

**BASIC STRATEGY FOR**  
**GG/UU & ESL/UURI**

- **Establish center of excellence  
in the Geosciences in order  
to support DOE/Geothermal  
Programs.**



# **INDUSTRY COUPLED PROGRAM**

**Phase 1 (Utah) & II (N. Nevada)**

**DOE FUNDS - \$14,000,000**

**DOE & INDUSTRY EXPLORATION - \$32,000,000**

**GEOSCIENCE DATA FOR 14 GEOTHERMAL RESERVOIRS**

**8 INTEGRATED CASE STUDIES**

**20+ TOPICAL STUDIES**

**TECHNIQUE EVALUATIONS 10 METHODS**

**18 NEW EXPLORATION WELLS**

**28 DRILLING HISTORIES**





# STATE COUPLED DIRECT HEAT GEOTHERMAL PROGRAM

- FUNDED BY DGE/DOE
- 14 WESTERN STATES
- CONDUCTED BY STATE AGENCY
  - HELP FROM ESL/UURI, USGS, NOAA
- OBJECTIVES
  - STIMULATE GEOTHERMAL DEVELOPMENT
  - ASSIST USGS IN DATA COMPILATION,  $T > 20^{\circ}\text{C}$



# **PARTICIPANTS**



## **DGE/DOE**

- **FUNDING**
- **BUSINESS MANAGEMENT**

## **STATE AGENCY**

- **OVERALL PROJECT MANAGEMENT**
- **DATA COMPILATION, INTERPRETATION, REPORTING**
- **SITE SPECIFIC RESERVOIR CONFIRMATION**

## **ESL/UURI**

- **ASSIST DGE IN TECHNICAL PROJECT MANAGEMENT**
- **TECHNICAL HELP TO STATES**
- **COORDINATE BETWEEN STATES, USGS, NOAA**

## **USGS**

- **BASE DATA AT 1:500,000**
- **ASSIST GEOSCIENCE DATA INTERPRETATION**
- **DATA TRANSFER TO FILE GEOTHERM**

## **NOAA**

- **PUBLISH STATE GEOTHERMAL RESOURCE MAPS**

## PHASE I

### COMPILATION OF

- GEOTHERMAL DATA,  $T > 20\text{ }^{\circ}\text{C}$
- OTHER RELEVANT GEOSCIENCE DATA (recent volcanism,...)
- BASE DATA (cities, highways,...)

### INTERPRETATION

### PUBLICATION OF MAP AND REPORT

- AIMED AT POTENTIAL USERS

## PHASE II

### INVESTIGATION OF SPECIFIC SITES

(Selected by states, DOE, ESL/UURI, USGS)

### RESERVOIR CONFIRMATION DRILLING



## PUBLIC MAP

- SHADED RELIEF BASE WITH ROADS, TOWNS, RIVERS, COUNTIES, TOWNSHIP-RANGE, ETC.
  - PROHIBITED AREAS - NATIONAL PARKS AND MONUMENTS, ETC.
  - KGRA's
  - GEOTHERMAL DATA:
    - APPROPRIATE SIMPLIFIED GEOLOGY
    - SPRINGS
    - WELLS
    - HIGH T
    - MODERATE T
    - LOW T
- } AREAS AND INTERPRETATIONS  
(QUALITATIVE AND QUANTITATIVE)
- OPERATIONS RESEARCH AND UTILIZATION SQUIBS



# SCIENTIFIC MAP



- TOPOGRAPHIC BASE, USGS DIGITIZED, WITH ROADS, TOWNS, ETC.
  - PROHIBITED AREAS - NATIONAL PARKS AND MONUMENTS, ETC.
  - KRGA's
  - GEOTHERMAL DATA:
    - SPRINGS
    - WELLS
    - HEAT FLOW
    - THERMAL GRADIENTS
    - SPRING DEPOSITS
    - FAULTS/LINEMENTS
    - EARTHQUAKE EPICENTERS
    - WATER QUANTITY AND QUALITY
    - GEOCHEMICAL THERMOMETRY
    - HIGH T
    - MODERATE T
    - LOW T
- } AREAS AND INTERPRETATIONS (INCLUDE BUT DISTINGUISH POTENTIAL AREAS)
- IGNEOUS SYSTEMS
  - VOLCANIC CENTERS AND FLOWS (YOUNG)
  - OTHER SELECTED GEOLOGY AND GEOPHYSICS (OIL WELL DATA, DEPTH TO RESOURCES, ETC.)
  - HEAT CONTENTS
  - AREAS OF PRESENT USE
  - OPERATIONS RESEARCH DATA



## UU/UURI SUPPORT TO RA PROGRAMS

### ☆ PLANNING

- REGIONAL COMMERCIALIZATION PLANS - FY 78
- RA PLANNING WORKSHOP - MC LEAN, VA., FEB. 1979
- SUPPORT TO ID & EG & G ON
  - \* ET REQUIREMENTS DOCUMENT
  - \* DIRECT HEAT INFRASTRUCTURE REQUIREMENTS

