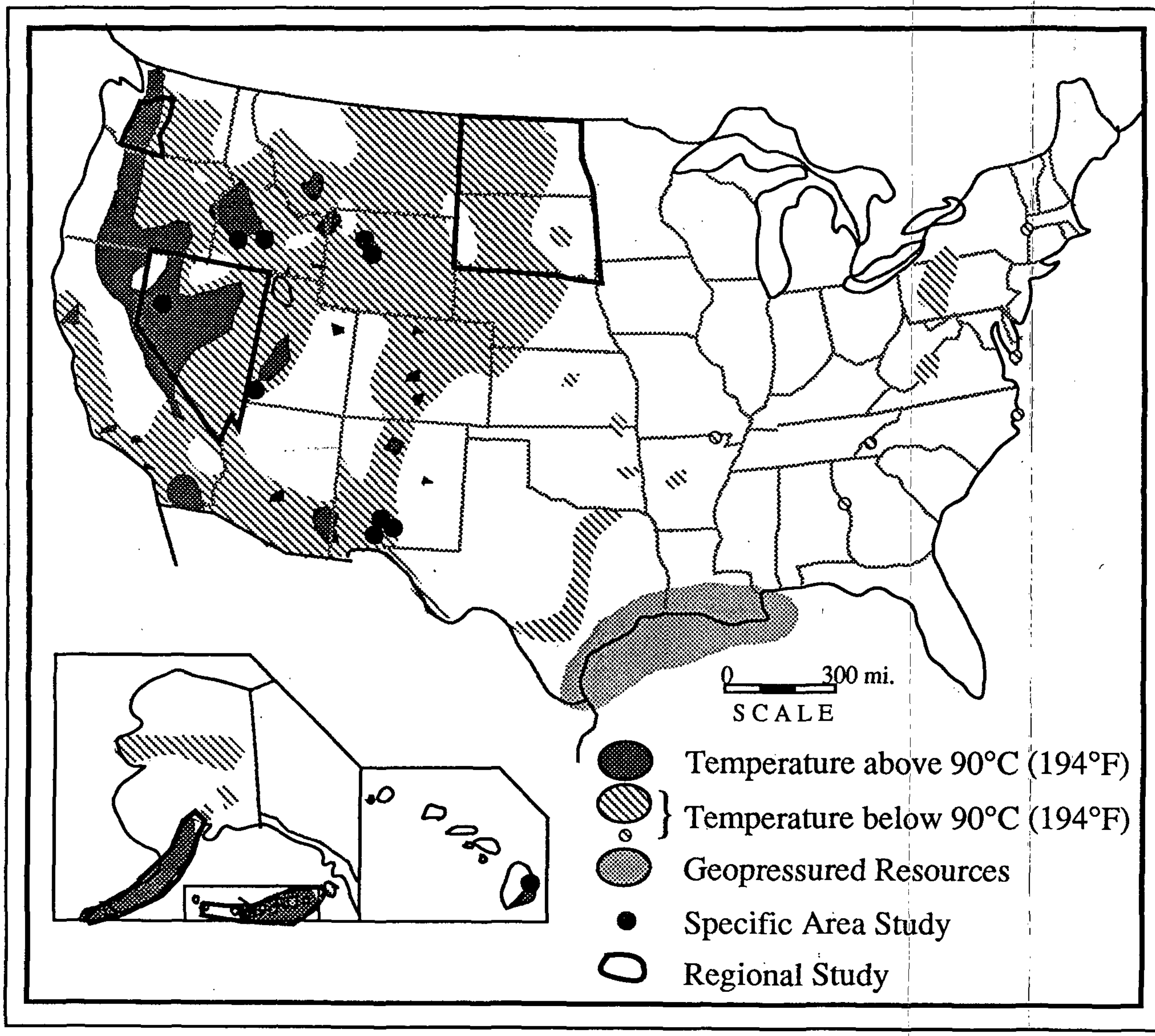
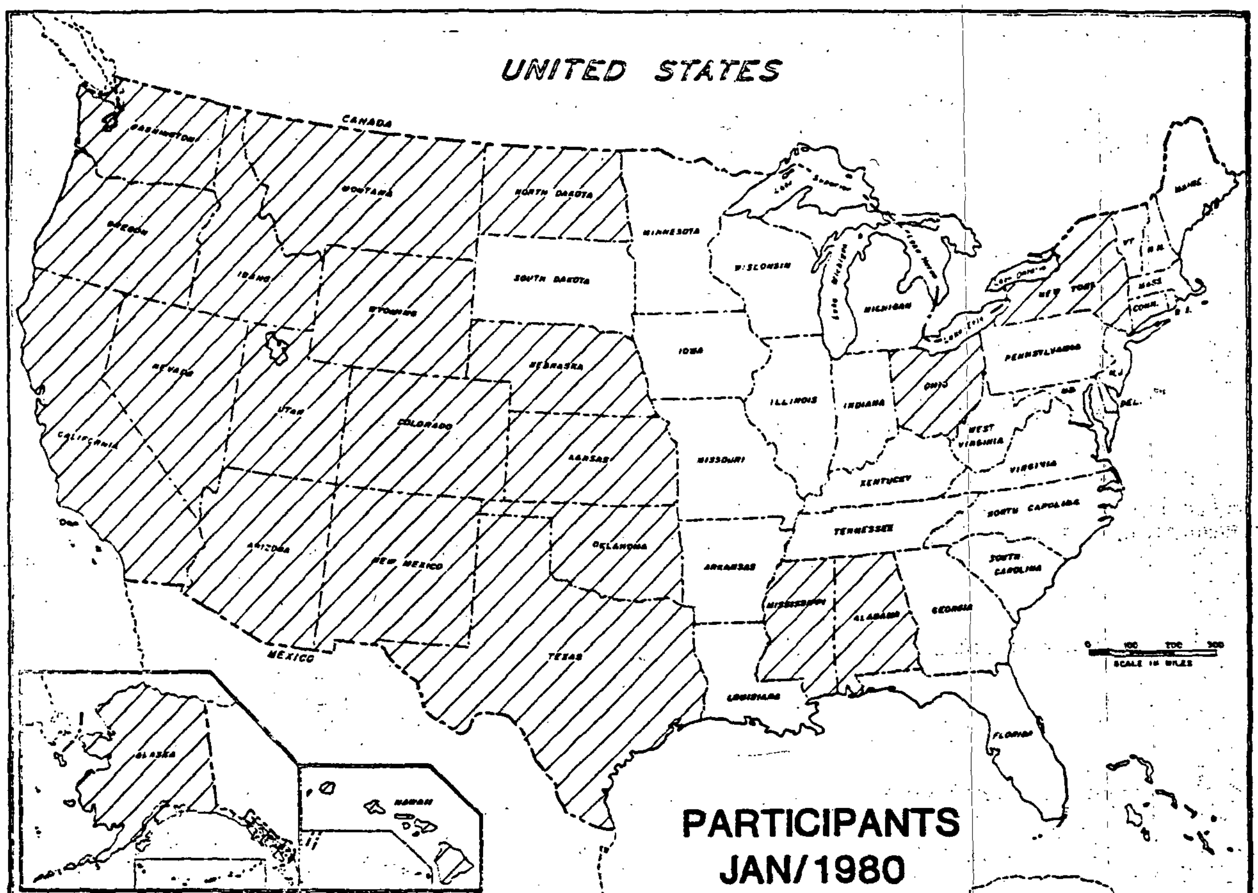
GL00926

1988 State Cooperative Program



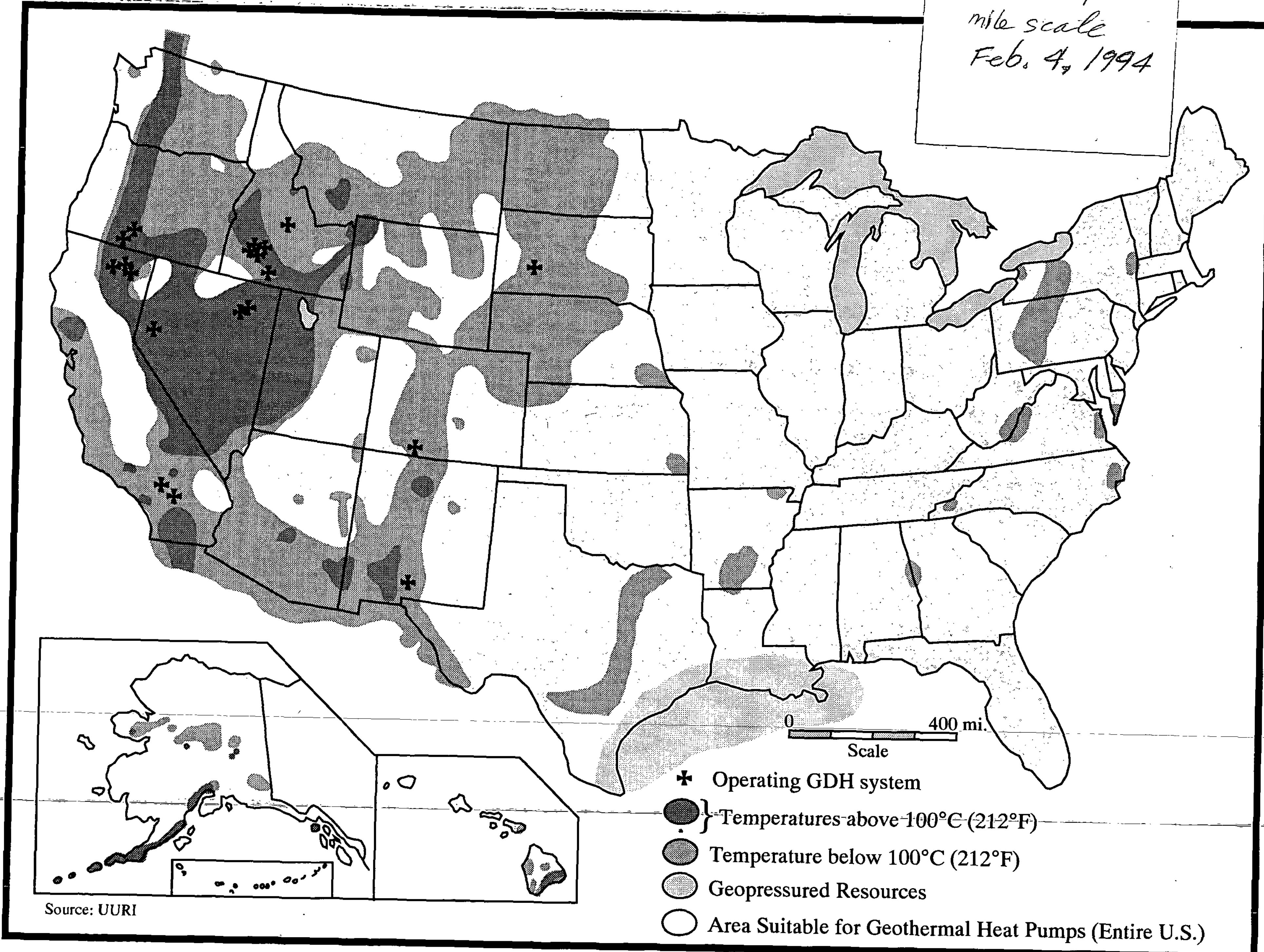
THE STATE COUPLED PROGRAM

LOW-AND MODERATE-TEMPERATURE GEOTHERMAL RESOURCES

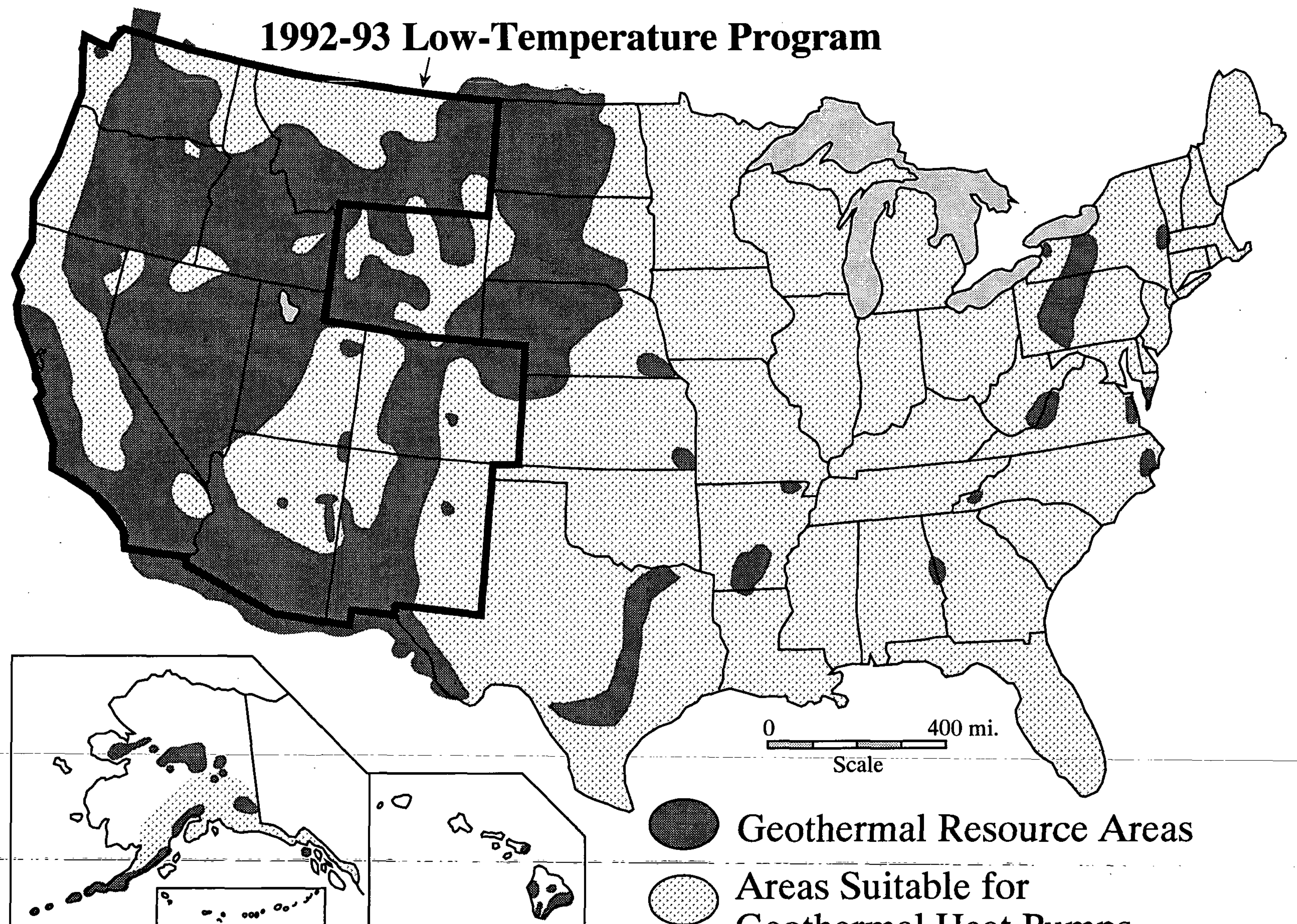


U.S. DEPARTMENT OF ENERGY
DIVISION OF GEOTHERMAL ENERGY

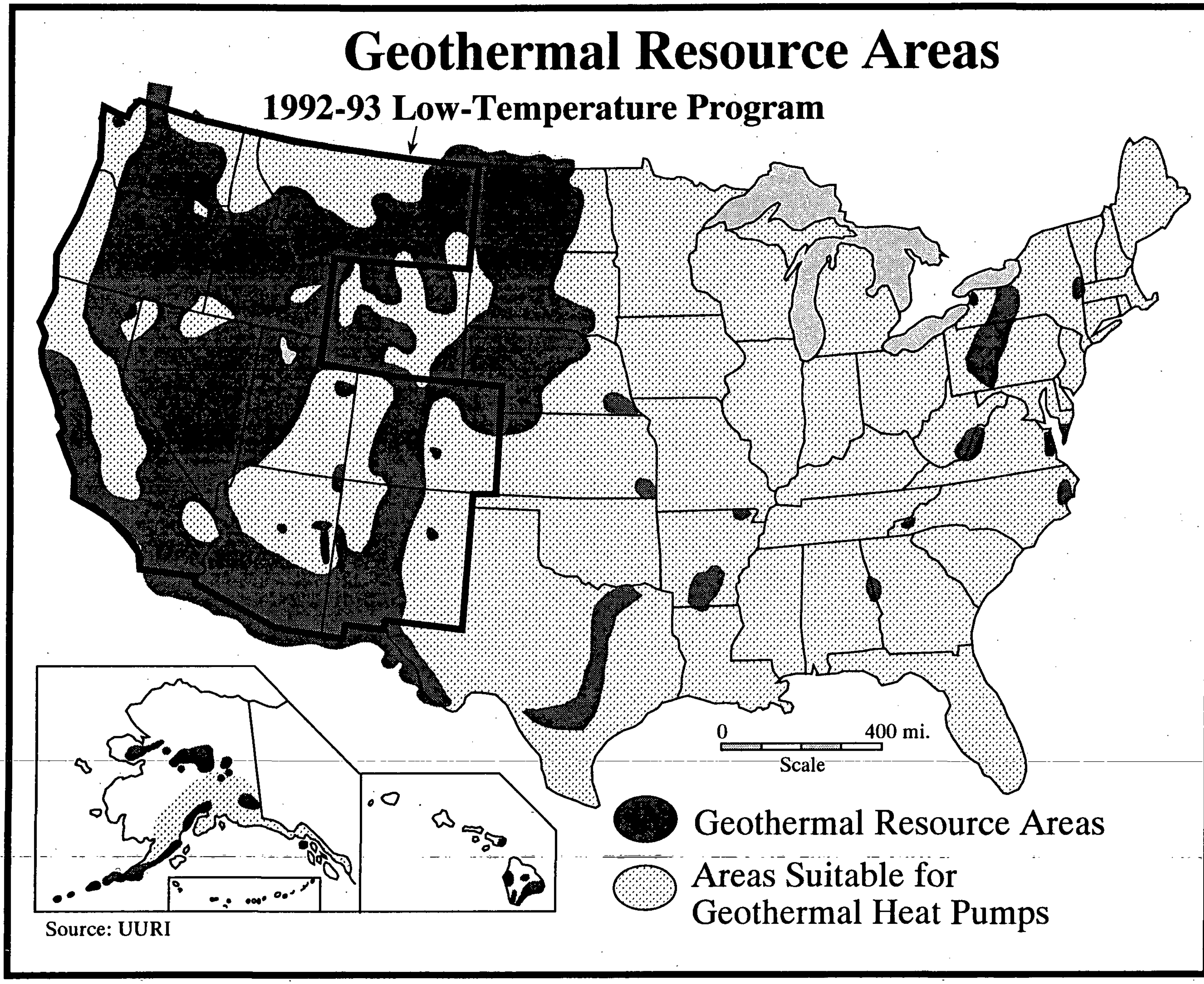
Corrected
mile scale
Feb. 4, 1994



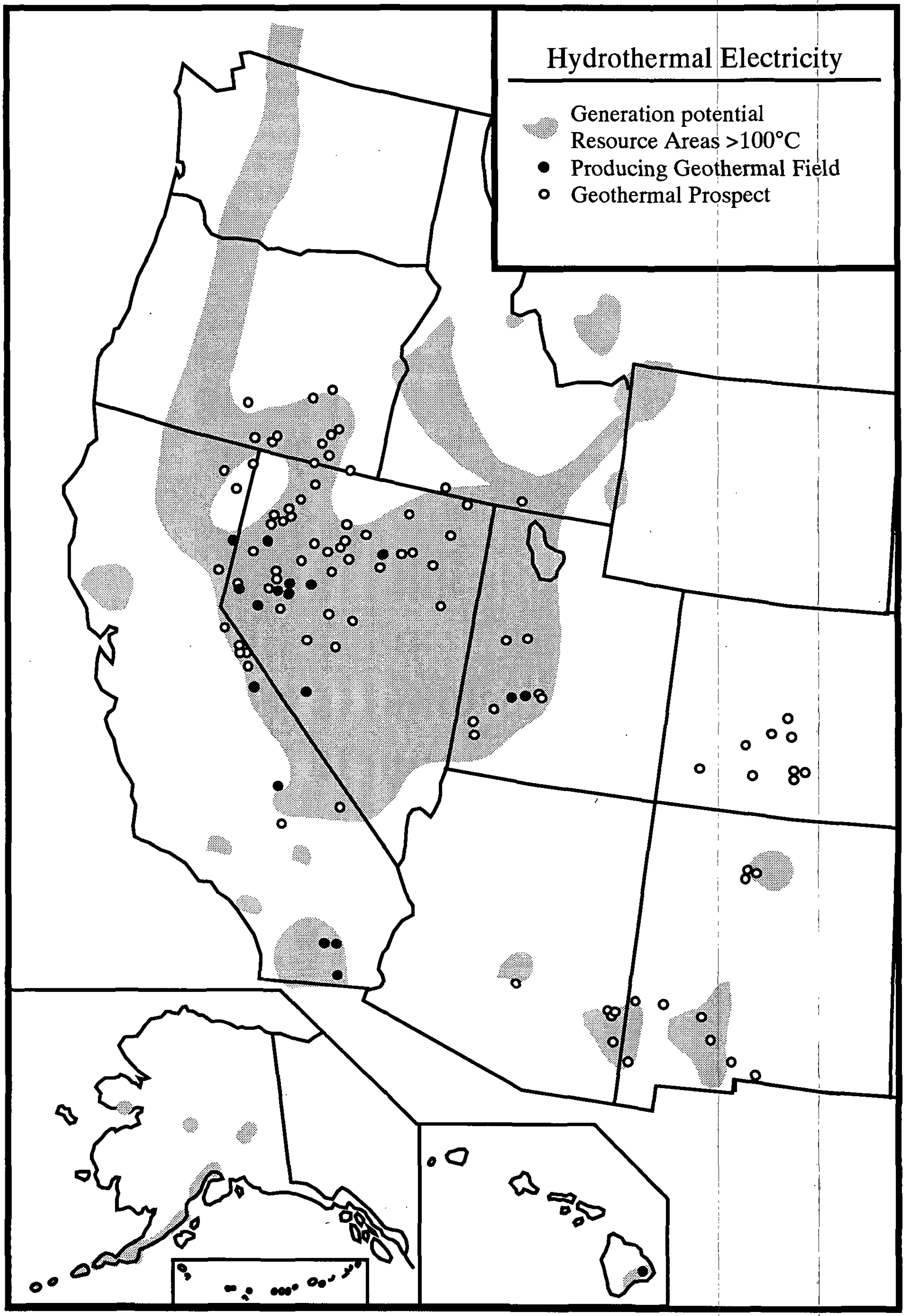
Geothermal Resource Areas



Source: UURI

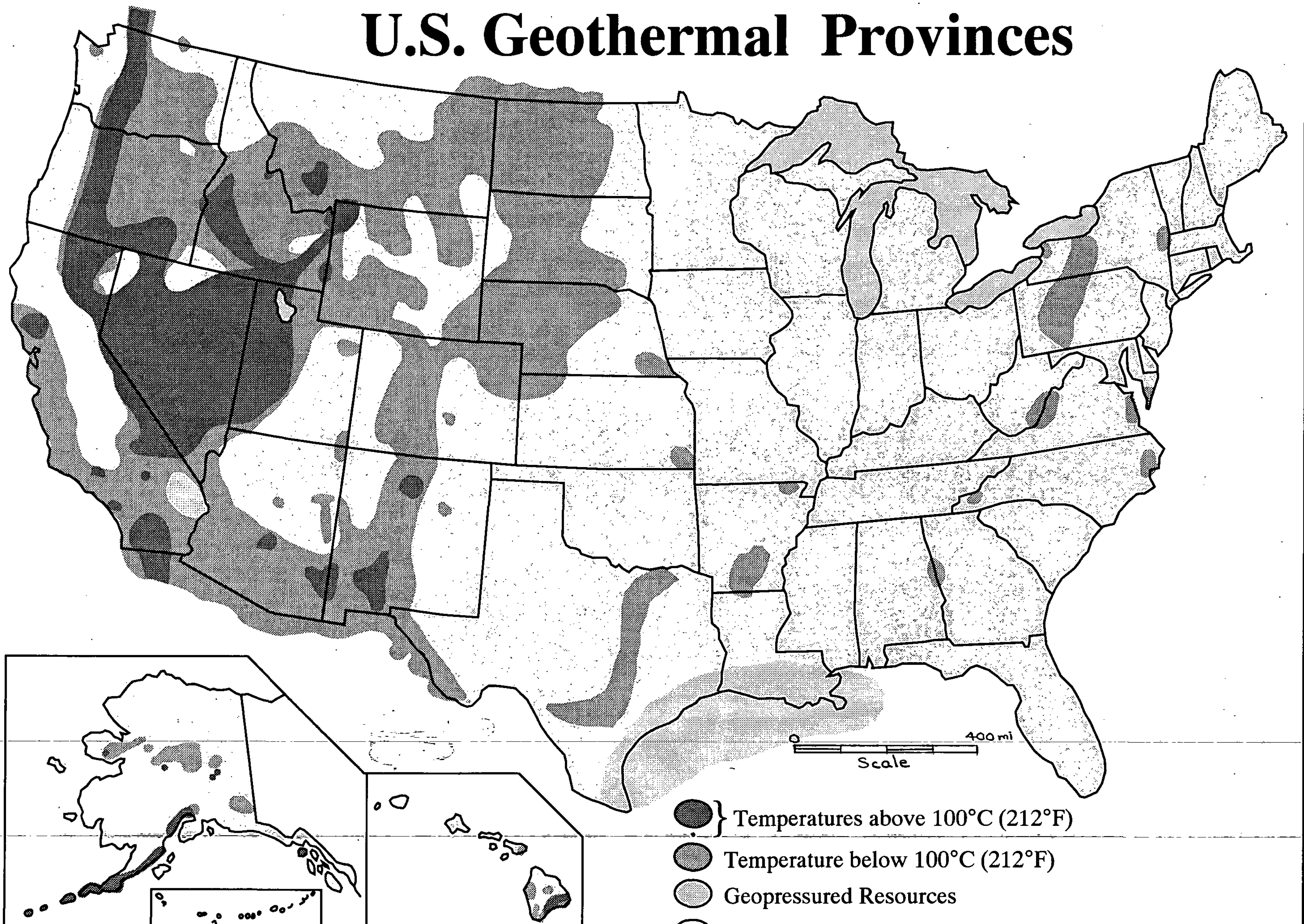


Geothermal Resource Areas
1992-93 Low-Temperature Program
0
400 mi.
Scale
Geothermal Resource Areas
Areas Suitable for
Geothermal Heat Pumps
Source: UURI


Hydrothermal Electricity
Generation potential
Resource Areas >100°C
Producing Geothermal Field
Geothermal Prospect

10/14/93

U.S. Geothermal Provinces



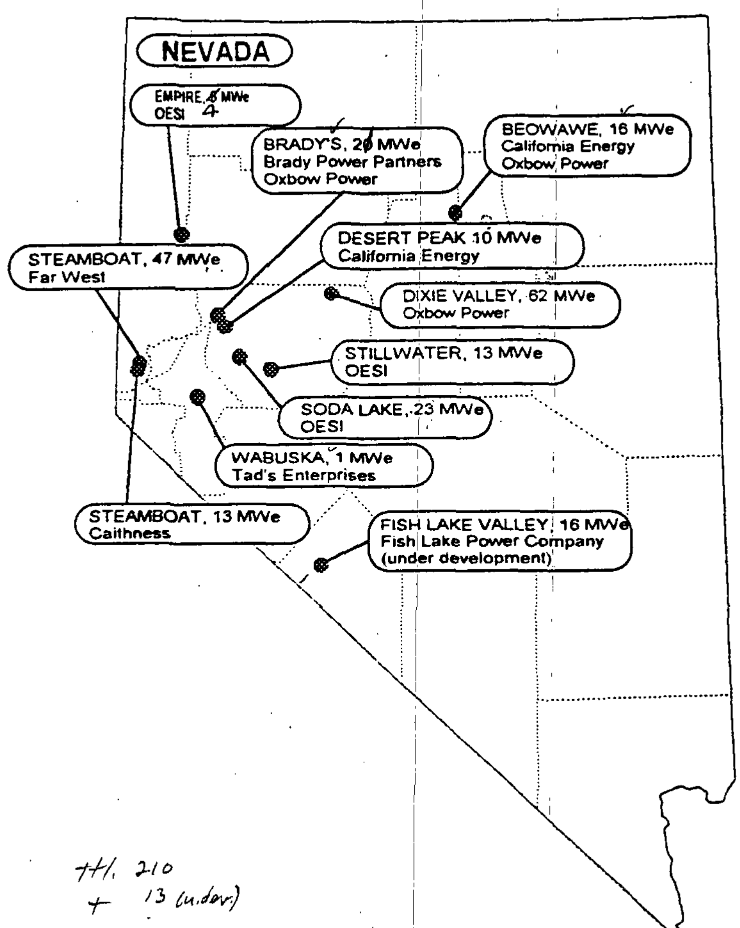
Source: UURI

DRAFT

COMPARATIVE ECONOMICS AND BENEFITS OF ELECTRICITY PRODUCED FROM GEOTHERMAL RESOURCES IN THE STATE OF NEVADA

1994

UNLV



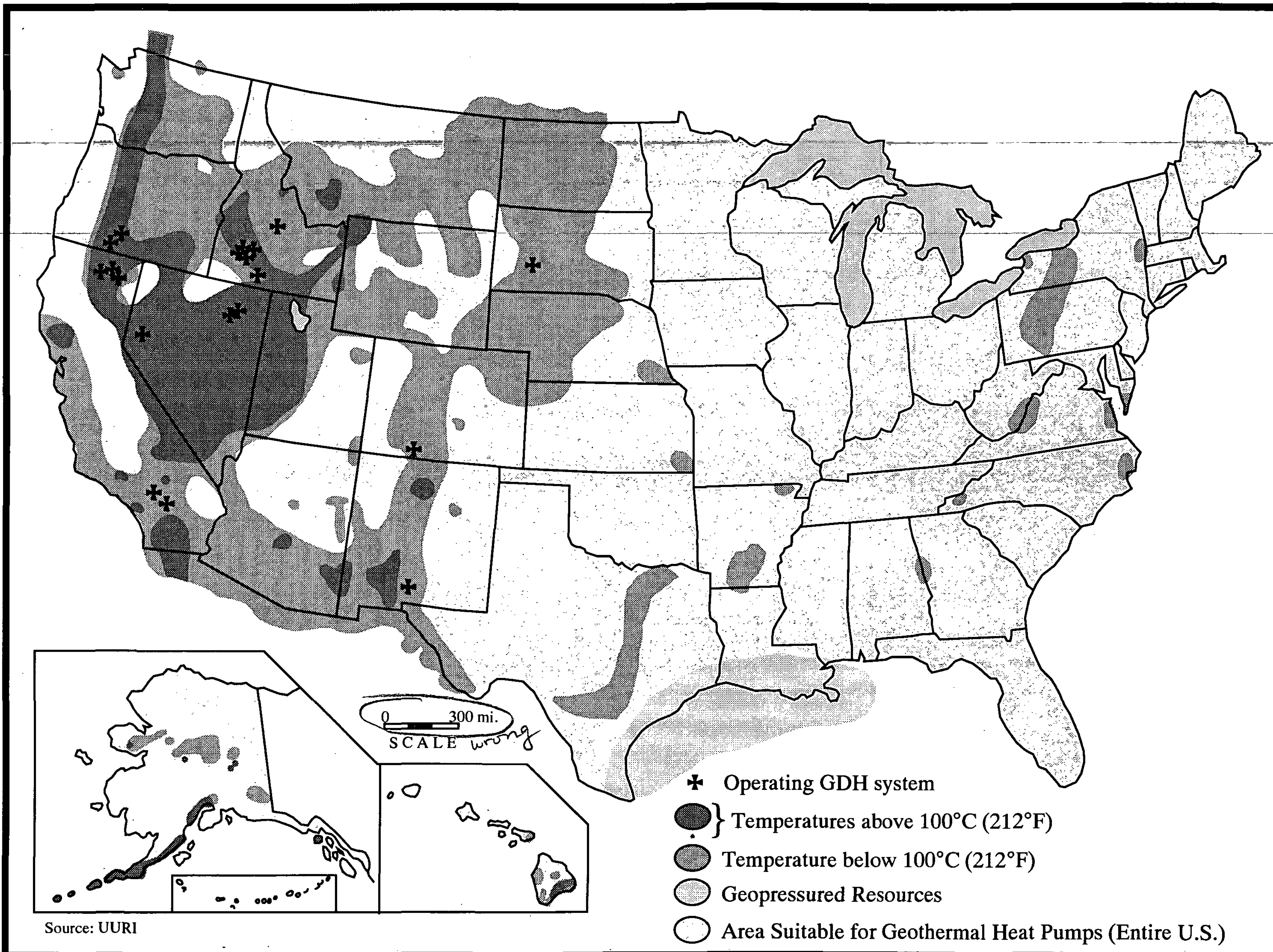
Prepared by:

Division of Earth Sciences
Harry Reid Center for Environmental Studies
University of Nevada Las Vegas

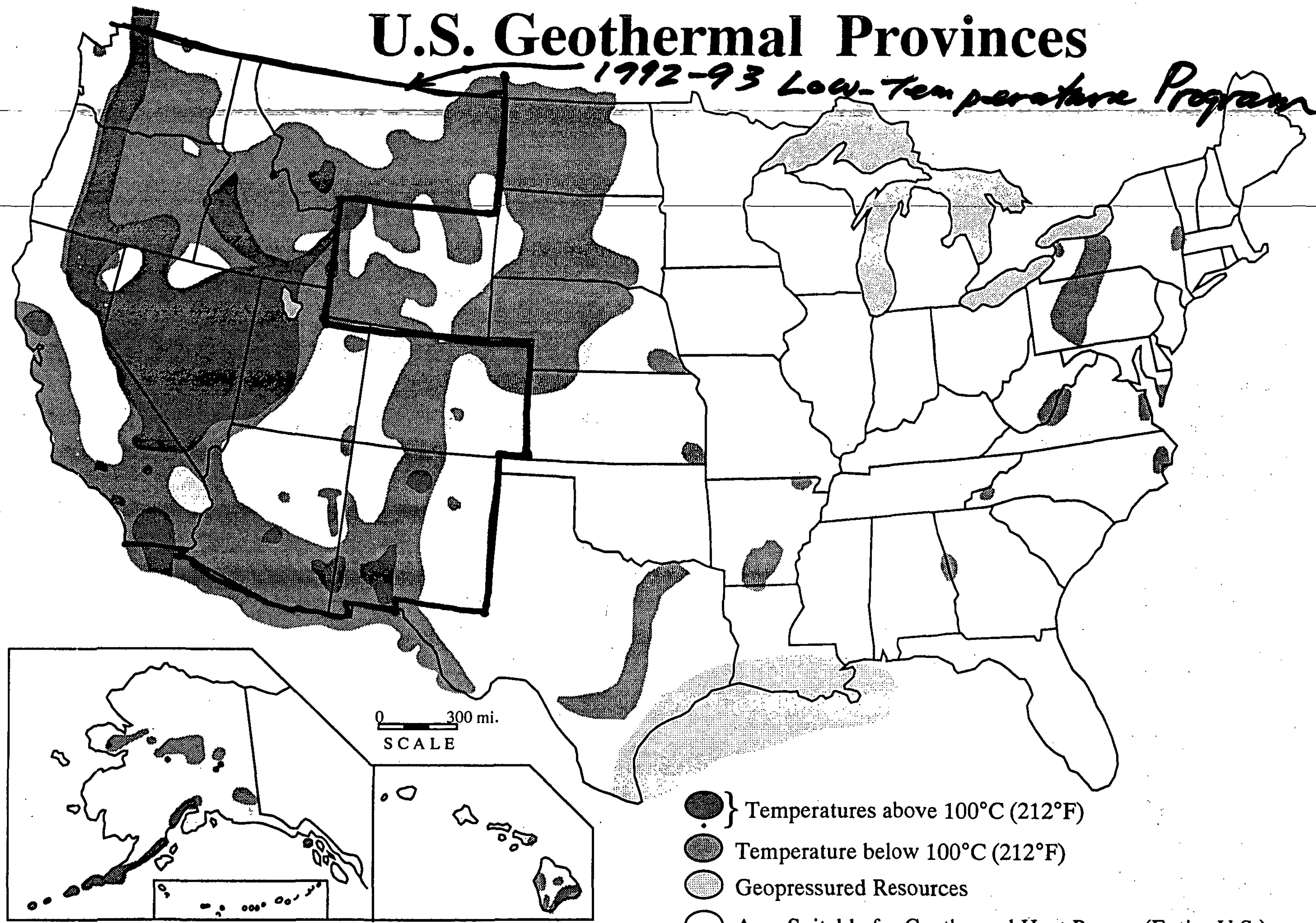
Prepared for:

The Geothermal Energy Association

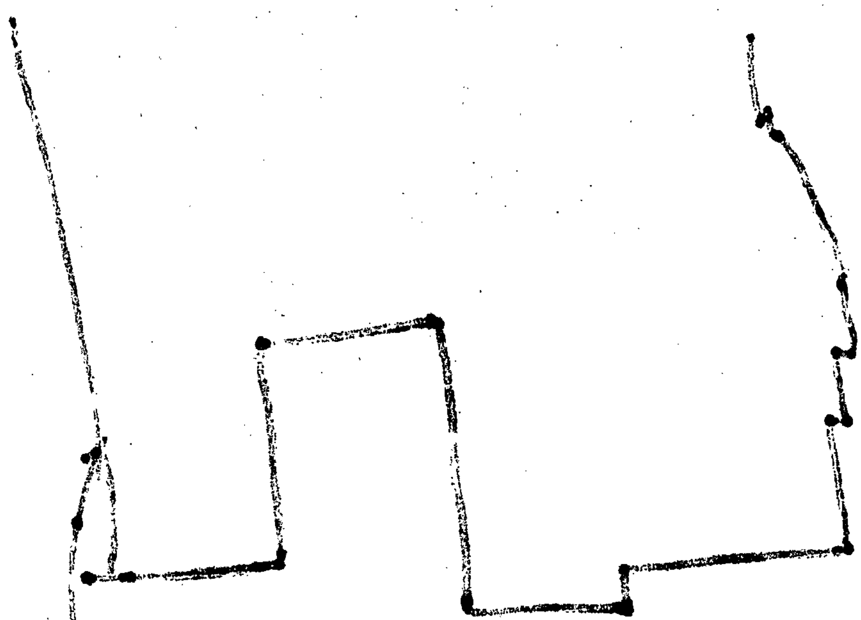
January, 1995

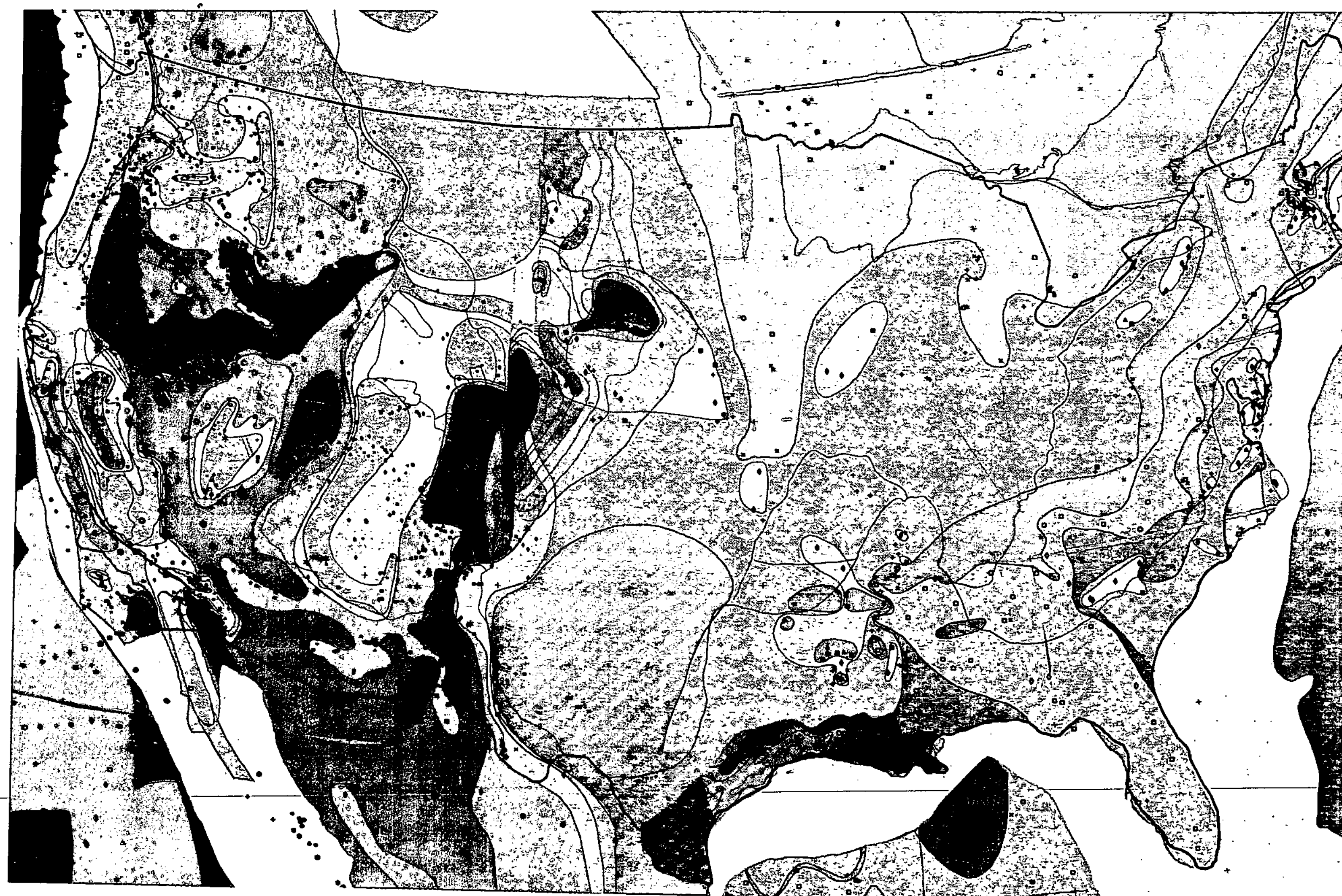

0 300 mi.
SCALE wrong
Operating GDH system
Temperatures above 100°C (212°F)
Temperature below 100°C (212°F)
Geopressured Resources
Area Suitable for Geothermal Heat Pumps (Entire U.S.)
Source: UURI

U.S. Geothermal Provinces



Source: UURI

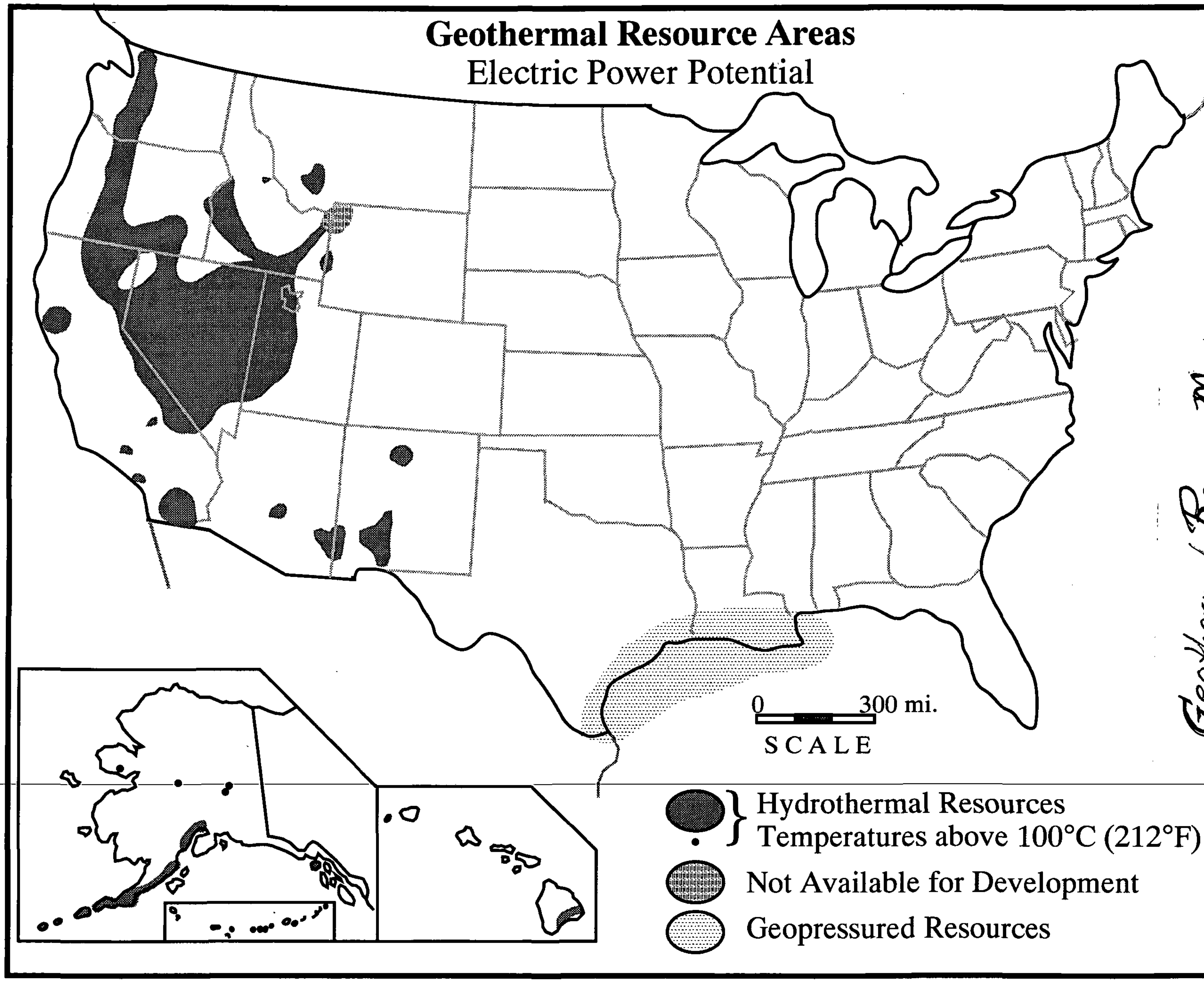




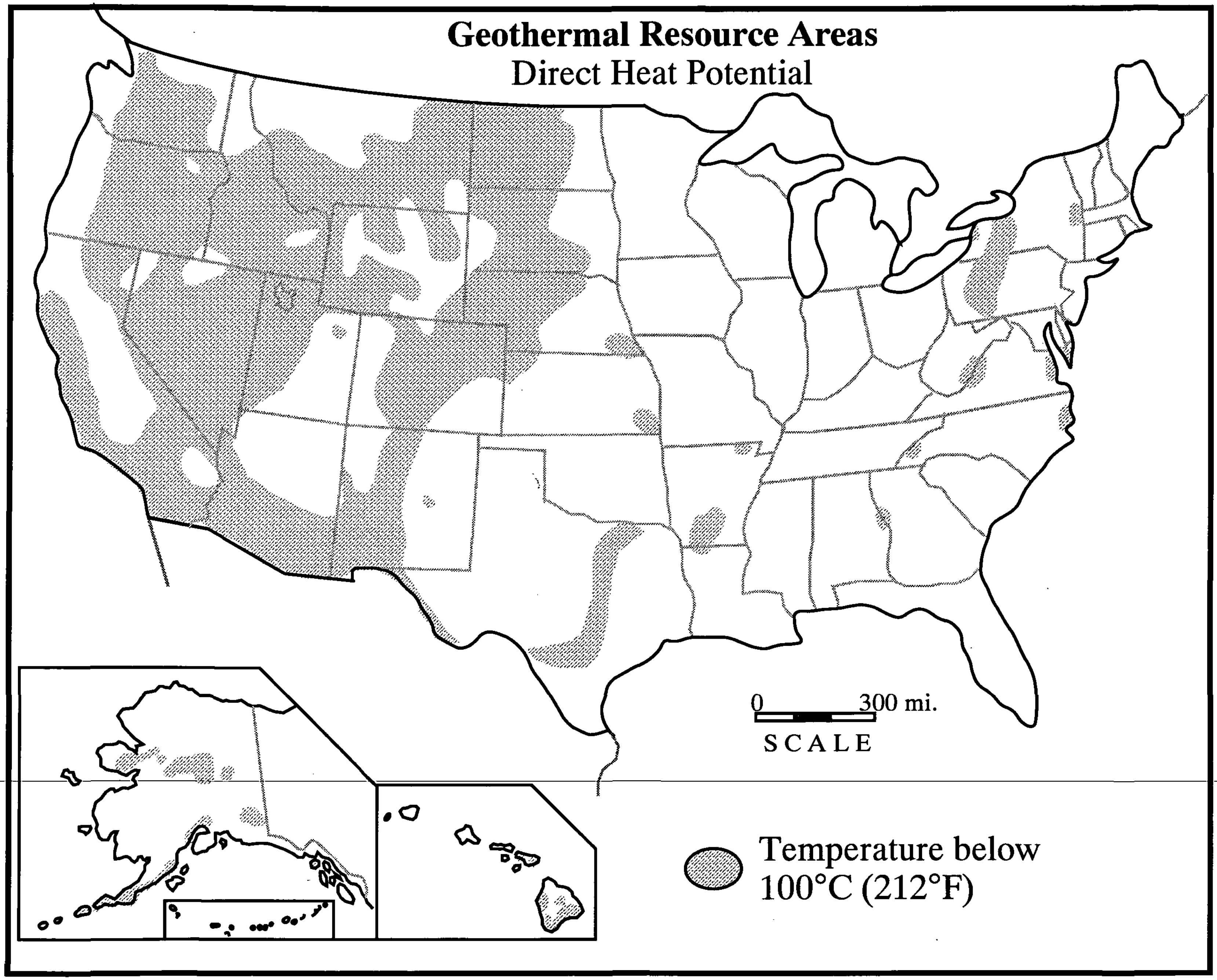
Draft copy of Blackwell's "Geothermal Map of North America" for GSA Decad of N A Geology" This was about 1988 —No color code received!

