LOW-TEMPERATURE GEOTHERMAL RESOURCE ASSESSMENT PROGRAM

Paul J. Lienau
Geo-Heat Center
Oregon Institute of Technology (OIT)

Howard P. Ross
Earth Sciences and Resources Institute (ESRI)
University of Utah

KEY WORDS

direct use, collocation, low-temperature, resource inventory, state teams

PROJECT BACKGROUND AND STATUS

In 1991, Congress appropriated money for the Department of Energy (DOE) to begin a new program for the evaluation and use of low-temperature (20° to 150°C) geothermal resources. In 1992, DOE funding came through the Idaho National Engineering Laboratory as contracts to the Earth Sciences and Resources Institute (ESRI), Oregon Institute of Technology (OIT) and Idaho Water Resources Research Institute (IWRRI). OIT began subcontracting to the state geothermal resource teams (State Teams) which had been selected to complete the resource inventory. IWRRI completed the resource inventory for Idaho. Figure 1 illustrates the geographic extent of this program.

The last major effort to assess the national potential of low-temperature geothermal resources occurred in the early 1980s. Since that time, substantial resource information has been gained through drilling for hydrologic, environmental, petroleum and geothermal projects, but there had been no significant effort to compile information on low-temperature resources. ESRI coordinated efforts with the state teams to complete the digital databases, reports, and resource maps. ESRI issued a revised water sampling manual and completed ten fluid chemistry analyses allocated to each state. In July 1993, ESRI and Utah Geological Survey hosted a meeting of the state teams to standardize data formats and to resolve problems and procedures. ESRI and OIT have reviewed state team reports, databases, and maps for errors and clarity. A comprehensive final report is being prepared that will summarize state team resource evaluation, inventory, recommendations, collocated resources and a method to evaluate the relative economic merit of geothermal energy at the sites.

PROJECT OBJECTIVE

The objective of this program is to encourage increased utilization of the nation's low-temperature geothermal resources and reduce our dependence on fossil fuels.

Technical Objectives

- Update the inventory of geothermal resources (20° to 150°C) in the West (initially ten states).
- Identify communities collocated with resources.
- Prioritize the more favorable resources for in-depth studies.
- Provide outreach to communities that have resource development potential through distribution of data, information and technical assistance.

Expected Outcomes

- An updated geothermal resource inventory will be available for ten western states. The data will be available in hard copy, a digital database, and new resource maps.
- A designated state agency or university group with current geothermal expertise will be available to assist local economic development agencies, community planners or industrial developers for these ten states.
- Identification of communities collocated with a resource of >50°C and within 8km.
- Those resources most suitable for near-term development will be identified and prioritized for additional technical studies.

APPROACH

State geothermal resource teams (State Teams) initiated their resource evaluation and database compilation efforts in late 1992 and early 1993, and completed these inventories and reports in 1994 and early 1995. The state teams reviewed essentially all available sources of information on water wells and geothermal literature to arrive at the new inventory. The most productive sources of information included the USGS's on-line water information from the National Water Data Storage and Retrieval System (WATSTORE), the 1983 USGS database file GEOTHERM, and previous state geothermal resource maps. State agency files of water well records submitted by drillers were key data sources for some states, as were open-file and published reports by state agencies. With very few exceptions, the databases do not include sites with only bottom-hole temperature or temperature gradient and heat flow sites. The data were checked for accuracy of site location, to the extent practical, and numerous corrections were made to previously published locations. Water analytical data were checked by evaluation of charge balance.

An important part of the assessment was to complete a statewide collocation study of geothermal resources and communities in the western states in order to identify and encourage those communities to develop their geothermal resources. The State Teams databases were searched for all the wells and springs with temperatures greater than or equal to 50°C. From that list a Paradox database was compiled which contained 18 data fields. The information included within the data fields are the collocated city, latitude and longitude, resource temperature, number of wells within the area, typical depth, total flow for all the resources within the area, typical use, and weather data.

