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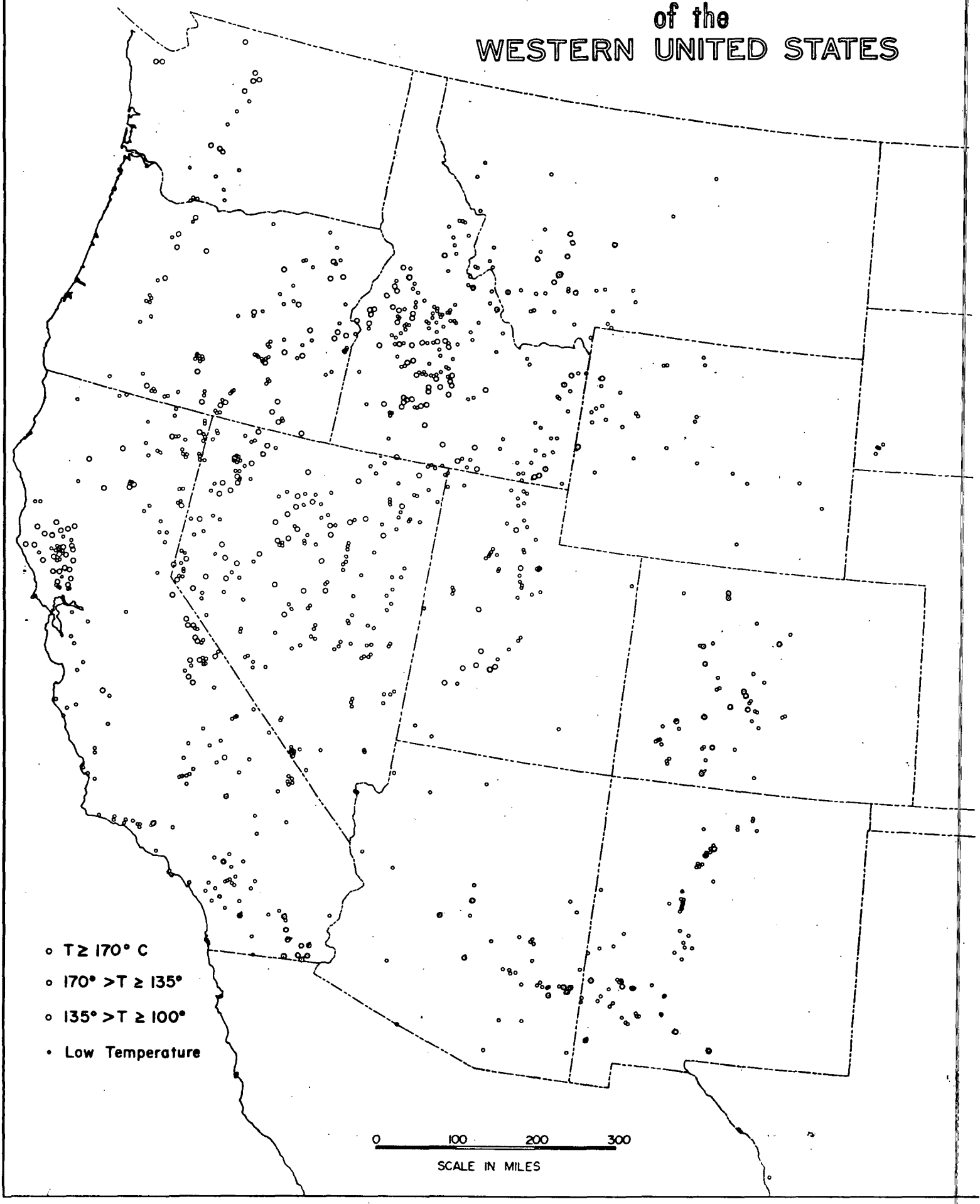
GEOTHERMAL ENERGY RESOURCES of the WESTERN UNITED STATES

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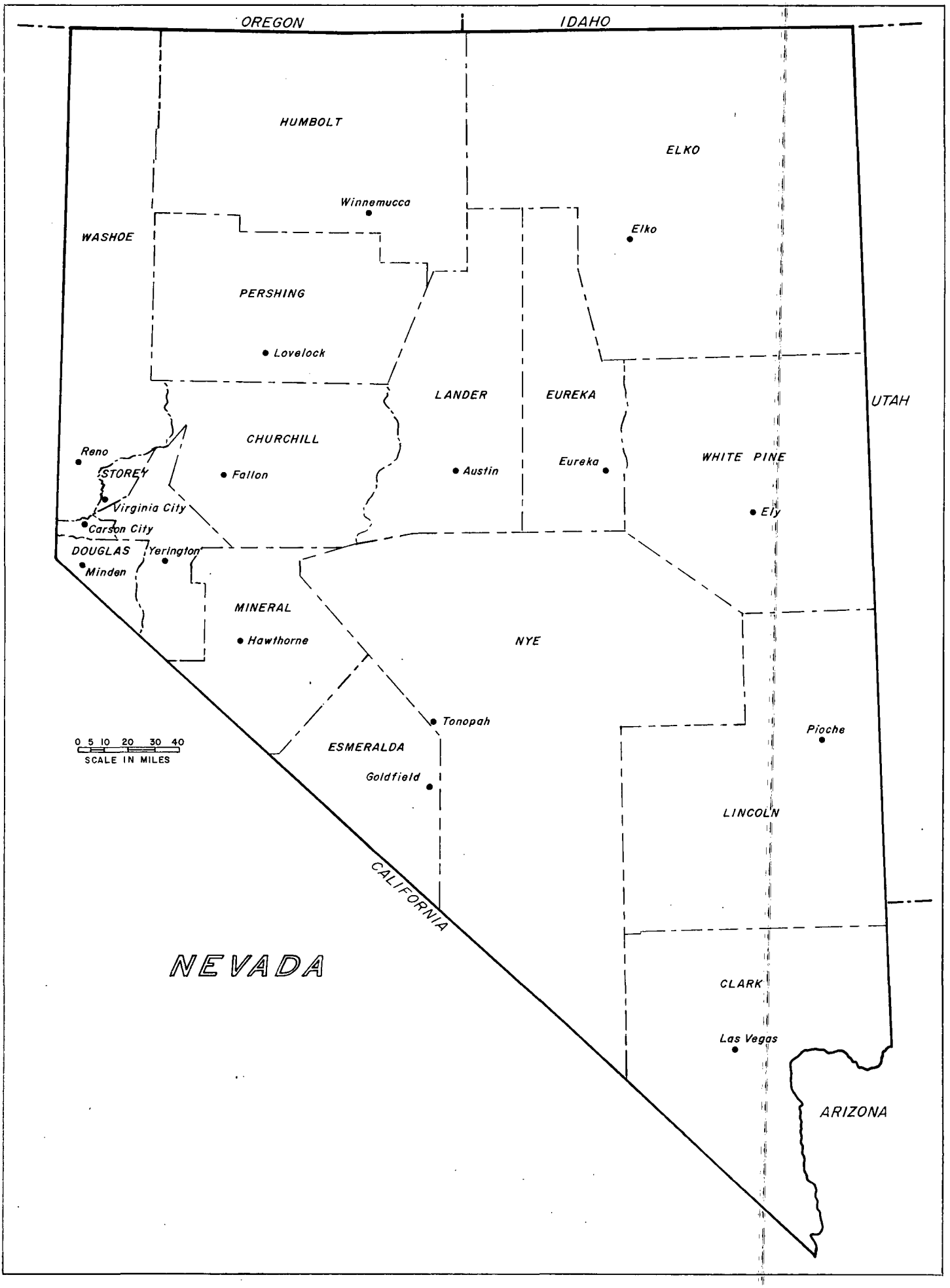
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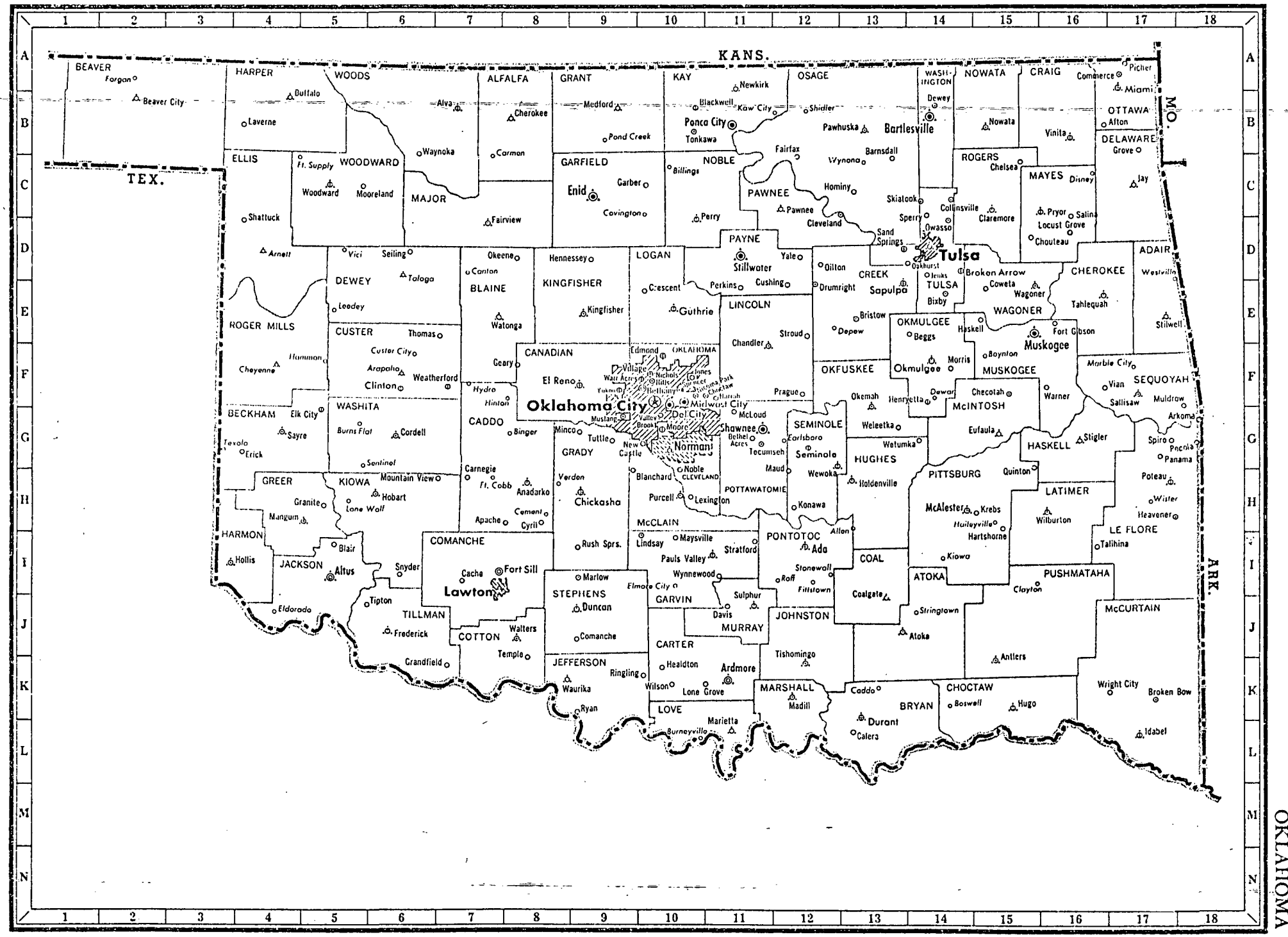
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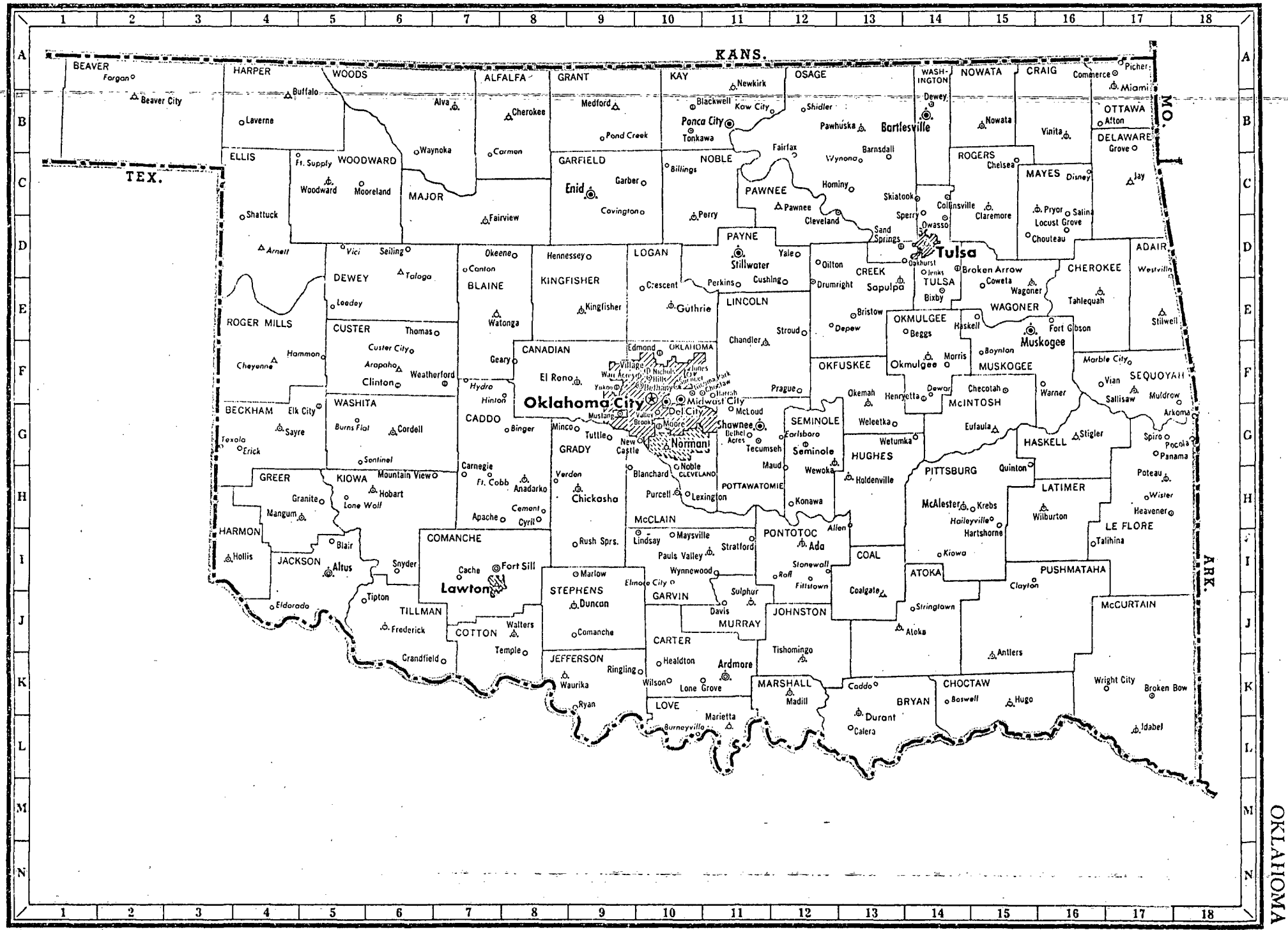
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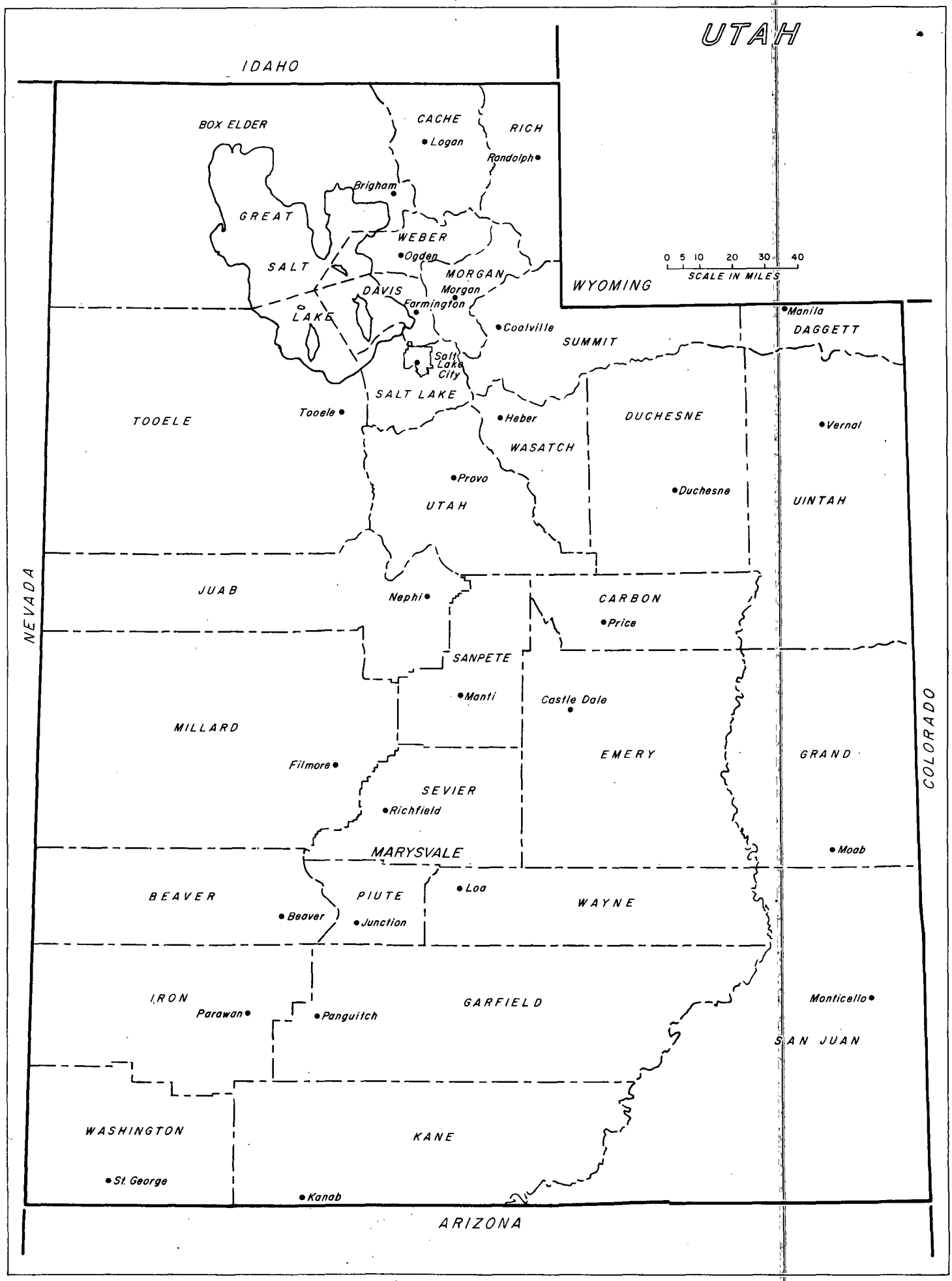
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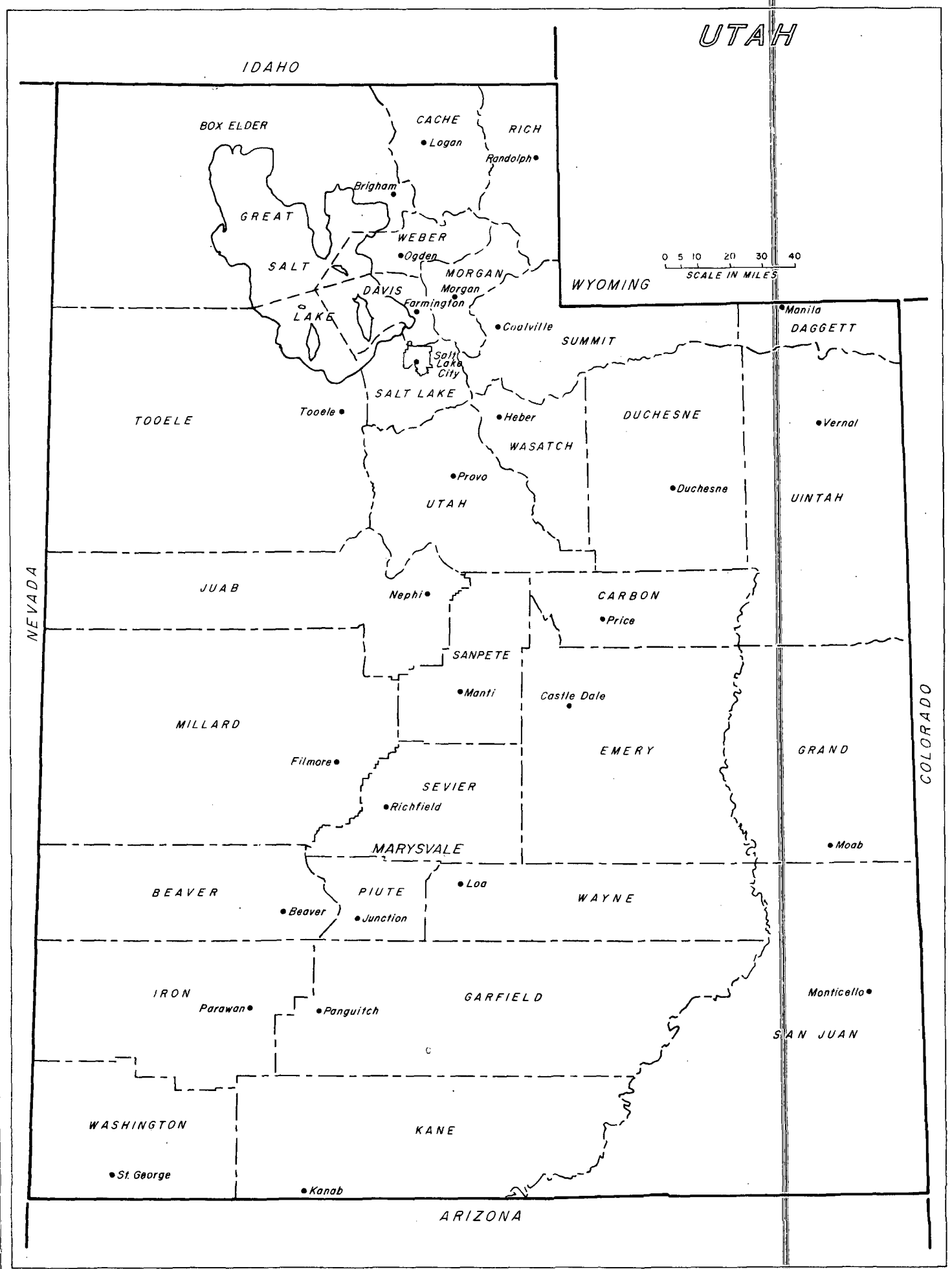
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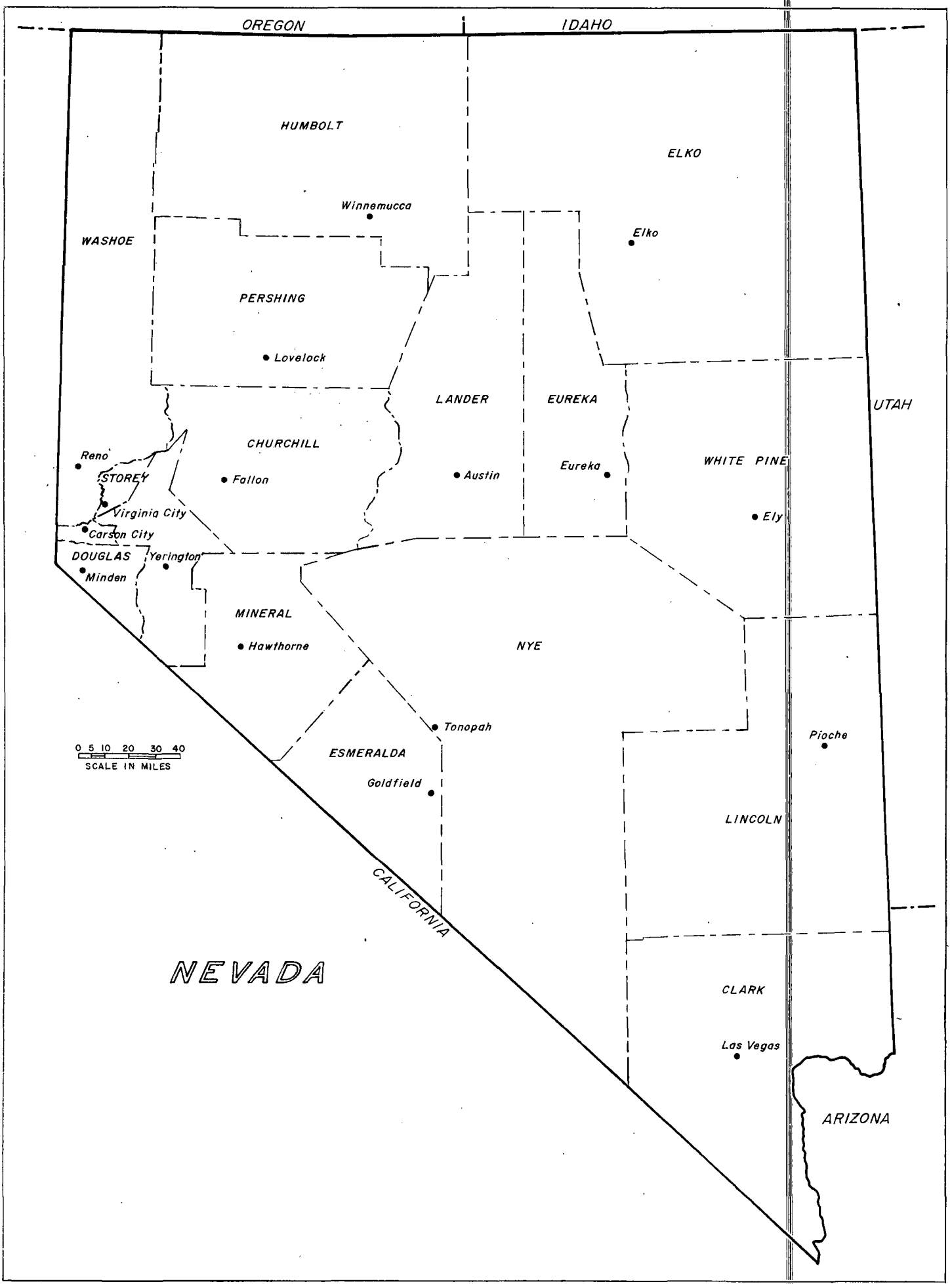
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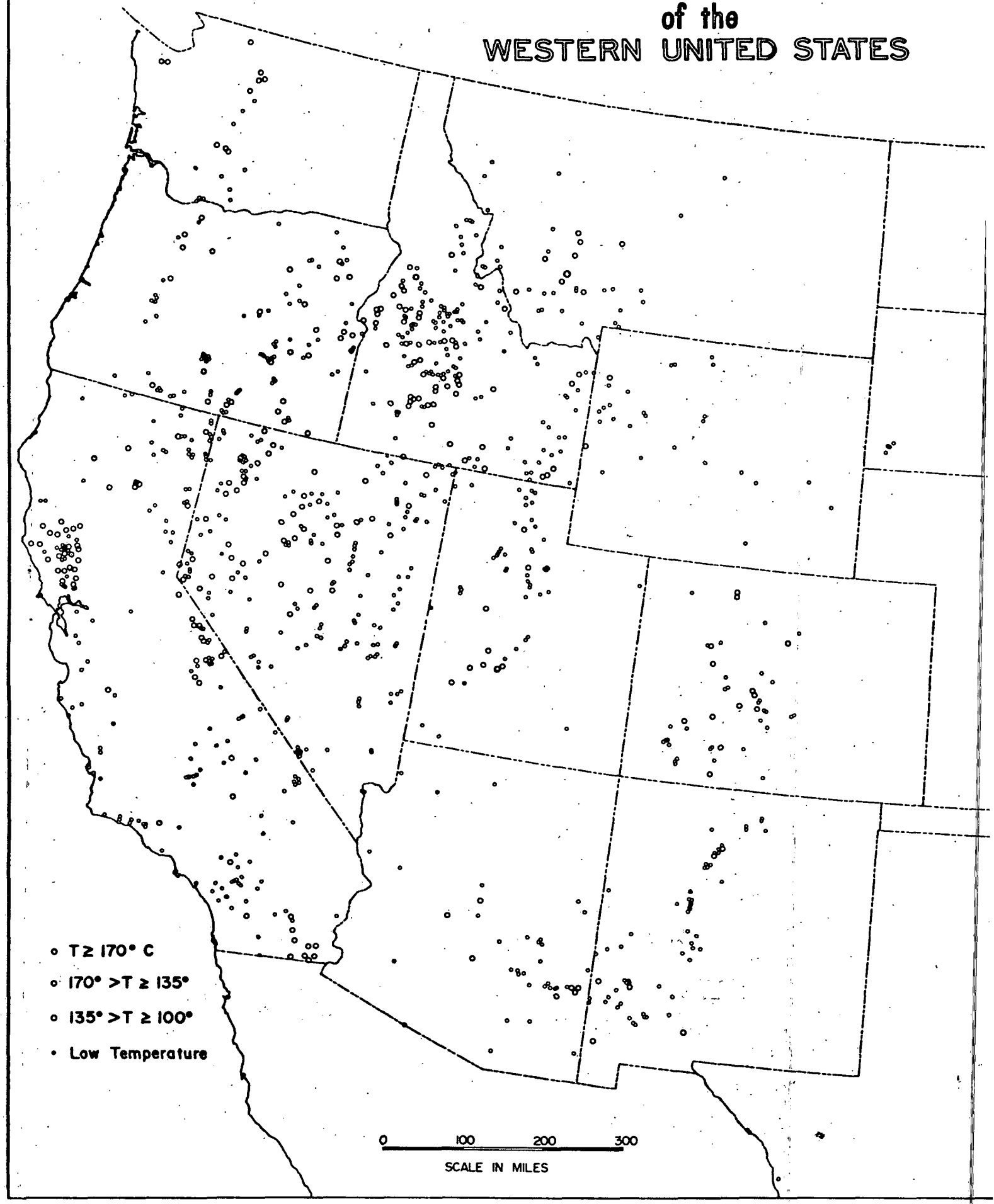
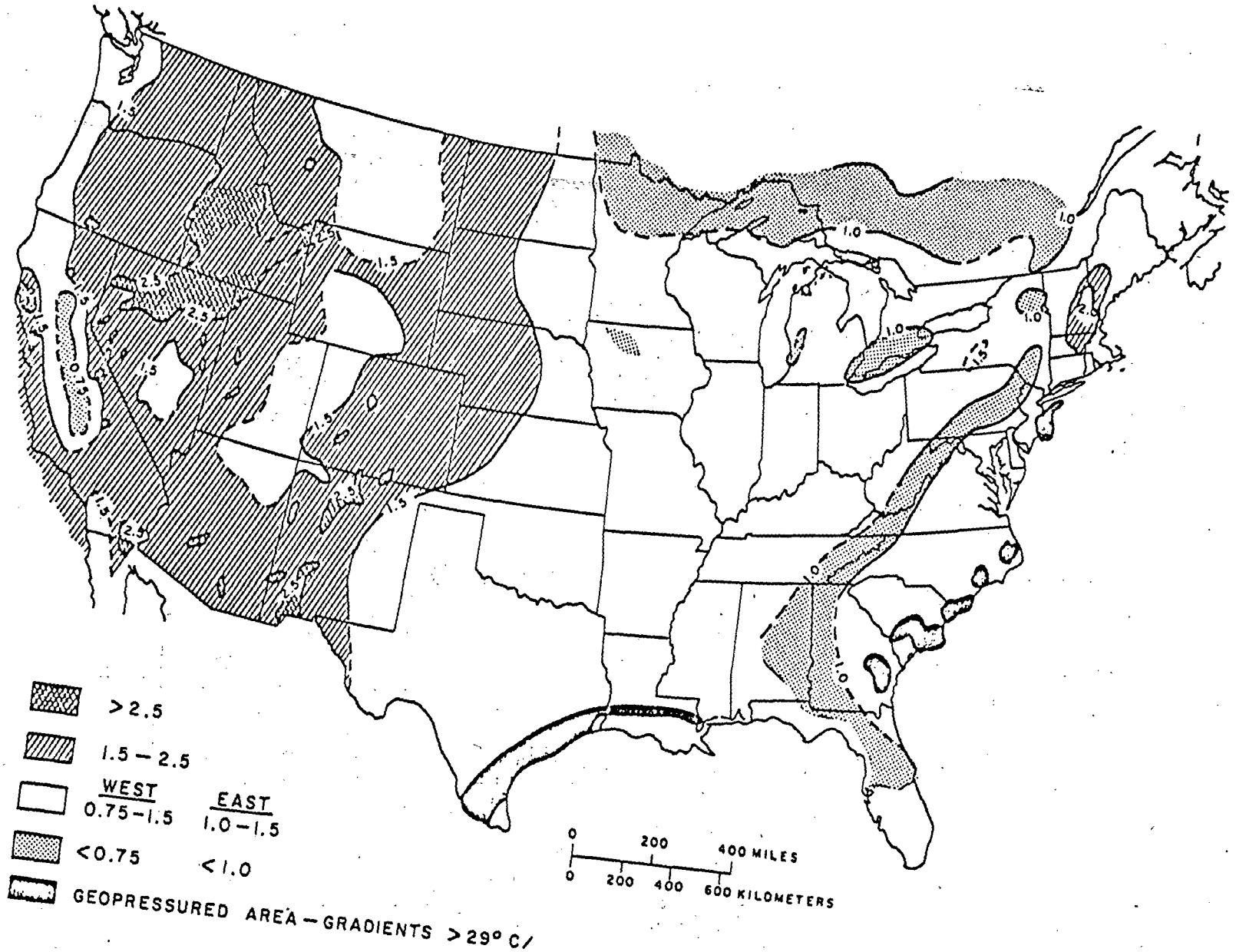


