widely than any of the other geothermal features (except perhaps for some of the low-temperature commercial projects related to the springs). Data about each thermal spring are organized in a chart printed on the back of the map. These include the name of the spring, the latitude and longitude, the county, the highest recorded temperature in ^{o}C, the flow rate in liters per minute, and the historical uses, such as water-supply augmentation, baths, pools, space heating, district heating, irrigation, aquaculture, greenhouse and heat exchanger applications, bottled water, idle and abandoned projects, and undeveloped springs.

Of course, California uses its high-temperature geothermal resources, as well, generating a great deal of electricity from them. In fact, more electricity from geothermal resources is generated in the United States than any other country, and most of it comes from California–about 2,429 megawatts of installed capacity in 1998 (California Energy Commission figures). The states of Hawaii, Nevada and Utah also generate small amounts.

Today in 2003, about 10 percent of the electricity in Northern California and about 5 percent of he electricity in the whole state are generated from geothermal hot water and steam. The map shows where the generation occurs-the locations of the geothermal fields, the wells with high-temperature resources, and the power plants with their names.

Plainly, many kinds of geothermal resources are important to California and many have important commercial uses. The resource variety and the resource locations are both critical, and they are clearly and artistically depicted here in full color.

TO ORDER A MAP

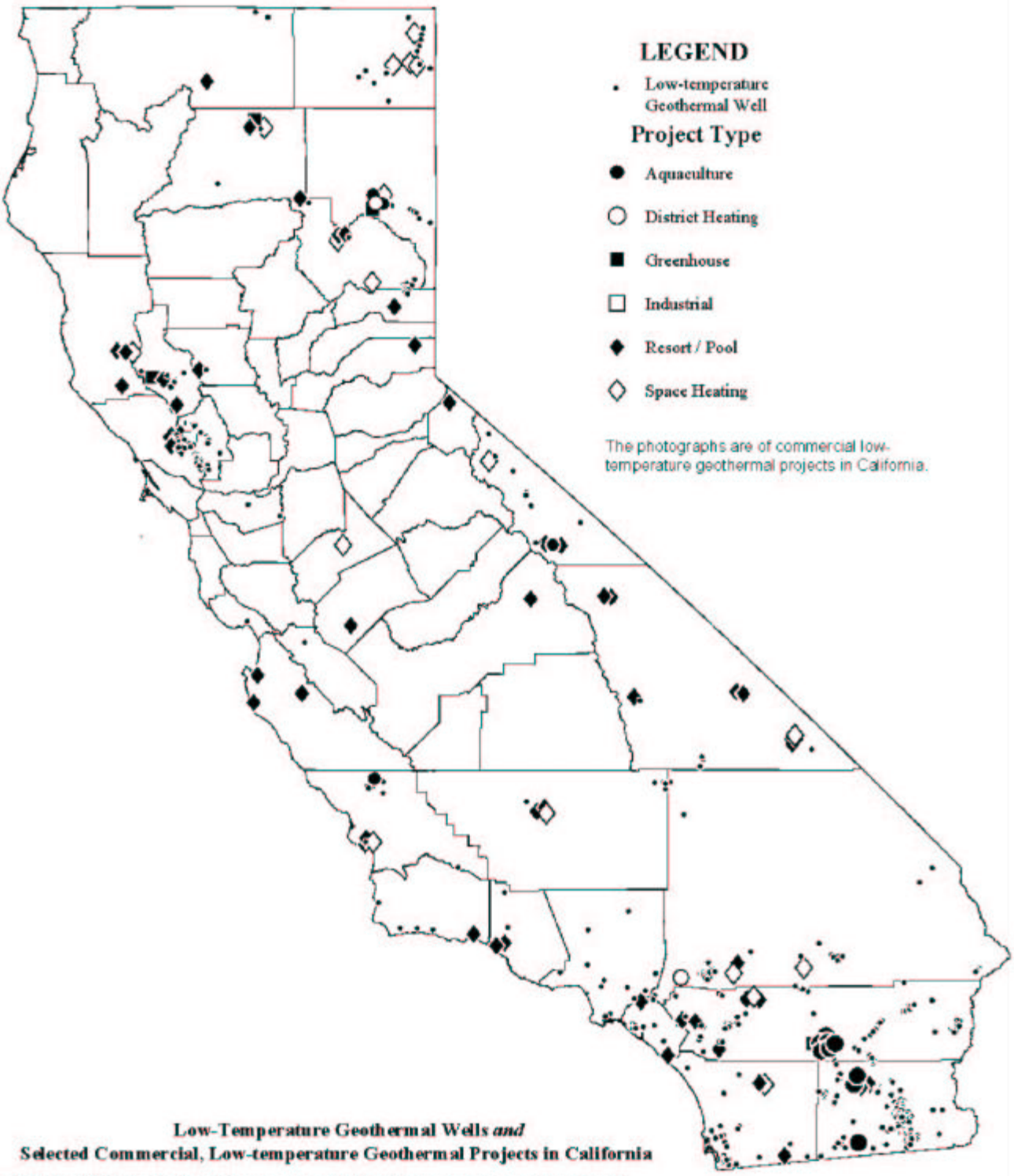
The "Geothermal Map of California" sells for $3, flat or folded, with handling and shipping included. To order a map, contact the California Division of Oil, Gas and Geothermal Resources, 801 K Street, MS 20-20, Sacramento, CA 95814-3530. Phone: (916) 445-9686.