RESEARCH RESULTS

Table 1 summarizes the catalog of 8,977 thermal wells and springs for the 10 western states; an increase of more than 82% compared to the previous assessment of 1980 to 1983. Each data entry in the inventory is a separate thermal well or spring. For purposes of this inventory and report, the State Teams have often selected a single well or spring to represent several (2 to 20) wells or springs within a small area (generally <1 km^2) within the same geothermal resource. Thus the true number of thermal wells and springs represented by this inventory is substantially greater than the numbers reported here.

To improve our reporting, the State Teams were asked to identify the number of distinct hydrothermal resource areas represented by the wells and springs in the inventory. A distinct resource area may be less than 1 km^2 in areal extent, in the case of a few wells or springs in a small, fault-controlled resource, or more than 100 km^2 in the case of extensive thermal aquifers such as in the Snake River Plain or Columbia Plateau. More than 900 low- to moderate-temperature resource areas are indicated, and perhaps a greater number of isolated (single) thermal wells or springs. The final reports, maps, and databases generated by the State Teams document the present knowledge of the resource base and its utilization and potential in some detail.

The State Teams and OIT Geo-Heat Center have documented direct-heat use of geothermal fluids at nearly 360 sites, including space and district heating, industrial applications and resorts/spas. High-priority resource study areas (48) have been identified, together with high potential for near-term direct-heat utilization at 150 new sites. The number of commercial and residential direct-heat users and the total energy use have increased dramatically in one decade. Even greater resource utilization would be expected without the competition of low-priced natural gas. With proper conservation and utilization of our geothermal resources, they will be there to serve us when natural gas and other fuel types are less competitive. Several problem areas have been identified however, where the heat or fluid content of these resources are largely wasted and additional monitoring, reservoir management, and possibly regulation is warranted.

The collocation study identified 271 cities in the 10 western states that could potentially utilize geothermal energy for district heating and other applications. A collocated community is defined as being within 8 km of a geothermal resource with a temperature of at least 50°C. Over 1900 thermal wells were identified by State Teams as having temperatures greater than or equal to 50°C and 1,469 are collocated with communities. Figure 2 is a representative state map of collocated communities in Idaho, that is similar to those developed for the other nine states.

In one specific project, ESRI and the Utah Geological Survey (UGS) extended the temperature and water level monitoring study of five observation wells in the Newcastle, Utah, geothermal resource. Observations continued on a quarterly basis until September 1995, concluding a two-year monitoring effort. The observations provide important background data for future numerical modeling efforts and qualitative evaluations of the impact of the rapidly developing greenhouse industry upon the Newcastle geothermal resource. Substantial temperature and water-level variations have been observed to date. Permeable zones within the thermal aquifer tend to become warmer during prolonged fluid production in the heating season, and three observation holes show substantial water-level declines during the irrigation season. No adverse effect on greenhouse fluid production or long-term changes to the thermal aquifer are indicated by the observations to date.

FUTURE PLANS

Although this direct-heat compilation of resource data indicates the tremendous potential for expanded utilization, many high-priority areas need further resource and ngineering studies. More specifically, for 48 high-priority sites these include:

- Geophysical exploration (10 sites)
- Confirmation drilling (12 sites)
- Hydrologic testing (11 sites)
- Comprehensive assessment (8 sites)
- District heating feasibility (12 sites)
- Industrial heating feasibility (7 sites)

We recommend a Phase 2 Low-Temperature Program, funded by DOE, to complete these studies. It is most important to support and mainmtain a local geothermal expertise (i.e., a State Team) to provide resource information and initial guidance to developers, in each of these states.

In addition, the states of Alaska, Hawaii, Nebraska, North Dakota, South Dakota, Texas and Wyoming need to update their low-temperature resource assessments and to establish new digital databases.

In the future we hope to continue R&D on improving methods for locating low- and moderate-temperature geothermal resources and on siting successful test and production wells. Part of this work will encompass development of better well-testing methods and better hydrologic models of these hydrothermal resources. These tasks are expected to pay off in further discoveries of resources and in better methods to evaluate reservoir production and ultimate-development capacity at an earlier stage in the development cycle than is now possible. This will further stimulate development of this greatly under-utilized and evironmentally-benign resource.