- HYDROTHERMAL CONVECTIVE
- GEOPRESSURED
- HOT DRY ROCK
- MAGMA
- RADIOGENIC
- NORMAL GEOTHERMAL GRADIENT


>2.5
1.5 – 2.5
WEST
0.75 – 1.5
EAST
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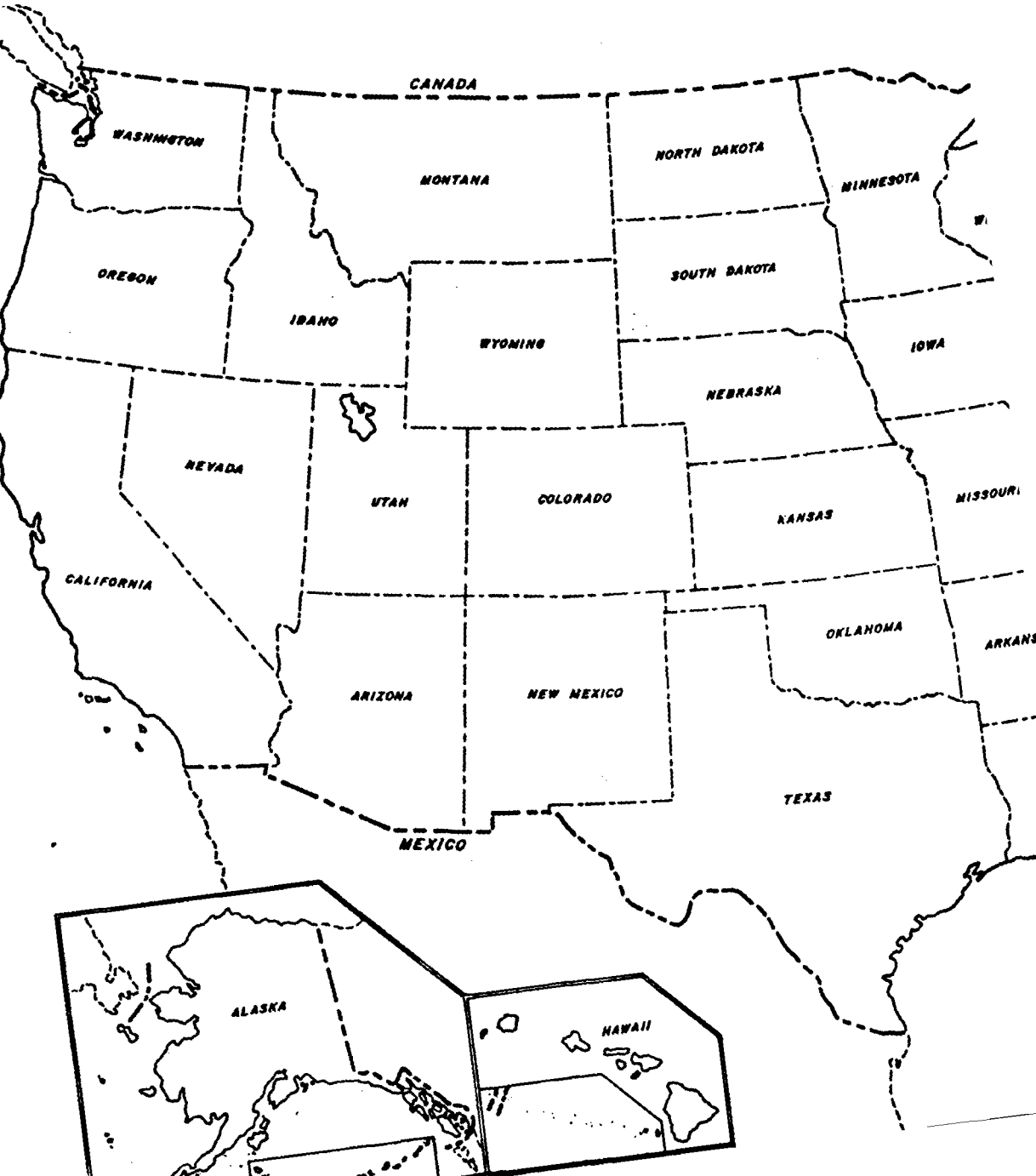
GEOPRESSURED AREA – GRADIENTS >29° C/
0 200 400 MILES
0 200 400 600 KILOMETERS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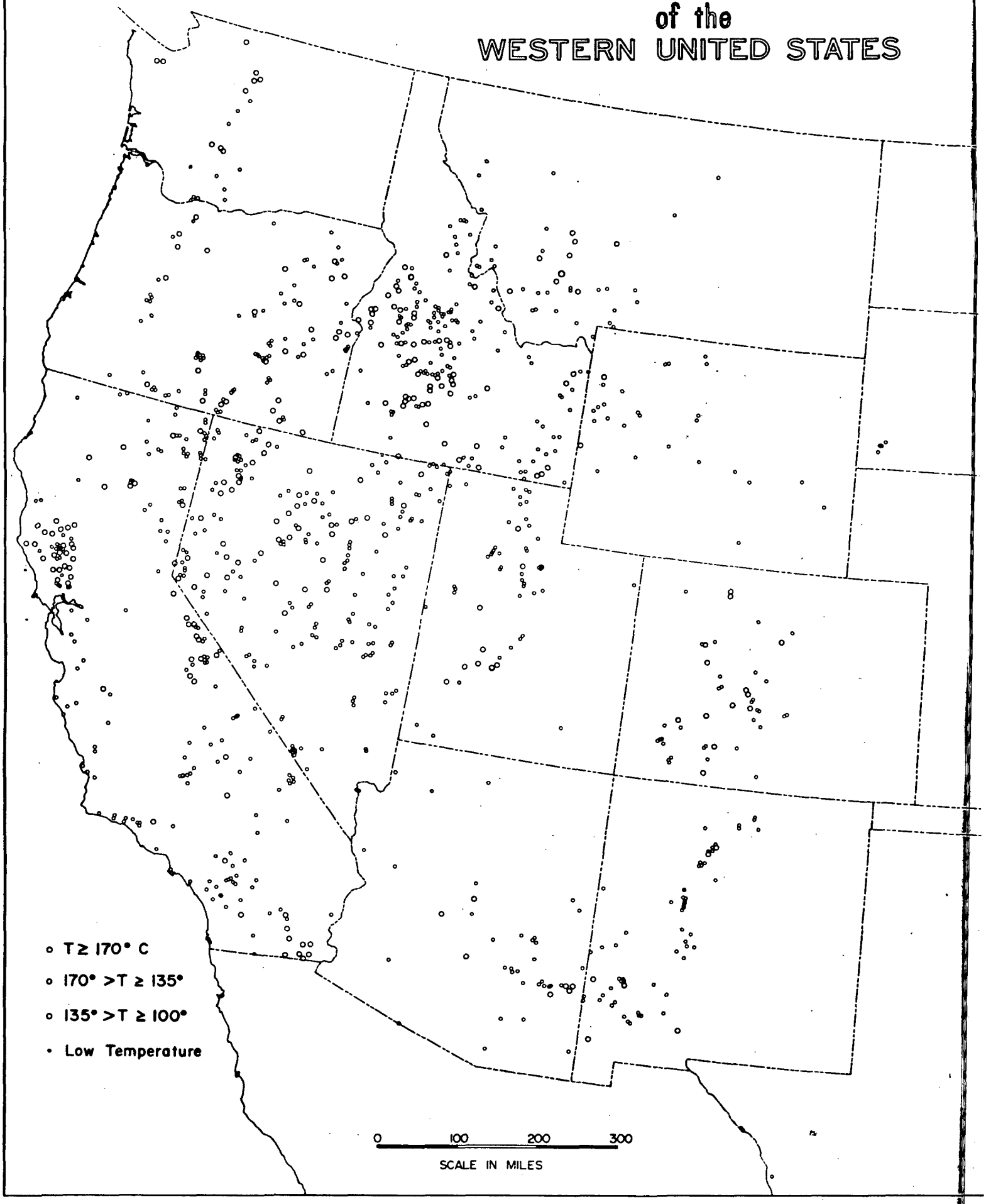

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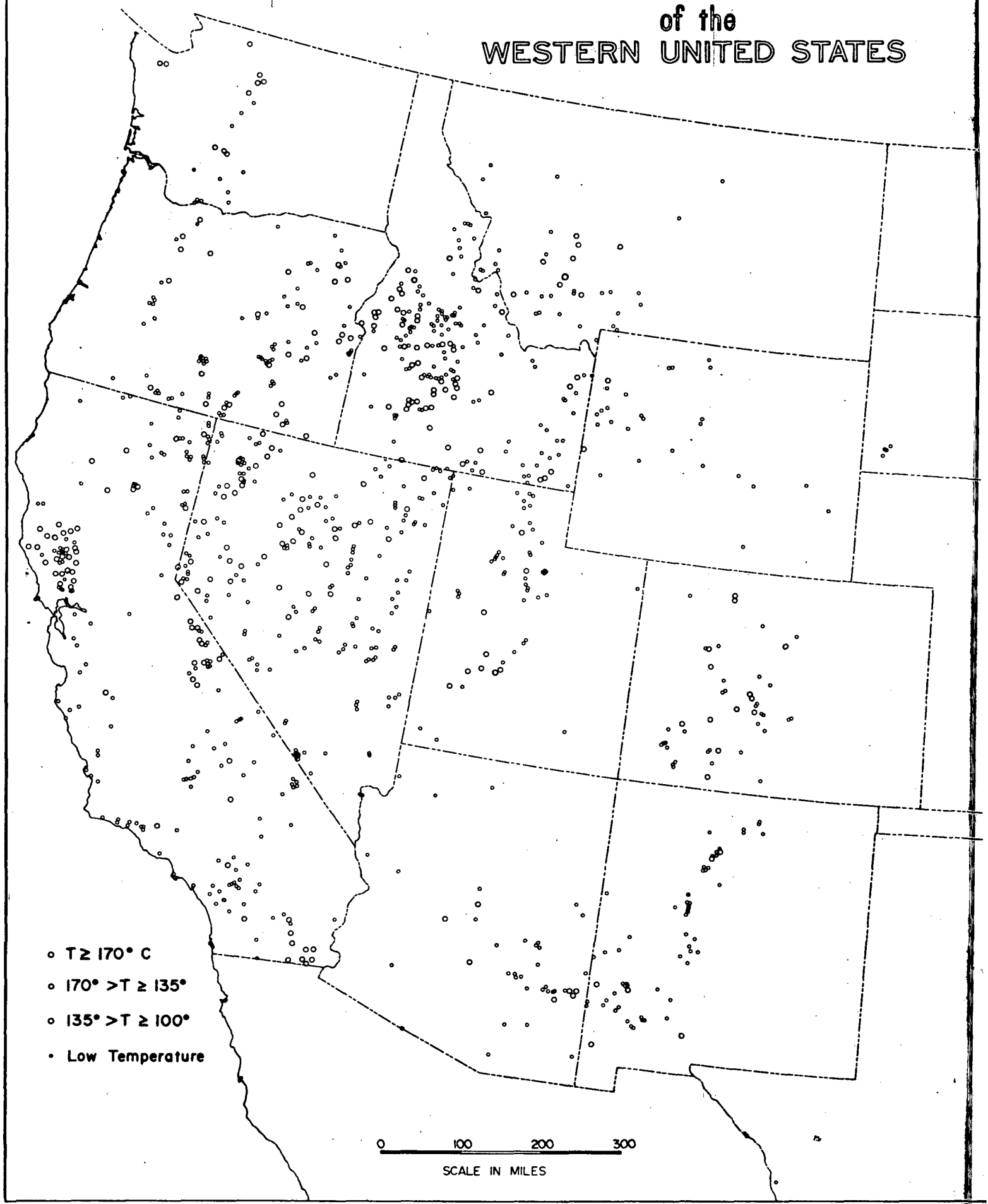