Draft copy of [illegible]
"Geological Map of [illegible]"
[illegible]
[illegible]
[illegible] 1988
[illegible]

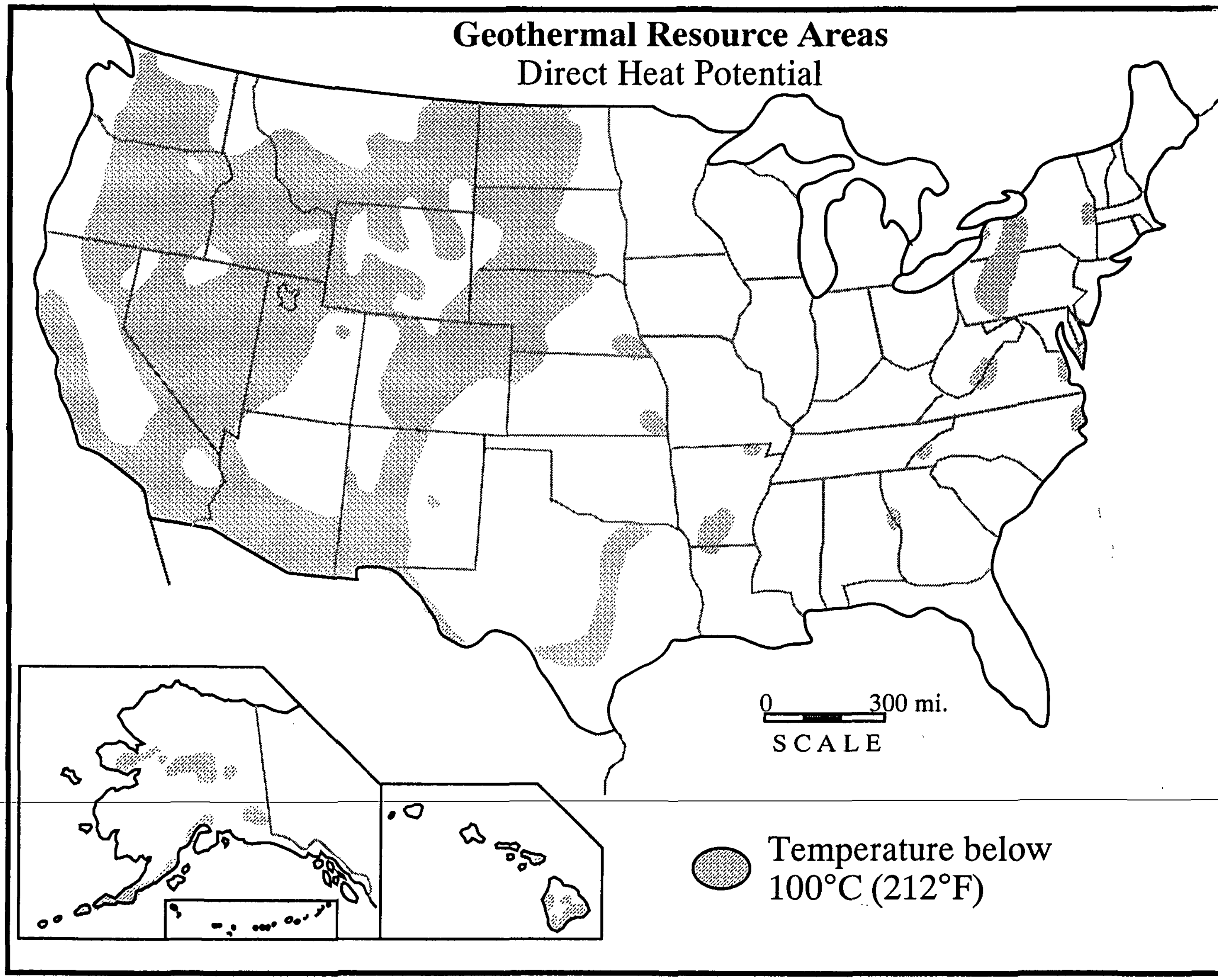
East Aurora
Cayuga Lake
Theresa Fm

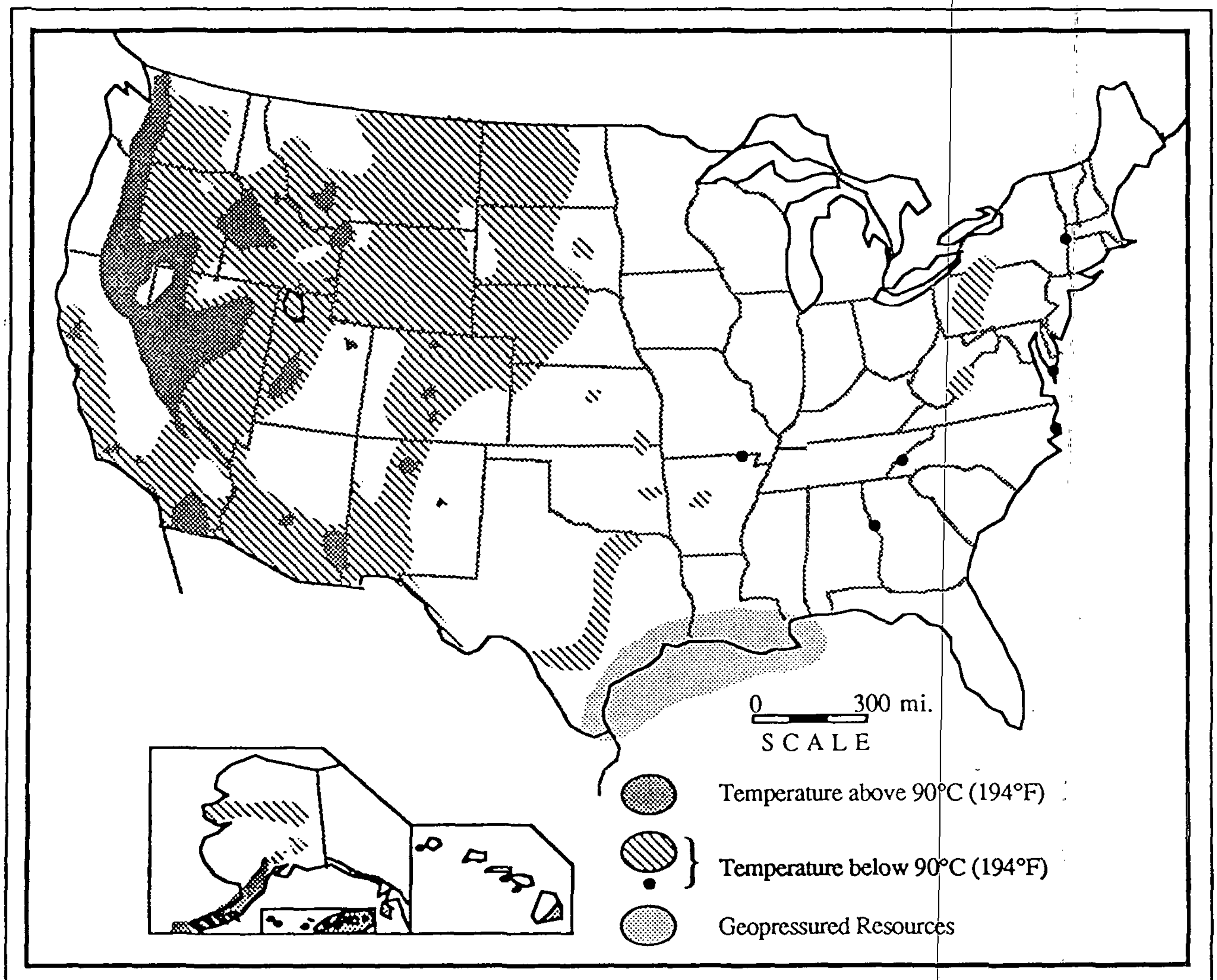


Geothermal Resource Maps
for Dave Lombard
DOE
for: presentation to DOE -



Geothermal Resource Areas
Direct Heat Potential
0 300 mi.
SCALE
Temperature below
100°C (212°F)


Geothermal Resource Areas
Direct Heat Potential
0 300 mi.
SCALE
Temperature below
100°C (212°F)


0 300 mi.
SCALE
Temperature above 90°C (194°F)
Temperature below 90°C (194°F)
Geopressured Resources

Gosnold, JGR, Jan. 1990

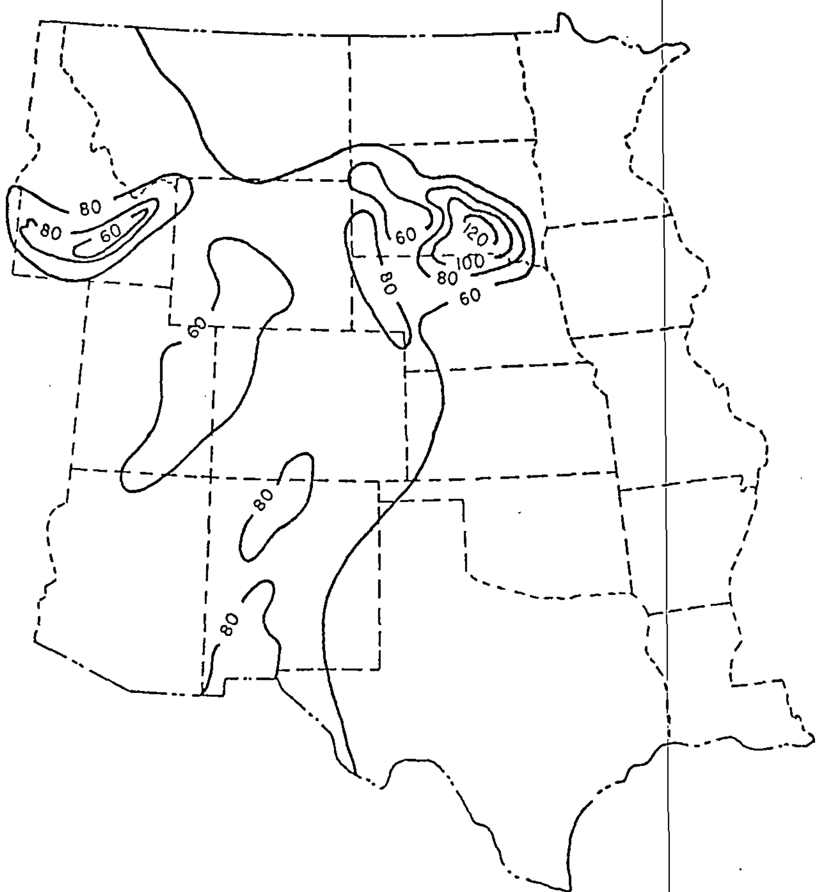


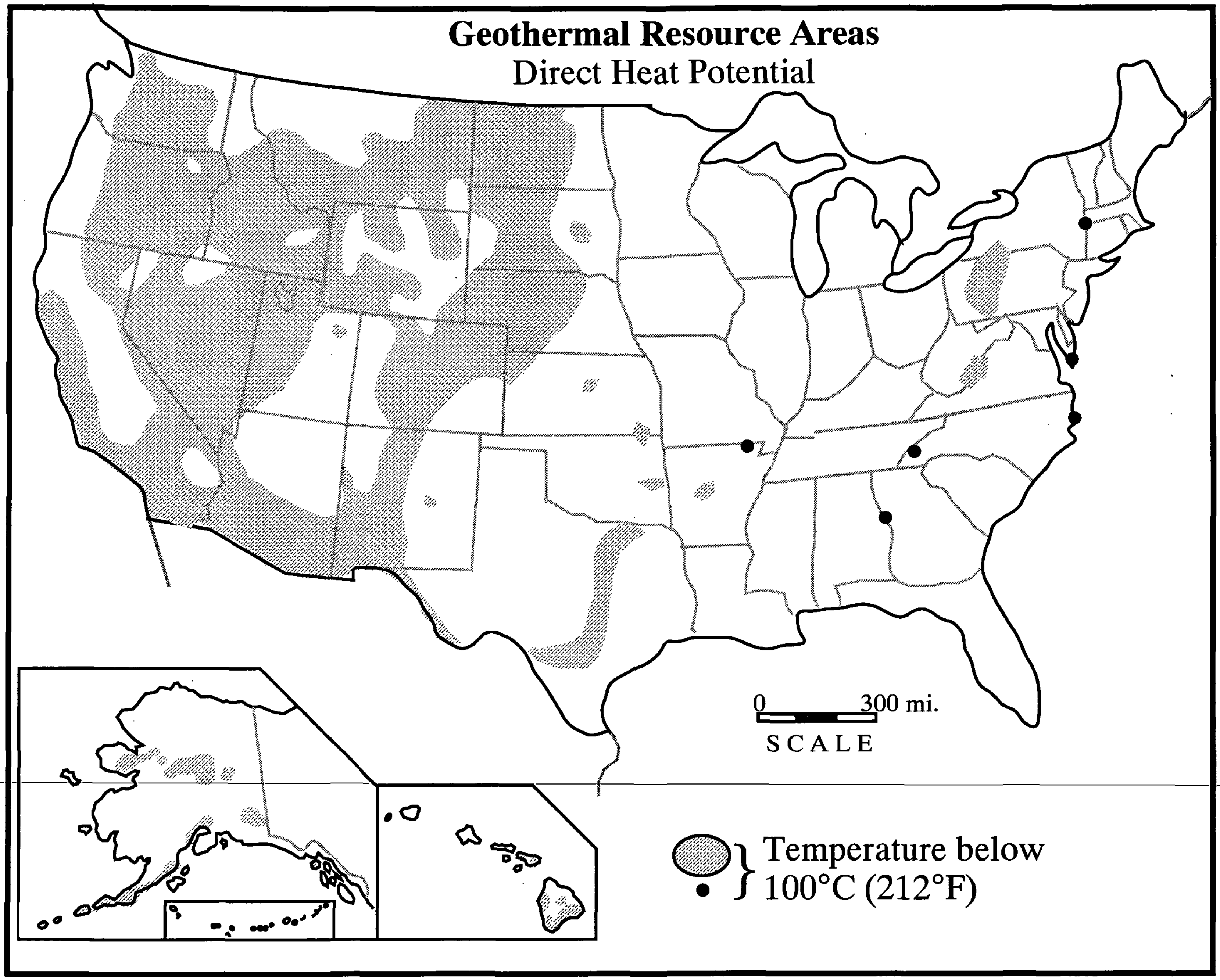
Fig. 12. Heat flow contour map of the central United States modified from Sass et al. [1981]. The high heat flow areas in the Great Plains are due to groundwater flow where deep regional aquifers discharge in several ways including subcrop contacts, outcrops, and cross-formational flow into stream systems.

the interpretation of Swanberg and Morgan [1979] that the silica data represent the recent thermal history of waters that have circulated to a depth of the order of about 2 km. A key conclusion from the results of this study is that the theoretical arguments for normal continental heat flow in the Great Plains Province seem justified.

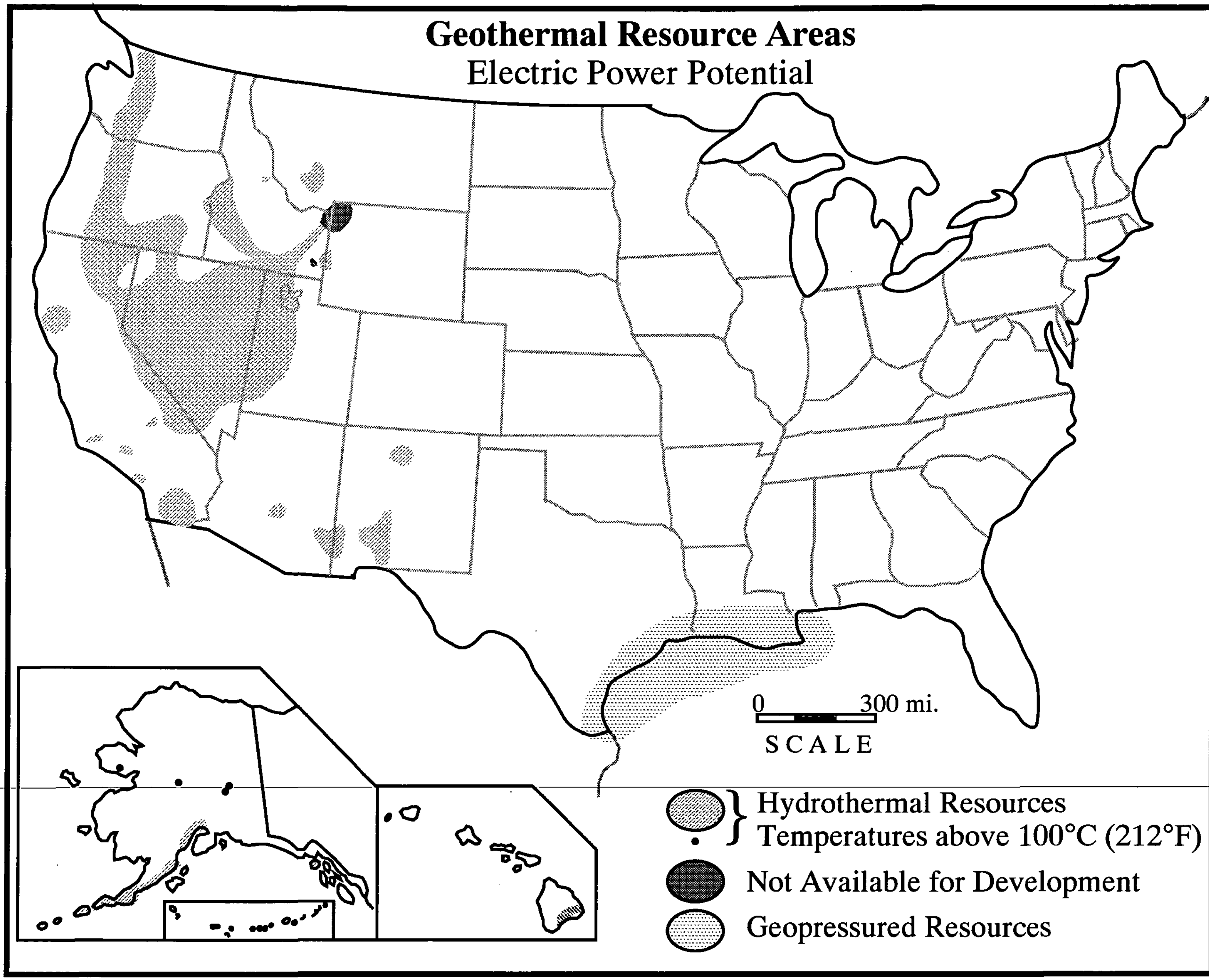
Heat flow determinations based on temperature gradients measured solely in shales or in using interval heat flow calculations for shale sections is a continuing problem. In this study it was assumed that for all but one heat flow site, Burton, Nebraska, heat flow is constant for the length of the hole. However, Majorowicz et al. [1986] assumed set values for effective thermal conductivities in predominantly shale sections (Cenozoic and Mesozoic) and predominantly carbonate sections (Paleozoic) in Saskatchewan and Manitoba and concluded that heat flows are distinctly different in the two different rock types. Although it is argued here that the conductivities used by Majorowicz et al., [1986] are too high, the issue cannot be resolved by comparing assumptions. Resolution of this issue can be achieved only by obtaining heat flow data from holes which yield reliable thermal conductivity measurements. Ultimately, one would prefer to obtain reduced heat flow data to resolve the issue. In light of the results of this investigation, it is suggested that interpretations of the thermal structure of the crust based on heat flow contour maps should be used cautiously in other geological or geophysical investigations.

The possible effects of long-duration advective heat flow systems include crustal thickening and thinning and local to regional uplift and subsistence of the order of several hundred meters.

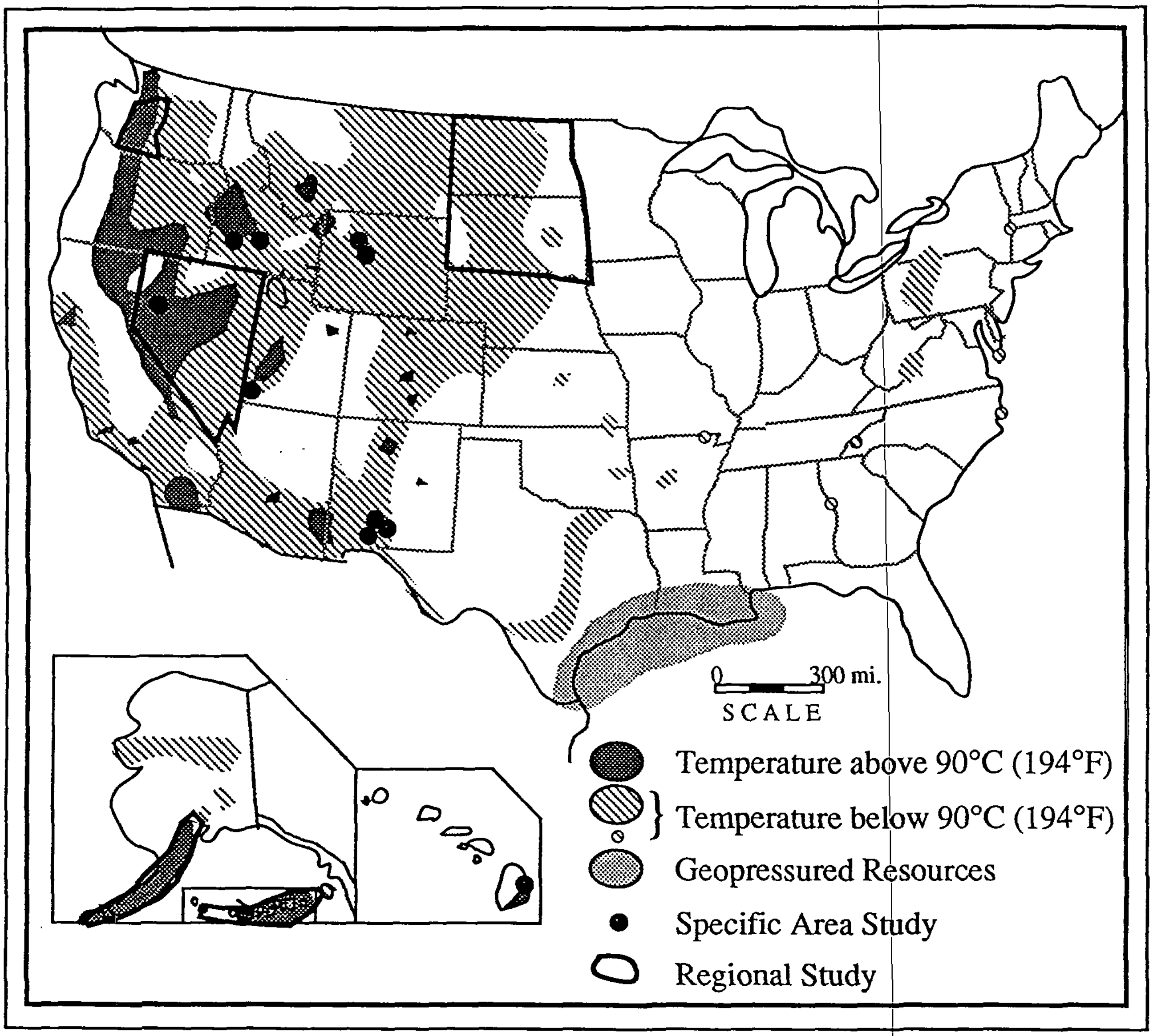
GEOTHERMAL RESOURCES
modified from USGS Circulars 790 & 892
CANADA
MEXICO
Meager Creek
WASHINGTON
OREGON
Newberry
Klamath Falls
Boise
IDAHO
Raft River
Medicine Lake
Lassen
The Geysers
Steamboat Springs
Desert Peak
Beowawe
NEVADA
Long Valley
CALIFORNIA
Coso
Imperial Valley
Cerro Prieto
UTAH
Cove Fort
Roosevelt Hot Springs
ARIZONA
MONTANA
Yellowstone
WYOMING
COLORADO
NEW MEXICO
Valles Caldera
NORTH DAKOTA
SOUTH DAKOTA
Madison Group
NEBRASKA
KANSAS
Nemaha Ridge
Anadarko Basin
OKLAHOMA
TEXAS
Balcones Zone
MINNESOTA
IOWA
MISSOURI
ARKANSAS
Ouachita Mtns.
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
WEST VIRGINIA
Valley & Ridge Province
MD.
DEL.
Atlantic Coastal Plain
PENNSYLVANIA
Appalachian Basin
N.J.
NEW YORK
CONN.
R.I.
MASS.
VT.
N.H.
MAINE
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario
ALASKA
Makushin
Adak
HAWAII
Puna
0 100 200 300
SCALE IN MILES
HYDROTHERMAL CONVECTION SYSTEMS
△ >150° C
○ 90° –150° C
GEOPRESSURED GEOTHERMAL RESOURCES
LOW TEMPERATURE GEOTHERMAL RESOURCES
INFERRED SUBSURFACE GEOTHERMAL RESOURCES OF EASTERN U.S.



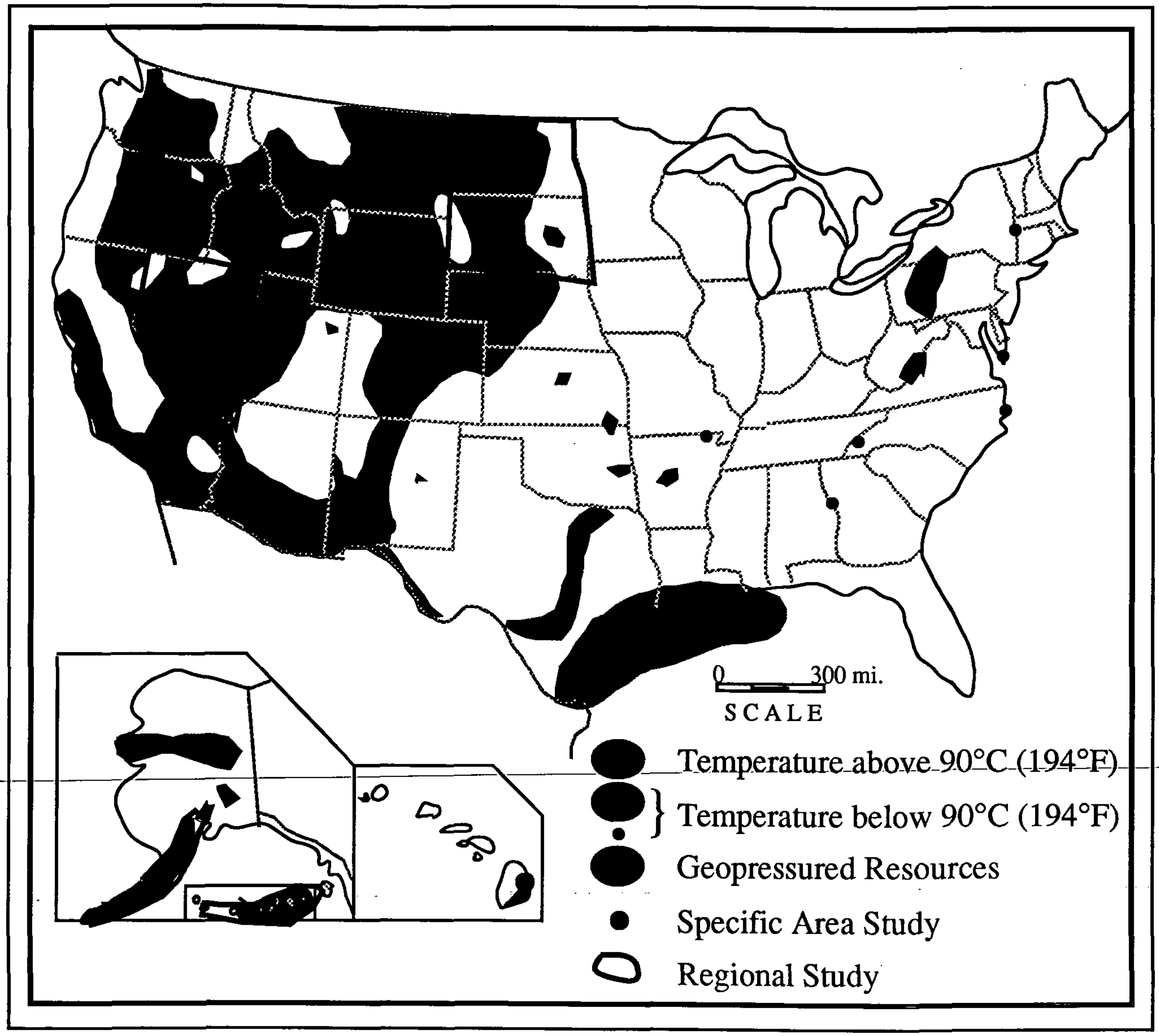
Geothermal Resource Areas
Direct Heat Potential
0
300 mi.
SCALE
Temperature below
100°C (212°F)


Geothermal Resource Areas
Electric Power Potential
0 300 mi.
SCALE
Hydrothermal Resources
Temperatures above 100°C (212°F)
Not Available for Development
Geopressured Resources

