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UNIVERSITY OF UTAH  
RESEARCH INSTITUTE

**UURI**

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December 5, 1977

MEMORANDUM

TO: Stan Ward  
FROM: Mike Wright  
SUBJECT: Status and Recommendations--State Cooperative Direct Heat Geothermal Program

The purposes of this memo are briefly to summarize the current status of the State Cooperative Direct Heat Geothermal Program, to assess in preliminary fashion what resources will be needed by the program and to list potential direct heat geothermal sites where known.

The ideal sequence of events leading to a responsive state program is:

- 1) Contact, preferably in person, with appropriate state agency representatives by DGE and/or ESL to discuss program scope and aims in order to facilitate formulation of the state program.
- 2) Program proposal from the state agency to DGE.
- 3) Letter of intent signed by the state agency, DOE, USGS, USFS and BLM.
- 4) Contract between the state agency and DGE, leading to initiation of work on the program.

Representatives from only a portion of the state agencies have had a personal visit by Wright and Crockett. These are: Utah, Idaho, Arizona, New Mexico, Washington and Montana. It is apparent that personal contact is necessary in order to convey the full scope of the program and to answer questions regarding proposal preparation. It is therefore recommended across the board that each of the remaining states be visited for the purpose of detailed program discussion.

DGE is separately funding a number of groups to provide support to each state effort. These groups and their responsibilities are:

1. USGS. They will provide interaction with computer file GEOTHERM for data compilation, will help in data interpretation (WRD offices in each state), and will provide digital base map data for the state maps (Topo. Div. in Reston).
2. NOAA. They will assemble, plot and print the Phase I maps for each state.
3. UURI. They will provide help in program formulation, will coordinate Phase I data compilation and map production, will provide geotechnical assistance as requested by each state agency, and will act as DGE technical representatives.

At the present time I believe that these groups will be able to provide all of the support necessary for successful project execution by the state agencies. There are no apparent voids.

The attached table gives the program status on a state-by-state basis. The FY 78 funding column lists current figures, perhaps subject to some change, but as I understand, they should be pretty firm. Also noted are states where drilling is likely in FY 79, and so project costs may need to be increased in that year. Current levels of program funding for USGS and UURI

seem to be appropriate in FY 79 unless technical assistance requests to UURI increase markedly. NOAA may need an increased FY 79 funding level if Phase I map production proceeds as hoped.

The potential geothermal sites listed are in some cases reasonably carefully considered by the state agency (Arizona, Idaho, New Mexico), in other cases are simply names of known areas of interest and in other cases have not been defined. During the next year each of these lists will receive significant refinement.

Mike (srm)

M. Wright

MW:srm

cc: Dave Crockett

STATE	AGENCY	STATUS OF PROGRAM	ASSISTANCE NEEDED	FY 78 FUNDING	SITES
Alaska	Univ. of Alaska	<ul style="list-style-type: none"> <li>• Program being proposed</li> <li>• No Contract</li> </ul>	<ul style="list-style-type: none"> <li>• Visit to state to help formulate program</li> </ul>	\$100K	Proposed new State Capital site? <ul style="list-style-type: none"> <li>• other areas not identified.</li> </ul>
Arizona*	Bureau of Mines and Geology	<ul style="list-style-type: none"> <li>• Phase I compilation underway</li> <li>• Planned second in line for NOAA map</li> <li>• Phase II site studies beginning</li> <li>• USGS-WRD studying upper Verde Valley</li> </ul>	<ul style="list-style-type: none"> <li>• LASL providing technical assist.</li> <li>• UURI role co-ordination of map production, tasks as requested</li> <li>• state has expertise to do project</li> </ul>	\$250K  <ul style="list-style-type: none"> <li>• drill funds needed FY 79</li> </ul>	Phoenix area Castle Hot Springs Florence San Bernardino Valley Clifton - Morenci Springerville-St. Johns Upper Verde Valley <ul style="list-style-type: none"> <li>• areas not prioritized</li> </ul>
California*	Division of Mines and Geology	<ul style="list-style-type: none"> <li>• Program proposal to DGE in advanced stages</li> <li>• No contract yet</li> </ul>	Not Identified	\$150K  <ul style="list-style-type: none"> <li>• drill funds needed FY 79</li> </ul>	<ul style="list-style-type: none"> <li>• numerous possible sites, not prioritized</li> <li>• more than 20 areas of interest</li> </ul>
Colorado	Colorado Geological Survey	<ul style="list-style-type: none"> <li>• contract in effect</li> <li>• Phase I data largely compiled</li> <li>• Some Phase II work underway--drilling at Pagosa</li> </ul>	<ul style="list-style-type: none"> <li>• visit to state</li> </ul>	\$165K  <ul style="list-style-type: none"> <li>• drill funds needed FY 79</li> </ul>	Poncha Pagosa Springs Glenwood Springs Alamosa Valley View H.S. Mineral H.S. <ul style="list-style-type: none"> <li>• other areas not selected</li> <li>• areas not prioritized</li> </ul>
Hawaii	not identified	<ul style="list-style-type: none"> <li>• no contract</li> <li>• project discussed with Helsley of Hawaii Institute of Geophysics</li> </ul>	<ul style="list-style-type: none"> <li>• visit to state to help formulate a program</li> </ul>	\$100K <ul style="list-style-type: none"> <li>• drill funds needed FY 79 (?)</li> </ul>	not selected
Idaho	Department of Water Resources	<ul style="list-style-type: none"> <li>• Phase I well underway</li> <li>• planned first in line for NOAA map</li> </ul>	<ul style="list-style-type: none"> <li>• UURI likely will help with Phase II data interpretation</li> <li>• Phase II coordination with USGS/DGE programs</li> </ul>	\$325K  <ul style="list-style-type: none"> <li>• drill funds needed FY 79</li> </ul>	Sugar City Bruneau-Grandview Mountain Home Castle Creek Boise Raft River Island Park <ul style="list-style-type: none"> <li>• areas not prioritized</li> </ul>

\* State representatives have received personal visit by Crockett and Wright

STATE	AGENCY	STATUS OF PROGRAM	ASSISTANCE NEEDED	FY 78 FUNDING	SITES
Montana*	Bureau of Mines and Geology	<ul style="list-style-type: none"> <li>Existing contract amended to do Phase Zero study</li> <li>Phase I proposal being reviewed by DGE</li> </ul>	<ul style="list-style-type: none"> <li>UURI technical assistance may be needed</li> </ul>	\$100K <ul style="list-style-type: none"> <li>drill funds FY 79 (?)</li> </ul>	White Sulphur Spr. Marysville Boulder Hot Springs Corwin Springs <ul style="list-style-type: none"> <li>other potential not identified</li> </ul>
Nevada	Bureau of Mines and Geology	<ul style="list-style-type: none"> <li>Existing contract amended to begin Phase I study</li> </ul>	<ul style="list-style-type: none"> <li>UURI technical assistance may be needed</li> </ul>	\$124K <ul style="list-style-type: none"> <li>drill funds likely needed FY 79</li> </ul>	<ul style="list-style-type: none"> <li>numerous possible sites not prioritized</li> <li>more than 20 known areas of interest</li> </ul>
New Mexico*	New Mexico Energy Institute at Las Cruces	<ul style="list-style-type: none"> <li>Proposal being reviewed by DGE</li> <li>No contract yet</li> <li>NMEI eager to go</li> </ul>	<ul style="list-style-type: none"> <li>little UURI help needed--will coordinate map production</li> <li>Lots of in-state expertise</li> <li>LASL to supply technical assistance</li> </ul>	\$150K <ul style="list-style-type: none"> <li>drill funds needed FY 79</li> </ul>	Valles Caldera Lightning Dock Radium Springs Lower Frisco Jemez Hot Springs Gila Hot Springs Sulphur Hot Springs Lyons Hunting Lodge Hot Springs Faywood Hot Springs Mimbres Hot Springs
Oregon	Department of Geology and Mineral Resources	<ul style="list-style-type: none"> <li>Mt. Hood Project active</li> <li>No Phase I underway</li> </ul>	<ul style="list-style-type: none"> <li>visit to state to help formulate Phase I</li> </ul>	\$250K (?) <ul style="list-style-type: none"> <li>drill funds FY 79 (?)</li> </ul>	Mt Hood Klamath Falls <ul style="list-style-type: none"> <li>numerous hot and warm springs</li> <li>areas not prioritized</li> </ul>
South Dakota	South Dakota State Geological Survey	<ul style="list-style-type: none"> <li>no contract yet</li> </ul>	<ul style="list-style-type: none"> <li>visit to state to help formulate a program</li> </ul>	? <ul style="list-style-type: none"> <li>drill funds FY 79 (?)</li> </ul>	<ul style="list-style-type: none"> <li>not selected</li> </ul>
Texas (Panhandle)	Bureau of Economic Geology	<ul style="list-style-type: none"> <li>no contract yet</li> </ul>	<ul style="list-style-type: none"> <li>visit to state to help formulate a program</li> </ul>	? <ul style="list-style-type: none"> <li>drill funds FY 79 (?)</li> </ul>	<ul style="list-style-type: none"> <li>not selected</li> </ul>

STATE	AGENCY	STATUS OF PROGRAM	ASSISTANCE NEEDED	FY 78 FUNDING	SITES
Utah*	Utah Geological and Mineral Survey	<ul style="list-style-type: none"> <li>• Phase I underway with consultant help</li> <li>• Phase II investigations beginning</li> </ul>	<ul style="list-style-type: none"> <li>• UURI geophysical data interpretation</li> </ul>	\$175K <ul style="list-style-type: none"> <li>• drill funds FY 79</li> </ul>	Crystal Hot Springs Becks and Wasatch H.S. Monroe Midway Roosevelt HS Cove Fort-Sulphurdale Thermo Lund Newcastle LaVerkin Tintic Ashley oil field <ul style="list-style-type: none"> <li>• numerous other occurrences</li> <li>• areas not prioritized</li> </ul>
Washington*	Battelle PNL, Dept. of Natural Resources	<ul style="list-style-type: none"> <li>• Battelle writing a proposal</li> <li>• No contract yet</li> </ul>	<ul style="list-style-type: none"> <li>• UURI assistance probably with map coordination-- Battelle can furnish the rest</li> </ul>	\$150K	<ul style="list-style-type: none"> <li>• not selected-- few known resources outside of active volcanic areas</li> </ul>
Wyoming	Geologic Survey of Wyoming	<ul style="list-style-type: none"> <li>• No contract</li> </ul>	<ul style="list-style-type: none"> <li>• visit to state to help formulate a program</li> </ul>	\$150K	<ul style="list-style-type: none"> <li>• hot water with oil wells near Sheridan</li> <li>• other areas not selected</li> </ul>

**U. S.**

**DEPARTMENT OF ENERGY**

**DIVISION OF GEOTHERMAL**

**ENERGY**

**STATE COUPLED PROGRAM**



# **TODAY'S PRESENTATION**

**NATIONAL DIRECT APPLICATIONS PROGRAM PLAN**

**STATE COUPLED PROGRAM**

**COMPANION PROGRAMS**

**COMMERCIALIZATION PLANNING**

**USER COUPLED DRILLING**

**PONs AND PRDAs**

**USER ASSISTANCE**

**USGS REGIONAL ASSESSMENT**





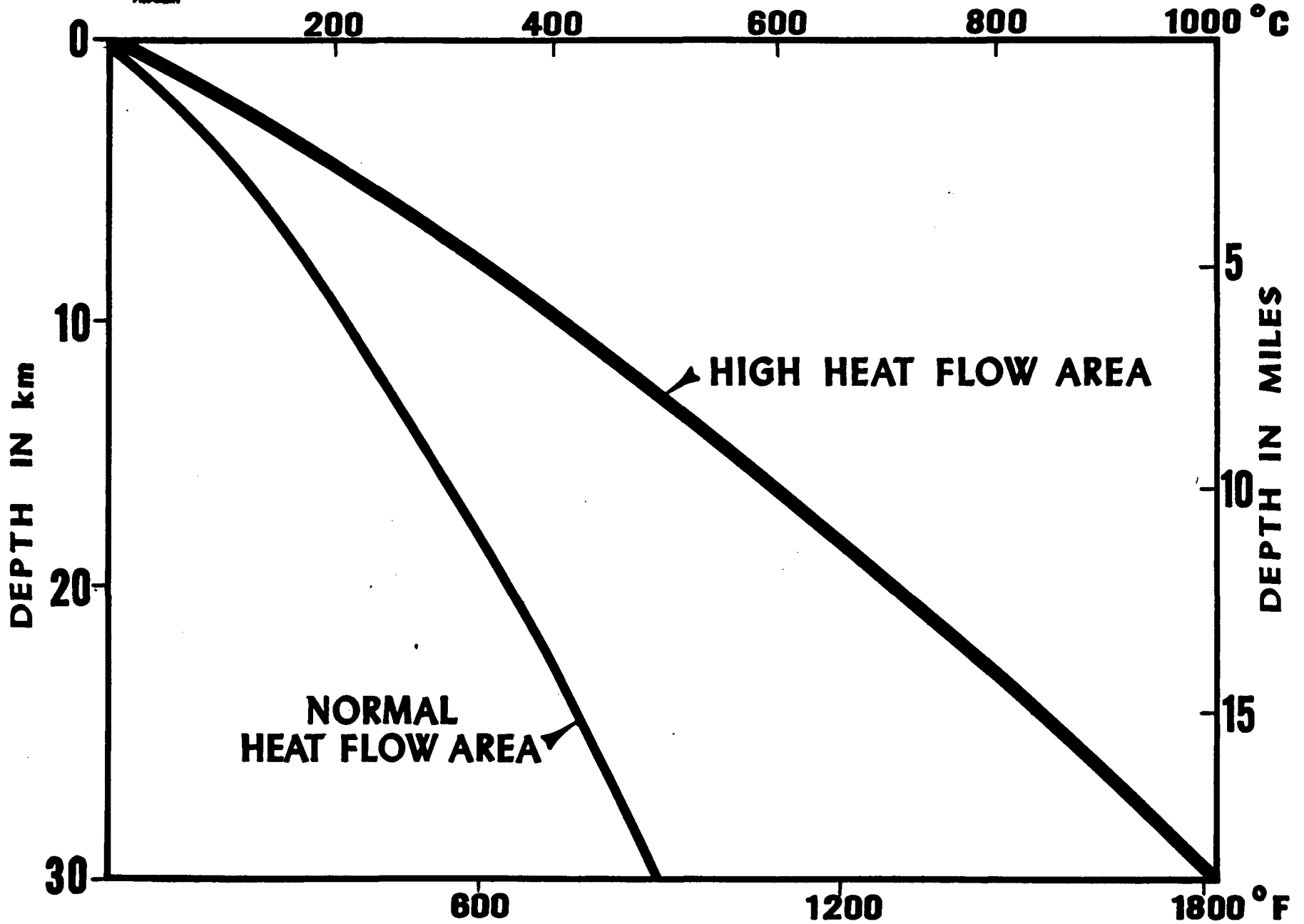
# WHAT IS A GEOTHERMAL RESOURCE

FLUIDS ABOVE MEAN SHALLOW GROUNDWATER  
TEMPERATURE  $\approx$  MEAN AIR TEMPERATURE

- FLUIDS DOWN TO GROUNDWATER TEMPERATURE  
ARE USEFUL
- THE HOTTER THE BETTER
- "RESOURCE" HAS ECONOMIC CONNOTATION

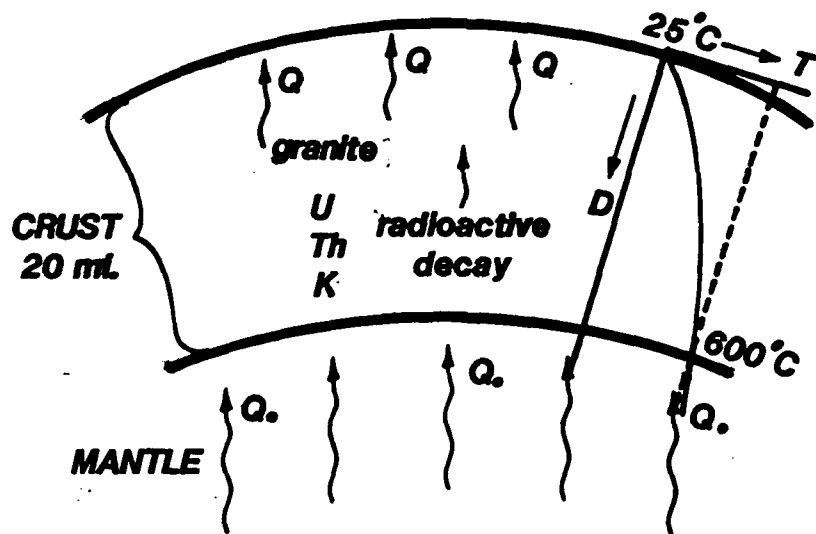


# TEMPERATURE VS DEPTH IN EARTH

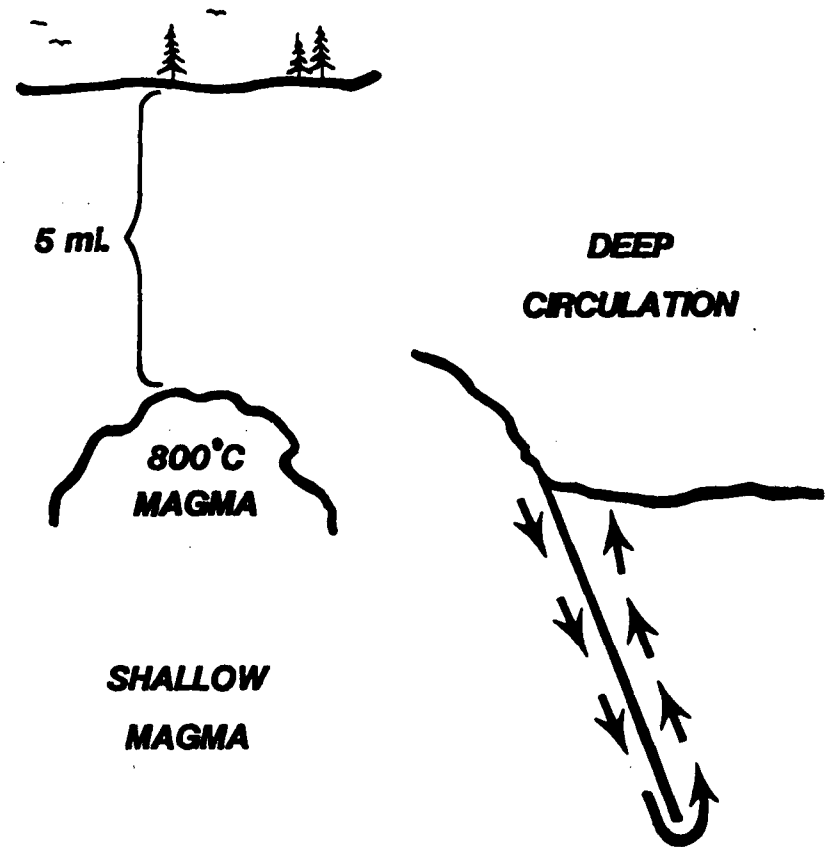


## NORMAL GRADIENT

**SURFACE HEAT FLOW**  
**= HEAT FROM CRUST**  
**+ HEAT FROM MANTLE**



## THERMAL ANOMALY



# **Today's Energy Picture in the U.S.**

- 1) The U.S. Produces Only 3/4 of the Energy it Consumes.**
- 2) Approximately 1/2 of our Oil comes from Foreign Sources. Many of these Sources have Unstable Governments.**
- 3) The Amount of Money being Spent in Foreign Markets has a Detrimental Effect on U.S. Economy.**
- 4) Capital Costs Required to Develop and Utilize Alternate Energy Sources are Very High.**
- 5) Energy Use Forecasts for the Year 2000 and Beyond Indicate that all Feasible Alternative Energy Sources Plus Conservation Measures will be Needed.**