INDUSTRY INTEREST AND TECHNOLOGY TRANSFER

Numerous inquiries have been received by state resource teams, the Geo-Heat Center and Earth Sciences and Resources Institute regarding geothermal resource location, quality, and suitability for development. County Economic Development agencies listed below have collocated communities within their service areas, and they have been provided resource data and technical assistance information.

Organization(s)	Type and Extent of Interest
County Economic Development Agency (62 contacted) County Chamber of Commerce (50 contacted)	Resource data and direct heat development potential
Milgro Nurseries, Inc., Utah	Sustainable fluid production at Newcastle greenhouse development

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CONTACTS

DOE Program Manager:

Marshall Reed
U. S. Department of Energy
Geothermal Division, EE-122
1000 Independence Ave., SW
Washington, D. C. 20585
Tel: (202) 586-8076
Fax: (202) 586-8185

Operations Office Program Manager:

Joel Renner
Idaho National Engineering Laboratory
P.O. Box 1625-3830
Idaho Falls, Idaho 83401-1563
Tel: (208) 526-9824
Fax: (208) 526-0969

Principal Investigators:

Paul J. Lienau
Geo-Heat Center
Oregon Institute of Technology
3201 Campus Drive
Klamath Falls, OR 97601
Tel: (541) 885-1750
Fax: (541) 885-1754

Phillip M. Wright (801) 585-7783
Howard P. Ross (801) 581-5184
Earth Sciences and Resources Institute
University of Utah
1515 E. Mineral Square, Room 109
Salt Lake City, UT 84112
Fax: (801) 585-3540

Table 1. State Geothermal Database Summary: 1992-95 Low-Temperature Program.

	State PGA	AZ 1982	CA 1980	CO 1980	ID 1980	MT 1981	NV 1983	NM 1980	OR 1982	UT 1980	WA 1981
1. Thermal Well/ Springs	1995	**1,251**	**989**	**157**	**1,537**	**267**	**457**	**359**	**2,193**	**792**	**975**
	PGA	501	635	125	899	68	796	312	912	315	368
2. Moderate Temp. Wells/Springs (100°C < T < 150°C)	1995	**0**	**32**	**0**	**20**	**0**	**16**	**10**	**88**	**3**	**1**
	PGA	0	48	0	0	0	35	3	79	3	1
3. Low Temp. Wells/Springs (20°C < T < 100°C)	1995	**1,251**	**957**	**157**	**1,517**	**267**	**441**	**349**	**2,105**	**789**	**974**
	PGA	501	587	125	899	58	761	309	925	312	367
4. Low Temp. Resource Areas (20°C < Tes < 150°C)	1995	**35**	**58**	**93**	**54**	**33**	**300**	**30**	**200**	**161**	**17**
	PGA	29	56	56	28	15	300	24	151	64	10
5. Space and District Heating Sites	1995	**2**	**23**	**16**	**16**	**9**	**11**	**2**	**44**	**2**	-
6. Industrial Appl. Sites (Dehydration, Greenhouses, Aquaculture, etc.)	1995	**4**	**15**	**6**	**17**	**4**	**9**	**5**	**6**	**7**	-
7. Resort/Spa Sites	1995	**4**	**55**	**18**	**17**	**15**	**15**	**6**	**17**	**9**	**5**
8. Areas, Collocated Communities	1995	**14**	**70**	**15**	**51**	**18**	**30**	**12**	**32**	**23**	**6**
9. Areas, High Priority Resource Study	1995	**3**	**7**	**6**	**5**	**4**	**4**	**4**	**5**	**4**	**6**

Comments: PGA - Previous Geothermal Assessment. Tres = Estimated reservoir temperature.
The minimum low-temperature criteria is typically 20°C, but varies with climate.