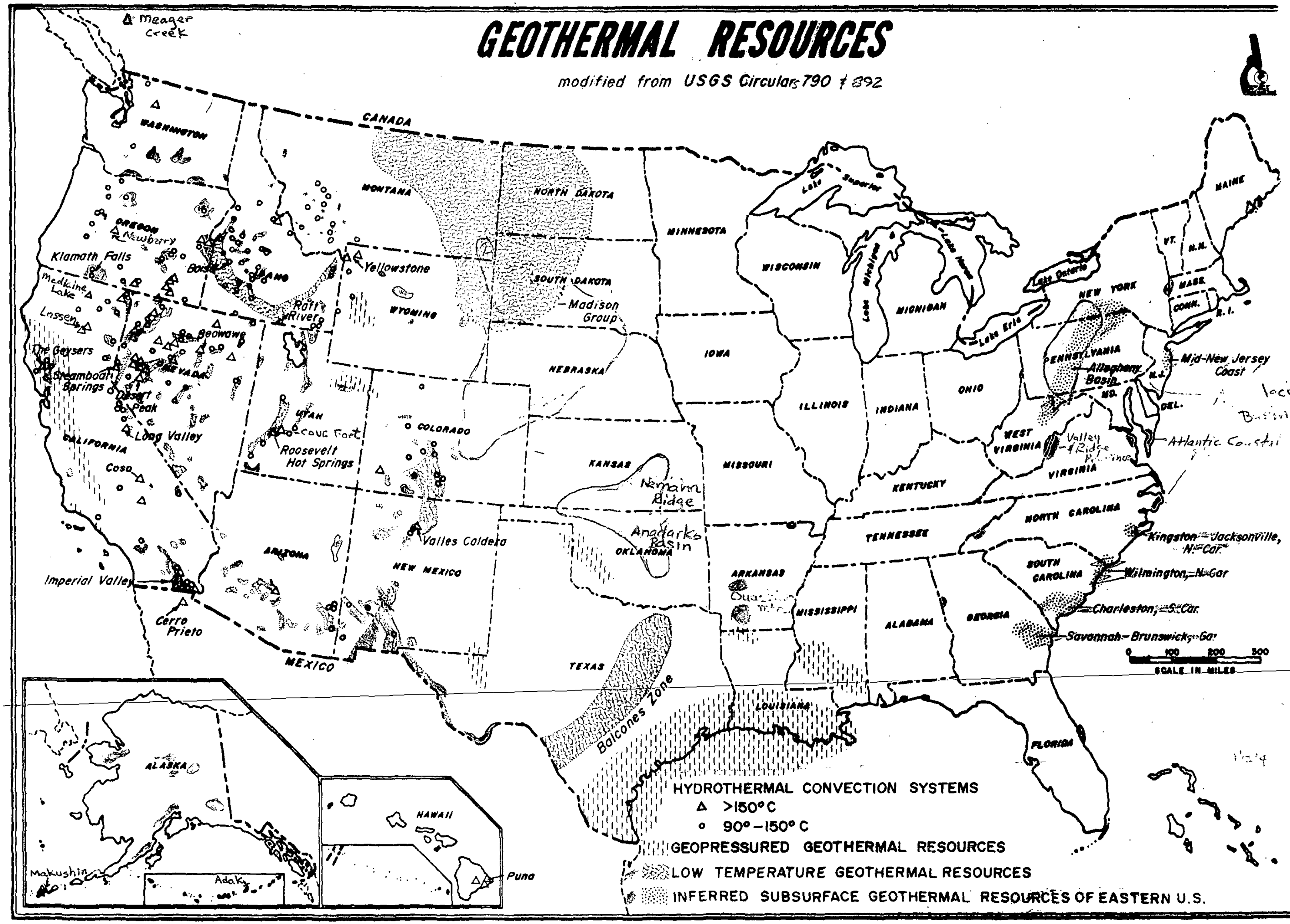
1988 State Cooperative Program



1988 State Cooperative Program



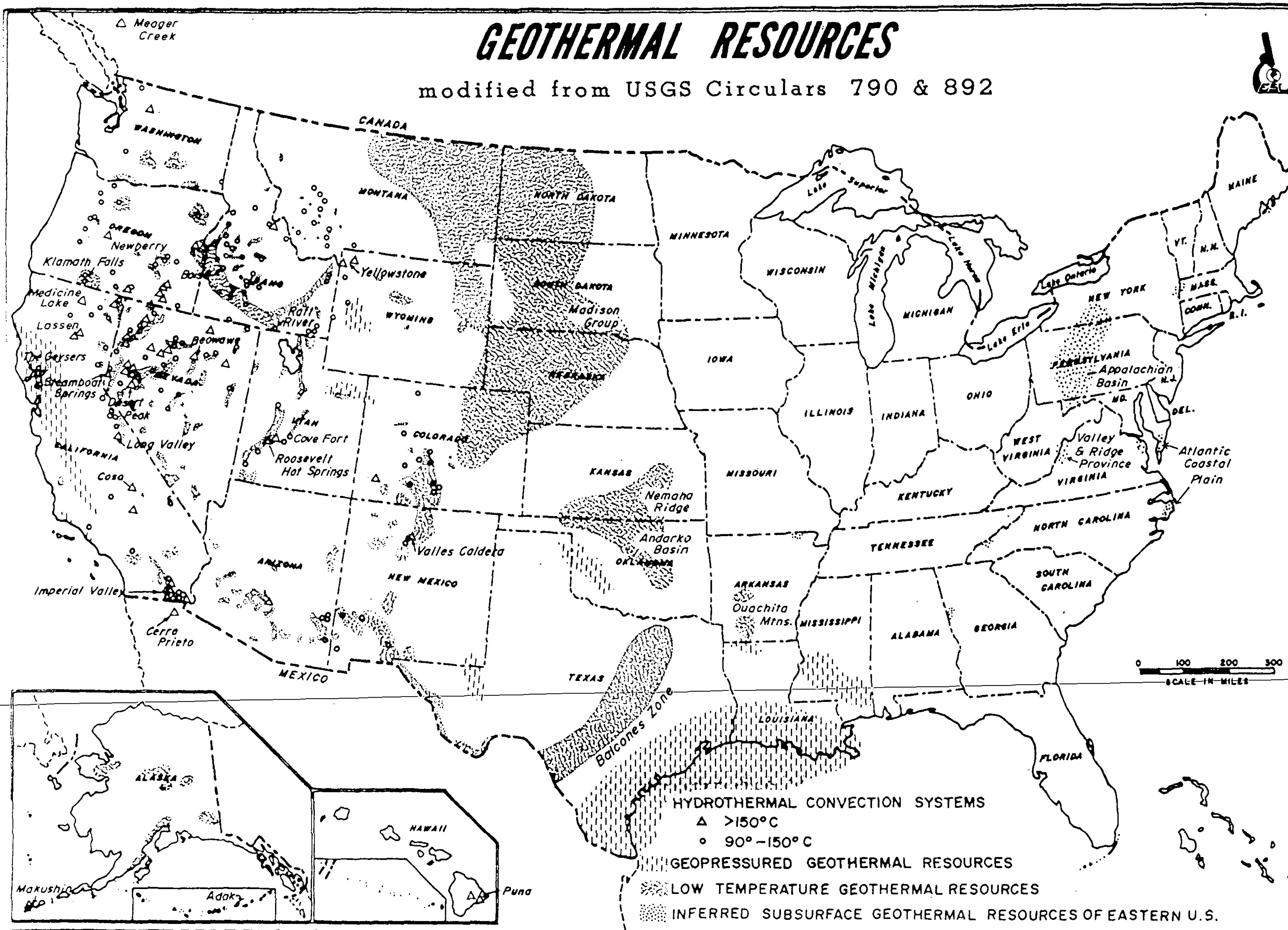
changes for
12-4-86



Geo/RM-003

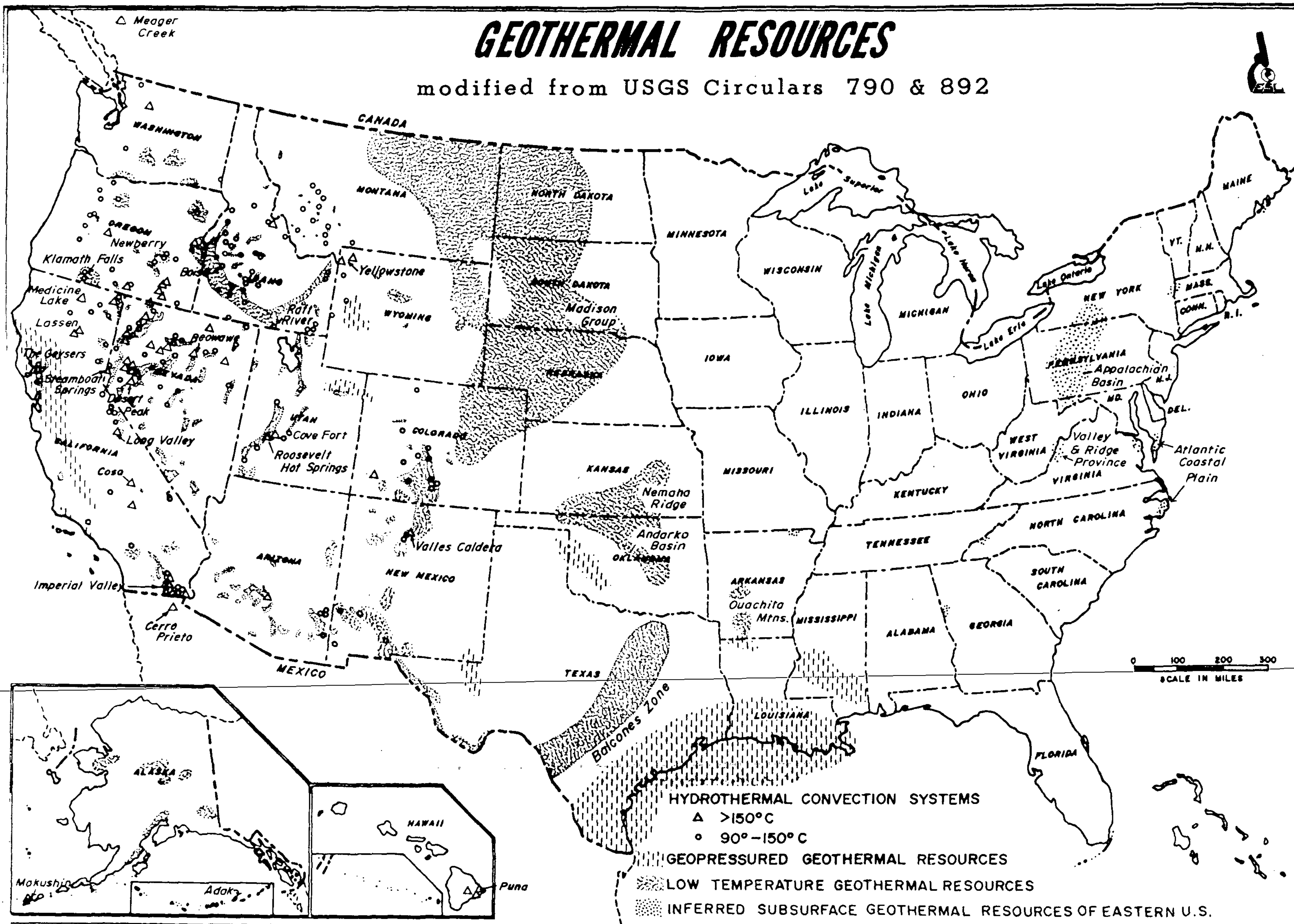
GEOTHERMAL RESOURCES

modified from USGS Circulars 790 & 892



GEOTHERMAL RESOURCES

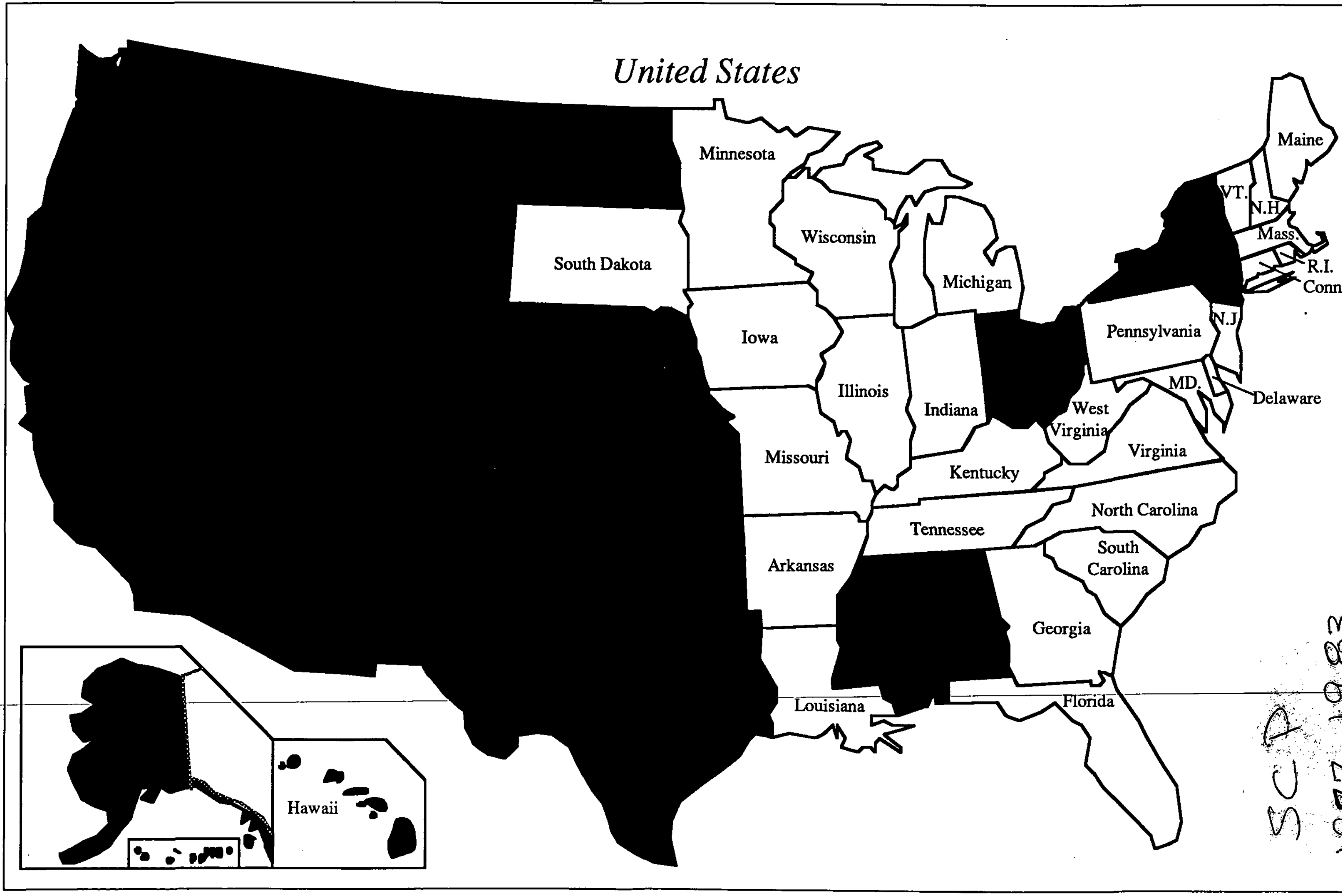
modified from USGS Circulars 790 & 892



Geo/RM-003

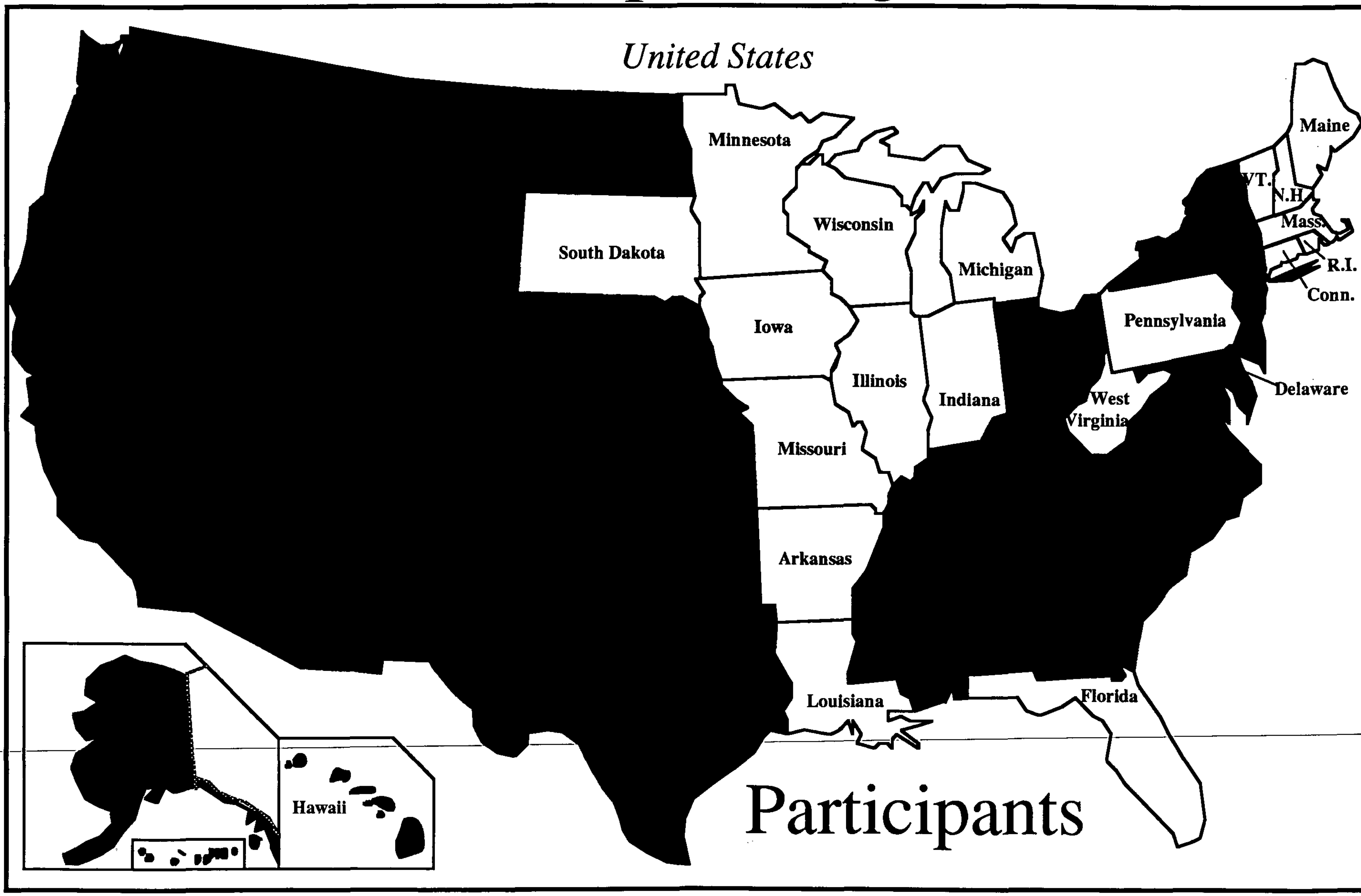
The State Coupled Program

Low-and Moderate-Temperature Geothermal Resources

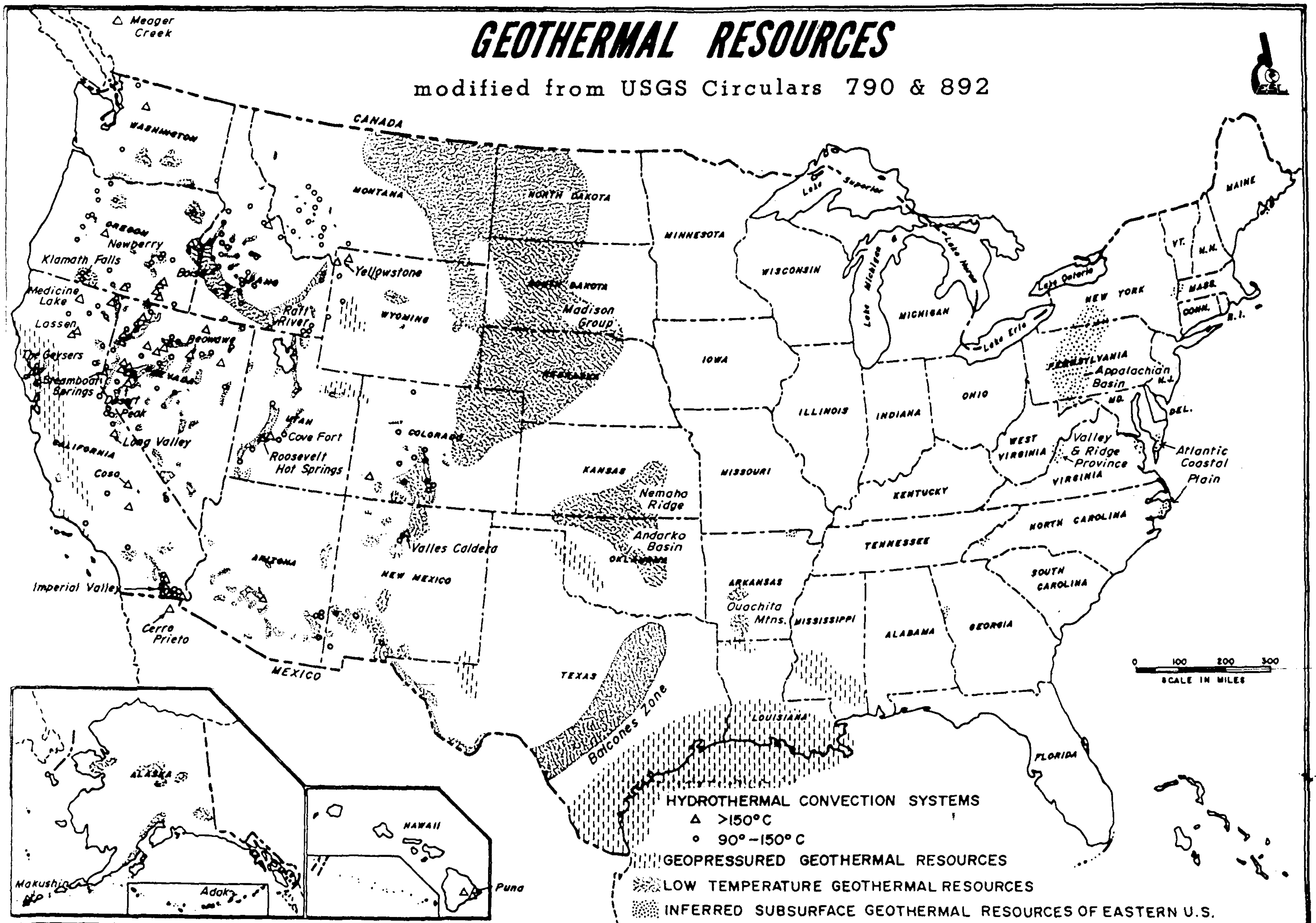


U.S. Department of Energy   Division of Geothermal Energy

State Coupled Program



Individual State Contracts
University Contracts covering several states


GEOTHERMAL RESOURCES
modified from USGS Circulars 790 & 892
Meager Creek
CANADA
WASHINGTON
OREGON
Newberry
Klamath Falls
Medicine Lake
Lassen
The Geysers
Steamboat Springs
Long Valley
CALIFORNIA
Coso
Imperial Valley
Cerro Prieto
Boise
IDAHO
Raft River
NEVADA
Beowawe
UTAH
Cove Fort
Roosevelt Hot Springs
ARIZONA
MEXICO
MONTANA
Yellowstone
WYOMING
COLORADO
NEW MEXICO
Valles Caldera
NORTH DAKOTA
SOUTH DAKOTA
Madison Group
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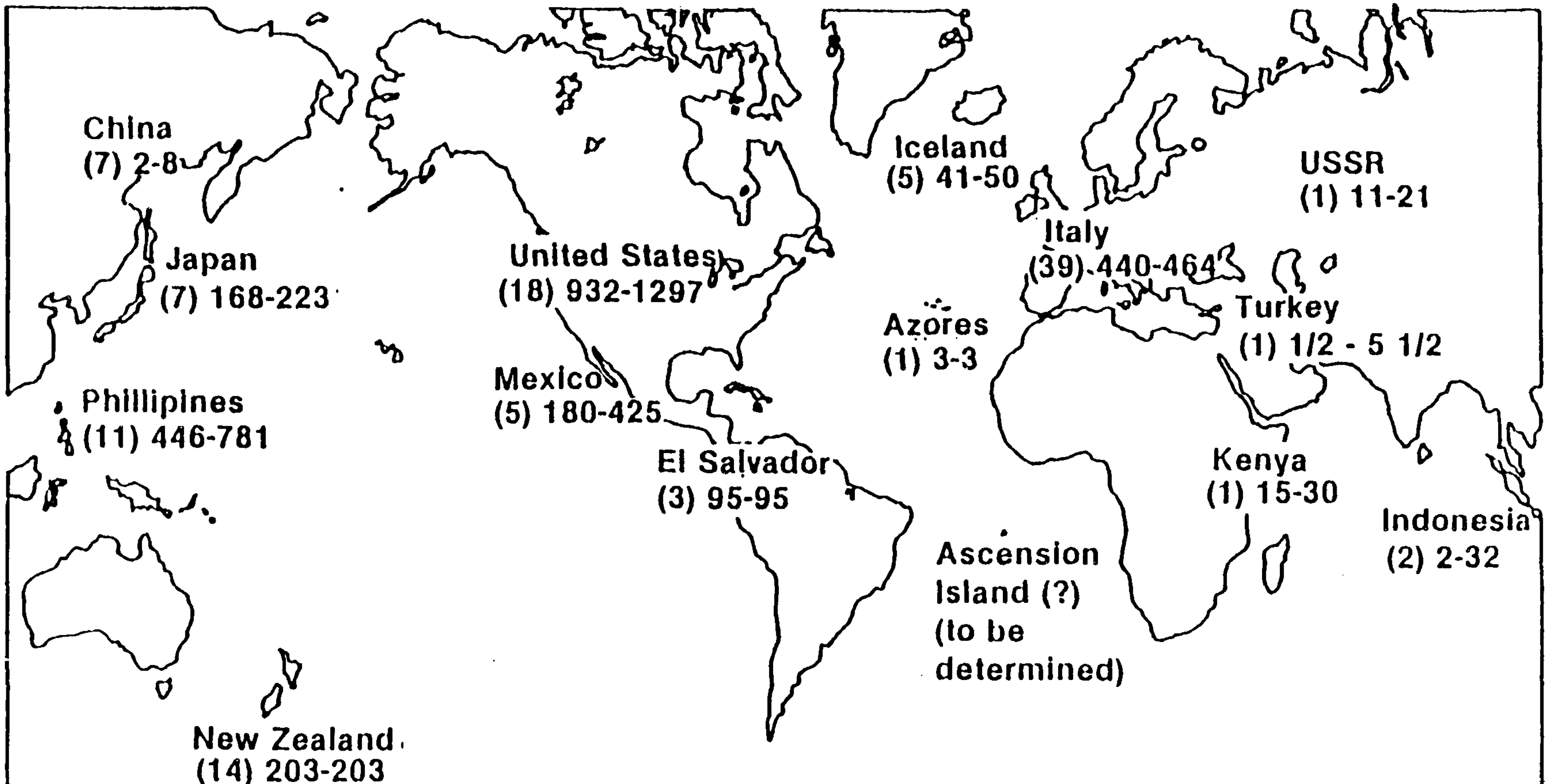
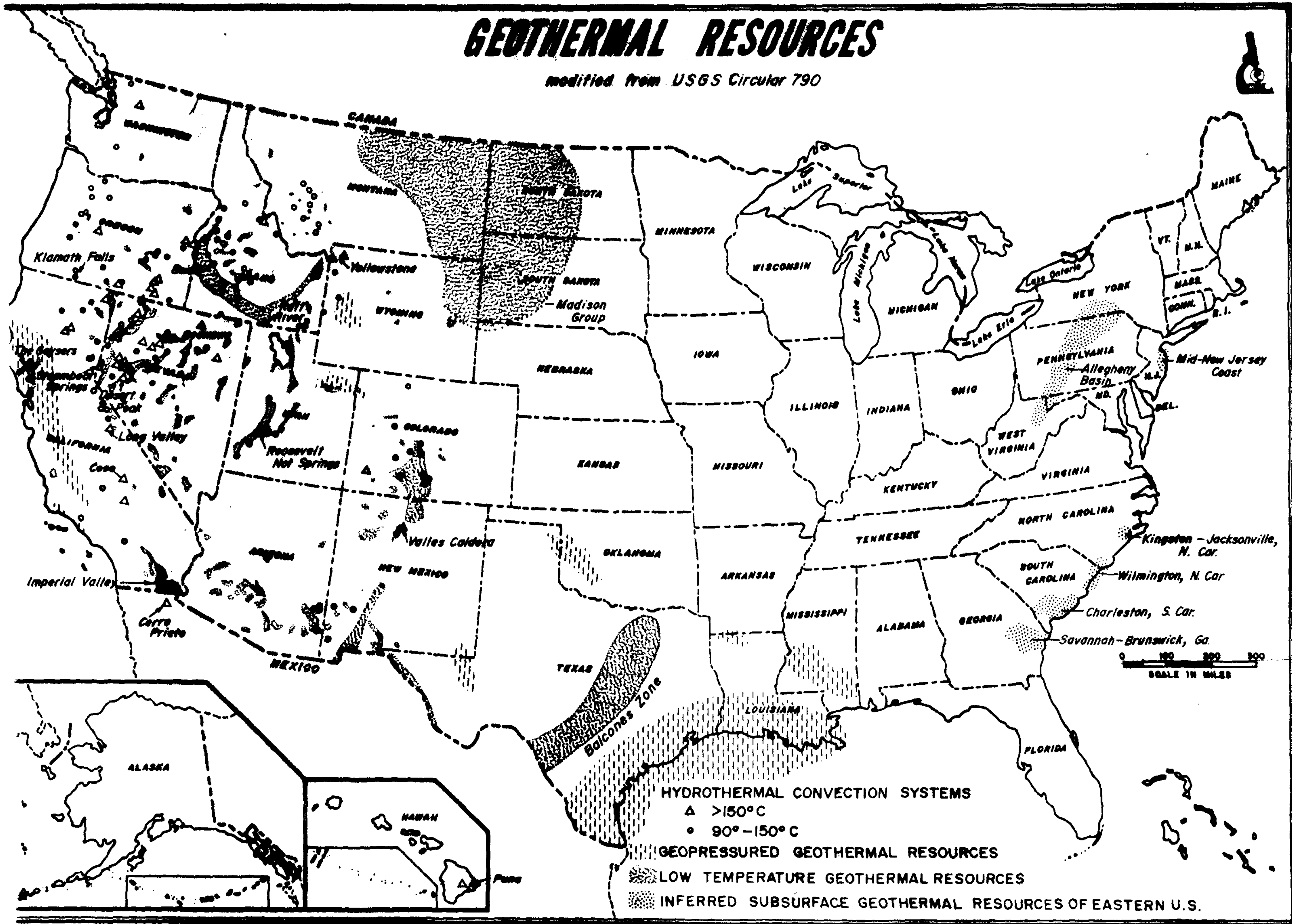
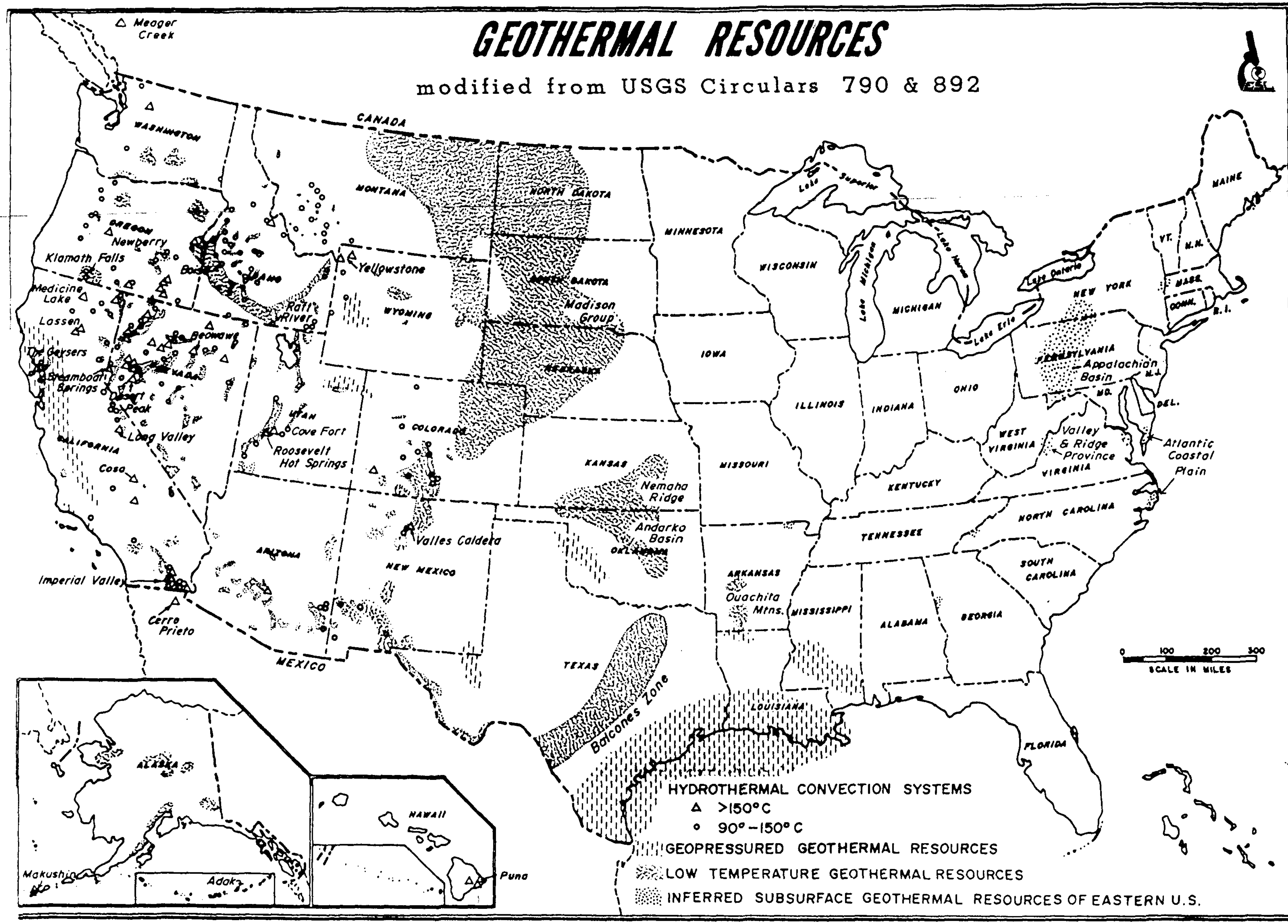
KANSAS
Nemaha Ridge
Andarko Basin
OKLAHOMA
TEXAS
Balcones Zone
MINNESOTA
IOWA
MISSOURI
ARKANSAS
Ouachita Mtns.
LOUISIANA
WISCONSIN
ILLINOIS
MISSISSIPPI
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario
MICHIGAN
INDIANA
KENTUCKY
TENNESSEE
ALABAMA
OHIO
WEST VIRGINIA
VIRGINIA
Valley & Ridge Province
PENNSYLVANIA
Appalachian Basin
NEW YORK
NORTH CAROLINA
SOUTH CAROLINA
GEORGIA
FLORIDA
Atlantic Coastal Plain
MAINE
VT.
N.H.
MASS.
CONN.
R.I.
N.J.
DEL.
MD.
0 100 200 300
SCALE IN MILES
ALASKA
Makushin
Adak
HAWAII
Puna
HYDROTHERMAL CONVECTION SYSTEMS
△ >150°C
○ 90°-150°C
GEOPRESSURED GEOTHERMAL RESOURCES
LOW TEMPERATURE GEOTHERMAL RESOURCES
INFERRED SUBSURFACE GEOTHERMAL RESOURCES OF EASTERN U.S.

Geothermal Power Plants in the World



	No. Units	Generating capacity (MW) 1981		Generating capacity (MW) 1983
Total	(115)	2538	-	3636


GEOTHERMAL RESOURCES
modified from USGS Circular 790
CANADA
MONTANA
NORTH DAKOTA
SOUTH DAKOTA
Madison Group
MINNESOTA
WISCONSIN
MICHIGAN
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario
NEW YORK
MAINE
VT.
N.H.
MASS.
CONN.
R.I.
PENNSYLVANIA
Allegheny Basin
N.J.
Mid-New Jersey Coast
MD.
DEL.
OHIO
INDIANA
ILLINOIS
IOWA
NEBRASKA
WYOMING
Yellowstone
Klamath Falls
OREGON
IDAHO
Roosevelt Hot Springs
COLORADO
KANSAS
MISSOURI
KENTUCKY
WEST VIRGINIA
VIRGINIA
NORTH CAROLINA
Kingston - Jacksonville, N. Car.
TENNESSEE
SOUTH CAROLINA
Wilmington, N. Car
Charleston, S. Car.
Savannah-Brunswick, Ga.
GEORGIA
ALABAMA
MISSISSIPPI
ARKANSAS
OKLAHOMA
LOUISIANA
TEXAS
Balcones Zone
NEW MEXICO
Valles Caldera
ARIZONA
MEXICO
Imperial Valley
Cerro Prieto
CALIFORNIA
Coso
Long Valley
The Geysers
Steamboat Springs
FLORIDA
ALASKA
HAWAII
Puna
0 100 200 300
SCALE IN MILES
HYDROTHERMAL CONVECTION SYSTEMS
Δ >150° C
• 90° - 150° C
GEOPRESSURED GEOTHERMAL RESOURCES
LOW TEMPERATURE GEOTHERMAL RESOURCES
INFERRED SUBSURFACE GEOTHERMAL RESOURCES OF EASTERN U.S.


GEOTHERMAL RESOURCES
modified from USGS Circulars 790 & 892
CANADA
MEXICO
WASHINGTON
OREGON
CALIFORNIA
MONTANA
NORTH DAKOTA
SOUTH DAKOTA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
KANSAS
TEXAS
MINNESOTA
WISCONSIN
IOWA
ILLINOIS
INDIANA
MICHIGAN
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MISSISSIPPI
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SOUTH CAROLINA
WEST VIRGINIA
VIRGINIA
NEW YORK
MAINE
VT.
N.H.
MASS.
CONN.
R.I.
N.J.
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Lake Superior
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Beowawe
Raft River
Yellowstone
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Roosevelt Hot Springs
Valles Caldera
Nemaha Ridge
Anadarko Basin
Ouachita Mtns.
Balcones Zone
Appalachian Basin
Valley & Ridge Province
Atlantic Coastal Plain
Makushin
Adak
Puna
0 100 200 300
SCALE IN MILES
HYDROTHERMAL CONVECTION SYSTEMS
>150°C
90°–150°C
GEOPRESSURED GEOTHERMAL RESOURCES
LOW TEMPERATURE GEOTHERMAL RESOURCES
INFERRED SUBSURFACE GEOTHERMAL RESOURCES OF EASTERN U.S.

PRDA No. DE-RP07-86ID12662
Attachment No. 6

STATE GEOTHERMAL RESEARCH AND DEVELOPMENT

MAILING LIST
(as of March 25, 1987)

1. State of Alaska
   Division of Geological & Geophysical Surveys
   400 Willoughby Bldg.
   Juneau, AK 99801
   ATTN: Dr. Roman Motyka

2. State of Alaska
   Alaska Power Authority
   P.O. Box 190869
   Anchorage, AK 99519-0869
   ATTN: David Denig-Chakroff

3. Arizona State University
   Office of Research Development
   and Administration
   Tempe, Arizona 85287
   ATTN: Elizabeth McHugh

4. Arkansas Geological Commission
   Vardelle Parham Geology Center
   3815 West Roosevelt Road
   Little Rock, AR 72204
   ATTN: Norman F. Williams
   State Geologist and Director

5. Arkansas Tech University
   Arkansas Mining & Mineral Resources
   Research Institute
   Russellville, AR 72801-2222
   ATTN: Henry Barwood

6. Bechtel National, Inc.
   P.O. Box 3965
   San Francisco, CA 94119
   ATTN: Janet L. Owen

7. Boise State University
   Department of Geology & Geophysics
   1910 University Drive
   Boise, ID 83725
   ATTN: Charles Waag

8. Bureau of Geology and Mineral Technology
Geological Survey Branch
845 N. Park Avenue
Tucson, AZ 85719
ATTN: Larry D. Fellows
State Geologist and Assistant Director

9. Colorado Geological Survey
1313 Sherman St., Room 715
Denver, CO 80203
ATTN: John W. Rold
Director and State Geologist

10. State of Colorado
Colorado Geological Survey
715 State Centennial Building
1313 Sherman Street
Denver, CO 80203
ATTN: Mark Davis

11. Consad Research Corporation
121 North Highland Avenue
Pittsburgh, PA 15206
ATTN: Wilbur A. Steger

12. Department of Commerce and Regulation
Energy Office
217-1/2 West Missouri
Pierre, SD 57501
ATTN: Steve Wegman

13. Department of Conservation
Division of Mines and Geology
1416 Ninth Street, Room 1341
Sacramento, CA 95814
ATTN: James F. Davis
State Geologist

14. Department of Energy
625 Marion Street, N.E.
Salem, OR 97310
ATTN: Alex Sifford

15. Department of Environmental
Quality Engineering
Division of Waterways
1-11 Winter Street
Boston, MA 02108
ATTN: Joseph A. Sinnott
State Geologist

16. Department of Natural Resources
    and Conservation
    Energy Division
    32 South Ewing
    Helena, MT 59620
    ATTN: Jeff Birkby

17. Department of Natural Resources and
    Community Development
    Division of Land Resources
    P.O. Box 27687
    Raleigh, NC 27611
    ATTN: Stephen G. Conrad
    Director and State Geologist

18. Division of Geological
    and Geophysical Surveys
    P.O. Box 7028
    Anchorage, AK 99510
    ATTN: Pedro Denton
    State Geologist and Director

19. Division of Water and Land Development
    Department of Land and Natural Resources
    P.O. Box 373
    Honolulu, HI 96809
    ATTN: Manabu Tagomori
    Manager-Chief Engineer

20. Eng, Inc.
    1430 Mass Ave., Harvard Square
    Cambridge, MA 02138
    ATTN: Aron Weis

21. Environmental Research Center - UNLV
    Division of Earth Sciences
    255 Bell St., Suite 200
    Reno, NV 89503
    ATTN: Mr. Dennis Trexler

22. Geoexplorers International, Inc.
    5701 East Evans Avenue
    Denver, CO 80222
    ATTN: Dr. Jan Krason

23. Georgia Geologic Survey Branch of the
    Environmental Protection Division of
    the Department of Natural Resources
    19 Martin Luther King, Jr. Dr., S.W.
    Atlanta, GA 30334
    ATTN: William H. McLemore
    State Geologist

75. Hawaii State of
Department of Planning and
Economic Development
P.O. Box 2359
Honolulu, HI 96804
ATTN: Takeshi Yoshihara

76. Idaho Department of Water Resources
1041 Blue Lakes Blvd. North
Twin Falls, ID 83301
ATTN: Ms. Leah V. Street

77. Institute of Gas Technology
3424 South State Street
Chicago, IL 60616
ATTN: Judi Cronin

78. Jacobs Engineering Group, Inc.
1511 K Street, Suite 1100
Washington, D.C. 20005
ATTN: Elaine Strass

79. Kent State University
Research and Sponsored Programs
Lowry Hall
Kent, Ohio 44242
ATTN: Shirley Perry

80. Laboratory of Isotope Geochemistry
Department of Geosciences
University of Arizona
Tucson, AZ 85721
ATTN: Dr. Paul E. Damon

81. Louisiana State University
Louisiana Geological Survey
P.O. Box G, University Station
Baton Rouge, LA 708932-4107
ATTN: Virginia Van Sickle

82. Masson Grimm Burgum & Turnbow, Ltd.
106 North Carolina Avenue, S.E.
Washington, DC 20003
ATTN: Thomas Burgum

83. Montana College of Mineral Science
and Technology
Department of Physics and
Geophysical Engineering
West Park Street
Butte, MT 59701
ATTN: Dr. William R. Sill

84. Montana College of Mineral
  Science and Technology
  Department of Physics and
  Geophysical Engineering
  West Park Street
  Butte, MT 59701
  ATTN: Dr. Charles J. Wideman

85. Montana College of Mineral Science and Technology
  Engineering Hall
  Butte, MT 59701
  ATTN: Dean of Research and Graduate Studies

86. State of Nevada
  Office of Community Development
  Capitol Complex
  Carson City, NV 89710
  ATTN: James P. Hawke

87. State of Nevada
  Office of Community Services
  Capitol Complex
  Carson City, NV 89710
  ATTN: Curtis Framel

88. New Mexico Bureau of Mines
  & Mineral Resources
  Campus Station
  Socorro, NM 87801
  ATTN: Frank E. Kottlowski
  Director

89. New Mexico Energy Institute
  Box 3-PSL
  Las Cruces, NM 88003
  ATTN: Dr. Rudy Schoenmachers

90. New Mexico Research and
  Development Institute
  Pinion Building, Suite 358
  1220 South St. Francis Drive
  Santa Fe, NM 87501
  ATTN: Dr. Larry Icerman

91. State of New Mexico
  Energy and Minerals Department
  525 Camino de los Marquez
  Santa Fe, NM 87501
  ATTN: Charles P. Wood

92. New York State Energy Research and
Development Authority
Two Rockefeller Plaza
Albany, NY 12223
ATTN: Steven F. Lewis
Director of Administration and Contracts

93. New York State Geological Survey
State Museum
3136 Cultural Education Center
Empire State Plaza
Albany, NY 12230
ATTN: Robert H. Fakundiny

94. North Dakota Geological Survey
University Station
Grand Forks, ND 58202
ATTN: Sidney B. Anderson
Acting State Geologist

95. Office of Management and Budget
State Capitol
Bismarck, ND 58505
ATTN: Michael Mahlum

96. Oregon Department of Geology and
Mineral Industries
1005 State Office Building
Portland, OR 97201
ATTN: Dr. George R. Priest

97. State of Oregon
Department of Geology
and Mineral Industries
910 State Office Building
1400 S.W. 5th Avenue
Portland, OR 97201-5528
ATTN: George Priest

98. E. H. Pechan & Associates, Inc.
5537 Hempstead Way
Springfield, VA 22151
ATTN: Lynanne Roth

99. Pennsylvania State University
Department of Geosciences
406 Deike Building
University Park, PA 16802
ATTN: Kevin P. Furlong
(814) 863-0567

100. Purdue Research Foundation
Division of Sponsored Programs
Hovde Hall
West Lafayette, IN 47907
ATTN: Suzie M. Jero

101. Railroad Commission of Texas
Capitol Station - P.O. Drawer 12967
Austin, TX 78711-2967
ATTN: Lynda Nesenholtz

102. Resource Management International, Inc.
1010 Hurley Way, Suite 500
Sacramento, CA 95825
ATTN: Ronald Nichols

103. Rosebud Sioux Tribe
Rosebud Indian Reservation
P.O. Box 430
Rosebud, SD 57570
ATTN: Eugene F. LeRoy, Sr.

104. Science Applications International Corporation
1200 Prospect Street
P.O. box 2351
LaJolla, CA 92038
ATTN: Joy Van Laningham

105. Southern Illinois University
Coal Research Center
315 W. Grand Avenue
Carbondale, IL 62901
ATTN: Harold Foster

106. South Dakota Geological Survey
Department of Water and
Natural Resources
Science Center USD
Vermillion, SD 57069
ATTN: Merlin J. Tipton
State Geologist

107. Southern Methodist University
Department of Geological Sciences
Dallas, TX 75275
ATTN: Dr. David D. Blackwell

108. The Earth Technology Corporation
2801 Youngfield, Suite 390
Golden, CO 80401
ATTN: Debbie Neev

109. University of Alaska
Geophysical Institute
Fairbanks, AK 99775-0800
ATTN: Dr. Eugene Wescott

110. University of Alaska
Geophysical Institute
Fairbanks, AK 99775-0800
ATTN: Dr. Donald Turner

111. University of Alaska
Geophysical Institute
C. T. Elvey Building
Fairbanks, AK 99701
ATTN: Dr. Eugene M. Wescott

112. University of California
Office of Research Development
Administration
Santa Barbara, CA 93106
ATTN: Susan Clark

113. University of Cincinnati
University Dean's Office
309 Braunstein
Cincinnati, OH 45221-0627
ATTN: Mary Lou Cutler

114. University of Florida
Department of Geology
1112 Turlington Hall
Gainsville, FL 32611
ATTN: Douglas Smith

115. University of Hawaii at Manoa
Hawaii Natural Energy Institute
Homes Hall 240-A
2540 Dole Street
Honolulu, HI 96822
ATTN: Harry J. Olson

116. University of Hawaii at Manoa
Hawaii Natural Energy Institute
Holmes Hall 246
2540 Dole Street
Honolulu, HI 96822
ATTN: Dr. Donald Thomas

117. University of Houston
Center of Applied Technology
15534 Weldon Drive
Houston, TX 77032
ATTN: Dr. Kathy Greewood

118. University of Idaho
Idaho Geological Survey
Moscow, ID 83843
ATTN: Maynard M. Miller
Director and State Geologist

119. University of Idaho
Office of University Research
Moscow, ID 83843
ATTN: Nancy Weller

120. University of Kansas
Kansas Geological Survey
1930 Constant Avenue
Campus West
Lawrence, KS 66046
ATTN: Director and State Geologist

121. University of Nebraska
Institute of Agriculture and
Natural Resources
Lincoln, NE 68588-0517
ATTN: Vincent H. Dreeszen, Director
Conservation and Survey Division

122. University of Nebraska-Lincoln
Mechanical Engineering Department
255 Walter Scott Engineering Center
Lincoln, NE 68588-0525
ATTN: Dr. Peter E. Jenkins

123. University of Nevada
Nevada Bureau of Mines and Geology
Reno, NV 89557-0088
ATTN: John Schilling
Director/State Geologist

124. University of Nevada, Las Vegas
Division of Earth Sciences
255 Bell Street, Suite 200
Reno, Nevada 89503
ATTN: Susan Wehrkamp

125. University of New York
NY State Education Department
Room 121 EB
Albany, NY 12234
ATTN: Clesson Bush

126. University of North Dakota
Mining and Mineral Resources
Research Institute
Box 8103, University Station
Grand Forks, ND 58202
ATTN: Dr. William Gosnold

127. University of Oklahoma
Oklahoma Geological Survey
Norman, OK 73019
ATTN: Charles J. Mankin
Director

128. University of Texas at Austin
Bureau of Economic Geology
Austin, TX 78713
ATTN: W. L. Fisher
Director and State Geologist

129. University of Wyoming
Department of Geology and Geophysics
P.O. Box 3006
Laramie, WY 82071
ATTN: Dr. Henry P. Heasler

130. Utah Geological and Mineral Survey
606 Black Hawk Way
Salt Lake City, UT 84108
ATTN: Dr. Raymond L. Kearns, Jr.

131. Utah Geological and Mineral Survey
606 Black Hawk Way
Salt Lake City, UT 84108
ATTN: Dr. Donald Mabey

132. Utah State University
Research Information Office
Logan, UT 84322-1450
ATTN: Sydney Peterson

133. Virginia Division of Mineral Resources
P.O. Box 3667
Charlottesville, VA 22903
ATTN: Robert C. Milici
State Geologist

134. Washington State Department of
Natural Resources
Division of Geology and Earth Resources
Olympia, WA 98504
ATTN: Mr. J. Eric Schuster
Assistant State Geologist

135. Washington State Department of
Natural Resources
Division of Geology and Earth Resources
Olympia, WA 98504
ATTN: Mr. Michael A. Korosec

136. Washington State Energy Office
400 E. Union, 1st Floor ER-11
Olympia, WA 98504-2411
ATTN: Stuart Simpson

137. Washington State Energy Office
400 E. Union, First Floor ER-11
Olympia, WA 98504
ATTN: Dr. Gordon Bloomquist

138. West Virginia Geological and
Economic Survey
Mont Chateau Research Center
P.O. Box 879
Morgantown, WV 26507-0879
ATTN: Robert B. Erwin
Director and State Geologist

139. State of Wyoming
Economic Development
and Stabilization Board
Herschler Building
Cheyenne, WY 82002
ATTN: John Goodier

140. New Mexico State University
P.O. Box 3805
Las Cruces, NM 88003-3805
ATTN: John T. Patton

141. Battelle Pacific Northwest Lab
P.O. Box 999
Richland, WA 99352
ATTN: Eleanor C. Corley

142 Pinnacle Geotechnical Services Ltd.
310 S.W. 4th Avenue
Portland, OR 97204
ATTN: Gerald O. Thompson

143 Babcock & Wilcox
3315 Old Forest Road
P.O. Box 10935
Lynchburg, VA 24505-0935
ATTN: Charles J. Mayer

144 Tennessee Technological University
P.O. Box 5032
Cookeville, TN 38505
ATTN: George Tsatsaronis

Hawaii - Dept. of Business & Economic Development

DE-FG07-88ID12741

G. Lesperance
548-7208 new phone 02/22/90

Voucher #		Amount	$ DOE Added	Σ billed	$ Left	5	Billed thru	Date of Voucher	8 COMMENTS		
	1		$ 87,173						Grant Signed 6/14/88		
Pd No. 1	2	7,114.27 ✓		7,114.27	80,	→ April 89	6/20/88 – 4/30/89	5/30/89	1st Invoice		
No. 2.	3	9,006.61 ✓		16,120.88 ✓		→ May/89				not paid by DOE	[illegible]
Pd No. 3	4	10,847.06 ✓		26,967.94 ✓		→ June	6/1/89 – 6/30/89		Rec DOE 12/29/89		
Pd No 4	5	6,918.99 ✓		33,886.93 ✓		July 89	7/1/89 – 7/31/89	10/30/89	4th Invoice		
Pd No. 5	6	12,678.41 ✓		46,565.89 ✓		August '89	8/1/89 – 8/31/89		Rec DOE 12/29/89		
Pd No. 6	7	6,987.44 ✓		53,553.34	$ 33,619.66	Sept. '89	9/1/89 – 9/30/89	12/26/89	6th Invoice		
No. 7	8	14,333.99 ✓		67,887.33 ✓	19,285.69	Nov. Oct. '89	10/1/89 – 11/30/89	2/09/90	7th Inv.	ok	03/20/9[illegible]
No. 8	9	4,236.51 ✓		$ 72,123.84 ✓	$ 15,049.16	Dec. '89	12/01/89 – 12/31/89	2/28/90	8th Inv.	ok	03/20/9[illegible]
No. 9	10	6,601.02 ✓		$ 78,724.86 ✓	$ 8,448.14 ✓	Jan. '90	1/31/90	3/9/90	9th Inv.		leaves less than 10[illegible]
No. 10	11	4,400.80		$ 83,125.66 ✓	$ 4,047.34	Feb & Mar '90	3/31/90	5/21/90	10th Inv.		
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IDAHO - DWR VOUCHER RECORD

	B-TF Task 1	BG AS Task 2	WRG Task 3	F. Rep Task 4
Year 1	47,314 ✓	26,318 ✓	3,412	
Year 2	37,851	21,054	2,730	15,40[illegible]

Voucher #		Amount	$ DOE Added	Σ $ billed	$ Left	Σ Task $	Billed thru	Voucher Date	COMMENTS		
DOE Co-Op	1		154,088 *					3-21-88	~~Grant~~ Co-OP Ag. DE-FC07-88		ID1274
1	2	}									
2	3	} 8,037.35 ✓		8,037.35	$ 146,050.65		3/21 → 6/30.				
3	4	}									
4 T-2	5	1,417.93 }					8-31-88		7/1-8/31	Rec. 10/14	
5 T-3	6	2,127.45 }	7,089.69 ✓	15,127.04	$ 138,960.96		8-31-88		7/1-8/31	"	
6 T-1	7	3,544.31 }					8-31-88		7/1-8/31	"	
7 T-1	8	3,816.88 }					9-31-88		9/1-9/30	Rec. 11/28	
8 T-2	9	2,257.85 }					10-31-88		10/1-10/31	Rec. 11/22	
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EFFICIENCY® LINE NO. 6636

77,044 yr. 1
77,044 yr. 2

ID - DWR VOUCHER RECORD - BY TASK

T-4 = 15,409 yr. 2

Task 1 - Twin Falls Co. $37,851 yr. 2, $47,314 yr. 1 } $85,165.–
T-2 Boise $21,054 yr. 2, $26,318 yr. 1 } $47,372.–
T-3 Wood River $2,730. yr. 2, $3,412. yr. 1 } $6,142.00

Inv.	Period	Amt	Σ Inv.	Balance		Inv.	Period	Amt	Σ Inv.	Balance	Inv.	Per.	Amt.	Σ Inv.	Balance	
T1-0	3-21-88 5-31-88	4,741.72	4741.72	42,572.28		T2-1	6-1 — 6-30	1,290.38	1,290.38	25,027.62	T3-1	6-1-88 6-30	1,181.34	1,181.34	2,230.66	
T1-1	6-1 — 6-30-88	823.91	5,565.63	41,748.37		T2-2	7-1 — 8-30	1,417.93	2,706.31	23,609.69	T3-2	7-1 — 8-31	2,127.45	3,308.79	103.21	
T1-2	7-1 → 8-31-88	3,544.31	9,109.94	31,304.06		T2-3	9-1 — 9-31	0	..	..	T3-3	9-1 9-31	0	..	..	
T1-3	9-1 → 9-31-88	3,816.88	12,926.82	34,387.19		T2-4	10-1 — 10-31	0	..	..	T3-4	10-1 10-31				
T1-4	10-1 → 10-31-89	2,257.85	15,184.67	32,129.33		T2-5	11-1 → 11-30	0	..	..						
T1-5	11-1 11-30	4,577.98	19,762.65	27,551.36		T2-6	12-1 — 12-31	0	..	..						
	12-1 12-30	2,398.72	22,161.37	25,152.64		T2-7	1-1 1-31	ded 295.11	3,003.42	23,314.58	T3-5	1-1 — 1-31	0	..	..	
T1-7	1-1 1-31	2,654.73	24816.10 25,014.90	22,295.10		T2-8	2-1 2-28-89	0	3,003.42	23,314.58						
	2-1 — 2-28	3,910.47	28,726.57			T2-9	3-1 — 3-31	0	..	..						
	3-1 — 3-31	5,559.07	34,285.64			T2-10	4-1 — 4-30	0	..	..						
	4-1 4-30	2,826.95	37,112.59			T2-11	5-1 — 5-30	0	..	..	T3-6	5-1 — 5-31	0	"	103.21	
T1-10	5-1 — 5-31	4,507.27	41,619.86 39,037.96	8,276.04		T2-12	6-1 — 6-30	BGI 20,000.–	23,003.42	3,314.58		—				
T1-11	6-1 — 6-30	2,580.77	44,200.63	3,113.37		T2-13	6-22-30	0	23,003.42	"			T+1 1+2+3	$65,350.17	$88,737.83	
		2nd Yr Fund +		$37,851.–				2nd Yr Funds	+	21,054			2nd Yr Funds		+2,730.–	
		New Balance		$40,964.37				New Balance					New Balance	=	2,833.21	
T1-12	7-1 → 8-31	5,818.68	50,222.55 DWR 50,019.31 HE			T2-14	9-30-89	1,477.61	24,481.03	22,890.97	T3-7	9-30-89	0.00	$3,308.79	$2,833.21 ✓	
T1-13	9-1 — 9-30-89	4,442.41	54,664.84 accept this!													
T1-14	10-1 — 10-31	2,287.06	56,951.90	HE 28,213.10	DWR 28,213.10	T2-15	10-31	0	24,481.03	22,890.97	T3-8	10-31	0.00	3,308.79	$2,833.21	T4 still $15,409.
T1-15	11-1 → 11-30	2,038.41	58,990.31	26,174.69	26,174.69	T2-16	11-30	0	24,481.03	22,890.97	T3-9	11-31	0.00	3,308.79	$2,833.21	.. ✓
T1-16	12-1 → 12-31	10,672.93	69,663.24	15,501.76		T2-17	12-31	10,000.–	34,481.03		T3-10	12-31	2,833.21	6,142.00	0	..
T1-17	1-1 → 1-31	6,255.76	75,919.00	9,246.00		T2-18	1-1 to 1-31	0	34,481.03	12,890.97	T3-11	1-1 to 1-31	0.00	6,142.00	0	..
		~~7,214.26~~	~~83,133.26~~			T2-19	2-1 → 2-29	7,350.00	41,831.03							
T1-19	3-1 → 3-31-90	2,031.74	85,165.00	0			3-1 → 3-30	1,500.00	43,331.03	4,040.97			T4 - REPORTING			
							9/20	1,565.54		2,475.43	T4-10	12-1 — 12-31	0.0	0.0	15,409	
											T4		456.19			
											T4-13 ?	3-1 → 3-31	7,302.55	7,758.74	7650.26	
											T4-14 ?	4-1 → 4-30	6,607.11	14,365.85	1,043.15	less than 1%.

leak left 9/15/ charges since leak $32K left

ID – DWR – Voucher Record by Task

	Twin Falls Task 1 (TFCGS)			Boise Task 2 (BGAS)			Wood River Task 3 (WRG)						
Invoice	1 DOE In	2 Inv. Amt.	3 Balance	4 DOE In	5 Inv. Amt.	6 Balance	7 DOE In	8 Inv. Amt.	9 Balance	10	11	12	13
YR #1 1	47,314			26,318			3,412						
no rec. 2 BGA 2					1,290.38 (deduced)	25,027.62							
no rec. 3 WR? 3								1,181.34 (deduced)	2,230.66				
no rec. 0+1 TFC-1		5,565.63 (deduced)	41,748.37										
4 BGA 5				cum 2,708.73	1,417.93	23,609.69							
5 WR 6							cum 3,308.79	2,127.45	103.21				
6 TFC-7		3,544.31	38,204.06										
7 TFC-8	cumul 12,926.81	3,816.88	34,387.18										
8 TFC-9	cumul 15,184.66	2,257.85	32,129.33										
8 BGA 10					0.00	23,609.69							
9 TFC 11			-24K inv.										
10 BGA 12				cum 3,003.42	deduced 294.69	23,314.58							
11 13													
12 TFC 14	cum 39,037.96	4,507.27	8,276.04										
13 BGA 15 May 89				cum 3,003.42	0	23,314.58							
14 BGA 16 June 89				23,003.42	20,000.00	3,314.58							

TOPS FORM 3622
LITHO IN U.S.A.