# **GOAL OF DIRECT APPLICATIONS PROGRAM**

**TO STIMULATE COMMERCIAL USE OF A  
VERY LARGE ENERGY RESERVE**

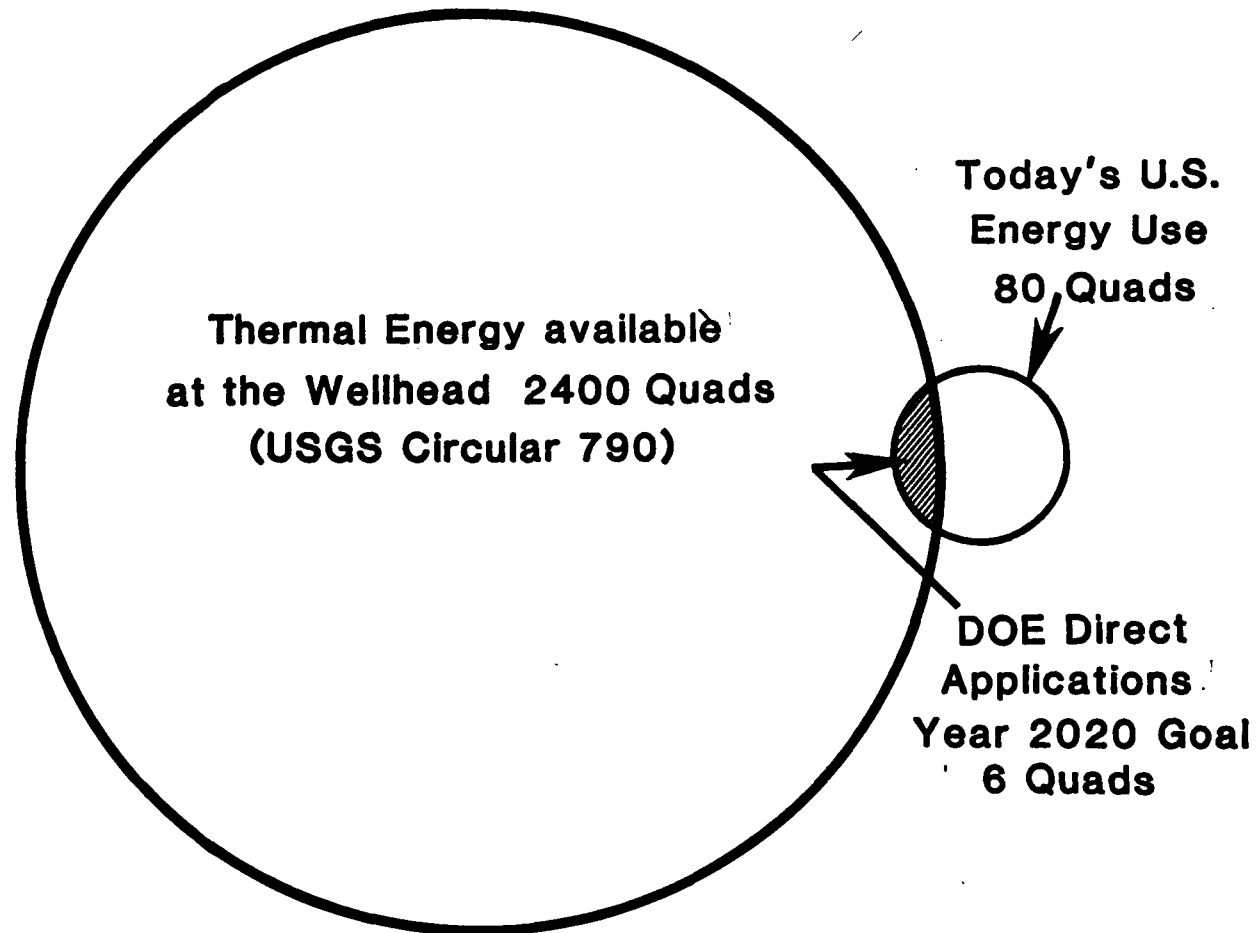


# **STATE COUPLED PROGRAM**

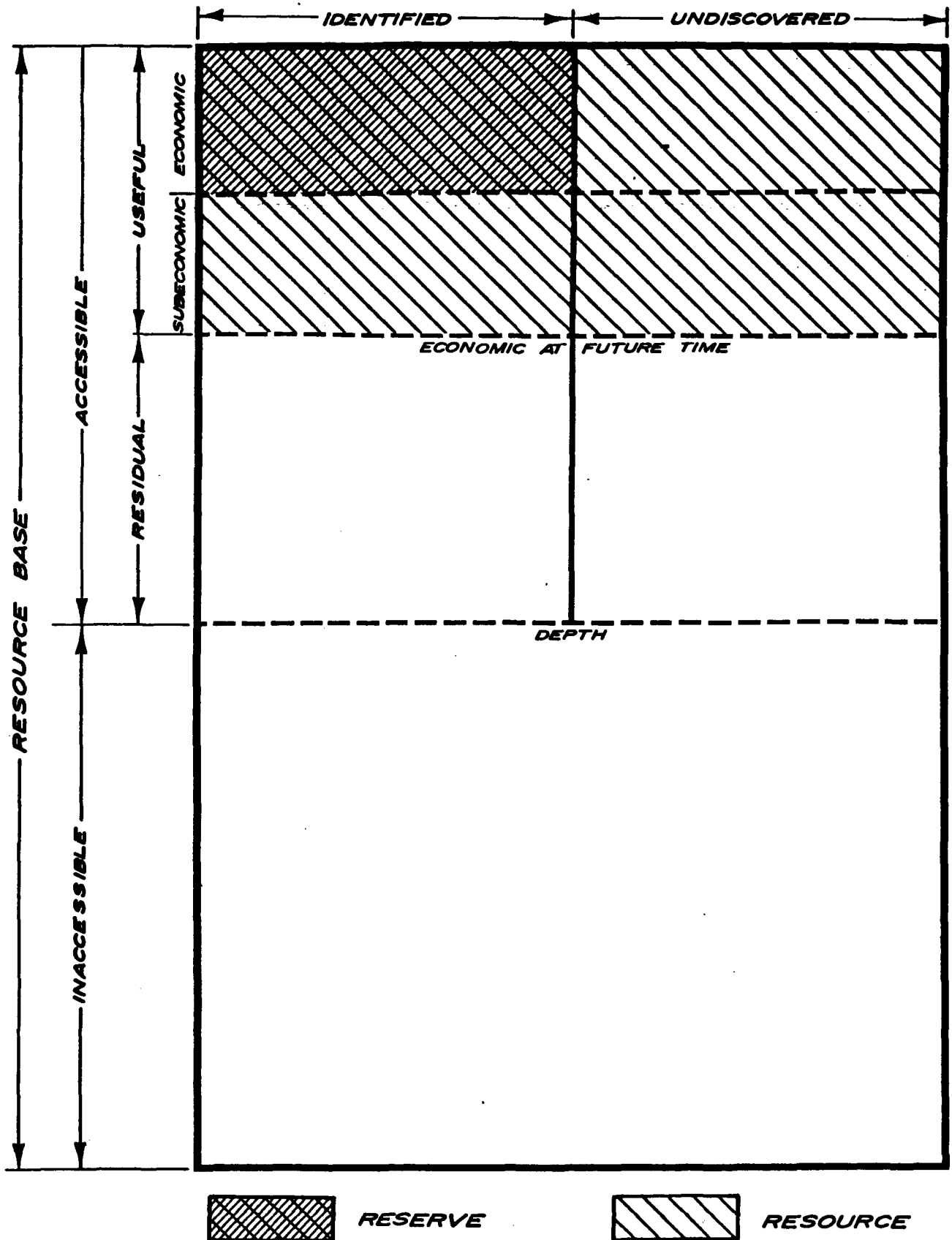
**BASIC COMPONENT OF  
HYDROTHERMAL DIRECT  
APPLICATIONS PROGRAM**



# Stimulate Commercial Use of A Very Large Energy Reserve



# MCKELVEY DIAGRAM





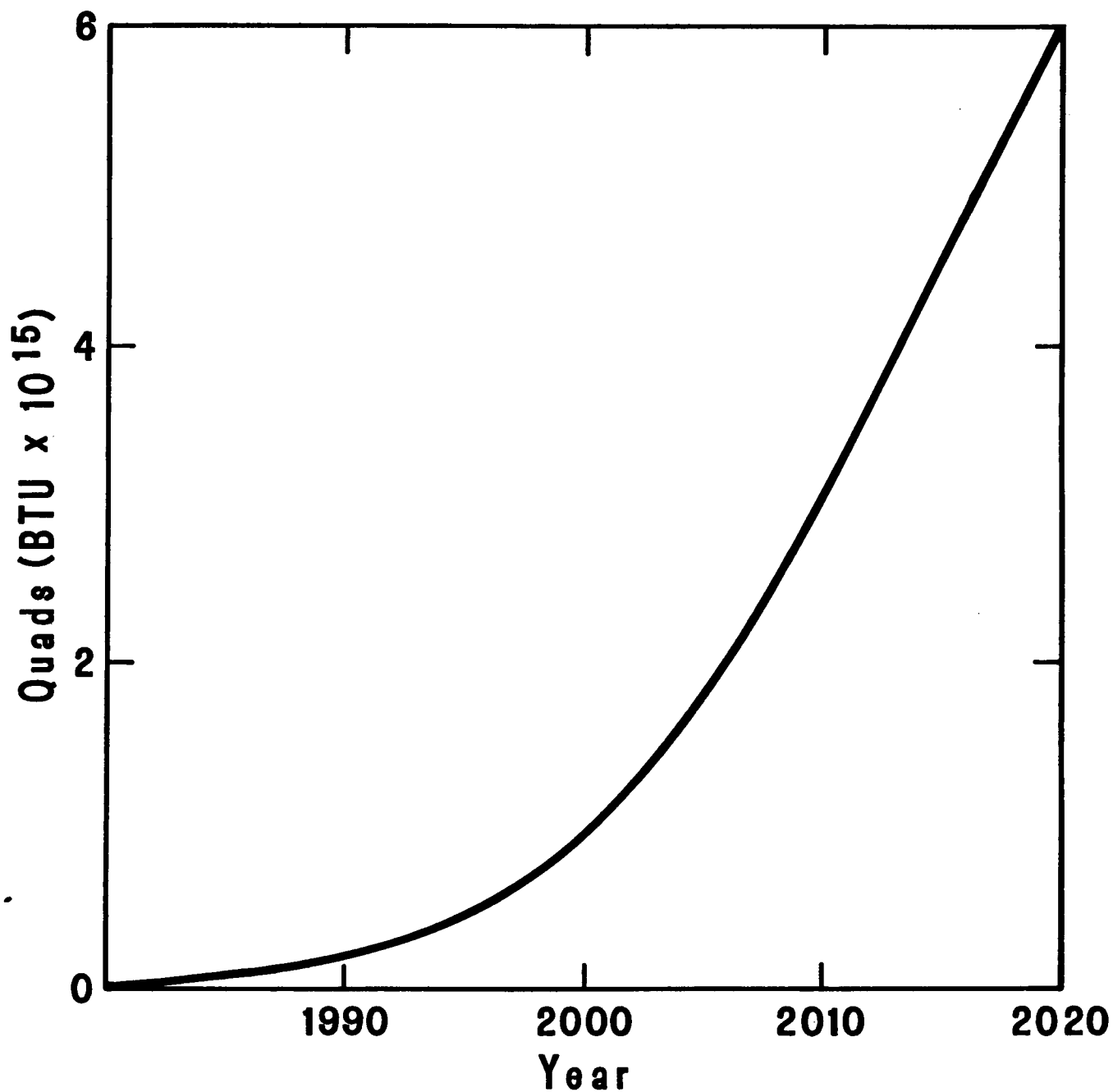
# DOE GOAL FOR COMMERCIALIZATION OF GEOHERMAL DIRECT HEAT

	<u>1985</u>	<u>2000</u>	<u>2020</u>
GOAL	0.1 Q/yr	1.0 Q/yr	6.0 Q/yr
PETROLEUM SAVED	18 Million bbl/yr	180 Million bbl/yr	1080 Million bbl/yr

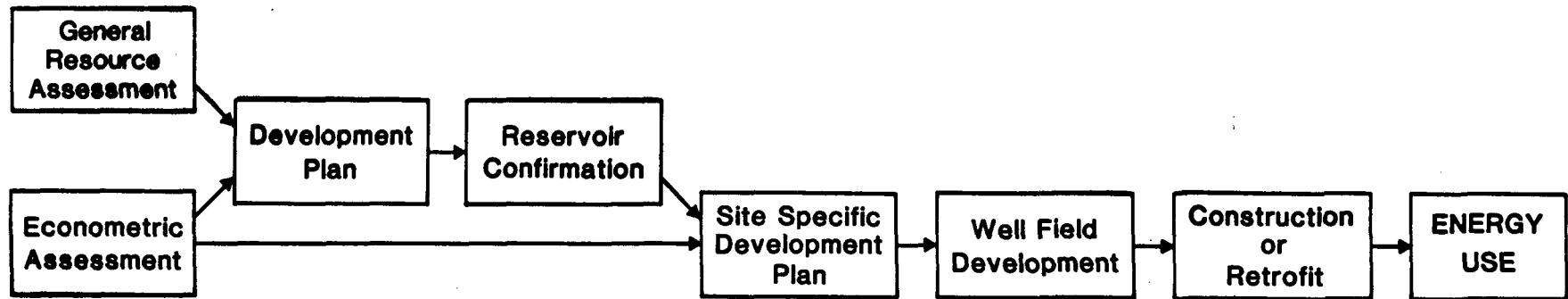
Today's U.S. Energy Use  $\cong$  80 Quads/yr



# GOALS DIRECT ENERGY USE



# COMMERCIALIZATION SEQUENCE



# **MAJOR BARRIERS TO COMMERCIALIZATION**

- **Lack of defined resources**
- **Lack of an established industry**
- **Limited technical and economic data**
- **Policy and regulatory confusion**
- **Environmental impact uncertainties**

# PROGRAM DEVELOPMENT MATRIX

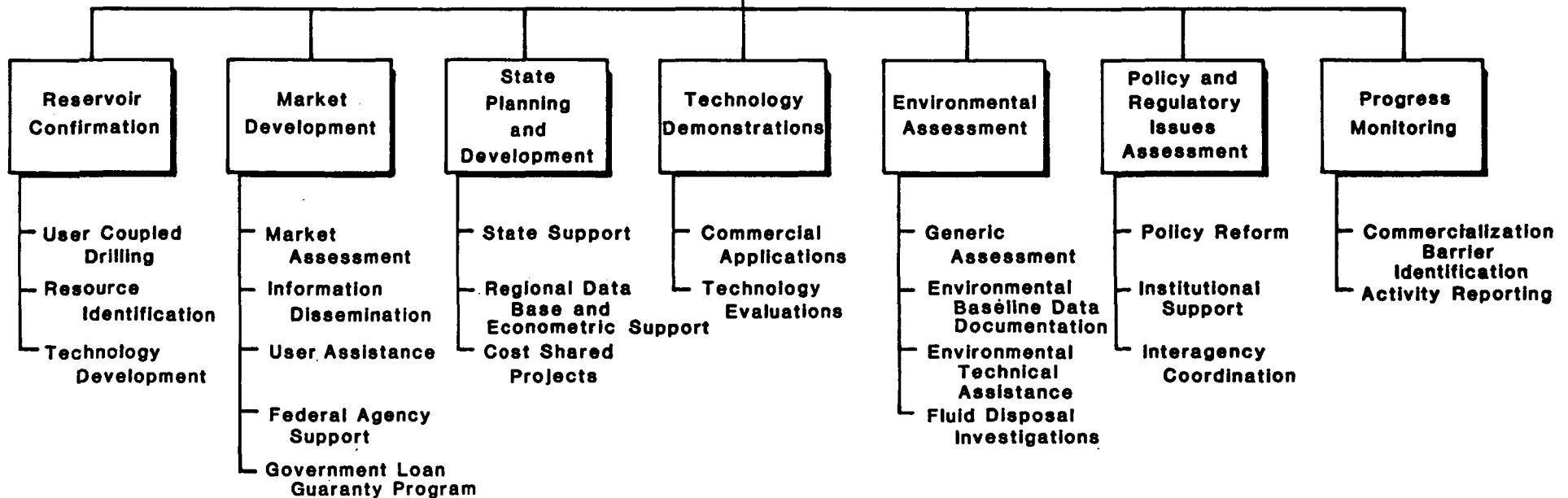
Barriers → Program Elements	Lack of Defined Resources	Lack of an Established Industry	Limited Technical Data	Policy and Regulatory Confusion	Environmental Impact Uncertainties
• Reservoir Confirmation	<b>XX</b>	<b>XX</b>	<b>XX</b>	<b>X</b>	<b>X</b>
• Market Development		<b>XX</b>	<b>X</b>		
• State Planning and Development	<b>X</b>	<b>XX</b>	<b>X</b>	<b>XX</b>	<b>X</b>
• Technology Demonstrations		<b>XX</b>	<b>XX</b>	<b>X</b>	<b>X</b>
• Environmental Assessment		<b>X</b>	<b>X</b>	<b>XX</b>	<b>XX</b>
• Policy and Regulatory Issues Assessment		<b>X</b>	<b>X</b>	<b>XX</b>	<b>X</b>
• Progress Monitoring	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>