The map is by Susan F. Hodgson and Leslie G. Youngs, and the cartography is by Roberto A. Coronel.

DIRECT-USE SITES IN CALIFORNIA

NAME	COUNTY	TEMP ºC (ºF)	FLOW RATE L/MIN (GPM)	USE
Grover Hot Springs	Alpine	60 (140)	400 (106)	B, H
Wilbur Hot Springs	Colusa	60 (140)	80 (21)	B
Mercy Hot Springs	Fresno	48 (118)		B
Keough Hot Springs	Injyo	59 (138)	2000 (528)	B
Tecopa Hot Springs	Inyo	42 (108)	757 (200)	B, C
Nevares Springs	Inyo	40 (104)	1325 (350)	A
Miracle Hot Springs	Kern	50 (122)	49 (13)	A, B
Delonegha Hot Springs	Kern	44 (111)	30 (8)	B
Democrat Hot Springs	Kern	46 (115)	57 (15)	B
Placer Claim Springs	Kern	40 (104)	9.5 (2.5)	B
Howard Hot Springs	Lake	46.3 (115)	55 (14.5)	B
Bassett Hot Springs	Lassen	79 (174)	200 (53)	A, B
Zamboni Hot Springs	Lassen	40 (104)	95 (25)	B, C
“Trilby Spring”	Mendocino	28 (82)		B
“Pool Spring”	Mendocino	29 (84)		B
Vichy Springs	Mendocino	29 (84)		B, J
SX Ranch Spring	Modoc	26 (79)	19 (5)	A, E
Little Hot Spring	Modoc	73.5 (164)	300 (79)	E
Fales Hot Springs	Mono	61 (1402	1000 (264)	B
Tassajara Hot Springs	Monterey	60 (140)	189 (50)	B
Paraiso Springs	Monterey	43 (109)	57 (15)	B, E
Brockway Hot Springs	Placer	55 (131)	600 (158)	B
Warm Springs at Twain	Plumes	38 (100)	19 (5)	B
White Sulfur Springs	Plumes	27 (81)	95 (25)	B, C
Murrieta Hot Springs	Riverside	54 (129)		B
Agua Caliente Spring	Riverside	41 (106)		B, C
Warner Hot Springs	San Diego	56 (133)	500 (132)	B, C
Agua Caliente Springs	San Diego	37 (99)	56 (15)	B, C
Newsom Springs	San Luis Obispo	36 (97)	57 (15)	B
Montecito Hot Springs	Santa Barbara	48 (118)	300 (79)	A
Hunt Hot Springs	Shasta	56 (133)	27 (7)	B
Big Bend Hot Springs	Shasta	82 (180)	340 (90)	B
Campbell Hot Springs	Sierra	42 (108)	284 (75)	B
California Hot Springs	Tulare	45 (113)	500 (132)	A, B

A - Augmenting water supply B - Direct-use in baths/pools C - Space heating D - District heating E - Irrigation
F - Fish farming H - Heat exchanger in use J - Bottled water



Low-Temperature Geothermal Wells *and* Selected Commercial, Low-temperature Geothermal Projects in California

- In 1993, the California Geological Survey prepared a list of low-temperature geothermal wells in California. Low-temperature wells have water 68 °F to 212 °F and the locations are shown on the map.

◆ In 1996, the Geo-Heat Center identified 99 commercial, low-temperature geothermal projects in California and prepared a map with some of the locations. For more information, contact the Geo-Heat Center at the Oregon Institute of Technology, 3201 Campus Drive, Klamath Falls, OR 97601. (541) 885-1750; or http://geoheat.oit.edu