Washington - Dept. Natural Resources - Voucher Record

VOUCHER	[1] Amount	[4] $ DOE Added	Σ $ billed	$ Left	5	Billed thru	[7] Date of Voucher	8 COMMENTS
DOE Grant		$170,776						Grant DE-FG07-88ID12740 [illegible]/88 → [illegible]/89
1	$10,592.00 ✓		10,592	160,184 ✓		4/1 → 6/30/88	9/14/88	ok @ ESL - 10/1
2	4,806.15		15,398.15 ✓	155,377.85		7/1 → 9/30/88	11/16/88	ok @ ESL 11/2[illegible]
3	132,762.14 ✓		148,160.29	22,615.71		10/1 → 12/31/88	3/2/89	ok @ ESL 3/15/89
4	22,615.88		170,776.17	0		1/1/89 → 6/30/89	8/3/89	Rec @ ESL 8/18/89 HOLD
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NEW MEXICO RESEARCH & DEVELOPMENT INSTITUTE
VOUCHER RECORD

Voucher #		Amount	$ DOE Added	Σ $ billed	$ Left	5	Billed Thru	Date of Voucher	8 COMMENTS		
Grant			$126,267					9/2/88 Larry I[illegible]	Aug 29, '88	by DOE/ID	
1	2	$46,341.32		$46,341.32	$79,925.68		9/01/88 – 03/01/90	7/26/89	ok		
2	3	24,582.67		70,923.99	55,343.01		– 2/28/90	6/22/90	ok to pay	07/09/90	
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UNIV. NEVADA SYS. – DESERT RESEARCH INST
VOUCHER RECORD

Voucher #	Amount	$ DOE Added	Σ$ billed	$ Left	5	Billed Thru	Date of Voucher	8 COMMENTS
GRANT 1		$140,639						May 26, 1988 signed
#1 2	$18,794.08		$18,794.08	$121,844.92		7/1/88 – 11/4/88	Nov. 10, '88	ok to KT, 11/21/88
603066 #2 3	11,554.62		$30,348.70	$110,290.30		11/5/88 – [illegible]	Feb. 2, '89	ok to KT, [illegible]/89
#3 4	22,899.18		53,247.88	87,391.12		1/7/89 – 5/4/89	5/10/89	ok to KT, 05/23/89
4 5	10,439.09		63,686.97	76,952.03		5/5 – 6/30	8/7/89	ok to KT, [illegible]/23/89.
5 6	11,555.44		75,242.41	65,396.59		7/1 – 10/5	10/16/89	ok to KT 10/30/89
6 7	30,460.66		105,703.07	34,935.93		10/6 – 5/4/90	5/17/90	ok to KT 6/18/90
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NORTH DAKOTA - UND VOUCHER RECORD

Voucher #		Amount	$ DOE Added	Σ $ billed	$ Left	Σ Tasks	Billed thru	Date Voucher	COMMENTS	
DOE Grant			$ 194,814						Grant DE-FG07-88ID12736	
1	2								4/1/88 - 3/31/90	
2	3									
3	4			31,214.80	163,599.20					
4	5	8,104.61		39,319.41	155,494.59		08/01 → 08/31/88		Rec 10/14/88 ok	
5	6	2,037.59		41,357.00	153,457.00		09-01 → 09/31/88		Rec 11/02/88 ok	
6	7	1,726.63		43,083.63	151,730.37		10-01 → 10-31/88		Rec 12/13/88 ok	
7	8	3,315.61		46,399.24	148,414.76 ✓		11-01 → 11-30/88		Rec 01/19/89 ok	
8	9	3,411.12		49,810.36	145,003.[illegible]		12/01 → 12/31/88		Rec 02/[illegible] ok	
9	10	1,702.39		51,512.75	143,301.25		01/01 → 01/31/89		Rec 03/14/89 ok	
10	11	1,208.73		52,721.48 ✓	142,092.52		02/01 → 02-28/89		Rec [illegible]/2[illegible]/89 ok	✓
11	12	1,242.79		53,964.27 ✓	140,849.73		03/01 → 03-31/89		Rec 05/01/89 ok	✓
12	13	2,157.64		56,121.91 ✓	138,692.09		04/01 → 04/30/89		Rec. 06/13/89 ok	✓
13	14	7,288.43		63,410.34 ✓	131,403.66 ✓		05/01 → 05/31/89		Rec. 07/06/89 ok	✓
14	15	20,853.94		84,264.28 ✓	110,549.72		06/01 → 06/30/89		Rec. 08/22/89 ok	✓
15	16	20,480.79		104,745.07	90,068.93		07/01 → 08/31/89		Rec. 10/10/89 ok	✓
16	17	3,486.35		108,231.42	86,582.58		9/01 → 9/30/89		Rec. 10/27 ok	✓
17 missing	18	1,885.62		110,117.04 ✓	84,696.96 ✓		10/01 → 10/31/89		Rec. 02/22/90	
18	19	2,354.81		112,471.85 ✓	82,342.15 ✓ ?		11/01 → 11/30/89		Rec. 1/02/90 ok	✓
19	20	2,219.88		114,691.73 ✓	80,122.27 ✓		12/01 → 12/31/89		Rec 1/19/90 ok	
20	21	39,795.77		154,487.50 ✓	40,326.50 ✓		01/01 → 01/31/90		Rec 02/22/90 ok	
21	22	1,072.80		155,560.30	39,253.70		02/01 → 02/28			not rec.
22	23	972.79		156,533.09	38,280.91		03/01 - 03/31	04/19/90	Rec 05/14/90 ok	
23	24	1,530.72		158,063.81						
24	25	10,624.13		168,687.94	26,126.06					
	26									
	27									
	28									
	29									
	30									
	31									

M E M O R A N D U M

TO: Ben Lunis, EG&G
Isamu Aoki, DOE/ID

FROM: Howard Ross

SUBJECT: Draft Statement of Work, DOGAMI Grant

DATE: November 30, 1988

Enclosed are my thoughts on a Phase I SOW for the DOGAMI proposal based on our meeting of last Monday. I have tried to modify an earlier draft of the DOGAMI SOW to make an integrated document. The main changes are indicated in the text. Additional inserts for your consideration follow. This is certainly a "rough draft" stage so edit as you see fit.

SOW INSERTS

1.0 INTRODUCTION

This project will be completed in two phases. Phase I will include all site selection, site identification, permiting and pre-drilling environmental studies to satisfy NEPA requirements. Phase II will include drilling, data acquisition, interpretation, core curation and final reporting as described in 4.0, Technical Tasks.

Phase I will be funded at a level of approximately 10 percent of the total project amount. Phase II funding will be contingent on the satisfactory completion of Phase I activities, and the availability of funds when a final report of Phase I activities has been submitted to, and accepted by, DOE.

6.0 SCHEDULE

Funding for deserving DOE geothermal projects is limited, and the future availability of uncommitted funds cannot be guaranteed. Therefore the following schedule will apply to this grant.

Phase I. To be completed within five months of receipt of grant.

Phase II. To be completed within 24 months of receipt of grant. Drilling will begin not later than August 1, 1989.

7.0 SPECIAL CONDITIONS

DOGAMI may wish to reenter the subject hole and extend the drilling at some later date with non-DOE funds. If this should be the case, DOGAMI will accept all legal responsibility for the future conduct of the drilling and for later plugging and abandonment of the drill hole. DOGAMI will provide the necessary legal documents, fully executed, to DOE to show that this transfer of responsibility has been accomplished.

Some items within these inserts may be more appropriate for a cover letter to DOGAMI, especially as pertains to funding and schedule. Please have the DOE legal staff review the final document.

Howard

Howard Ross

State of Oregon, Department of Geology and Mineral Industries
Grant No. DE-FG07-88ID____________

STATEMENT OF WORK

1.0 INTRODUCTION

The goal of this grant is to support research in resource assessment in the Cascade Range of Oregon. The U. S. Geological Survey and the geothermal industry have identified the Cascade volcanic province as a region of high geothermal resource potential. The Oregon Department of Geology and Geophysics (DOGAMI) has been funded by DOE since 1979 for geothermal resource assessment activities, and a recent DOE initiative supported cost shared drilling with industry.

The principal objective of this grant is to obtain temperature gradient, heat flow, and hydrologic information along the axis of Cascade volcanism. This is in contrast with earlier deep drilling which tested local known or perceived hot spots, generally associated with major volcanic complexes. Favorable results from the drilling program to be conducted in this grant would likely stimulate and guide industry in additional resource exploration and development.

new → (INSERT A)

2.0 SCOPE

The technical objectives of this grant are to conduct resource assessment along the axis of Cascade volcanism away from major volcanic centers. The proposed drilling will also provide the first drilling in a proposed deep continental drilling transect across the Santiam Pass area. Following a review of geologic, geophysical, and geochemical data, a site will be selected and a 650 m temperature gradient hole will be drilled. Temperature and other geophysical logs will be completed, and the temperature gradient and heat flow will be determined. Hydrologic and lithologic information will also be determined. All data will be interpreted and the results presented in a final report. All project work will be completed and a final report submitted within 24 months.

3.0 APPLICABLE DOCUMENTS

The research described herein is abstracted from an unsolicited proposal titled "Investigation of the Thermal Regime of the Volanic Axis of the High Cascades, Oregon", dated May 28, 1988 and submitted by the Oregon Department of Geology and Mineral Industries. Previous studies and recommendations for scientific drilling in the Santiam Pass area were submitted to DOE in DOGAMI Open File Report O-86-3, titled "Investigation of the Thermal Regime and Geologic History of the Cascade Volcanic Arc: First Phase of a Program for Scientific Drilling in the Cascade Range". This report was a deliverable under DOE Grant No. DE-FG07-84ID12526.

4.0 TECHNICAL TASKS

new The following tasks will be acomplished in two Phases under this Grant. Phase II tasks will be completed subject to availability of funding and the satisfactory completion of Phase I tasks.

new → Phase I

4.1 Site Selection. Compile a geologic map at a scale of 1:62,500 which covers the area from Santiam Junction on the west to Green Ridge on the east, and from Three Fingered Jack volcano on the north to Mount Washington on the south. Compile all geophysical and geochemical data for this area, and relavent data for adjacent areas. Interpret geoscience data and evaluate environmental factors, and select the optimum feasible drill site in conjunction with relevant county, state, and federal regulatory personnel. Identify the drill site in writing and on maps. new →

4.2 Permitting and Environmental Studies. Prepare a detailed plan of operations, and obtain all necessary permits for drilling. Complete environmental studies to conform with NEPA requirements. new →

4.3 Complete a technical report sumarizing Tasks 4.1 and 4.2 and submit as a Phase I Final Report to DOE. Include the geologic map (Task 4.1) as part of this deliverable. new →

new → Phase II

4.4 Solicit bids for drilling and select a qualified drilling contractor.

4.5 Drilling and Data Acquisition. Complete a diamond cored drill hole to about 650 m. Log the hole using accepted geophysical logging procedures. Airlift at any deep aquifers and take down-hole fluid samples from these aquifers. Set a string of 6.4 cm diameter pipe to final depth and surround with heavy mud. Demobilize rig. Monitor temperatures for a period of one year, recording not less than three complete temperature logs. Plug hole and abandon site in accordance with existing regulations following completion of temperature monitoring.

4.6 Interpret geophysical logs and drill cuttings, and prepare a lithologic log for the drill hole. Prepare temperature gradient profiles, measure thermal conductivities for all major lithologic units, and determine heat flow. Correlate subsurface rock units with surface lithologies using petrologic, mineralogic, and geochemical analyses. Prepare an east-west cross section passing through the drill site and the area of the geologic map. Complete geochemical analyses for any fluids recovered as down hole samples. Interpret water-rock interaction and the location of and importance of fluid pathways.

4.7 Core Curation. Curate drill core using accepted methods established by the DOE. Complete core photography and initial sample dissemination from a temporary facility near the drill site. Drill core will be transmitted to permanent storage upon completion of the technical studies, but not later than the delivery date of the final report. Permanent storage will be either at DOGAMI or the UURI Geothermal Sample Library, with core abstracts at the other facility.

4.8 Reporting. Complete an integrated interpretation of all data obtained during the project, and prepare a final technical report describing the methodologies used, the data obtained, the interpretation developed, and the significance of the results. Document all new data in appendicies, and submit drill logs to Petroleum Information Service, Denver, Colorado for distribution to the public. The technical results may be presented at appropriate public forums.

5.0 REPORTS, DATA, AND OTHER DELIVERABLES

5.1 Management Records

Reports will be due as indicated on the Federal Assistance Reporting Checklist and the Report Distribution List.

new → 5.2 A Phase I Final Report shall be completed which summarizes all Phase I activities. This report will include the site selection data, the geologic map, and copies of appropriate NEPA and other environmental studies.

5.3 Final Report

A detailed final technical report will be prepared which will describe the drilling history and the methodologies of all technical studies employed during the project. All new data will be presented in the report together with interpretations and significance of the results. Deliverables will include appropriate representations of the compiled geologic, geochemical, and geophysical data maps, lithologic and temperature logs for the drill hole, and a geologic cross section across the area of the drill hole. A draft final report will be submitted for review and comment not less than 45 days prior to the scheduled delivery of the final report.

M E M O R A N D U M

TO: Isamu Aoki

FROM: Howard Ross

SUBJECT: Draft letter response to George Priest, Nov. 30, 1988

Dear George:

DOE appreciates receiving a copy of your November 23 announcement of the next Task Force Meeting for Cascade Scientific Drilling, at the December AGU meeting. I feel compelled to indicate our displeasure about the negative image of the DOE funding process which you have presented to the scientific community.

Please recall that your proposal to DOE for Cascade Drilling was an unsolicited proposal and that no specific funding authorization had been provided by Congress. The DOE efforts to fund this proposal have therefore required internal and external review, thorough justification, and the identification of any appropriate funds. It should be obvious that DOE cannot casually fund all the proposals, solicited or unsolicited, which it receives.

We feel that DOGAMI must bear part of the responsibility for the "one more bureaucratic hurdle" and the "red tape" which you refer to. DOE is obligated to comply with the NEPA requirements and must have complete assurance that all environmental concerns are adequately addressed by subcontractors and grantees. Because DOGAMI has been unable to identify the drill site proposed for this Cascade drilling project the environmental studies have not been completed and as a consequence funds for the drilling project cannot yet be awarded. DOE is presently trying to help DOGAMI through this process by awarding incremental funding. Phase I funding will address site selection and environmental studies, and Phase II will address the drilling and technical studies, and will be contingent upon satisfactory completion of Phase I.

Paragraph four of your memorandum also raises new concerns for DOE that a meaningful conductive heat flow determination may not result from the proposed drilling of a 650 m hole. If the probability of success is small, based on location (and elevation) of the chosen site, then the project should not be funded.

DOE regrets that sufficient monies are not available within this grant to "support meaningful science". Please understand that the funds which may be committed to this project are part of the DOE-Division of Geothermal Technology budget, and are not intended as a substitute for funding from the Continental Scientific Drilling Program.

We think that DOE deserves better treatment before the scientific community than that expressed in the negative tone of your November 23 memorandum. Please clarify your concern that the available funding may be insufficient to penetrate the cold water blanket.

October 25, 1988

Dr. George R. Priest
Regional Geologist
Department of Geology and Mineral Industries
910 State Office Building
1400 SW 5th Ave.
Portland OR 97201-5528

Dear George:

As I noted in our telephone conversation of last week, DOE-Idaho Operations has been trying to finalize a grant to fund your unsolicited proposal for a deep drill hole along the axis of the Oregon Cascade Range. The funding process is presently held up because DOE requires written assurance that activities undertaken in completion of this grant will have no adverse environmental impact and that appropriate environmental reviews (and permit applications) have been satisfactorily completed. Your letter of October 25 to Isamu Aoki, DOE/ID, does not provide this assurance. DOE has also expressed concern that environmental approval for geothermal drilling projects in Oregon should not be taken for granted.

George, I think you should identify the specific drill site and apply for permits for this site as soon as possible. To expedite DOE funding please send a letter describing the site location (accompanied by a location map), land status, description of any environmentally sensitive aspects of the drilling operation and copies of appropriate permit applications to Isamu Aoki at DOE/ID. DOE is anxious to complete this grant while funds are available, but they must comply with the new environmental requirements of the funding process.

Please call me if you consider it useful to discuss this matter in more detail.

Sincerely,

Howard P. Ross
Project Manager

cc: I. Aoki
M. Reed

Telefax to
S. Aoki-DOE/ID
M. Reed-DOE/DGE

please review this draft letter and comment before it is mailed to George Priest.

UNIVERSITY OF UTAH RESEARCH INSTITUTE
UURI
EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

October 19, 1988

Dr. George R. Priest
Regional Geologist
Department of Geology and Mineral Industries
910 State Office Building
1400 SW 5th Ave.
Portland OR 97201-5528

Dear George:

Thank you for the opportunity to review your draft final report for USDOE Contract DE-FG07-84ID12526. This report provides a thorough description of the DOE grant and its modifications, and ties all the tasks to DOGAMI deliverables. The highlights of the studies are nicely summarized in brief and reference is made to the appropriate DOGAMI publication or map for additional details. This report should be a useful reference for anyone interested in the geothermal potential or volcanic geology of the Oregon Cascades.

The format of your final report (in draft form) is somewhat different from other final reports submitted to DOE, but this is appropriate since all the technical details and specific conclusions are reported in DOGAMI publications. The format suggests that this report may not be a specific DOGAMI publication, but rather a stand-alone Final Report to DOE. With this in mind, and because final reports to DOE are submitted to the DOE Technical Information Center (Oak Ridge, TN) for archieval storage and possible printing and distribution, I have a few recommendations regarding format and other comments (attached). Please call me to discuss any of these comments in more detail.

George, if you anticipate any major delays in completing this report or in submitting DOGAMI O.F. 0-88-5 please let me know so we can discuss the need for a no cost time extension.

Thanks again for the opportunity to review and comment on your final report. It looks like all the deliverables for this 1984 grant will soon be completed.

Sincerely,

Howard

Howard P. Ross
Project Manager

encl.

cc: Ken Taylor

Review Comments

Draft Final Report for Grant DE-FG07-84ID12526, Geothermal Research, Oregon Cascades.

Format

- The final report should have: a cover page; Table of Contents; Disclaimer Statement (see NTIC reports). The Grant Number should be included on the cover page.

- The DISCUSSION section is the body of the report, in which several separate topics are discussed. Appropriate subheadings would help to structure this section and would guide the reader. In the order discussed, the subheadings appear to be:

  Previous Studies
  Interpretation of Geologic Mapping and Heat Flow
  Studies
  Geologic Mapping
  Cascades Scientific Drilling

- List the references for any publications cited in the text (i.e., Blackwell et al., 1982) but not fully identified.

- A Bibliography of DOGAMI reports and maps generated under this grant would be desirable, and could follow the Conclusions. A listing of other papers and presentations (GRC, GSA, AGU) resulting from this work would also be appropriate and desirable.

Typos, etc.

- Page 4, line 1. <u>These</u> data indicate...
  Page 4, line 18. <u>These</u> data ...
  Page 8, item 2. the <u>heat</u> source
  Page 8, item 5. convergence <u>so</u> that ...
  Page 11, item 8. is necessary to <u>better</u> understand

  Pages 2, 5, 10. The symbol for approximate (~) should be lowered to mid-line level as so (~).

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UURI Disclaimer (before title page)

UNIVERSITY OF UTAH RESEARCH INSTITUTE
UURI
EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

MEMORANDUM

TO: Kenneth Taylor, DOE/ID

FROM: Howard Ross

SUBJECT: Estimated Support for DOE State Cooperative Reservoir Analysis Program (SCP) - Technical Assistance - FY 89

DATE: October 20, 1988

1.0 Introduction

UURI is funded by DOE/ID to provide technical assistance for the DOE-GTD State Cooperative Reservoir Analysis Program (also called the State Coupled Program, or SCP) under Contract DE-AC07-85ID12489. As a result of the 1988 DOE-SCP solicitation and the wrap up of earlier grants, 14 grants and cooperative agreements are now active in the State Cooperative Program. At least seven grants will continue into mid-FY 90, and one or two additional state teams may be funded. We understand that specific funding for SCP activities was not included in the FY 89 Congressional Budget.

2.0 Scope

UURI will provide technical and administrative support to DOE/ID and DOE/GTD in the continuation of the State Cooperative Program. Anticipated activities include assistance to DOE in the solicitation process, progress monitoring, review of state team expenditures, critical review of state team technical reports and technical assistance (geological, geotechnical, geophysical) to the state teams.

3.0 Funding Required

UURI salaries, supplies,
geochemical analyses, travel: FY 89 $96,978

We estimate carryover funds of approximately $30,000, pending our final FY closing. It has been DOE and UURI policy that UURI should carry over enough funding for 3 to 5 months operations because it is characteristically that length of time before all of our funds have become available from DOE for the new FY. UURI is such a small organization that we can not operate on our own for any significant period of time.

Please contact me or Wil Forsberg (588-3442) for additional clarification. A more complete Statement of Work narrative, from FY88, is attached for your information.

HPR by [signature]

Howard P. Ross
Project Manager

Contract No. DE-AC07-85ID12489
Attachment A

STATEMENT OF WORK

STATE COOPERATIVE RESERVOIR ANALYSIS PROGRAM

1.0 Introduction

The State Cooperative Reservoir Analysis Program (SCP) was established by DOE in the mid-1970's, as the State Coupled Program to assess low-and moderate-temperature geothermal resources in the U.S. The early efforts of the State Coupled Program were national in scope. Geoscientific investigations were made in all states, with the more intensive activity focusing on states with either known existing geothermal resources or a large user potential. These studies provided extensive input to the USGS computer file GEOTHERM and demonstrated that most moderate-and high-temperature geothermal resources are found in the western portion of the country, with low-temperature resources also found in the great plains and Atlantic coast region. These and subsequent studies have led to the publication and distribution of a series of state geothermal resource maps. More recent work has expanded upon earlier resource assessment activities and included detailed reservoir analysis and generic studies.

UURI has provided technical program monitoring, coordination, and administrative support to DOE for the SCP, and has provided technical support to state teams. UURI has also provided technical and administrative support to DOE/ID and DOE/HQ during the establishment of new grants, including the 1987 PRDA solicitation.

2.0 Scope

UURI will provide technical and administrative support to DOE/ID and DOE/HQ in the continuation of the State Cooperative Program. Seven contracts with State teams remain active as of October 1, 1987 and ten or more new grants may result from the 1987 SCP PRDA. Anticipated activities include assistance to DOE in the solicitation process, progress monitoring, review of state team expenditures, critical review of state team technical reports and technical assistance to the state teams.

3.0 Applicable Documents

Reports submitted on geoscience research and technical assistance conducted under DOE Contract No. DE-AC07-85ID12489. DOE/ID Program Research and Development Announcement (PRDA) for State Geothermal Research and Development-PRDA No. DE-PR07-87ID12662.

4.0 Technical Tasks

Task 4.1 Progress Monitoring

Monitor the technical progress of state teams on all tasks funded through the State Cooperative Program. Accomplish such monitoring through telephone conversations, written communications, and at on-site visits or meetings as may be required. Provide DOE/ID and DOE/HQ with regular updates and evaluations of state team progress.

Task 4.2 Technical Support

Provide geoscience technical support to state teams through conducting studies that support state team efforts or contribute to state team results. Provide geological, geochemical and geophysical consultation and services as appropriate and within available UURI funding. Provide critical technical report reviews.

5.0 Reports, Data and Deliverables

Prepare appropriate reports and deliverables based on the above tasks, including monthly progress reports, a year-end progress report, and technical reports as appropriate.

6.0 Special Considerations

None.

7.0 Proposed Budget

The proposed budget to complete this project is $98,490.

UNIVERSITY OF UTAH RESEARCH INSTITUTE
UURI
EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

September 23, 1988

Ms. Leah V. Street
Idaho - Dept. of Water Resources
Southern Division
2148 4th Ave. East
Twin Falls, ID 83301

Dear Leah:

A few weeks ago I recommended that you try to include a number of nationally recognized geothermal reservoir experts in the mailing list of the RFP for the Boise aquifer study. From our earlier conversation I understand that the standard distribution may be limited to an existing list of qualified Idaho contractors.

I have copied a listing of geothermal reservoir engineering firms for the GRC Registry of Services and highlighted several firms that appear to be qualified and may be interested in your RFP. This list is enclosed. I would also suggest the names of two well-known geothermal consultants, whose names and addresses are given below.

Mr. Joseph L. Iovenitti
Consulting Geologist
2337 Panorama Drive
Concord, CA 94520

Mr. John R. Counsil
Engineering Consultant
1148 Shadyoak Place
Santa Rosa, CA 95404

Please be certain that these firms and individuals are aware of the RFP in order to insure a good response to the RFP.

Sincerely,

Howard

Howard P. Ross
Project Manager

encl.

6.0 SPECIAL CONSIDERATIONS

The California Energy Comission will contribute a portion of administrative and technical salaries and fringe benefits as the state cost share for this project.

To: Ken Taylor, DOE-ID
Marshall Reed, DOE-DGT

From: Howard Ross, UURI

Date: June 8, 1988

STATE TEAM STATUS

1. Arizona - K/Ar Dating Grant Number DE-FG07-86ID12622

Financial:

	Total Funding Authorized	$29,999
	Invoices Through 6/1/88	$18,500
	Total Funds Remaining	$11,499

Project Period: 1-31-89

Deliverables:	Date Received
1. 2 samples, Cerro Prieto -Moore/Reed	4/2/87
2. 2 samples, OR Cascades- DOGAMI-Priest	9/16/87
3. 6 samples, Ascension- UURI- Nielson	9/16/87
4. 4 samples, OR Cascades- DOGAMI- Priest	2/4/88
5. 6 samples, Los Azufres- Moore/Reed	4/4/88
6. 4 samples, OR Cascades- DOGAMI- Priest	4/18/88
7. 1 sample, Ascension- UURI- Nielson	5/4/88

Current Issues:
15 samples remain to be completed; Washington State (DNR) wishes to date 10-12 samples- DOGAMI would like to date 4-6 Damon's lab is not busy at present.

2. Idaho Dept. Water Resources Grant Number DE-FG07-84ID12549

Financial:

	Total Funding Authorized:	$158,579
	Invoices Through 6/1/88:	$125,000
	Total Funds Remaining:	$ 33,579

Project Period: 8-29-88

Deliverables:	Date Received
1. "Geothermal Resource Analysis in Twin Falls County, Idaho": IDWR Final Report	1/11/88
2. "Evaluation of the Boise Geothermal System": Boise State Univ. Final Report	1/11/88
3. "The Hydrothermal System in Central Twin Falls County, Idaho": USGS Final Report (as a subcontractor to IDWR)	Overdue

Current Issues:
USGS report is in final editing, then must wait for printing; delivery date to IDWR is uncertain.

3. Montana-MCMS&T Grant Number DE-FG07-84ID12525

Financial:

	Total Funding Authorized:	$93,421
	Invoices Through 6/1/88:	$92,993
	Total Funds Remaining:	$ 427

Project Period: 6-31-88

Deliverables: Date Received

1. Final Report, Geophysical Research on Geothermal Resources in Montana
   1a) "Three Dimensional Gravity Modeling Techniques with Application to the Ennis Geothermal Area" by D. Semmens — 12/23/87
   1b) "A Controlled Source Ausiomagnetotelluric Investigation of the Ennis Hot Springs Geothermal Area, Ennis, Montana" by G. R. Emilsson — Overdue

Current Issues:
G. R. Emilsson, the student completing the CSAMT study as a Master's Thesis has left the school for employment and has made little progress toward finalizing the thesis and report. Dr. Sill will complete the DOE report this month. Dr. Sill will meet with me in Salt Lake City on 6/8/88 to discuss the changes which I requested.

4. New Mexico-NMRDI — Grant Number DE-FG07-84ID12546

Financial:

Total Funding Authorized:	$109,970
Invoices Through 6/1/88:	$105,609
Total Funds Remaining:	$ 4,360

Project Period: 6-15-88

Deliverables: Date Received

1. Final Report
   1a) South-central New Mexico study (NMSU) — overdue
   1b) Animas Valley (Lightning Dock Geothermal) — overdue
   1c) Orgrande geothermal resource assessment (Lightning Dock Geothermal) — overdue

Current Issues:
Draft final report received 2/1/88; some problems between P. I. and subcontractor (LDG) in responding to UURI critique and P. I. rewrite of subcontractor sections. Final report expected by 1/10/88.

5. Oregon-DOGAMI — Grant Number DE-FG07-84ID12526

Financial:

Total Funding Authorized:	$359,357
Invoices Through 6/1/88:	$279,066
Total Funds Remaining:	$ 80,291

Project Period: 10-31-88

Deliverables: Date Received

Original Grant

Task 1.1 Geologic Map, Breitenbush River Area (1:62,500; GMS-46, 1987) — 8/7/87

Geologic Map, Crescent Mountain Area (1:62,500; GMS-47, 1987) — 8/7/87

Geologic Map, NW/4 of Broken Top 15′ (1:24,000; Spec. Paper 21) — 8/7/87

Task 1.2 Temperature Data Collection — 8/7/87

Geothermal-Geradient Data for Oregon
(1982-1984); Open File Rep. O-86-2
Task 1.3 Project Management and Reporting Quarterly

Mod. M-001
Task 1.1 Feasibility Study/Scientific Plan for Research (Open File Rep. O-86-3) 8/7/87
Task 1.2 Geologic Map, McKenzie Bridge 15' Quad., with data, interp., description.
Task 1.3 Project Management and Reporting Quarterly

Mod. A-002
Task I. Geologic map, approx. 15 sq. mi. centered on CTG drill site, Sec.28,T8S,R8E, E/2 Breitenbush 15'topo quad.
Task II. Raw data and analyses, well core, CTG drill hole. (archival storage at UURI)
Task III. CTG well study: comprehensive report with geologic and geothermal implications and geologic models.

Current Issues: Appears to be on schedule with revised contract close date.

6. Southern Methodist Univ. Grant Number DE-FG07-84ID12623

Financial:

Total Funding Authorized:	$	115,790
Invoices Through 6/1/88:	$	97,817
Total Funds Remaining:	$	17,972

Project Period: 5-31-88

Deliverables: Date Received
1. Annual Data Report (GRC Trans., v.11) 3/14/88
2. Final Tech. Report on Cascades heat flow studies and the Heat Flow Map of North America "U.S. Geothermal Database and Oregon Cascade Thermal Studies", by D.D. Blackwell, J. L. Steele, L. Carter.

Current Issues: Final report should be in the mail,6/8/88

7. North Dakota-NDMMRI Grant Number DE-FG07-84ID12606

Financial:

Total Funding Authorized:	$	47,000
Invoices Through 6/1/88:	$	47,000
Total Funds Remaining:	$	0

Project Period: Closed Out

Deliverables: Date Received
1. Task 5. Geothermal resource map of South Dakota (scale 1:1,000,000) overdue
2. Task 7. Final report."Geothermal Resource 8/28/87

Assessment of South Dakota", by
W. D. Gosnold, Jr.

Current Issues: Dr. Gosnold continues to work on the final map, which is nearing completion. No date has been set for printing and delivery.

r nomore hardcopy

To: S.PRESTWICH (DOE1020)
To: P.WRIGHT (DOE4433)
From: P.WRIGHT (DOE4433) Delivered: Thu 9-June-88 11:25 EDT Sys 164 (57
0)
Subject: STATE SOWS
Mail Id: IPM-164-880609-102770015
Acknowledgment Sent

--More--

MEMO TO: KEN TAYLOR

FROM: HOWARD ROSS

SUBJECT: STATE SOWS

DATE: June 8, 1988

New Mexico Research and Development Institute
Grant No. DE-FG07-88ID________

STATEMENT OF WORK

1.0 INTRODUCTION

The goal of this grant is to support cost-shared research in resource assessment in the Rio Grande rift geothermal province. Several geothermal systems have been identified within the Rio Grande rift, and the U. S. Geological Survey has calculated an acccessible thermal energy resource base of 5.4 x 10^18 Joules for the province in Circular 892. Radon gas soil surveys have been used in the exploration for and delineation of high-temperature systems in the Basin and Range province, and high radon-222 discharges have been documented at Radium Springs and Faywood Hot Springs in New Mexico. The general applicability of time-integrated radon-222 soil-gas surveys to define low-intermediate temperature geothermal resources is not established, however. The purpose of this research is threefold: 1) to test the use of time-integrated radon-222 soil-gas surveys for low-intermediate temperature geothermal resource delineation; 2) to test a geologic model for shallow geothermal resource occurrence; and 3) to characterize and delineate additional geothermal resources.

Previous DOE cost-shared and state-coupled resource assessment programs have played an important role in geothermal resource discovery, characterization, and utilization in New Mexico. The proposed research will provide a test of the radon-222 soil-gas survey method as a cost-effective exploration technique for geothermal resources in the Rio Grande rift environment and will accomplish a preliminary resource assessment of three areas.

2.0 SCOPE

The technical objectives of this research are to conduct resource assessment in the southern Rio Grande rift geothermal area of New Mexico. The testing of a new and previously untried exploration technique for low-to-intermediate temperature geothermal resources is a part of the resource assessment work. Radon-222 surveys will be conducted using Track-Etch radon detectors and established survey techniques at the Tortugas Mountain, Radium Springs, and Rincon areas. The survey results will be used to test a proposed geologic model for shallow low-to-moderate temperature geothermal resource occurrence in the southern Rio Grande rift, and to characterize and delineate additional resource areas. The survey and research results will be documented and evaluated, and presented in a final report. All project work will be completed and a final report submitted within an 18 month period.

3.0 APPLICABLE DOCUMENTS

The research described herein is abstracted from a proposal titled "Evaluation of Time-Integrated Radon Soil-Gas Surveys in the Southern Rio Grande Rift", dated June 17, 1987 as amended October 16, 1987. This proposal was submitted by the New Mexico Research and Development Institute in response to a DOE/ID Program Research and Development Announcement (PRDA) for State Geothermal Research and Development - PRDA No. DE-PR07-87ID12662.

4.0 TECHNICAL TASKS

The following tasks will be accomplished under this Grant.

4.1 Complete two soil-depth, radon gas surveys to determine radon concentrations as a function of soil depth and type, and to determine the preferred burial depth for the time-integrated radon detectors. One survey will profile radon soil gas over a young geomorphic surface with little or no caliche development. The other depth profile will detail radon soil gas over an old geomorphic surface with well-developed caliche. A total of 15 soil background concentration measurements and 15 time-integrated field measurements will be made.

4.2 Tortugas Mountain Survey. Complete one reconnaissance radon soil-gas profile eight miles in length and two detailed radon profiles with a total length of nine miles in the Tortugas Mountain area. The reconnaissance profile will include 40 pairs of soil background and time-integrated field measurements. The detailed profiles will include 270 pairs of soil background and time-integrated field measurements. Evaluate and interpret these data using known Hg soil-gas, U-238 and U-238 disequilibrium data, temperature gradient infor- mation, and electrical resistivity and seismic reflection data.

4.3 Radium Springs Survey. Complete one radon soil-gas grid survey of seven square miles, three detailed radon profiles with a total line length of two miles, and two temperature-gradient holes in the Radium Springs survey area. The radon grid survey will include 175 pairs of soil background and time-integrated field measurements. The detailed profiles will include 60 pairs of soil background and time-integrated field measurements. Evaluate and interpret these data. The temperature gradient holes will be drilled to a maximum depth of 300 feet (91 m) and completed with PVC pipe in a manner suitable for accurate temperature measurements. Temperatures will be measured at 2-meter intervals with a thermistor temperature measurement tool. A minimum of two logs will be completed for each hole, one shortly after drilling and one at least two weeks later.

4.4 Rincon Survey. Complete one radon soil-gas grid survey, two and one-half square miles in area, one detailed radon profile totaling one mile in length, and two temperature-gradient holes. The grid survey will include 60 pairs of soil background and time-integrated field measurements. The detailed profiles will include 30 pairs of soil background and time-integrated field measurements. The temperature gradient holes will be drilled to a maximum depth of 300 feet (91 m) and completed with PVC pipe in a manner suitable for accurate temperature measurements. Temperatures will be measured at 2-meter intervals with a thermistor temperature measurement tool. A minimum of two logs will be collected for each hole, one shortly after drilling and one at least two weeks later.

4.5 Complete an evaluation and interpretation of all the radon soil-gas and temperature gradient data. Prepare a final report which will include a description of the proposed model for shallow geothermal resource areas in the study area, a description of the research methodology and radon field surveys, a description of the temperature-gradient data summaries, and qualitative and quantitative interpretation of the research results. Complete an evaluation of the use of radon soil-gas surveys for low-to-moderate temperature geothermal resource exploration, and recommendations for future work.

5.0 REPORTS, DATA, AND OTHER DELIVERABLES

5.1 Management Records

Reports will be due as indicated on the Federal Assistance Reporting Checklist and the Report Distribution List.

5.2 Final Report

A detailed final technical report will be prepared which will describe the radon soil-gas field studies, the observed data, and the evaluation and interpretation of the radon soil-gas and temperature gradient data. The locations of field samples and drill holes will be included, and all data will be tabulated, in appendicies. A draft final report will be submitted for review and comment not less than 45 days prior to the scheduled delivery of the final report.

6.0 SPECIAL CONSIDERATIONS

The State of New Mexico will contribute direct monetary and administrative (in kind) support to this project as a state cost share.

California Energy Commission
Grant No. DE-FG07-88ID_______

STATEMENT OF WORK

1.0 INTRODUCTION

The goal of this grant is to support cost-shared research in resource assessment which will study the suitability of moderate-temperature geothermal resources in Northern California for well-head power generation. Site-specific resource assessment will be conducted at the Wilbur Hot Springs area to determine resource characteristics which will be used as a model to test the applicability of several well-head generation technologies. An atlas and matrix of resource characteristics versus well-head generation technology will be developed for other moderate-temperature geothermal resources in northern California. The results of this analysis is expected to benefit utilities, energy planners and small power producers by demonstrating geothermal resource availability, resource characteristics, and the associated geothermal power cycles suitable for each site.

2.0 SCOPE

The technical objectives of this research are twofold. An extensive geochemical survey will be completed in the area defined by a negative gravity anomaly, centered approximately 1.5 km south of Wilbur Hot Springs, to better delineate and characterize this moderate-temperature geothermal resource. The geochemical survey will include a radon soil-gas survey and trace-metal investigation, and sampling of all surface and hot spring waters which can be located. The results of these studies, integrated with existing data, will be used to site an eventual production well to support a well-head power generation system. Based on the information derived from the power generation assessment of the Wilbur Hot Springs area, an evaluation of resource characteristics and optimum geothermal power generation systems will be completed for other potential moderate temperature geothermal areas in northern California. A geothermal atlas for the northern California area will be completed which will include graphs showing economical geothermal capacity in megawatts as a function of system power costs in dollars per kilowattt-hour, using estimated resource temperatures and production rates. All project work will be completed, and a final report submitted, within a 12 month period following California legislature approval of cost share funding.