**XX** Primary Impact    **X** Secondary Impact

# DOE PROGRAM WORK ELEMENTS

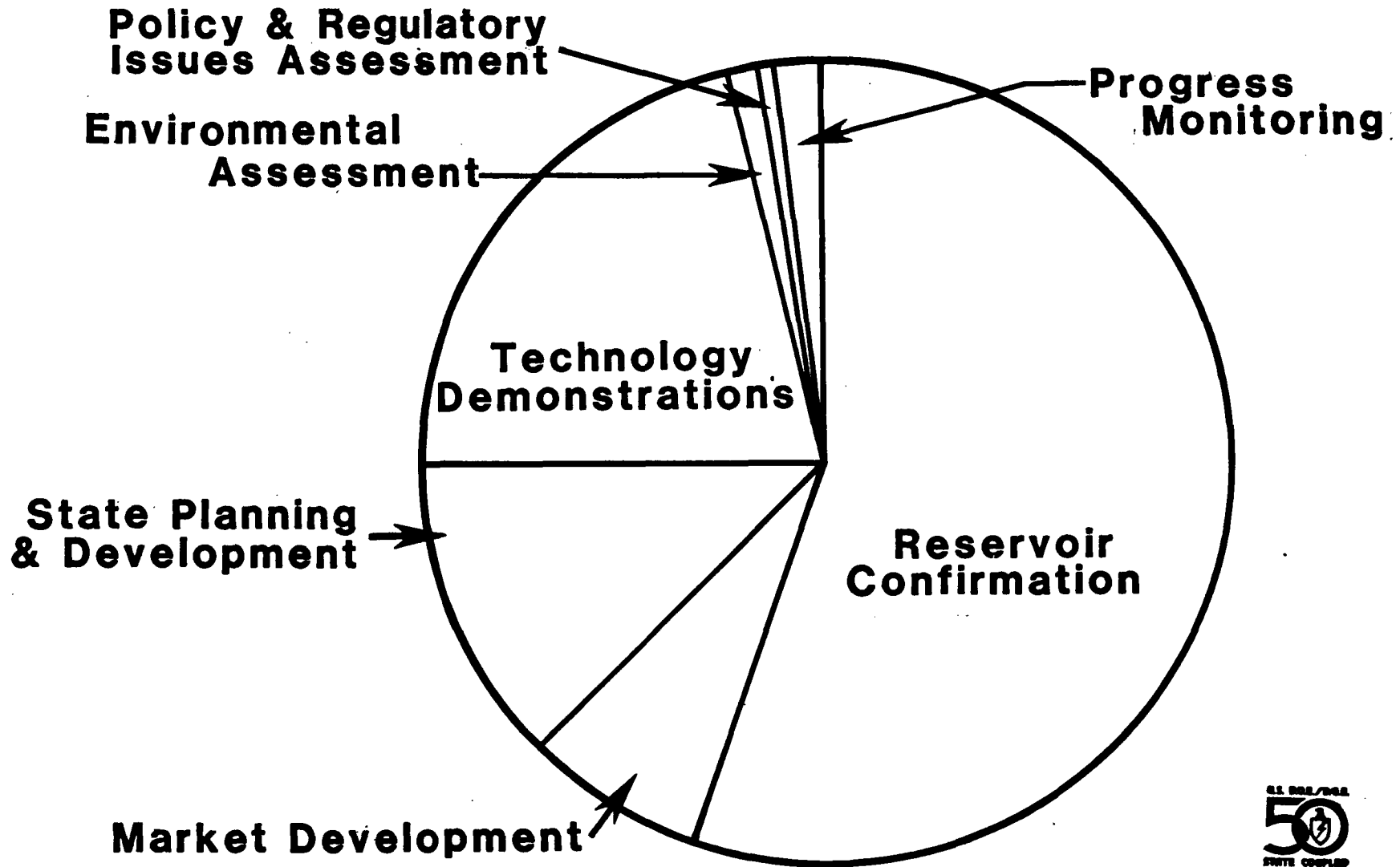
National  
Hydrothermal  
Commercialization  
Plan

Direct  
Applications  
Program

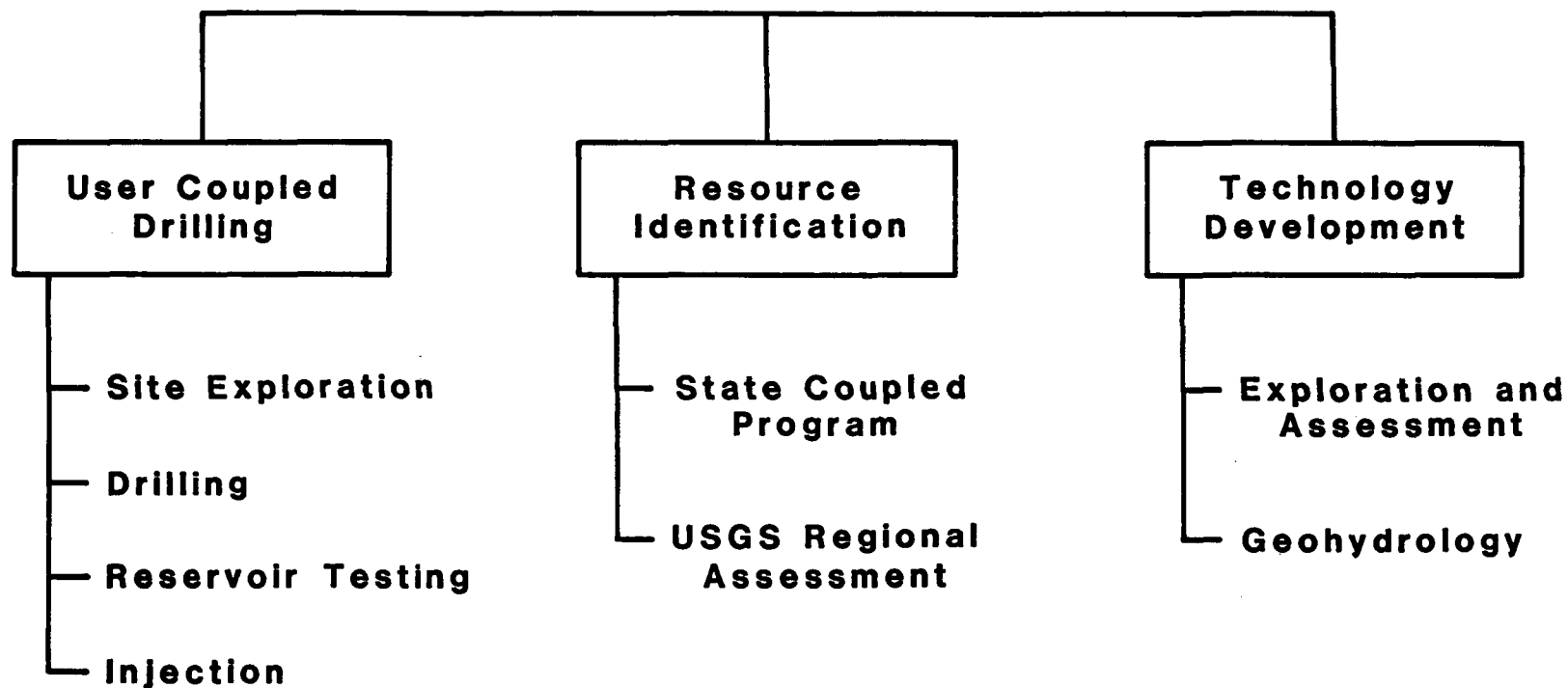


# BUDGET ALLOCATION

(FY 81 PROPOSED)



# RESERVOIR CONFIRMATION





# **STATE COUPLED PROGRAM**

## **PURPOSE**

- **TO COLLECT AND PUBLISH REGIONAL  
AND AREAL GEOTHERMAL RESOURCE DATA**

## **JUSTIFICATION**

- **TO FACILITATE SELECTION OF HIGH-QUALITY  
SITES FOR FURTHER EXPLORATION BY  
USERS AND DEVELOPERS**

# **STATE COUPLED PROGRAM**

**A GOAL-ORIENTED PROGRAM TO  
COLLECT AND PUBLISH REGIONAL  
AND AREAL GEOTHERMAL DATA**

- TO ENCOURAGE DEVELOPMENT BY  
PROSPECTIVE USERS**
- TO ASSIST USGS IN RESOURCE  
INVENTORY (Circular 790 Update)**



# **PROGRAM PARTICIPANTS**

## **DOE – HEADQUARTERS (WASHINGTON)**

**Program Planning, Guidance, Priorities**

## **DOE – OPERATIONS OFFICES**

**Program Guidance, Implementation, Contracting, Management**

## **STATE CONTRACTORS**

**Performance of State Project**

## **UNIVERSITY OF UTAH RESEARCH INSTITUTE (UURI)**

## **LOS ALAMOS SCIENTIFIC LABORATORY (LASL)**

## **GRUY FEDERAL**

## **VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY (VPI)**

**Management Assist. to DOE, Exploration, and Tech. Dev.**

## **NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)**

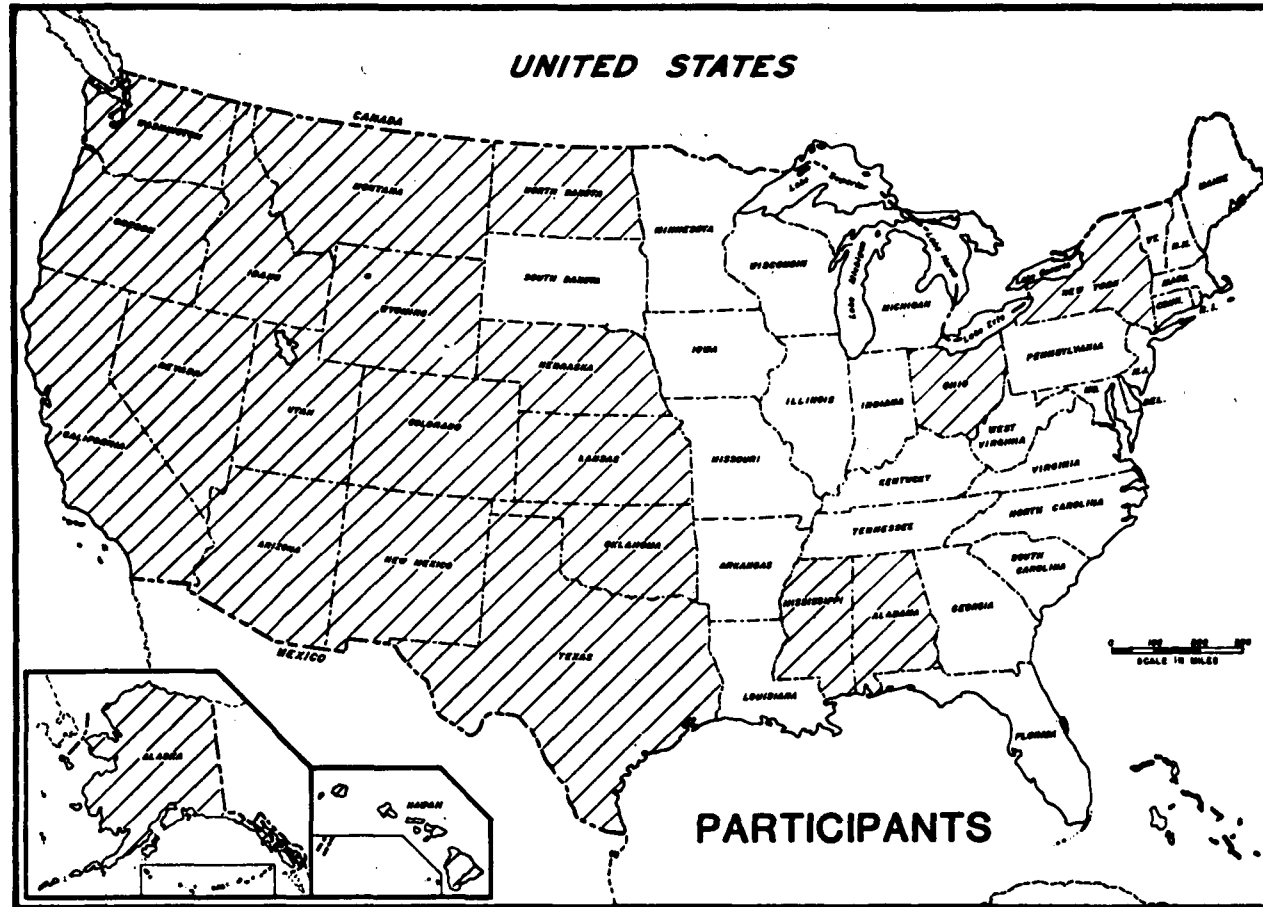
**Publishing State Resource Maps**

## **U.S. GEOLOGICAL SURVEY (USGS)**

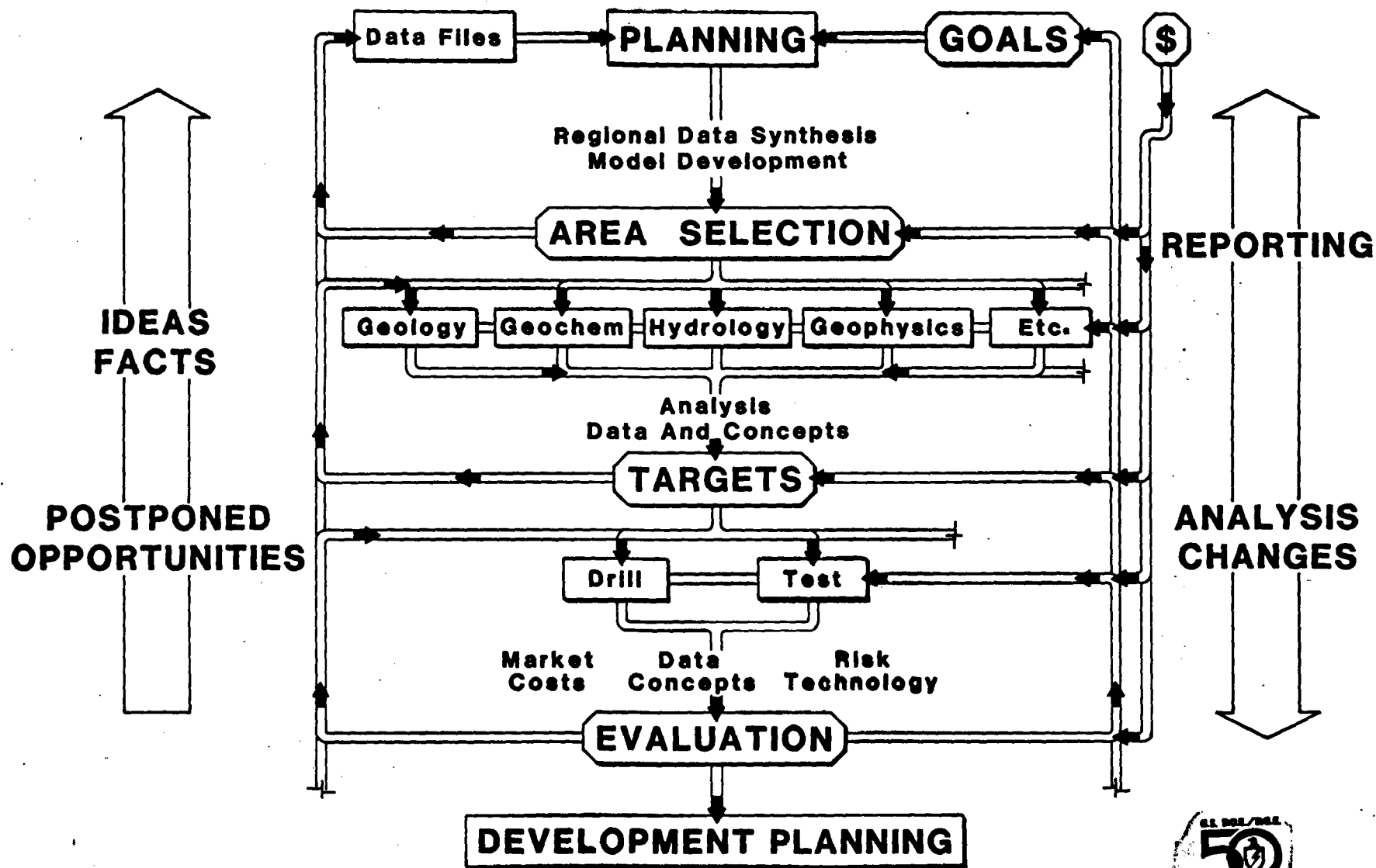
**U.S. Resource Assessment and Computer Storage**



# STATE COUPLED PROGRAM



# EXPLORATION



# **DIRECT VS INDIRECT DETECTION**

**DIRECT METHOD - TEMPERATURE MEASUREMENT  
SPRINGS AND DRILL HOLES**

**INDIRECT METHODS - HEAT FLOW STUDIES**

- GRADIENT EXTRAPOLATION**
- CHEMICAL GEOTHERMOMETRY**
- GEOLOGIC MAPPING**
- GEOPHYSICAL SURVEYS**
- GEOCHEMICAL SURVEYS**
- HYDROLOGIC STUDIES**

# **DIRECT DETECTION OF THERMAL WATERS**

**(HIGH PRIORITY)**

- NO COMPLETE DATA COMPILATION EXISTS**
- MANY REPORTED TEMPERATURES ARE INACCURATE**
- MANY WELLS LACK MEASURED TEMPERATURES**
- DIRECT DETECTION IS A QUICK AND INEXPENSIVE WAY TO LOCATE RESOURCE AREAS**



# FINDING WELLS

State Geological Surveys

Advertise for  
Thermal Wells in  
Local Papers

State Water Divisions

State Oil &  
Gas Commissions

Universities

Petroleum  
Information Corp.

USGS - Water  
Resources Div.  
Computer File  
WATSTOR

Industry Contacts

Agricultural Agencies



# **TEMPERATURE MEASUREMENT**

- **BOTTOM HOLE TEMPERATURE TO NEAREST 1°C  
0.1°C FOR GRADIENTS**
- **INSTRUMENTS MUST BE CALIBRATED**
- **PORTABILITY AND SIMPLICITY NECESSARY**
- **CAN BE DONE BY TECHNICIANS, STUDENTS**
- **GOOD FIELD NOTES A MUST**

# TEMPERATURE VS HEAT FLOW

- **GEOHERMAL RESOURCES = ELEVATED TEMPERATURES**
- **HIGH HEAT FLOW DOES NOT ALWAYS MEAN HIGH TEMPERATURE**
- **HIGH TEMPERATURE DOES NOT ALWAYS MEAN HIGH HEAT FLOW**

Heat Flow = Thermal Conductivity x Temperature Gradient

$$Q = K \frac{\Delta T}{\Delta Z}$$

- **THEREFORE IN GEOHERMAL EXPLORATION**
  - **TEMPERATURE DATA ARE OF PRIMARY IMPORTANCE**
  - **HEAT FLOW DATA ARE OF SECONDARY IMPORTANCE**
- **SIMPLE TEMPERATURE DATA ARE QUICK AND INEXPENSIVE**
- **HEAT FLOW DATA ARE SLOW AND EXPENSIVE**

# EXPLORATION STAGES

- STATEWIDE INVENTORY
  - RECONNAISSANCE 1,000–  
LARGE REGIONS 10,000 Sq. mi.
  - AREA EXPLORATION 100–  
SELECTED AREAS 1,000 Sq. mi.
  - SITE EXPLORATION less than  
SELECTED SITES 10 Sq. mi.
  - TEST AND PRODUCTION  
WELL DRILLING
- STATE  
COUPLED  
PROGRAM
- USER  
COUPLED  
DRILLING  
PROGRAM



# **STATEWIDE INVENTORY**

**PURPOSE - TO OBTAIN AN OVERVIEW OF RESOURCES**

- **RECONNAISSANCE AREA SELECTION**
- **SETTING PRIORTIES**

**METHODS - COMPILATION AND ANALYSIS OF AVAILABLE DATA**

- **WELL AND SPRING TEMPERATURES**
- **GEOLOGY**
- **HEAT FLOW**
- **CHEMICAL GEOTHERMOMETRY**

**PRODUCTS - RECONNAISSANCE REGIONS DEFINED AND  
PRIORITIZED**

# **RECONNAISSANCE**

**PURPOSE – TO SELECT AREAS FOR MORE  
DETAILED STUDY**

**METHODS – MEASUREMENT OF TEMPERATURE,  
WATER QUALITY, PRODUCTIVITY  
IN WELLS & SPRINGS**

**– ANALYSIS OF ALL DATA TO LOCATE  
GOOD GEOTHERMAL ENVIRONMENTS**

**PRODUCTS – PRELIMINARY STATE MAP & REPORT  
– STUDY AREAS DEFINED & PRIORITIZED  
(With input From State Planning Team)**