GEOTHERMAL RESERVOIR TYPES

HOT WATER (HYDROTHERMAL; CONVECTIVE)

- HIGH TEMPERATURE (>150°C; 300°F)
- MODERATE TEMPERATURE (90-150°C; 195-300°F)
- LOW TEMPERATURE (<90°C; 195°F)

VAPOR DOMINATED (240°C)

HOT DRY ROCKS

GEOPRESSURED ZONES

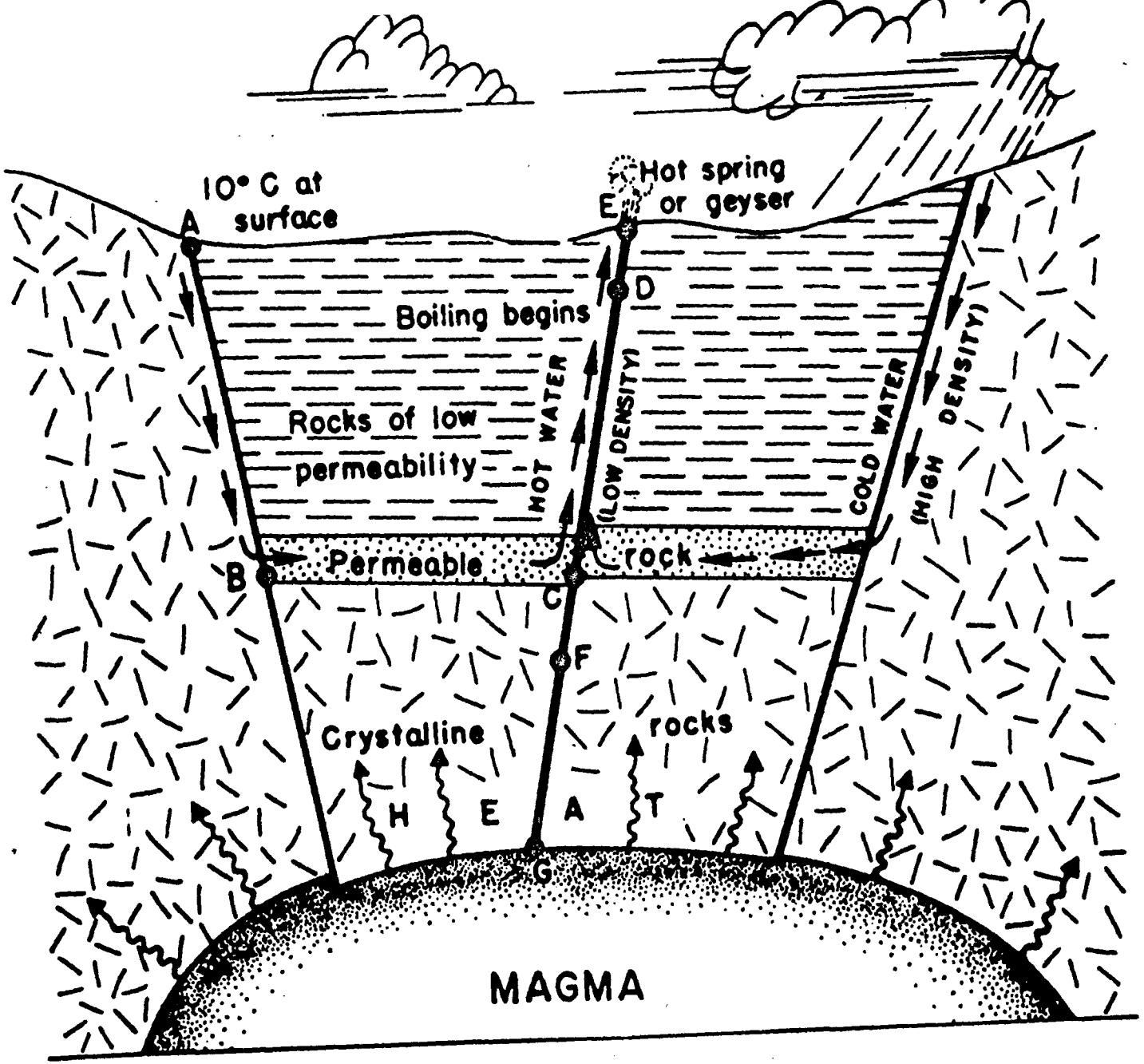
RADIOGENIC

IGNEOUS RELATED SYSTEMS

DEEP CIRCULATION (GEOTHERMAL GRADIENT >35°C/Km) SYSTEMS

FRACTURE CONTROLLED RESERVOIRS

STRATIGRAPHIC RESERVOIRS


10° C at surface
A
Hot spring or geyser
E
Boiling begins
D
Rocks of low permeability
HOT WATER
(LOW DENSITY)
COLD WATER
(HIGH DENSITY)
Permeable rock
B
C
F
Crystalline rocks
H E A T
G
MAGMA

VII. REGIONAL MARKET PENETRATION GOALS

Hydrothermal Energy Application	Present Hydrothermal Use	Hydrothermal Energy Goals		
		1985	2000	2020
Electric Generation (MWe)	— 0 —	300 (1)	9,500 (2)	35,000 (3)
Direct Heat Uses, Quads (Megawatts Equivalent)	<0.001 (< 25)	0.2 (≈8000)	1.0 (≈25,000)	2.5 (≈67,000)
ENERGY EQUIVALENTS				
Electric Generation (4) (Equivalent Fossil Fuel Energy, Quads per Year)	— 0 —	0.03	0.8	2.9
Direct Heat Uses (Expressed directly in Quads per Year)	<0.001	0.2	1.0	2.5
Total Equivalent Energy, Quads/yr (5)	<0.001	0.23	1.8	5.4
Barrels of Oil Equivalent	$< 1 \times 10^6$/yr	40×10^6/yr	304×10^6/yr	910×10^6/yr

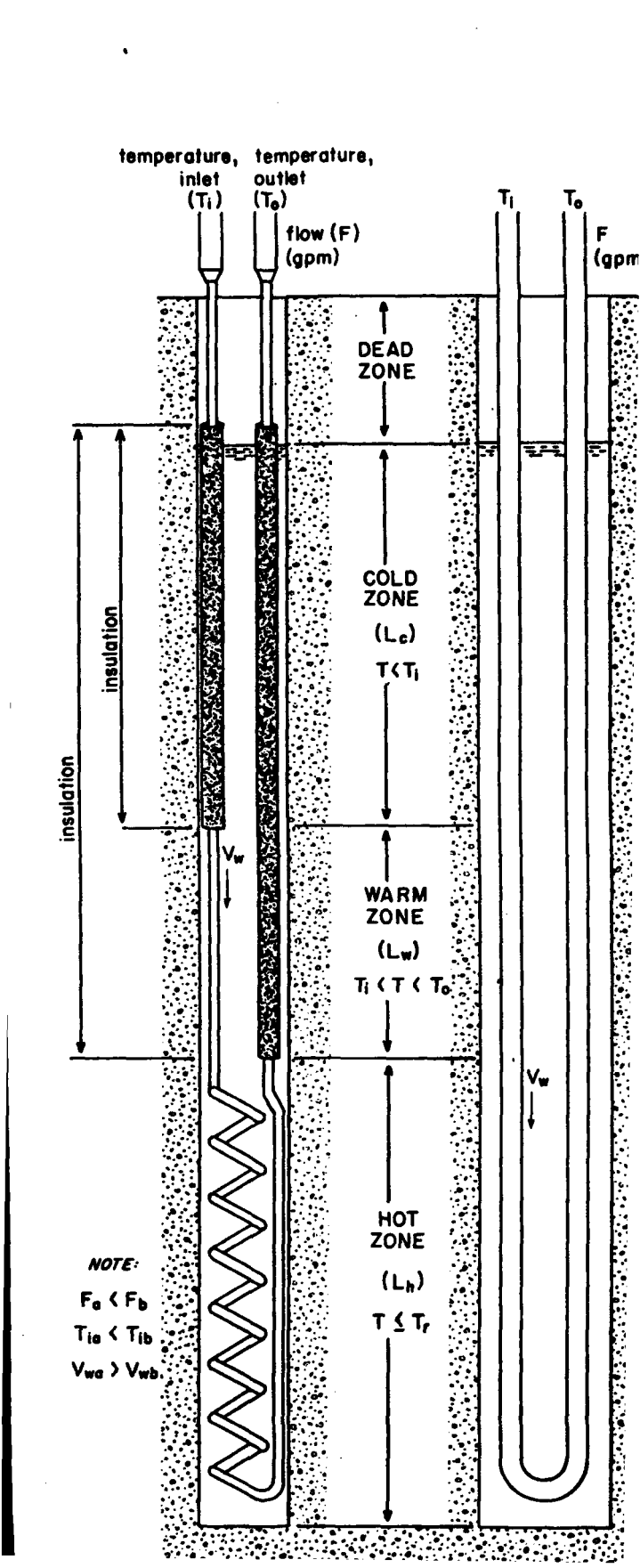
(1) Assuming additional 150 MW of proven reserves established by 1980.

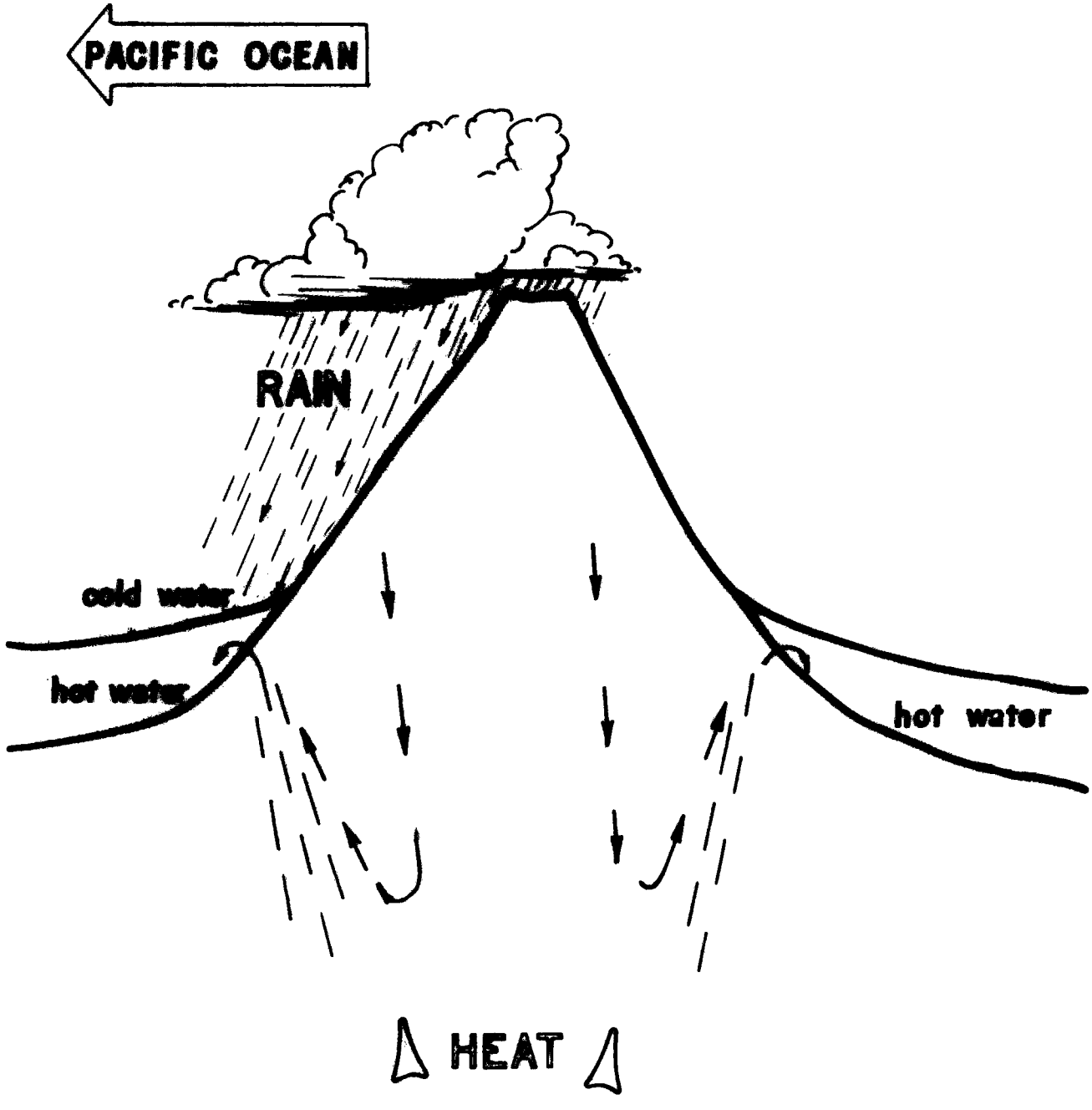
(2) Assuming commercialization of 8000 MW of proven, potential and inferred resources and 1500 MW of high grade undiscovered resources

(3) Assuming the economically competitive reservoir temperature is lowered to 150°C.

(4) 35% cycle efficiency applied to obtain fossil fuel equivalents for electric power generation.

(5) A quad is a unit of energy defined as 10^{15} BTU's or 1 quadrillion BTU's


temperature, inlet (T_i)
temperature, outlet (T_o)
flow (F) (gpm)
T_i
T_o
F (gpm
DEAD ZONE
COLD ZONE (L_c) $T < T_i$
WARM ZONE (L_w) $T_i < T < T_o$
HOT ZONE (L_h) $T \leq T_r$
insulation
insulation
V_w
V_w
NOTE:
$F_a < F_b$
$T_{ia} < T_{ib}$
$V_{wa} > V_{wb}$


PACIFIC OCEAN
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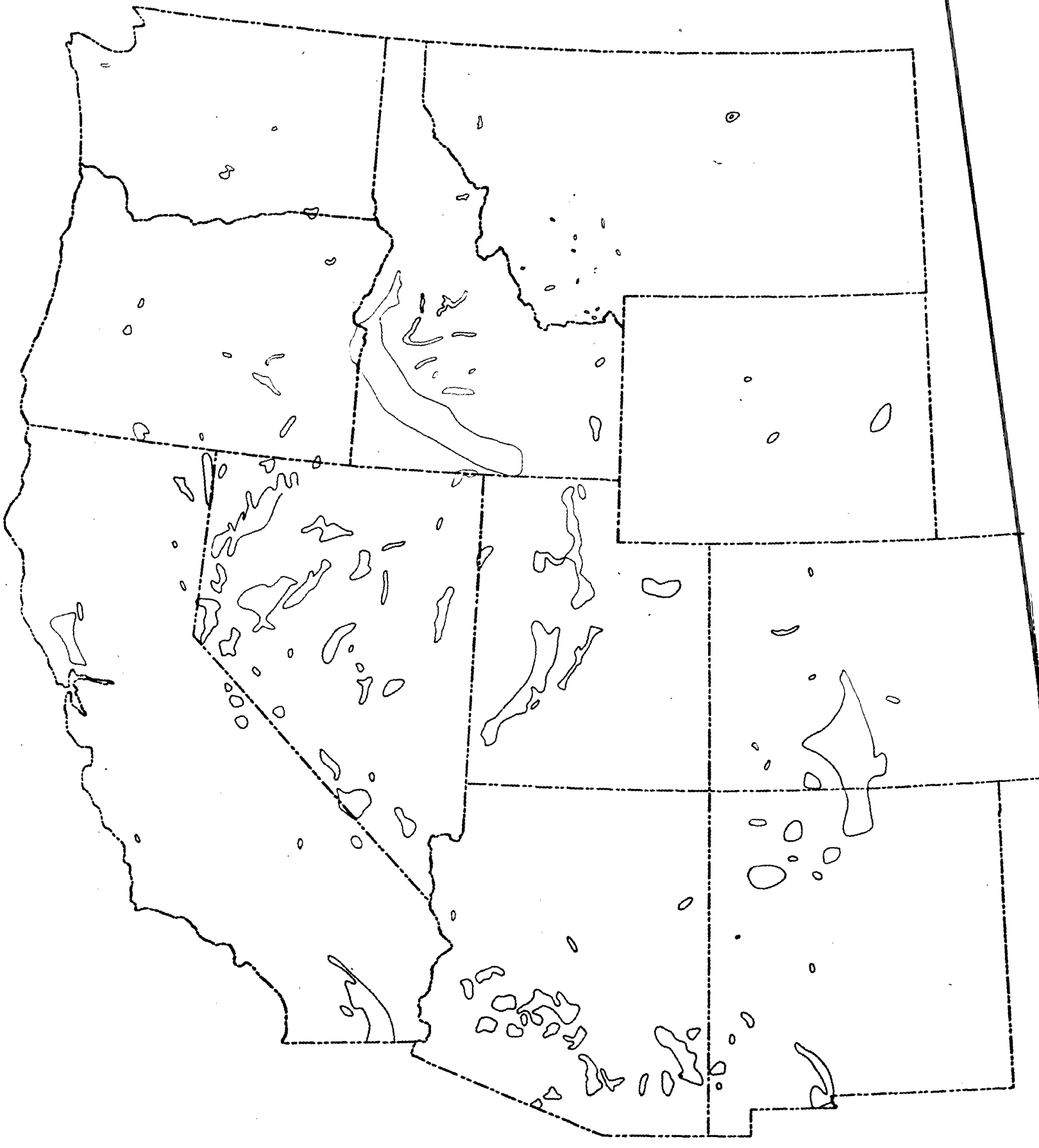
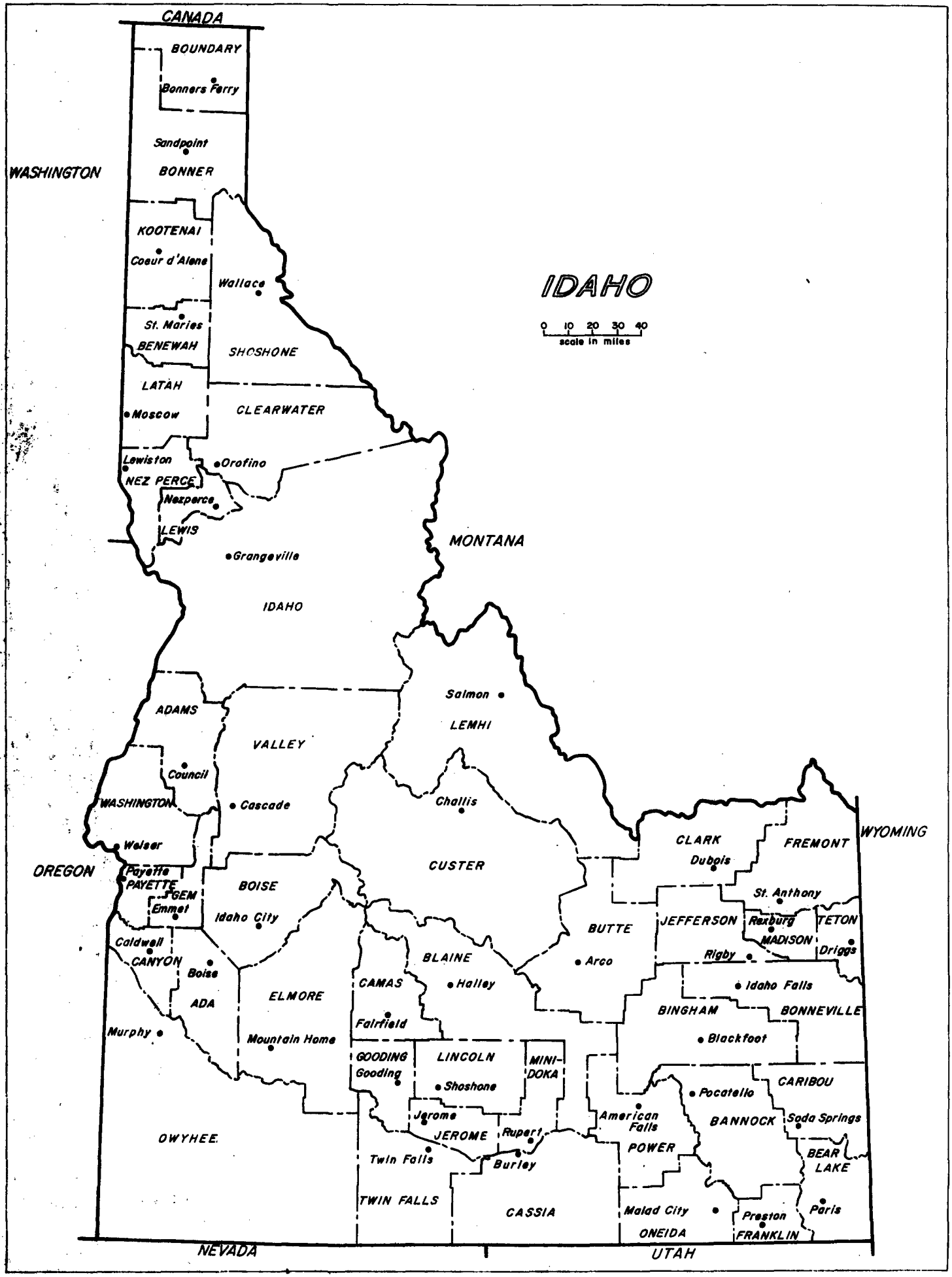
hot water
hot water
HEAT