### ☆ GENERAL

- SUPPORT TO ID - WEEKLY & MONTHLY HYDROTHERMAL ACTIVITIES REPORT
- SUPPORT TO EG & G - STATE HYDROTHERMAL COMMERCIALIZATION BASELINE DOCS.
- EVALUATION OF GEOTHERMAL POTENTIAL OF USFS RARE II AREAS
- PLANNED EVALUATION OF GEOTHERMAL POTENTIAL OF BLM ROADLESS AREAS
- GEOSCIENCE DATA BASE
- GEOSCIENCE INPUT TO NATIONAL MONITORING PROGRAM

### ☆ USER ASSISTANCE

- PARTNERSHIP WITH EG & G, IDAHO
- SERVICING REQUESTS FROM WESTERN STATES
- OUTREACH



# **ESL's ROLE IN THE BLM WILDERNESS STUDY**

## **☆ PROVIDE INFORMATION ON BLM WILDERNESS INVENTORY PROCESS**

- TO DOE**
- TO STATE COUPLED RESOURCE ASSESSMENT TEAMS**
- TO INDUSTRY**

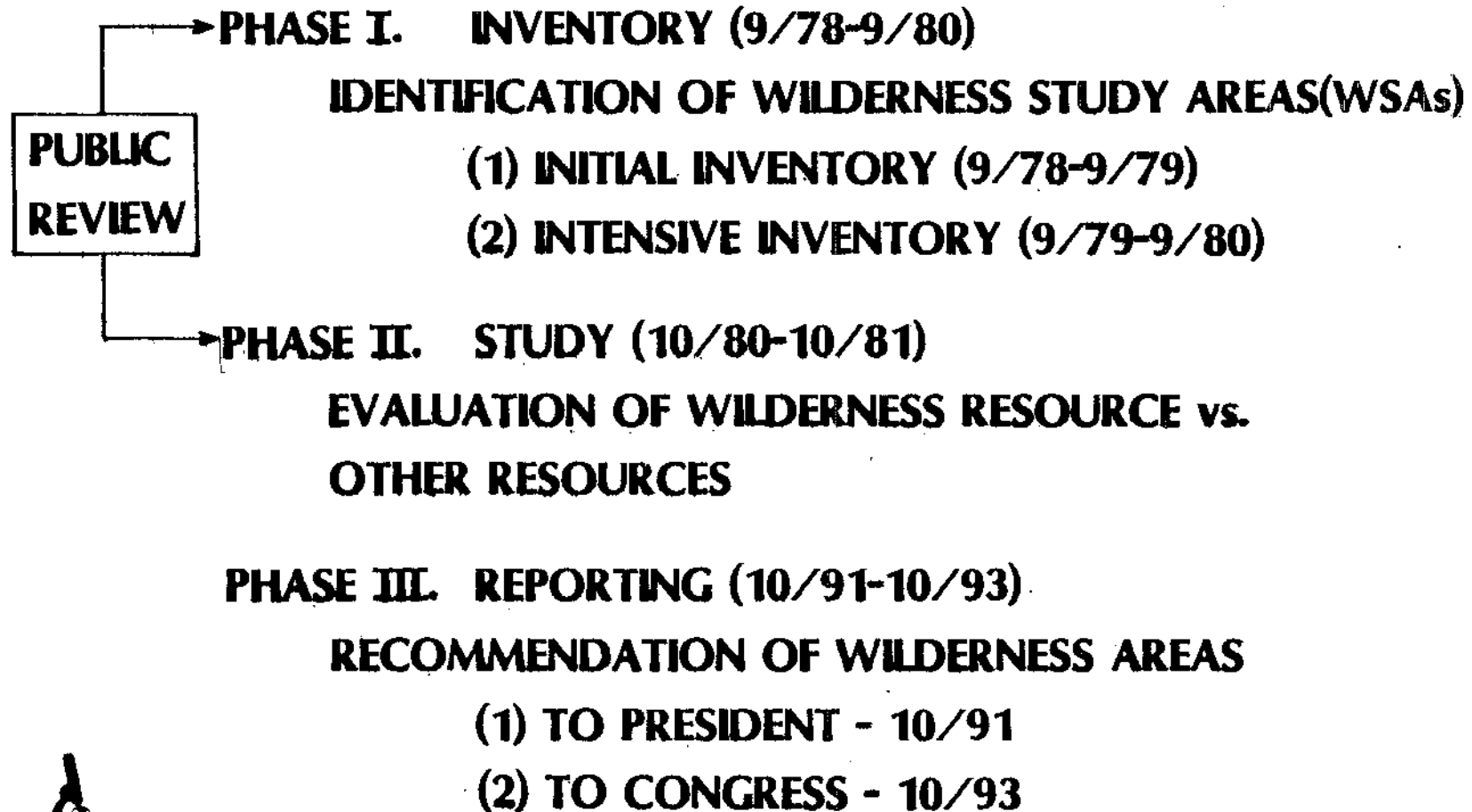
## **☆ IDENTIFICATION OF OVERLAPPING WSA<sub>s</sub> AND POTENTIAL GEOTHERMAL RESOURCE AREAS**