# AREA EXPLORATION

**PURPOSE** - TO ENABLE USERS AND DEVELOPERS TO  
SELECT SITES FOR DETAILED EXPLORATION  
AND DRILLING

**METHODS** - DIRECT TEMPERATURE MEASUREMENT IN ALL  
WELLS AND SPRINGS

- APPLICATION OF INDIRECT EXPLORATION  
METHODS

- GENERAL GEOLOGICAL & HYDROLOGICAL  
CHARACTERIZATION OF RESOURCES

**PRODUCTS** - STATEWIDE MAP AND REPORT

- AREA MAPS AND REPORTS

- SITES LOCATED





# PROPOSALS

(TAILORED TO EACH STATE'S NEEDS)

## SUGGESTED % EFFORT

**STATEWIDE INVENTORY**

**REGIONAL RECONNAISSANCE**

**AREA EXPLORATION AND MODEL  
DEVELOPMENT**

**MAP PRODUCTION**

**REPORTING**

**USER ASSISTANCE**

**USGS INTERFACE**

**COMMERCIALIZATION PLANNING SUPPORT**

**DOE REQUESTS FOR DATA**

	YEAR			OUT-YEARS
	1	2	3	
STATEWIDE INVENTORY	30	10	5	5
REGIONAL RECONNAISSANCE	25	25	10	5
AREA EXPLORATION AND MODEL DEVELOPMENT	5	15	20	25
MAP PRODUCTION	10	10	10	5
REPORTING	5	5	10	5
USER ASSISTANCE	5	10	25	35
USGS INTERFACE	10	10	5	5
COMMERCIALIZATION PLANNING SUPPORT	5	10	10	10
DOE REQUESTS FOR DATA	5	5	5	5

# **GEOHERMAL MODEL DEVELOPMENT**

- PURPOSE** – TO DEVELOP AND TEST NEW  
GEOHERMAL TARGET MODELS
- METHODS** – GEOLOGICAL AND HYDROLOGICAL  
REASONING, DRILL TESTING
- PRODUCTS** – PROVEN TARGET CONCEPTS
- EXAMPLE** – MODEL FOR EAST COAST  
GEOHERMAL RESOURCES  
DEVELOPED AT VPI



# REPORTS

NEEDS OF PROSPECTIVE USERS ARE PARAMOUNT

- **RESOURCE DESCRIPTION**

**LOCATION, TEMPERATURE, DEPTH,  
WATER QUALITY, PRODUCTIVITY**

- **GEOLOGIC CHARACTERIZATION**
- **DISCOVERY POTENTIAL**
- **SOURCES OF FURTHER INFORMATION**
- **SUPPORTING SCIENTIFIC DATA**

PERIODIC REPORTS ALSO REQUIRED BY DOE

# PUBLIC MAPS

## BASE DATA

◇ SPRING

○ WELL

RED > 50 °C

BLUE < 50 °C

TEMP	FLOW
TDS	DEPTH

TOPO., DRAINAGE

CULTURE, POLITICAL BOUND.,

TOWNSHIP, RANGE, SECTION,

FOREST, WILDERNESS,

INDIAN, MILITARY

## GEOHERMAL DATA

THERMAL SPRINGS AND WELLS

TEMP., FLOW, DEPTH, TDS

FAVORABLE AREAS

FEDERAL, STATE KGRAs

SQUIBS

# TECHNICAL MAP DATA

**BASE DATA - AS ON PUBLIC MAP**

**GEOHERMAL DATA - AS ON PUBLIC MAP**

**OTHER DATA SETS: (SHOPPING LIST)**

**HEAT FLOW**

**SPRING DEPOSITS**

**FAULTS/LINEAMENTS**

**EARTHQUAKE EPICENTERS**

**Hg, As, U, S DEPOSITS/PROSPECTS**

**WATER QUALITY**

**AQUIFER PRODUCTIVITY**

**GEOCHEMICAL THERMOMETRY**

**HIGH T**

**MODERATE T**

**LOW T**

**AREAS AND INTERPRETATIONS (INCLUDE BUT  
DISTINGUISH POTENTIAL AREAS)**

**IGNEOUS SYSTEMS**

**VOLCANIC CENTERS AND FLOWS (YOUNG)**

**THERMAL GRADIENTS**

**OTHER SELECTED GEOLOGY AND GEOPHYSICS**

**AREAS OF PRESENT USE**

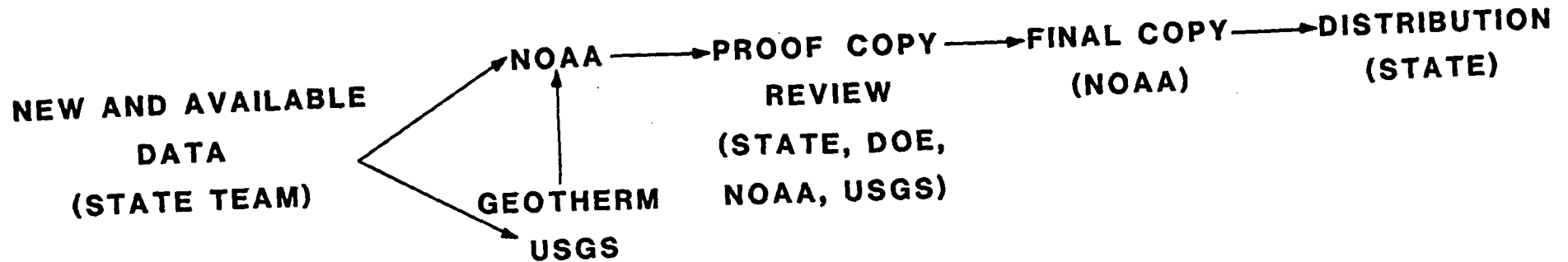
**HEAT CONTENTS**

**DEPTH TO RESOURCES**

**SQUIBS**

# MAP PRODUCTION

NOAA WILL HELP PREPARE MAPS



MAPS WILL BE PART OF STATE PUBLICATIONS



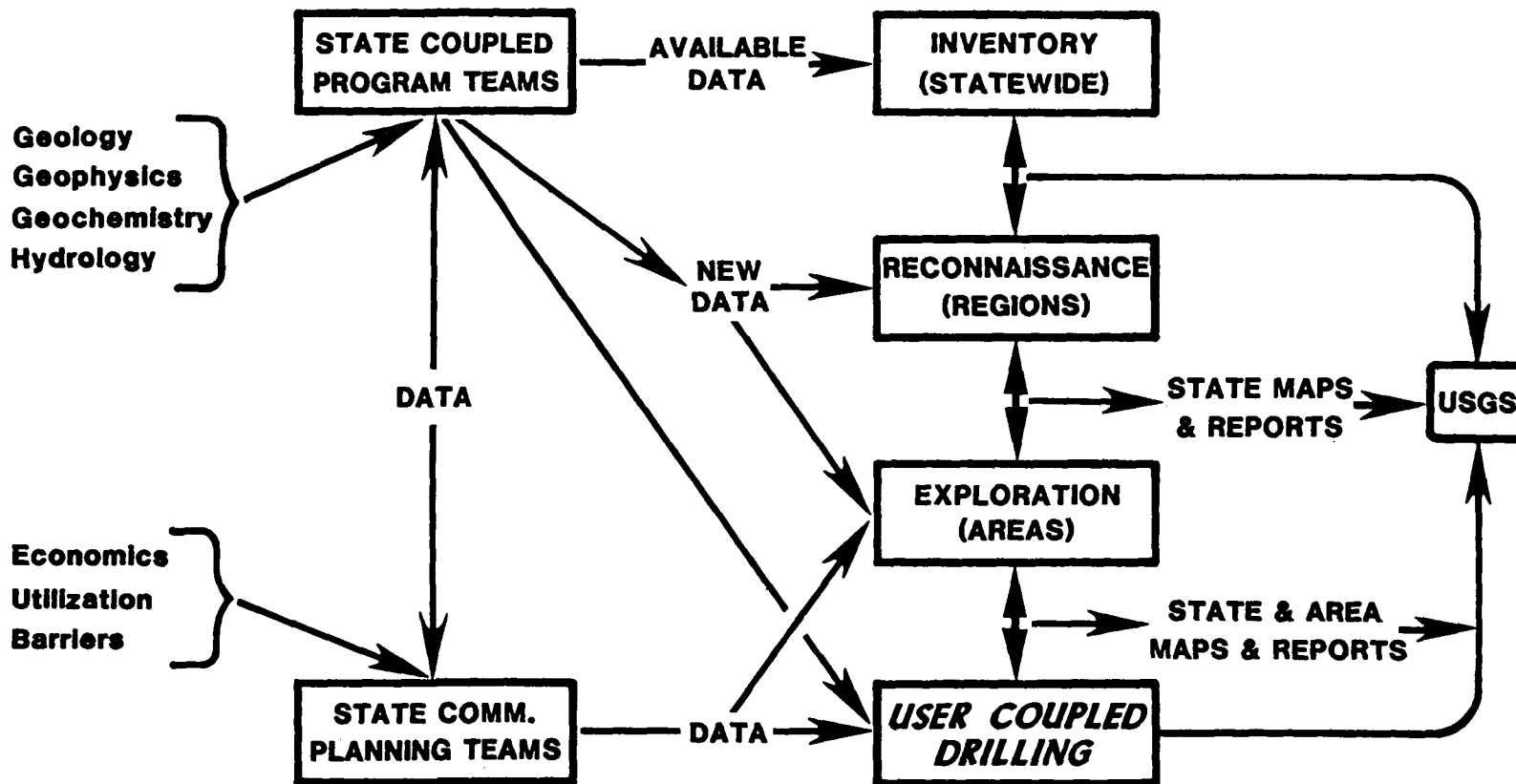
# **NOAA CAN HELP WITH**

- **COMPUTER PLOTTING**
  - **LIMITED DIGITIZING**
- **MAP STANDARDIZATION**
  - **MAP PRODUCTION**
- **EDITORIAL ASSISTANCE**

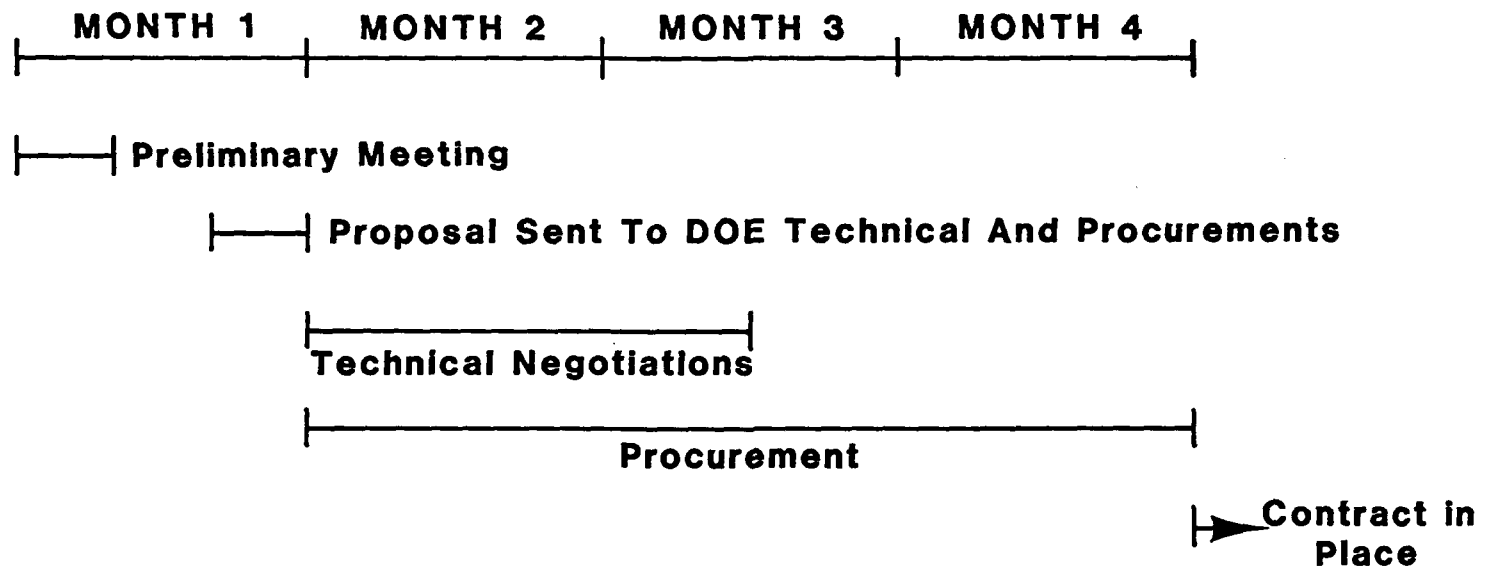
**PLAN TO TAKE ADVANTAGE OF NOAA'S EXPERTISE  
IT'S FREE**



# STATE COUPLED PROGRAM



# IDEAL CONTRACT RENEWAL SCHEDULE



# **COMPANION PROGRAMS**

- **COMMERCIALIZATION PLANNING**
- **USER COUPLED DRILLING**
- **PONs AND PRDAs**
- **USER ASSISTANCE**
- **USGS REGIONAL ASSESSMENT**



# **GEOHERMAL COMMERCIALIZATION PLANNING**

## **PURPOSE**

**TO ASSIST STATES IN DEVELOPMENT OF  
INDIGENOUS GEOHERMAL PLANNING AND  
PROJECT IMPLEMENTATION**



# STATE CP TEAMS

- **COMMERCIALIZATION PLANNING TEAM IN EACH STATE**
  - STATE EMPLOYEES, FEDERAL FUNDS
- **DOE FUNDING REMOVED IN STAGES AS STATE FUNDING TAKES OVER**
- **TEAMS DEVELOP AND COMMUNICATE:**
  - BARRIER IDENTIFICATION
  - TECHNICAL ASSISTANCE CAPABILITY
  - ECONOMIC PLANNING CAPABILITY
  - INFORMATION PROGRAMS
  - STATEWIDE DEVELOPMENT PLANS
  - SITE SPECIFIC DEVELOPMENT PLANS

# **SUPPORT FOR COMMERCIALIZATION PLANNING**

- **STATE RESOURCE TEAM**
  - **FURNISHES DATA TO CP TEAM**
- **NEW MEXICO ENERGY INSTITUTE (NMEI)**
  - **ECONOMIC MODELS, AGGREGATE REGIONAL DATA BASE**
- **EG&G, OREG. INSTITUTE TECH. (OIT), WESTERN ENERGY PLANNERS**
  - **ENGINEERING SUPPORT, MANAGEMENT ASSISTANCE**

# **GEOHERMAL COMMERCIALIZATION**

- **EXPLORATION IS NEEDED AT 500 SITES PER YEAR  
TO REACH YEAR 2000 GOAL OF 1 QUAD**
- **THIS WILL COST ABOUT \$500 MILLION/YR  
JUST FOR RESERVOIR CONFIRMATION**
- **DEVELOPMENT OF THIS MAGNITUDE WILL REQUIRE**
  - **PRIVATE SECTOR MANPOWER AND FINANCING**
  - **FAVORABLE ECONOMICS**
- **FEDERAL ASSISTANCE IS NEEDED TO STIMULATE  
RESERVOIR CONFIRMATION BY USERS AND  
DEVELOPERS**

# **USER COUPLED DRILLING PROGRAM**

- OBJECTIVES**
- TO DEVELOP INFRASTRUCTURE IN PRIVATE SECTOR
  - TO DEMONSTRATE VIABILITY OF DIRECT HEAT

**JUSTIFICATION** - DEVELOPMENT LAGS BECAUSE OF:

1. LACK OF RESOURCE KNOWLEDGE: RESERVOIR LIMITS, DEPTH, TEMPERATURE, PRODUCTIVITY, LONGEVITY
2. INABILITY OF MANY USERS/DEVELOPERS TO SPREAD HIGH RISKS AND COSTS
3. UNWILLINGNESS OF SOME USERS/DEVELOPERS TO TAKE HIGH RISKS

**GOAL** - TO FOSTER INFRASTRUCTURE CAPABLE OF DEVELOPING 2300 MWt-YR/YR

# **USER PROBLEMS**

- **INABILITY TO SPREAD RISK AND COST OF RESERVOIR CONFIRMATION**
  - **Large Resource Companies Spread Risk and Cost Over Many Projects**
- **UNWILLINGNESS TO TAKE RISKS OF RESERVOIR CONFIRMATION**
- **INABILITY TO COLLECT REGIONAL AND AREAL DATA NEEDED FOR SITE SELECTION**
- **LACK OF ENOUGH EXPERIENCED CONSULTANTS, CONTRACTORS**
- **LACK OF ECONOMIC DATA ON EXPLORATION, DEVELOPMENT, OPERATION**

# IMPLEMENTATION

- **DOE COMPETITIVE PROCUREMENT**

PROPOSALS FROM PRIVATE SECTOR, STATE  
AND LOCAL GVTS.