CANADA
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scale in miles
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NEZ PERCE
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LEWIS
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IDAHO
Salmon
ADAMS
LEMHI
VALLEY
Council
WASHINGTON
Cascade
Challis
Weiser
CLARK
FREMONT
WYOMING
OREGON
Payette
PAYETTE
GEM
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BOISE
Idaho City
CUSTER
Dubois
St. Anthony
BUTTE
JEFFERSON
Rexburg
TETON
MADISON
Driggs
Caldwell
CANYON
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ADA
BLAINE
Arco
Rigby
Idaho Falls
CAMAS
Hailey
ELMORE
BINGHAM
BONNEVILLE
Murphy
Fairfield
Mountain Home
Blackfoot
GOODING
Gooding
LINCOLN
Shoshone
MINI-DOKA
CARIBOU
Pocatello
Jerome
American Falls
BANNOCK
Soda Springs
JEROME
Rupert
OWYHEE
POWER
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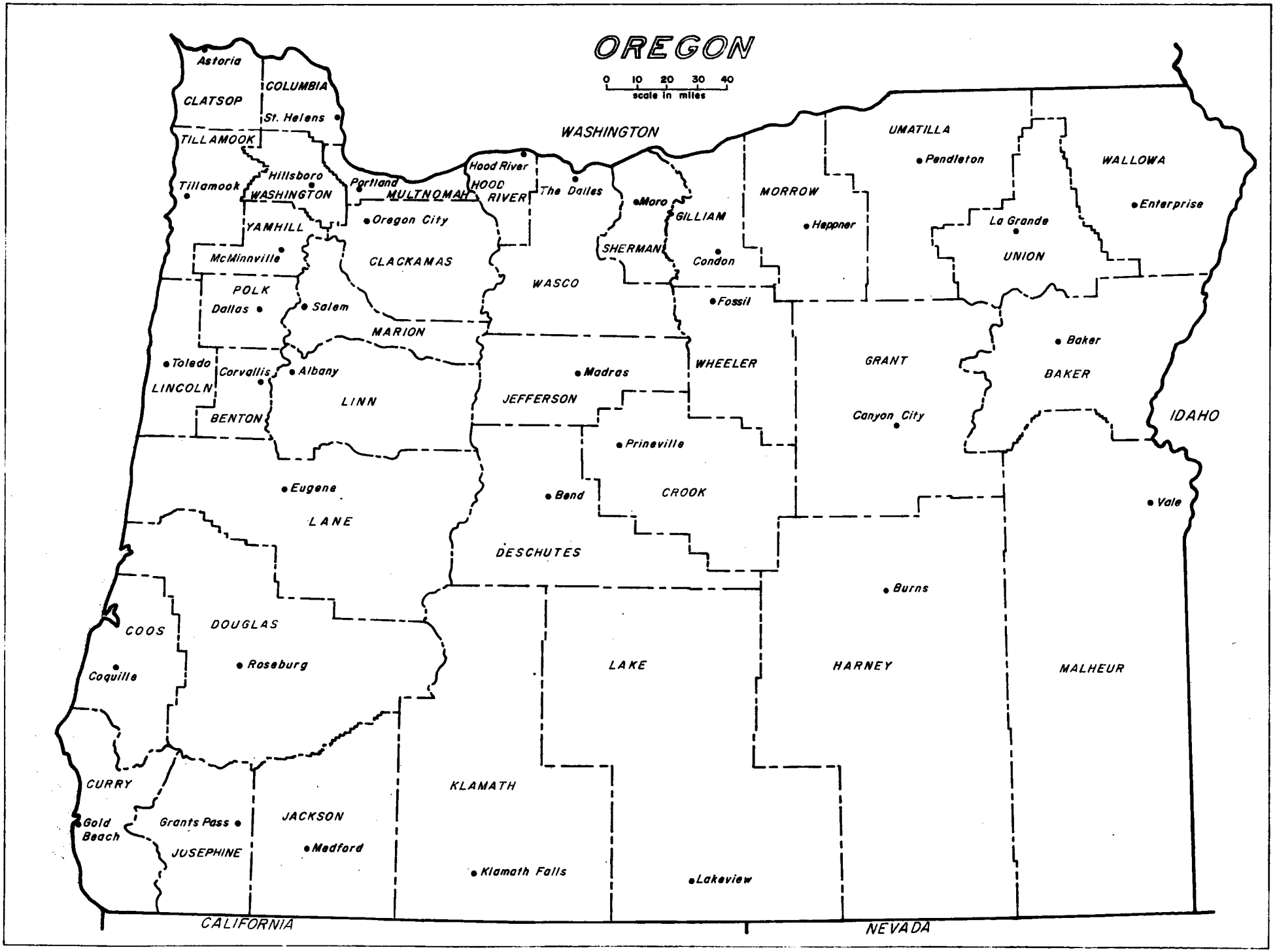
Preston
Paris
ONEIDA
FRANKLIN
NEVADA
UTAH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Pendleton
WALLOWA
Enterprise
Tillamook
Hillsboro
WASHINGTON
Portland
MULTNOMAH
Moro
GILLIAM
MORROW
Heppner
La Grande
UNION
YAMHILL
Oregon City
CLACKAMAS
SHERMAN
Condon
McMinnville
POLK
Dallas
Salem
WASCO
Fossil
MARION
Baker
Toledo
Corvallis
Albany
Madras
WHEELER
GRANT
BAKER
LINCOLN
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JEFFERSON
BENTON
Canyon City
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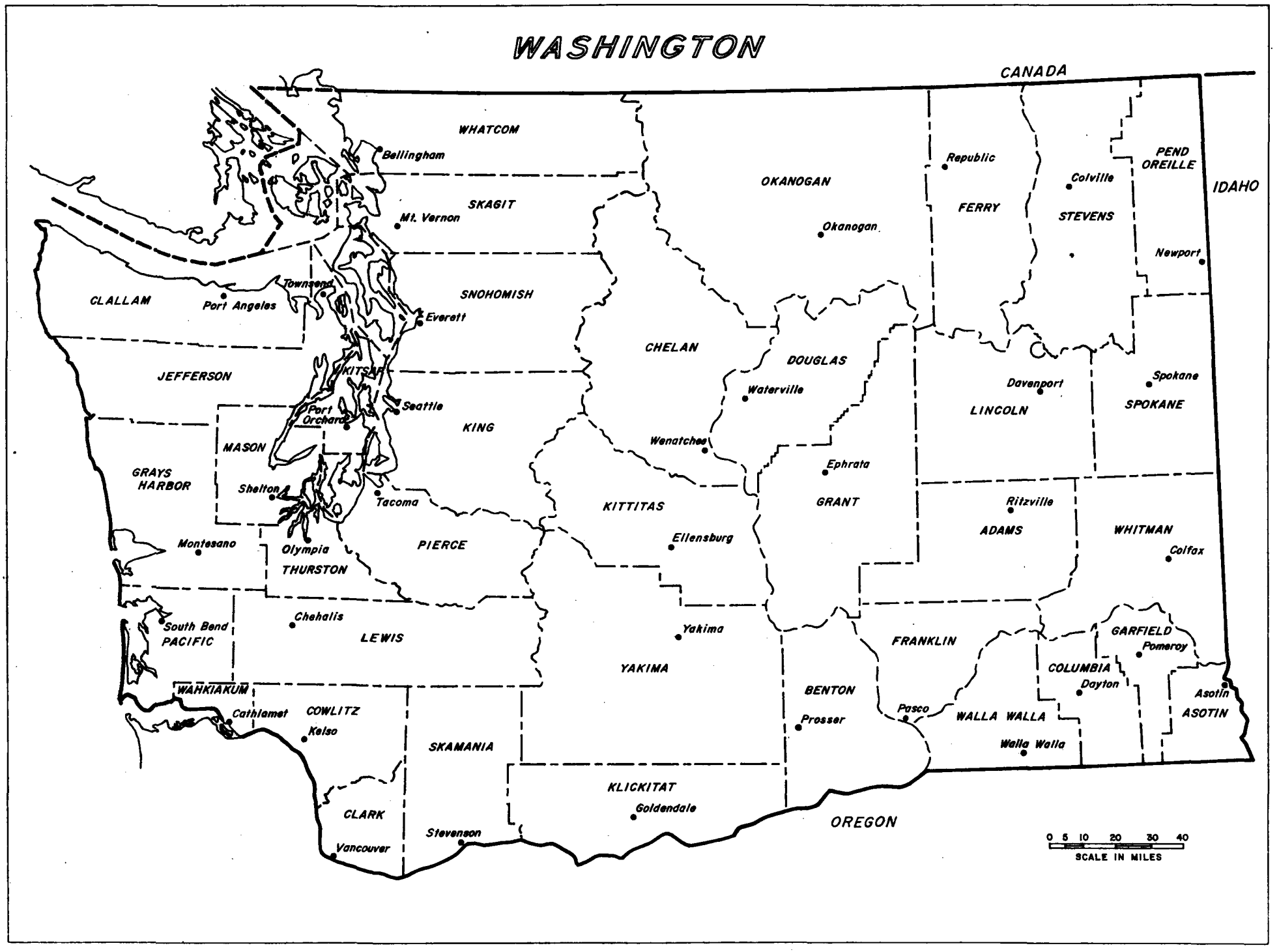
Prineville
Eugene
Bend
CROOK
Vale
LANE
DESCHUTES
Burns
COOS
DOUGLAS
Roseburg
LAKE
HARNEY
MALHEUR
Coquille
CURRY
Gold Beach
Grants Pass
JACKSON
KLAMATH
JOSEPHINE
Medford
Klamath Falls
Lakeview
CALIFORNIA
NEVADA


WASHINGTON
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Newport
CLALLAM
Port Angeles
Townsend
SNOHOMISH
Everett
CHELAN
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Waterville
JEFFERSON
KITSAP
Port Orchard
Seattle
KING
Wenatchee
Davenport
LINCOLN
Spokane
SPOKANE
MASON
GRAYS HARBOR
Shelton
Tacoma
Ephrata
GRANT
KITTITAS
Ellensburg
Ritzville
ADAMS
WHITMAN
Colfax
Montesano
Olympia
THURSTON
PIERCE
South Bend
PACIFIC
Chehalis
LEWIS
Yakima
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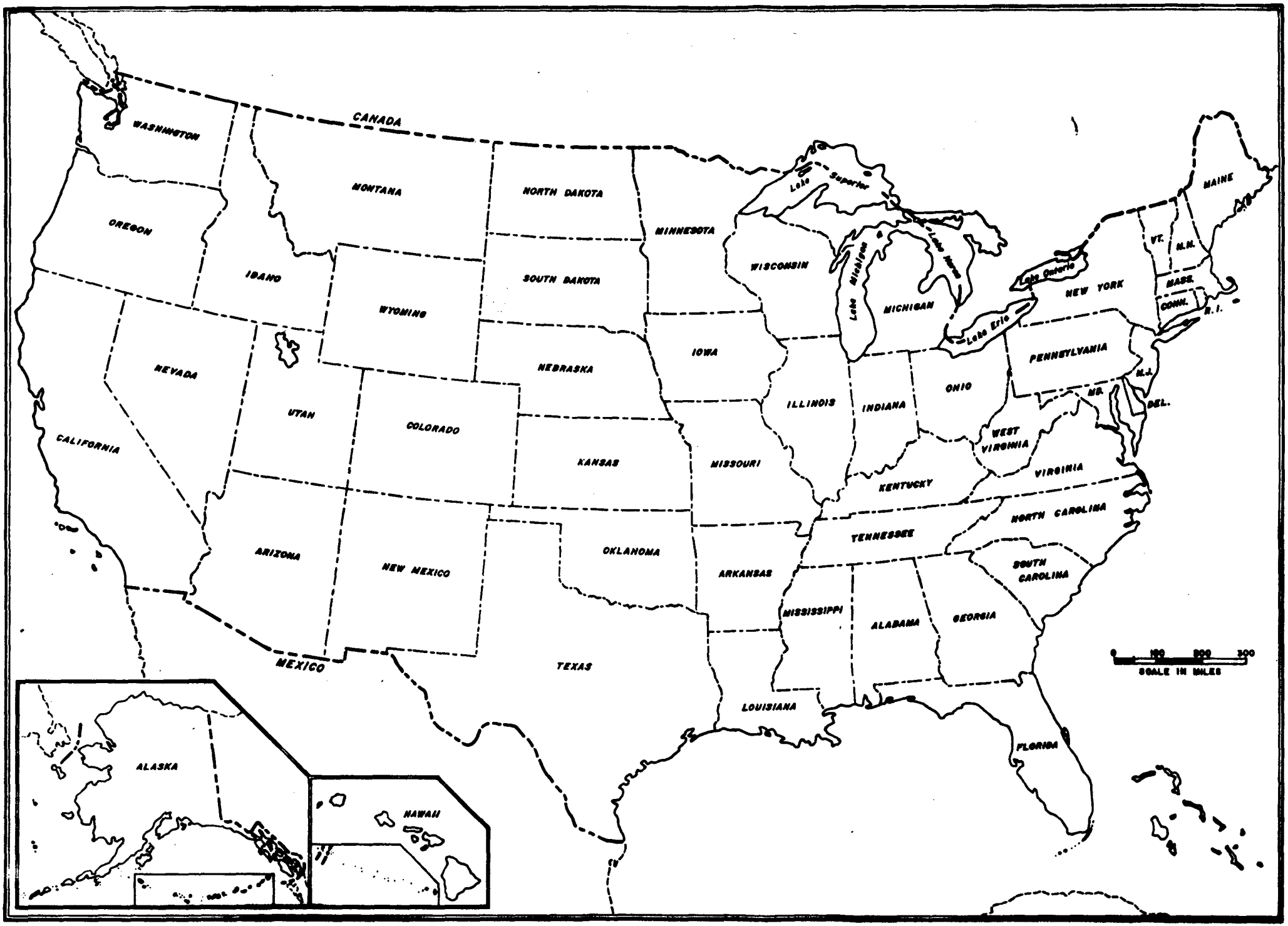
SCALE IN MILES


CANADA
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SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
WEST VIRGINIA
PENNSYLVANIA
NEW YORK
MAINE
VT.
N.H.
MASS.
CONN.
R.I.
N.J.
MD.
DEL.
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario
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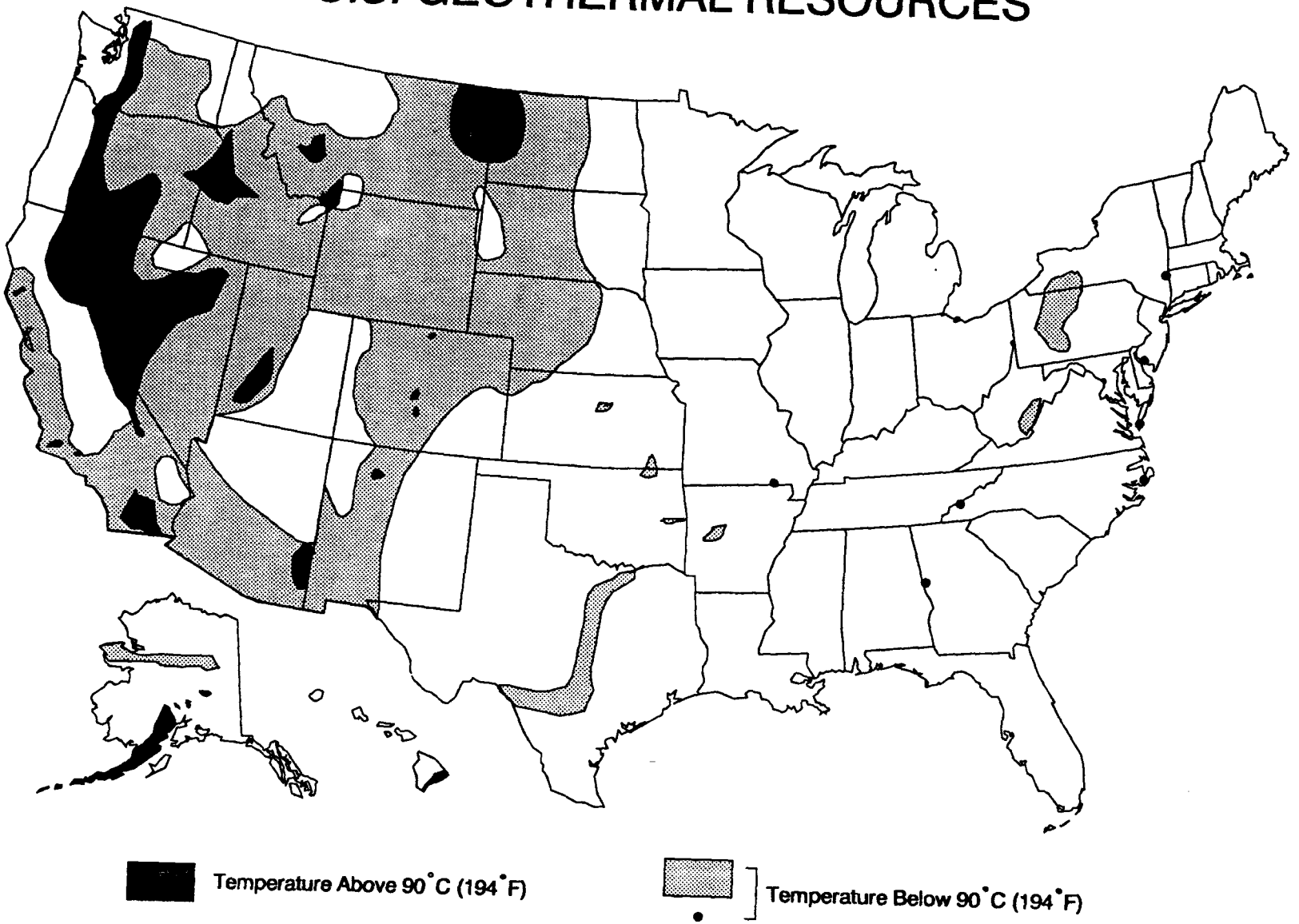
ALASKA
HAWAII
SCALE IN MILES

POSSIBLE INCLUSION

U.S. GEOTHERMAL RESOURCES



State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720 -(208) 327-7900

CECIL D. ANDRUS
GOVERNOR
R. KEITH HIGGINSON
DIRECTOR

April 9, 1990

Mr. Ken Taylor, Project Manager
U.S. Department of Energy
Advanced Technologies Branch
785 DOE Place
Idaho Falls, ID 83402

Re: NEPA documentation checklist

Dear Mr. Taylor:

Enclosed is the signed copy of the "Exception from Environmental Checklist Requirement" form. I appreciate getting the details over the phone Monday; it satisfies me that our project should provide no adverse environmental impact whatsoever.

Sincerely,

Paul M. Castelin
Senior Hydrogeologist

Enclosure

cc: Howard Ross

DOE plans to support the following activity:

GEOTHERMAL RESOURCES ANALYSES IN IDAHO

CONTRACT NO. DE-FC07-88ID12748

The proposed activity will:

NO A. occur within the walls or on the grounds of an existing facility or building, and;

NO B. produce no change in the quantity of matrix of chemical constituents released through existing air or liquid effluent streams from the facility, including sewage systems, and;

NO C. produce no additional hazardous, radioactive, or mixed wastes or contaminated material in excess of normal facility operational quantities, and;

NO D. result in no increase or change in chemical storage practices, and;

NO E. disturb no asbestos-containing materials, and;

NO F. require no additional water use which would result in construction of new, expanded, or modified water supply systems, either drinking or industrial water, and;

NO G. require no soil movement outside of the facility fence or long-term disturbance of vegetation, and;

NO H. result in no exposure of personnel to high or very high radiation levels as defined by the contractor radiological safety manual, and;

NO I. produce no noise levels requiring hearing protection devices for personnel outside of the work area where the proposed activity occurs, and;

NO J. require no pesticide use, and;

NO k. disturb no endangered species and will not occur on a floodplain or wetlands area, and;

NO L. cause no controversy by the general public, citizen groups, local, State, or Federal government agencies, or Indian tribes.

Therefore, no environmental checklist concerning this activity will be submitted per ID-EPO Guidelines

Paul M. Castel
Technical Project Manager

9 APR 90
Date

cc: EPO Representative
Contract Specialist

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720 -(208) 327-7900

CECIL D. ANDRUS
GOVERNOR
R. KEITH HIGGINSON
DIRECTOR

January 25, 1990

Mr. Ken Taylor
U.S. Department of Energy
785 DOE Place
Idaho Falls, ID 83402

Re: DE-FC07-88ID12748, Completion of Task 2

Dear Mr. Taylor:

Enclosed are three copies of the final report of Berkeley Group, Inc.'s analysis of the Boise Geothermal Aquifer System. Completion of the report satisfies most of the requirements for Task 2, with the exception of presentation of the results by BGI at a meeting in Boise on February 6, and some training of IDWR staff on use of the model on February 7, 1990.

Please also consider this letter a request for a 3-month no-cost time extension to complete Tasks 1 and 3 of the above cooperative agreement. The previous principal investigator, Leah Street, has not progressed as rapidly as she desired on Task 3 since changing employment. She still desires to complete the report, but I would like to have the extension of time to assure that it can be done within the time constraints of the agreement. As the principal investigator replacing Leah, I have also found it difficult to consult her on items not documented in her notes, and to integrate completion of Task 1 into my existing workload. With the additional time required for me to "get up to speed" on this contract work, I believe the extension of time to be justified.

If you should have questions regarding any aspect of work being completed under the above cooperative agreement, please feel free to get in touch with me.

Sincerely,

Paul M. Castelin

Paul M. Castelin
Senior Hydrogeologist

Enclosures (3)

cc: Howard Ross
Ken Osborne

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720 -(208) 327-7900

CECIL D. ANDRUS
GOVERNOR
R. KEITH HIGGINSON
DIRECTOR

March 6, 1990

Ms. Leah Street
EG&G Idaho, Inc.
P.O. Box 1625
Idaho Falls, ID 83415-4153

Dear Leah:

I do appreciate receiving the draft of the Wood River report, and from what I've seen so far, it looks good. The disk you sent me, however, contains a file regarding in-situ vitrification rather than the Wood River report. Penny tells me that we have a translate utility which is capable of translating Multimate files to Wordperfect 4.2 format, which we can then convert to WordPerfect 5.0. WP 5.0 is also capable of reading in an ASCII file directly. In any event, if you would send the Wood River report on disk, we will simply merge it with the tables you sent, which we will format in WP 5.0. We will also complete a location map, and will include the abstract and bibliography as soon as we receive them from you.