- USING STATE TEAM INPUT**
- USING INDUSTRY INPUT**

## **☆ TRANSFER OF THIS INFORMATION TO BLM AND DOE**



# **BLM WILDERNESS INVENTORY PROCESS**



# ***IMPACT OF BLM WILDERNESS INVENTORY ON GEOTHERMAL EXPLORATION***

☆ ***MANY GEOTHERMAL SYSTEMS ON BLM LANDS***

☆ ***WSA MANAGEMENT - RESTRICTION OF SOME EXPLORATION ACTIVITIES***

- ***NO PERMANENT IMPACTS***

- ***DRILLING PERMITTED ON A CASE-BY-CASE BASIS***

- ***NO POWER PLANT CONSTRUCTION***

☆ ***WSA MANAGEMENT POLICIES EFFECTIVE FROM THE PRESENT TO OCTOBER, 1993***



# USER ASSISTANCE PROGRAM

**Lack of Resource Knowledge Holds Up  
Commercialization**

☆ Location ☆ Temperature

☆ Depth ☆ Productivity ☆ Longevity

**Federal Help Needed**

☆ Resource Assessment-Reservoir Confirmation

☆ User Assistance



## USER ASSISTANCE



**GOAL - PROMOTE COMMERCIAL DIRECT HEAT  
GEOHERMAL DEVELOPMENT**

**JUSTIFICATION - PRIVATE SECTOR DEVELOPMENT  
IS INADEQUATE**

**APPROACH - PUBLIC AWARENESS**

**(State Coupled Program Maps, Outreach)**

- UP TO 100 HOURS GEOSCIENCE PROFESSIONAL  
TIME FOR ASSISTANCE**
  - Kindling, to get things started**
  - On request basis**
  - Teamwork with EG&G, Idaho**
- CONSULTANT, CONTRACTOR FILE**

**STATUS - PROGRAM, RAPIDLY INCREASING IN PACE**

# USER ASSISTANCE

## ACCOMPLISHMENTS - ASSISTANCE PROVIDED

Hill Air Force Base	Space Heating	Ogden, UT
Williams Air Force Base	Air Conditioning	Phoenix, AZ
Half Circle Ranch	General	Beowawe, NV
Lamb Western	Potato Processing	OR, WA
Industrial Engineering Co.	General	San Francisco
Mountain States Resources	General	UT
Forminco	Mineral Benef.	Cove Ft, UT
Dixie - Escalante Electric	General	SW UT
Utah Roses	Space Heating	Salt Lake City



## USER ASSISTANCE

### ACCOMPLISHMENTS - ASSISTANCE PROVIDED

CROWN ZELLERBACH	INDUSTRIAL PROCESSING	CAMAS, WA
SYLVIA GOELTZ	INDUSTRIAL PROCESSING	BERYL, UT
EMMA	DIRECT USES	THERMO H.S., UT
TWO RAVENS CORP	SPACE HEATING CONDOS	LOWMAN, ID
SALMON SCHOOL BOARD	SPACE HEATING	SALMON, ID
CITY of LAVA HOT SPRINGS	SPACE HEATING	LAVA H.S., ID
BARBARA VOLKER, (Realtor)	SPACE HEATING	KETCHUM, ID
SNOW COLLEGE	SPACE HEATING	EPHRAIM, UT
JEFF PLATT	SPACE HEATING	SALT LAKE, UT
FAIRFIELD SCHOOL BOARD	SPACE HEATING	FAIRFIELD, UT
ALAN RAGOZZINE	HEATING, PROCESSING	LA VERKIN, UT
FUGRO, INC	GENERAL	WESTERN UTAH
G.L. SPRUDE CO.	SPACE HEATING	LOWMAN, ID





## USER ASSISTANCE



<b>Peter Janns</b>	<b>Gasahol</b>	<b>Ketchum, Id</b>
<b>Big Horn Barley Growers Assoc.</b>	<b>Gasahol</b>	<b>Powell, Wyo</b>
<b>Thiokol Corp</b>	<b>Industrial heating</b>	<b>Brigham City, Ut</b>
<b>Bill Davis</b>	<b>Potato waste Gasahol</b>	<b>Kimberly, Id</b>
<b>Id Office of Energy</b>	<b>Space heating, school</b>	<b>Malad City, Id</b>
<b>B. Schultz/Investor</b>	<b>?</b>	<b>Diamond Valley, Nv</b>
<b>Bob O'Connor</b>	<b>District space heating</b>	<b>Decker, Mt</b>
<b>Steve Mortensen</b>	<b>Commercial dairy farm</b>	<b>Near Roberts, Id</b>
<b>Harley Kirschenmann</b>	<b>Greenhouse</b>	<b>Upper Snake River, Id</b>

# USER ASSISTANCE

## PUBLIC AWARENESS CAMPAIGN

- MEDIA ADVERTISING -

PROFESSIONAL PR GUIDANCE

- USER REQUESTS FUNNELED TO

UU/UURI

EG&G



# **UU/UURI PROPOSED SUPPORT RESOURCE APPLICATION GEOTHERMAL PROGRAMS**

## **PLANNING AND ANALYSIS**

- **SITE SPECIFIC DEVELOPMENT PLANS -  
GEOSCIENCE INPUT, COORD BETWEEN  
STATE RESOURCE & OR TEAMS**
- **STATE & LOCAL PLANNING SUPPORT -  
GEOSCIENCE INPUT, COORD BETWEEN  
STATE RESOURCE & OR TEAMS**
- **NATIONAL PROGRAM MONITORING -  
EXPLORATION ACTIVITIES**
- **INTERAGENCY COORD & FEDERAL POLICY  
ANALYSIS -  
ROADLESS AREA REVIEWS, OTHER  
GENERAL ITEMS**