- **COST-SHARE CONTRACT WITH USER OR DEVELOPER**

SPECIFIES – EXPLORATION PROGRAM  
– CRITERIA TO DEFINE SUCCESS  
– COST-SHARE BASIS

- **LOAN FROM BANK**

TO FINANCE PROJECT

- **WHEN WELL IS DRILLED AND TESTED**

– DEGREE OF SUCCESS DETERMINED  
– DOE PAYS COST SHARE

# **SOLICITATION**

- **PROPOSALS ACCEPTED FROM**
  - **PRIVATE SECTOR USERS/DEVELOPERS**
  - **STATE AND LOCAL GOVERNMENTS**
- **PROJECTS GIVEN PREFERENCE**
  - **LARGE DIRECT HEAT USE POTENTIAL**
  - **COMMITTED USER**
  - **HIGH LIKELIHOOD OF EXISTENCE OF RESOURCE**



# **PROPOSAL**

## **QUALIFICATION -- Proposal must contain**

- 1. Proof of right of access and/or ownership to lands**
- 2. Proof of right to use water**
- 3. Statement of intent to use resource**
- 4. Intent to drill and test at least 1 new well or flow test old well**
- 5. A plan to determine degree of success of project in terms of temperature and flow of encountered fluids**
- 6. A plan for variable DOE cost share based on degree of success -- DOE share to be low for high degree of success**

# PROPOSAL EVALUATION

## TECHNICAL PROPOSAL

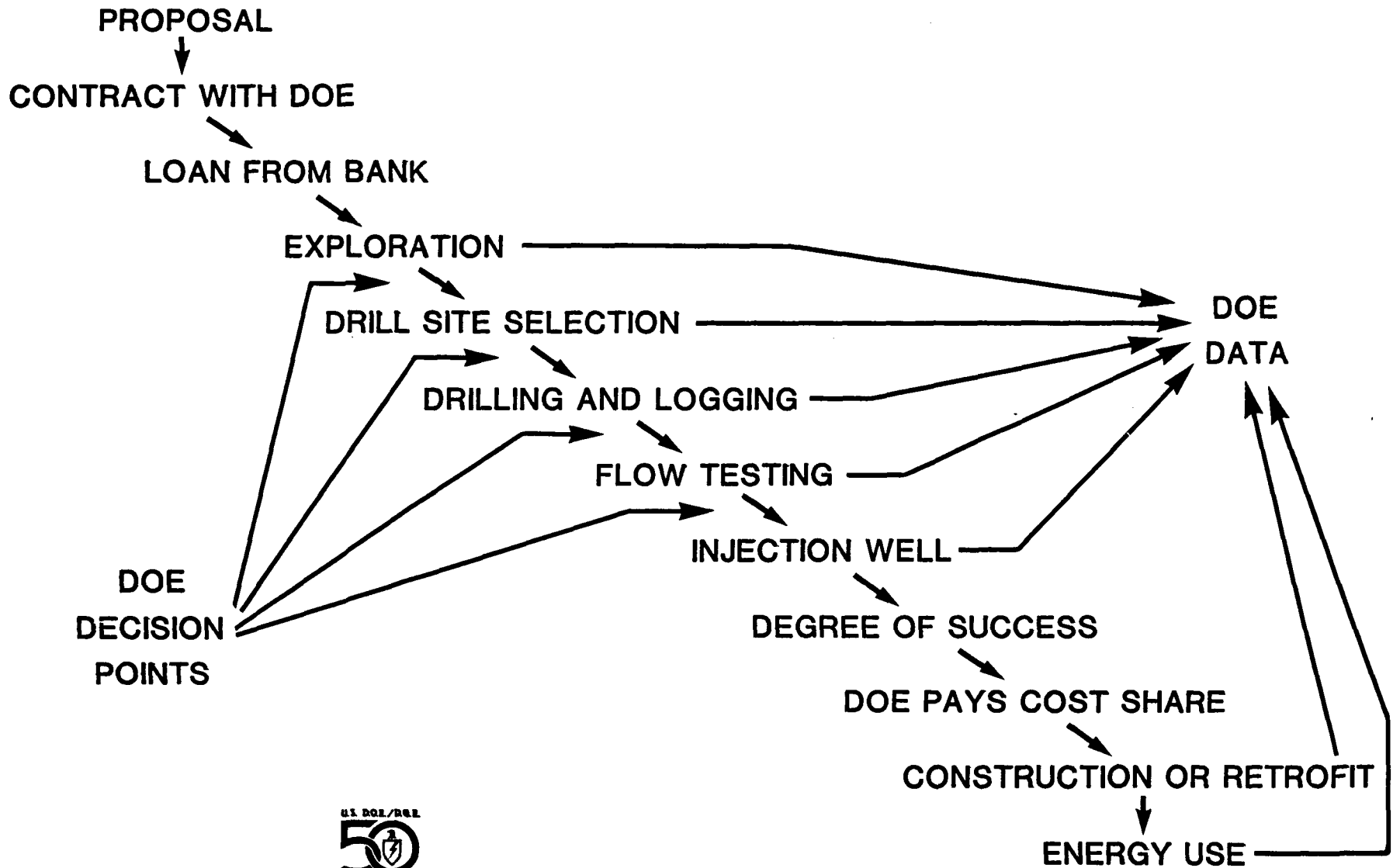
1. Exploration Program to Pick Drill Site(s)
2. Drilling Plan
3. Well Testing Plan
4. Fluid Disposal Plan
5. Institutional and Environmental Considerations
6. Project Management Plan

## BUSINESS PROPOSAL

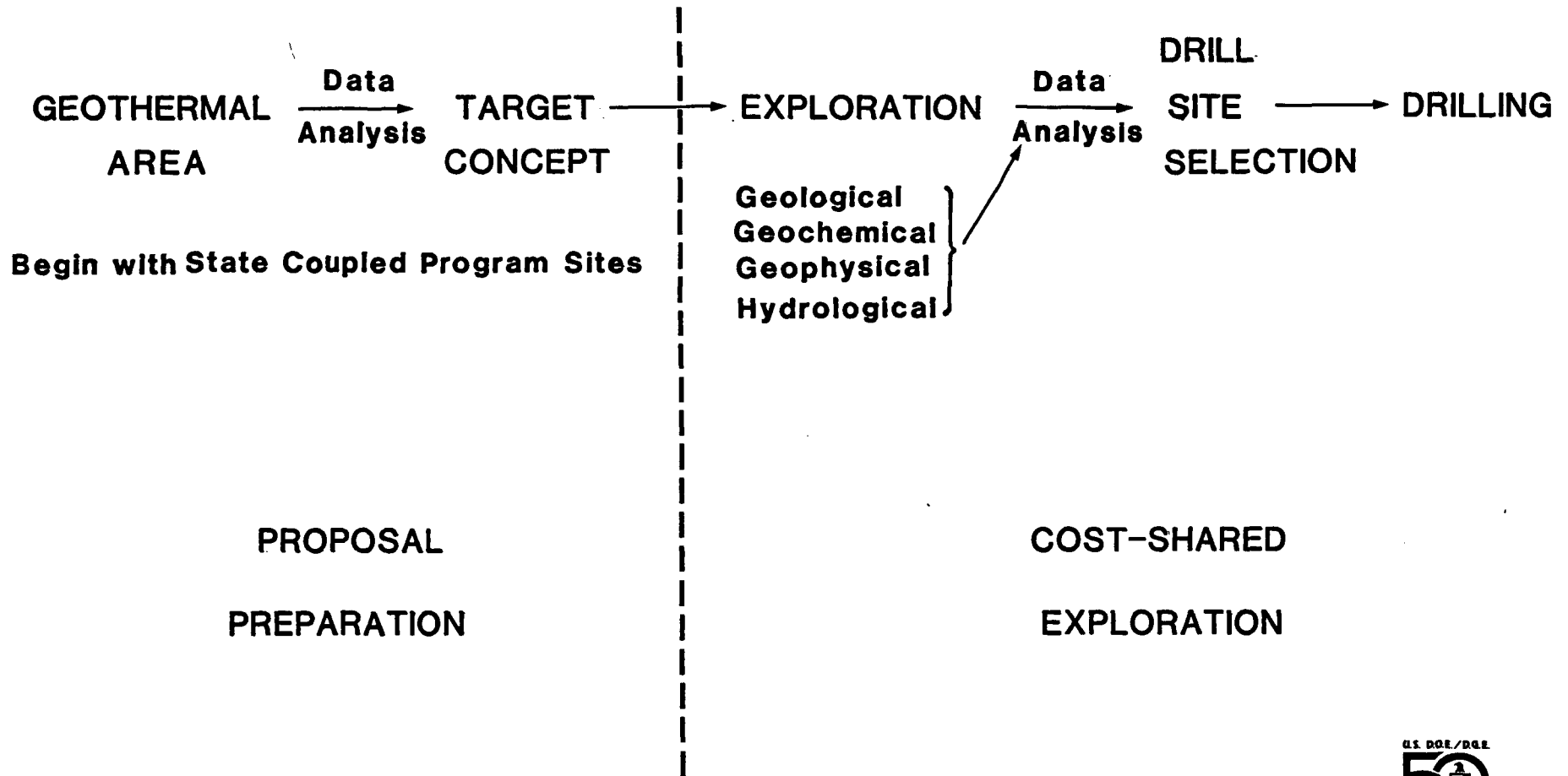
1. Project Cost and Schedule
2. Organization Information
3. Variable Cost Share Plan -- Degree of Success

# PROJECT WORK FLOW

(as performed by contractor)



# EXPLORATION SEQUENCE



# **RESERVOIR CONFIRMATION**

**WELL TESTING – temperature and other logs**  
– flow test  
– analysis of data

**DETERMINE SUCCESS**

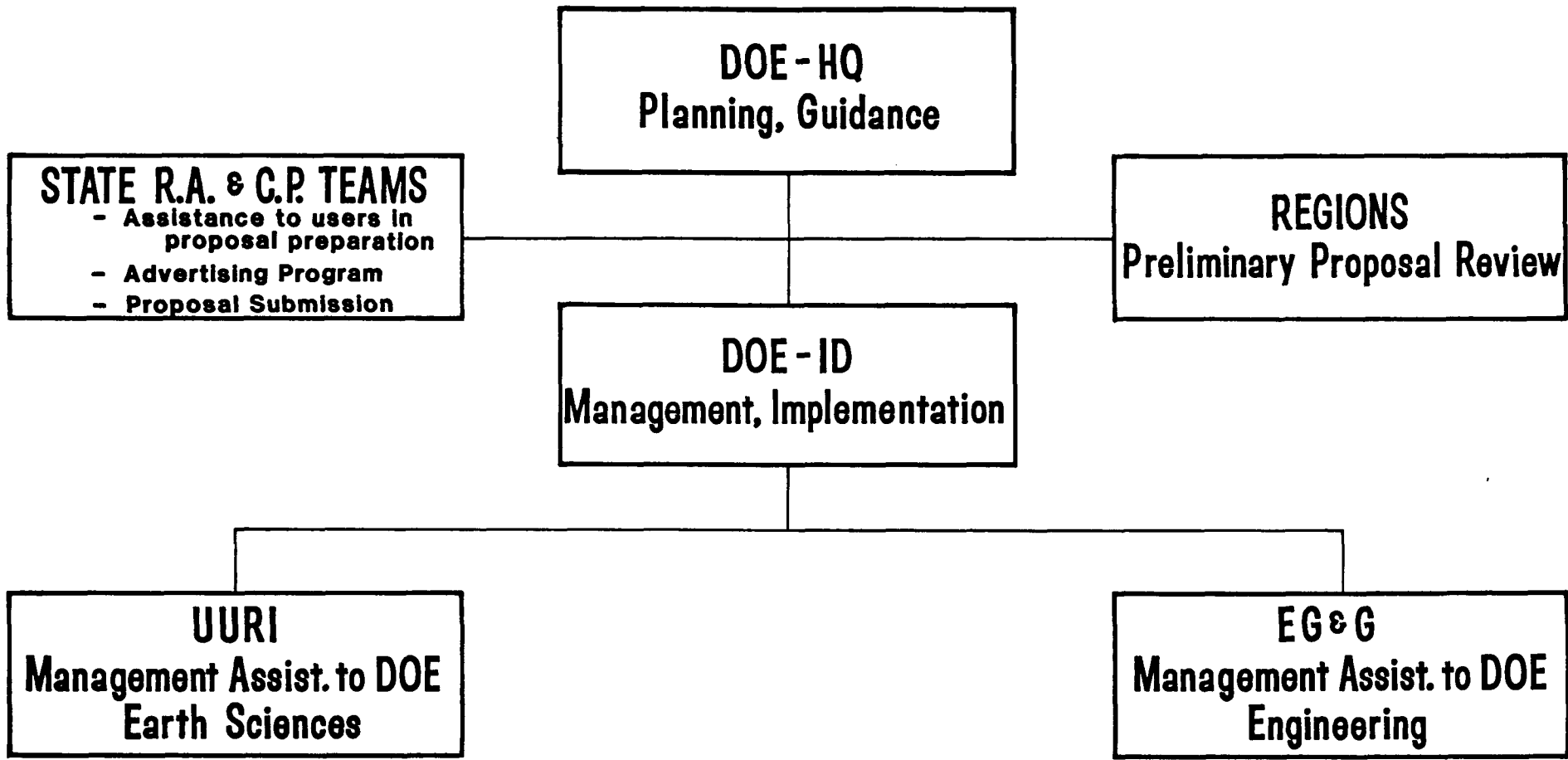
**DETERMINE COST SHARE**



# **ITEMS FOR DOE COST SHARE**

- 1. USER FEASIBILITY STUDY**
- 2. EXPLORATION DRILL SITE SELECTION**
- 3. SITE PREPARATION**
- 4. DRILLING**
- 5. FLOW TESTING**
- 6. FLUID DISPOSAL**
- 7. WELL COMPLETION**
- 8. INJECTION WELL (if needed)**

# MANAGEMENT



# **DOE SUPPORT CONTRACTORS**

**UURI AND EG&G**

## **MANAGEMENT ASSISTANCE TO DOE**

- Implementation and Coordination Assistance**
- Proposal Review Assistance**
- Contract Monitoring Assistance**
- Publication of Results -- Case Studies**





# RESPONSIBILITIES

## STATE COUPLED RESOURCE PROGRAM

1. REGIONAL GEOTHERMAL  
DATA COMPILATION
2. IDENTIFICATION OF  
RESOURCE AREAS
3. PUBLICATION OF MAPS  
AND REPORTS
4. AREA SPECIFIC  
EXPLORATION

## USER COUPLED DRILLING PROGRAM

1. SITE SPECIFIC EXPLORATION  
- GEOLOGICAL , GEOCHEMICAL,  
GEOPHYSICAL, HYDROLOGICAL
2. DRILLING AND TESTING
3. ENGINEERING STUDIES

# **STATE RESOURCE TEAM INVOLVEMENT IN USER COUPLED DRILLING**

## **1. ASSISTANCE TO USERS/DEVELOPERS**

- Information Dissemination**
- Advice and Help on Proposal**

## **2. SELLING PROGRAM**

- In Cooperation with State Planning Team , Getting Users /Developers and Resource Sites Together**
- Public Relations**

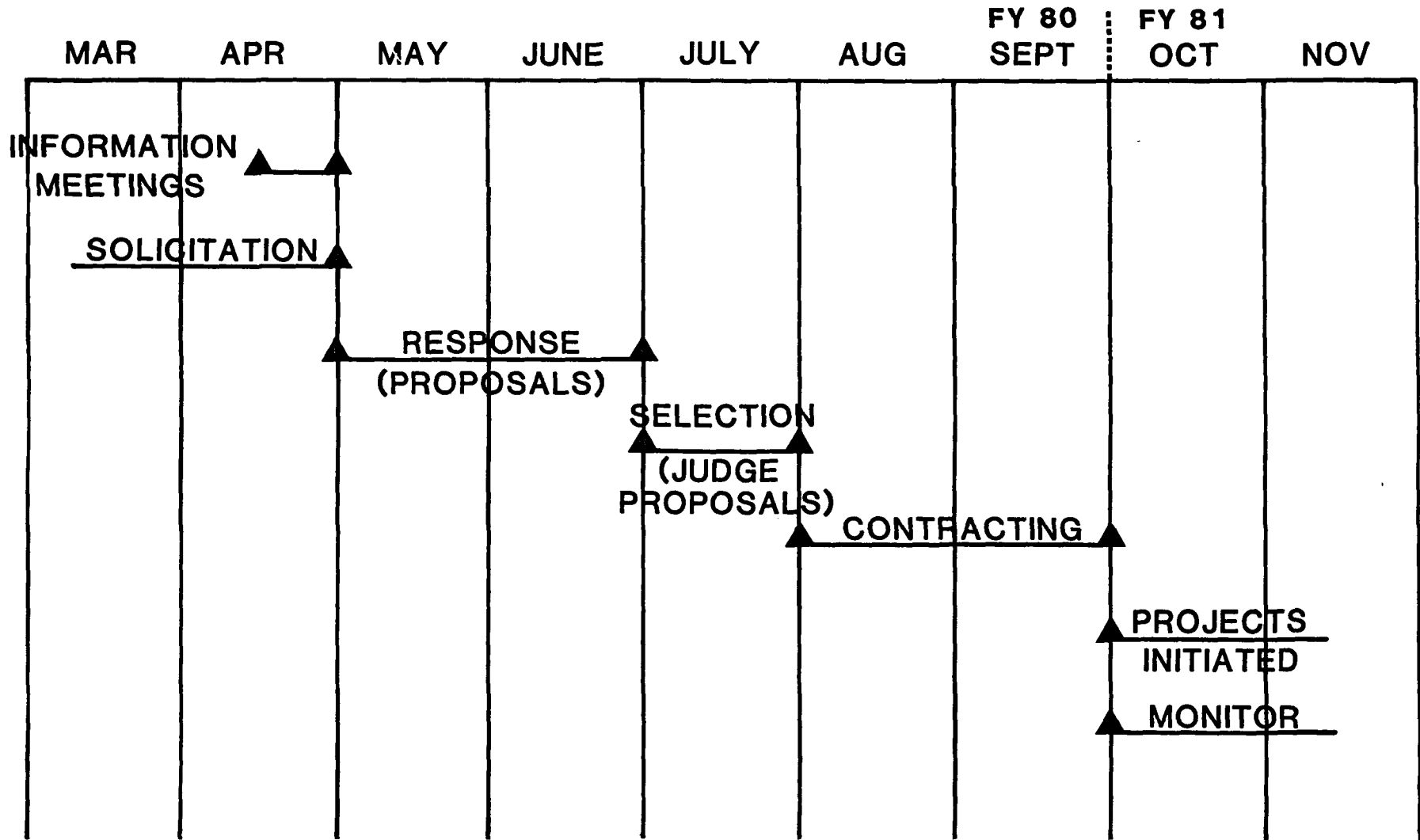
## **3. PROPOSAL SUBMISSION**

- For Reservoir Confirmation, to Develop Direct Heat Use of State and Local Government Facilities**

## **4. REVIEW OF PROPOSALS AS REQUESTED BY DOE**



# SCHEDULE



# **PONs**

## **PROGRAM OPPORTUNITY NOTICES**

**FIELD EXPERIMENTS**

**DOE COST SHARE OF FRONT END FINANCIAL  
RISKS**

**PROJECTS:**

**KLAMATH FALLS DISTRICT HEATING**

**ORE-IDA FOOD PROCESSING**

**UTAH PRISON HEATING**



**23 FUNDED SO FAR**



# **PRDAs**

## **PROGRAM RESEARCH & DEVELOPMENT ANNOUNCEMENTS**

**ENGINEERING STUDIES**

**ECONOMIC STUDIES**

**PROJECTS: SPACE HEATING  
INDUSTRIAL PROCESSING  
AGRICULTURE**

**ETHANOL**

**SUGAR**

**FROZEN FOODS**



**33 FUNDED SO FAR**



# **USER ASSISTANCE**

## **PURPOSES**

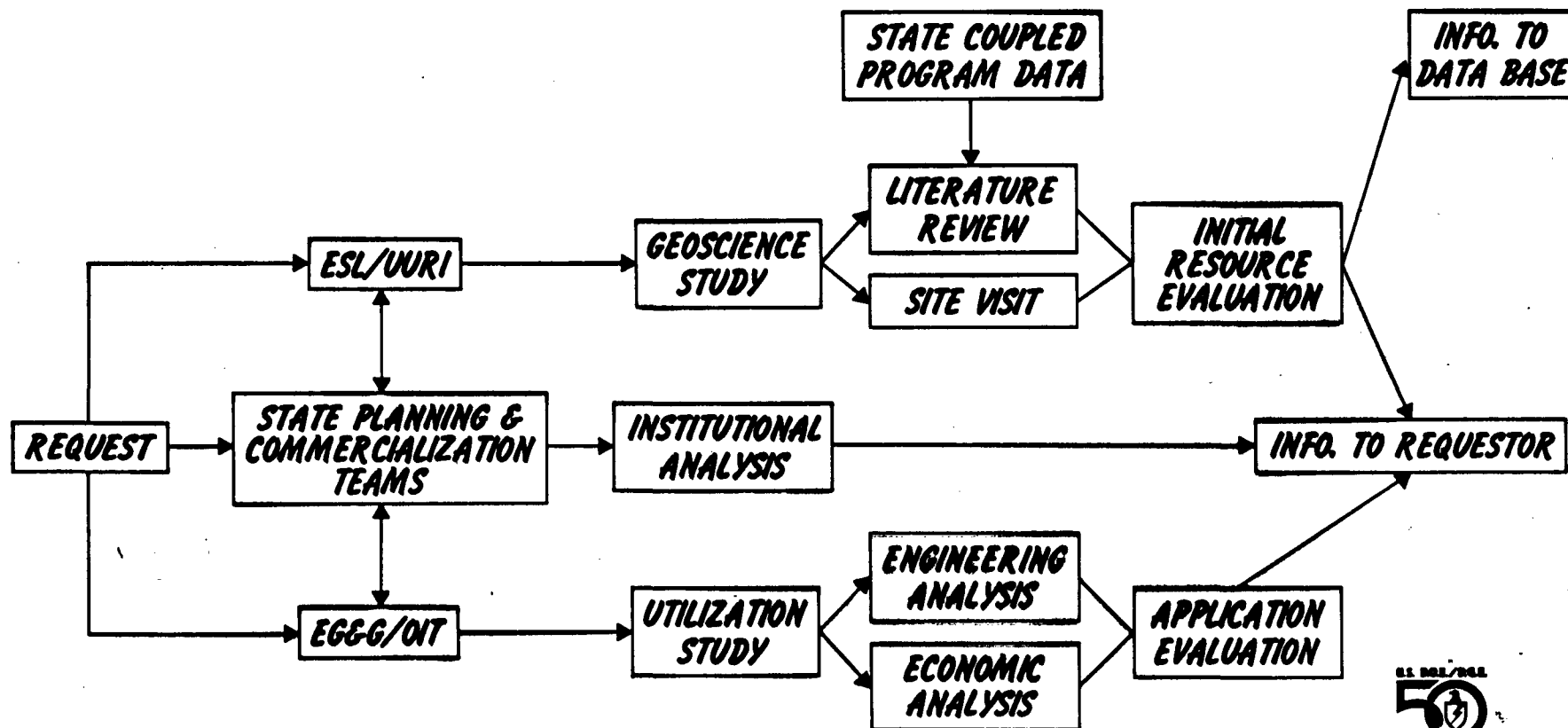
**TO STIMULATE COMMERCIAL GEOTHERMAL DEVELOPMENT  
BY PROVIDING USERS WITH:**

- Technical Information**
- Preliminary Resource Assessment**
- Preliminary Engineering & Economic Analyses**
- Institutional Analysis**