3.0 APPLICABLE DOCUMENTS

The research described herein is abstracted from a proposal titled "Resource Assessment of the Wilbur Hot Springs Area", dated June 19, 1987 as revised October 7, 1987. This proposal was submitted by the California Energy Commission in response to a DOE-ID Program Research and Development Announcement (PRDA) for State Geothermal Research and Development - PRDA No. DE-PR07-87ID12662.

4.0 TECHNICAL TASKS

The following tasks will be accomplished under this Grant.

4.1 Wilbur Hot Springs Site-Specific Study

4.1.1 Conduct a literature search for all pertinent geologic and geothermal information concerning the Wilbur Hot Springs area including the published literature, geologic maps, geophysical data, unpublished reports, dissertations, theses, well logs, open file reports, water information and subsurface logs. Complete an analysis and evaluation of these data.

4.1.2 Complete a geologic field reconnaissance of the Wilbur Hot Springs area and the adjacent negative gravity anomaly area. Acquire stereo aerial photographic coverage and interpret this photography for fault intersections, lineaments, spring locations, surface manifestations of hot spring activity, leaching, mineralization, and other significant geologic features. Complete reconnaissance-level field mapping to document structural features and hot and cold springs identified from aerial photos, and establish a grid system for the soil geochemical survey.

4.1.3 Complete soil geochemical surveys and the sampling of all surface and spring waters in the area including the negative gravity anomaly and Wilbur Hot Springs. The geochemical surveys will include radon soil-gas observations using Terra-Tech radon detectors, and analyses of soil samples for trace metals characteristic of the gold-mercury-geothermal association. Surface and spring waters will be sampled and analyzed to determine chemical characteristics and subsurface temperatures. Complete a draft technical report summarizing the results of all geochemical studies and recommending a location for the drilling of a production or exploration well.

4.2 Optimum Geothermal Power Cycles Study

4.2.1 Complete technical data collection for optimum geothermal power cycle determinations from sources such as the Electric Power Research Institute (EPRI), Geothermal Resources Council (GRC), the Heber binary-cycle demonstration plant, and various equipment manufactures.

4.2.2 Evaluate the technical data obtained in Task 4.2.1 for consistancy and completeness and compile available data on costs and performance. Update technical data, efficiencies, and cost data to the present day. Obtain relevant experience data from existing wellhead power plant operators.

4.2.3 Develop a validated technical database for relevant capital equipment costs, operating and maintenance costs, and performance and operating characteristics based on the data and analysis of task 4.2.2.

4.3 Site-Specific Geothermal Technology Characterization for Potential Resource Areas in Northern California.

4.3.1 Complete a study of constructing a utility-scale power plant at Wilbur Hot Springs and evaluate the economic potential of the well-head modular systems.

4.3.2 Develop a geothermal atlas for the northern California area to show the potentials of geothermal resource availability, resource characterics, and the associated types of geothermal power cycles for these resources. Prepare graphs which show economical geothermal capacity in megawatts as a function of system power costs in dollars per kilowatt-hour. Evaluate the implications of these data with respect to future power costs, priorities for future development and the time frame when well-head geothermal resources will be economical.

4.4 Prepare a final report which summarizes the results of the Wilbur Hot Springs assessment and the integration of the site-specific Wilbur Hot Springs resource data with the technology assessment data. The Geothermal Atlas for northern California moderate-temperature geothermal resources will be completed as a separate document but is included as a part of the final report.

5.0 REPORTS, DATA, AND OTHER DELIVERABLES

5.1 Management Records

Reports will be due as indicated on the Federal Assistance Reporting Checklist and the Report Distribution List.

5.2 Deliverables

The deliverables for this grant will include a detailed final technical report for the Wilbur Hot Springs site-specific study, and the Geothermal Atlas for northern California moderate-temperature geothermal resources. The final report for the site-specific study will discuss in detail the relevant results of the literature search, the aerial photo and field reconnaissance study, and the soil and fluid geochemical surveys. Sample locations and analytical results will be fully documented in the text or in appendicies, as is appropriate. The Geothermal Atlas for northern California will include a stand-alone summary of the technology database developed in the study and the tabulation and discussions of northern California resources and well-head power generation potential. A draft final report for each document will be submitted for review and comment not less than 45 days prior to the scheduled delivery of the final report.

UNIVERSITY OF UTAH RESEARCH INSTITUTE
UURI
EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

July 7, 1988

Dr. Dave Blackwell
Dept. of Geological Sciences
Southern Methodist Univ.
Dallas, Texas 75275-0395

Dear Dave:

Transmitted herewith are the two Open File data items which you requested. I have also enclosed a new Open File data list with current prices and availability.

I note that there are three McCoy temperature gradient data items, all authored by AMAX Exploration, Inc. The descriptive title seems to be the best title use in referring to them. I believe they were all released to UURI, and to Open File in 1982, although items 1 and 2 may have been completed earlier, i.e. 1980.

Thanks for sending the final reports, so we can start to close out the contract (except for the new supplemental funding). I have not yet received the additional maps, but I trust that they are on the way.

Regards,

Howard

Howard Ross
Section Head/ Applied Geophysics

encl.

UNIVERSITY OF UTAH RESEARCH INSTITUTE
UURI
EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

March 23, 1988

Dr. David D. Blackwell
Department of Geological Sciences
Southern Methodist University
Dallas, Texas 75275-0395

Dear Dave:

Thank you for your package of March 10 which included quarterly reports, a copy of the last no cost time extension, the request for a new one through 5/31/88, and the draft copy of your final report.

I have enjoyed reading your draft final report. It certainly gave me a better appreciation for your project, especially the magnitude of the "Geothermal Map of North America" task. The report is well written, and presents the data in tables, figures, and appendices in a clear, efficient manner.

I have noted a few typos and suggested wording changes, and other comments in the margins of the text. A few other comments are included on the enclosed comment page. Please feel free to use these thoughts if you feel they may improve the text. One part of the text that does concern me are the discussions relating to the temperature gradients from 150 m holes being adequate to evaluate thermal conditions at much greater depth. In view of the "rain curtain" effect and possible intraborehole flow demonstrated in some parts of the Oregon Cascades, the area for which this conclusion applies, and any limitations to this conclusion, should be very clearly spelled out. My concern is the improper use of shallow thermal gradient holes by industry (and others) which could be based on a misunderstanding of your report.

I have included in my comments a list of fairly recent reports, mostly funded under the DOE State Cooperative Geothermal Program, which were not cited in your Appendix B. In some cases the basic data may be available from a cited source. It may be too late to add new data to the DNAG map or data base, but I thought I should make sure that you are aware of these references anyway. Perhaps some of these should be included as "Other References" or in some other fashion for completeness.

Dave, thank you very much for the opportunity to review the draft copy of your report. As far as I am concerned, only minor changes need to be made to bring the report to final form. Please feel free to call me to discuss any of my comments.

Sincerely,

Howard

Howard P. Ross
Project Manager

encl.

REVIEW COMMENTS

U. S. GEOTHERMAL DATABASE AND OREGON CASCADE THERMAL STUDIES

1. The DOE Contract No. is noted on the title page and cover page. Would it also be appropriate to state in the introduction that the study has been completed under funding from the U. S. Department of Energy, Grant No. -----?

2. Thanks for remembering to include the Disclaimer statement. Could this be done in a little larger type , or in a clearer print?

3. Page 6, Para. 1. The discussion regarding high thermal gradients determined from shallow holes (150 m) which can be extrapolated to great depth to calculate regional thermal conditions is confusing. Does this apply only to the area shown by the pattern in Fig. 2, and to all of this area? Certainly it does not apply to many regions of lateral cold water flow, or to the areas of holes N-1, N-3, CTGH-1, USGS-NB-2, SAN-RD01. To what extent can geothermal explorationists use this 150 m temperature gradient hole guideline?

4. Page 14, Para. 3. The conclusion about extrapolating results of 150 m holes to depths of 2.5 km should be less general. The gradient for CTGH-1 does not become a conductive gradient until 400 m or more- see figure 5.

5. Table 1. What is N? - If it is the number of thermal conductivity samples, it is not in agreement with Table 2. Please identify.

6. Figures 1-7. Include Figure number in final report.

7. Fig. 2. Names are faded out in xerox copy (Mt. Jefferson, Three Sisters, Newberry Crater).

8. Fig. 3. No arrow at 350 - 400 m as referred to in text.

9. Fig. 6. A pattern to bring out the ground surface would be helpful.

10. Fig. 7. Does the dashed line represent the estimated conductive gradient?

OTHER REFERENCES WITH THERMAL GRADIENT-HEAT FLOW DATA

Barnett, B., The 1985 Geothermal gradient drilling project for the State of Washington; D.O.E. Contract No. DE-AC07-79ET27014, Washington DNR Open File Rep. 86-2, 34 pp., 1986.

Budding, K. E., and S. N. Sommer, Low-temperature assessment of the Santa Clara and Virgin River Valleys, Washington County, Utah; Utah Geological and Mineralogical Survey Spec. Studies 67, 34 pp., 1986.

Cunniff, R. A., New Mexico State University Geothermal Exploratory Well, 26 pp., in New Mexico Statewide Geothermal Energy Program, L. Icerman and S. K. Parker, eds., New Mexico Research and Development Institute Final Tech. Rep. to DOE, 1988.

Cunniff, R. A., and R. L. Bowers, Temperature, water-chemistry, and lithological data for the Lightning Dock Known Geothermal Resource Area, Animas Valley, New Mexico, 34 pp., in New Mexico Statewide Geothermal Energy Program, L. Icerman and S. K. Parker, eds., New Mexico Research and Development Institute Final Tech. Rept. to DOE, 1988.

Cunniff, R. A., and R. L. Bowers, Preliminary Geothermal Resource Assessment of the Orogrande, New Mexico, Area, 38 pp., in New Mexico Statewide Geothermal Energy Program, L. Icerman and S. K. Parker, eds., New Mexico Research and Development Institute Final Tech. Rep. to DOE, 1988.

Gosnold, W. D., Jr., Geothermal Resource Assessment - South Dakota, Final Rep. to DOE, Univ. of North Dakota, Bull. No. 87-07-MMRRI-01, 159 pp., 1987.

Heasler, H. P., Geothermal modeling of Jackson Hole, Teton County, Wyoming, Final Rep. to DOE, Grant. No. DE-FG07-85ID12607, Univ. Wyoming, Dept. Geology and Geophysics, 35 pp., 1987.

Mabey, D. R., and K. E. Budding, High-temperature geothermal resources of Utah, Utah Geol. and Min. Survey, Bull. 123, 64 pp., 1987.

Ross, H. P., D. L. Nielson, and J. N. Moore, Roosevelt Hot Springs Geothermal System, Utah - Case Study; AAPG Bull., v. 66, p. 879-902, 1982.

Semmens, Dave, Three dimensional gravity modeling techniques with application to the Ennis Geothermal Area, 183 pp., unpublished Master's Thesis and Final Rep. to DOE, Montana College of Mineral Science and Technology, 1987.
(includes thermal gradient and heat flow data not published elsewhere)

Smith, D. L., Heat flow in Arkansas, unpublished Final Tech. Rep. to Univ. Utah Res. Inst. by Univ. of Florida, Dept. of Geology, 37 pp., 1987.
(you should have received a copy of these data via Dr. Smith-perhaps he has a better publication reference by now)

* Witcher, J. C., R. Schoenmacker, and J. Whittier, Geologic, geohydrologic, and thermal settings of Southern New Mexico geothermal resources, 116 pp., in New Mexico Statewide Geothermal Energy Program, L. Icerman and S. K. Parker, eds., Final Tech. Rep. to DOE, New Mexico Research and Development Institute, 1988.
(a fine summary report of thermal gradient and heat flow data in south central New Mexico- Dr. Witcher may have a more accessible reference to these data)

Dave,

I realize it is rather late to add or include some of these data in the map or database listing, if they haven't already been transmitted to you by the authors. Perhaps you could find some way to include these in you geothermal references, however.

DUNCAN FOLEY * Geologist
P.O. Box 45246 Tacoma, Washington 98444 (206) 536-1065

December 17, 1987

Dr. Howard Ross
Earth Science Laboratory
University of Utah Research Institute
391 Chipeta Way, Suite A
Salt Lake City, UT 84108

Dear Howard:

It was good to talk to you last Friday, even if you did not have good things to say about the amount of snow in the mountains. Maybe our Cascade cement is starting to look pretty good after all.

I am sorry to be slow in getting this brochure to you, but this is finals week, and my time has been rather filled with, in the spirit of the season, a lot of giving. And grading. I have searched my files, and have enclosed a few things for your information. I am sending along a copy of the Colorado Geological Survey list of publications. The two lists of state team work compiled by Carl Ruscetta are ESL publications 60 and 99. There should be extra copies of these in the store room.

Eastern publications may be difficult to track down. Joel Renner should have some sense of how many reports were created, but he may or may not have a comprehensive list. ESL should have extra copies of the report by Gerry Brophy that I told you about. ESL should also have library copies of all the reports by Johns Hopkins, but they may be listed under Fletcher Paddison, Johns Hopkins, or the Applied Physics Laboratory in the ESL library. ESL, to the best of my knowledge, never had a complete list of publications done by Costain and others at VPI, nor did we have listings from work done by NYSERDA, DOE at Crisfield, MD., and perhaps others. Joel may know about these; otherwise the best option would be to get a list of publications from NTIS.

State publication lists are available from the State Couple Program participants, especially the state geological surveys. There may also be state publications on geothermal energy that were not funded by the State Coupled Program or any of its DOE-funded relatives (e.g. Gordon Bloomquist, OIT, etc.). I suggest that you have Bennie write directly to the state surveys, universities, and energy agencies involved in the program to get a list of other possible publications. State survey addresses were published in the October issue of Geotimes.

Sincerely,

Duncan Foley

DUNCAN FOLEY
GEOLOGIST
P.O. Box 45246
Tacoma, WA 98444
(206) 536-1065

Oct. 12, 1987

Dr. Howard Ross
Earth Science Laboratory
University of Utah Research Institute
391 Chipeta Way, Suite C
Salt Lake City, Utah 84108

Dear Howard:

Attached please find review sheets that I have prepared after our meeting in Idaho earlier this week. I have been brief on the sheets, but hope that my comments will be suitable. If you would like more detail, I will be happy to provide it. Note that there are two editions of the sheets: one dated Nov. 10, on which I have randomly written the concensus review scores, and a second form dated Nov. 11, on which concensus scores are found at the bottom.

I have also enclosed a copy of the Washington Department of Natural Resources proposal (Part I only).

I will be sending a statement soon, but do not hesitate to let me know if there is anything else you need. I have enjoyed this project, but in the interest of all I hope that we can bring it to a conclusion soon.

Sincerely,

Duncan

Duncan Foley

UNIVERSITY OF UTAH RESEARCH INSTITUTE
UURI
EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

October 14, 1987

Ms. Leah V. Street
Idaho-Department of Water Resources
2148 4th Avenue East
Twin Falls, ID 83301

Dear Leah:

Peggy Brookshier and Susan Prestwich have asked me to forward to you some additional comments on the Waag report, together with suggestions for changes in the text. I have compiled comments by Ben Lunis, DOE staff and others in addition to my own. Some of these may duplicate your own thoughts.

As you know we are concerned about the details of wording and conclusions because of the limited monitoring period and some limitations on the data base, because no quantitative or statistical study has been undertaken to support the interpretation, and because of an apparent conflict-of-interest on the part of Dr. Waag.

Please try to effect the changes which you think are appropriate as well as the others you have already pointed out. Please call me if you wish to discuss any of these comments in more detail. I hope that Dr. Waag is agreeable to these minor changes, and can complete the report very soon.

Best Regards,

Howard

Howard Ross
Project Manager

cc: P. A. M. Brookshier
S. M. Prestwich

enc.

HPR:kr

COMMENTS, DR. CHARLES WAAG REPORT 2nd DRAFT
2

1. Report needs a title and cover page

2. Report needs an acknowledgement of funding source: ID-DWR and DOE Grant

3. Report needs a List of Illustrations and Tables.

4. Report needs a Table of Contents

5. Include a DOE disclaimer statement (Strengthened, and in a prominent page position as suggested by Leah Street)

6. Pg. 1-2; para 3, l. 1 delete "and exploitation"

7. Pg. 1-2, para 3, l. 2 delete "an annual"

8. Pg. 1-3, para 2, l. 2 delete "Therefore, the most obvious explanation," replace with "One likely explanation"

9. Pg. 1-4, para 3, l. 1,2 Suggest "The aquifer seems to have been near or at equilibrium prior to the 1983-84 production by the ..."

10. p. 1-4, l- 5 noteworthy, not "note worthy"

11. p. 1-5, para 2, **Suggest** "The increasing rates of decline in the recovery levels, evident since 1983, occurred without a significant corresponding increase in geothermal fluid production by the principal producers; it is cause for pause and concern."

12. p. 1-5, para 3, l. 3-9 **Suggest rewording of** "Serious consideration should be given to restricting further development and production from the system until we have a petter understanding of its recharge and thermal transfer characteristics, and its overall capacity for fluid production. Consideration should also be given to a requirement for reinjection of produced waters where feasible. Although the data base is insufficient to predict ... accurately ..."

13. p. 1-6, para 1, l. 2 "Suggests that an effective program of reinjection will significantly affect the economic productivity and extend the life of the resource."

14. p. 1-6, **Comment:** High recovery indicated by data taken since this spring by the City do not appear to be acknowledged.

15. p. 1-11, para 2, "Expansion of demand ...." This paragraph is a restatement of the previous page and should be deleted.

16. p. 1-12, duplicates p. 1-9 - **delete it**

17. p. 2-1, para 1, l. 8 "Figures 2-2 and 2-3 show drawdown ..." l. 10. "in thousands of gallons per minute (Kgpm) from ..."

18. p. 2-2, Figure 2-1, Map reproduction is of poor quality and difficult to read. Distance sale is lost in map detail. Label is difficult to read, needs capitalization of first words, etc.

19. p. 2-3, Figure 2-2, Vertical scale should be KGPM (I believe)

20. p. 2-4, Figure 2-3, (Same as above)

21. p. 2-7, para 1, l. 6 "... was well ahead of last year." **replace** last year with 1986-87 or 1984-85, whichever is intended - it's not clear from text or Figure 2-4.

22. p. 2-8, Fig. 2-4, Since water level is plotted in the inverse since, i.e., depth to water level, it would be useful to also plot an elevation sale with values on the left hand axis as for Fig. 2-2, 2-3.

23. p. 2-12, para 2, l. 3 **delete** "arbitrary" (not necessary and begs comment)

24. p. 2-19, para 1, l. 5 "These fluctuations are clearly ..." **replace** "with these fluctuations are interpreted as responses..." (no data are presented)

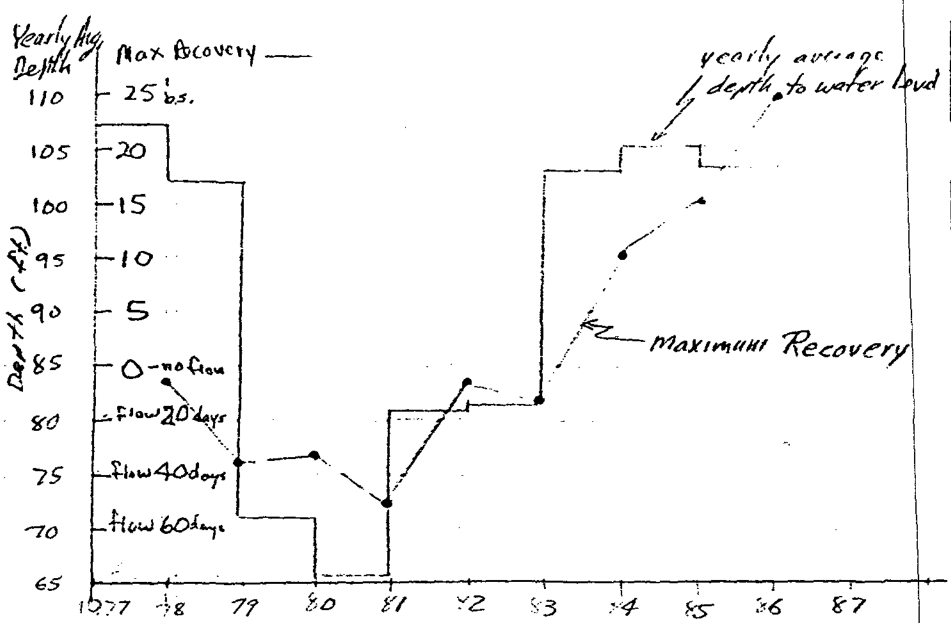
25. p. 2-20, para 1, l. 7 **delete** "clearly"

26. p. 2-27, l. 3 from bottom "annual head change" not "annual head charge"

27. p. 2-27, para 2, **Comment:** The analysis of a 100-110 feet cold water table fluctuation to induce the recorded potentiometric surface fluctuations must include other assumptions, i.e., (no) leakage from the cold water aquifer, rigidity, recharge variations etc. Are these sufficiently described on pg. 2-27, and 2-28?

28. p. 2-35 **Comment:** An attempt to graph the data of Table II and III(see attached graph) verifies that in general a good

correlation does exist; the correlation is substantially less than 100% (1:1) however, especially pre-1979. Thus some other factors are involved. This is adequately discussed on page 2-36.



Comparison of Tables II and III

Yearly Average Depth to Water Level
and
Maximum Recovery Level
(depth below surface)

UNIVERSITY OF UTAH RESEARCH INSTITUTE

UURI

EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108-1295
TELEPHONE 801-524-3422

November 5, 1987

Michael A. Korosec
Division of Geology and Earth Resources
Washington State Department of National Resources
Mail Stop PY-12
Olympia, WA 98504

Dear Mike:

Enclosed are one of the information sheets Dr. Damon requires for age dating of samples, and a brief memo describing sample collection procedures and guidelines.

As I noted in our telephone conversation, I will be able to discuss the number of samples that can be done under Damon's grant after the solicitation process is completed. I will call you then.

Sincerely,

Howard

Howard P. Ross
Project Manager

HPR:kr

encl.

DUNCAN FOLEY
GEOLOGIST
P.O. Box 45246
Tacoma, WA 98444
(206) 536-1065

Nov. 1, 1987

Dr. Howard Ross
Earth Science Laboratory
University of Utah Research Institute
391 Chipeta Way, Suite C
Salt Lake City, Utah 84108

Dear Howard:

Enclosed are two signed copies of the extension to my consulting agreement with the Earth Science Laboratory. Everything looks to be in order, and I have signed the copies.

I received a package from Peggy on Friday, which contained information from several states. I will be ready to comment on this material when I see you next Sunday, and when we meet with DOE in Idaho Falls on the 9th of November.

If you need to reach me after I arrive in Salt Lake City, I will be at 272-0526.

Sincerely,

Duncan

Duncan Foley

TO: Susan Prestwich

FROM: Howard Ross

DATE: October 28, 1987

SUBJECT: Suggested Text of Memorandum to Active State Cooperative Program Teams from Susan Prestwich

M E M O R A N D U M

Effective immediately Susan Prestwich will replace Peggy Brookshier as the DOE Project Officer for active State Cooperative Reservoir Analysis Program (SCP) grants. Peggy Brookshier has been transferred to the Electric Vehicle Program and will leave the SCP upon completion of her responsibilities with the 1987 SCP PRDA. All reports and correspondence formerly addressed to Peggy Brookshier should now be directed to Susan Prestwich. Susan has previously been a Project Officer for SCP grants and contracts and looks forward to a more active involvement with the SCP. R. Jeffrey Hoyles continues as the DOE Contracting Officer for SCP grants.

Please review the DOE reporting requirements for your grants. Quarterly reports, Federal Assistance Management Summary Report and Federal Assistance Program/Project Status Report, are due 15 days after the end of the calander quarter. Draft copies of technical reports and maps are due 45 days prior to the grant completion date for technical review by DOE and UURI. Please be sure to distribute copies of quarterly and technical reports, and invoices, to Howard Ross, UURI, to expedite our review and comment.

UNIVERSITY OF UTAH RESEARCH INSTITUTE
UURI
EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

MEMORANDUM

TO: Peggy Brookshier
Susan Prestwich

FROM: Howard Ross

SUBJECT: State Cooperative Program Monthly Report
September, 1987

DATE: October 14, 1987

Draft Statements of Work (SOW) were completed for the Wyoming and North Dakota grants which should result from the 1987 State Cooperative Program PRDA. Technical evaluation sheets were also completed for the Wyoming and North Dakota proposals, and then submitted to DOE/ID.

Chapters 1 and 2 of the revised Boise Geothermal System report by Dr. Charles Waag were reviewed and comments sent to DOE/ID and to Ben Lunis, EG & G. Some phrasing of observations and conclusions could still be regarded as sensitive in these chapters, but the observations are generally valid and should be stated with only minor changes. Further discussion of the report may be warranted in October.

Routine project monitoring activities during September included calls to the Montana team requesting action on overdue final technical reports and a no cost time extension, and tracking of the Idaho-DWR report status. UURI also responded to questions regarding proposals to the 1987 PRDA.

Howard Ross

Howard Ross
Project Manager

UNIVERSITY OF UTAH RESEARCH INSTITUTE
UURI
EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

MEMORANDUM

TO: Peggy Brookshier
Susan Prestwich

FROM: Howard Ross

SUBJECT: State Cooperative Program Monthly Report August 1987

DATE: October 14, 1987

State Cooperative Program (SCP) activity at UURI continued at reduced level during August due to the interim status of state team reporting, the notification period for the PRDA responses and vacation and other project activities at UURI.

SCP activities included the review and logging of state team invoices and telephone calls to monitor project status and reporting for selected teams. Several attempts to contact Roman Motyka and Christopher Nye (Alaska-DGGS) were unsuccessful so a letter was sent requesting a project update and a letter asking for a no cost time extension to the existing grant. Conversations with Larry Icerman (New Mexico team) provided assurance that no data obtained under the new contract modification (M003) would be held proprietary. Telephone calls were made to Idaho, North Dakota, and Montana teams regarding the status of final technical reports.

Howard Ross
Howard Ross
Project Manager

UNIVERSITY OF UTAH RESEARCH INSTITUTE
UURI
EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

September 2, 1987

Marshall Reed
Geothermal Technology Division
Mail Stop CE-342
1000 Independence Ave, S.W.
Washington, D.C. 20585

Dear Marshall:

Enclosed is your copy of the final report "Heat Flow in Arkansas" by Dr. Douglas Smith, University of Florida. You will recall that this work was completed with minor funding support through a UURI Purchase Order.

Although the new heat flow data are certainly significant data points, the results are not encouraging for any new geothermal potential. Work progresses (slowly) on the new grants resulting from the PRDA.

Best regards,

Howard

Howard P. Ross
Geophysicist

Enclosure

HPR:vb

UNIVERSITY OF UTAH RESEARCH INSTITUTE
UURI
EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

June 9, 1987

Dr. William Sill
Dept. of Physics and Geophysical Engineering
Montana College of Mineral Science and Technology
Butte, Montana 59701

Dear Bill:

Thanks for the opportunity to review the thesis by Gunnar Robert Emilsson, "A Controlled Source Audiomagnetotelluric Investigation of the Ennis Hot Springs Geothermal Area, Ennis, Montana" which is part of the final report deliverable to DOE.

The thesis is generally well written and seems to summarize the study quite nicely. I was perhaps a little disappointed that a more complete comparison of the CSAMT and the gravity survey results was not included. I do understand that these were separate thesis projects and a detailed integration of the two results may have been beyond the scope of each study.

I have enclosed a list of general comments for your consideration and have enclosed the text with comments re typos, grammar, spelling, etc. The main areas that need to be addressed are references and illustrations. I have not checked all the equations; I trust that you will.

Please call me to discuss any of these comments. I hope that the necessary changes can be made promptly so that the final report can be submitted to DOE-ID by June 30.

Sincerely,

Howard
Howard Ross
Project Manager

encl.
cc: Peggy Brookshier

REVIEW COMMENTS

"A CONTROLLED SOURCE AUDIOMAGNETOTELLURIC INVESTIGATION OF THE ENNIS HOT SPRINGS GEOTHERMAL AREA"

1. Cover Page. Please submit the report with a cover page that identifies it as a final report to DOE with title, author, institution, date, etc. The present thesis title page can follow.

2. DOE Disclaimer Page. A standard DOE disclaimer should be included, perhaps on the inside cover.

3. References. The most obvious problem with the report as presently written is referencing. There are many missing references, some incorrect dates, and incomplete and inconsistant references.

4. Grammar. Some incorrect grammar, typos, and suggestions for alternate word usage are noted in the text.

5. Abstract and Conclusion. The buried conductive layer in the center of the valley is attributed to a thick layer of clay. Has the possibility of low resistivity fluids (i.e. higher t.d.s.) confined to a single porous horizon been ruled out?

5. A more complete discussion of how the CSAMT model relates to the detailed gravity model of Semmons, 1987 would be useful.

6. Illustrations. The size of lettering is too small, and/or the quality of copy too poor to be legible for portions of several illustrations. This is especially important for model parameters and results, and data, i.e. Fig. 6,7,8,9, 11. Other illustrations could benefit from increased labeling such as north arrows, direction labels on axes, hatchuring of closed lows, etc. as on Fig.13, 14, 15, 16, 17, 18,19,28,30,33,35. It would be most useful to outline the Ennis CSAMT survey area on the regional AMT data maps, Fig. 20,21.

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UURI
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SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

May 5, 1987

William D. Gosnold, Jr.
Mining and Mineral Resources Research Institute
Box 8103, University Station
Grand Forks, N. D. 58202

Dear Will:

Thank you for the opportunity to review the first draft of your final report, "Geothermal Resource Assessment, South Dakota".

The report format and content of Sections I - IV look fine, even at this first draft stage, and the technical material is both interesting and significant. I have noted a few comments in the text and on the attached comment page. I'm certain that you would have caught most of these on the next iteration, but thought I'd note them now just to be sure.

Will, this has been a productive study both for you and for DOE. Your methodology for the subsurface thermal resource evaluation is clearly described and nicely applied. I would be pleased to review the final draft of the report when you have completed it.

Sincerely,

Howard

Howard Ross
Section Head/Geophysics

encl
cc: P. Brookshier

COMMENTS ON FIRST DRAFT
GEOTHERMAL RESOURCE ASSESSMENT, SOUTH DAKOTA

Page	Description
i	Table of Contents - Section titles not quite the same as in the text. - Include VII - References - Appendicies listed independent of Chapters.
2	Geothermal Resource Defn.- It would be useful to begin this section with a 1/2 page description of the general geology of South Dakota incorporating reference to Fig. 1, stratigraphy. Also note major changes in stratigraphy throughout the state that would differ from Fig. 1.
3	Eq. 1 -4, etc. You could use a small k for thermal conductivity to differentiate from K (temperature).
6	Is the reference to Sass and Galanis 1983 or 1984 as used later?
6	A schematic diagram of the two modes of advective transfer would be helpful - i.e. Circl. 892, p.19, 20.
6	Eq. - Check form of equation; define R.
10	Could you comment on the accuracy of the estimates of recoverable water (+/- % or +/- x km3); and of q_r? These would be of general interest.
13-15	Conclusions - The discussions of applicability to petroleum exploration (thermal maturity), and to CSDDP are certainly of interest. Will there also be some discussion of: areas and units most promising for development of geothemal waters? colocation of resource and users? highest temperature fluids? possible application types, etc.? This information may be of more direct use in stimulating direct use of geothermal fluids.

Appendix A-1, and A-2 would benefit from a cover page, and perhaps a short (1/2 page) description of program function and parameters, and comments as indicated in pencil on the draft.

References - the dates of some references vary from citation to citation.

Don't forget to include: DOE Disclaimer; Funding Acknowledgement; References: List of Illustrations;

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391 CHIPETA WAY, SUITE C
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TELEPHONE 801-524-3422

May 12, 1987

Dr. Duncan Foley
Dept. of Earth Sciences
Pacific Lutheran University
Tacoma, WA 98447

Dear Duncan:

Transmitted herewith are three copies of the UURI Independent Consultant Agreement for your work on the State Cooperative Program review panel. The agreement has been endorsed by Mike Wright and myself. If you are in agreement with the terms of this agreement please endorse all copies and return the original and one copy to me.

I look forward to bringing you up to date on SCP activities, and to comparing notes on the various teams. See you in June!

Regards,

Howard

Howard Ross
Project Manager

encl.

May 5, 1987

William D. Gosnold, Jr.
Mining and Mineral Resources Research Institute
Box 8103, University Station
Grand Forks, N. D.   58202

Dear Will:

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Sincerely,

Howard Ross
Section Head/Geophysics

encl
cc: P. Brookshier

COMMENTS ON FIRST DRAFT
GEOTHERMAL RESOURCE ASSESSMENT, SOUTH DAKOTA

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Don't forget to include: DOE Disclaimer; Funding Acknowledgement; References: List of Illustrations;

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UURI

EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

M E M O R A N D U M

TO: Peggy A. M. Brookshier
Susan M. Prestwich
Trudy A. Thorne

FROM: Howard P. Ross

SUBJECT: Comments regarding September 11, 1987 letter by Dr. Donald A. Hull, DOGAMI, to Trudy A. Thorne

As a member of the Technical Evaluation Panel for PRDA No. DE-PR07-87ID12662 I offer the following comments regarding the subject letter, and the earlier request to delete the drilling task from the DOGAMI proposal. Dr. Hull discusses two concerns expressed by the TEP.

1) Inability to meet the proposed schedule. The "small" Cascade project currently funded now totals $359,357 in total funding-substantially more than requested in the proposal to the 1987 PRDA. The schedule for completion of the existing Grant was 4/30/88 after amendment no. M001, and was later modified to 7/31/88 after amendment no. M002. A later request for a no cost time extension to 7/31/89 was denied by DOE. The completion of the Feasibility Study Plan for Cascade Drilling was established as 12/31/85 by Mod. M001, then extended to 9/11/86 by Mod. M002. The study plan was received by DOE in August 1987.

The Oregon work on another DOE program, a proposal for the Supercollider (SSC) project, was not a funded DOE project, but rather a state sponsored effort which was given priority over an existing grant.

The overall goal of a crustal transect across the Cascade Range through Santiam Pass in Oregon is a priority established by DOGAMI, not a solicited and acknowledged DOE priority.

2) Concern about the hole depth being too shallow to obtain a useful temperature gradient. Table 1 of the subject letter does present some new encouragement that a 650 m drill hole would yield a meaningful conductive geothermal gradient. Nevertheless, Blackwell and Steele (1987, GRC) show that strong intrahole water flows preclude a satisfactory determination of the "conductive"

geothermal gradient for Geo Operator holes N-1 and N-3 above depths of 1150 and 1200 m respectively, and that an average gradient can only be established using data from these depths (see attached Figure 2 from DOGAMI proposal). The geothermal gradient in the CTGH-1 hole changes to a substantially lower value at a depth of approximately 650 m. In addition, drill hole LI-4, eight miles southwest of Santiam Pass, recorded a maximum temperature of 25 degrees C for a maximum depth of 557 m (Geothermal Resources Map of Oregon, 1982).

The Technical Evaluation Panel still believes that there is a reasonably large risk that a geothermal gradient for the proposed 650 m drill hole would not be a meaningful value.

Two other factors resulted in a low ranking for this proposal, using the uniform guidelines established for the proposal evaluations. DOGAMI does not appear to be adequately staffed at present to undertake this work. Most of the staff, including a senior geologist and a drill site geologist, must be hired for the proposed project. Geophysical work for the project would be delegated to a subcontractor. Thus most of the staff required for the project is not currently in house at DOGAMI.

The primary product from the proposed work would be the temperature profile, heat flow and related data from a single drill hole. If the temperature profile is disturbed or otherwise nonrepresentative, the deliverable would have limited technical value, even though the proposed work had required a large portion of the funding available to the entire PRDA.

While the DOE/GTD is deeply interested in the geothermal potential of the Cascades, and hence of the proposed PSDC Santiam Pass drilling transect, funding within the State Cooperative Program is limited and is oriented toward more specific resource assessment projects. A project the magnitude of the PSDC is better addressed by other funding agencies.

Howard Ross

Howard P. Ross

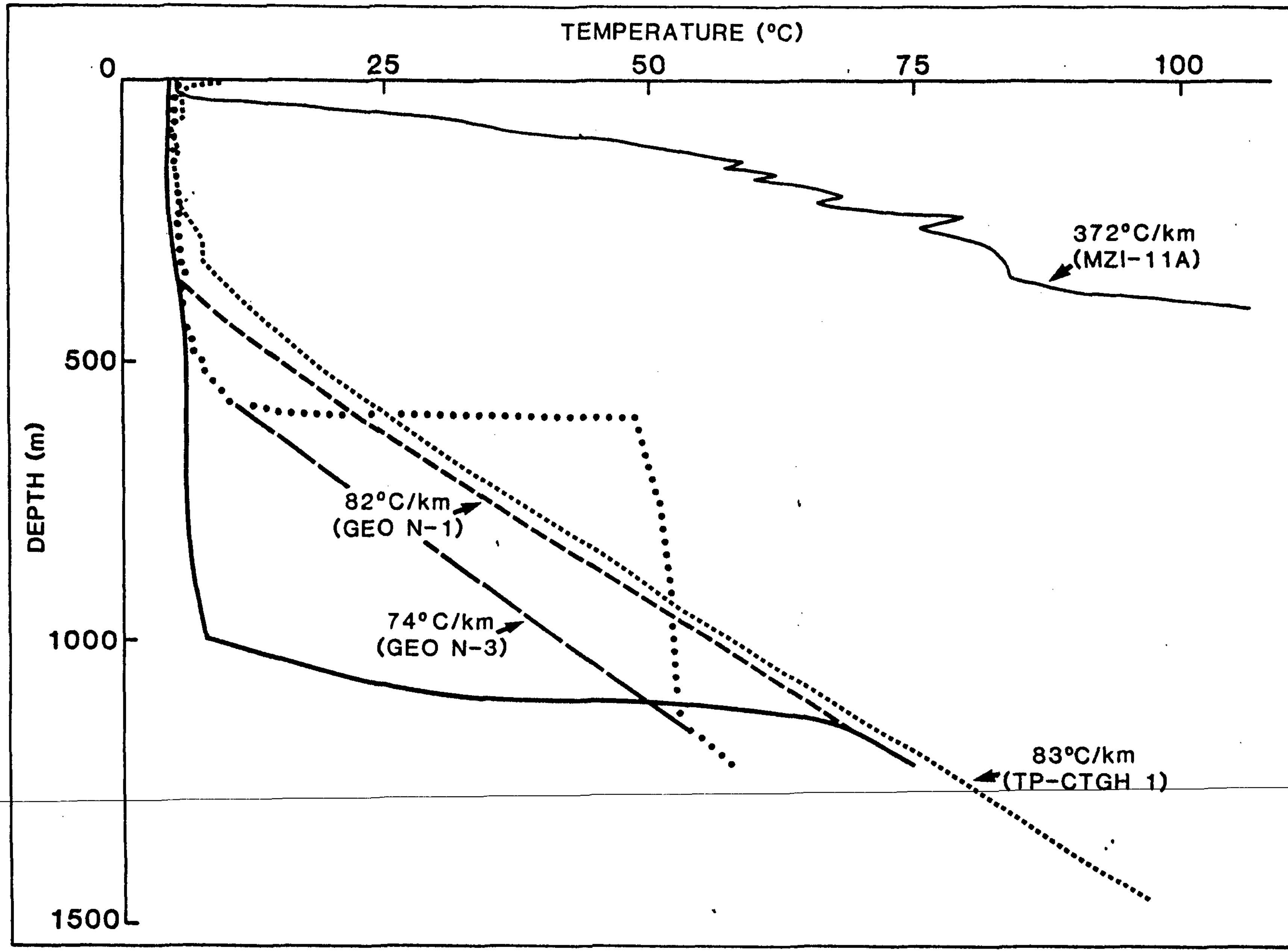

Figure 2. Temperature-depth curves of holes from the USDOE Cascade Deep Thermal Gradient Drilling Program. Dashed lines show the temperature-depth curves as they would be were they not affected by inferred intra-borehole fluid circulation Inferred temperature gradients are shown in degrees Centigrade per kilometer. Temperature data in hole MZI-11A were taken only 20 hours after circulation of drilling fluids, so hole temperatures had probably not completely stablized. Temperatures for MZI-11A were measured by Al Waibel of Columbia Geoscience; other measurements are by David D. Blackwell of Southern Methodist University. See Figure 1 for locations.

MONTANA COLLEGE OF MINERAL SCIENCE AND TECHNOLOGY

BUTTE, MONTANA 59701

March 10, 1987

Howard Ross
Earth Science Laboratory
University of Utah Research Institute
391 Chipeta Way, Suite C
Salt Lake City, UT 84108

Dear Howard:

Here are three of the four rock samples you sent up. As I mentioned in our telephone conversation, we would like to keep sample 4228 for a bit longer and see how it equilibrates over a long period of time. We will also keep about half of sample 4625 which we had to recut.

You should get a bill directly from the Montana Tech business office for lab and instrument use ($60). The invoice for student wages will come separately.

If you should need any of the above samples in the near future, let me know.

Regards,

Bill

William R. Sill, Chair
Department of Physics and
Geophysical Engineering

WRS:wi

UNIVERSITY OF UTAH RESEARCH INSTITUTE
UURI
EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

April 15, 1987

Dr. Henry P. Heasler
Department of Geology and Geophysics
The University of Wyoming
P. O. Box 3006
Laramie, Wyoming 82071

Dear Henry:

I enjoyed reading the draft of your final report "Geothermal Modeling of Jackson Hole, Teton County, Wyoming". Your integration of the observed data with the numerical model results provides a solid basis for the conclusion that deep circulation of groundwater is the likely source for the thermal springs in the Jackson Hole area. The report is a well organized, well writen summary of a fine technical study.

I believe that only minor changes need to be made before the report can be finalized and transmitted to D O E. I have noted a number of typos, puncuation changes, etc. on the accompanying page of comments. Please also consider those questions directed to the Conclusions section of the report.

Please note the contract requirements regarding distribution of the final report. Please call me if there are any questions about my comments or other matters related to completing the final report and concluding your grant.

Sincerely,

Howard Ross

Howard P. Ross
Project Manager

cc: Peggy Brookshier

pg. 26, Fig.7: Why not label a, b, c, d at top of figures, i.e.
a) Heat Flow = 50 mW/m2 b) Heat Flow = . . .?

pg. 27, 1.5 from bottom: A reasonable upper limit ...

pg. 28, 1.10 from bottom: Darcian

pg. 30, 1.11: maximum temperatures ... are

pg. 34, missing reference, Muffler, 1979

MISC.

It would be easier to appreciate the different model results in Tables V and VI if a short form (abbreviated description) of the model paramaters was included below the tables on the same page.

CONSULTING SERVICES AGREEMENT

With: Dr. Duncan Foley
Department of Earth Sciences
Pacific Lutheran University
Tacoma, WA 98447

(206) 535-7568

Period: June 1, 1987 - September 30, 1987

Account: 85102, State Cooperative Program
(and others as may be required)

Reimbursement Rate: $_00.00 per day, or $__.00 per hour, based on a standard eight hour work day.

Dr. Foley will be reimbursed in full for reasonable travel and personal expenses authorized and approved by UURI.

Services: Professional technical services to include:

1) Services as a member of the DOE-ID Technical Review Committee for reviewing the proposals from the State Geothermal Research and Development PRDA No. DE-PR07-87ID12662. Travel from Tacoma area residence to DOE offices in Idaho Falls, ID and return to principal residence. Technical review is presently scheduled for the period June 23-25, 1987.

2) Other technical services as a Consultant to UURI as may arise and be mutually agreed upon by UURI and Dr. Foley.

Responsible UURI Contact: Dr. Howard P. Ross, Project Manager, State Cooperative Program.

April 15, 1987

Dr. Henry P. Heasler
Department of Geology and Geophysics
The University of Wyoming
P. O. Box 3006
Laramie, Wyoming 82071

Dear Henry:

I enjoyed reading the draft of your final report "Geothermal Modeling of Jackson Hole, Teton County, Wyoming". Your integration of the observed data with the numerical model results provides a solid basis for the conclusion that deep circulation of groundwater is the likely source for the thermal springs in the Jackson Hole area. The report is a well organized, well writen summary of a fine technical study.

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Please note the contract requirements regarding distribution of the final report. Please call me if there are any questions about my comments or other matters related to completing the final report and concluding your grant.

Sincerely,

Howard P. Ross
Project Manager

cc: Peggy Brookshier

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UURI
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391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

April 15, 1987

Ms. Leah V. Street
Idaho Department of Water Resources
Twin Falls, ID 83301

Dear Leah:

Enclosed are the output sheets for the 24 C I P W Norm calculations which you requested. If you have any questions please call me.

Sincerely,

Howard

Howard Ross
Section Head/Geophysics

encl.

January 27, 1987

Dr. Paul E. Damon
Department of Geosciences
Gould-Simpson Building
The University of Arizona
Tucson, Arizona 85721

Dear Dr. Damon:

We are transmitting under separate cover six rock samples for age daing under your DOE grant. The samples were obtained by Dennis Nielson of UURI as part of his geothermal studies of Ascension Island, South Atlantic Ocean. We anticipate that all samples are less than 1 Ma.