## **PRIVATE SECTOR DEVELOPMENT**

- **OUTREACH -  
USER ASSISTANCE ON REQUEST BASIS  
WITH EG&G**



# UU/UURI PROPOSED BUDGET

## RESOURCE APPLICATION GEOTHERMAL PROGRAMS

### PLANNING AND ANALYSIS

**\$ K**

SITE SPECIFIC DEVELOPMENT PLANS	15
STATE & LOCAL PLANNING SUPPORT	15
NATIONAL PROGRAM MONITORING	20
INTERAGENCY COORD.& FEDERAL POLICY ANALYSIS	65

### PRIVATE SECTOR DEVELOPMENT

#### OUTREACH

310

### TOTAL FY 80

**\$ 425K**

### OUTYEARS

FY-81	FY-82
\$550K	\$600K
\$700K	\$1100K

If direct heat reservoir  
confirmation program  
is instituted



## ***DIRECT HEAT RESERVOIR CONFIRMATION***

### **OBJECTIVES**

- ***TO QUICKLY DEMONSTRATE VIABILITY OF THESE RESERVOIRS***
- ***TO DEVELOP INFRASTRUCTURE IN PRIVATE SECTOR***

### **JUSTIFICATION**

- ***DEVELOPMENT LAGS BECAUSE OF:***
  - \*LACK OF RESOURCE KNOWLEDGE: RESERVOIR LIMITS, DEPTH, TEMPERATURE, PRODUCTIVITY, LONGEVITY***
  - \*INABILITY OF SMALL DEVELOPERS TO SPREAD HIGH RISKS & COSTS***

### **GOAL**

- ***TO FOSTER INFRASTRUCTURE CAPABLE OF DEVELOPING 0.1 Q/YR (3350 MWT-YR/YR) BETWEEN 1986 - 2000***

### **COST TO DOE**

- | <b><i>FY80</i></b> | <b><i>FY81</i></b>  | <b><i>FY82</i></b>  | <b><i>FY83</i></b>  | <b><i>FY84</i></b>  | <b><i>FY85</i></b>  | <b><i>FY86</i></b>  | <b><i>TOTAL</i></b>  |
|--------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------------|
| <b><i>\$1M</i></b> | <b><i>\$20M</i></b> | <b><i>\$48M</i></b> | <b><i>\$69M</i></b> | <b><i>\$64M</i></b> | <b><i>\$39M</i></b> | <b><i>\$11M</i></b> | <b><i>\$252M</i></b> |



# DIRECT HEAT RESERVOIR CONFIRMATION

## ASSUMPTION 1

- ★ 1.5 Q DIRECT HEAT UTILIZATION DEVELOPED 1986-2000  
➡ IMPLIES 3350 MWt-YR/YR

<u>UTILIZATION SYSTEM</u>	<u>NUMBER</u>	<u>PERCENT</u>	<u>CONTRIBUTION</u>
100 MWt	4	2	400 MWt
50	15	8	750
25	50	27	1250
10	75	41	750
5	<u>40</u>	<u>22</u>	<u>200</u>
	184	100	3350 MWt

- ★ SUCCESS RATE FOR CONFIRMATION = 25%  
➡ IMPLIES 736 SITES/YR

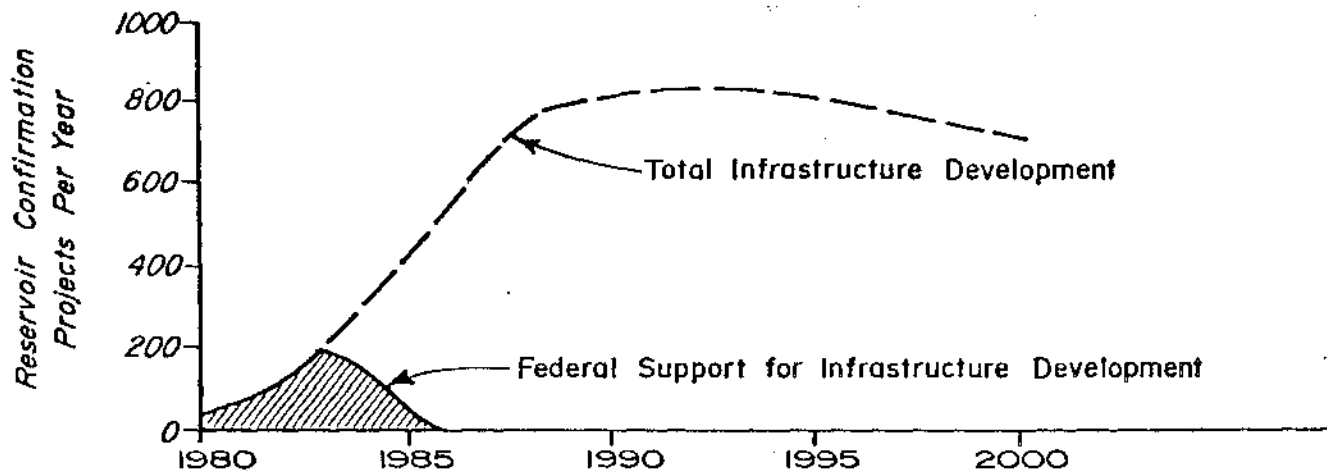




# DIRECT HEAT RESERVOIR CONFIRMATION

## ASSUMPTION 2

- ★ INFRASTRUCTURE NEEDED IS PROPORTIONAL TO NUMBER OF SITES PER YEAR
- ★ DOE SUPPORT REQUIRED TO DEVELOP 25% OF TOTAL INFRASTRUCTURE NEEDED FOR YEAR 2000 GOAL