I know, too, that we have discussed by telephone several of the questions on the list I sent earlier, but my notes from our conversations are not as complete as I would like and several of the questions I've never asked before. I've enclosed a copy of the list of questions for your convenience. More importantly, you are the one who devised the work plan for the Twin Falls study and did the field work, and know best how the data should be interpreted and presented.

I understand that you have sent copies of the draft to Bill Young and Duncan Foley and that I am to send a copy to Howard Ross. Thanks much for sending the draft; we're that much closer to wrapping these reports up.

With best regards,

Paul M. Castelin
Senior Hydrogeologist

Enclosures

cc: Howard Ross

1) Locate by T, R, and 1/4 1/4 Section the rock sample localities. We also need to know what the abbreviated names mean (SF, CM, etc.). (Ignore this one; we do have this from Bob).

2) What evidence is there (from geology or geochemistry) for the conclusion of the USGS that the Paleozoics and Tsv are isolated thermal systems?

3) Looking at the enclosed tables of rock and water chemistry, what conclusions can be drawn?

4) What additional geologic mapping was done to verify any southern extent of the Burger-Buhl structure zone?

5) Are there any wells other than Nat-Soo-Pah and Jones Corp. which encounter the Paleozoic rocks within the study area?

6) What is the geology of Monument Springs? Why was it chosen as a control; because it is in the probable recharge area in rhyolites, or what?

7) Are you convinced that water within the rhyolites, as shallow as they are, are capable of reaching the observed temperatures from heat flow alone? You haven't stated that anywhere, but the Survey seems to be convinced.

8) Did you refine discharge calculations of the Twin Falls - Banbury system, and if so, where do we find the documents? If not, how did you intend to do so?

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720 -(208) 327-7900

CECIL D. ANDRUS
GOVERNOR
R. KEITH HIGGINSON
DIRECTOR

Rec 01/25/90
HPR

January 22, 1990

Howard Ross
University of Utah Research Institute
Earth Science Laboratory
391 Chipeta Way, Suite C
Salt Lake City, UT 84108-1295

Dear Howard:

On February 6, 1990, Berkeley Group, Inc. (BGI) will present the results of their analysis of the Boise Geothermal System. The presentation will begin at 1:30 P.M. in the large conference room on the second floor of the Idaho Department of Water Resources offices at 1301 N. Orchard Street in Boise. Mr. Peter Pyle of BGI will be available to answer questions following his presentation.

Please plan to attend or send an appropriate alternate. This study represents an important step in characterizing the Boise Geothermal System up to this stage of its development and provides some insight into its future.

Sincerely,

Paul

Paul M. Castelin
Contract Coordinator

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720 -(208) 327-7900

CECIL D. ANDRUS
GOVERNOR
R. KEITH HIGGINSON
DIRECTOR

January 25, 1990

Mr. Howard Ross
University of Utah Research Institute
Earth Science Laboratory
391 Chipeta Way, Suite C
Salt Lake City, UT 84108-1295

Re: DE-FC07-88ID12748, Completion of Task 2

Dear Howard:

Enclosed is a copy of the final report of Berkeley Group, Inc.'s analysis of the Boise Geothermal Aquifer System. Completion of the report satisfies most of the requirements for Task 2, with the exception of presentation of the results by BGI at a meeting in Boise on February 6, and some training of IDWR staff on use of the model on February 7, 1990.

As I indicated to you today, I have not yet received information from Leah that I need in order to progress on Task 1, nor have I received a draft report from her on Task 3. I intend to request a three-month no-cost extension of time from DOE in order to remove any possibility that the reports cannot be completed on time.

Thanks for helping me decipher the requirements of the contract. It's much appreciated!

Sincerely,

Paul M. Castelin
Senior Hydrogeologist

Enclosure

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720 -(208) 327-7900

CECIL D. ANDRUS
GOVERNOR
R. KEITH HIGGINSON
DIRECTOR

January 25, 1990

Mr. Ken Taylor
U.S. Department of Energy
785 DOE Place
Idaho Falls, ID 83402

Re: DE-FC07-88ID12748, Completion of Task 2

Dear Mr. Taylor:

Enclosed are three copies of the final report of Berkeley Group, Inc.'s analysis of the Boise Geothermal Aquifer System. Completion of the report satisfies most of the requirements for Task 2, with the exception of presentation of the results by BGI at a meeting in Boise on February 6, and some training of IDWR staff on use of the model on February 7, 1990.

Please also consider this letter a request for a 3-month no-cost time extension to complete Tasks 1 and 3 of the above cooperative agreement. The previous principal investigator, Leah Street, has not progressed as rapidly as she desired on Task 3 since changing employment. She still desires to complete the report, but I would like to have the extension of time to assure that it can be done within the time constraints of the agreement. As the principal investigator replacing Leah, I have also found it difficult to consult her on items not documented in her notes, and to integrate completion of Task 1 into my existing workload. With the additional time required for me to "get up to speed" on this contract work, I believe the extension of time to be justified.

If you should have questions regarding any aspect of work being completed under the above cooperative agreement, please feel free to get in touch with me.

Sincerely,

Paul M. Castelin

Paul M. Castelin
Senior Hydrogeologist

Enclosures (3)

cc: Howard Ross
Ken Osborne

UNIVERSITY OF UTAH RESEARCH INSTITUTE

UURI

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

January 5, 1990

Paul M.Castelin
Senior Hydrogeologist
Idaho- Department of Water Resources
1301 North Orchard Street
Statehouse Mail
Boise, Idaho 83720

Dear Paul:

Thank you for the opportunity to review the BGI Draft report, Part II, for the Boise Geothermal Aquifer study. I think that this is a high quality study by BGI, but it appears to be limited by the quality of the data available. In asking for clarification of a few points we should be concerned about someone using the hypothetical injection well locations (used in the modeling) as the sole basis for siting an injection well. It would really be nice to have a schematic illustration of a conceptual model to accompany the discussion of the conclusions.

Please review these comments and delete those which you feel are incorrect or should not be submitted to BGI. Please call me if you have any questions.

Sincerely,

Howard

Howard P. Ross
Project Manager

encl.

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720 -(208) 327-7900

CECIL D. ANDRUS
GOVERNOR
R. KEITH HIGGINSON
DIRECTOR

Rec 01/02/90 HAR

December 27, 1989

Ms. Leah Street
EG&G Idaho, Inc.
P.O. Box 1625
Idaho Falls, ID 83415

Dear Leah:

Hope you're acclimating yourself to your new job and surroundings. Steve McCormick says that he's found conditions quite different from the State, and not necessarily better! Something about clearances and approvals, and bureaucracy. Oh, well, what can you do?

We have received the draft draft of the Boise Front ground-water model from BGI, and have sent a copy to Howard Ross for review. I'm to call him soon, and would like to let him know when he can expect the Big Wood and Twin Falls draft reports. How's the Big Wood report coming? Are you having any trouble getting that last 20% finished? Let me know as soon as possible when to expect the completed draft.

We've got a shopping list of questions for you, now that we've delved into your data files. Please fill us in on the following:

1) Locate by T, R, and 1/4 1/4 Section the rock sample localities. We also need to know what the abbreviated names mean (SF, CM, etc.)

2) What evidence is there (from geology or geochemistry) for the conclusion of the USGS that the Paleozoics and Tsv are isolated thermal systems?

3) Looking at the enclosed tables of rock and water chemistry, what conclusions can be drawn?

4) What additional geologic mapping was done to verify any southern extent of the Burger-Buhl structure zone?

5) Are there any wells other than Nat-Soo-Pah and Jones Corp. which encounter the Paleozoic rocks within the study area?

6) What is the geology of Monument Springs? Why was it chosen as a control; because it is in the probable recharge area in rhyolites, or what?

7) Are you convinced that water within the rhyolites, as shallow as they are, are capable of reaching the observed temperatures from heat flow alone? You haven't stated that anywhere, but the Survey seems to be convinced. I'm not sure that I am; I believe that deeper circulation is necessary.

8) Did you refine discharge calculations of the Twin Falls - Banbury system, and if so, where do we find the documents? If not, how did you intend to do so?

9) Why did the chicken cross the road?

We would very much like to get a draft put together, but only you can answer many of the above questions, since most of it is not documented on paper. Bob deTar is on two weeks leave, and failed to supply me with some information before he left, so it's a bit tough to do much until the questions are answered. Hope that you can help!

With best regards,

Paul

Paul M. Castelin
Senior Hydrogeologist

Enclosures

cc: Howard Ross

State of Idaho
DEPARTMENT OF WATER RESOURCES
Southern Region, 2148 4th Ave. East, Twin Falls, Idaho 83301 (208) 734-3578

CECIL D. ANDRUS
Governor

R. KEITH HIGGINSON
Director

May 25, 1989

Howard Ross
University of Utah Research Institute
391 Chipeta Way, Suite C
Salt Lake City, Utah 84108-1295

Dear Howard:

Enclosed is another copy of Lewis and Young's report on the Twin Falls system. Ken Taylor requested that I send it to you so you can forward it to the Technical Information Center. He is going through the necessary paperwork to close out that grant, and wanted the report to be sent.

It looks like it's going to be a typical Memorial Day weekend - cool and windy. Even so, I'm sure that we'll both be enjoying the extra day. Have a good weekend.

Sincerely,

Leah V. Street
Hydrogeologist

UNIVERSITY OF UTAH RESEARCH INSTITUTE

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: Kenneth Taylor, DOE/ID DATE: April 11, 1989

FROM: Howard P. Ross

RE: Annual Budget Review, Cooperative Agreement No. DE-FG07-88ID12748, State of Idaho, Department of Water Resources

The State of Idaho-Department of Water Resources (ID-DWR) did not submit a specific project status report with the Financial Status Report but the project status is known from the Quarterly Project Status Report signed March 22, 1989 and conversations with Ms. Leah Street, Principal Investigator.

Task 1, Twin Falls County Geothermal Systems, is on schedule with well monitoring and fluid sampling continuing and other field studies underway. Work is approximately on schedule for Task 2, Boise Geothermal Aquifer Study, after a protracted RFP and contract award process. A contract was signed with the Berkeley Group, Inc. in March for the quantitative evaluation of the Boise geothermal aquifer using a multi-rate multi-well wellfield simulator program adapted for geothermal modeling. Initial fluid samples have been collected and analyses received for Task 3, Wood River Geothermal Systems, and a second round of sampling is underway. This project is also on schedule.

First year expenditures are approximately 70% of planned expenditures, excepting subcontract amounts. All obligated funds will be required for the completion of this cooperative agreement.

Howard Ross

Howard P. Ross
Project Manager

DOE F 4600.1
(7-81)

U.S. DEPARTMENT OF ENERGY
NOTICE OF FINANCIAL ASSISTANCE AWARD
(See Instructions on Reverse)

RECEIVED
MAR 22 1988

Under the authority of Public Law PL 93-410 and
subject to legislation, regulations and policies applicable to *(cite legislative program title)*: Department of Water Resources
Geothermal Energy Research, Development, and Demonstration Act of 1974

1. PROJECT TITLE
Geothermal Resources Analyses in Idaho

2. INSTRUMENT TYPE
☐ GRANT ☒ COOPERATIVE AGREEMENT

3. RECIPIENT *(Name, address, zip code, area code and telephone no.)*
State of Idaho. Dept. of Water Resources
Energy Resources Bureau
Statehouse, Boise, ID 83720

4. INSTRUMENT NO.
DE-FC07-88ID12748

5. AMENDMENT NO.

6. BUDGET PERIOD
FROM: 3/21/88 THRU: 3/21/89

7. PROJECT PERIOD
FROM: 3/21/88 THRU: 3/21/90

8. RECIPIENT PROJECT DIRECTOR *(Name and telephone No.)*
Leah V. Street (208) 734-3578

10. TYPE OF AWARD
☒ NEW ☐ CONTINUATION ☐ RENEWAL
☐ REVISION ☐ SUPPLEMENT

9. RECIPIENT BUSINESS OFFICER *(Name and telephone No.)*
Robert W. Hoppie (208) 334-7968

12. ADMINISTERED FOR DOE BY *(Name, address, zip code, telephone No.)*
Trudy A. Thorne (208) 526-9519
U. S. Department of Energy
Idaho Operations Office
785 DOE Place
Idaho Falls, ID 83402

11. DOE PROJECT OFFICER *(Name, address, zip code, telephone No.)*
Susan M. Prestwich (208) 526-1147
U. S. DOE, Idaho Operations Office
785 DOE Place, Idaho Falls, ID 83402

13. RECIPIENT TYPE
☒ STATE GOV'T ☐ INDIAN TRIBAL GOV'T ☐ HOSPITAL ☐ FOR PROFIT ORGANIZATION ☐ INDIVIDUAL
☐ LOCAL GOV'T ☐ INSTITUTION OF HIGHER EDUCATION ☐ OTHER NONPROFIT ORGANIZATION ☐ C ☐ P ☐ SP ☐ OTHER *(Specify)*

14. ACCOUNTING AND APPROPRIATIONS DATA

a. Appropriation Symbol	b. B & R Number	c. FT/AFP/OC	d. CFA Number
89x0224.91	AM1510000	410	

15. EMPLOYER I.D. NUMBER/SSN

16. BUDGET AND FUNDING INFORMATION

a. CURRENT BUDGET PERIOD INFORMATION

(1) DOE Funds Obligated This Action	$ 154,088
(2) DOE Funds Authorized for Carry Over	$ -0-
(3) DOE Funds Previously Obligated in this Budget Period	$ -0-
(4) DOE Share of Total Approved Budget	$ 154,088
(5) Recipient Share of Total Approved Budget	$ 17,079
(6) Total Approved Budget	$ 171,167

b. CUMULATIVE DOE OBLIGATIONS

(1) This Budget Period *(Total of lines a.(1) and a.(3))*	$ 154,088
(2) Prior Budget Periods	$ -0-
(3) Project Period to Date *(Total of lines b. (1) and b. (2))*	$ 154,088

17. TOTAL ESTIMATED COST OF PROJECT $ 171,167
(This is the current estimated cost of the project. It is not a promise to award nor an authorization to expend funds in this amount.)

18. AWARD/AGREEMENT TERMS AND CONDITIONS

This award/agreement consists of this form plus the following:

a. Special terms and conditions (if grant) or schedule, general provisions, special provisions (if cooperative agreement)

b. Applicable program regulations *(specify)* _____ *(Date)* _____

c. DOE Assistance Regulations, 10 CFR Part 600, as amended, Subparts A and ☐ B (Grants) or ☒ C (Cooperative Agreements).

d. Application/proposal dated June 17, 1987. ☐ as submitted ☒ with changes as negotiated

19. REMARKS This agreement consists of this NFAA (DOE Form 4600.1); Form EIA-Budget Plan; Schedule Articles; Appendix A - Statement of Work; Form EIA-459A-Federal Assistance Reporting Checklist. DOE Financial Assistance Rules (10 CFR Part 600); OMB Circular A-102; OMB Circular A-87 and Circular A-128 "Audits of State and Local Government" are hereby incorporated by reference.

20. EVIDENCE OF RECIPIENT ACCEPTANCE
Wayne T. Haas 3/25/88
(Signature of Authorized Recipient Official) *(Date)*
Wayne T. Haas, Administrator
(Name)
Resource Analysis Division
(Title)

21. AWARDED BY
J. P. Anderson 3-21-88
(Signature) *(Date)*
J. P. Anderson, Contracting Officer
(Name)
Chief, R&D Contracts Branch
(Title)

APPENDIX A

STATEMENT OF WORK

1.0 Introduction

The goal of the Cooperative Agreement is to support cost-shared resource assessment on three geothermal resources in the state of Idaho. The thermal aquifer associated with Paleozoic rocks and adjacent to the Twin Falls aquifer has not been studied in detail and its relationship to the developed Twin Falls aquifer is not understood. Increased development of the Boise aquifer could have a substantial impact on reservoir performance characteristics. Production and observation wells must be monitored for a longer period of time, and the data submitted to quantitative evaluation, to provide a basis for prudent management of the geothermal resource. Thermal waters in the Wood River area may be high in fluoride content. The extent of the thermal waters and the geochemistry of the fluids and possible reservoir rocks should be determined to guide future development and utilization of the resource. This resource assessment Cooperative Agreement will extend previous studies by the Principal Investigator and others, and will address specific problems and areas of interest discovered in earlier studies.

2.0 Scope

The technical objectives of the Cooperative Agreement are to acquire and interpret new data for three geothermal systems in southern Idaho. The activities will differ somewhat for each of the three areas, as described in Section 4.0-Technical Tasks, reflecting the different level of understanding and development of the three geothermal systems. Specific activities include: the inventory of existing wells and springs (Cassia Mountains and Wood River areas); completion of temperature profiles and water level monitoring of wells; quantitative reservoir evaluation of the Boise aquifer; geochemical studies of fluids and rocks at Wood River; and interpretation and reporting. All tasks will be completed within a 24 month period.

3.0 Applicable Documents

The reservoir assessment activities described herein are abstracted from a proposal titled "Geothermal Resource Analyses in Idaho - Boise, Twin Falls and the Wood River Valley, Idaho," dated June 17, 1987, and submitted by the State of Idaho - Department of Water 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-PR07-87ID12662.

4.0 Technical Tasks

The following tasks will be accomplished under this grant.

Task 1. Twin Falls County Geothermal Systems

Conduct a technical evaluation of geothermal resources in the Banbury-Twin Falls area and in the Paleozoic units of the Cassia Mountains to determine the relationship, if any, between these resources.

1.1 Inventory existing thermal wells and springs associated with the Cassia Mountains. Establish a monitoring network for monthly water level and temperature measurements.

1.2 Complete temperature profiles in existing wells in both systems and determine geothermal gradients.

1.3 Complete measurements of water levels in both systems and determine hydraulic gradient.

1.4 Sample thermal fluids for background, C14, C13 and isotopes in both systems.

1.5 Extend existing geologic mapping to determine if there is a southern extension of the Buhl-Berger Structure Zone as defined by Street and DeTar (1987).

1.6 Sample rocks for whole rock and trace element analyses to determine chemistry of reservoir rock.

1.7 Continue temperature and water level monitoring of existing network of the Twin Falls-Banbury area. Resample selected wells to determine if fluid chemistry has changed since the water levels have declined.

1.8 Refine discharge calculations of the Twin Falls-Banbury system and compute discharge for the Paleozoic system.

1.9 Complete a final report which describes the results of the study.

Task 2. Boise Geothermal Aquifer Study

Continue the data collection and monitoring of the Boise Geothermal Aquifer for an additional 12 months. At the conclusion of the data gathering year, submit the data to a qualified reservoir engineer (consultant) for evaluation, interpretation, recommendations and reporting.

2.1 Continue water level and temperature measurements for the existing network of the Boise geothermal system and for any new thermal wells. Refine discharge calculations for the system. This task will be completed by a subcontractor.

2.2 Complete a detailed review and quantitative evaluation of existing and new reservoir data. Define the interrelationship between the various wells and the effects of present and continued development. Submit recommendations for additional data collection ~~an aquifer test~~ if this seems necessary. Also estimate the longevity of the resource based on present development and evaluate effects of future development. This task will be completed by a qualified reservoir engineer (consultant) who will be approved by DOE/ID.

2.3 Provide management for subcontractor and consultant efforts to provide project direction and to insure the quality of results and adherence to work and reporting schedules.

Task 3. Geochemistry of Wood River Geothermal Systems

Extend previous studies of the thermal systems of the Wood River area and complete a comprehensive geochemical study of thermal fluids and reservoir rocks. Document and evaluate the implications of the fluoride content of the thermal fluids.

3.1 Inventory the wells in the study area to determine the number of thermal wells.

3.2 Sample the seven thermal springs for major and trace elements, including C14 and C13. Sample selected cold springs for major and trace elements.

3.3 Sample suspected reservoir rocks and have analyzed for major and trace elements.

3.4 Complete temperature logs for existing wells and determine geothermal gradients.

3.5 Complete final report which describes the studies, data and results.

Task 4. Final Report(s)

A detailed final technical report will be prepared which will include all new data and describe all data tables, temperature data, maps, methods of research, and data reduction. A final technical report may be submitted separately for each task, or the reports for all tasks may be submitted in a single volume.

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 include all new data and describe all data tables, temperature data, maps, methods of research, and data reduction. A final technical report may be submitted separately for each task, or the reports for all tasks may be submitted in a single volume. A draft final report will be submitted to DOE 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 Idaho-Department of Water Resources will provide hydrologic instrumentation, vehicles, air photos, computer time and the State Well Inventory to this project as an in-kind contribution.

wp/Thorne

DOE F 4600.1
(7-81)

U.S. DEPARTMENT OF ENERGY Howard Pass

NOTICE OF FINANCIAL ASSISTANCE AWARD

(See Instructions on Reverse)

Under the authority of Public Law PL 93-410 and subject to legislation, regulations and policies applicable to *(cite legislative program title)*:
Geothermal Energy Research, Development, and Demonstration Act of 1974

1. PROJECT TITLE
Geothermal Resources Analyses in Idaho

2. INSTRUMENT TYPE
☐ GRANT ☒ COOPERATIVE AGREEMENT

4. INSTRUMENT NO.
DE-FC07-88ID12748

5. AMENDMENT NO.
M001

3. RECIPIENT *(Name, address, zip code, area code and telephone no.)*
State of Idaho, Dept. of Water Resources
Energy Resources Bureau
Statehouse, Boise ID 83720

6. BUDGET PERIOD
FROM: 3/21/88 THRU: 3/21/89

7. PROJECT PERIOD
FROM: 3/21/88 THRU 3/21/90

10. TYPE OF AWARD
☐ NEW ☐ CONTINUATION ☐ RENEWAL
☒ REVISION ☐ SUPPLEMENT

8. RECIPIENT PROJECT DIRECTOR *(Name and telephone No.)*
Leah V. Street (208) 734-3578

9. RECIPIENT BUSINESS OFFICER *(Name and telephone No.)*
Robert W. Hoppie (208) 334-7968

12. ADMINISTERED FOR DOE BY *(Name, address, zip code, telephone No.)*
Trudy A. Thorne (208) 526-9519
U. S. Department of Energy
Idaho Operations Office
785 DOE Place
Idaho Falls, Idaho 83402

11. DOE PROJECT OFFICER *(Name, address, zip code, telephone No.)*
S. Aoki (208) 526-0583
U.S. DOE, Idaho Operations Office
785 DOE Place, Idaho Falls, Idaho 83402

13. RECIPIENT TYPE
☒ STATE GOV'T ☐ INDIAN TRIBAL GOV'T ☐ HOSPITAL ☐ FOR PROFIT ORGANIZATION ☐ INDIVIDUAL
☐ LOCAL GOV'T ☐ INSTITUTION OF HIGHER EDUCATION ☐ OTHER NONPROFIT ORGANIZATION ☐ C ☐ P ☐ SP ☐ OTHER *(Specify)*

14. ACCOUNTING AND APPROPRIATIONS DATA

a. Appropriation Symbol	b. B & R Number	c. FT/AFP/OC	d. CFA Number
N/A			

15. EMPLOYER I.D. NUMBER/SSN

16. BUDGET AND FUNDING INFORMATION

a. CURRENT BUDGET PERIOD INFORMATION

(1) DOE Funds Obligated This Action	$ -0-
(2) DOE Funds Authorized for Carry Over	$ -0-
(3) DOE Funds Previously Obligated in this Budget Period	$ 154,088
(4) DOE Share of Total Approved Budget	$ 154,088
(5) Recipient Share of Total Approved Budget	$ 17,079
(6) Total Approved Budget	$ 171,167

b. CUMULATIVE DOE OBLIGATIONS •

(1) This Budget Period *[Total of lines a.(1) and a.(3)]*	$ 154,088
(2) Prior Budget Periods	$ -0-
(3) Project Period to Date *[Total of lines b. (1) and b. (2)]*	$ 154,088

17. TOTAL ESTIMATED COST OF PROJECT $ 171,167

(This is the current estimated cost of the project. It is not a promise to award nor an authorization to expend funds in this amount.)