Enclosed for your information is a copy of an informal memo from Dennis to me with estimated age information and a table of previous age dates obtained from Ascension Island. We appreciate your support in completing these age dates.

Sincerely,

Howard P. Ross
Section Head/Geophysics

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M E M O R A N D U M

TO: Peggy Brookshier

FROM: Howard Ross

SUBJECT: Mailing List Update for the State Cooperative Program PRDA

DATE: January 7, 1987

The following changes are recommended for the subject mailing list which I submitted on October 21, 1986.

Additions

Dr. Kent Murray
California Energy Commission
1516 9th Street
Sacramento, CA 95814

Dr. Douglas Smith
Department of Geology
University of Florida
Gainesville, FL 32611

Dr. Roman J. Motyka
Alaska Department of Natural Resources
Division of Geological and Geophysical Surveys
400 Willoughby Bldg., 3rd Floor
Juneau, AK 99801

Address Change

Ms. Leah V. Street
Idaho Department of Water Resources
Southern Division
2148 4th Ave. East
Twin Falls, ID 83301

Howard Ross

Howard P. Ross
Section Head/Geophysics

Mike 1/2/87

APPENDIX A, ATTAC

QUALITY ASSURANCE S
FOR
TBD

ACTIVE HYDROTHERMAL NATURAL ANAI

I found the top article and ordered the second one and put a rush on it. The last one I couldn't locate. Do you have more information? Let me know. Thanks Bev

A.0 GENERAL R

A.1 Scope and Applicability

A.1.1 The Contractor shall document, implement, and maintain a quality assurance (QA) program that complies with the applicable criteria of 12 CFR Part 50, Appendix B as interpreted by ANSI/ASME NQA-1, and this Specification.

A.1.2 The QA program shall be graded to a complexity commensurate with the importance of the work activities identified in the Statement of Work. In planning, preparing, and implementing a QA program the Contractor must address the criteria identified in the "Minimum Quality Assurance Program Requirements" shown in Figure 1 and other requirements of this Specification. These requirements, considered the minimum to effect an adequate QA program, do not relieve the Contractor from considering and complying with any of the other criteria deemed necessary to obtain an effective QA program.

A.2 References

A.2.1 Title 10 Code of Federal Regulations Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants."

ORDERED 1/2/87
OCLC 11270228

A.2.2 ANSI/ASME NQA-1, "Quality Assurance Program Requirements for Nuclear Facilities" (latest revision and addenda).

IL MA VA
SPI RYB MTR

A.2.3 NRC Review Plan: Quality Assurance Programs for Site Characterization of High Level Nuclear Waste Repositories, June 1984.

Couldn't locate / Need more information

Cooperative Agreement No. DE-FC07-84ID12481

SCHEDULE

ARTICLE I - STATEMENT OF JOINT OBJECTIVE

The purpose of this Cooperative Agreement between the United States Department of Energy (DOE or Government) and Ott Water Engineers, Inc. (Participant) is to conduct research and development on inexpensive cross-flow hydropower turbines. This action is authorized by Federal Law and is in furtherance of the Government's objective to stimulate development and use of hydropower resources by development of cost-effective technology through cost-shared engineering research and development projects. The Participant will receive the benefit of the hydropower development and DOE will obtain data on inexpensive cross-flow hydropower turbines.

ARTICLE II - THE PROJECT MANAGEMENT PLAN

A. Participant's Responsibilities. The Participant shall furnish the materials, facilities, equipment, personnel, services, and all other necessary and related items for the research and development on new, more energy efficient technology for inexpensive cross-flow hydropower turbines. Requirements of the project are further set forth in Appendix A to this Agreement which is titled "STATEMENT OF WORK" and which is made a part hereof by this reference. The Participant shall provide the funding and reports as specifically provided elsewhere in this Agreement, and obtain all necessary licenses and permits.

B. DOE's Responsibilities. DOE will provide a specified amount of financial assistance, and will monitor the project to observe the progress. In addition, DOE will act upon the Participant's requests for approval in those instances in which DOE's approval is required.

ARTICLE III - FINANCIAL SUPPORT

A. Estimated Cost. The total estimated cost of the work under this Agreement is Nine Hundred Seventy-One Thousand One Hundred Seventy Dollars ($971,170.00). If at any time the Participant has reason to believe that this or any revised estimate is in error, the Participant shall so notify DOE in writing and provide DOE with a new estimate with the next monthly Federal Assistance Management Summary Report.

B. DOE's Financial Support. DOE will pay 75% of costs as incurred. The total cost to DOE for all the work under this project is Seven Hundred Twenty-Eight Thousand Three Hundred Seventy-Eight Dollars ($728,378.00), and under no circumstances will DOE's support exceed this amount. This limitation includes termination costs, if any.

C. Participant's Financial Support. All costs in excess of the amount to be provided by DOE will be borne by the Participant. The estimated cost to the Participant is Two Hundred Forty-Two Thousand Seven Hundred Ninety-Two Dollars ($242,792.00).

ARTICLE III - FINANCIAL SUPPORT (Cont'd)

D. Obligated Funds. The amount of funds obligated to this Agreement by DOE is Seven Hundred Twenty-Eight Thousand Three Hundred Seventy-Eight Dollars ($728,378.00).

ARTICLE IV - PAYMENTS

A. Progress Payments. Costs will be shared 75% DOE and 25% Participant as incurred. Payments will be made not more frequently than monthly in amounts approved by the Contracting Officer when applicable milestones are achieved and invoices are submitted (in four copies on SF 1034 with certification that payment requested represents incurred, allowable costs):

PHASE I - FIRST YEAR

Milestone	Description
1	Submission of FERC License; letter and money to PG&E for Interconnection Study.
2	Submission of Survey Topo of Diversion Structure and Powerhouse; P-Line Survey with X-Sections on low-pressure and penstock; geotechnical report.
3	Submission of Hydraulic Analysis report; functional requirements of hydraulic, civil, and mechanical requirements of project; functional requirements of electrical and control systems, one-line diagram, and functional block diagram; list remote control functions and data acquisition parameters; functional requirements of turbine, generator, and switchgear.
4	Submission of detail requirements of remote control and data acquisition system, transmission type, scale factor, engineering units, accuracy, sampling rates, storage requirements, display and printer requirements; detail requirements of turbine, generator, switchgear, test equipment.
5	Submission of facility plans (50% complete) and specifications for civil, mechanical, electrical and control systems.
6	Submission of Facility Plans (100% complete) and specifications for civil, mechanical, electrical and control systems, turbine, generator, and switchgear.
7	Turbine Manufacturing: a. 25% Complete b. 50% Complete c. 75% Complete d. 100% Complete

ARTICLE IV - PAYMENTS (Cont'd)

Milestone	Description
8	Submission of acceptance plan and construction contract award.
9	Contractor mobilization and site preparation; roads and culverts; land rights; construction inspection; progress reports.
10	Diversion and inlet construction complete.
11	Powerhouse foundation and tailrace construction.
12	Powerhouse structure and mechanical equipment complete.
13	Transmission line construction complete.
14	Low-pressure pipeline, transition structure, and penstock complete.
15	Utility connection and switchyard complete.
16	Turbine, generator, and switchgear installed.
17	Systems control and monitoring equipment installed; operation and maintenance manual.
18	Construction completed and construction and cost report submitted and approved by DOE.
19	Field testing completed and report submitted and approved by DOE.
PHASE 2 - SECOND AND THIRD YEAR	
20	First year of Operation and Maintenance (O&M) monthly progress reports: First Semi-Annual Payment Second Semi-Annual Payment
21	Second year O&M monthly progress reports: First Semi-Annual Payment Second Semi-Annual Payment
22	Final O&M report and final technical report.

Cooperative Agreement No. DE-FC07-84ID12481

APPENDIX A

STATEMENT OF WORK

Ott Water Engineers, Inc. (OTT), with the subconsultants will design, manufacture, and install at the Arbuckle Mountain Hydroelectric Site a low-head cross-flow turbine and complete hydroelectric facilities. The turbine and powerplant will undergo extensive field testing for two years. All work on the project, including manufacturing of the turbine, will be conducted in the town of Redding, California. OTT will manage the technical as well as budgetary aspects of the project and will submit all reports identified in this Statement of Work and on the attached Federal Assistance Reporting Checklist.

A low-cost 250-kW cross-flow turbine will be installed on site along with extensive monitoring and testing equipment. OTT and its subcontractors will field test the site throughout the construction phase and for the two-year monitoring process thereafter.

The project will be developed in two phases. Phase I includes permitting, design, and construction. Phase II includes the monitoring program during which Ott will monitor performance for two full operating seasons with a minimum of 180 days of operation during each operating season. If the system is not operational for the minimum 180 days, monitoring will continue until two full seasons have been monitored and included in reporting. Following is a detailed breakdown of the major tasks in each of these phases.

PHASE I - FIRST YEAR

Task 1 - Permits

A Federal Energy Regulatory Commission (FERC) Preliminary Permit was issued for the project September 18, 1983. All other required permits and licenses will be obtained. Letters of consultation showing an intent to submit an exemption have been sent to the nineteen agencies that could be involved in this project.

Task 2 - PG&E Interconnection Agreement

A power purchase contract has been negotiated and signed for the site by the property owners. Pacific Gas and Electric (PG&E) requires repayment to conduct the interconnection study. PG&E will require six weeks to complete the interconnection study and provide a cost for final hookup.

Task 3 - Project Startup and Site Visit

This task includes bringing the project team together and laying out a detailed, item-by-item work plan for accomplishing the studies and design of the project. A preliminary site visit is to be conducted with the project manager, all the designers, and the Contractor to determine the most effective and efficient way of designing and constructing the project.

Task 4 - Geotechnical Exploration

Immediately after the first site visit and after the diversion structure, pipeline, and powerhouse locations are flagged in the field, the geotechnical exploration will be conducted. This exploration will determine the foundation design of the diversion, transition, and powerhouse structures. It will also determine the type and depth of pipe placement. Possible geological site constraints, such as active surface faulting, erosion, and unstable ground, will be noted and measures identified to alleviate these conditions if present. A Geotechnical Exploration Report will be issued at the end of this task.

Task 5 - Site Surveying

Once the project has been field located, a one-foot topographic map will be completed on the diversion site, powerhouse site, and transition structure. A center-line survey will be made of the pipeline route with cross-sections taken every 50 feet to allow for detail design of the piping system. The survey will be completed within two weeks after the field visit. Permanent bench marks will be set so that precise elevation measurements can be conducted after the project is built.

Task 6 - Hydraulic Analysis and Design

Detailed analyses will be made of water surface elevations at the powerhouse and the diversion structure including the 25-, 50-, and 100-year flood levels. This task will also set the detailed configuration of the intake structure and fish screen to insure all California Department of Fish and Game (CDFG) requirements are met. Critical hydraulic design will insure that all the possible losses in the transport pipelines as well as the transition structures are minimized. The hydraulic design also will include detail analysis of the tailrace sections.

Task 7 - Civil and Structural Design

The civil and structural design drawings and specifications will be prepared for the diversion and inlet structures, pipelines, transition structure, penstock, powerhouse, and tail race. Detail drawings will be completed for each facility of the project on OTT's standard 22- by 34-inch design sheets. This task will be completed within twelve weeks after the hydraulic analysis is completed.

Task 8 - Mechanical Design

Mechanical design includes heating and ventilating systems (HVAC), any special valving and piping needed inside the powerhouse, transition and diversion structures, and detail analysis and design of the screening systems. Design drawings and specifications will be generated in this task for all mechanical equipment except the turbine and generator. This task will also be complete twelve weeks after the hydraulic design.

Task 9 - Electrical and Control Systems Design

Once the hydraulic design is complete, the electrical and control system team will work with the turbine design team and all other team members, as needed, to work out the detailed electrical, monitoring, and control equipment design. This coordination is important so that proper facilities can be built into each one of the structures for allowing insertion of probes and water level recorders. The electrical and control systems plans and specifications for the computer monitoring telemetry equipment as well as the remote control systems will be completed in this task.

Task 10 - Plant Design Report to DOE

At the conclusion of the design efforts, the plant design report will be submitted to DOE for review and approval. This report will include reduced sections of the design drawings submitted in Tasks 7, 8, and 9. It is anticipated that DOE review and approval of these design drawings and specifications will require thirty days.

Task 11 - Turbine, Generator, and Switchgear Design

The turbine manufacturer will work closely with the electrical, systems control, and the powerhouse designers to insure that the turbine and monitoring components will function as a system. The finalized turbine runner design, its mechanical linkage to the innovative inlet control valve, the speed increaser, and the synchronous generator and governor will be designed.

Task 12 - Turbine Design Report

Detail drawings of the complete turbine package will be submitted to DOE for review and approval within ten weeks after the hydraulic analysis is complete. Full specifications will also be submitted for DOE approval. It is assumed that DOE will require thirty days for review and approval of these drawings.

Task 13 - Turbine Manufacturing

Within two weeks after DOE approves the concept of the turbine design, all materials for the turbine will be ordered. These will arrive within two weeks and at that time the turbine manufacturing process will proceed.

During the manufacturing process, quality control will be maintained and frequent inspections will be made by OTT's engineering team. The systems control people will also work closely with the turbine designers to insure compatiblility of the headwater sensing and automatic gate valve control mechanisms. Once the turbine is manufactured, three weeks of shop testing will commence. Testing will check for alignment, drag forces, clearances at operating speed, and compliance with the specifications.

Immediately after DOE approval, the materials will be ordered for the speed increaser. The speed increaser will be built simultaneously with the turbine and should be ready for testing at the end of ten weeks. Three weeks of shop testing in conjunction with the shop testing of the turbine will be conducted.

Switchgear materials will also be ordered and fabrication of the switchgear will commence as soon as the materials arrive. Close collaboration with the electrical and control systems team will be necessary.

Soon after approval is received, specifications for the synchronous generator will be written and the unit ordered from the manufacturer. It is anticipated that delivery will take twelve weeks and be at the shop in time for the three-week extensive shop testing.

Task 14 - Turbine Installation

As soon as the powerhouse is enclosed so that it is weatherproof the turbine, generator, and switchgear will be transported to the site and installed. It should take four and one-half weeks for total installation and hookup of the turbine gear inside the powerhouse. The construction subcontractor, systems control engineers, and turbine manufacturer's representatives will work to insure that the equipment is properly installed.

Task 15 - Finalize Construction Contract

As soon as DOE approves the plans and specifications for the powerhouse, turbine, generator, and switchgear, detailed on-site reviews will be held with the constructon subcontractor. With detailed examination of the plans and specifications as finally designed, a final contract price will be agreed with the construction subcontractor. Fixed price subcontracts will be executed with a construction subcontractor at this time.

Task 16 - Mobilization to the Site

After the contract is signed and final permits are near issuance, the construction subcontractor will mobilize his equipment and portable facilities to the site. These will be contained on the site property.

Task 17 - Site Preparation and Excavation of Access Roads

Immediately upon the granting of the FERC license, the construction subcontractor will commence the site preparation. This preparation includes grading of existing roadways, pipeline routes, and in particular, the excavation of the diversion and powerhouse/tailrace areas. It is imperative that the structures in stream be excavated at low water and in a manner that is in compliance with the stream alteration permit. Care will be taken in all excavation and clearing areas to minimize the amount of riparian vegetation disturbance along the stream.

Task 18 - Order All Long-Lead Time Equipment

During this task, all the miscellaneous steel, fish screens, pipelines, and long-lead time electrical items such as transformers, lightening arrestors, and systems switchgear will be ordered. Procurement orders will be issued for long-lead time equipment. A detailed schedule of equipment orders and expected on-site arrivals will be made to optimize placement and minimize needed storage areas.

Task 19 - Diversion Inlet Construction

The first facility to be built on the site will be the diversion inlet structure. It is imperative that this be installed during the low-water season. The diversion structure will take approximately three weeks to build. The fish screen addition to the inlet structure as well as the valves will be completed at the end of the fourth week of construction. The structure will be built in time to allow full curing and operation before the high water season commences.

Task 20 - Powerhouse Construction

The powerhouse construction will commence at the same time as the diversion/inlet construction. Low-water construction is as critical for the tailrace section of the powerhouse as it is for the diverison/inlet structure. It is imperative at the start of the powerhouse construction that the details of the imbedded parts for the turbine, turbine speed increaser, and generator be provided to the construction subcontractor to insure that the proper bolts and keyways are provided. The powerhouse will be built so that in three weeks it may be enclosed to the point that inside work can be commenced in case of inclimate weather. The powerhouse construction will take ten weeks to complete all of the interior and exterior facilities.

Task 21 - Pipeline Construction

Once the major concrete work has been completed on the diversion and tailrace structure, the low-pressure pipeline and penstock will be constructed. Because of the short distance involved, construction should be completed within four weeks.

Task 22 - Transition Structure Construction

As soon as the low-pressure pipeline and penstock are in place, the transition structure can be constructed with the grating and valves installed within one to two weeks.

Task 23 - Powerline Construction

The powerlines can be constructed anytime after the FERC permit and Bureau of Land Management (BLM) use permits are received. It is anticipated that powerline construction will commence within three weeks after the concrete work on the project is complete. The powerline construction for the four miles along the road will be completed in such a way that it will not interfere with local residents' travel up and down the road. The PG&E Interconnection Agreement in Task 2 will specify most of the criteria for this powerline construction. The powerline will be completed when the detail work commences inside the powerhouse so that the project will have a constant source of power.

Task 24 - Install Systems Monitoring Equipment

This equipment has some longer lead-time items and therefore will start later in the construction process. All the systems monitoring and sensing equipment will be ordered and installed during the seven-week period before startup. All on-site sensing and monitoring equipment will be installed on the different structures and the powerhouse. Equipment will be installed in the OTT home office to be able to receive remote monitoring and operational signals from the powerhouse.

Task 24 - Install Switchyard

During the latter part of the powerline construction, the switchyard will be installed immediately outside the powerhouse. All components will be on concrete pads or poles and will be built within a three-week period. The critical items for the switchyear are the long-lead step-up transformer main breakers. Input from Task No. 2, PG&E Interconnection Agreement, will also affect this task.

Task 26 - Construction Inspection

OTT will conduct all construction inspections of the site. Inspections will be made to insure that the foundations are placed properly and that steel and concrete are placed according to plans and specifications. Laboratory tests will be made on the concrete to insure that the proper mix is used and strength is derived on the major concrete pours. Electrical and systems inspection will be conducted by the electrical and systems engineers during the installation of the project. All engineering inspectors will keep proper logs which will be summarized and included in the Plant Construction Report.

Task 27 - Plant Construction and Cost Report

This report will sumarize the schedule and milestones. Budgetary amounts versus actual money spent on each item as well as problems and solutions identified during construction will be discussed in the report. The intent of this report is to show how a small-scale hydroelectric project can be constructed in a cost-effective and efficient manner, especially when good project management is brought to bear. Detailed costs of each phase on a unit basis will be kept for each facility on the project. This will allow DOE to summarize the actual cost of a small-scale hydroelectric project of this size. Comparisons will be made of actual cost-to-budget and explanations of variances from these budgets will be given. The reports will be detailed enough that it will ensure that DOE will have a true and accurate cost of all phases of construction of a small hydroelectric facility.

Task 28 - PG&E Electrical Checkout

Once the project is ready to come on-line, PG&E will conduct a detailed check of all systems equipment to ensure that their system is protected from any damage from the proposed system and vice-versa. This testing usually takes one to two days followed by routine startup within a week after total construction.

Input to the electrical checkout will also come from the details in the appendix of the power-purchase contract and the interconnection agreement obtained in Task 2.

Task 29 - Startup and Testing

Once the plant is connected to PG&E, the startup of the plant can be conducted. For the remaining seven weeks, the total plant will undergo extensive testing and monitoring. This monitoring will include detailed turbine, speed increaser, generator, electrical switchgear, and sensing and monitoring equipment testing. This testing will be conducted under a variety of design flows. In general, the tests include everything from testing with a dynamometer, the break-horsepower of the turbine to total water-to-wire testing of all systems and components through a large range of flows and heads. This will include detailed monitoring and logging of head, flow, and power measurements throughout the total plant system.

Task 30 - Field Test Report

This report will contain a detailed analysis of all field tests performed in the seven weeks after startup. It will include a description of the data collected, the analysis procedures, and the results. The report will be complete enough to ensure that DOE knows how well the plant performed in every aspect of a primary interest will be the question, "did the turbine perform exactly as depicted in the proposed efficiency curve?" Generator and electrical systems efficiencies will be documented accurately enough to ensure that DOE can utilize these data on a nation-wide basis to evaluate this type of hydroelectric site equipment.

Task 31 - Progress Reports to DOE

Report will be submitted in accordance with attached Federal Assistance Reporting Checklist. Included will be a summary of the work completed each month, any major design changes that affect any other member of the team, a progress report on the schedule, and the anticipated tasks to be completed for the next month.

The topical report and final technical reports will be issued as required throughout the project and will be completed within 5 days after the activity. The final technical report will follow as scheduled within 90 days of the performance.

PHASE II - SECOND AND THIRD YEAR

Phase II of the project consists of collecting operation and maintenance data for two full years of operation (with minimum of 180 days of operation during each operating season) following the construction and start-up of the project. During this period, basic data will be collected and published on the perforance of the turbine and total powerplant plus the detailed cost of operation and maintenance of the powerplant. The tasks are described in general as follows:

Task 1 - Testing and Monitoring

Ongoing testing and monitoring of the turbine and total plant efficiencies at various flow conditions will be conducted. The basic generation period is from November through July. During this period, head, flow, and power production and consumption will be monitored. Basic data will be collected on a continuous basis for various flow conditions so that the continuous "water-to-wire" efficiencies can be monitored throughout all types of hydrologic conditions.

Task 2 - Testing and Monitoring of Remote Sensing and Control Equipment

The remote sensing and monitoring equipment will be tested to ensure that the plant can be controlled during various types of adverse weather conditions. Most of the energy is lost at the site during adverse flow conditions or routine alarm shutdown where auto-restart or remote sensing and restart capabilities do not exist. Testing will be conducted to assess the reliability of remote controlling of the small hydroelectric plant. The innovative control valving system for the cross-flow turbine will be tested through all adverse types of conditions at this time.

Task 3 - Team Meetings on Performance and Update of Designs

At the end of the generation season each year, team meetings will be held which will include DOE, the designers, the system control people, turbine manufacturer, and the operation/maintenance people to determine how the system has performed. They will discuss innovative methods to update the designs in place. Any major design suggestions will be incorporated in the monthly progress report to DOE and, if approved, will be incorporated into the design during Task 4, Turbine Major Inspection and Maintenance.

Task 4 - Turbine Major Inspection and Maintenance

The low-generation periods are August through October at the Arbuckle site. This time will be utilized to conduct major turbine inspections (i.e. tear down turbine and inspect runner blades, determine blade conditions, inspect for wear on all bearings and perform extensive testing of the monitoring equipment.) Any design innovations or changes that would be incorporated into the system will be made during this time so that the total system will be ready for the water season which generally begins the first part of November.

Task 5 - Monthly Progress Reports

Monthly management and status reports will be distributed to all team members and DOE. Problems incurred by the plant during each month will be summarized in the respective monthly report. A summary of the project's status and any innovations that are planned to be designed in the next month will be included.

Task 6 - Annual Technical Progress Reports

At the end of each one of the three years a technical progress report will be made listing all the technical findings that have been concluded in the project. This will include drawings of actual efficiency curves that were derived for the equipment on the project, all cost data, and new innovations that could be included in plants elsewhere. Enough information will be included to allow a detailed determination of the total energy cost of this plant.

Task 7 - Operation and Maintenance Report to DOE

At the end of the two-year monitoring period, an operation and maintenance (O&M) report will be prepared that will include the O&M schedules that have been used, a summary of all detail O&M work that has been completed throughout each year, detail cost breakdowns of the O&M, and procedures that were used during the O&M, and procedures that were used during the O&M process in enough detail so they could be utilized for other projects of this type. The project will have a total determination of all O&M costs involved for the site.

Task 8 - Final Technical Report

This is the final report on the project at the end of the project. This report will summarize all of the data collected on the project, include methodology used to collect the data, and the success achieved. All costs will be developed and summarized in sufficient detail to allow DOE to make a determination of the total energy cost of the project. A detailed outline of this final report will be submitted to DOE 90 days before the preparation of the report is started so that there will be concurrence of all the items that should be included in the report.

U.S. DEPARTMENT OF ENERGY

FEDERAL ASSISTANCE REPORTING CHECKLIST

FORM EIA-459A (10/80)

FORM APPROVED OMB NO. 1900-0127

1. Identification Number: DE-FC07-84ID12481

2. Program/Project Title: Inexpensive Cross-Flow Hydropower Turbine

3. Recipient:

4. Reporting Requirements:

	Frequency	No. of Copies	Addressees
PROGRAM/PROJECT MANAGEMENT REPORTING			
[X] Federal Assistance Milestone Plan	O	4	
[X] Federal Assistance Budget Information Form	O	4	
[X] Federal Assistance Management Summary Report	M	5	
[X] Federal Assistance Program/Project Status Report	M	4	
[ ] Financial Status Report, OMB Form 269			
TECHNICAL INFORMATION REPORTING			
[X] Notice of Energy RD&D	O	3	
[X] Technical Progress Report	Y	4	
[X] Topical Report	A	7	
[X] Final Technical Report	F	7	

FREQUENCY CODES AND DUE DATES:

- A - ~~As Necessary; within 5 calendar days after events.~~ As required.
- F - Final; 90 calendar days after the performance of the effort ends.
- Q - Quarterly; within 30 days after end of calendar quarter or portion thereof.
- O - One time after project starts; within 30 days after award.
- X - Required with proposals or with the application or with significant planning changes.
- Y - Yearly; 30 days after the end of program year. (Financial Status Reports 90 days).
- S - Semiannually; within 30 days after end of program fiscal half year.
- M - Monthly, within 15 days after end of the reporting period.

5. Special Instructions:

* Topical Reports will be prepared on the following phases of the project:

- Geotechnical Exploration
- Turbine Design
- Plant Design
- Plant Construction and Cost
- Field Tests
- Operation and Maintenance
- Annual Progress Reports
- Final Technical Report

Testing and Instrumentation Plan - due 60 days after award.

6. Prepared by: (Signature and Date)

7. Reviewed by: (Signature and Date)

FEDERAL ASSISTANCE REPORTING CHECKLIST

PURPOSE

This form serves to identify plans and reports selected by DOE as reporting requirements for the Federal Assistance Program/Project.

INSTRUCTIONS

Item 1 — Enter the program /project identification number as it appears in the official award.

Item 2 — Enter the program/project description as it appears in the official award.

Item 3 — Enter the name of the recipient.

Item 4 — Check spaces to indicate plans and reports selected. For each report checked, indicate frequency of delivery in column provided using one of the frequency of delivery codes as shown, as well as the number of copies requested and to whom they should be sent.

Federal Assistance Milestone Plan — presents, with the accompanying Milestone Log, a schedule of the planned activity.

Federal Assistance Budget Information Form — presents the planned costs,

Federal Assistance Management Summary Report — registers planned progress and costs to actual progress and costs in a capsulized format.

Federal Assistance Program/Project Status Report — periodically reports project status, explains variances and problems, and discusses any other areas of concern or achievements.

Financial Status Report, OMB Form 269 — presents the status of funds committed to the project.

Notice of energy R&D Project — provides information on unclassified DOE R&D Project for dissemination to the scientific, technical, and industrial communties and to the public. Also provides information to the Smithsonian Information Exchange and to the DOE Technical Information Center.

Technical Progress Report — periodically reports progress and/or results of DOE supported R&D and scientific projects covering a specific reporting period.

Topical Report — presents the technical results of work performed on a specific phase of a project.

Final Technical Report — presents a technical accounting of the total work performed on a project.

Frequency Codes - Each code represents a specific reporting frequency (such as Quarterly). These time periods are suggested in the program announcement and negotiated at the time of the award.

Item 5 — Identify any special reporting requirements or instructions not identified in Item 4. (Use additional sheets as necessary.).

Item 6 — Signature of person preparing the checklist and the date prepared. Preparation is by person responsible for program solicitation.

Item 7 — Signature of the person reviewing the checklist and date reviewed.

U.S. DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE

REPORT DISTRIBUTION LIST

Addressees	Federal Assistance Milestone Plan	Federal Assistance Budget Information Form	Federal Assistance Management Summary Report	Federal Assistance Program/Project Status Report	Financial Status Report, OMB Form 269	Notice of Energy RD&D	Technical Progress Report	Topical Report	Final Technical Report
U. S. Department of Energy Idaho Operations Office 550 Second Street Idaho Falls, ID 83401									
ATTN: Peggy A. M. Brookshier Energy & Technology Div.	1	1	1	1		1	1	4*	4*
ATTN: Kent R. Hastings Contracts Management Div.	1	1	1	1		1	1	1	1
ATTN: Earl G. Jones Financial Management Div.			1						
EG&G Idaho, Inc. P. O. Box 1625 Idaho Falls, ID 83415 ATTN: J. R. Chappell	1	1	1	1			1	1	1
U. S. Department of Energy Forrestal Bldg., 1000 Independence CE-324 Washington, DC 20585 ATTN: John V. Flynn	1	1	1	1			1	1	1
DOE Technical Information Center P. O. Box 62 Oak Ridge, TN 37830						1			

Special Instructions

* Includes one reproducible copy.

UNIFORM DOE CONTRACTOR SCIENTIFIC, TECHNICAL AND ENGINEERING REPORT NUMBERING SYSTEM

Effective with the implementation of the Procurement/Contract numbering system as shown in the example below, the following guidelines are established for identifying scientific and technical reports (progress, interim, final topical, etc.) conference papers, proceedings, theses, and translations.

1. All DOE contractors now applying uniquely identifying codes and systems approved by TIC are to continue using such codes and systems.

2. DOE Field Office codes such as ALO, IDO, COO, HCP, NVO, ORO, RLO, SAN, and SRO; and program codes such as FE, DSE, etc., are no longer approved for use by contractors.

3. Contractors having no approved unique codes are to number information products as shown below. All contractors in this category should create unique report numbers by (a) identifying the report with a DOE code, (b) selecting the final seven characters from the applicable contract number (two alphabetic and five numerals), and (c) adding suffix numbers sequentially for each report generated under the contract. For new contracts, the sequential number should begin with 1. For existing contracts the established sequence should continue. Slash marks and hyphens should be applied as shown in the examples.

   Examples: Report numbers generated from contract number DE-AC03-79ET01834.M001:

   DOE/ET/01834-1; DOE/ET/01834-2; DOE/ET/01834-3; etc.

   Note: It is essential that both the final five-digit numeral and the two preceeding alphabetical characters be extracted from the contract number as shown. The modification number, if any, normally shown as M001, etc., following the basic five-digit number is NOT used in the report number.

4. Reports issued in more than one binding, or reissued as revisions or later editions, are to be identified by adding the following aditional suffixes to the basic number: Rev. - Revision; Vol. -Volume; Pt. - part: Add. - Addenda; Ed. - Edition, etc.

   Examples: DOE/ET-01834-1 Rev.
   DOE/ET/01834-1 Rev. 2

   DOE/ET-01834-1 Pt. 1
   DOE/ET/01834-1 Pt. 2

It is intended that report numbers be structured exactly as specified in the examples insofar as possible. If modification to this basic format is essential, it is to be approved through normal channels before being used.

NMRDI

New Mexico Research and Development Institute
Grant No. DE-FG07-88ID__________

STATEMENT OF WORK

1.0 INTRODUCTION

The goal of this grant is to support cost-shared research in resource assessment in the Rio Grande rift geothermal province. Several geothermal systems have been identified within the Rio Grande rift, and the U. S. Geological Survey has calculated an acccessible thermal energy resource base of 5.4×10^{18} Joules for the province in Circular 892. Radon gas soil surveys have been used in the exploration for and delineation of high-temperature systems in the Basin and Range province, and high radon-222 discharges have been documented at Radium Springs and Faywood Hot Springs in New Mexico. The general applicability of time-integrated radon-222 soil-gas surveys to define low-intermediate temperature geothermal resources is not established, however. The purpose of this research is threefold: 1) to test the use of time-integrated radon-222 soil-gas surveys for low-intermediate temperature geothermal resource delineation; 2) to test a geologic model for shallow geothermal resource occurrence; and 3) to characterize and delineate additional geothermal resources.

Previous DOE cost-shared and state-coupled resource assessment programs have played an important role in geothermal resource discovery, characterization, and utilization in New Mexico. The proposed research will provide a test of the radon-222 soil-gas survey method as a cost-effective exploration technique for geothermal resources in the Rio Grande rift environment and will accomplish a preliminary resource assessment of three areas.

2.0 SCOPE

The technical objectives of this research are to conduct resource assessment in the southern Rio Grande rift geothermal area of New Mexico. The testing of a new and previously untried exploration technique for low-to-intermediate temperature geothermal resources is a part of the resource assessment work. Radon-222 surveys will be conducted using Track-Etch radon detectors and established survey techniques at the Tortugas Mountain, Radium Springs, and Rincon areas. The survey results will be used to test a proposed geologic model for shallow low-to-moderate temperature geothermal resource occurrence in the southern Rio Grande rift, and to characterize and delineate additional resource areas. The survey and research results will be documented and evaluated, and presented in a final report. All project work will be completed and a final report submitted within an 18 month period.

3.0 APPLICABLE DOCUMENTS

The research described herein is abstracted from a proposal titled "Evaluation of Time-Integrated Radon Soil-Gas Surveys in the Southern Rio Grande Rift", dated June 17, 1987 as amended October 16, 1987. This proposal was submitted by the New Mexico Research and Development Institute in response to a DOE/ID Program Research and Development Announcement (PRDA) for State Geothermal Research and Development - PRDA No. DE-PR07-87ID12662.

4.0 TECHNICAL TASKS

The following tasks will be accomplished under this Grant.

4.1 Complete two soil-depth, radon gas surveys to determine radon concentrations as a function of soil depth and type, and to determine the preferred burial depth for the time-integrated radon detectors. One survey will profile radon soil gas over a young geomorphic surface with little or no caliche development. The other depth profile will detail radon soil gas over an old geomorphic surface with well-developed caliche. A total of 15 soil background concentration measurements and 15 time-integrated field measurements will be made.

4.2 Tortugas Mountain Survey. Complete one reconnaisance radon soil-gas profile eight miles in length and two detailed radon profiles with a total length of nine miles in the Tortugas Mountain area. The reconnaissance profile will include 40 pairs of soil background and time-integrated field measurements. The detailed profiles will include 270 pairs of soil background and time-integrated field measurements. Evaluate and interpret these data using known Hg soil-gas, U-238 and U-238 disequilibrium data, temperature gradient infor- mation, and electrical resistivity and seismic reflection data.

4.3 Radium Springs Survey. Complete one radon soil-gas grid survey of seven square miles, three detailed radon profiles with a total line length of two miles, and two temperature-gradient holes in the Radium Springs survey area. The radon grid survey will include 175 pairs of soil background and time-integrated field measurements. The detailed profiles will include 60 pairs of soil background and time-integrated field measurements. Evaluate and interpret these data. The temperature gradient holes will be drilled to a maximum depth of 300 feet (91 m) and completed with PVC pipe in a manner suitable for accurate temperature measurements. Temperatures will be measured at 2-meter intervals with a thermistor temperature measurement tool. A minimum of two logs will be completed for each hole, one shortly after drilling and one at least two weeks later.

4.4 Rincon Survey. Complete one radon soil-gas grid survey, two and one-half square miles in area, one detailed radon profile totaling one mile in length, and two temperature-gradient holes. The grid survey will include 60 pairs of soil background and time-integrated field measurements. The detailed profiles will include 30 pairs of soil background and time-integrated field measurements. The temperature gradient holes will be drilled to a maximum depth of 300 feet (91 m) and completed with PVC pipe in a manner suitable for accurate temperature measurements. Temperatures will be measured at 2-meter intervals with a thermistor temperature measurement tool. A minimum of two logs will be collected for each hole, one shortly after drilling and one at least two weeks later.

4.5 Complete an evaluation and interpretation of all the radon soil-gas and temperature gradient data. Prepare a final report which will include a description of the proposed model for shallow geothermal resource areas in the study area, a description of the research methodology and radon field surveys, a description of the temperature-gradient data summaries, and qualitative and quantitative interpretation of the research results. Complete an evaluation of the use of radon soil-gas surveys for low-to-moderate temperature geothermal resource exploration, and recommendations for future work.

5.0 REPORTS, DATA, AND OTHER DELIVERABLES

5.1 Management Records

Reports will be due as indicated on the Federal Assistance Reporting Checklist and the Report Distribution List.

5.2 Final Report

A detailed final technical report will be prepared which will describe the radon soil-gas field studies, the observed data, and the evaluation and interpretation of the radon soil-gas and temperature gradient data. The locations of field samples and drill holes will be included, and all data will be tabulated, in appendicies. A draft final report will be submitted for review and comment not less than 45 days prior to the scheduled delivery of the final report.

6.0 SPECIAL CONSIDERATIONS

The State of New Mexico will contribute direct monetary and administrative (in kind) support to this project as a state cost share.

CEC

California Energy Commission
Grant No. DE-FG07-88ID________

STATEMENT OF WORK

1.0 INTRODUCTION

The goal of this grant is to support cost-shared research in resource assessment which will study the suitability of moderate-temperature geothermal resources in Northern California for well-head power generation. Site-specific resource assessment will be conducted at the Wilbur Hot Springs area to determine resource characteristics which will be used as a model to test the applicability of several well-head generation technologies. An atlas and matrix of resource characteristics versus well-head generation technology will be developed for other moderate-temperature geothermal resources in northern California. The results of this analysis is expected to benefit utilities, energy planners and small power producers by demonstrating geothermal resource availability, resource characteristics, and the associated geothermal power cycles suitable for each site.

2.0 SCOPE

The technical objectives of this research are twofold. An extensive geochemical survey will be completed in the area defined by a negative gravity anomaly, centered approximately 1.5 km south of Wilbur Hot Springs, to better delineate and characterize this moderate-temperature geothermal resource. The geochemical survey will include a radon soil-gas survey and trace-metal investigation, and sampling of all surface and hot spring waters which can be located. The results of these studies, integrated with existing data, will be used to site an eventual production well to support a well-head power generation system. Based on the information derived from the power generation assessment of the Wilbur Hot Springs area, an evaluation of resource characteristics and optimum geothermal power generation systems will be completed for other potential moderate temperature geothermal areas in northern California. A geothermal atlas for the northern California area will be completed which will include graphs showing economical geothermal capacity in megawatts as a function of system power costs in dollars per kilowattt-hour, using estimated resource temperatures and production rates. All project work will be completed, and a final report submitted, within a 12 month period following California legislature approval of cost share funding.

3.0 APPLICABLE DOCUMENTS

The research described herein is abstracted from a proposal titled "Resource Assessment of the Wilbur Hot Springs Area", dated June 19, 1987 as revised October 7, 1987. This proposal was submitted by the California Energy Commission in response to a DOE-ID Program Research and Development Announcement (PRDA) for

State Geothermal Research and Development - PRDA No. DE-PR07-87ID12662.

4.0 TECHNICAL TASKS

The following tasks will be accomplished under this Grant.

4.1 Wilbur Hot Springs Site-Specific Study

4.1.1 Conduct a literature search for all pertinent geologic and geothermal information concerning the Wilbur Hot Springs area including the published literature, geologic maps, geophysical data, unpublished reports, dissertations, theses, well logs, open file reports, water information and subsurface logs. Complete an analysis and evaluation of these data.

4.1.2 Complete a geologic field reconnaissance of the Wilbur Hot Springs area and the adjacent negative gravity anomaly area. Acquire stereo aerial photographic coverage and interpret this photography for fault intersections, lineaments, spring locations, surface manifestations of hot spring activity, leaching, mineralization, and other significant geologic features. Complete reconnaissance-level field mapping to document structural features and hot and cold springs identified from aerial photos, and establish a grid system for the soil geochemical survey.

4.1.3 Complete soil geochemical surveys and the sampling of all surface and spring waters in the area including the negative gravity anomaly and Wilbur Hot Springs. The geochemical surveys will include radon soil-gas observations using Terra-Tech radon detectors, and analyses of soil samples for trace metals characteristic of the gold-mercury-geothermal association. Surface and spring waters will be sampled and analyzed to determine chemical characteristics and subsurface temperatures. Complete a draft technical report summarizing the results of all geochemical studies and recommending a location for the drilling of a production or exploration well.

4.2 Optimum Geothermal Power Cycles Study

4.2.1 Complete technical data collection for optimum geothermal power cycle determinations from sources such as the Electric Power Research Institute (EPRI), Geothermal Resources Council (GRC), the Heber binary-cycle demonstration plant, and various equipment manufactures.

4.2.2 Evaluate the technical data obtained in Task 4.2.1 for consistancy and completeness and compile available data on costs and performance. Update technical data, efficiencies, and cost data to the present day. Obtain relevant experience data from existing wellhead power plant operators.

4.2.3 Develop a validated technical database for relevant capital equipment costs, operating and maintenance costs, and performance and operating characteristics based on the data and analysis of task 4.2.2.

4.3 Site-Specific Geothermal Technology Characterization for Potential Resource Areas in Northern California.

4.3.1 Complete a study of constructing a utility-scale power plant at Wilbur Hot Springs and evaluate the economic potential of the well-head modular systems.

4.3.2 Develop a geothermal atlas for the northern California area to show the potentials of geothermal resource availability, resource characterics, and the associated types of geothermal power cycles for these resources. Prepare graphs which show economical geothermal capacity in megawatts as a function of system power costs in dollars per kilowatt-hour. Evaluate the implications of these data with respect to future power costs, priorities for future development and the time frame when well-head geothermal resources will be economical.

4.4 Prepare a final report which summarizes the results of the Wilbur Hot Springs assessment and the integration of the site-specific Wilbur Hot Springs resource data with the technology assessment data. The Geothermal Atlas for northern California moderate-temperature geothermal resources will be completed as a separate document but is included as a part of the final report.

5.0 REPORTS, DATA, AND OTHER DELIVERABLES

5.1 Management Records

Reports will be due as indicated on the Federal Assistance Reporting Checklist and the Report Distribution List.

5.2 Deliverables

The deliverables for this grant will include a detailed final technical report for the Wilbur Hot Springs site-specific study, and the Geothermal Atlas for northern California moderate-temperature geothermal resources. The final report for the site-specific study will discuss in detail the relevant results of the literature search, the aerial photo and field reconnaissance study, and the soil and fluid geochemical surveys. Sample locations and analytical results will be fully documented in the text or in appendicies, as is appropriate. The Geothermal Atlas for northern California will include a stand-alone summary of the technology database developed in the study and the tabulation and discussions of northern California resources and well-head power generation potential. A draft final report for each document will be submitted for review and comment not less than 45 days prior to the scheduled delivery of the final report.

6.0 SPECIAL CONSIDERATIONS

The California Energy Comission will contribute a portion of administrative and technical salaries and fringe benefits as the state cost share for this project.

ND

North Dakota Mining and Mineral Resources
Research Institute
Grant No. DE-FG07-87ID

STATEMENT OF WORK

1.0 Introduction

The goal of this research is to support cost-shared research on geothermal resources in North Dakota and South Dakota. Recent studies have shown that a large accessible geothermal resource base is present in both North Dakota and South Dakota but the detailed nature of the resource is not well understood. A comprehensive assessment of the geothermal resources in these states will be completed which extends the previous studies by the Principal Investigator and by others, and specifically addresses problems and areas of interest discovered in earlier studies.

2.0 Scope

The database of accurate temperature and temperature gradient data for North Dakota and South Dakota will be increased by logging available deep and shallow wells. Bottom-hole temperature (BHT) data will be analyzed to look for high and low heat flow zones similar to occurrences reported in Saskatchewan and Manitoba, Canada, and a systematic evaluation of the thermal conductivities of rocks in the Williston Basin will be conducted. The grantee will drill four heat flow holes in North Dakota and four heat flow holes in South Dakota to investigate hydrologic disturbances and sources of high heat flow in additional detail. All the new data resulting from these tasks will be integrated into the geothermal database, and analyzed and interpreted to complete a geothermal resource assessment which includes calculations of the production potential for all potential geothermal aquifers in the two state study area. Finally, the results of the study will be disseminated at the state level by meetings with appropriate state offices and service agencies, and through professional publications and presentations. This research will be accomplished in a period of 24 months.

3.0 Applicable Documents

The reseach described herein is abstracted from a proposal titled "Stratabound Geothermal Resources in North Dakota and South Dakota", dated 18 June 1987 and submitted by the North Dakota Mining and Mineral Resources Research Institute. This proposal was submitted in response to DOE/ID Program Research and Development Announcement (PRDA) for State Geothermal Research and Development - PRDA No. DE-PR07-87ID12662.

4.0 Technical Tasks

The following tasks will be accomplished under this Grant.

4.1 Obtain temperature and temperature gradient data by logging available deep and shallow wells which become available as holes of opportunity, i.e. oil and gas exploration wells, deep water wells, scientific test holes, or holes drilled for mineral exploration.