POSTULATED INFRASTRUCTURE DEVELOPMENT



**IMPLIES SCENARIO FOR DOE PROGRAM**

	<u>FY80</u>	<u>FY81</u>	<u>FY82</u>	<u>FY83</u>	<u>FY84</u>	<u>FY85</u>
<b>NO. SITES</b>	0	100	165	200	130	65

## DIRECT HEAT RESERVOIR CONFIRMATION

★ EACH SITE PROJECT WOULD CONSIST OF:

	<u>EASY, SHALLOW AREA</u>	<u>DIFFICULT, DEEP AREA</u>
● CONFIRMATION		
SURFACE EXPLORATION	\$40K	\$200K
GRADIENT DRILLING	40	300
PRODUCTION WELL	<u>190</u>	<u>950</u>
	\$270K	\$1450K
● POST-CONFIRMATION (SUCCESSSES ONLY)		
ENGINEERING, HYDROLOGY	\$20K	\$20K
INJECTION WELL	<u>200</u>	<u>820</u>
	\$220K	\$840K

\* SUCCESS DEFINED ON TECHNICAL CRITERIA--SPECIFIED IN CONTRACT

\* DOE COST SHARE BASED ON SUCCESS (10% IN 1981, 5% IN 1985)  
FAILURE (100% IN 1981, 90% IN 1985)