18. AWARD/AGREEMENT TERMS AND CONDITIONS

This award/agreement consists of this form plus the following:

a. Special terms and conditions (if grant) or schedule, general provisions, special provisions (if cooperative agreement)

b. Applicable program regulations *(specify)* _____ *(Date)* _____

c. DOE Assistance Regulations, 10 CFR Part 600, as amended, Subparts A and ☐ B (Grants) or ☒ C (Cooperative Agreements).

d. Application/proposal dated _____, ☐ as submitted ☐ with changes as negotiated

19. REMARKS

See Attached

20. EVIDENCE OF RECIPIENT ACCEPTANCE

Wayne T. Haas 11/18/88
(Signature of Authorized Recipient Official) *(Date)*

Wayne T. Haas
(Name)

Administrator
(Title)

21. AWARDED BY

J. P. Anderson 11-3-88
(Signature) *(Date)*

J. P. Anderson
(Name)

Contracting Officer
(Title)

This modification incorporates the following changes:

All references to Susan M. Prestwich are hereby changed to Isamu Aoki (208) 526-0583.

Add the following to the Schedule Articles (Reference 10 CFR Part 600 1/1/87 Edition).

ARTICLE XII - PATENT CLAUSES

The following patent clauses are applicable to this award:

600.118(b)(2) "Patent Rights (Short Form)"

600.118(b)(3) "Rights in Technical Data (Short Form)"

600.118(b)(5) "Authorization and Consent"

600.118(b)(6) "Notice and Assistance"

600.118(c) "Reporting of Royalties"

Appendix A, Statement of Work, Task 2. Boise Geothermal Aquifer Study, Section 2.2, third sentence, is changed to read: Submit recommendations for additional data collection if this seems necessary.

Rec 10/20/88

U.S. DEPARTMENT OF ENERGY

FEDERAL ASSISTANCE PROGRAM/PROJECT STATUS REPORT

FORM EIA-459F (10/80)

FORM APPROVED OMB No. 1900-0127

1. Program/Project Identification No.	2. Program/Project Title	3. Reporting Period
DE-FC07-88ID12748	Geothermal Resource Analyses in Idaho	6/21/88 through 9/21/88

4. Name and Address
Idaho Department of Water Resources
2148 4th Ave. East Twin Falls, Idaho 83301

5. Program/Project Start Date
3/21/88

6. Completion Date
3/21/90

7. Approach Changes

☒ None

8. Performance Variances, Accomplishments, or Problems

I have requested a change to the statement of work of Task 2, Boise Geothermal Study, reflecting the cancellation of the aquifer test.
The contract with the U.S. Geological Survey Water Resource Division for water sampling, analyses and monitoring has been signed. The RFP for hiring a consultant for the Boise study has been finalized and is now at the Idaho Division of Purchasing for their approval.
I am presently involved with the equipment selection for monitoring flow for several wells within the Twin Falls area. The data will be used for quantifying and managing the resource.

☐ None

9. Open Items

☒ None

10. Status Assessment and Forecast

☒ No Deviation from Plan is Expected

11. Description of Attachments

☒ None

12. Signature of Recipient and Date	13. Signature of DOE Reviewing Representative and Date
Jack V. Hunt 10/1/88	

FORM EIA-459E
(10/80)

U.S. DEPARTMENT OF ENERGY

FEDERAL ASSISTANCE MANAGEMENT SUMMARY REPORT

FORM APPROVED
OMB No. 1900-0127

Page ___ of ___

1. Program/Project Identification No.	2. Program/Project Title	3. Reporting Period
DE-FC07-88ID12748	Geothermal Resource Analyses in Idaho	6/21/88 through 9/21/88

4. Name and Address
Idaho Department of Water Resources
2148 4th Ave. East Twin Falls, Idaho 83301

5. Program/Project Start Date: 3/21/88

6. Completion Date: 3/21/90

7. FY: 88

8. Months or Quarters: Second Quarter

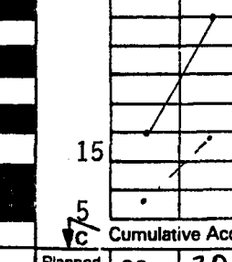
9. Cost Status a. Dollars Expressed in: thousands* includes subcontracts

b. Dollar Scale

10. Cost Chart

Fund Source		Quarter 1st	Quarter 2nd	Quarter 3rd	Quarter 4th	Cum. to Date	Tot. Plan
DOE	P	20	20				
	A	8	10				
IDWR	P	1	1				
	A	1	1				
	P						
	A						
	P						
	A						
Total P		21	21				
Total A		9	11				
Variance		12	10				

P = Planned A = Actual



Total Planned Costs for Program/Project: $171,167

	1	2
Planned	20	20
Actual	8	10
Variance	(12)	(10)

11. Major Milestone Status	Units Planned / Units Complete
Task 1: monitoring continuing	P / C
sample sites selected	P / C
mapping started	P / C ▲
Task 2: RFP sent to Division	P / C
of Purchasing	P / C
monitoring started	P / C ▲
Task 3: rock samples taken	P / C
water sample sites selected	P / C
Contract signed with USGS WRD	P / C
for sampling, analyses and	P / C
monitoring	P / C ▲
	P / C
	P / C
	P / C
	P / C
	P / C
	P / C

12. Remarks

13. Signature of Recipient and Date: Leah V. Street 10/1/89

14. Signature of DOE Reviewing Representative and Date

Conversion from Grant Format to Cooperative Agreement No. DE-FC07-88ID

APPENDIX A

4.0 Technical Tasks

The following tasks will be accomplished under this grant.

4.1 Twin Falls County Geothermal Systems

Conduct a technical evaluation of geothermal resources in the Banbury-Twin Falls area and in the Paleozoic units of the Cassia Mountains to determine the relationship, if any, between these resources.

4.1.1 Inventory existing thermal wells and springs associated with the Cassia Mountains. Establish a monitoring network for monthly water level and temperature measurements.

4.1.2 Complete temperature profiles in existing wells in both systems and determine geothermal gradients.

4.1.3 Complete measurements of water levels in both systems and determine direction of flow.

4.1.4 Sample thermal fluids for background, C14, C13 and isotopes in both systems.

4.1.5 Extend existing geologic mapping to determine if there is a southern extension of the Buhl-Berger Structure Zone as defined by Street and DeTar (1987).

4.1.6 Sample rocks for whole rock and trace element analyses to determine chemistry of reservoir rock.

4.1.7 Continue temperature and water level monitoring of existing network of the Twin Falls-Banbury area. Resample selected wells to determine if fluid chemistry has changed since the water levels have declined.

4.1.8 Refine discharge calculations of the Twin Falls-Banbury system and compute discharge for the Paleozoic system.

4.1.9 Complete a final report which describes the results of the study.

4.2 Boise Geothermal Aquifer Study

Continue the data collection and monitoring of the Boise Geothermal Aquifer for an additional 12 months. At the conclusion of the data gathering year, submit the data to a qualified reservoir engineer (Consultant) for evaluation, interpretation, recommendations and reporting.

4.2.1 Continue water level and temperature measurements for the existing network of the Boise geothermal system and for any new thermal wells. Refine discharge calculations for the system. This task will be completed by a subcontractor, Boise State University, under the direction of Dr. Charles Waag, Principal Investigator.

4.2.2 Complete a detailed review and quantitative evaluation of existing and new reservoir data. Define the interrelationship between the various wells and the effects of present and continued development. Submit recommendations for an aquifer test if this seems necessary, and recommendations for management of the resource. This task will be completed by a qualified reservoir engineer (Consultant) who will be approved by DOE/ID.

4.2.3 Provide management for subcontractor and consultant efforts to provide project direction and to insure the quality of results and adherence to work and reporting schedules.

4.3 Geochemistry of Wood River Geothermal Systems

Extend previous studies of the thermal systems of the Wood River area and complete a comprehensive geochemical study of thermal fluids and reservoir rocks. Document and evaluate the implications of the fluoride content of the thermal fluids.

4.3.1 Inventory the wells in the study area to determine the number of thermal wells.

4.3.2 Sample the seven thermal springs for major and trace elements, including C14 and C13. Sample selected cold springs for major and trace elements.

4.3.3 Complete whole rock analyses of suspected reservoir rocks for major and trace elements.

4.3.4 Complete temperature logs for existing wells and determine geothermal gradients.

4.3.5 Complete final report which describes the studies, data and results.

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 include all new data and describe all data tables, temperature data, maps, methods of research, and data reduction. A final technical report may be submitted separately for each task, or the reports for all tasks may be submitted in a single volume. A draft final report will be submitted to DOE 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 Idaho-Department of Water Resources will provide hydrologic instrumentation, vehicles, air photos, computer time and the State Well Inventory to this project as a contribution-in-kind.

State of Idaho
Department of Water Resources
Grant No. DE-FG07-87ID_____

STATEMENT OF WORK

1.0 Introduction

The goal of this grant is to support cost-shared resource assessment on three geothermal resources in the state of Idaho. The thermal aquifer associated with Paleozoic rocks and adjacent to the Twin Falls aquifer has not been studied in detail and its relationship to the developed Twin Falls aquifer is not understood. Increased development of the Boise aquifer could have a substantial impact on reservoir performance characteristics. Production and observation wells must be monitored for a longer period of time, and the data submitted to quantitative evaluation, to provide a basis for prudent management of the geothermal resource. Thermal waters in the Wood River area may be high in fluoride content. The extent of the thermal waters and the geochemistry of the fluids and possible reservoir rocks should be determined to guide future development and utilization of the resource. This resource assessment grant will extend previous studies by the Principal Investigator and others, and will address specific problems and areas of interest discovered in earlier studies.

2.0 Scope

The technical objectives of this grant are to acquire and interpret new data for three geothermal systems in southern Idaho. The activities will differ somewhat for each of the three areas, as described in section 4.0- Technical Tasks, reflecting the different level of understanding and development of the three geothermal systems. Specific activities include: the inventory of existing wells and springs (Cassia Mountains and Wood River areas); completion of temperature profiles and water level monitoring of wells; quantitative reservoir evaluation of the Boise aquifer; geochemical studies of fluids and rocks at Wood River; and interpretation and reporting. All tasks will be completed within a 24 month period.

3.0 Applicable Documents

The reservoir assessment activities described herein are abstracted from a proposal titled "Geothermal Resource Analyses in Idaho - Boise, Twin Falls and the Wood River Valley, Idaho", dated June 17, 1987 and submitted by the State of Idaho - Department of Water 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-PR07-87ID12662.

Cooperative Agreement No. DE-FC07-
87ID_____

State of Idaho
Department of Water Resources

SCHEDULE

ARTICLE I - STATEMENT OF JOINT OBJECTIVE

The purpose of this Cooperative Agreement between the United States Department of Energy (DOE or Government) and the State of Idaho - Department of Water Resources (ID-DWR) (Participant) is to support cost-shared resource assessment on three geothermal resource areas in the state of Idaho. This action is authorized by Federal Law and is in furtherance of the Government's objective to support state oriented geothermal resource assessment, resource development and technical assistance. The Participant will receive the benefit of these geothermal research activities and DOE will obtain data on three southern Idaho geothermal resource systems.

ARTICLE II - THE PROJECT MANAGEMENT PLAN

ARTICLE III - FINANCIAL SUPPORT

ARTICLE IV - PAYMENTS

A. Progress Payments. Costs will be shared 90% DOE and 10% 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	Task 1.	Complete inventory of existing thermal wells and springs, Cassia Mountains; establish monitoring network. Revision of discharge measurements, Twin Falls-Banbury, and discharge computations for Paleozoic system, 50% complete.
	Task 2.	Contract let for monitoring of Boise geothermal system wells. Monitoring 20% complete.

Milestone		Description
2	Task 1.	Monitoring and geothermal gradient measurements 25% completed. Initial stage of discharge measurements completed.
	Task 2.	Boise monitoring 30% completed.
3	Task 1.	Mass measurements, stage 1, completed. Water sampling and mapping 30% completed. Monitoring and geothermal gradients 30% completed.
	Task 2.	Boise monitoring 60% completed. Procurement for reservoir engineer consultant completed.
4	Task 1.	Monitoring, geothermal gradients 50% completed. Water sampling 60% completed. Mapping 50% completed.
	Task 3.	Wood River area water level measurements and water sampling completed.
5	Task 1.	Second stage of mass measurements completed. Cassia Mountains water sampling completed. Mapping and rock sampling completed.
	Task 3	Wood River geothermal gradient determinations and rock sampling completed.
PHASE II SECOND YEAR		
6	Task 1.	Twin Falls-Banbury monitoring network, geothermal gradient study, monitoring 60% complete. Interim progress report for Task 1 completed.
	Task 2.	Boise geothermal study by consultant 60% completed; progress report submitted to DOE and to ID-DWR for review.
	Task 3.	Submit draft technical report, Wood River study, to DOE and ID-DWR for internal review.

Milestone	Description

next pg

7	Task 1.	Monitoring network, geothermal gradients 75% completed.
	Task 2.	Draft final report, Boise geothermal study, submitted to DOE and ID-DWR for review.
	Task 3.	Final report, Wood River study, submitted to DOE.
8	Task 1.	Monitoring network, geothermal gradient studies 85% complete. All mass measurements and discharge determinations completed.
9	Task 1.	Monitoring network, geothermal gradient measurements completed. Draft final report submitted to DOE, and to ID-DWR for internal review.
10	Task 1.	Final report, Twin Falls-Banbury and Cassia Mountains area submitted to DOE.

Cooperative Agreement No. DE-FC07-87ID__

APPENDIX A

STATEMENT OF WORK

The Idaho Department of Water Resources (ID-DWR), with its subconsultants and subcontractors, will conduct geothermal resource evaluations at three resource areas in southern Idaho. The activities will differ somewhat for each of the three areas, reflecting the different levels of understanding and development of the three geothermal systems. Specific activities include: the inventory of existing wells and springs (Cassia Mountains and Wood River areas); completion of temperature profiles and water level monitoring of wells; quantitative reservoir evaluation of the Boise aquifer; geochemical studies of fluids and rocks at Wood River; and interpretation and reporting. All tasks will be completed within a 24 month period.

Technical Tasks

The following tasks will be accomplished under this cooperative agreement.

1.0 Twin Falls County Geothermal Systems

Conduct a technical evaluation of geothermal resources in the Banbury-Twin Falls area and in the Paleozoic units of the Cassia Mountains to determine the relationship, if any, between these resources.

1.1 Inventory existing thermal wells and springs associated with the Cassia Mountains. Establish a monitoring network for monthly water level and temperature measurements.

1.2 Complete temperature profiles in existing wells in both systems and determine geothermal gradients.

1.3 Complete mesurements of water levels in both systems and determine direction of flow.

1.4 Sample thermal fluids for background, C14, C13 and isotopes in both systems.

1.5 Extend existing geologic mapping to determine if there is a southern extension of the Buhl-Berger Structure Zone as defined by Street and DeTar (1987).

1.6 Sample rocks for whole rock and trace element analyses to determine chemistry of reservoir rock.

1.7 Continue temperature and water level monitoring of existing network of the Twin Falls-Banbury area. Resample selected wells to determine if fluid chemistry has changed since the water levels have declined.

1.8 Refine discharge calculations of the Twin Falls-Banbury system and compute discharge for the Paleozoic system.

1.9 Complete a final report which describes the results of the study.

2.0 Boise Geothermal Aquifer Study

Continue the data collection and monitoring of the Boise Geothermal Aquifer for an additional 12 months. During and at the conclusion of the data gathering year, submit the data to a qualified reservoir engineer (Consultant) for evaluation, interpretation, recommendations and reporting.

2.1 Continue water level and temperature measurements for the existing network of the Boise geothermal system and for any new thermal wells. Refine discharge

calculations for the system. This task will be completed by a subcontractor yet to be determined.

2.2 Complete a detailed review and quantitative evaluation of existing and new reservoir data. Define the interrelationship between the various wells and the effects of present and continued development. Submit recommendations for an aquifer test if this seems necessary, and recommendations for management of the resource. This task will be completed by a qualified reservoir engineer (Consultant) who will be approved by DOE/ID.

2.3 Provide management for subcontractor and consultant efforts to provide project direction and to insure the quality of results and adherence to work and reporting schedules. Coordinate studies with the USGS research and City of Boise studies.

3.0 Geochemistry of Wood River Geothermal Systems

Extend previous studies of the thermal systems of the Wood River area and complete a comprehensive geochemical study of thermal fluids and reservoir rocks. Document and evaluate the implications of the fluoride content of the thermal fluids.

3.1 Inventory the wells in the study area to determine the number of thermal wells.

3.2 Sample the seven thermal springs for major and trace elements, including C14 and C13. Sample selected cold springs for major and trace elements.

3.3 Complete whole rock analyses of suspected reservoir rocks for major and trace elements.

3.4 Complete temperature logs for existing wells and determine geothermal gradients.

3.5 Complete final report which describes the studies, data and results.

~~State of Idaho~~

Grant Form; Delete

Department of Water Resources
Grant No. DE-FG07-87ID_____

STATEMENT OF WORK

1.0 Introduction

The goal of this grant is to support cost-shared resource assessment on three geothermal resources in the state of Idaho. The thermal aquifer associated with Palezoic rocks and adjacent

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720 -(208) 327-7900

CECIL D. ANDRUS
GOVERNOR
R. KEITH HIGGINSON
DIRECTOR

October 19, 1990

Mr. Howard Ross
University of Utah Research Institute
Earth Science Laboratory
391 Chipeta Way, Suite C
Salt Lake City, UT 84108-1295

Dear Howard:

Enclosed are two copies each of the final reports for work done under DOE Cooperative Agreement DE-FG07-88ID12748:

Geothermal Resource Analysis in Twin Falls County, Idaho, Part 2

Geothermal Resource Analysis in the Big Wood River Valley, Blaine County, Idaho

With this distribution, the IDWR considers the above agreement to be honored and close-out of the grant has been requested.

On a more personal note, I want to express my appreciation for your timely and appropriate reviews of drafts, excellent suggestions and unfailing willingness to help whenever possible. In my opinion, DOE got a very good reviewer when they got you! I can't say it was an unmitigated pleasure to have to deal with completing a contract initiated by someone else, particularly when we would have structured some aspects of the study quite differently, but you were certainly a very bright spot in the process. Steve Baker and I both look forward to a long, continuing relationship with you. Thanks very much for your help.

Sincerely,

Paul

Paul M. Castelin, Manager
Ground-Water Monitoring Section

Enclosures

cc: Ken Taylor, DOE-Idaho
Elizabeth Bowhan, DOE-Idaho
Marshall Reed, DOE-Washington, D.C.
Hal Anderson

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720 - (208) 327-7900

CECIL D. ANDRUS
GOVERNOR
R. KEITH HIGGINSON
DIRECTOR

Rec 10/24/90 KHH

October 19, 1990

Ms. Elizabeth M. Bowhan
Chief, Financial Assistance Branch
Contracts Management Division
U.S. Department of Energy
785 DOE Place
Idaho Falls, ID 83402

Re: Completion of work under DOE Grant No. DE-FG07-88ID12748

Dear Ms. Bowhan:

Enclosed as the final deliverables under the above grant are one copy each of the following reports:

Geothermal Resource Analysis in Twin Falls County, Idaho; Part 2

Geothermal Resource Analysis in the Big Wood River Valley, Blaine County, Idaho

With this distribution, the IDWR considers the contract to be honored, and that close-out of the grant should be initiated. Please let me know what other steps may need to be taken. You may reach me at (208) 327-7894.

Sincerely,

Paul M. Castelin

Paul M. Castelin, Manager
Ground-Water Monitoring Section

Enclosures

cc: Howard Ross, UURI, (2 report copies each)
Ken Taylor, DOE-Idaho, (3 report copies each)

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720 -(208) 327-7900

CECIL D. ANDRUS
GOVERNOR
R. KEITH HIGGINSON
DIRECTOR

rec 10/24/90 HPR

October 19, 1990

Mr. Marshall Reed
U.S. Department of Energy
Forrestal Bldg., CE-342
1000 Independence Avenue, SW
Washington, DC 20585

Re: DE-FC07-88ID12748, Completion of Work

Dear Mr. Reed:

Enclosed for your use is a copy of each of two final reports of work done under the above contract:

Geothermal Resource Analysis in Twin Falls County, Idaho, Part 2
Geothermal Resource Analysis in the Big Wood River Valley, Blaine County, Idaho

These two reports represent the final deliverables under the above contract, and close-out of the grant has been requested to be initiated.