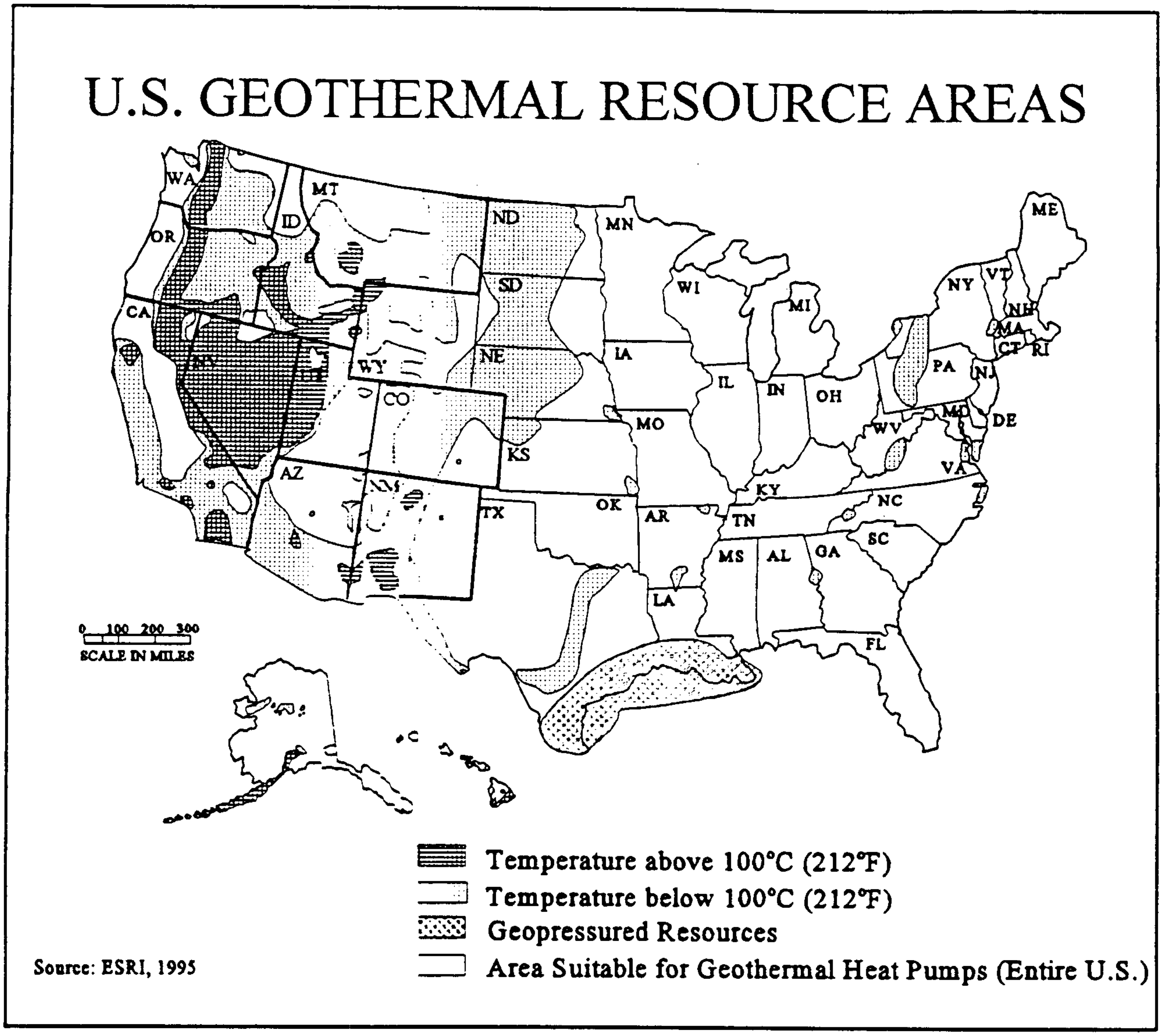

Figure 1. Geographic extent of the new resource assesment identified in bold outlines.