# DIRECT HEAT RESERVOIR CONFIRMATION

## IMPLEMENTATION

COMPETITIVE DOE PROCUREMENT--CONTRACT WITH  
USER OR DEVELOPER

WOULD DEVELOP INDUSTRY - BASED INFRASTRUCTURE  
TO CARRY PROGRAM BEYOND 1985

WOULD INCREASE TALENT AVAILABLE

MANAGEMENT ASSISTANCE TO DOE

EXPLORATION EXPERIENCE VITAL

GEOSCIENCE ASPECTS  
ENGINEERING ASPECTS  
STATE LEVEL

UURI  
EG&G  
STATE RESOURCE  
& OR TEAMS



# DIRECT HEAT RESERVOIR CONFIRMATION

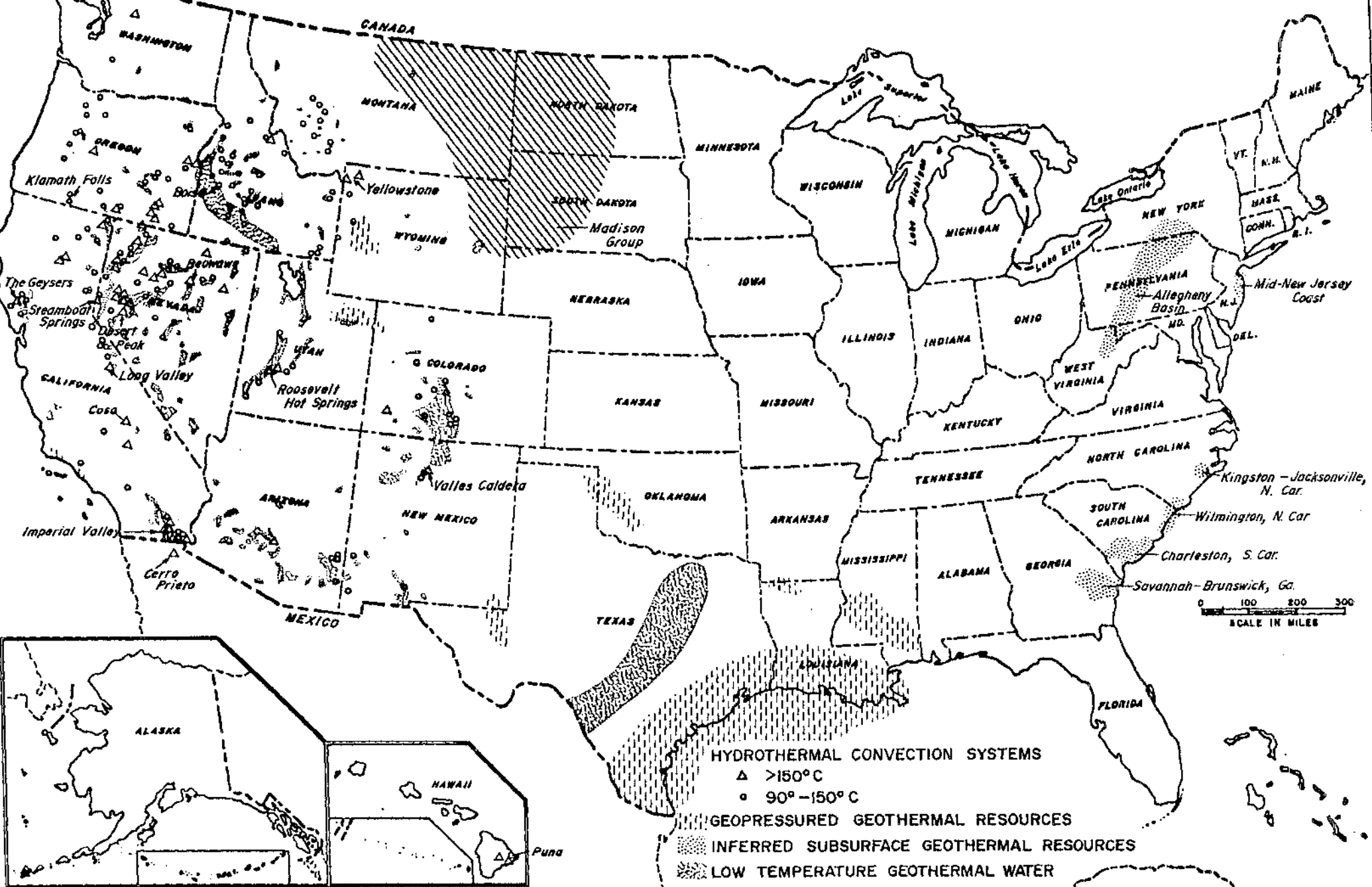
## DOE PROGRAM SUMMARY

	<u>FY80</u>	<u>FY81</u>	<u>FY82</u>	<u>FY83</u>	<u>FY84</u>	<u>FY85</u>	<u>FY86</u>	<u>TOTAL</u>
SITES	0	100	165	200	130	65	0	660
SUCCESS RATE	-	60	54	41	31	25	-	43(av.)
DOE COST SHARE, % (SUCCESS/FAILURE)	-	$\frac{10}{100}$	$\frac{10}{100}$	$\frac{5}{95}$	$\frac{5}{92}$	$\frac{5}{90}$	$\frac{5}{90}$	-
MWt, CUM	0	0	0	800	2000	3300	4500	4500
CONFIRMATION COSTS, \$M	0	18	44	65	61	37	11	236
MANAGEMENT COSTS, \$M	1	2	4	4	3	2	-	16
TOTAL DOE COSTS (W/OUT DOE STAFF)	1	20	48	69	64	39	11	252