Sincerely,

Paul M. Castelin

Paul M. Castelin, Manager
Ground-Water Monitoring Section

Enclosures

cc: Ken Taylor, DOE-Idaho
Elizabeth Bowhan, DOE-Idaho
Howard Ross, UURI

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720 -(208) 327-7900

CECIL D. ANDRUS
GOVERNOR
R. KEITH HIGGINSON
DIRECTOR

June 11, 1990

Ms. Elizabeth M. Bowhan
Chief, Financial Assistance Branch
Contracts Management Division
U.S. Department of Energy
785 DOE Place
Idaho Falls, ID 83402

Re: DOE Grant No. DE-FG07-88ID12748

Dear Ms. Bowhan:

Departure of the original principal investigator in the above project, coupled with the inability to access some data which may have been collected by her, has caused continuing delays. These delays may require data to be reacquired, causing further delays in project completion. To avoid any chance of delay beyond the current project completion date of June 30, 1990, we have granted ourselves, the Idaho Department of Water Resources, a four-month no-cost time extension, thereby changing the budget period and project period termination dates from June 30, 1990, to October 30, 1990. This change in the final budget period of the project is provided for in 10 CFR Part 600, Section 600.31(d) as amended by FR Doc. 89-24243, filed October 12, 1989. No additional federal funds are requested.

In addition, I request that funds amounting to $4,040.97 currently remaining in Task 2 be transferred to Task 4, because charges which should have been made against Task 2 were not made, and this adjustment is seen as necessary to help bring the allocated amounts back into balance. This transfer, making the Task 2 budget now $43,331.03 and the Task 4 budget $19,449.97, involves less than 5 percent of the total project budget, and appears to be provided for in Special Terms and Conditions for Research Grants, items 2 and 7. Once again, no additional federal funds are requested by this action. I will assume that the required changes will be made unless I hear from you otherwise.

Finally, enclosed are the invoices for the period May 1-May 31, 1990.

Sincerely,

Paul M. Castelin

Paul M. Castelin
Principal Investigator

Enclosures

cc: Howard Ross, UURI
Kenneth J. Taylor, DOE-Idaho

State of Idaho
DEPARTMENT OF WATER RESOURCES
Southern Region, 2148 4th Ave. East, Twin Falls, Idaho 83301 (208) 734-3578

CECIL D. ANDRUS
Governor

R. KEITH HIGGINSON
Director

Rec 9/7/89
ltr receipt

September 1, 1989

Howard Ross
University of Utah Research Institute
Earth Science Laboratory
391 Chipeta Way, Suite C
Salt Lake City, Utah 84108-1295

RE: DE-FC07-88ID12748

Dear Howard

I have accepted a position with EG&G, Idaho Falls and will no longer be working for the Idaho Department of Water Resources as of September 15, 1989. Paul Castelin, a Senior Hydrogeologist with the Department, has been assigned the Principal Invesigator of this contract. His phone number and address are as follows: 208-327-7894, 1301 N. Orchard, Boise, Idaho 83720.

The contract also needs to be modified to delete the sampling for C14 in the thermal waters in both study areas. After discussing the suitability of this technique with several researchers at the U.S. Geological Survey, it was decided that the results would be unreliable. The money not used for this sampling technique will be used for additionel cold spring analysees. This information will futher define the age of the waters in relation to the thermal waters.

I have enjoyed our past working relationship and hope to work together again on another project.

Sincerely,

Leah

Leah V. Street
Hydrogeologist

DOE F 4600.1
(7-81)

U.S. DEPARTMENT OF ENERGY
NOTICE OF FINANCIAL ASSISTANCE AWARD
(See Instructions on Reverse)

RECEIVED
MAR 22 1988

Under the authority of Public Law PL 93-410 and
subject to legislation, regulations and policies applicable to *(cite legislative program title)*: Department of Water Resources
Geothermal Energy Research, Development, and Demonstration Act of 1974

1. PROJECT TITLE
Geothermal Resources Analyses in Idaho

2. INSTRUMENT TYPE
☐ GRANT ☒ COOPERATIVE AGREEMENT

3. RECIPIENT *(Name, address, zip code, area code and telephone no.)*
State of Idaho. Dept. of Water Resources
Energy Resources Bureau
Statehouse, Boise, ID 83720

4. INSTRUMENT NO.
DE-FC07-88ID12748

5. AMENDMENT NO.

6. BUDGET PERIOD
FROM: 3/21/88 THRU: 3/21/89

7. PROJECT PERIOD
FROM: 3/21/88 THRU: 3/21/90

8. RECIPIENT PROJECT DIRECTOR *(Name and telephone No.)*
Leah V. Street (208) 734-3578

9. RECIPIENT BUSINESS OFFICER *(Name and telephone No.)*
Robert W. Hoppie (208) 334-7968

10. TYPE OF AWARD
☒ NEW ☐ CONTINUATION ☐ RENEWAL
☐ REVISION ☐ SUPPLEMENT

11. DOE PROJECT OFFICER *(Name, address, zip code, telephone No.)*
Susan M. Prestwich (208) 526-1147
U. S. DOE, Idaho Operations Office
785 DOE Place, Idaho Falls, ID 83402

12. ADMINISTERED FOR DOE BY *(Name, address, zip code, telephone No.)*
Trudy A. Thorne (208) 526-9519
U. S. Department of Energy
Idaho Operations Office
785 DOE Place
Idaho Falls, ID 83402

13. RECIPIENT TYPE
☒ STATE GOV'T ☐ INDIAN TRIBAL GOV'T ☐ HOSPITAL ☐ FOR PROFIT ORGANIZATION ☐ INDIVIDUAL
☐ LOCAL GOV'T ☐ INSTITUTION OF HIGHER EDUCATION ☐ OTHER NONPROFIT ORGANIZATION ☐ C ☐ P ☐ SP ☐ OTHER *(Specify)*

14. ACCOUNTING AND APPROPRIATIONS DATA

a. Appropriation Symbol	b. B & R Number	c. FT/AFP/OC	d. CFA Number
89x0224.91	AM1510000	410	

15. EMPLOYER I.D. NUMBER/SSN

16. BUDGET AND FUNDING INFORMATION

a. CURRENT BUDGET PERIOD INFORMATION

(1) DOE Funds Obligated This Action	$ 154,088
(2) DOE Funds Authorized for Carry Over	$ -0-
(3) DOE Funds Previously Obligated in this Budget Period	$ -0-
(4) DOE Share of Total Approved Budget	$ 154,088
(5) Recipient Share of Total Approved Budget	$ 17,079
(6) Total Approved Budget	$ 171,167

b. CUMULATIVE DOE OBLIGATIONS

(1) This Budget Period *[Total of lines a.(1) and a.(3)]*	$ 154,088
(2) Prior Budget Periods	$ -0-
(3) Project Period to Date *[Total of lines b. (1) and b. (2)]*	$ 154,088

17. TOTAL ESTIMATED COST OF PROJECT $ 171,167
(This is the current estimated cost of the project. It is not a promise to award nor an authorization to expend funds in this amount.)

18. AWARD/AGREEMENT TERMS AND CONDITIONS

This award/agreement consists of this form plus the following:

a. Special terms and conditions (if grant) or schedule, general provisions, special provisions (if cooperative agreement)

b. Applicable program regulations *(specify)* _____ *(Date)* _____

c. DOE Assistance Regulations, 10 CFR Part 600, as amended, Subparts A and ☐ B (Grants) or ☒ C (Cooperative Agreements).

d. Application/proposal dated June 17, 1987. ☐ as submitted ☒ with changes as negotiated

19. REMARKS This agreement consists of this NFAA (DOE Form 4600.1); Form EIA-Budget Plan; Schedule Articles; Appendix A - Statement of Work; Form EIA-459A-Federal Assistance Reporting Checklist. DOE Financial Assistance Rules (10 CFR Part 600); OMB Circular A-102; OMB Circular A-87 and Circular A-128 "Audits of State and Local Government" are hereby incorporated by reference.

20. EVIDENCE OF RECIPIENT ACCEPTANCE
Wayne T. Haas 3/25/88
(Signature of Authorized Recipient Official) *(Date)*
Wayne T. Haas, Administrator
(Name)
Resource Analysis Division
(Title)

21. AWARDED BY
J. P. Anderson 3-21-88
(Signature) *(Date)*
J. P. Anderson, Contracting Officer
(Name)
Chief, R&D Contracts Branch
(Title)

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

FORM EIA 459C
(10 80)

FORM APPROVED
OMB No. 1900-0127

1. Program/Project Identification No.	2. Program/Project Title
DE-FC07-88ID12748	Geothermal Resource Analyses in Idaho
3. Name and Address: Idaho Department of Water Resources, Statehouse Mail, Boise, Idaho 83720	4. Program/Project Start Date: March 21, 1988
	5. Completion Date: March 21, 1989

SECTION A - BUDGET SUMMARY

Grant Program, Function or Activity (a)	Federal Catalog No. (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non Federal (d)	Federal (e)	Non Federal (f)	Total (g)
1. 12693	81.087	$	$	$	$	$
2. First Year				77,044	8,540	85,584
3. Second Year				77,044	8,539	85,583
4.						
5. TOTALS		$	$	$	$	$ 171,167

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	DOE Share - Grant Program, Function or Activity		Idaho Share		Total (5)
	(1) First Year	(2) Second Year	(3) First Year	(4) Second Year	
a. Personnel	$27,000	$ 27,000	$	$	$54,000
b. Fringe Benefits	6,210	6,210			12,420
c. Travel	1,625	1,625			3,250
d. Equipment					
e. Supplies	1,125	1,125			2,250
f. Contractual	21,750	21,750			43,500
g. Construction					
h. Other Samples * / Printing	5,400 / 1,500	5,400 / 1,500	Computer Time 250	250	10,800* / 3,500
i. Total Direct Charges	64,610	64,610	250	250	129,720
j. Indirect Charges DOE 21% / Idaho 14% / 35%	12,434	12,434	8,290	8,289	41,447
k. TOTALS	$77,044	$77,044	$ 8,540	$8,539	$171,167
7. Program Income	$	$	$	$	$

NOTE: This Cooperative Agreement is for a two-year period at a total estimated DOE cost of $154,088 and total estimated Participant cost of $17,079 for a total of $171,167.

This will be funded as follows:

	DOE	Participant
First Year	$77,044	$8,540
Second Year	$77,044	$8,539

* No indirect charges on samples.

SCHEDULE

ARTICLE I - STATEMENT OF JOINT OBJECTIVE

The purpose of this Cooperative Agreement between the United States Department of Energy (DOE or Government) and the State of Idaho - Department of Water Resources (ID-DWR) (Participant) is to support cost-shared resource assessment on three geothermal resource areas in the state of Idaho. This action is authorized by Federal Law and is in furtherance of the Government's objective to support state oriented geothermal resource assessment, resource development and technical assistance. The Participant will receive the benefit of these geothermal research activities and DOE will obtain data on three southern Idaho geothermal resource systems.

ARTICLE II - THE PROJECT MANAGEMENT PLAN

A. The Participant's Responsibilities. The Participant shall furnish the materials, facilities, equipment, personnel, services, and all other necessary and related items for research directed toward acquiring and interpreting new data for three geothermal systems in southern Idaho. Requirements are further set forth in Appendix A to this Agreement which is entitled STATEMENT OF WORK and FEDERAL ASSISTANCE REPORTING CHECKLIST which is made a part hereof by this reference. The Participant shall provide the funding and reports as specifically provided for elsewhere in this Agreement and obtain all necessary licenses and permits.

B. DOE's Responsibilities. DOE will provide a specified amount of financial assistance, as set forth in ARTICLE III below 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.

C. The term "technical support" refers to the technical monitoring functions of DOE and its contractor, EG&G. The main activities involved in DOE's technical support function are as described in the following:

Technical Review

(1) Performance of the work under the Agreement shall be subject to the technical review of the Program Officer designated in ARTICLE IX, paragraph D. The term "technical review" is defined to include but not necessarily be limited to:

(i) Provisions of written information to the Participant which assists in the interpretation of technical portions of the work description; and

(ii) Review and, where required by the Agreement, approval of technical reports, drawings, specifications, and technical information to be delivered by the Participant to the Government under this Agreement.

(2) Technical review must be within the scope of work stated in this Agreement.

ARTICLE III - FINANCIAL SUPPORT

A. Estimated Cost. The total estimated cost of performing the work under this Agreement is One Hundred Seventy-One Thousand One Hundred Sixty Seven ($171,167).

B. Cost-Sharing Responsibilities. For performance of work under this Agreement, the total estimated allowable costs in the amount of One Hundred Seventy-One Thousand One Hundred Sixty Seven Dollars ($171,167) will be cost shared as set forth in ARTICLE IV, Estimated Cost and Cost Share. 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 within thirty days.

C. DOE's Financial Support. The total cost to DOE for all the work under this project is One Hundred Fifty-Four Thousand Eighty-Eight Dollars ($154,088), and under no circumstances will DOE's support exceed this amount.

D. Participant's Financial Support. All costs in excess of the One Hundred Fifty-Four Thousand Eighty-Eight Dollars ($154,088) to be provided by DOE will be borne by the Participant.

E. Completion of Project. If actual costs of the project exceed the total estimated costs in A. above, the Participant will pay all costs necessary to complete the project. The estimated cost to the Participant is Seventeen Thousand Seventy Nine Dollars ($17,079).

F. Obligated Funds. The amount of funds hereby obligated to this Agreement by DOE is One Hundred Fifty-Four Thousand Eighty-Eight Dollars ($154,088).

ARTICLE IV - ESTIMATED COST AND COST SHARE

A. DOE Cost Share and Allowable Cost Ceilings

	Year 1	Year 2
Task 1	47,314	37,851
Twin Falls County Geothermal Systems		
Conduct a technical evaluation of geothermal resources in the Banbury-Twin Falls area and in the Paleozoic units of the Cassia Mountains to determine the relationship, if any, between these resources.		
Task 2	26,318	21,054
Boise Geothermal Aquifer Study		
Continue the data collection and monitoring of the Boise Geothermal Aquifer for an additional 12 months. At the conclusion of the data gathering year, submit the data to a qualified reservoir engineer (consultant) for evaluation, interpretation, recommendations and reporting.		
Task 3	3,412	2,730
Geochemistry of Wood River Geothermal Systems		
Extend previous studies of the thermal systems of the Wood River area and complete a comprehensive geochemical study of thermal fluids and reservoir rocks. Document and evaluate the implications of the fluoride content of the thermal fluids.		
Task 4		15,409
DOE Acceptance of Final Report(s)		

B. State of Idaho Cost Share

The State of Idaho - Department of Water Resources will contribute computer time and a percentage of the indirect cost charges.

The cost share breakdown is as follows:

	Year 1	Year 2
DOE	$77,044	$77,044
Idaho	8,540	8,539
TOTAL	$85,584	$85,583

For details refer to Form EIA-459C - Federal Assistance Budget Information Form.

ARTICLE V - PAYMENTS

Payments will be made on progress as allowable costs are incurred, but not in excess of the DOE cost share ceilings as shown in ARTICLE IV, Paragraph A. above, "DOE Allowable Cost Ceilings." Invoices must be broken down by cost element for the participant's cost share and DOE's cost share. The breakdown of each cost element in the invoice shall be in the same cost categories and cost share ratios until DOE ceilings are reached as shown in Section B of the Federal Assistance Budget Information Form (EAI-459C). The invoices submitted should also indicate by task the current amount being invoiced, cumulative cost to date, and the amount remaining for both DOE and Idaho. To be an invoiced cost, a cash or non-cash cost must be allowable under the terms and conditions of the award and meet the applicable cost principle tests of allowability in 10 CFR 600.213.

Payments due for amounts properly invoiced in accordance with the terms and conditions specified elsewhere in the Cooperative Agreement shall be made either by Treasury check(s) payable to the Participant or by electronic funds transfer(s) to a financial institution designated by the Participant. The method of payment shall be determined by the Government at the time of payment in accordance with applicable Department of Treasury requirements.

ARTICLE VI - TERM OF THE AGREEMENT

The work under this Agreement shall be completed within two years after award date or within any extension of time as may be mutually agreed to in writing by the parties.

ARTICLE VII - PROJECT INFORMATION SYSTEM

The Federal assistance recipient shall prepare and submit (postage prepaid) the plans and reports indicated on the Federal Assistance Reporting Checklist (Appendix A) to the addresses and in the number of copies designated on the checklist. Preparation of the specified plans and reports shall be in accordance with DOE Order 1332.2, Uniform Reporting System for Federal Assistance (grants and cooperative agreements). The level of detail the recipient provides in the plans and reports shall be commensurate with the

scope and complexity of the task and shall be as delineated in Block 4 - Reporting Requirements and Block 5 - Special Instructions. The prime recipient shall be responsible for acquiring data from any subcontractors, or subrecipients to ensure that data submitted are compatible with the data elements which prime recipients submit to DOE. Plans and reports submitted in compliance with this provision are in addition to any other reporting requirements of the Federal assistance instrument.

All reports, as described in the preceding paragraph, after delivery to DOE shall be the sole property of DOE. The Participant shall not claim that any report contains any trade secrets or commercial or financial information deemed by the Participant to be privileged or confidential, or that the Participant has any proprietary interest in any report.

ARTICLE VIII - PROPERTY

The Participant will own and maintain title of all items of materials, supplies, and all tangible property purchased or acquired under this Agreement.

ARTICLE IX - RESPONSIBLE PERSONS AND PERSONNEL

A. The Participant agrees to permit any specified DOE personnel or designated DOE Contractor personnel subject to confidentiality requirements to have necessary access to the Participants and/or major subcontractor's facilities, personnel, and records pertaining to the project. Such DOE contractor personnel may be used to assist the Project Manager in carrying out their responsibilities.

B. The Contracting Officer has the responsibility/authority for executing, amending, and terminating award instruments. In addition, the Contracting Officer, or designee, has the responsibility for: conducting negotiations concerning the statement of work, costs, and schedule; administration of the agreement; arranging for audits, as appropriate, and resolving audit findings; assuring policies and procedures are implemented; approving payments; and taking actions required to close-out the agreement.

C. The Project Manager is DOE's technical representative for the Agreement and has the following responsibilities: monitors and assesses the status of progress toward achieving the program milestones and objectives; reviews and evaluates all technical reports prepared by the Participant; represents DOE at program review meetings; reviews cost vouchers; and coordinates with the Participant in choosing among alternatives for future program activities. The Project Manager will be assisted by designated DOE Contractor personnel in carrying out these responsibilities.

D. The Project Manager for DOE under this Agreement, and the person who shall be the Participant's contact for all technical matters pertaining to

this Agreement shall be the person named below or such other person as may be designated in writing by the Contracting Officer:

Susan M. Prestwich

E. The representative for the Participant for the purposes of this Agreement shall be the person named below or such other person as may be designated in writing by the Participant:

Leah V. Street

ARTICLE X - PUBLIC INFORMATION RELEASES

The parties agree that public disclosure or dissemination of new data or information arising out of the design, construction or operation of the project will be coordinated by the parties, it being understood that the intent of both the Participant and DOE is to release all data and information to the greatest practicable extent in order to achieve the objective of obtaining maximum public value from the results of this project. It is understood that the foregoing is not intended to afford either party the right to prevent a public release by the other; however, nothing in this article shall impair the rights of the parties set forth elsewhere in this Agreement, including but not necessarily limited to General Provisions 20 entitled "Patent Rights - Short Form."

The Participant shall provide DOE one copy of any news releases, information folders, brochures, advertisements, technical papers, and magazine or newspaper articles pertaining to work performed under this Agreement. The Participant shall advise the Contracting Officer in a timely manner of significant news media or public reactions to work performed under the Agreement.

ARTICLE XI - ADDITIONAL AGREEMENT PROVISIONS

The below listed Appendix, attached hereto, is made a part hereof and sets forth additional provisions of this agreement:

APPENDIX A: STATEMENT OF WORK and FEDERAL ASSISTANCE REPORTING CHECKLIST

wp/Thorne

APPENDIX A

STATEMENT OF WORK

1.0 Introduction

The goal of the Cooperative Agreement is to support cost-shared resource assessment on three geothermal resources in the state of Idaho. The thermal aquifer associated with Paleozoic rocks and adjacent to the Twin Falls aquifer has not been studied in detail and its relationship to the developed Twin Falls aquifer is not understood. Increased development of the Boise aquifer could have a substantial impact on reservoir performance characteristics. Production and observation wells must be monitored for a longer period of time, and the data submitted to quantitative evaluation, to provide a basis for prudent management of the geothermal resource. Thermal waters in the Wood River area may be high in fluoride content. The extent of the thermal waters and the geochemistry of the fluids and possible reservoir rocks should be determined to guide future development and utilization of the resource. This resource assessment Cooperative Agreement will extend previous studies by the Principal Investigator and others, and will address specific problems and areas of interest discovered in earlier studies.

2.0 Scope

The technical objectives of the Cooperative Agreement are to acquire and interpret new data for three geothermal systems in southern Idaho. The activities will differ somewhat for each of the three areas, as described in Section 4.0-Technical Tasks, reflecting the different level of understanding and development of the three geothermal systems. Specific activities include: the inventory of existing wells and springs (Cassia Mountains and Wood River areas); completion of temperature profiles and water level monitoring of wells; quantitative reservoir evaluation of the Boise aquifer; geochemical studies of fluids and rocks at Wood River; and interpretation and reporting. All tasks will be completed within a 24 month period.

3.0 Applicable Documents

The reservoir assessment activities described herein are abstracted from a proposal titled "Geothermal Resource Analyses in Idaho - Boise, Twin Falls and the Wood River Valley, Idaho," dated June 17, 1987, and submitted by the State of Idaho - Department of Water 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-PR07-87ID12662.

4.0 Technical Tasks

The following tasks will be accomplished under this grant.

Task 1. Twin Falls County Geothermal Systems

Conduct a technical evaluation of geothermal resources in the Banbury-Twin Falls area and in the Paleozoic units of the Cassia Mountains to determine the relationship, if any, between these resources.

1.1 Inventory existing thermal wells and springs associated with the Cassia Mountains. Establish a monitoring network for monthly water level and temperature measurements.

1.2 Complete temperature profiles in existing wells in both systems and determine geothermal gradients.

1.3 Complete measurements of water levels in both systems and determine hydraulic gradient.

1.4 Sample thermal fluids for background, C14, C13 and isotopes in both systems.

1.5 Extend existing geologic mapping to determine if there is a southern extension of the Buhl-Berger Structure Zone as defined by Street and DeTar (1987).

1.6 Sample rocks for whole rock and trace element analyses to determine chemistry of reservoir rock.

1.7 Continue temperature and water level monitoring of existing network of the Twin Falls-Banbury area. Resample selected wells to determine if fluid chemistry has changed since the water levels have declined.