4.2 Analyze bottom hole temperature data to look for high and low heat flow zones similar to the cases reported in Saskatchewan and Manitoba, Canada.

4.3 Conduct a systematic evaluation of the thermal conductivities of rocks in the Williston Basin.

4.4 Drill four heat flow holes in North Dakota to investigate the hydrologic disturbances described in task 4.2.

4.5 Drill four heat flow holes in South Dakota to investigate the sources of high heat flow in central and southern South Dakota.

4.6 Assimilate available data and calculate production potential for all potential geothermal aquifers in the study area.

4.7 Assimilate stratigraphic and hydrologic data into the geothermal database.

4.8 Analyze and interpret the data to complete the geothermal resource assessment.

4.9 Disseminate the results of this research at the state and national level through meetings with appropriate state agencies and presentations at professional meetings.

5.0 Reports, Data, and Other Deliverables

5.1 Management Records

Reports will be due as indicated on the Federal Assistance Reporting Checklist and the Report Distribution List.

5.2 Final Report

A detailed final technical report will be prepared which will describe all new temperature data, data reduction methods, computer algorithms used, data tables, maps, and methods of research. A draft final report will be submitted for review and comment not less than 45 days prior to the scheduled delivery of the final report.

6.0 Special Considerations

The North Dakota Geological Survey and the South Dakota Geological Survey will be involved in this project through the direct participation of geologists from their staffs. A N.D.G.S. logging truck with a continuous temperature logging system will be available for this study.

WY

University of Wyoming
Grant No. DE-FG07-87ID

STATEMENT OF WORK

1.0 Introduction

The goal of this Grant is to support cost-shared research on geothrmal resources in Wyoming and the Rocky Mountain region in general through the application of several new finite difference computational schemes to the calculation of subsurface temperatures. Ground and water temperatures will be calculated by considering both conductive and forced convective heat transport equations. The improved computational schemes will be used to model either the Cody or Thermopolis hydrothermal systems in Wyoming as a check on the validity of the numerical techniques. The ultimate aim of these calculations and studies is an understanding of hydrothermal resources typical of Wyoming and the Rocky Mountain region in general.

2.0 Scope

The technical objectives of this grant are to develop and test improved three-dimensional computational schemes for solving the combined heat conduction and forced convection equations for the purpose of determining subsurface temperatures. Both the speed and the precision of the three-dimensional finite difference modeliing algorithm will be enhanced beyond existing routines. Temperature data from existing wells will then be used to determine geothermal groundwater parameters. The validity of the improved computational scheme will be determined by applying the model to either the Cody or the Thermopolis hydrothermal systems in the Bighorn Basin, Wyoming where both thermal and hydrologic data already exist. All tasks will be completed in a 12 month period.

3.0 Applicable Documents

The research described herein is abstracted from a proposal titled "Improved Computational Schemes for the Numerical Modeling of Hydrothermal Resources in Wyoming", dated June 10, 1987 and submitted by the University of Wyoming. This proposal was submitted in response to a DOE/ID Program Research and Development Announcement (PRDA) for State Geothermal Reseach and Development - PRDA No. DE-PR07-87ID12662.

4.0 Technical Tasks

The following tasks will be accomplished under this grant.

4.1 Develop algorithms for the conjugate gradient solver.

4.2 Develop algorithms for heat transfer due to forced convection using a second order difference representation.

4.3 Develop algorithms for heat transfer due to Newton's Law of cooling using a second order difference representation.

4.4 Develop algorithms for three dimensional heat transfer using operator splitting or alternating direction iterative methods.

4.5 Apply grid refinement methods to improve the precision of the solution in areas of large gradient change.

4.6 Gather additional temperature data form wells in either the Cody or Thermopolis area to supplement the existing data base.

4.7 Apply the developed finite difference model to either the Cody or the Thermopolis hydrothermal system to test the improved computational schemes.

4.8 Complete the documentation for all computer algorithms, document all new temperature data, and present a discussion of the numerical methods and test results in a final report.

5.0 Reports, Data, and Other Deliverables

5.1 Management Records

Reports will be due as indicated on the Federal Assistance Reporting Checklist and the Report Distribution List.

5.2 Final Report

A detailed final technical report will be prepared which will describe all computer algorithms, data tebles, maps, methods of research and data reduction. All new data obtained as a result of this grant will be summarized in the technical report. A listing of new computer programs which are developed will be included as appendicies to the final report. A draft final report will be submitted for review and comment not less than 45 days prior to the scheduled delivery of the final report.

6.0 Special Considerations

The University of Wyoming will contribute computer software (three-dimensional plotting routines, and a Fortran update) to aid in algorithm development as part of the University of Wyoming cost share. The level of quality assurance (QA) completed for this software and new software develope under this grant will be described in the final report.

University of Nevada, Las Vegas
Division of Earth Sciences

Grant No. DE-FG07-88ID________

STATEMENT OF WORK

1.0 Introduction

The goal of this grant is to support cost-shared research on geothermal resources of the Great Basin region of Nevada. Nevada has extensive geothermal resources, with more than 300 known hot springs and wells, and several electric power plants or other industrial developments on line or in construction. Earlier resource assessment activities have focused on the location and basic characteristics of the resources. Fluid genesis, and longevity of the geothermal resources have not been adequately addressed in these earlier studies. The principal objectives of this study are to determine the recharge areas, flow rates and paths, and provinces of geothermal fluids that occur at the surface today. These objectives will be achieved by integrating and interpreting a variety of fluid geochemical, archaeological, and paleontological data. The ultimate goal is to develop a model of geothermal fluid genesis within the Great Basin. Such a model will provide significant benefits to the geothermal industry and to state agencies responsible for regulating geothermal energy and water rights issues.

2.0 Scope

The technical objectives of this grant are to develop a model of geothermal fluid genesis within the Great Basin. The research program will delineate hydrothermal convection systems in Nevada on the basis of geothermal fluid chemistry, stable light-isotope composition, trace element geochemistry, and other data sets. Recharge areas will be resolved by analyzing paleo-fluid composition from three potential sources: artifact data resulting from American Indian habitation in Nevada from 10,000 years ago to historic time; existing ice core data; and fluid age-determinations. Carbon-14, deuterium, oxygen-18, and stable light-isotope data will be utilized in these studies. An integrated interpretation of the various data sets will be completed. All tasks including the writing of a comprehensive final report will be completed in a 12 month period.

3.0 Applicable Documents

The research described herein is abstracted from a proposal titled "Geothermal Fluid Genesis in the Great Basin", dated June 19, 1987 as amended October 16, 1987. This proposal was submitted by the University of Nevada, Las Vegas, Division of Earth Sciences, in response to a DOE/ID Program Research and Development Announcement (PRDA) for State Geothermal Research and Development - PRDA No. DE-PR07-87ID12662.

4.0 Technical Tasks

The following tasks will be accomplished under this grant.

4.1 Collect and evaluate existing data obtained through an extensive literature search.

4.1.1 Collect fluid chemistry data for thermal and non-thermal fluids throughout the Great Basin with emphasis on isotopic ratios, apparent ages, and tritium values, to form a baseline for subsequent work. Potential data sources include the geothermal literature; data from the Nevada Test Site and High-Level Nuclear Waste Isolation Program; and the NURE program.

4.1.2 Collect corresponding data for major geothermal reservoir rocks or rock types with emphasis on stable light-isotope ratios. These data are essential for establishing model resolution limits.

4.1.3 Collect existing glacial ice data from sites in western North America, Greenland, and Antartica and compare to snow/ice packs in the Sierra Nevada, White Mountains, Wheeler Peak, and Ruby Mountains. Existing ice core data, tephra deposits, and glacial till material with corresponding stable isotope ratios will be used to reconstruct paleoclimatic conditions within the Great Basin.

4.1.4 Acquire and describe preserved organic archaeological material from prehistoric habitation sites and from packrat middens and other natural organic deposits throughout the Great Basin. Analize appropriate materials for stable light isotopes and date by radiometric carbon-dating techniques. Compare to present isotope ratios in geothermal fluids and project the isotopic composition of paleo fluids precipitated at various elevations throughout the Great Basin.

4.2 Format the technical data base. Produce maps and tables that differentiate data sources, establish spatial, temporal, and elevation relationships for principal geotherml systems. Identify data voids and mitigate where possible. Determine preliminary model parameters for chemical data, temporal and spatial constraints, and regional geologic setting. Submit technical resource data to GEOTHERM for archiving.

4.3 Sampling and Analysis

4.3.1 Systematically sample, record, and submit for chemical analyses geothermal fluids from selected large geothermal springs and large geothermal systems presently under development. Chemical analyses will include major, minor, and trace elements, stable light isotopes, Tritium, and Carbon-14. Integrate with baseline data from Task 4.1 and produce graphs that illustrate various parameters with respect to time at both idle hot springs and geothermal developments.

4.3.2 Complete precision isotopic analyses of selected archaeological material (plant material from caves, charcoal, reed baskets, coprolites, middens, food caches) from representative sites throughout the Great Basin. Include data in data base maps of Task 4.2.

4.4 Develop conceptual geothermal fluid genesis and recharge models based on geology, inferred paleoclimatic conditions, geothermal fluid chemical and isotopic composition. Compare to existing regional models. Interpret the various data in terms of the contemporary fluid recharge model and the paleo recharge model. Identify and discuss conflicting data and evaluate those data that influence the models. Integrate detailed geochemical data with overall reservoir performance data where appropriate. Provide geothermal utilities, developers, and State legislative committees and regulatory agencies with timely progress reports. Consider performance characteristics with respect to geothermal provinces.

4.5 Complete the documentation for all new data, including geochemical data, age dates, isotope ratios, and final interpretations and present with appropriate discussion in a final technical report. Detailed geochemical sampling data on geothermal systems and developments will be presented on large scale maps.

5.0 Reports, Data, and Other Deliverables.

5.1 Management Records

Reports will be due as indicated on the Federal Assistance Reporting Checklist and the Report Distribution List.

5.2 Final Report

A detailed final technical report will be prepared which will describe all new geochemical data, data tables, age dates, isotope ratios, data synthesis, and interpretation. A draft final report will be submitted for review and comment not less than 45 days prior to the scheduled delivery of the final report.

6.0 Special Considerations

The University of Nevada, Las Vegas, will provide as a cost share item salary and fringe benefits for the Senior Geologist for a period of four months. In addition, UNLV will provide vehicles to the project at a charge of $0.30 per mile for gas, oil, and general maintenance.

UNLV 1-3S

SCP. SW3

University of Nevada, Las Vegas
Division of Earth Sciences

Grant No. DE-FG07-8~~7~~8ID________

STATEMENT OF WORK

1.0 Introduction

The goal of this grant is to support cost-shared research on geothermal resources of the Great Basin region of Nevada. Nevada has extensive geothermal resources, with more than 300 known hot springs and wells, and several electric power plants or other industrial developments on line or in ~~progress.~~ construction. Earlier resource assessment activities have focused on the location and basic characteristics of the resources. Fluid genesis, and longevity of the geothermal resources have not been adequately addressed in these earlier studies. The principal objectives of this study are to determine the recharge areas, flow rates and paths, and provinces of geothermal fluids that occur at the surface today. These objectives will be achieved by integrating and interpreting a variety of fluid geochemical, archaeological, and paleontological data. The ultimate goal is to develop a model of geothermal fluid genesis within the Great Basin. Such a model will provide significant benefits to the geothermal industry and to state agencies responsible for regulating geothermal energy and water rights issues.

2.0 Scope

The technical objectives of this grant are to develop a model of geothermal fluid genesis within the Great Basin. The research program will delineate hydrothermal convection systems in Nevada on the basis of geothermal fluid chemistry, stable light-isotope composition, trace element geochemistry, and other data sets. Recharge areas will be resolved by analyzing paleo-fluid composition from three potential sources: artifact data resulting from American Indian habitation in Nevada from 10,000 years ago to historic time; existing ice core data; and fluid age-determinations. Carbon-14, deuterium, oxygen-18, and stable light-isotope data will be utilized in these studies. An integrated interpretation of the various data sets will be completed. All tasks including the writing of a comprehensive final report will be completed in a 12 month period.

3.0 Applicable Documents

The research described herein is abstracted from a proposal titled "Geothermal Fluid Genesis in the Great Basin", dated June 19, 1987 as amended October 16, 1987. This proposal was submitted by the University of Nevada, Las Vegas, Division of Earth Sciences, in response to a DOE/ID Program Research and Development Announcement (PRDA) for State Geothermal Research and Development - PRDA No. DE-PR07-87ID12662.

4.0 Technical Tasks

The following tasks will be accomplished under this grant.

4.1 Collect and evaluate existing data obtained through an extensive literature search.

4.1.1 Collect fluid chemistry data for thermal and non-thermal fluids throughout the Great Basin with emphasis on isotopic ratios, apparent ages, and tritium values, to form a baseline for subsequent work. Potential data sources include the geothermal literature; data from the Nevada Test Site and High-Level Nuclear Waste Isolation Program; and the NURE program.

4.1.2 Collect corresponding data for major geothermal reservoir rocks or rock types with emphasis on stable light-isotope ratios. These data are essential for establishing model resolution limits.

4.1.3 Collect existing glacial ice data from sites in western North America, Greenland, and Antartica and compare to snow/ice packs in the Sierra Nevada, White Mountains, Wheeler Peak, and Ruby Mountains. Existing ice core data, tephra deposits, and glacial till material with corresponding stable isotope ratios will be used to reconstruct paleoclimatic conditions within the Great Basin.

4.1.4 Acquire and describe preserved organic archaeological material from prehistoric habitation sites and from packrat middens and other natural organic deposits throughout the Great Basin. Analize appropriate materials for stable light isotopes and date by radiometric carbon-dating techniques. Compare to present isotope ratios in geothermal fluids and project the isotopic composition of paleo fluids precipitated at various elevations throughout the Great Basin.

4.2 Format the technical data base. Produce maps and tables that differentiate data sources, establish spatial, temporal, and elevation relationships for principal geotherml systems. Identify data voids and mitigate where possible. Determine preliminary model parameters for chemical data, temporal and spatial constraints, and regional geologic setting. Submit technical resource data to GEOTHERM for archiving.

4.3 Sampling and Analysis

4.3.1 Systematically sample, record, and submit for chemical analyses geothermal fluids from selected large geothermal springs and large geothermal systems presently under development. Chemical analyses will include major, minor, and trace elements, stable light isotopes, Tritium, and Carbon-14. Integrate with baseline data from Task 4.1 and produce graphs that illustrate various parameters with respect to time at both idle hot springs and geothermal developments.

4.3.2 Complete precision isotopic analyses of selected archaeological material (plant material from caves, charcoal, reed baskets, coprolites, middens, food caches) from representative sites throughout the Great Basin. Include data in data base maps of Task 4.2.

4.4 Develop conceptual geothermal fluid genesis and recharge models based on geology, inferred paleoclimatic conditions, geothermal fluid chemical and isotopic composition. Compare to existing regional models. Interpret the various data in terms of the contemporary fluid recharge model and the paleo recharge model. Identify and discuss conflicting data and evaluate those data that influence the models. Integrate detailed geochemical data with overall reservoir performance data where appropriate. Provide geothermal utilities, developers, and State legislative committees and regulatory agencies with timely progress reports. Consider performance characteristics with respect to geothermal provinces.

4.5 Complete the documentation for all new data, including geochemical data, age dates, isotope ratios, and final interpretations and present with appropriate discussion in a final technical report. Detailed geochemical sampling data on geothermal systems and developments will be presented on large scale maps.

5.0 Reports, Data, and Other Deliverables.

5.1 Management Records

Reports will be due as indicated on the Federal Assistance Reporting Checklist and the Report Distribution List.

5.2 Final Report

A detailed final technical report will be prepared which will describe all new geochemical data, data tables, age dates, isotope ratios, data synthesis, and interpretation. A draft final report will be submitted for review and comment not less than 45 days prior to the scheduled delivery of the final report.

6.0 Special Considerations

The University of Nevada, Las Vegas, will provide as a cost share item salary and fringe benefits for the Senior Geologist for a period of four months. In addition, UNLV will provide vehicles to the project at a charge of $0.30 per mile for gas, oil, and general maintenance.

DNI
UNS

44

Desert Research Institute
University of Nevada System

Grant No. DE-FG07-87ID

STATEMENT OF WORK

1.0 Introduction

The goal of this Grant is to support cost-shared research ~~on~~ in the form of technical assistance on ~~a resource assessment of~~ the Moana geothermal system, a moderate-temperature hydrothermal reservoir located in Reno, Nevada. The Moana resource is currently used for space heating by over 200 residences and numerous commercial establishments. Additional development is currently underway and is proceeding in an uncoordinated manner which could affect the quality and longeviety of the resource. Three state agencies have regulatory responsibility over various aspects of geothermal development but a better data base and a quantitative predictive model is needed to assist these agencies and developers in sound development of the resource with minimal environmental impact. The aim of the proposed research is to obtain the necessary data and to construct, calibrate, and verify a numerical model of the Moana system. The model will be made available to developers and regulatory agencies.

2.0 Scope

The objectives of this grant are to construct, calibrate and verify a numerical model of the Moana geothermal reservoir. The model will be capable of simulating fluid, heat and contaminant transport under steady or transient conditions. Initial efforts will focus on an inventory and assessment of existing data, followed by additional data collection for one full heating year (13 months). The USGS numerical model SUTRA will be used to model the Moana system and the model will be calibrated and verified with respect to the observed data. Reservoir simulation will then be completed for a number of development scenarios and the results made available to developers and regulators. All tasks will be completed in a period of 22 months.

3.0 Applicable Documents

The research described herein is abstracted from a proposal titled "Quantitative Evaluation and Numerical Simulation of the Moana Geothermal System", dated June 18, 1987 as modified on October 26, 1987. This proposal was submitted by the Desert Research Institute, University of Nevada System, in response to a DOE/ID Program Research and Development Announcement (PRDA) for State Geothermal Research and Development - PRDA No. DE-PR07-87ID12662.

4.0 Technical Tasks

The following tasks will be accomplished under this grant.

4.1 Collect and assess the quality of all relevant existing data including hydraulic data, thermal data, well data, geologic data, hydrochemical data and hydrologic data.

4.2 Collect new data on the Moana geothermal system for a period of 13 months. Perform weekly measurements of water levels and temperatures in selected wells. Design and conduct aquifer tests to characterize storage and fluid conductive properties of the reservoir and the nature of the boundaries. Determine thermal gradients in wells, and chemical analyses of well fluids.

4.3 Complete calibration and verification of a numerical model simulating the Moana geothermal resevoir using the data from Tasks 4.1 and 4.2. Verify the accuracy of the model under both steady state and transient conditions. The USGS numerical model program SUTRA will be used for the modeling and simulation of the resevoir.

4.4 Perform reservoir simulations for a variety of development scenarios using the calibrated and verified SUTRA model. The simulations will show the effects of temperature distributions due to pumping and injection; plumes of lower temperature water due to injection; solute concentrations and distributions due to pumping; high solute concentration plumes due to reinjection; and areas of decreased water levels due to groundwater withdrawal.

4.5 Complete the documentation of all new resource data, a description of the Moana reservoir model and the results and interpretation of the model simulations. Prepare a user's manual for the Moana reservoir model and deliver to the three state regulatory agencies and to interested parties.

5.0 Reports, Data, and Other Deliverables

5.1 Reports will be due as indicated on the Federal Assistance Reporting Checklist and the Report Distribution List.

5.2 A detailed final technical report will be prepared which will document all inventoried and new resource data, and will describe the Moana resevoir model and the results and interpretation of the model simulations. A user's manual for the Moana reservoir model will be included as an appendix. Any new software developed which is necessary for the execution of the reservoir model will be described and a listing included. A draft final report will be submitted to DCS/ID for review and comment not less than 45 days prior to the scheduled delivery of the final report.

6.0 Special Considerations

The Desert Research Institute, University of Nevada System, will contribute a funding equivalent of $16,300 as a cost share to this project. This cost share will be made available to the project as staff salaries and benefits, and indirect costs.

SOW.AK

Geophysical Institute, University of Alaska
Grant No. DE-FG07-88ID

STATEMENT OF WORK

1.0 Introduction

The goal of this grant is to support cost-shared research on geothermal resources in the State of Alaska. The Aleutian Islands-Alaska Peninsula region is known to be one of the largest geothermal energy resource areas of the United States, but the resource areas are remote and the population is scarce. The increased development of the American bottom-fish industry in the Bering Sea and the northern Pacific Ocean, and increased oil and gas exploration in the Bering Sea are generating an increased need for power in the region. The objective of this resource assessment study is to obtain new site specific data on one promising resource area so that these data are available for future exploration and development activities. The geothermal resource assessment will be conducted at the Geyser Bight KGRA.

2.0 Scope

Geyser Bight KGRA on Umnak Island is the hottest and most extensive area of thermal springs in Alaska but the resource has not been studied in detail. An integrated geological and geochemical study will be completed which will include a 1:25,000 scale geologic map of Geyser Creek Valley and the surrounding area, fluid geochemistry, K-Ar dating, petrography and rock chemistry. A detailed chemical model of fluid chemistry will be developed which will constrain deep reservoir temperatures, origins of fluids, and mixing between different fluids. The period of performance for this study, including final reporting, will be 20 months.

3.0 Applicable Documents

The research described herein is abstracted from a proposal titled "Geothermal Resource Assessment in the Aleutian Islands and Alaska Peninsula", dated June 15, 1987 as revised on October 28, 1987. This proposal was submitted by the Geophysical Institute, University of Alaska, and the Alaska Division of Geological and Geophysical Surveys in response to DOE/ID Program Research and Development Announcement (PRDA) for State Geothermal Research and Development - PRDA No. DE-PR07-87ID12662.

4.0 Technical Tasks

The following tasks will be accomplished under this grant.

4.1 Geyser Bight KGRA Site-specific Study

4.1.1 Complete field geologic mapping and interpretation to complete a 1:25,000-scale geologic map of Geyser Creek valley and the surrounding area. Mapping information will include geological structures, Quaternary valley-fill deposits, alteration, plutonic rocks, major contacts, and volcanic rocks. Geologic mapping will be supported by K-Ar age dating. Information relating to volcanic hazards will be noted and evaluated. The Alaska DGGS will participate in and contribute to this subtask.

4.1.2 Fluid Chemistry Investigation of the Geyser Bight KGRA. Provide management, logistical and technical support to Alaska DGGS personnel who will complete ~~most of~~ the technical and reporting portions of this subtask.

4.1.3 Interpret and analyze all new and existing geological and geochemical data, and then integrate with Alaska DGGS studies to produce an integrated final report on the Geyser Bight geothermal study area. This evaluation will include improved estimates of the reservoir temperatures and of the magnitude of the energy available for development.

5.0 Reports, Data, and Other Deliverables

5.1 Management Records

Reports will be due as indicated on the Federal Assistance Reporting Checklist and the Report Distribution List.

5.2 Final Report

A detailed final technical report will be published which will describe the geology, lithologies, rock geochemistry, K-Ar dates, and potential for volcanic hazards of the Geyser Creek valley and surrounding area. The report will include a detailed 1:25,000-scale geologic map of the Geyser Creek valley area, and a detailed report of the Alaska DGGS fluid geochemistry study, complete with tables of chemical analyses and isotopic data. The report will also include an integrated interpretation of all the relevant data, estimates of reservoir temperature and of the magnitude of the energy available for development. A draft final report will be submitted to DOE/ID for review and comment not less than 45 days prior to the scheduled delivery of the final report.

6.0 Special Considerations

The Geyser Bight KGRA studies will be completed as a cooperative study with the State of Alaska, Division of Geological and Geophysical Surveys. The Geophysical Institute will contribute radio equipment, a Zodiac inflatable boat and outboard motor, and tents to the project at no cost to the budget. The Geophysical Institute will contribute staff salaries and K-Ar age dates valued at $4,000 as a cost share.

State of Alaska
Division of Geological and Geophysical Surveys
Grant No. DE-FG07-88ID

STATEMENT OF WORK

1.0 Introduction

The goal of this ~~research~~ grant is to support cost-shared research on geothermal resources in the State of Alaska. The Aleutian Islands-Alaska Peninsula region is known to be one of the largest geothermal energy resource areas of the United States, but the resource areas are remote and the population is scarce. The increased development of the American bottom-fish industry in the Bering Sea and the northern Pacific Ocean, and increased oil and gas exploration in the Bering Sea are generating an increased need for power in the region. The objectives of these resource assessment studies are to obtain new site specific data on one promising resource area, and to develop and document resource information for the entire region so that these data are available for future exploration and development activities.

Geothermal resource assessment will be conducted at the Geyser Bight KGRA which is the hottest and most extensive area of thermal springs in Alaska. A second task will involve the preparation and publication of a geotechnically-oriented geothermal resorce map of the Aleutian Islands and the Alaska Peninsula region with supplemental information on fluid chemistry, temperatures, isotopic compositions, and geothermometry. This effort will document in new detail the state of knowledge of these geothermal resources.

2.0 Scope

Geyser Bight KGRA on Umnak Island is the hottest and most extensive area of thermal springs in Alaska but the resource has not been studied in detail. The Alaska DGGS will complete a detailed study of the fluid geochemistry of the Geyser Bight KGRA and will contribute to field geologic studies and mapping managed by the Geophysical Institute-University of Alaska under a separate grant. A detailed chemical model of fluid chemistry will be developed which will constrain deep reservoir temperatures, origins of fluids, and mixing between different fluids.

A second task will result in the preparation and publication of a four-color, geotechnically-oriented geothermal resource map of the Aleutian Islands and the Alaska Peninsula region. This map and accompanying circular will document maximum surface temperatures, estimated convective heat discharge and reservoir temperatures, and water and gas chemistry. A brief description will be provided for each geothermal resource site. The accessible heat energy base stored in the Aleutian arc volcanic systems will be discussed. The period of performance for these studies, including final reporting, will be ~~18~~ 24 months.

3.0 Applicable Documents

The research described herein is abstracted from a proposal titled "Geothermal Resource Assessment in the Aleutian Islands and Alaska Peninsula", dated June 15, 1987 as revised on October 28, 1987. This proposal was submitted by the Geophysical Institute, University of Alaska, and the Alaska Division of Geological and Geophysical Surveys in response to DOE/ID Program Research and Development Announcement (PRDA) for State Geothermal Research and Development - PRDA No. DE-PR07-87ID12662.

4.0 Technical Tasks

The following tasks will be accomplished under this grant.

4.1 Geyser Bight KGRA Site-specific Study

4.1.1 Contribute to field geologic mapping and interpretation to complete a 1:25,000-scale geologic map of Geyser Creek valley and the surrounding area. Mapping information will include geological structures, Quaternary valley-fill deposits, alteration, plutonic rocks, major contacts, and volcanic rocks. Information relating to volcanic hazards will be noted and evaluated. This task will be managed by the Geophysical Institute-University of Alaska (GI-UAK).

4.1.2 Fluid Chemistry Investigation of the Geyser Bight KGRA. Perform preliminary chloride-enthalpy and fluid-mineral equilibria analyses. Examine and evaluate results of chemical and isotopic geothermometers. Examine the results of analyses of stable isotope compositions. Collect additional water samples for geochemical and isotopic analyses during the 1988 field season and complete these analyses. Measure thermal spring flow rates and temperatures and estimate heat loss due to surface and near-surface discharge of thermal waters. Analyze water samples for major and minor and slected trace element constituents and for stable isotope composition. Refine a) the chloride-enthalpy model, b) the analyses of fluid mineral equilibria, c) estimates of reservoir temperatures, and d) the estimate of the source of reservoir recharge waters.

4.1.3 Analize and interpret all new and existing geological and geochemical data, and then integrate with GI-UAK data to contribute to an integrated final report completed by GI-UAK on the Geyser Bight geothermal study area. This evaluation will include improved estimates of the reservoir temperatures and of the magnitude of the energy available for development.

4.2 Preparation of a 1:1,000,000 scale technical geothermal energy resource map for the Aleutian Islands-Alaska Peninsula region, and supporting documentation.

4.2.1 Prepare and publish a four-color, geotechnically-oriented geothermal resource map of the Aleutian Islands and the Alaska Peninsula region. The color-coded map will show locations of all known geothermal sites between Buildir Island on the west and Becharof Lake on the east. Map information for each site will include maximum surface temperatures, estimated convective heat discharge, estimated reservoir temperatures, total dissolved solids, and land status. The map will include larger-scale, more-detailed insets of three to five of the most promising geothermal prospects in this region.

4.2.2 Compile tables of all available geochemical data on geothermal fluids. These tables will contain water chemistry, gas chemistry and stable isotope compositions of thermal springs, geothermal wells, fumaroles, and thermal and local waters (as appropriate); isotopic compositions of gases; estimates of temperatures of thermal water based on chemical equilibria and appropriate geothermometry; and estimates of temperatures of geothermal gases based on geothermometers.

4.2.3 Prepare and publish a circular designed to accompany the Geothermal Resource Map (Task 4.2.1) which will contain brief descriptions of each geothermal site located on the resource map, with the more important sites receiving greater emphasis. The circular will include summaries of any site-specific investigations which have been conducted and relevant references. The circular will also contain comprehensive tables and brief discussion of pertinent geochemical data collected by the DGGS.

5.0 Reports, Data, and Other Deliverables

5.1 Management Records

Reports will be due as indicated on the Federal Assistance Reporting Checklist and the Report Distribution List.

5.2 Deliverables

Deliverables for this grant include the following: contributions to the GI-UAK geologic map of Geyser Creek valley area; a report on the fluid geochemistry of the Geyser Bight KGRA (may be included as a chapter in the GI-UAK report); and contributions to the final report on the Geyser Bight KGRA study (Task 4.1). Deliverables for Task

4.2 include the four-color, 1:1,000,000 scale geothermal resource map for Aleutian Islands-Alaska Peninsula Region; tables of fluid geochemistry; and a circular accompanying the four-color resource map. A draft copy of all final deliverable items will be submitted to DOE/ID for review and comment not less than 45 days prior to the scheduled delivery of maps, tables or reports.

6.0 Special Considerations

The Geyser Bight KGRA studies will be completed as a cooperative study with the Geophysical Institute-University of Alaska, which will be responsible for the overall management and reporting for the project. The Alaska DGGS will contribute hand-held radios and a repeater station at no cost to the project, and will contribute staff personnel, benefits, and $1,000 for map production costs as a cost share to the project.

SOW.GMC

Utah Geological and Mineral Survey
Grant No. DE-FG07-88ID

STATEMENT OF WORK

1.0 Introduction

The goal of this grant is to support cost-shared geothermal resource assessment at the Newcastle geothermal area in Iron County, Utah. Thermal water was discovered in the Newcastle area in 1975 during test pumping of an irrigation well. Since then limited studies have been conducted in the area but a systematic evaluation of the resource has not been completed. Newcastle may be just one of a large number of hydrothermal resources within the Basin and Range province that are "blind systems" which have no noticable surface expression. The objectives of this resource assessment study are to complete a detailed evaluation of the Newcastle geothermal resource using an integrated program of geological, geophysical, and geochemical studies, and to contribute to the development of an exploration methodology for the discovery and evaluation of other basin and range blind hysrothermal systems.

2.0 Scope

A multidisciplinary study of the Newcastle geothemal area will be completed with the broad objective of constructing a refined, conceptual geologic model of the resource. These studies will include: the mapping of Quaternary structure and stratigraphy; geologic mapping of bedrock in adjacent hills; acquisition and analysis of detailed gravity and magnetic data; a geochemical study including a soil mercury survey and water analyses; and thermal gradient studies within a shallow, exploratory drill hole. The various data will be interpreted and integrated to develop a conceptual geological model for the Newcastle system. The applicability of the various methods for the evaluation of other blind geothermal resources will be evaluated. All tasks will be completed in a 14 month period.

3.0 Applicable Documents

The research described herein is abstracted from a proposal titled "Geothermal Resouce Assessment at Newcastle, Iron County, Utah", dated June 19, 1987 as revised on October 21, 1987. This proposal was submitted by the Utah Geological and Mineral Survey in response to DOE/ID Program Research and Development Announcement (PRDA) for State Geothermal Research and Development - PRDA No. DE-PR07-87ID12662.

4.0 Technical Tasks

The following tasks will be accomplished under this grant.

4.1 Complete a comprehensive examination and compilation of all available background data for the Newcastle resource area. These data will be obtained from State regulatory agencies and published sources, and from private companies that have performed exploration in the area (to the extent that such data may be released).

4.2 Study Quaternary deposits in the study area to determine stratigraphic and structural controls to the hydrothermal system. Map Quaternary fault scarps and surfacial deposits using air-photo interpretation and field studies.

4.3 Compile existing bedrock geologic data and supplement with additional field work to verify structural relationships in complex fault intersection zones. Prepare a geologic map at a scale of 1:25,000 (or 1:24,000) suitable for the interpretation and integration of other project data.

4.4 Acquire ground based gravity data to supplement existing gravity data. Obtain ground magnetic data to supplement aeromagnetic data for the area, which will be acquired from a private source. Determine station locations and elevations and complete data reduction.

4.5 Complete a soil mercury geochemical survey across the area of the Newcastle thermal anomaly. The survey will include approximately 200 soil samples taken on a grid of the order of approximately 1,000 by 1,000 feet covering an area of about eight square miles. Collect water samples from available wells and analyze the samples for total dissolved solids (TDS), SO4, Cl, F, pH, and alkalinity. Prepare tri-linear plots and determine reservoir equilibration temperature by geothermometry. Obtain samples for oxygen and hydrogen isotope determinations and perform these analyses.

4.6 Site one temperature gradient test hole based upon the results of tasks 4.1 through 4.5, and drill this hole after obtaining necessary permits and permission. Complete temperature measurements when hole has equilibrated and determine the thermal gradient.

4.7 Compile and evaluate all data sets. Complete an integrated interpretation of all data to arrive at a refined conceptual model of the hydrothermal system. Evaluate the utility of the techniques used as a methodology for the exploration of other blind Basin and Range hydrothermal systems.

5.0 Reports, Data, and Other Deliverables

5.1 Management Records

Reports will be due as indicated on the Federal Assistance Reporting Checklist and the Report Distribution List.

5.2 Final Report

A detailed final technical report will be prepared which will describe all new geological, geochemical and geophysical data. Data reduction methods and computer algorithms used will be described in the text and significant new data will be included as data tables, maps, and illustrations. A geologic map of the Newcastle area will accompany the text. A draft final report will be submitted to DOE/ID for review and comment not less than 45 days prior to the scheduled delivery of the final report.

6.0 Special Considerations

The Utah Geological and Mineral Survey will contribute personnel time, and supplies and purchases valued at $1,000 as a cost share for this research. University of Utah faculty and students will perform the gravity and magnetic field studies, Task 4.4, at no cost to this project.

REVISIONS TO STATEMENT OF WORK

4.6 Develop a lithologic log and generalized temperature profile using well data obtained from Union Geothermal Corporation. The profile and log will be constructed to a depth of at least 1,000 ft.

4.7 Perform temperature monitoring of multiple, shallow temperature gradient test holes. Program will consist of drilling using light, portable equipment some 20 to 40 shallow (less than 50 ft) test holes and completing the holes for temperature gradient profiling. Monitoring will be performed over an approximate six-month period following completion of test hole drilling. Computer-aided modeling of thermal gradient data will be performed using other geological and geophysical data to help generate a conceptual geo-hydrologic model of the hydrothermal system at Newcastle.

4.8 Obtain additional close-spaced gravity data points as needed to supplement studies performed as part of the technical task described in paragraph 4.4. Combine all the data in reduced format to be used within the context of presenting a conceptual model.

Task 6: Lithologic and Temperature Log of Union Geothermal Well

As part of the overall project, officials from Union Geothermal -- a subsidiary of Union Oil of California (UNOCAL) have kindly agreed to release information pertaining to a 3,000 ft deep geothermal exploration well that ~~they~~ was completed at Newcastle in 1983. The information consists of a standard suite of down-hole electric logs, cuttings and, most importantly, a temperature profile of the well. The UGMS will obtain this information and have full use for the Newcastle study, although, as agreed, publishing of well data will be subject to review and consent of the responsible parties at Union.

To the extent permitted, the UGMS will construct a lithologic log from cuttings and prepare a generalized temperature-gradient plot of the well. This information will be incorporated into the follow-on conceptual modeling phase of the project.

Task 7: Temperature Gradient Profiling

A shallow temperature-gradient monitoring activity is proposed. The proposed activity will involve establishing a grid of shallow (generally less than 50 feet deep) test holes, inserting water-filled PVC pipe in each hole, and monitoring the temperature profile over a period of several months. Follow-on computer aided modeling using other project generated data will be done to construct a conceptual geo-hydrologic model.

The purpose of the activity will be to help determine the geometry of the discharge zone of the hydrothermal system. It is important to understand whether the discharge zone of the system is distributed in a linear fashion, say, parallel to the range front fault; distributed as a point source as in the case of a vertical upward moving fluid column; or as some intermediate stage between these two end members. Previous thermal gradient studies at Newcastle indicate that such a shallow, temperature gradient monitoring program will yield sufficient information to accurately map the upper surface of the system.

This work will be done under the direction and supervision of Dr. David S. Chapman (University of Utah) and Dr. Craig B. Forster (Utah State University).

Task 8: Additional Gravity Data Acquisition and Modeling

To supplement the work performed in Task 4, additional gravity data will be obtained. Gravity readings will be taken at close-spaced stations within and around the thermal area using a La Coste and Romberg model G gravimeter. As in the earlier task, gravity observations will be tied to the regional gravity base station in Enterprise (Utah). Data obtained in this task will be used in conjunction with the other gravity and magnetic data to approximate the configuration of basin fill deposits.

The work will be performed under the direction and supervision of Dr. Charles M. Schlinger (University of Utah).

CRAIG B. FORSTER

Summary of Qualifications and Experience

University-based contract research, geotechnical consulting and graduate research has provided eleven years of experience in hydrogeology. This experience forms the background necessary to meet the goals of the proposed research project. Current funded research is aimed at examining conceptual models for the origin of epithermal gold deposits in the Basin and Range Province through numerical modeling of hydrothermal systems.

At the University of British columbia, numerical methods for simulating coupled fluid flow and heat transfer in mountainous terrain were developed to study geothermal pehenomena observed in mountains of the Pacific Northwest. Insights gained from model results have important implications for understanding the development of thermal springs and designing geothermal exploration strategies. Reports of progress have been presented at the 1985 Stanford Geothermal Workshop and at the 1986 Fall session of the American Geophysical Union in two papers co-authored by my research advisor, Dr. J.L. Smith. We are currently preparing final reports on this work for submission to Water Resources Research and Journal of Geophysical Research.

At the University of Waterloo, I developed and applied field and laboratory methods for hydraulic testing of fractured rock. Performed as part of a U.S.-Swedish co-operative project, this work was aimed at characterizing high-level nuclear waste repositories in crystalline rock. Research results are presented in two technical reports co-authored by my research advisor, Dr. J.E. Gale, and published by Lawrence Berkeley Laboratory.

Employment in geotechnical consulting has provided technical experience in a wide range of projects and honed the skills required for day-to-day management of a technical team.

Education

Ph.D.	~~(pending)~~ 1987	Geological Sciences, Univ. of British Columbia
MSc.	1979	Earth Sciences, University of Waterloo
BSc.	1975	Geological Sciences, Univ. of British Columbia

Professional Record

1986 - Present	Assistant Professor, Utah State University
1982 - 1986	Research Assistant, Univ. of British Columbia
1980 - 1982	Hydrogeologist, Klohn Leonoff Consultants
1979 - 1980	Research Associate, University of Waterloo
1976 - 1979	Research Assistant, University of Waterloo
1975 - 1976	Hydrogeologist, Golder Assoc.

VA

State of Washington
Department of Natural Resources
Grant No. DE-FG07-87ID__________

STATEMENT OF WORK

1.0 Introduction

The goal of this Grant is to support cost-shared research on geothermal resources of the Cascade Range in the State of Washington. The Cascade Mountains of Washington, with their numerous Quaternary volcanic centers, tectonic setting, and complex structure represent the state's best province for the exploration of high temperature geothermal resources. Earlier studies supported by the U.S. Department of Energy's State-coupled assessment program have indicated areas of high thermal gradients in areas of no hydrothermal surface manifestations. This study would utilize temperature gradient drilling, K-Ar age dating, and geochemical studies to better define and characterize the region of high temperature gradients and geothermal potential.

2.0 Scope

The technical objectives of this grant are to refine time-space-volume models for Cascade volcanism and to relate this arc volcanism to the geothermal potential of the Cascade Range. The drilling of six temperature gradient holes will permit direct temperature gradient and heat flow determinations for a substantial area within the Southern Washington Cascades geothermal anomaly and thereby better define this thermal anomaly. A Quaternary volcanic study will be conducted which will include sampling for K-Ar age dating and geochemical analysis. The net result of the proposed work will be an improved understanding of the Cascades volcanism and a more complete evaluation of the Southern Washington Cascades geothermal resource potential.

3.0 Applicable Documents

The research described herein is abstracted from a proposal titled "Definition and Delineation of the Southern Washington Cascade Range Geothermal Anomaly" dated May 29, 1987 as revised by letter on October 7, 1987. The proposal was submitted by the State of Washington - Department of Natural Resources, Division of Geology and Earth Resources. This proposal was submitted in response to a DOE/ID Program Research and Development Announcement (PRDA) for State Geothermal Research and Development - PRDA No. DE-PR-07 87ID12662.

4.0 Technical Tasks

The following tasks will be accomplished under this grant.

4.1 Temperature gradient study. Drill four 150 m and two 300 m temperature gradient holes after a detailed siting study. Sample drill cuttings, case drill holes, and complete thermal gradient measurements. Complete thermal conductivity determinations or estimate this value to arrive at heat flow values for each drill hole. Conduct near site geologic mapping and sampling. Complete an analysis of these data and describe the study and results in a final report.

4.2 Quaternary volcanic studies. Sample 10 to 12 volcanic rocks for K-Ar age dating and geochemical analysis. Submit samples to the University of Arizona for K-Ar age dating. Integrate these new age dates with new and existing geochemistry, age dates, and geologic mapping to reconstruct and refine time-space-volume models for Cascade volcanism and relate this arc volcanism to the geothermal potential of the Cascade Range. Describe this study, all relavent data and interpretaions in a final report.

5.0 Reports, Data, and Other Deliverables

5.1 Management Records

Reports will be due as indicated on the Federal Assistance Reporting Checklist and the Report Distribution List.

5.2 Final Reports

Two final reports will be completed. A report for the drilling project will include background information, site maps, depths, lithologies, temperature gradient information, heat flow values, and a discussion and interpretation of the results. The volcanology studies will result in a report which lists the results of age dating and geochemical analyses, compiles previous data relating to the study, and includes a location map. This report will discuss all results and present an interpretation of time-space-composition-volume models of Cascade volcanism and how these models relate to plutonism and geothermal heat sources. Draft final reports will be submitted for review and comment not less than 45 days prior to the scheduled delivery of the final report.

6.0 Special Consideraions

The State of Washington - Department of Natural Resources will contribute staff time, office rent, a portion of project in-state travel and per diem, supplies and geochemical analyses for age date samples as the state cost share for this grant.

SOW. HII

State of Hawaii
Department of ~~Planning~~ Business and Economic Development
Grant No. DE-FG07-88ID

STATEMENT OF WORK

1.0 Introduction

The goal of this Grant is to support cost-shared research on geothermal resource development in the State of Hawaii. Several productive, high temperature geothermal wells have been drilled in the Kilauea East Rift Zone and a major geothermal resource is known to be present. The geothermal brines have a high silica content and brine disposal could have negative environmental impacts or inordinately expensive waste management for commercial scale power production. This research project will examine concepts for reducing the operating cost and potential environmental problems associated with the disposal of silica-laden geothermal brines.

2.0 Scope

The technical objective of this grant is to accomplish the initial phase of demonstrating that the large volume, high silica geothermal brines associated with the hydrothermal resource in the Kapoho Reservoir of the Kilauea East Rift Zone can be disposed of on a commercial scale, in an economical and environmentally acceptable manner. The rate of silica polymerization in the geothermal brines will be determined under both natural conditions and with the addition of known amounts of transition metal salts. A custom-made brine treatment system will be constructed into a side stream of the brine at the State-owned Puna Research Center for brine treatment tests. Chemical reacation rates, recovery and precipitation data will be obtained and the characteristics of the residual fluid will be determined. The recovered silica will be studied for chemical and physical characteristics and potential byproduct recovery value. Preliminary design for a larger scale system will be developed, and options for silica removal evaluated. All tasks including reporting will be completed in a 24 month period.

3.0 Applicable Documents

The research described herein is abstracted from a proposal titled "Hawaii Geothermal Research and Development Project", dated June 17, 1987 and submitted by the Department of Planning and Economic Development, State of Hawaii. This proposal was modified in a letter to DOE/ID dated October 28, 1987. The proposal was submitted in response to DOE/ID Program Research and Development Announcement (PRDA) for State Geothermal Research and Development - PRDA No. DE-PR07-87ID12662.

4.0 Technical Tasks

The following tasks wil be accomplished under this grant.