**TO ACT AS KINDLING TO GET USER STARTED IN RIGHT DIRECTION**



# USER ASSISTANCE PROGRAM WORK FLOW



# INTERFACING

## STATE COUPLED AND USER ASSISTANCE PROGRAMS

- STATE COUPLED TEAM RESOURCE DATA
- COORDINATION OF USER SPECIFIC STUDIES
- TRANSFER OF REQUESTS AS DESIRED

STATE COUPLED TEAMS



USER ASSISTANCE PROGRAM



# **USGS GEOHERMAL RESEARCH PROGRAM**

**(FY 80)**

- **NATIONAL AND REGIONAL RESOURCE INVENTORY**
- **EXPLORATION AND ASSESSMENT TECHNOLOGY**
- **RESOURCE CHARACTERIZATION**
- **GEOLOGIC CONTROLS OF SUBSURFACE POROSITY  
AND PERMEABILITY**
- **GEOENVIRONMENTAL EFFECTS OF PRODUCTION**

**PROGRAM COORDINATOR -- WENDELL A. DUFFIELD**



# **USGS REGIONAL ASSESSMENT**

- **USGS BEARS RESPONSIBILITY FOR U.S. RESOURCE ASSESSMENT**
  - **CIRC. 726, CIRC. 790**
  
- **STATE COUPLED TEAMS COOPERATE WITH USGS**
  - **DATA GOES TO FILE *GEOTHERM***
  - **STATE-LEVEL CONTACTS**



# **USGS**

## **LOW TEMPERATURE INVENTORY**

- **WILL INVOLVE STATE COUPLED RESOURCE TEAMS  
AND WATER RESOURCES DIVISION**
- **TO BE COMPLETED IN SEPT. 81**
- **SYSTEMS OF INTEREST 20°C (where applicable) to 100°C**
- **WILL DETERMINE  
GRADIENTS  
TEMPERATURES AT 1 km DEPTH  
RECOVERABLE HEAT**
- **NOAA WILL PRINT MAPS**
- **COORDINATED BY MARSHALL REED**

# **"MEGABUCKS FOR MEGAWATTS"**

**\$ AVAILABILITY CRUCIAL FOR GEOTHERMAL DEVELOPMENT**

## **BANK CRITERIA FOR LOANS:**

**1) GUARANTEED SOURCE OF RAW MATERIALS**  
**STATE COUPLED PROGRAM**  
**USER COUPLED DRILLING**  
**USER ASSISTANCE**

**2) PROVEN TECHNOLOGY**  
**PONs AND PRDAs**  
**USER ASSISTANCE**

**3) EXPERIENCED MANAGEMENT**  
**USER COUPLED DRILLING**

**4) MARKET FOR SALES**  
**COMMERCIALIZATION PLANNING**  
**USER COUPLED DRILLING**



# UURI

EARTH SCIENCE LABORATORY  
391 CHIPETA WAY, SUITE A  
SALT LAKE CITY, UTAH 84108  
801-581-5283

29 Jan., 1980

Mike:

Deb and I had a long talk yesterday on the problem of D.C. level staffing for the State Coupled Program. The approach I took ~~was~~<sup>was</sup> to try to answer two questions: why is the program viewed as a success in D.C., and why are the state teams happy with the D.C. arrangements at present?

On the first question, the program is succeeding on several fronts. Probably the major one is that it is producing concrete results that are directly relevant to the commercialization of resources.. These would be the contributions to the Circular 790 effort, the support of Geotherm, and the finally visable production of the state maps. On the second question, I think that one of the reasons that the state teams are happy is that they have been }  
{ in contact with ~~the~~ professional geologists all along the chain of command. One of the reasons that Gerry has been able to work so well with the teams is that he understands research geologists, has dealt a long time with various state geologists, and has spent a great deal of time in university settings. I feel that it is very important for whomever takes over the posttion to have a solid understanding of universities.

There are two philospphical points that a professional, active research geologist should bring to the job: a committment to centralized management, and an understanding for the need to produce more than just paper studies. As it now stands, the teams have only a few points of contact, and there are therefore very few variations in that the role should be for all the participants. Decentralized management would lead to decentralized role definition, and resulting confusion to the program. The planning teams are generally great in producing paper studies, but I really wonder if some of their studies are going to greatly aid in the commercialization of resources.

One further aspect of the program that is required is that whomever takes over in D.C. must be a professional geologist (or geoscientist) who is able to command the respect of the Geological Survey. For better or worse, life is a lot easier in this business<sup>if</sup> you have the respect of Pat Muffler et al. I doubt that many of the managerial types in D.C. could command this respect.

As a fianl note, the person must be able to function as an effective ~~advocate~~ advocate for the state teams, as well as to convey DOE needs to the teams. This means that a solid understanding of exploration problems and procedures is needed. The desire of teams to misdirect the program

UNIVERSITY OF UTAH  
RESEARCH INSTITUTE

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and produce irrelevant reports is something we are fighting now. A non-explorationist (or researching scientist at least) would not be able to effectively combat the teams tendency for self-desired, but geothermally irrelevant, studies.

On the personal side, I will spend, and so will Roy Mink, a lot of time traveling with the person in charce, so it would be nice if it were someone we could get along with.

Excuse the typing.

A handwritten signature in black ink, appearing to be 'D. C.', with a long horizontal line extending to the right.

DF:sob

strong dir. from DC

vacillation + change led to demoralization

active involvement in research along geol lines  
explorativists provide  
geol. theory devel.

strong leadership in geol w/ command respect of teams

USGS coop works w/ strong geol. @ helm

failures - hasn't gotten realism into planning teams  
products aren't relevant  
Cumbells Soup

Oak Ridge - need state involvement  
not run by resource people

Jan mty - inability to control field offices  
speaker  
last minute changes

interpersonal -  
indecisiveness (no luncheon speaker)  
anticipation of needs (last minute nickle and dime requests)

successes -

producing results (maps)  
generating data  
support to USGS  
doing expln. well  
relevancy to commercialization  
centralized mgmt (not philos)  
(strong <sup>philos.</sup> commitment)  
happy researchers (many people <sup>would leave</sup>)  
action, not studies (philos  
(commitment))  
professional geolists as contacts  
(active researchers)

guide users thru  
institutional  
merge

DIVISION OF GEOTHERMAL ENERGY

RESOURCE APPLICATIONS

1. BROPHY, Gerald P. 633-9491
2. CARWILE, Clifton 633-8105
3. DiBONA, Bennie G. 633-8118
4. GRAY, Robert A. 633-8112
5. HOLLIDAY, Robert O., Jr. 633-8754
6. JELACIC, Allan J. 633-8164
7. LaSALA, Raymond J. 633-8750
8. LOMBARD, David B. 633-8106
9. McFARLAND, Clifton B. 633-9471
10. OLIVER, Robert E. 633-8755, 8756
11. REEBER, Robert R. 633-8750, 8751, 8757, 8748
12. SALISBURY, John W. 633-9362
13. SCHEVE, Martin R. 633-8110
14. SKALKA, Morris 633-8755, 8756
15. TOMS, Ronald S. H. 633-8111

MAILING ADDRESS AS OF 12/17/79:

Division of Geothermal Energy, RA-233  
M.S. 3344, Federal Bldg.  
12th and Penn., NW  
Washington, D.C. 20461



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Division of Geothermal Energy, RA-233  
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12th and Penn., NW  
Washington, D.C. 20461

CONTRACTING AGENCY: ALASKA DEPARTMENT OF NATURAL RESOURCES (ANCHORAGE)  
 CONTRACT NUMBER(S): DE-FC07-79 ET 27105  
 PRINCIPAL INVESTIGATOR: ROSS SCHAFF

CONTRACT PERIOD	\$ CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
6/1/79 - 5/31/80	165,450	75,085	<ul style="list-style-type: none"> <li>• RESOURCE ASSESSMENT</li> <li>• GEOCHEMISTRY</li> </ul>	STATEWIDE SELECTED AREAS	
6/1/80 - 5/31/81	69,469.50	224,907	<ul style="list-style-type: none"> <li>• THERMAL SPRING INVENTORY</li> <li>• THERMAL SPRING SAMPLING</li> <li>• CHEMICAL ANALYSES</li> <li>• REPORTING</li> </ul>	STATEWIDE " " "	

CONTRACTING AGENCY: UNIVERSITY OF ALASKA (FAIRBANKS)  
 CONTRACT NUMBER(S): EW-78-S-07-1720,  
 PRINCIPAL INVESTIGATOR: DA. TURNER

CONTRACT PERIOD	\$ CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
1/1/78 - 9/30/78	100,000	- 0 -	• COMPILE DATA ON LOW TO MODERATE TEMPERATURE RESOURCES	STATEWIDE	
9/1/78 - 10/31/78	25,000	- 0 -	• EVALUATE IGNEOUS BODIES	SUGARLOAF, JUMBO DOME, CINDER CONES	
10/1/78 - 6/30/79	45,000	- 0 -	• AERIAL PHOTOGRAPHY • GROUND CONTROL NETWORK • PROJECT REPORT	MT. WRANGELL CALDERA " " " " " "	
7/1/79 - 10/30/79	50,000	- 0 -	• MEASURE GLACIAL MOVEMENTS • PHOTOGRAMMETRY	" " " " " "	
3/7/79 - 3/6/80	320,081	8,357	• RESOURCE ASSESSMENT • TEMPERATURE & GRAVITY STUDIES • GEODATUMS • ACTIVE SEISMIC PROBING • ELECTROMAGNETIC STUDIES	NEW AREAS SELECTED AREAS " " " " " "	
3/6/80 - 3/6/81	149,971	5,410	• REGIONAL RECONNAISSANCE • GEOLOGICAL/GEOPHYSICAL STUDIES	CHENA HOT SPRINGS UNALASKA	

CONTRACTING AGENCY: UNIVERSITY OF ARIZONA  
 CONTRACT NUMBER(S): EG-77-S-02-4362, DE-FC07-79TD12009  
 PRINCIPAL INVESTIGATOR: RICHARD HAHMAN

CONTRACT PERIOD	\$ CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
5/1/77 - 4/30/78	95,301	- 0 -	• REGIONAL STUDIES	STATEWIDE	
1/16/79 - 1/15/80	226,739	- 0 -	• EXPLORATION TECHNIQUE • SITE SPECIFIC STUDIES • ENERGY RESOURCE MAP.	GENERAL " "	
Mod. # A001 ? 1/15/80 - 5/31/80	130,231	- 0 -	• TIME EXTENSION		
5/31/80 - 1/15/81	300,000	- 0 -	• GEO DATA • LOCATE, SAMPLE, TEMP. • MAPPING, WATER TESTS, AGE DATES • HEAT FLOW MAPPING • GRAVITY SURVEY & STRUCTURAL GEOLOGY, WATER TESTS, • RECONNAISSANCE • GEO DATA • GEO DATA • GEO DATA, STRUCTURE, GRAVITY • GEO DATA	AURA VALLEY ALL ARIZONA HOT SPRINGS CLIFTON AND GILLARD HOT SPRINGS STATEWIDE NORTHERN HASSAVAMP PLAIN UNSTUDIED AREAS. DAPAGO & YUMA INDIAN RESERVATIONS. SAN PEDRO VALLEY SAFFORD - SAN SIMON AREA TUCSON AREA	

CONTRACTING AGENCY: COLORADO GEOLOGICAL SURVEY  
 CONTRACT NUMBER(S): EG-77-S-07-1678, DE-AS07-77ET08365  
 PRINCIPAL INVESTIGATOR: Richard Pearl

CONTRACT PERIOD	\$ CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
6/27/77 - 6/06/78	154,130	7,000	<ul style="list-style-type: none"> <li>• DATA SYNTHESIS</li> <li>• GEOLOGIC &amp; GEOPHYSICAL STUDIES</li> <li>• ENVIRONMENTAL ASSESSMENT</li> </ul>	STATEWIDE SELECTED SITES USFS LANDS.	
1/1/79 - 10/31/79	100,000	D. PEARL'S SALARY	<ul style="list-style-type: none"> <li>• GEOLOGY &amp; GEOPHYSICS -</li> <li>• GEOLOGY &amp; GEOPHYSICS</li> <li>• GEOPHYSICAL STUDIES</li> <li>• TESTING AND ANALYSIS</li> </ul>	SAN LUIS VALLEY CAÑON CITY OTHER AREAS JAGOSA SPRINGS WELL	
6/21/79 - 10/31/79	100,000	- 0 -	?	?	
3/1/80 - 2/28/81	?	?	<ul style="list-style-type: none"> <li>• SEISMIC PROFILE</li> <li>• RESISTIVITY &amp; SEISMIC SURVEY</li> <li>• RECONNAISSANCE STUDY</li> <li>• GEOLOGIC STUDY</li> <li>• GEOLOGIC STUDY</li> <li>• THERMAL GRADIENTS</li> <li>• GROUND WATER TEMPS AND FIELD MAP</li> <li>• GEOPHYSICAL DATA ACQUISITION</li> <li>• SOIL MERCURY SURVEYS</li> <li>• NOAA &amp; USGS ASSISTANCE</li> </ul>	• CAÑON CITY • CAÑON CITY • IDAHO SPRINGS • OURAY AREA • ANIMAS VALLEY • STATEWIDE • STATEWIDE • STATEWIDE • SELECTED HOT SPRINGS	

CONTRACTING AGENCY: IOPHO DEPARTMENT OF WATER RESOURCES  
 CONTRACT NUMBER(S): EG-77-S-07-1663, AE-AS07-77ET28407  
 PRINCIPAL INVESTIGATOR: JOHN MITCHELL

CONTRACT PERIOD	\$ CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
1/28/77 - 7/1/77	6000	- 0 -	<ul style="list-style-type: none"> <li>• COMPILATION AND SYNTHESIS PLAN</li> <li>• TECHNICAL PLAN DEV.</li> </ul>	STATEWIDE SOUTHERN IOAHO	
?	146,329	?	<ul style="list-style-type: none"> <li>• GEOTHERM DATA</li> <li>• STATEWIDE DATA SYNTHESIS</li> <li>• FIELD DATA COLLECTION</li> <li>• GEOCHEMICAL COMPUTERIZATION</li> <li>• LINEAMENT STUDY</li> <li>• GEOPHYSICAL DATA (UNPUB.)</li> <li>• SITE RECOMMENDATION</li> <li>• ENVIRONMENTAL ASSESSMENTS</li> <li>• FINAL REPORT</li> </ul>	STATEWIDE — SELECTED AREAS STATE WIDE STATEWIDE SELECTED AREAS — SELECTED AREAS	
5/15/78 - 9/30/78	206,000	- 0 -	<ul style="list-style-type: none"> <li>• GEOLOGY &amp; GEOPHYSICS</li> </ul>	POCATELLO - TYNNE NIAMI - CALDWELL	?
10/1/78 - 9/30/79	223,040	- 0 -	<ul style="list-style-type: none"> <li>• SPRING DEPOSITS</li> <li>• GEOLOGY &amp; GEOPHYSICS</li> <li>• SPRING DEPOSITS</li> </ul>	STATEWIDE POCATELLO - TYNNE NIAMI - CALDWELL STATEWIDE.	?



CONTRACTING AGENCY: IDAHO DEPARTMENT OF WATER RESOURCES (CONT.)  
 CONTRACT NUMBER(S): EG-77-S-07-1663, DE-AS07-77ET08407  
 PRINCIPAL INVESTIGATOR: JOHN MITCHELL

CONTRACT PERIOD	\$ CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
9/29/79 - 9/30/80	53,125	- 0 -	• GEOTHERMAL/GROUNDWATER STUDY	RAFT RIVER SITE	
4/30/80 - 4/30/81	250,000	17,500	• GEOTHERMAL INVESTIGATION • GEOTHERMAL INVESTIGATION • " " " • ASSISTANCE	WIND RIVER VALLEY WASHINGTON COUNTY SOUTHEAST IDAHO IDAHO OFFICE OF ENERGY	

CONTRACTING AGENCY: KANSAS GEOLOGICAL SURVEY  
 CONTRACT NUMBER(S): DE-AS07-79 ET 2704  
 PRINCIPAL INVESTIGATOR: DAVID STEEDLES

CONTRACT PERIOD	\$ CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
8/6/79 - 3/31/80	85,642	6,251	<ul style="list-style-type: none"> <li>• GEOTHERMAL GRADIENT MAP</li> <li>• AEROMAGNETIC SURVEY</li> <li>• TREND ANALYSIS</li> <li>• THERMAL CONDUCTIVITY PROFILES</li> <li>• HYDROTHERMAL POTENTIAL</li> </ul>	STATEWIDE NORTHWEST KANSAS STATEWIDE _____ ARBUCKLE FM.	
4/6/80 - 3/31/81	123,835	12,753	<ul style="list-style-type: none"> <li>• THERMAL GRADIENT MAP</li> <li>• AEROMAGNETIC STUDIES</li> <li>• GRAVITY SURVEY</li> <li>• GEOCHEMISTRY</li> <li>• GEOTHERM FILES</li> <li>• REPORTING.</li> </ul>	FIELD CHECKED WESTERN KANSAS SOUTHEAST KANSAS STATEWIDE	

CONTRACTING AGENCY: MONTANA BUREAU OF MINES AND GEOLOGY  
 CONTRACT NUMBER(S): EY-76-S-06-2426, DE-FC07-791012033  
 PRINCIPAL INVESTIGATOR: John L. Sauderogger

CONTRACT PERIOD	\$ CONTRIBUTION:		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
10/1/77 - 9/30/79	86,400	- 0 -	<ul style="list-style-type: none"> <li>• SAMPLE AND TEST SPRINGS</li> <li>• COMPILER GEOLOGIC / GEOPHYSICAL DATA</li> <li>• HYDROLOGIC MODELS</li> <li>• GEOTHERM UPDATE</li> <li>• PRELIMINARY RESOURCE MAP</li> </ul>	MADISON / RED ROCK AREAS " " " " " " STATE OF MONTANA	
5/1/78 - 9/30/78	34,415	3,254	<ul style="list-style-type: none"> <li>• THERMAL SPRING INVENTORY</li> <li>• STATE / LOCAL ASSISTANCE</li> <li>• NEW AREA STUDIES</li> <li>• DATA TRANSFER TO USGS</li> </ul>	STATE WIDE — —	
5/1/78 - 9/30/78	29,191	6,214	<ul style="list-style-type: none"> <li>• BEGIN W. YELLOWSTONE STUDY</li> <li>• GEOPHYSICAL STUDIES - HOT SPRINGS</li> </ul>	— SELECTED SITES	
2/15/79 - 2/14/80	99,917	10,778	<ul style="list-style-type: none"> <li>• CENTENNIAL VALLEY PROJECT</li> <li>• GEOPHYSICAL &amp; HYDROGEOLOGIC DATA - KANON HOT SPRINGS</li> <li>• DATA TRANSFER TO USGS</li> <li>• W. YELLOWSTONE STUDY ?</li> <li>• DATA COMPILATION DEADLINES</li> <li>• AIRBORN HEAT SENSING ANALYSIS</li> <li>• TEST DRILLING</li> </ul>	SELECTED SITES — — — ENNIS, MONT.	