# GEOHERMAL RESOURCES

modified from USGS Circular 790



## HYDROTHERMAL CONVECTION SYSTEMS

△ >150°C

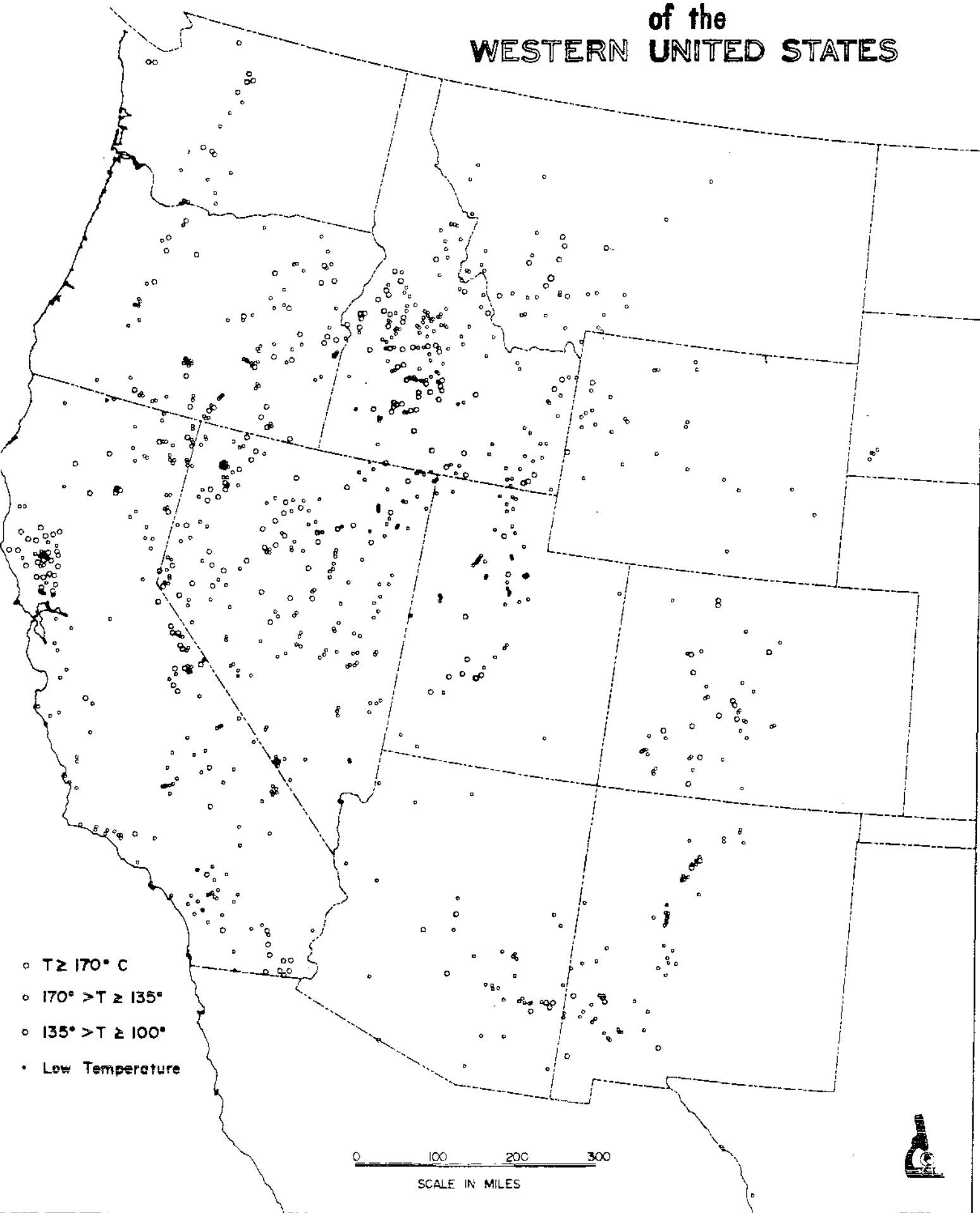
○ 90°-150°C

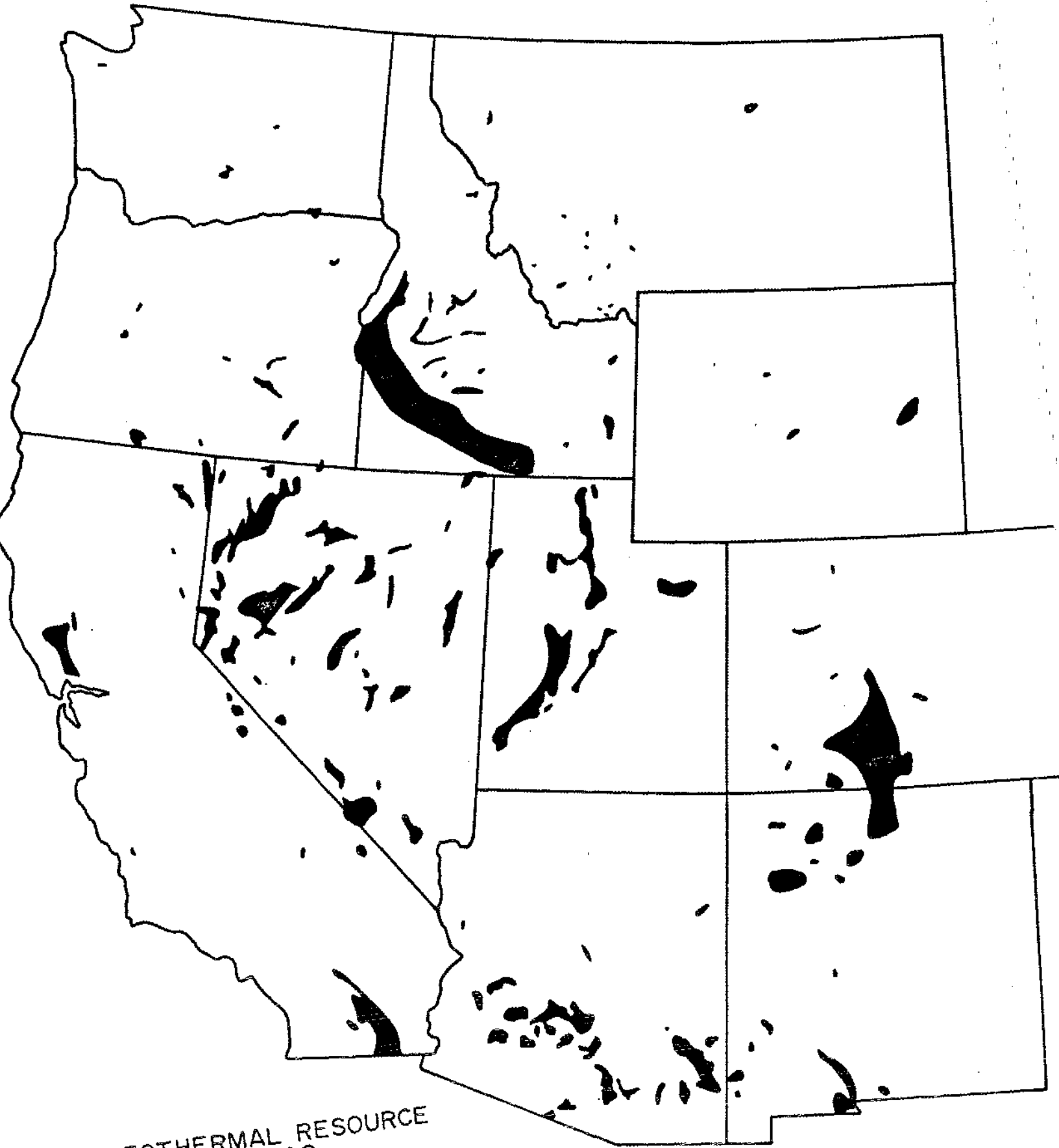
▨ GEOPRESSURED GEOTHERMAL RESOURCES

▤ INFERRED SUBSURFACE GEOTHERMAL RESOURCES

▧ LOW TEMPERATURE GEOTHERMAL WATER

# GEOHERMAL ENERGY RESOURCES of the WESTERN UNITED STATES

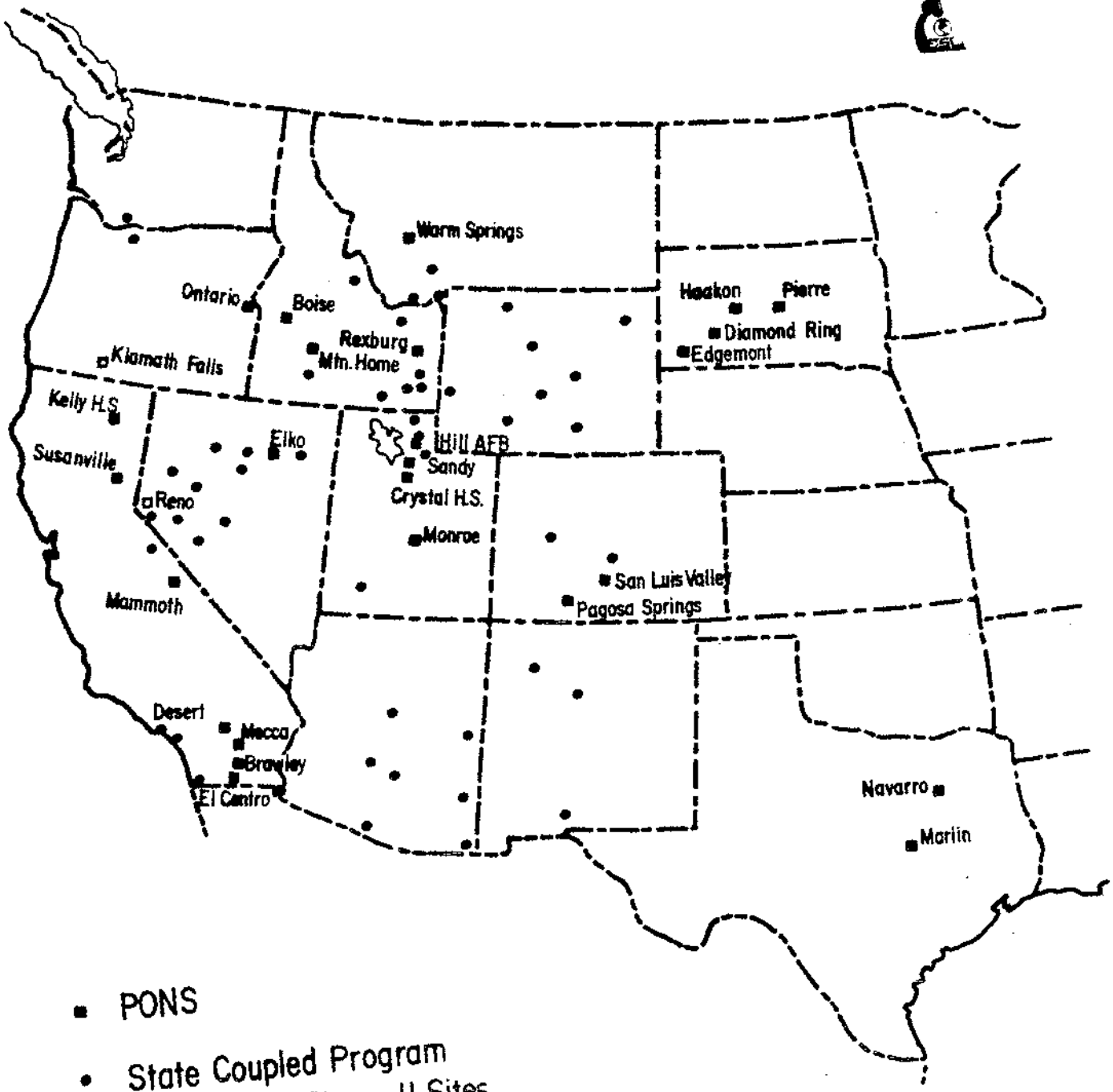




GEOTHERMAL RESOURCE  
AREAS

( $T < 150^{\circ}\text{C}$ )

(790)



- PONS
- State Coupled Program Potential Phase II Sites

## HIGH QUALITY DIRECT HEAT DRILLING TARGETS (7/79)

STATE	>150° C	150°-90° C	<90° C	TOTAL
ARIZONA	1	2	11	14
CALIFORNIA	5	14	9	28
COLORADO	1	5	7	13
IDAHO	2	13	7	22
MONTANA	0	4	3	7
NEVADA	5	7	10	22
NEW MEXICO	1	3	5	9
OREGON	4	9	7	20
UTAH	2	4	5	11
WASHINGTON	0	0	1	1
WYOMING	0	2	3	5
<b>TOTAL</b>	<b>21</b>	<b>63</b>	<b>68</b>	<b>152</b>

**CRITERIA:**

- 1) QUALITY OF RESOURCE
- 2) PROXIMITY OF POTENTIAL USERS
- 3) DISTRICT CONCEPT