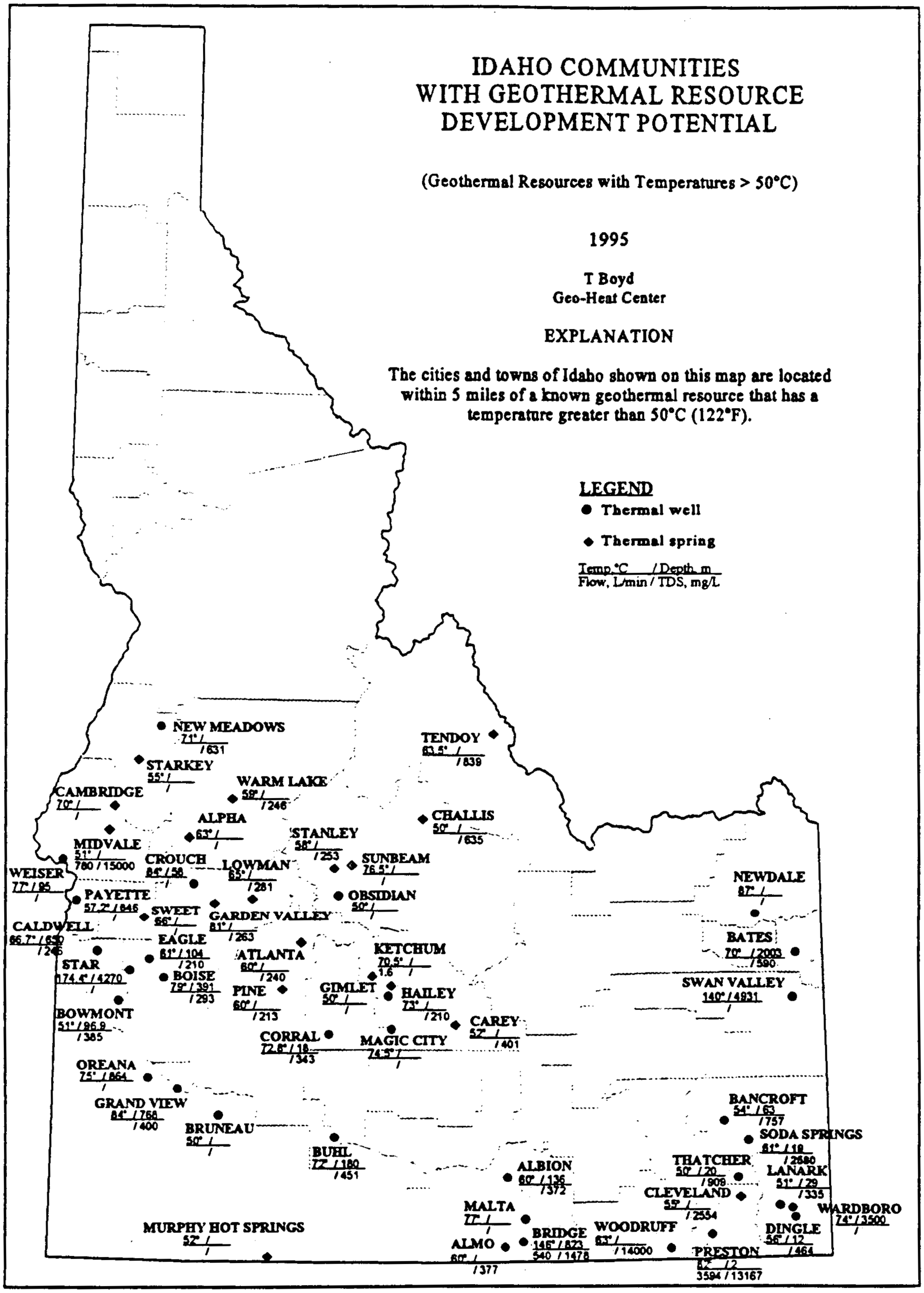

Figure 2. Collocated communities in Idaho.