1.8 Refine discharge calculations of the Twin Falls-Banbury system and compute discharge for the Paleozoic system.

1.9 Complete a final report which describes the results of the study.

Task 2. Boise Geothermal Aquifer Study

Continue the data collection and monitoring of the Boise Geothermal Aquifer for an additional 12 months. At the conclusion of the data gathering year, submit the data to a qualified reservoir engineer (consultant) for evaluation, interpretation, recommendations and reporting.

2.1 Continue water level and temperature measurements for the existing network of the Boise geothermal system and for any new thermal wells. Refine discharge calculations for the system. This task will be completed by a subcontractor.

2.2 Complete a detailed review and quantitative evaluation of existing and new reservoir data. Define the interrelationship between the various wells and the effects of present and continued development. Submit recommendations for an aquifer test if this seems necessary. Also estimate the longevity of the resource based on present development and evaluate effects of future development. This task will be completed by a qualified reservoir engineer (consultant) who will be approved by DOE/ID.

2.3 *Provide management for subcontractor and consultant efforts to* provide project direction and to insure the quality of results and adherence to work and reporting schedules.

Task 3. Geochemistry of Wood River Geothermal Systems

Extend previous studies of the thermal systems of the Wood River area and complete a comprehensive geochemical study of thermal fluids and reservoir rocks. Document and evaluate the implications of the fluoride content of the thermal fluids.

3.1 Inventory the wells in the study area to determine the number of thermal wells.

3.2 Sample the seven thermal springs for major and trace elements, including C14 and C13. Sample selected cold springs for major and trace elements.

3.3 Sample suspected reservoir rocks and have analyzed for major and trace elements.

3.4 Complete temperature logs for existing wells and determine geothermal gradients.

3.5 Complete final report which describes the studies, data and results.

Task 4. Final Report(s)

A detailed final technical report will be prepared which will include all new data and describe all data tables, temperature data, maps, methods of research, and data reduction. A final technical report may be submitted separately for each task, or the reports for all tasks may be submitted in a single volume.

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 include all new data and describe all data tables, temperature data, maps, methods of research, and data reduction. A final technical report may be submitted separately for each task, or the reports for all tasks may be submitted in a single volume. A draft final report will be submitted to DOE 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 Idaho-Department of Water Resources will provide hydrologic instrumentation, vehicles, air photos, computer time and the State Well Inventory to this project as an in-kind contribution.

wp/Thorne

REPORT DISTRIBUTION LIST

Contract No. DE-FG07-88ID12748

Report/Plan	Form No.	Frequency	No. of Copies	Address
Federal Assistance Management Summary Report	EIA-459E	Q	1,1,1,1,1	a,b,c,d,e
Notice of Energy RD&D	DOE 538	O	1,1	a,f
Technical Progress Report	EIA-459F	Q	1,1,1,1	a,b,d,e
Topical Report	N/A	A	1,4,1,1	a,b,d,e
Final Technical Report	N/A	F	1,4,1,1	a,b,d,e
Final Financial Report	SF-269	F	1,1	a,c

LIST OF ADDRESSEES

a. U.S. Department of Energy
785 DOE Place
Idaho Falls, ID 83402
Attn: Trudy A. Thorne

b. Same as above
Attn: Susan M. Prestwich

c. Same as above
Attn: Earl Jones

d. U.S. Department of Energy
Forrestal Bldg., CE-342
1000 Independence Ave, SW
Washington, DC 20585
Attn: Lew Pratsch

e. University of Utah Research Institute
Earth Science Laboratory
391 Chipeta Way, Suite C
Salt Lake City, UT 84108-1295
Attn: Howard Ross

f. U.S. Department of Energy
Technical Information Center
P.O. Box 62
Oak Ridge, TN 37830

Cooperative Agreement No.
DE-FC07-88ID12748

U.S. DEPARTMENT OF ENERGY

FEDERAL ASSISTANCE REPORTING CHECKLIST

FORM EIA-459A
(10-90)

FORM APPROVED
OMB NO 1900-0127

1. Identification Number: DE-FG07-88ID12748	2. Program/Project Title: Geothermal Resources Analyses in Idaho

3. Recipient: State of Idaho, Department of Water Resources

4. Reporting Requirements:	Frequency	No. of Copies	Addressees
PROGRAM/PROJECT MANAGEMENT REPORTING			
☐ Federal Assistance Milestone Plan			
☐ Federal Assistance Budget Information Form			
☒ Federal Assistance Management Summary Report	Q	1,1,1,1,1	a,b,c,d,e
☐ Federal Assistance Program/Project Status Report			
☒ Financial Status Report, OMB Form 269	F	1,1	a,c
TECHNICAL INFORMATION REPORTING			
☒ Notice of Energy RD&D	O	1,1	a,f
☒ Technical Progress Report	Q	1,1,1,1	a,b,d,e
☒ Topical Report	A	1,4*,1,1	a,b*,d,e
☒ Final Technical Report	F	1,4*,1,1	a,b*,d,e

FREQUENCY CODES AND DUE DATES:

A - As Necessary; within 5 calendar days after events.
F - Final; 90 calendar days after the performance of the effort ends.
O - 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.

5. Special Instructions:
*3 copies plus a camera-ready copy

6. Prepared by: (Signature and Date)	7. Reviewed by: (Signature and Date)
Susan M. Prestwich 3/3/88	Judy A. Thorne 3/3/88

DEPARTMENT OF ENERGY SUPPORT

IDAHO GEOTHERMAL STUDIES

The United States government has had a substantial, long term commitment to the delineation, development, understanding, and protection of geothermal resources in the State of Idaho. Funding through the initial phase of the Department of Energy State Cooperative Reservoir Assessment Program (SCP) from 1977 to 1981 resulted in a statewide geothermal resource inventory, and the publication of a 1:500,000 scale map, "Geothermal Resources of Idaho", in 1980. This map has been widely used and has been out-of-print since 1985.

More recent funding from the Department of Energy was directed toward generic studies and detailed resource areas. A recently completed grant (DE-FG07-84ID12549) to the Department of Water Resources provided $158,579 for studies from grant inception, August 17, 1984, to its conclusion in May 1989. There were three principal tasks in this study.

One task provided for an ongoing monitoring program of temperature, pressure, and flow rate for wells in the Twin Falls-Banbury area, a chemical analyses of the fluids, and interpretaion of these data. Another task provided for an in-depth hydrogeological study of geothermal resources in Twin Falls County by both the Idaho-Department of Water Resources and the U. S. Geological Survey. A third task funded monitoring of wells of the Boise geothermal system and an evaluation of these data by a subcontractor, Boise State University. The results of these studies were documented in final technical reports.

Additional work funded by this grant resulted in a preliminary evaluation of the Artesian City geothermal recource, and a well-publicized study of high fluorine content in well waters of the Ketchum area. The latter study called attention to possible health problems which might result from misuse of these fluids.

A Cooperative Agreement (No. DOE-FC07-88ID12748) now active with the Idaho-Department of Water Resources provides for funding in the amount $154,088 for in-depth technical studies of three geothermal resource areas. A continuing study of Twin Falls County geothermal systems will include continued monitoring of wells in the Twin Falls and Banbury resources, and geologic and fluid chemistry studies of the known resource areas and the Cassia Mountains, a possible recharge area for these resources.

A second task extends earlier studies of thermal systems of the Wood River area, documents the fluid chemistry, and evaluates the implications of high fluorine content of the thermal fluids. A third task provides for additional monitoring of the Boise geothermal system and a detailed data review and quantitative evaluation of all available reservoir data. The goal of this task is to provide a numerical model which will estimate the

effects of present and continued development on the resource parameters and longevity. This work is being carried out by Berkeley Group, Inc., a highly qualified outside consultant. Plans and DOE funding for an important production test of the Boise geothermal reservoir, planned for August-September 1988, were withdrawn because of the threat of litigation by Boise geothermal water users.

In summary, these grants represent a strong commitment by the Department of Energy to the beneficaial utilization of Idaho's low-to-moderate temperature resources, and to a basic understanding of resource parameters essential to the protection of these resources.

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M E M O R A N D U M

TO: Ken Taylor

FROM: Howard Ross

DATE: June 21, 1988

SUBJECT: Possible modification to Idaho-Department of Water Resources Cooperative Agreement DE-FC-07-88ID12748

The subject Cooperative Agreement with Idaho-DWR was signed by DOE-ID on March 21, 1988. Because of this and delays in the Idaho-DWR procurement process the RFP for a consultant reservoir engineer to perform Subtask 2.2 has just been issued. Leah Street, Principal Investigator, has indicated that it is unlikely that the consultant will have time to review the data base and provide significant recommendations as input for the DOE funded reservoir test by EG&G tentatively scheduled for August. Accordingly she has deleted the requirement for the consultant to provide these recommendations in her RFP, with my concurrence.

I feel that the wording of Subtask 2.2 is sufficiently broad that the consultant does not have to submit recommendations for an aquifer test, and would have to complete an interpretation of the new test data, without modification of the CA Subtask 2.2. Leah may wish to word her own SOW somewhat differently, however.

If you feel it is necessary to modify the Idaho-DWR statement of work, I suggest the following modifications.

Subtask 2.2 Delete "Submit recommendations for an aquifer test if this seems necessary" and replace it with "Contribute to design of the scheduled Boise aquifer test and/or comment on test parameters. Interpret the aquifer test results and integrate this interpretation into the quantitative reservoir evaluation."

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M E M O R A N D U M

TO: Ben Lunis

FROM: Howard Ross

SUBJECT: S O W for Boise Geothermal Study Task, Idaho - Department of Water Resources

DATE: March 9, 1988

The Statement of Work (SOW) for the Idaho-Department of Water Resources Co-Operative Agreement, Boise Geothermal Aquifer Study is reproduced below. Some minor modifications to this SOW may be made before the agreement is signed.

4.2 Boise Geothermal Aquifer Study

Continue the data collection and monitoring of the Boise Geothermal Aquifer for an additional 12 months. During and at the conclusion of the data gathering year, submit the data to a qualified reservoir engineer (Consultant) for evaluation, interpretation, recommendations and reporting.

4.2.1 Continue water level and temperature measurements for the existing network of the Boise geothermal system and for any new thermal wells. Refine discharge calculations for the system. This task will be completed by a subcontractor.

4.2.2 Complete a detailed review and quantitative evaluation of existing and new reservoir data. Define the interrelationship between the various wells and the effects of present and continued development. Submit recommendations for an aquifer test if this seems necessary. Estimate the reservoir longeviety at the present development rate, and the effects of future development. Consider both temperature and productivity declines. This task will be completed by a qualified reservoir engineer (Consultant) who will be approved by DOE/ID.

4.2.3 Provide management for subcontractor and consultant efforts to provide project direction and to insure the quality of results and adherence to work and reporting schedules. Coordinate studies with the USGS research and City of Boise studies.

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M E M O R A N D U M

To: Leah Street

From: Howard Ross

Subject: Comments on Boise Meeting of March 18, 1988

Date: March 22, 1988

Ben Lunis (EG&G,ID) and Richard Berger (DOE/ID) opened the meeting with introductory comments and introductions. Others present included: Bill Young (USGS), Chuck Michaelson (City Engr, Boise), Bob Hoppe and Frank Sherman (Idaho-DWR), and Howard Ross (UURI). Lunis described the general purpose of the meeting, i.e. to discuss DOE concerns about the early drilling of injection wells, and DOE funded activities planned for study of the Boise Geothermal System.

H. Ross said that his main interest in this meeting was to understand the extent of present monitoring activities, to see how they fit into the ID-DWR monitring study, and to clarify what monitoring should be funded by DOE/ID. He noted that he had just learned from Leah Street (ID-DWR Principal Investigator, who was unable to attend the meeting) that Dr. Waag was already funded to continue a monitoring program, presumably the same six wells as before, for a period of about one year. Further he understood that Bill Young would be monitoring one well in conjuction with his other studies for about six months. Ross indicated that he would like to identify the best use of monitoring funds presently planned for ID-DWR.

Bill Young described the studies he would be doing as a result of his contract with DOE through Marshall Reed. He will continue monitoring one well (BLM well) for about six months. His inventory of wells includes 37 wells (as compared to 22 in the Waag report). He has sampled 14 to date. His study will include a broad range of chemical and isotope studies, as well as notes on well location, condition, water level, etc. He expects a data report to be available by August 1988. He will revisit five wells in the non stress period. He measures temperature, pH at well head temperature, conductance, alkalinity, etc in the field.

In response to questions, Bill said that he really had minimal funding for his study, has been bootlegging times for some monitoring efforts. He appeared to be receptive to continued monitoring of the BLM well, and possibly other wells, if funds were available (i.e. from ID-DWR). He feels that the six wells (probably) being monitored by Waag were well located for monitoring purposes. The group did not have first hand knowledge of which wells these were, however.

Ross suggested that in view of uncertainities of which wells were being monitored and for how long, that it would be best to wait for an evaluation of this by ID-DWR, and their recomendation as to what the monitoring study should be. As a minimum the USGS monitoring study could be extended, and perhaps enlarged by a few wells if these appeared to be in critical locations. No attempt would be made to change the SOW for the Co-Op agreement at present. ID-DWR indicated that it may be useful to fund Waag for continued monitoring of his present wells beyond the period for which he is presently funded.

There was a general discussion of the City of Boise plans to add customers to the system and the need for an injection well. Ross and Lunis expressed doubts that anyone knows the right place to put an injection well- hence the need for more monitoring, a study by a consultant reservoir engineer, and a step stress test. Lunis noted that Marshall Reed was trying to locate funds ($100K) for such a test this August, possibly to be done by Roy Mink (MK). City of Boise and ID-DWR seemed to appreciate the extent of the DOE commitment to the Boise reservoir study, especially in view of tight DOE funds.

Ross described the study to be undertaken by a "world class" reservoir engineer (Consultant), the need for three dimensional subsurface modeling, an individual with no vested interest in the Boise system, etc. ID-DWR noted that there wasn't much time to complete a procurement for such a consultant, and for the consultant to become familiar with the data base in time to have input for the August pump test. Ross inquired if the procurement process could be initiated immediately with the formal (generic) announcement, then followed up with added information or a preproposal briefing, in order to save some time. ID-DWR indicated that this may be possible. After more discussion it was agreed that ID-DWR would submit a draft SOW for the Consultant after Leah was funded and could begin work on the project.

Chuck Michaelson indicated that they would like to have some input to the Technical Study Group proposed by DOE (through B. Lunis). Lunis indicated that the Technical Study Group would be headed by Leah Street, who would also be a member of the Supervisory Group. Boise's participation would be more appropriate in this group, but there would be lots of opportunity for exchange of ideas. Ross indicated that it would be important for the Consultant to sit in on the Technical Study Group, and to

have access to Bill Young's ideas and interpretations (as well as his data report) on an ongoing basis in order to make the most of the time available before the finalization of a reservoir test. Chuck Michaelson inquired whether all the work discussed would result in the optimum siting of an injection well. The group feeling was that after these studies, and the pump test, the well would be sited on the best available information, and this would be far better than siting an injection well on the basis of present information only. Nonetheless, the could be no guarantee for the results of an injection well even if sited with the more complete information base.

From Ruth
01/20/89

ID DEPT OF WATER RESOURCES

1 WARF-1

ELEMENT		CONCENTRATION
NA	% OX.	3.74
K	% OX.	3.84
CA	% OX.	2.17
MG	% OX.	0.796
FE	% OX.	1.13
AL	% OX.	15.53
SI	% OX.	70.50
TI	% OX.	0.376
P	% OX.	0.144
SR	PPM	515
BA	% OX.	0.167
V	PPM	< 250
CR	PPM	3
MN	% OX.	0.064
CO	PPM	117
NI	PPM	< 5.00
CU	PPM	< 5.00
MO	PPM	< 50.0
PB	PPM	21
ZN	PPM	107
CD	PPM	< 5.00
AG	PPM	< 2.00
AU	PPM	< 4.00
AS	PPM	< 25.0
SB	PPM	< 30.0
BI	PPM	< 100
U	PPM	< 2500
TE	PPM	< 50.0
SN	PPM	< 5.00
W	PPM	< 1200
LI	PPM	25
BE	PPM	1.8
B	PPM	< 400
ZR	PPM	46
LA	PPM	66
CE	PPM	105
TH	PPM	< 150
LOI	%	0.77
FeO	%	1.63
	TOTAL	~~98.453~~ 100.896
F	%	0.043

ID DEPT OF WATER RESOURCES

14 T1V

ELEMENT			CONCENTRATION
NA	% OX.		4.54
K	% OX.		3.41
CA	% OX.		3.42
MG	% OX.		2.77
FE	% OX.		1.64
AL	% OX.		15.74
SI	% OX.		64.30
TI	% OX.		0.541
P	% OX.		0.187
SR	PPM		688
BA	% OX.		0.167
V	PPM	<	250
CR	PPM		70
MN	% OX.		0.073
CO	PPM		36
NI	PPM		41
CU	PPM		10
MO	PPM	<	50.0
PB	PPM		28
ZN	PPM		78
CD	PPM	<	5.00
AG	PPM	<	2.00
AU	PPM	<	4.00
AS	PPM	<	25.0
SB	PPM	<	30.0
BI	PPM	<	100
U	PPM	<	2500
TE	PPM	<	50.0
SN	PPM	<	5.00
W	PPM	<	1200
LI	PPM		18
BE	PPM		2.1
B	PPM	<	400
ZR	PPM		114
LA	PPM		53
CE	PPM		81
TH	PPM	<	150
LOI	%		0.99
FeO	%		2.67
	TOTAL		~~96.792~~ 100.481
F	%		0.029

ID DEPT OF WATER RESOURCES

15 WARF-2

ELEMENT			CONCENTRATION
NA	% OX.		0.084
K	% OX.		0.479
CA	% OX.		40.44
MG	% OX.		3.05
FE	% OX.		0.234
AL	% OX.		3.22
SI	% OX.		51.70
TI	% OX.		0.206
P	% OX.		0.083
SR	PPM		254
BA	% OX.		0.033
V	PPM	<	250
CR	PPM		38
MN	% OX.		0.049
CO	PPM		29
NI	PPM		22
CU	PPM		17
MO	PPM	<	50.0
PB	PPM		25
ZN	PPM		88
CD	PPM	<	5.00
AG	PPM	<	2.00
AU	PPM	<	4.00
AS	PPM	<	25.0
SB	PPM	<	30.0
BI	PPM	<	100
U	PPM	<	2500
TE	PPM	<	50.0
SN	PPM	<	5.00
W	PPM	<	1200
LI	PPM		8
BE	PPM		0.8
B	PPM	<	400
ZR	PPM		179
LA	PPM	<	5.00
CE	PPM		31
TH	PPM	<	150
LOI	%		1.35
FeO	%		0.73
	TOTAL		~~99.572~~ 101.672
F	%		0.020

ID DEPT OF WATER RESOURCES

16 TCV

ELEMENT			CONCENTRATION
NA	% OX.		4.42
K	% OX.		3.26
CA	% OX.		3.91
MG	% OX.		2.31
FE	% OX.		1.98
AL	% OX.		16.56
SI	% OX.		63.40
TI	% OX.		0.644
P	% OX.		0.201
SR	PPM		627
BA	% OX.		0.173
V	PPM	<	250
CR	PPM		28
MN	% OX.		0.075
CO	PPM		46
NI	PPM		19
CU	PPM		17
MO	PPM	<	50.0
PB	PPM		19
ZN	PPM		76
CD	PPM	<	5.00
AG	PPM	<	2.00
AU	PPM	<	4.00
AS	PPM	<	25.0
SB	PPM	<	30.0
BI	PPM	<	100
U	PPM	<	2500
TE	PPM	<	50.0
SN	PPM	<	5.00
W	PPM	<	1200
LI	PPM		20
BE	PPM		1.9
B	PPM	<	400
ZR	PPM		326
LA	PPM		54
CE	PPM		81
TH	PPM	<	150
LOI	%		1.09
FeO	%		2.70
	TOTAL		~~96.941~~ 100.782
F	%		0.051

ID DEPT OF WATER RESOURCES

17 WRC

ELEMENT			CONCENTRATION
NA	% OX.		0.044
K	% OX.		2.99
CA	% OX.		1.74
MG	% OX.		0.546
FE	% OX.		1.99
AL	% OX.		9.08
SI	% OX.		79.40
TI	% OX.		0.575
P	% OX.		0.173
SR	PPM		13
BA	% OX.		0.288
V	PPM	<	250
CR	PPM		63
MN	% OX.		0.010
CO	PPM		38
NI	PPM		16
CU	PPM		8
MO	PPM	<	50.0
PB	PPM	<	10.0
ZN	PPM		35
CD	PPM	<	5.00
AG	PPM	<	2.00
AU	PPM	<	4.00
AS	PPM	<	25.0
SB	PPM	<	30.0
BI	PPM	<	100
U	PPM	<	2500
TE	PPM	<	50.0
SN	PPM	<	5.00
W	PPM	<	1200
LI	PPM		17
BE	PPM		1.7
B	PPM	<	400
ZR	PPM		150
LA	PPM		30
CE	PPM		49
TH	PPM	<	150
LOI	%		2.90
FeO	%		0.58
	TOTAL		~~96.834~~ 100.346
F	%		0.032

ID DEPT OF WATER RESOURCES

18 T1V (repeat)

ELEMENT			CONCENTRATION
NA	% OX.		4.50
K	% OX.		3.38
CA	% OX.		3.37
MG	% OX.		2.74
FE	% OX.		1.60
AL	% OX.		15.62
SI	% OX.		64.30
TI	% OX.		0.533
P	% OX.		0.188
SR	PPM		681
BA	% OX.		0.165
V	PPM	<	250
CR	PPM		68
MN	% OX.		0.073
CO	PPM		37
NI	PPM		41
CU	PPM		10
MO	PPM	<	50.0
PB	PPM		29
ZN	PPM		76
CD	PPM	<	5.00
AG	PPM	<	2.00
AU	PPM	<	4.00
AS	PPM	<	25.0
SB	PPM	<	30.0
BI	PPM	<	100
U	PPM	<	2500
TE	PPM	<	50.0
SN	PPM	<	5.00
W	PPM	<	1200
LI	PPM		18
BE	PPM		2.1
B	PPM	<	400
ZR	PPM		99
LA	PPM		54
CE	PPM		83
TH	PPM	<	150
	TOTAL		96.464