4.1 Polymerization Studies. Complete an analysis of the rate of polymerization of the dissolved silica from the geothermal brine at temperatures ranging from 100 degrees C down to 30 degrees C, and after the addition of the following reagents: acid and caustic; iron sulfate; and potassium aluminum sulfate. Investigate other commercially available reagents for scale/polymerization control to determine whether it will be possible to either better accelerate or to retard the rate of silica polymerization.

4.2 Low-temperature Brine Treatment. Conduct an experiment to treat a continuous side stream of brine (cooled to tempratures of less than 100 degrees C) with pH control and metal ion reagents at the optimum levels determined in the polymerization studies. Analyze the depositional characteristics of the brine for settling efficiency, recovery rates, and fouling temperatures of less than 100 degrees C. Analyze the effect of reagent addition and retention times on the rate of silica deposition inside the treatment system, in the heat exchanger, and in a retention volume at the outlet of the treatment system. Test the efficiency of removal of the silica from the low temperature fluids. Design a high-temperature pressurized treatment system.

4.3 Fabricate a pilot scale treatment system based on the results of subtask 4.2. Conduct tests with pH control and reagent addition to determine the effects of the brine treatment on the deposition rate of silica in the piping system and in the heat exchanger.

4.4 Fluid Characterization. Analyze the discharge fluids from subtask 4.3 for solids settling rates and residual silica concentrations. Conduct a particle size/fouling experiment to determine fouling rates of filters having varying pore sizes.

4.5 Preliminary Design of Pilot Scale System. Prepare a preliminary design for a larger scale silica treatment system capable of handling the full brine load from the HGP-A geothermal generator.

4.6 Byproduct Characterization. Retain the precipitated silica recovered from the long-term operation of the small scale treatment system and analyze this silica for its physical and chemical characteristics that are relevant to possible commercial use. Analyze for particle sizes, specific surface areas, overall purity, and concentrations of key coloration elements such as iron, zinc, and manganese.

Investigate potential uses for the silica and determine the silica removal and treatment conditions that will optimize the most valuable characteristics of the recovered byproduct.

5.0 Reports, Data, and Other Deliverables

5.1 Management Records

Reports will be due as indicated on the Federal Assistance Reporting Checklist and the Report Distribution List.

5.2 Final Report

A final technical report will be submitted which will describe all experiments and experimental apparatus in detail. Chemical analyses and physical property determinations will be tabulated in an appropriate form and included in this report. Interpretations and conclusions will also be presented. A draft of the final technical report will be submitted not later than 60 days after completion of all subtasks, and not less than 45 days prior to the scheduled delivery of the final report.

6.0 Special Considerations

The State of Hawaii will provide substantial management, professional, and clercial manpower, and related fringe benefits, as a contibution in kind. The State of Hawaii will also provide $45,000 to construct and install a reagent mixing system and $2,000 in supplies as cost share contibutions. True/Mid-Pacific Geothermal will make a monetary contribution of $10,000 for supplies and expendable equipment for the brine project.

C.P. DRI

Desert Research Institute
University of Nevada System

Grant No. DE-FG07-87ID

STATEMENT OF WORK

1.0 Introduction

The goal of this Grant is to support cost-shared research in the form of technical assistance, on the Moana geothermal system, a moderate-temperature hydrothermal reservoir located in Reno, Nevada. The Moana resource is currently used for space heating by over 200 residences and numerous commercial establishments. Additional development is currently underway and is proceeding in an uncoordinated manner which could affect the quality and longeviety of the resource. Three state agencies have regulatory responsibility over various aspects of geothermal development but a better data base and a quantitative predictive model is needed to assist these agencies and developers in sound development of the resource with minimal environmental impact. The aim of the proposed research is to obtain the necessary data and to construct, calibrate, and verify a numerical model of the Moana system. The model will be made available to developers and regulatory agencies.

2.0 Scope

The objectives of this grant are to construct, calibrate and verify a numerical model of the Moana geothermal reservoir. The model will be capable of simulating fluid, heat and contaminant transport under steady state or transient conditions. Initial efforts will focus on an inventory and assessment of existing data, followed by additional data collection for one full heating year (13 months). The USGS numerical model SUTRA will be used to model the Moana system and the model will be calibrated and verified with respect to the observed data. Reservoir simulation will then be completed for a number of development scenarios and the results made available to developers and regulators. All tasks will be completed in a period of 22 months.

3.0 Applicable Documents

The research described herein is abstracted from a proposal titled "Quantitative Evaluation and Numerical Simulation of the Moana Geothermal System", dated June 18, 1987 as modified on October 26, 1987. This proposal was submitted by the Desert Research Institute, University of Nevada System, in response to a DOE/ID Program Research and Development Announcement (PRDA) for State Geothermal Research and Development - PRDA No. DE-PR07-87ID12662.

4.0 Technical Tasks

The following tasks will be accomplished under this grant.

4.1 Collect and assess the quality of all relevant existing data including hydraulic data, thermal data, well data, geologic data, hydrochemical data and hydrologic data.

4.2 Collect new data on the Moana geothermal system for a period of 13 months. Perform weekly measurements of water levels and temperatures in selected wells. Design and conduct aquifer tests to characterize storage and fluid conductive properties of the reservoir and the nature of the boundaries. Determine thermal gradients in wells, and chemical analyses of well fluids.

4.3 Complete calibration and verification of a numerical model simulating the Moana geothermal resevoir using the data from Tasks 4.1 and 4.2. Verify the accuracy of the model under both steady state and transient conditions. The USGS numerical model program SUTRA will be used for the modeling and simulation of the resevoir.

4.4 Perform reservoir simulations for a variety of development scenarios using the calibrated and verified SUTRA model. The simulations will show the effects of temperature distributions due to pumping and injection; plumes of lower temperature water due to injection; solute concentrations and distributions due to pumping; high solute concentration plumes due to reinjection; and areas of decreased water levels due to groundwater withdrawal.

4.5 Complete the documentation of all new resource data, a description of the Moana reservoir model and the results and interpretation of the model simulations. Prepare a user's manual for the Moana reservoir model and deliver to the three state regulatory agencies and to interested parties.

5.0 Reports, Data, and Other Deliverables

5.1 Reports will be due as indicated on the Federal Assistance Reporting Checklist and the Report Distribution List.

5.2 A detailed final technical report will be prepared which will document all inventoried and new resource data, and will describe the Moana resevoir model and the results and interpretation of the model simulations. A user's manual for the Moana reservoir model will be included as an appendix. Any new software developed which is necessary for the execution of the reservoir model will be described and a listing included. A draft final report will be submitted to

DOE/ID for review and comment not less than 45 days prior to the scheduled delivery of the final report.

6.0 Special Considerations

The Desert Research Institute, University of Nevada System, will contribute a funding equivalent of $16,300 as a cost share to this project. This cost share will be made available to the project as staff salaries and benefits, and indirect costs.

DOE WCP SWI
9/1/87

University of Wyoming
Grant No. de-FG07-87ID

STATEMENT OF WORK

1.0 Introduction

The goal of this Grant is to support cost-shared research on geothrmal resources in Wyoming and the Rocky Mountain region in general through the application of several new finite-difference computational schemes to the calculation of subsurface temperatures. Ground and water temperatures will be calculated by considering both conductive and forced convective heat-transport equations. The improved computational schemes will be used to model either the Cody or Thermopolis hydrothermal systems in Wyoming as a check on the validity of the numerical techniques. The ultimate aim of these calculations and studies is an understanding of hydrothermal resources typical of Wyoming and the Rocky Mountain region in general.

2.0 Scope

The technical objectives of this grant are to develop and test improved three-dimensional computational schemes for solving the combined heat-conduction and forced-convection equations for the purpose of determining subsurface temperatures. Both the speed and the precision of the three-dimensional finite difference modeliing algorithm will be enhanced beyond existing routines. Temperature data from existing wells will then be used to determine geothermal groundwater parameters. The validity of the improved computational scheme will be determined by applying the model to either the Cody or the Thermopolis hydrothermal systems in the Bighorn Basin, Wyoming where both thermal and hydrologic data already exist. All tasks will be completed in a 12-month period.

3.0 Applicable Documents

The research described herein is abstracted from a proposal titled "Improved Computational Schemes for the Numerical Modeling of Hydrothermal Resources in Wyoming", dated June 10, 1987 and submitted by the University of Wyoming. This proposal was submitted in response to a DOE/ID Program Research and Development Announcement (PRDA) for State Geothermal Reseach and Development - PRDA No. DE-PR07-87ID12662.

4.0 Technical Tasks

The following tasks will be accomplished under this grant.

4.1 Develop algorithms for the conjugate gradient solver.

SOW.AK

COMBINED SOW

Geophysical Institute, University of Alaska
Alaska Division of Geological and Geophysical Surveys
Grant No. DE-FG07-88ID

STATEMENT OF WORK

1.0 Introduction

The goal of this research is to support cost-shared research on geothermal resources in the State of Alaska. The Aleutian Islands-Alaska Peninsula region is known to be one of the largest geothermal energy resource areas of the United States, but the resource areas are remote and the population is scarce. The increased development of the American bottom-fish industry in the Bering Sea and the northern Pacific Ocean, and increased oil and gas exploration in the Bering Sea are generating an increased need for power in the region. The objectives of these resource assessment studies are to obtain new site specific data on one promising resource area, and to develop and document resource information for the entire region so that these data are avaailable for future exploration and development activities.

Geothermal resource assessment will be conducted at the Geyser Bight KGRA which is the hottest and most extensive area of thermal springs in Alaska. A second task will involve the preparation and publication of a geotechnically-oriented geothermal resorce map of the Aleutian Islands and the Alaska Peninsula region with supplemental information on fluid chemistry, temperatures, isotopic compositions, and geothermometry. This effort will document in new detail the state of knowledge of these geothermal resources.

2.0 Scope

Geyser Bight KGRA on Umnak Island is the hottest and most extensive area of thermal springs in Alaska but the resource has not been studied in detail. An integrated geological and geochemical study will be completed which will include a 1:25,000 scale geologic map of the resource area, fluid geochemistry, K-Ar dating, petrography and rock chemistry. A detailed chemical model of fluid chemistry will be developed which will constrain deep reservoir temperatures, origins of fluids, and mixing between different fluids. A second task will result in the preparation and publication of a four-color, geotechnically-oriented geothermal resource map of the Aleutian Islands and the Alaska Peninsula region. This map and accompanying circular will document maximum surface temperatures, estimated convective heat discharge and reservoir temperatures, and water and gas chemistry. A brief description will be provided for each geothermal resource site. The accessible heat energy base stored in the Aleutian arc volcanic systems will be discussed. The period of performance for this study, including final reporting, will be 24 months.

complete these analyses. Measure thermal spring flow rates and temperatures and estimate heat loss due to surface and near-surface discharge of thermal waters. Analyze water samples for major and minor and slected trace element constituents and for stable isotope composition. Refine a) the chloride-enthalpy model, b) the analyses of fluid mineral equilibria, c) estimates of reservoir temperatures, and d) the estimate of the source of reservoir recharge waters.

4.1.3 All new and existing data will be analyzed, interpreted, and then integrated to produce an integrated final report on the Geyser Bight geothermal study area. This evaluation will include improved estimates of the reservoir temperatures and of the magnitude of the energy available for development.

4.2 Preparation of a 1:1,000,000 scale technical geothermal energy resource map for the Aleutian Islands-Alaska Peninsula region, and supporting documentation.

3.0 Applicable Documents

The research described herein is abstracted from a proposal titled "Geothermal Resource Assessment in the Aleutian Islands and Alaska Peninsula", dated June 15, 1987 as revised on October 28, 1987. This proposal was submitted by the Geophysical Institute, University of Alaska, and the Alaska Division of Geological and Geophysical Surveys in response to DOE/ID Program Research and Development Announcement (PRDA) for State Geothermal Research and Development - PRDA No. DE-PR07-87ID12662.

4.0 Technical Tasks

The following tasks will be accomplished under this grant.

4.1 Geyser Bight KGRA Site-specific Study

4.1.1 Complete field geologic mapping and ~~photographic~~ interpretation to complete a 1:25,000-scale geologic map of Geyser Creek valley and the surrounding area. Mapping information will include geological structures, Quaternary valley-fill deposits, alteration, plutonic rocks, major contacts, and volcanic rocks. Geologic mapping will be supported by K-Ar age dating. Information relating to volcanic hazards will be noted and evaluated.

4.1.2 Fluid Chemistry Investigation of the Geyser Bight KGRA. Perform preliminary chloride-enthalpy and fluid-mineral equilibria analyses. Examine and evaluate results of chemical and isotopic geothermometers. Examine the results of analyses of stable isotope compositions. Collect additional water samples for geochemical and isotopic analyses during the 1988 field season and complete these analyses. Measure thermal spring flow rates and temperatures and estimate heat loss due to surface and near-surface discharge of thermal waters. Analyze water samples for major and minor and slected trace element constituents and for stable isotope composition. Refine a) the chloride-enthalpy model, b) the analyses of fluid mineral equilibria, c) estimates of reservoir temperatures, and d) the estimate of the source of reservoir recharge waters.

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Geophysical Institute, University of Alaska
Alaska Division of Geological and Geophysical Surveys
Grant No. DE-FG07-88ID

STATEMENT OF WORK

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HPRoss

Selection of Grantees for State Geothermal Research and Development (PRDA No. DE-PR07-87ID12662)

On December 21, 1987, I met with the Source Evaluation Panel for the State Geothermal Research and Development Program to receive the Panel's report of their evaluation of proposals.

Evaluation Panel

On February 23, 1987, I appointed a Source Evaluation Panel consisting of a Chairman, two additional voting members, an executive secretary, a legal advisor and alternate legal advisor. The Panel appointed a technical committee consisting of one voting member from the Source Evaluation Panel who acted as the Chairman, four technical members, and two advisors. The Panel used the DOE Source Evaluation Board Handbook (DOE/MA-0154), dated May 1984 as a guide for the conduct of its activities.

Description of Procurement

The objective of this procurement is to select and award several cost-share grants with state and/or state-designated organizations on those aspects of geothermal energy that are not being studied by private industry but which have the potential for results that will be applicable by industry in the development of geothermal resources. Program policy is to encourage geographic and resource diversity in this program.

This effort shall include research related to: (1) resource assessment, (2) resource development, or (3) technical assistance and related activities. The relevant geoscience research is included within resource assessment which may include geological, geochemical, geophysical, and hydrological investigations or studies of hydrothermal systems. Research on the selection, testing, and interpretation of new technologies designed to locate and characterize hidden geothermal reservoirs is encouraged as well as resource assessment efforts that would enhance the knowledge base of geothermal systems or regions and would provide important information that would not otherwise be available to encourage the development of geothermal resources. The suggested areas within resource development are test well drilling and hydrologic testing to determine production and reservoir parameters. However, it was stated in the solicitation that proposals for construction and operation of an end user facility would not be funded. The suggested project areas within technical assistance are preparation of documents and/or the development of appropriate computer programs for new methods of project development, equipment and material development, and resource exploration and development. However, the solicitation stated that proposals for activities normally performed by industry consultants would not be considered. The data gathered by this research may be incorporated in existing geothermal libraries and may be made available to the public.

Background

The Geothermal Energy Research, Development, and Demonstration Act of 1974 provides for DOE to enter into agreements to develop geothermal resources and other non-conventional sources of energy. DOE has the charter to conduct research and develop technology required to enable the geothermal industry to better satisfy the energy needs of the United States. Congress has mandated funds to be used to assist states which have significant hydrothermal resources. To be consistent with this objective, the Idaho Operations Office (ID) submitted a Program Research and Development Announcement (PRDA) on June 19, 1987, which was published in the March 5, 1987, Commerce Business Daily and the March 18, 1987, Federal Register. The notices stated proposals were desired from state and/or state-designated organizations desiring to cost share on state-oriented geothermal research and development.

Proposals Received

The solicitation was sent to the Governors of all states and U. S. territories, any university or state agency that DOE technical personnel were aware of that dealt with geothermal resources, and all others responding to the Commerce Business Daily and Federal Register notices. A total of 187 copies of the PRDA were mailed to potential proposers and other interested parties. Prior to the closing date of June 19, 1987, 4:00 p.m., local time, twenty-three proposals were received from the following twenty-one organizations:

1. State of Washington Department of Natural Resources
2. Arizona Solar Energy Commission
3. University of Wyoming
4. University of Alaska
5. State University of New York at Buffalo
6. University of Nevada, Las Vegas
7. State of Hawaii
8. New Mexico Research and Development Institute (Rio Grande)
9. New Mexico Research and Development Institute (Tularosa)
10. Colorado Geological Survey
11. Washington State Energy Office
12. Desert Research Institute
13. Idaho Department of Water Resources
14. North Dakota Mining and Mineral Resources Research Institute
15. Oregon Department of Energy
16. Louisiana State University
17. Utah Geological and Mineral Survey
18. California State Lands Commission
19. California Energy Commission (Brockway)
20. Arkansas Mining and Mineral Resources Research Institute
21. American Samoa Government
22. Oregon Department of Geology and Mineral Industries
23. California Energy Commission (Wilbur)

Two proposals were received from New Mexico Research and Development Institute and from California Energy Commission. All proposals received were timely and none of the agencies appeared on the current list of contractors debarred, suspended, or ineligible for Government contracts. A preproposal conference concerning this solicitation was not conducted.

In order for the proposer to qualify for consideration, the Program Research and Development Announcement included the following four minimum requirements. The proposer shall: (1) be a state or designated by the state; (2) propose research in the areas of resource assessment, resource development, or technical assistance; (3) propose research related to hydrothermal resources with a significant hydrothermal resource base; and (4) propose work be done in the state or have written approval from the state where the proposed work is to be done. Twenty-two of the proposals met the minimum requirements. One proposal did not meet the minimum requirements but was evaluated and considered not eligible for selection.

Basis for Evaluation

The purpose of the evaluation of the proposals submitted under the solicitation was to identify proposals which met the objectives of the PRDA and are most advantageous to the Government. The technical and business portions of the proposals were thoroughly evaluated by the Panel in accordance with the established DOE rules and regulations.

As announced in the PRDA, the proposals were evaluated on the basis of the following criteria, each of which were weighted. Weights were not announced but the relationship of weightings was described in general terms.

Technical Criteria

Criterion A: Statement of Work

1. Usefulness of the proposed research on resource assessment, resource development, or technical assistance and related activities to industry and others in the development of geothermal resources.

2. Technical quality of the proposed work, including consideration of the merit of the proposed approach and probability of achieving positive results.

3. The significance of the hydrothermal resource base.

Criterion B: Qualifications and Capabilities

1. Key personnel capability, knowledge and understanding of the technology involved in the proposed work, as demonstrated by education, publication, and work experience.

2. Proposing organization's and subcontractor's capabilities with regard to availability of the necessary facilities and support. Past technical performance was also evaluated.

Business Criteria

Criterion C: Cost-Sharing - The degree of cost-sharing and the ability of the offeror to provide its cost-share commitment.

Criterion D: Project Financial Plan - Realism and reasonableness of the proposed costs, manhours, duration of the total project and adequacy of cost breakdown by cost element and tasks.

Program Policy and Preference Factors

In addition to the technical and business criteria, the following six program policy and preference factors were included in the PRDA which I may consider in making the selections for negotiation and final award.

1. The DOE cost-share will not exceed $200,000 per award, and the proposer must cost-share a minimum of 10% of the gross amount requested.

2. The potential benefit of the proposed project for the amount of DOE dollars spent.

3. The selection of projects which provide the greatest potential for data to enhance the goals of DOE.

4. Selections may be made to encourage geographic and resource diversity in the program.

5. Cost Considerations - The proposed cost is a function of the management approach, the technical approach, the manpower, the facilities, the organization, the uncertainties of the work, the proposer's competitive strategy and the economy. The panel determined its own estimate of what it will probably cost the Government taking into account relevant data available. All other considerations being equal, total cost to the Government may be used in the final selection.

6. Selections may be made so as to effectively utilize available funding.

The PRDA informed proposers that:

"DOE reserves the right to support all, none, or any number, or part of the proposals submitted."

Determination of Competitive Range

The technical advisory committee convened in Idaho Falls, evaluated the proposals, and presented their findings to the Panel. The Panel members separately evaluated each proposal and scored them on the basis of the evaluation criteria. The voting Panel members held discussions concerning all of the proposals and established an initial ranking. The Panel desired to fund as many proposals or portions of proposals possible which meet the objectives of the PRDA and are most advantageous to the Government. The Panel therefore evaluated the proposals to determine which of the proposals could, through response to questions and other clarification, become the most advantageous to the Government and therefore eligible for an award. The Panel determined that fourteen of the proposals, either in part or in whole, contained work that met the DOE objectives. The remaining nine proposals were eliminated from further consideration since the work proposed did not enhance the DOE objectives for this program. It was determined that the nine lowest rated proposals could not be improved significantly for selection. The following is a summary of those proposals eliminated from further consideration:

Arizona Solar Energy Commission

The Arizona Solar Energy Commission has proposed a project which would create a comprehensive computer database of geologic, geophysical, hydrologic and geochemical data which would be used to produce a geothermal data disk. This disk would be available for copying by the general public. The data base would cover the Mojave, Sonoran Desert and Mexican Highland sections of the Basin and Range Province in Arizona. The project does not have any significant usefulness to geothermal exploration, development or utilization. The proposed work offers little technical quality for an area of low resource potential. The emphasis of the proposal is on data base preparation and manipulation rather than geothermal energy. The proposed "cell" size of 625 square miles is much too large to be useful in delineating geothermal resources. Although the key personnel have substantial familiarity with the computational aspects of the study, these personnel and the proposing organization did not demonstrate significant experience in the field of geothermal energy. The total estimated cost was $102,000 with an approximate 19 percent cost-share proposed by the offeror.

State University of New York at Buffalo

The State University of New York at Buffalo has proposed a resource assessment of the geothermal potential of the Theresa Formation in south central New York State. The study would include the analysis of bottom hole temperature data, geologic data from wells, the acquisition and interpretation of reflection seismic data and related studies associated with siting a well near Hornell, NY. Although the quality of the study could be good, the resource potential is low and the net usefulness of the study is also considered low. The evaluation of BHT data and thermal conductivity to determine regional heat flow would be worthwhile but the reflection seismic study is premature without a preliminary evaluation of what reservoir temperatures, well depths and flow rates would be economic in light of drilling and production costs. The principal beneficiary of the study might be a single Hornell company. The key personnel and proposing organization are competent to complete and support the study. The total estimated cost was $85,058 with an approximate 27 percent cost-share proposed by the offeror.

New Mexico Research and Development Institute (Tularosa Basin)

New Mexico Research and Development Institute (NMRDI) has proposed a geothermal resource assessment in the Tularosa Basin using thermal data mapping, soil mercury studies, detailed gravity and magnetic studies, and drilling for heat flow determinations. More than two-thirds of the Basin is under military control and the White Sands Missile Range is envisioned to be the potential user for any resources which may be identified and later developed. Moderate temperature brines have been intersected at depth in oil and gas well tests but extrapolations to higher temperatures and the presence of a significant geothermal resource are speculative. The usefulness of the proposed study and the significance of the resource are considered to be low. There is no indication that the state designated geothermal agency for Texas supports this study for the Hueco Tanks area. Some parameters of the proposed surveys may not be appropriate. The key personnel proposed for the study would be competent to complete the study. The total estimated cost was $246,046 with an approximate 19 percent cost-share proposed by the offeror.

Colorado Geological Survey

The Colorado Geological Survey (CGS) and the Department of Geophysics, Colorado School of Mines (CSM) jointly propose a geothermal resource assessment study of the San Luis Valley of south-central Colorado. These organizations propose a compilation and evaluation of existing geoscience data followed by new geological, geochemical, geophysical and hydrologic studies. The technical quality of the proposed study would be good but a substantial database already exists. The resource temperatures would be low thereby limiting the range of uses and downgrading the significance of the resource and usefulness of the proposed work. The remote sensing study, gravity and magnetic surveys and deep electrical resistivity investigations may contribute relatively little to the geothermal resource evaluation. The proposed cost share is the minimum amount and would be difficult to verify. The total estimated cost was $220,000 with an approximate 9 percent cost-share proposed by the offeror.

Oregon Department of Energy

The Oregon Department of Energy proposed resource development research at McKenzie Bridge, Oregon in the Belknap-Foley KGRA. The study would include drilling of a test well, hydrologic testing and evaluation of temperature and fluid chemistry data. The proposed drill site is approximately one mile northwest of Belknap Springs (and possibly across controlling structures) and perhaps three miles from Foley Springs. The highest estimated reservoir temperatures for these springs are near the lower limit for binary power generation and the Eugene-Springfield metropolitan area, 80 Km away, is probably too far away to permit economic direct utilization of these fluids. The proposed drill hole is sited on private land without significant geologic or geophysical encouragement. The program for well design, drilling, monitoring, and testing are left to the landowner and driller, and are considered weak. The usefulness, technical quality, and significance of the resource are all considered to be weak. The proposed key personnel did not receive a high rating. The total estimated cost was $56,907 with an approximate 35 percent cost-share proposed by the offeror.

Louisiana State University

The Louisiana State University, Department of Petroleum Engineering, proposed a study of two phase flow (gas and water) in the wellbore. This proposal addresses geopressured-geothermal wells rather than hydrothermal resources and as such does not meet the DOE objectives for this PRDA. Evaluated in terms of criteria for hydrothermal resource proposals, this proposal has little or no usefulness and resource significance, and would be of low technical quality. The key personnel and proposing organization are recognized to be competent in the study area proposed. The total estimated cost was $283,114 with an approximate 30 percent cost-share proposed by the offeror.

California Energy Commission (Brockway Hot Springs)

This proposal by the California Energy Commission requests funding for a resource assessment study of the Brockway Hot Springs area on the north shore of Lake Tahoe. The proposed study would include a geologic field reconnaissance, geophysical surveys, well and spring evaluation and temperature-gradient well drilling. There is considerable doubt that the geophysical (SP and VLF) surveys proposed will contribute significantly to a three-dimensional picture of the structure surrounding the Brockway Hot Springs because of grounded structures associated with local development. The resource appears to be relatively low temperature and direct use development would probably benefit relatively few individuals in this area of exclusive resort development. The key personnel and proposing organization are competent to complete the work but the significance of the resource, the technical quality, and the net usefulness of the proposed study are ranked low. The total estimated cost was $83,787 with an approximate 27 percent cost-share proposed by the offeror.

Arkansas Mining and Mineral Resources Research Institute (AMMRRI)

The Arkansas MMRRI has submitted a proposal titled, "Geochemical Exploration for Undiscovered Resources, Ouachita Mountains, Arkansas." The potential for thermal fluids in deep synclinal aquifers of the Ouachita Mountains would be evaluated through geochemical analyses of cold water springs and wells, and any warm waters should they be discovered. The poultry industry is suggested as a potential user of low temperature geothermal fluids. The occurrence of two warm spring systems 55 km apart is not a significant indicator of a vast (undiscovered) low temperature resource, and without some additional encouragement such as warm well waters, the resource potential and project usefulness are judged to be low. The preliminary study of fluid samples from the Hot Springs area would duplicate earlier work and some aspects of a current solicitation by the National Park Service. The key personnel do not appear to have any experience in geothermal studies. The total estimated cost was $21,713 with an approximate 41 percent cost-share proposed by the offeror.

American Samoa Government

The American Samoa Government submitted a response to the PRDA which included a brief proposal dated December 1986 by KRTA, Limited to Dr. John W. Shupe, Pacific Site Office, U.S. DOE; and portions of a March 1980 report titled, "Geothermal Energy for American Samoa." The materials submitted did not conform to the format and information requirements of the PRDA and did not address cost-share, project management, key personnel and a financial plan. The proposal does not meet the DOE objectives for this PRDA. An evaluation of the materials submitted indicates the existence of a geothermal resource is only weakly supported and the significance of the resource and usefulness of the work are judged to be low. The work proposed in the KRTA proposal is incompletely described and not supported by discussion or exploration rationale.

Final Evaluation of Organizations in the Competitive Range

All proposers in the competitive range were requested to submit clarifications to their proposal by November 2, 1987. Oregon Department of Geology and Mineral Industries and California State Lands Commission withdrew from consideration.

The Source Evaluation Panel and Technical Evaluation Committee then met and reviewed each final revised proposal and re-evaluated each proposal in light of the information supplied in response to the written questions and clarification. As a result of this final evaluation, the Panel ranked the proposals. Each is briefly described below in the order of their final ranking.

University of Wyoming

The University of Wyoming has proposed to develop and test improved three-dimensional computational schemes for solving the combined heat conduction and forced convection equations for the purpose of determining subsurface temperatures. Temperature data from existing wells will then be used to determine geothermal ground water parameters and a model will be developed for either the Cody or Thermopolis hydrothermal system in the Bighorn Basin, Wyoming. The work proposed is original and will extend the state-of-the-art in numerical modeling of these types of resources. The computational schemes will have general applicability to a substantial resource base throughout the Rocky Mountains and may be applicable to the evaluation of a large number of other mixed convective - conductive geothermal resources. New observational data will be obtained for one hydrothermal system. The work is very useful and has a high probability of success. A highly qualified research team has been assembled at the University of Wyoming, and the members of this team have previously completed high quality resource assessment projects for the Department of Energy. This significant work will be completed in a 12-month period at a relatively modest cost to DOE and a favorable cost-share. This proposal received the highest technical ranking and the highest total ranking. The total estimated cost was $63,208 with an approximate 28 percent cost-share proposed by the offeror.

North Dakota Mining and Mineral Resources Research Institute

The North Dakota MMRRI brings together the North Dakota and South Dakota Geological surveys and excellent UND staff to propose a comprehensive assessment of the significant but relatively untapped resources in these two states. New drilling and heat flow measurements will supplement the existing drill holes and data base. The data will be quantitatively interpreted in terms of distinct stratigraphic and hydrologic units and promising geothermal aquifers will be identified. A specific task calls for dissemination of the results of the study at meetings with state research and development agencies to encourage commercial development. The accessible resource base is large enough to have a significant impact on the economies of these two states. The Principal Investigator has made major contributions to geothermal resource assessment and leads an excellent team in this two-state cooperate resource assessment. The study is regarded as highly useful, very practical and of excellent quality with a high probability of success. The study will extend and refine recent results which demonstrated a large increase in the accessible resource base of South Dakota. A favorable cost-share is proposed. This proposal placed second in both technical and total rankings. The total estimated cost was $239,013 with an approximate 18 percent cost-share proposed by the offeror.

State of Hawaii

The State of Hawaii study seeks to investigate methods of controlling silica deposition from geothermal fluids of the Hawaii East Rift Zone. The study addresses a major problem inherent to this high temperature resource area and has a good probability of success in solving the silica deposition problem and possibly producing high quality silica as an economic by-product. The proposed work is judged to be highly useful. The technical approach is described in considerable detail and has a good probability of achieving positive results. The East Rift Zone is known to be one of the highest temperature geothermal resources in the world and three very productive wells have been drilled. A Phase II investigation which evaluates the effects of reinjection on an injection well is not essential to the silica study, may duplicate the work of industry and if funded would decrease the cost effectiveness of the overall study. The research team is well qualified to complete the silica deposition study. The cost-share proposed is the highest offered and is highly beneficial to the DOE. The total estimated cost was $195,593 with an approximate 39 percent cost-share proposed by the offeror.

Washington State Energy Office

The Washington State Energy Office has proposed the development and field testing of the geothermal optimization computer program GEODIM. GEODIM is a partially completed program designed by the University of Lund, Sweden which supports the design and optimization of wells, pipes, pumps and heat transfer systems. Completion and documentation of the program and its field testing at geothermal operating systems in Yakima and Walla (WA), Boise (ID) and Klamath Falls (OR) are considered highly relevant projects which could result in higher efficiency and improved resource utilization for many direct heating systems.

The proposed work will produce a high quality, readily usable computer program. It is quite likely that the use of GEOIDM can increase the efficiency of several operating systems by 1-10% thereby delivering more usable energy without added depletion of the resource. The proposing organization has an outstanding record of performance on DOE geothermal projects and has assembled a talented group of professionals to complete this project at only modest cost to DOE. The Washington State Energy Office proposes a high cost-share that is advantageous to the DOE. The total estimated cost was $65,094 with an approximate 21 percent cost-share proposed by the offeror.

Desert Research Institute, University of Nevada System

The Desert Research Institute (DRI), has proposed detailed hydrologic monitoring followed by a quantitative evaluation and numerical simulation of the Moana Geothermal System. Uncoordinated development of this moderate-temperature resource is rapidly expanding and the long-term productivity of the Moana system may be threatened. The proposed work includes the appropriate data gathering and interpretation which will provide baseline data and understanding, and a quantitative model of the Moana system. Thus, three state regulatory agencies and several developers will have the information and guidance necessary for the effective long-term utilization of the resource. This is a useful project which should help extend the lifetime of the resource. The proposer offers a high quality study which addresses an important problem for a heavily used resource. A highly qualified team is available at DRI to participate in this study. A minimal cost-share is proposed. The total estimated cost was $162,987 with an approximate 10 percent cost-share proposed by the offeror.

Utah Geological and Mineral Survey

The Utah Geological and Mineral Survey (UGMS) has proposed an integrated, multi-method study of the Newcastle geothermal system which could have broad applicability to the discovery and evaluation of other blind Basin and Range geothermal systems. Thus, the project is ranked highly useful. The study includes an appropriate mix of quaternary and bedrock geologic mapping, gravity and magnetic studies, soil-mercury investigations, fluid geochemistry and thermal gradient drilling. These are appropriate methods for a detailed study of this resource and other blind resources, and indicate a high quality study which is likely to yield positive results. The UGMS proposes a modest total cost to DOE, and a high state cost-share. In addition, a substantial amount of geophysical work will be completed by students of the University of Utah at little or no cost to the project. The proposed study would be completed by a qualified team and would contribute to the exploration methodology for basin and range blind hydrothermal systems. The total estimated cost was $78,488 with an approximate 20 percent cost-share proposed by the offeror.

Washington Department of Natural Resources

The Washington-Department of Natural Resources (WDNR) seeks to refine time-space-volume relationships for Cascade volcanism and to relate improved models to the geothermal potential of the Cascades Range. These topics are addressed through an integrated effort of thermal gradient drilling, new geologic mapping, new K/Ar-age dating, thermal gradient studies and geochemistry. The proposal is considered to have a high degree of usefulness and good probability of success in a large area of moderate-to-high resource potential. The methodology is sound and appropriate and will be performed by competent, experienced personnel. WDNR has an established track record in the conduct, interpretation and reporting of geothermal studies. The financial plan is realistic and shows a detailed cost breakdown. The proposed state cost-share at 23% is high and is advantageous to the DOE. The total estimated cost was $214,751 with an approximate 23 percent cost-share proposed by the offeror.

University of Alaska/State of Alaska

The University of Alaska Geophysical Institute and Alaska Division of Geological and Geophysical Surveys jointly propose a geological and geochemical study of Geyser Bight, the hottest (180-264°C) and most extensive area of thermal springs in Alaska. Although this is a major geothermal resource, Geyser Bight is located on a remote uninhabited Aleutian island and the net usefulness of the study, and resource potential, have been correspondingly downgraded. Geological and geochemical data on the resource may contribute to our knowledge of volcanic island arc systems in general. A related task will result in the preparation and publication of a four-color, geotechnically-oriented geothermal resource map of the Aleutian Islands and the Alaska Peninsula region and an accompanying descriptive circular. These products will document in new detail the present state of knowledge of geothermal resources for the area, and be a starting point for exploration, resource assessment and development efforts in the future. The work would be completed by competent, experienced geoscientists of these institutions. The total cost appeared excessive to the Panel. Several items in the University of Alaska-Division of Geological and Geophysical Surveys budget appear too high. The total estimated cost was $184,642 with an approximate 31 percent cost-share proposed by the offeror.

Idaho Department of Water Resources

The Idaho Department of Water Resources (ID-DWR) has proposed continued monitoring of the Banbury-Twin Falls resource and extended resource assessment activities; a geochemical study of Wood River geothermal systems; and continued monitoring and evaluation of the Boise geothermal system. The proposed work appears very useful as it addresses development problems in two substantial resource areas and appropriate resource assessment studies. It is especially important to continue detailed monitoring of the Boise resource and to evaluate the need for a reservoir test and quantitative model, but this work must be completed at the state-of-the-art and totally free from conflicts of interest. The methodologies proposed for Tasks 1 and 3 are appropriate and should result in quality studies with a good possibility of achieving positive results. The cost of consultant services for Task 2 is excessive. The staff proposed for these studies is competent to complete the work but is poorly supported by the DWR. The total estimated cost was $218,142 with an approximate 10 percent cost-share proposed by the offeror.

University of Nevada, Las Vegas

The proposed University of Nevada, Las Vegas - Division of Earth Sciences study would integrate fluid geochemistry, stable light isotope data, glacial ice data and archaeological information to study the genesis of geothermal fluids in the Great Basin. Nevada has numerous high and moderate temperature resources, several of which are under development, and the new data and interpretation would be useful in better understanding these important resources. The most useful part of the study would be the detailed sampling, chemical analyses and study of geothermal fluids from the hot springs and geothermal developments. Other aspects of the project such as archaeological studies, isotopic analyses and paleoclimatic studies are interesting but more likely to be inaccurate or subject to multiple interpretations. Thus, the probability of achieving positive results and the net usefulness of the project are downgraded. Task 1 addresses the gathering of existing data and Task 2 would format these data. Although essential to the project proposed, these are not innovative tasks and no new data are generated. The University of Nevada, Las Vegas - Division of Earth Sciences personnel are competent and experienced geoscientists who can complete the proposed study with good technical quality. Several items in the revised project financial plan are not consistent with the schedule and revisions from the original proposal, especially computer time and vehicle mileage. The proposer cost-share is one of the three lowest proposed. This work should be funded in accordance with proposal rankings and the availability of funds. The total estimated cost was $182,712 with an approximate 11 percent cost-share proposed by the offeror.

New Mexico Research and Development Institute

The New Mexico Research and Development Institute (NMRDI) has proposed three options for a study titled "Evaluation of Time-Integrated Radon Soil-Gas Surveys in the Southern Rio Grande Rift." The study would result in an interesting evaluation of the radon gas technique as a geothermal exploration method in the soils and caliche covered areas of the Southern Rio Grande Rift. The study would include an evaluation of soil-depth profiles and caliche effects and surveys in the Tortugas Mountain, Radium Springs and Rincon areas, plus interpretation and reporting. The proposals show a good understanding of the radon gas method and an appropriate selection of field test areas for the completion of the study. The study would be completed by competent geoscientists and managed by NMRDI, which has an established record of reporting and project management with DOE geothermal projects.

The Panel determined the proposed study to be a useful project offering only minor innovations to geothermal resource assessment. The usefulness of the radon surveys in this environment has not been established and positive results for the delineation of low-to-moderate temperature resources are not guaranteed. This is basically an extended field test for a single exploration method. The significance of the resource base is low as compared to most of the proposed project areas. The proposed cost-share is reasonable. DOE funding for NMRDI is recommended consistent with final evaluation scores and the availability of funds. The total estimated cost for Option 1 was $152,000 with an approximate 18 percent cost-share proposed by the offeror.

California Energy Commission

California Energy Commission (CEC) in conjunction with the Pacific Gas and Electric Company (PG&E) have proposed a two-fold research project which includes a limited resource assessment of an area near Wilbur Hot Springs and a technical study to determine optimum power cycles for well head binary cycle generation systems as related to resources in northern California. The geologic reconnaissance and geochemical surveys may add to the knowledge of the Wilbur Hot Springs resource, but are directed toward an area of unknown resource potential 1.5 Km away. It is unclear that the present owners of Wilbur Hot Springs will cooperate with the proposed studies. No interpretation is presented for the gravity low that seems to be important for the area of proposed geochemical studies, and no information is presented as to the grid for radon surveys. The geology of the proposed survey area is not described in any significant detail. The geothermal power cycle study and technology characterization for Northern California resource areas would provide some useful information but is not considered a high priority study. The proposal does not indicate specific experience with the radon exploration method or nearby wells which may be available to the study. The usefulness of the proposed study is judged to be low and the quality of the proposed work, as judged by the proposal would be marginal. The significance of the resource is ranked low-to-moderate. The total estimated cost was $90,683 with an approximate 39 percent cost-share proposed by the offeror.

Selection

The evaluation by the Panel has been very thorough, has been consistent with all applicable regulations, and has given consideration to all of the proposals based upon the criteria and other selection considerations set forth in the PRDA. As a result of the use of specialized technical personnel on the Technical Evaluation Committee, a very competent evaluation was performed in the specialized technical areas.

In light of DOE's program objectives, available funding, the evaluation criteria and their relative importance as set forth in the PRDA, I have considered the Panel's evaluation along with the relative quality and suitability of the technical and management aspects of the proposals. Accordingly, I select the following proposers for negotiation and possible award for the state geothermal research and development program:

University of Wyoming
North Dakota M–m–R–e–I–
Washington State Energy Office
Utah Geological and Mineral Survey
Washington Department of Natural Resources

Subject to appropriate justification and support of the reasonableness of their proposed budget and costs to the satisfaction of the Contracting Officer, I select the proposal submitted by the following:

State of Hawaii
Desert Research Institute
University of Alaska/State of Alaska
Idaho Department of Water Resources

If any funds are remaining or if additional funds become available, the following proposals, in the order listed, are selected for negotiation and award:

1. University of Nevada, Las Vegas
2. New Mexico R&D Institute (Rio Grande)
3. California Energy Commission (Wilbur)

These proposals are likewise subject to the cost justification and support requirement set forth above.

With the exception of the Idaho Department of Water Resources, all awards will be grants. A cooperative agreement will be the appropriate award instrument for Idaho due to the substantial technical involvement between DOE and them.

Joseph R O Lee acting CMD Dir
Source Selection Official

12-23-87
Date

T2g-1357K

Baum...

United States Government **Department of Energy**

memorandum

Idaho Operations Office

Rec. 11/14/88
UPR

DATE: January 11, 1988

SUBJECT: Proposed Use of the State Team FY-88 Funds

TO: Dr. John E. Mock
Director of Geothermal Technology
DOE-HQ, Forrestal Bldg., CE-342

It is my understanding that part of the State Team FY-88 funds will be used to fund the unsolicited proposal submitted by Oregon Department of Geology and Mineral Industries (ODOGAMI). ID believes it would be unfair to use State Team funds for award to ODOGAMI as long as any proposers selected for award remain unfunded for the following reasons:

1. ODOGAMI's unsolicited proposal is very similar to the proposal submitted under the PRDA No. DE-PR07-87ID12662. The procedures of 10 CFR Part 600.14(e)(ii) require returning unsolicited proposals submitted during the course of a solicitation when the unsolicited proposal is within the scope of the solicitation.

2. The Source Selection Statement is now publicly available. Other states will know what ODOGAMI proposed and that they did participate in the PRDA. Funding their unsolicited proposal with State Team funds may compromise the intent of the PRDA.

3. The Source Selection Statement also allows for the use of new funds for those proposals selected, contingent upon additional funding becoming available.

4. You should be aware that OIT received a five-year grant in FY-87. The first-year funding was $350,000. Thus, Oregon would appear to have received adequate support for their geothermal activities.

We recognize that there is pressure to fund ODOGAMI. However, it would not be to DOE's benefit to have a sound competitive process compromised by reaction to pressure from a competitor who did not get what they wanted.

If you have any questions, please call Peggy Brookshier.

R E Wood

Richard E. Wood, Assistant Manager
Projects and Energy Programs

cc: Charles Gilmore, DOE-ID
Elaine Richardson, DOE-ID
Marshall Reed, DOE-HQ
Howard Ross, UURI
Ben Lunis, EG&G Idaho, Inc.

University of Wyoming
Grant No. DE-FG07-87ID

STATEMENT OF WORK

1.0 Introduction

The goal of this Grant is to support cost-shared research on geothermal resources in Wyoming and the Rocky Mountain region in general through the application of several new finite difference computational schemes to the calculation of subsurface temperatures. Ground and water temperatures will be calculated by considering both conductive and forced convective heat transport equations. The improved computational schemes will be used to model either the Cody or Thermopolis hydrothermal systems in Wyoming as a check on the validity of the numerical techniques. The ultimate aim of these calculations and studies is an understanding of hydrothermal resources typical of Wyoming and the Rocky Mountain region in general.

2.0 Scope

The technical objectives of this grant are to develop and test improved three-dimensional computational schemes for solving the combined heat conduction and forced convection equations for the purpose of determining subsurface temperatures. Both the speed and the precision of the three-dimensional finite difference modeliing algorithm will be enhanced beyond existing routines. Temperature data from existing wells will then be used to determine geothermal groundwater parameters. The validity of the improved computational scheme will be determined by applying the model to either the Cody or the Thermopolis hydrothermal systems in the Bighorn Basin, Wyoming where both thermal and hydrologic data already exist. All tasks will be completed in a 12 month period.

3.0 Applicable Documents

The research described herein is abstracted from a proposal titled "Improved Computational Schemes for the Numerical Modeling of Hydrothermal Resources in Wyoming", dated June 10, 1987 and submitted by the University of Wyoming. This proposal was submitted in response to a DOE/ID Program Research and Development Announcement (PRDA) for State Geothermal Reseach and Development - PRDA No. DE-PR07-87ID12662.

4.0 Technical Tasks

The following tasks will be accomplished under this grant.

4.1 Develop algorithms for the conjugate gradient solver.