CONTRACTING AGENCY: MONTANA BUREAU OF MINES AND GEOLOGY (CONT.)  
 CONTRACT NUMBER(S): E4-76-3-06-2426, DE-FC07-79ID12033  
 PRINCIPAL INVESTIGATOR: John L. SANDEREGGER

CONTRACT PERIOD	# CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
1/3/80 - 9/2/80	150,000	23,410	<ul style="list-style-type: none"> <li>• FIELD STUDIES</li> <li>• HEAT SENSING IMAGERY</li> <li>• DATA TO GEOTHERM</li> <li>• WARM WELL AND SPRING INVENTORY</li> <li>• GEOLOGY &amp; GEOPHYSICS</li> </ul>	W. YELLOWSTONE, LITTLE BITTERROOT VALLEY, RADESBURG  _____  _____  EASTERN MONTANA  DEER LODGE, ANACONDA VALLEY, HELENA VALLEY	

CONTRACTING AGENCY: NEW MEXICO STATE UNIVERSITY  
 CONTRACT NUMBER(S): EW-78-S-07-1717, OE-AS07-781001717  
 PRINCIPAL INVESTIGATOR: \_\_\_\_\_

CONTRACT PERIOD	# CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
3/15/78 - 9/30/79	150,000	35,000	<ul style="list-style-type: none"> <li>• SUBSURFACE TEMPERATURES</li> <li>• WATER ANALYSES TABULATION</li> <li>• SEISMICITY STUDY</li> <li>• HEAT FLOW DATA</li> <li>• THERMAL GRADIENT STUDY</li> <li>• VOLCANIC TECTONICS</li> <li>• GEOPHYSICAL DATA COMPILATION</li> <li>• HYDROLOGIC INVESTIGATIONS</li> <li>• DRILLING PROGRAM</li> </ul>	STATEWIDE STATEWIDE STATEWIDE STATEWIDE NEAR USER MARKETS. (LARGE CITIES) RIO GRANDE RIFT? MAJOR GEOTHERMAL AREAS " " " LAS ALTURAS, SOMERO PEAK	
5/15/79 - 5/15/80	200,000	40,015	<ul style="list-style-type: none"> <li>• SEISMIC PROFILE</li> <li>• SEISMIC STUDY, TRITIUM STUDY, HYDROLOGY</li> <li>• GEODATA</li> <li>• GEOPHYSICAL STUDIES</li> <li>• THERMAL WELL LOGGING</li> <li>• FAULT MAPPING, SAMPLING</li> <li>• RECONNAISSANCE STUDY</li> </ul>	LAS ALTURAS SOCORRO TRUTH OR CONSEQUENCES CHAMBERLAIN & MESQUITE SOUTH CENTRAL COUNTIES BLACK RANGE, PATRILLO MOUNTAINS, TULAMSA BASIN NORTHWEST COUNTIES.	

CONTRACTING AGENCY: NEW MEXICO STATE UNIVERSITY (CONT.)  
 CONTRACT NUMBER(S): DE-AS07-781001717  
 PRINCIPAL INVESTIGATOR: \_\_\_\_\_

CONTRACT PERIOD	\$ CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
5/15/80 - 5/15/81	300,000	43,054	PUBLIC & TECHNICAL MAPS OIL & GAS WELL DATA COLLECTION RESEARCH DATA COLLECTION LINEAMENT MAP WATER WELL DATA GEOPHYSICS & THERMAL GRADIENT DRILLING THERMAL GRADIENT DRILLING GROUNDWATER COMPUTER SIMULATION	STATEWIDE STATEWIDE STATEWIDE STATEWIDE SOUTH RIO GRANDE RIFT WEST MESA OF ALBU. DONA ANA & LUNA COS. ANIMAS VALLEY/ LIGHTNING ROCK KGRA	

CONTRACTING AGENCY: UNIVERSITY OF NORTH DAKOTA  
 CONTRACT NUMBER(S): OE-FC07-79ID12030  
 PRINCIPAL INVESTIGATOR: KENNETH L. HARRIS

CONTRACT PERIOD	# CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
1/15/79 - 1/14/80	41,597	9,547	<ul style="list-style-type: none"> <li>• OIL &amp; GAS CATION HOLE DATA</li> <li>• COMPUTER MAPS - HYDRO-THERMAL RESERVOIRS</li> <li>• WATER QUALITY</li> <li>• GEOTHERMAL POTENTIAL</li> </ul>	STATEWIDE  STATEWIDE  MADISON AQUIFER  STATEWIDE	
3/8/80 - 3/7/81	108,169	20,171	<ul style="list-style-type: none"> <li>• THERMAL GRADIENT MAP</li> <li>• GEOLOGIC MAPS - AQUIFERS</li> <li>• WATER QUALITY DATA</li> <li>• GEOTHERM FILES</li> </ul>	STATEWIDE  SELECTED AREAS  STATEWIDE  —	

CONTRACTING AGENCY: UNIVERSITY OF NEBRASKA  
 CONTRACT NUMBER(S): DE-AS07-79ET27205  
 PRINCIPAL INVESTIGATOR: \_\_\_\_\_

CONTRACT PERIOD	\$ CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
4/1/79 - 5/31/81	161,843	5,500	<ul style="list-style-type: none"> <li>• OIL &amp; GAS WELL TEMPERATURE DATA BANK (13,000)</li> <li>• THERMAL GRADIENT DRILLING</li> <li>• MAP &amp; SECTION DISPLAY</li> </ul>	STATEWIDE  SELECTED SITES  _____	



CONTRACTING AGENCY: OREGON DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES  
 CONTRACT NUMBER(S): DE-EG07-79D12044, 79ETS7920  
 PRINCIPAL INVESTIGATOR(S) DONALD A. HULL, Joseph Riccio

CONTRACT PERIOD	\$ CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
<u>5/23/79 - 7/30/80</u>	660,447	30,472	*GEOLOGY AND LINEAMENT STUDY *TECTONIC FRAMEWORK STUDY *THERMAL GRADIENT DRILLING *GEOCHEMISTRY *GRAVITY SURVEY - *AEROMAG & GRAVITY SURVEY	CASCADE RANGE COAST RANGE AND WESTERN CASCADES WESTERN AND CENTRAL CASCADES GENERAL NORTHERN CASCADES SOUTHERN CASCADES	
<u>5/23/79 - 12/31/80</u>	331,491	35,735	*GEOGRAPHIC COMPILATION *GEOLOGIC MAPPING *TEMPERATURE GRADIENT	9 AREAS 9 AREAS 9 AREAS	
<u>5/23/80 - 5/31/81</u>	400,000	30,450	*GEOGRAPHIC COMPILATION *GEOLOGIC MAPPING *TEMPERATURE GRADIENT *GEOCHEM SAMPLING *STATEWIDE RECONN.	3 AREAS 3 AREAS 3 AREAS GENERAL "	

CONTRACTING AGENCY: SOUTHERN METHODIST UNIVERSITY  
 CONTRACT NUMBER(S): DE-AS07-79ID12037  
 PRINCIPAL INVESTIGATOR: \_\_\_\_\_

CONTRACT PERIOD	# CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
7/10/79 - 5/31/80	163000	0	SURFACE AND SUBSURFACE GEOPHYSICAL STUDIES	CASCADE RANGE IN WASHINGTON AND OREGON. BASIN & RANGE IN OREGON	

CONTRACTING AGENCY: UNIVERSITY OF TEXAS AT AUSTIN  
 CONTRACT NUMBER(S): DE-AS07-791012057  
 PRINCIPAL INVESTIGATOR: \_\_\_\_\_

CONTRACT PERIOD	\$ CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
7/1/79 - 9/30/80	327,002	0	*HYDROLOGIC ASSESMENT CRETACEOUS AQUIFERS	CENTRAL TEXAS	
			*LINEAMENT STUDY	STATEWIDE	
			*LINEAMENT/FAULT STUDY	CENTRAL TEXAS	
			*WATER TEMPERATURE SURVEY	STATEWIDE	
			*GEOTHERMAL GRADIENT MAP	STATEWIDE	
			*GEOTHERM DATA FILES	—	
			*TEXAS PUBLIC MAP	—	

CONTRACTING AGENCY: TEXAS ENERGY AND NATURAL RESOURCES ADVISORY COUNCIL (TENRAC)  
 CONTRACT NUMBER(S): DE-FC07-791012080  
 PRINCIPAL INVESTIGATOR: DAVID M. WHITE

CONTRACT PERIOD	\$ CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
9/28/79 - 9/30/81	170,000	50,000	<ul style="list-style-type: none"> <li>• GEOLOGIC ANALYSIS</li> <li>• TEMPERATURE GRADIENT DRILLING</li> <li>• GEOPHYSICAL STUDIES</li> <li>• DATA ANALYSIS</li> <li>• REPORTING</li> </ul>	HUECO TANKS & PRESIDIO BOLSON AREAS HUECO TANKS & PRESIDIO BOLSON AREAS HUECO TANKS & PRESIDIO BOLSON _____ _____	



CONTRACTING AGENCY: WASHINGTON DEPARTMENT OF NATURAL RESOURCES  
 CONTRACT NUMBER(S): DE-AC03-79 ET 27014  
 PRINCIPAL INVESTIGATOR: \_\_\_\_\_

CONTRACT PERIOD	\$ CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
11/1/78 - 10/31/79	096,894	12,984	THERMAL SPRING INVENTORY PUBLICATION OF BIBLIOGRAPHY GEOTHERMOMETERS COMPILER DATA BANK	GENERAL	
4/1/80 - 3/31/81	993,406	- 0 -	HEAT FLOW DRILLING  TEMPERATURE MEASUREMENTS GEOLOGIC MAPPING GRAVITY SURVEY  GEOCHEMISTRY FAULT LINEAMENT MAP	SOUTHERN CASCADES  3 AREAS MT. ADAMS OR MT. BAKER  CENTRAL AND NORTHERN CASCADES.  4 AREAS SOUTHERN CASCADES ? SOUTHWEST COLUMBIA BASINS	8 HOLES DRILLED, 3 UNDER VOLCANIC ASH.

CONTRACTING AGENCY: UNIVERSITY OF WYOMING

CONTRACT NUMBER(S): DE-FC07-791018026

PRINCIPAL INVESTIGATOR: EDWARD DECKER

CONTRACT PERIOD	\$ CONTRIBUTION		WORK DESCRIPTION	LOCATION	REMARKS
	DOE	STATE			
12/11/72 - 9/30/79	99,439	7,048	<ul style="list-style-type: none"><li>• THERMAL SPRING ANALYSES</li><li>• THERMAL GRADIENTS</li><li>• DETAILED STUDIES</li><li>• MAGNETIC &amp; RADIOMETRIC SURVEYS</li><li>• OIL &amp; GAS WELL SURVEY DEEP AQUIFERS</li></ul>	STATEWIDE SELECTED AREAS GAS HILLS/DOUGLAS N. EXTENSION OF RIO GRANDE RFT. STATEWIDE	
6/13/79	16,239	1,137	<ul style="list-style-type: none"><li>• GEOTHERMAL ASSESSMENT</li></ul>	GAS HILLS/RED DESERT	
8/1/79	34,671	3,458	<ul style="list-style-type: none"><li>• TEMP, GRADIENT, HEAT FLOW</li><li>• THERMAL GRADIENT DRILL HOLES</li></ul>	SELECTED SITES COOY, WYOMING	
6/1/80 - 5/31/81	154,500	15,213	<ul style="list-style-type: none"><li>• THERMAL SPRING &amp; WELL INVENTORY</li><li>• THERMAL GRADIENT MAPS</li><li>• GEOLOGY &amp; HYDROLOGY</li><li>• CHEM. ANALYSES &amp; GEOL.</li><li>• HEAT FLOW MAPS</li><li>• GEOTHERM FILES</li><li>• REPORTING</li></ul>	STATEWIDE " SARATOGA, CASPER-MIDWEST AUBURN, OUBOIS SELECTED SPRINGS. SELECTED REGIONS _____ _____	

# UURI

EARTH SCIENCE LABORATORY  
420 CHIPETA WAY, SUITE 120  
SALT LAKE CITY, UTAH 84108  
TELEPHONE 801-581-5283

## MEMORANDUM

August 22, 1980

TO: State Coupled Program Core Group  
FROM: Robert Blackett and Duncan Foley  
SUBJECT: Resource Assessment Program - Equipment Needs

The following state by state summaries are the result of informal telephone conversations with individual RA teams. The purpose of the conversations was to assess each teams short term equipment needs for DOE budgetary purposes.

- Nevada: No equipment needs at the present time. They are anticipating additional funds for equipment through the MX missile program studies. All Nevada team members will be attending the GRC meeting in Salt Lake City.
- Nebraska: The Nebraska RA team needs to acquire a 4.5 digit Volt ohm-meter and 1500 to 2000 feet of 4 conductor cable. Estimated cost of equipment is from \$1500 to \$3000.
- Oregon: The Oregon team cannot get water analyses performed through the State Health Department due to recent budget cutbacks. They are currently sending water samples for analysis to UURI/ESL. They request the purchase of a portable spectrophotometer at an estimated cost of \$1000 to \$2000.
- Colorado: No equipment needs at the present time. They did however recently purchase a thermistor probe and accessory equipment from Fluid Dynamics, Inc. a Golden, Co. based company to use in thermal gradient studies. Dick Pearl reports that the equipment appears to be very well built and compact for their needs.
- Utah: The Utah RA team wishes to purchase 2 conductivity meters, 1 PH meter and other components to construct a thermal gradient probe similar to David Chapman's at the University of Utah. Estimated cost of the equipment is \$3500.



Montana:

The Montana RA team has requested the acquisition of a "multi-channel signal enhancement seismograph (12 channel) model #ES-1210F by EG&G Geometrics". The state of Montana will cost share the purchase of the device by contributing 25% of the total cost. The advantages of the seismograph will be its' utility in populated areas, where explosives cannot be used, and its' penetration depth of up to 1000 feet for assessment of shallow resources. The proposed cost share for the purchase price at \$19,355 is because the Montana Bureau of Mines and Geology and the Geophysics Department at Montana Tech. wish to use the seismograph on other projects. The Montana RA team expects a proposal to be submitted under the User Coupled Confirmation Drilling Program from an individual at the town of Ennis, Montana for space heating development of a clinic.

California:

The California RA team needs a good down hole water level measuring instrument. An estimated cost of the equipment and all accessories is about \$220. There may be some problem with getting money into the California program for purchase of the instrument as all government money is placed in a general fund. Apparently, the mechanism of retrieval of money out of the fund and into the program that it was meant for is quite complex.

Idaho:

The Idaho RA team would like to obtain a petrographic microscope. Estimated cost of the microscope is between \$3000 and \$5000 (this may be a very low estimate).

Texas-BEG:

Due to numerous problems encountered with their existing thermistor probe purchased from Envirolabs (a California corporation), the Texas RA team needs to obtain another probe with much more reliability. They suggested the possibility of looking into the Yellow Springs Instrument Company from Yellow Springs, Ohio. Estimated cost of the probe is about \$2500.


Texas-TENRAC:

The West Texas program also needs a good reliable thermistor probe and accessory equipment for thermal gradient studies. They estimate the costs for all the equipment at approximately \$5000.

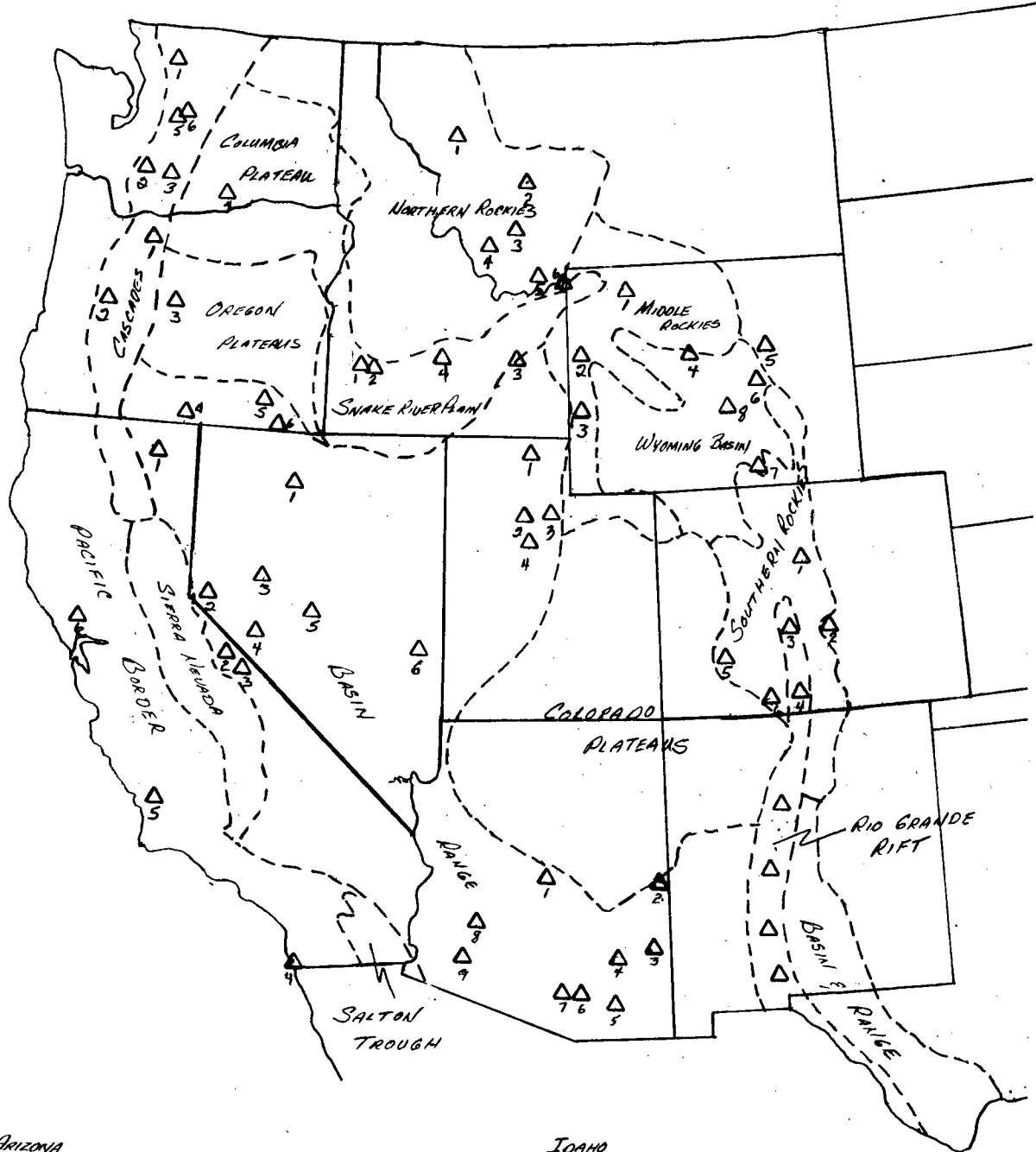
Washington:

The Washington RA team would like to replace their Gisco thermistor probe with some better equipment if possible. The Gisco equipment lacks mobility and sensitivity to temperature measurements. They would also like to purchase equipment to measure high temperatures in pyroclastic material on Mt. St. Helens. An estimated cost of the high temperature equipment from Markson Scientific, Inc. (Delmar, CA) is \$370 for the unit plus all accessories.

  
Robert Blackett

  
Duncan Foley

RB,DF/cw



ARIZONA

- |                    |                   |                     |
|--------------------|-------------------|---------------------|
| 1. VELDE VALLEY    | 4. SAFFORD        | 7. AVRA VALLEY      |
| 2. SPRINGER-ALPINE | 5. SAN PEDRO VAL. | 8. MASSAVAMPA PLAIN |
| 3. CLIFTON         | 6. TUCSON         | 9. PALAMOS-HADER.   |

CALIFORNIA

- |               |                    |
|---------------|--------------------|
| 1. KELLY HS.  | 4. IMPERIAL BRANCH |
| 2. BRIDGEPORT | 5. PASA ROBLES     |
| 3. MONO       | 6. CALISTOGA       |

COLORADO

- |                |                    |
|----------------|--------------------|
| 1. JOHNS SPR.  | 4. SAN LUIS VALLEY |
| 2. CANTON CITY | 5. OURAY           |
| 3. ANIMAS VAL. | 6. PAGOSA          |

IDAHO

- |                   |                      |
|-------------------|----------------------|
| 1. NAMPA-CALDWELL | 4. WOOD RIVER VALLEY |
| 2. BOISE          |                      |
| 3. TYHEE          |                      |

MONTANA

- |                  |                               |
|------------------|-------------------------------|
| 1. LITTLE BITTER | 4. DEER LODGE-ANACONDA VALLEY |
| 2. HELENA        | 5. CENTERINIAL VALLEY         |
| 3. RADERSBURG    | 6. WEST YELLOWSTONE           |

NEVADA

- |                |                     |
|----------------|---------------------|
| 1. GOLCONDA    | 4. HAWTHORNE        |
| 2. CARSON CITY | 5. BIG SMOKY VALLEY |
| 3. FALLON      | 6. CALIENTE         |

OREGON

- 1. PARKDALE 4. LAKEVIEW
- 2. BELKNAP-FOLEY 5. ALDRIDGE DESERT
- 3. POWELL BUTTES 6. McDERMITT

UTAH

- 1. N. WASCATCH 3. MIDWAY
- 2. JORDAN VALLEY 4. CRYSTAL HS.

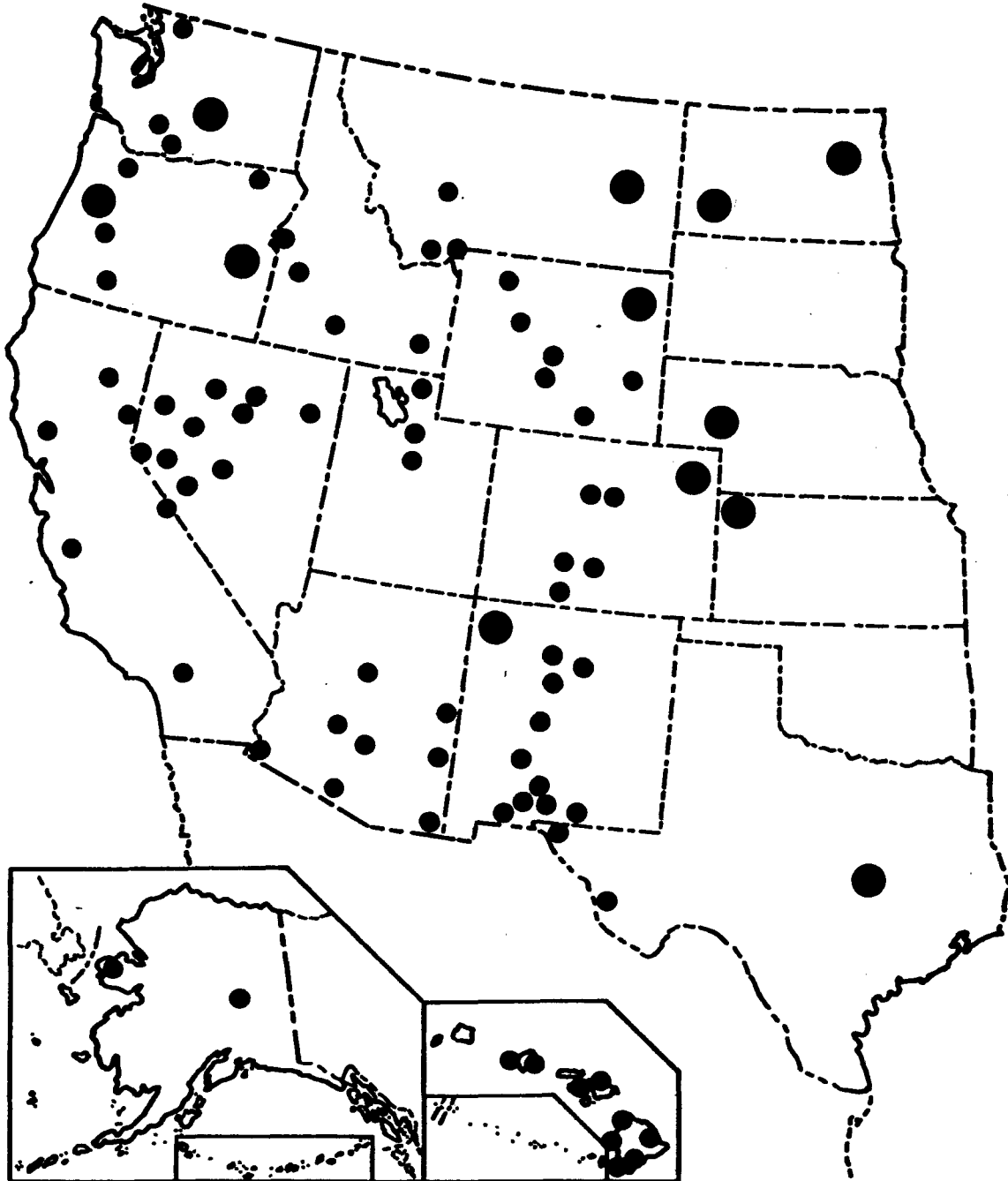
WASHINGTON

- 1. MT. BAKER 3. MT. ADAMS
- 2. MT. ST. HELENS 4. S.W. COLUMBIA BASIN
- 5. SNOQUALMIE PASS
- 6. STEVENS PASS
- 7.

WYOMING

- 1. COOY 4. THERMOPOLIS
- 2. DUBOIS 5. MIDWEST
- 3. AUBURN 6. CASPER
- 7. SARATOGA
- 8. GAS HILLS

# **CURRENT RESOURCE ASSESSMENT PROGRAMS**



- **REGIONAL STUDIES**
- **AREA STUDIES**

# UURI

EARTH SCIENCE LABORATORY  
420 CHIPETA WAY, SUITE 120  
SALT LAKE CITY, UTAH 84108  
TELEPHONE 801-581-5283

## M E M O R A N D U M


June 23, 1981

TO: Rodger H. Chapman  
FROM: Duncan Foley  
RE: Resistivity Modeling, San Bernardino, CA

Enclosed please find a memorandum written by Mr. Claron Mackelprang, a geophysicist with the Earth Science Laboratory. Claron modeled the data you provided from San Bernardino; these models are enclosed.

I hope these models will help you in understanding the San Bernardino geothermal system.

If you have any questions, please contact either Claron or me at the phone number above.



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DF:gm

enclosures

# UURI

EARTH SCIENCE LABORATORY  
420 CHIPETA WAY, SUITE 120  
SALT LAKE CITY, UTAH 84108  
TELEPHONE 801-581-5283

## MEMORANDUM

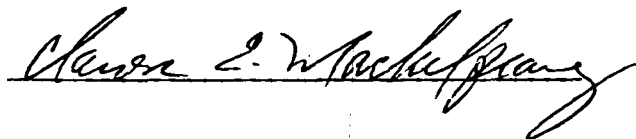
June 22, 1981

TO: Duncan Foley  
FROM: Claron E. Mackelprang  
SUBJECT: Dipole-Dipole Resistivity Modeling San Bernardino area, California

Attached please find model results for the data submitted to ESL by Mr. Rodger H. Chapman of California Division of Mines and Geology regarding the captioned area. Only Line DD #1 (Urbeta) has barely sufficient data to warrant any degree of confidence in the model as shown. Line DD #2 (Harlem Springs) is very ambiguous due to the paucity of data provided. Three possible models are shown for this line, none of which give a good fit to the observed data along all the diagonals, but are however included to show the range in ambiguity present.

In evaluating the models, please note depths shown along the sides of the computer printouts are fractions of the dipole length. Numbers shown in the model are also related to assigned media resistivity (ohm-feet) in the order given. Locations of the respective electrodes are also shown across the pseudosection.

The models require intrinsic resistivities that range between 50 and 1500 ohm-feet in order to closely approximate the observed data. The lower resistivities may be related to the thermal fluids present. The higher resistivities could perhaps be explained by fresh water saturated sands or gravels. This is not intended as an interpretation of the data but rather as a means of explaining the sharp resistivity contrasts required by the models in order to approximate the field data.



CEM:jp

attachments

SAN BERNARDINO, CALIFORNIA

LINE D-D' #1 (URBETA)

MEDIA RESISTIVITY (OHM-METERS)

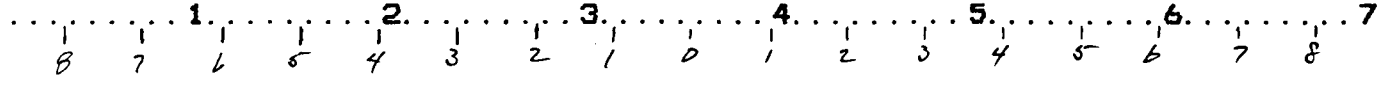
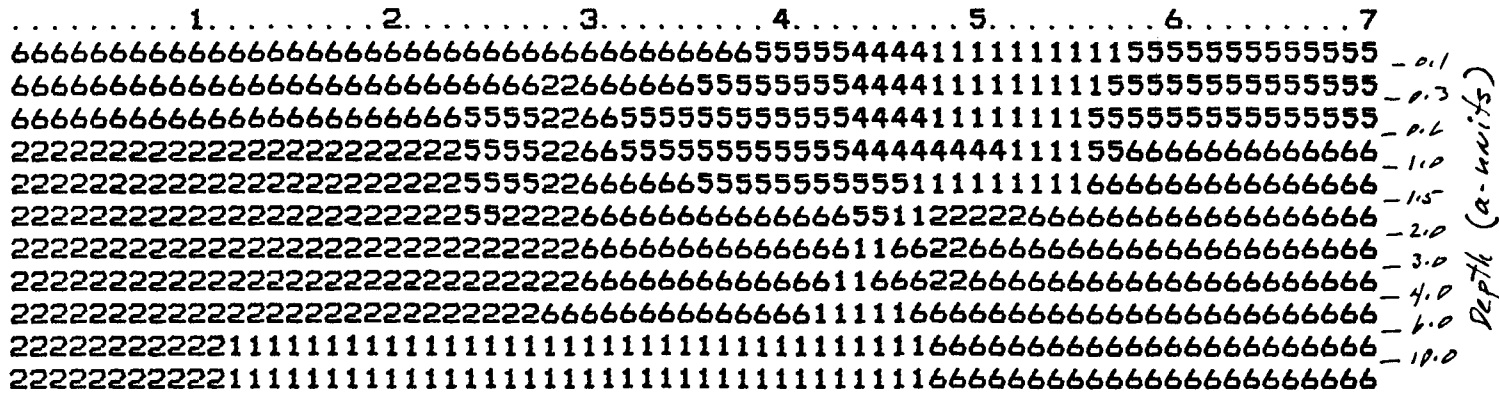
50.00 100.00 150.00 200.00 300.00

500.00

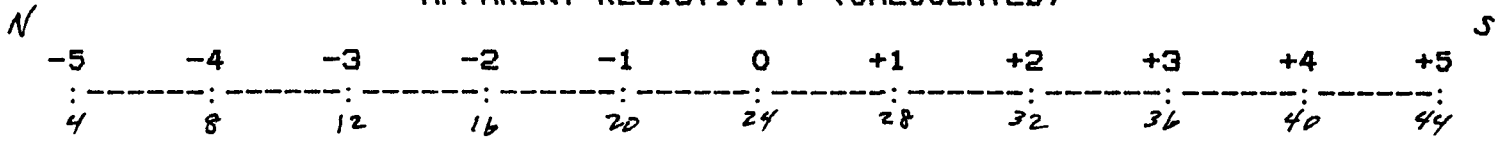
MEDIA PFE (%)

0.00 0.00 0.00 0.00 0.00

0.00

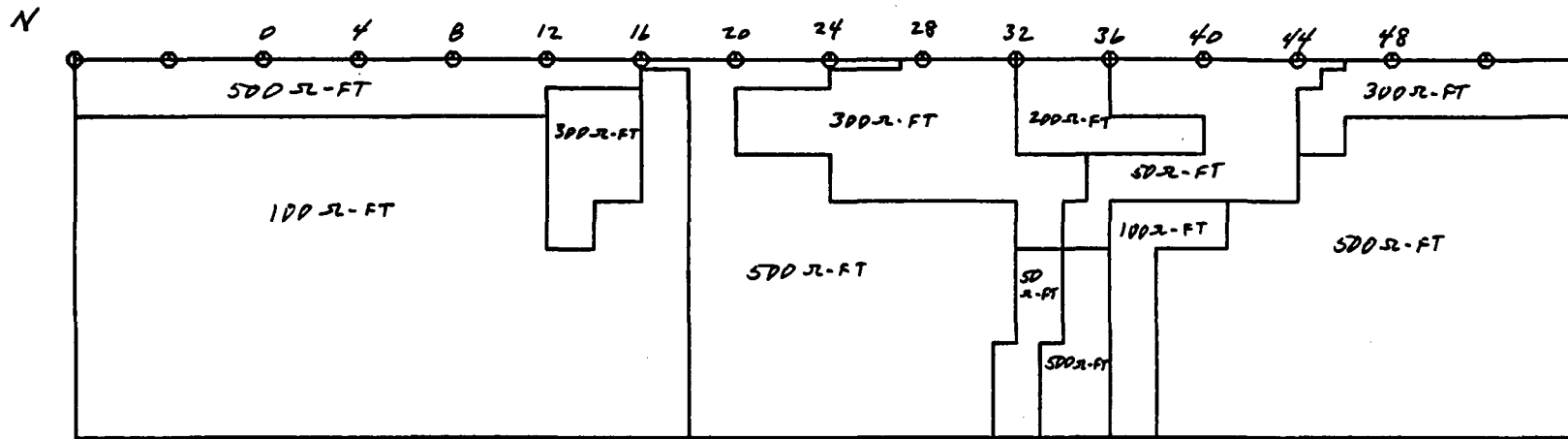


APPARENT RESISTIVITY (CALCULATED)

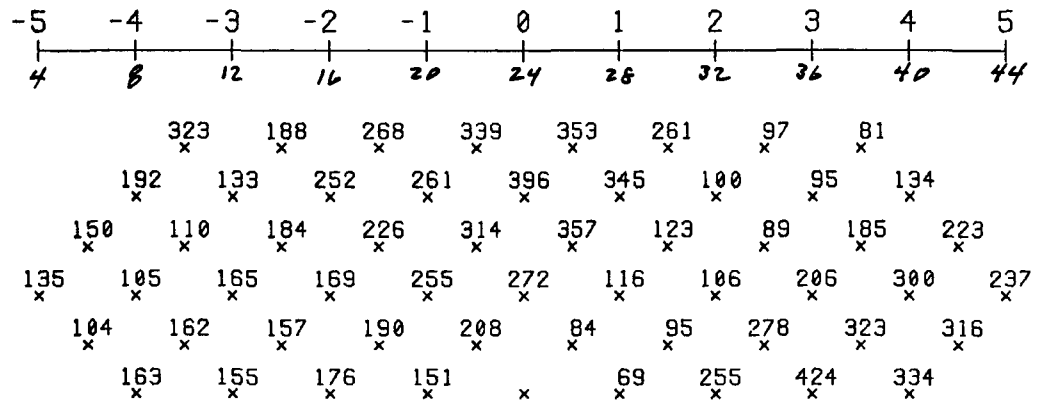


			163		333		272		88	
observed	323.	188.	268.	339.	353.	261.	97.	81.		
calculated	240		225		341		114		145	
	192.	133.	252.	261.	396.	345.	100.	95.	134.	
	150.	160		229		369	130	100	239	
	110.	184.	226.	314.	357.	123.	89.	185.	223.	
	135.	105.	127		210		117		278	
	165.	169.	255.	272.	116.	106.	206.	300.	237.	
	104.	162.	152		128		80		315	
	157.	190.	208.	84.	95.	278.	323.	316.		
	163.	155.	140		151.		69.		292	
	176.		255.	424.	334.					

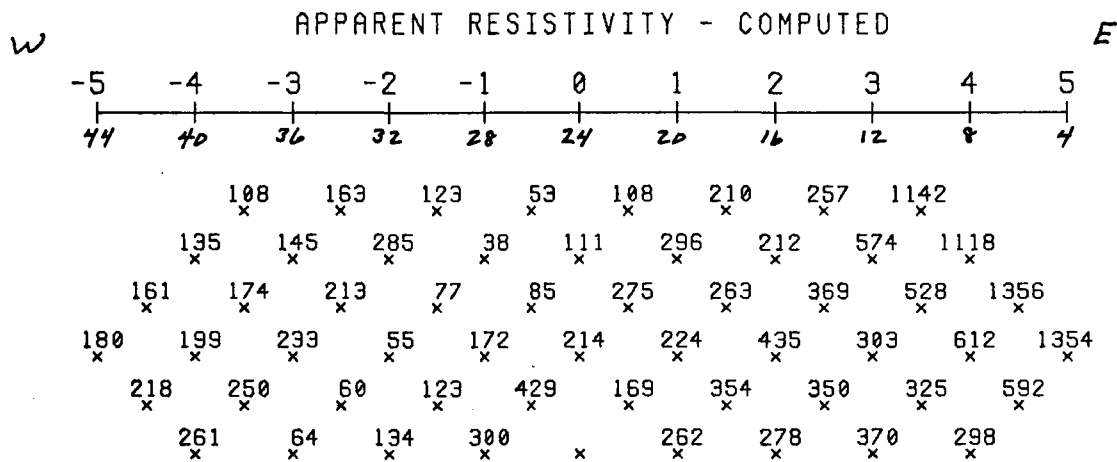
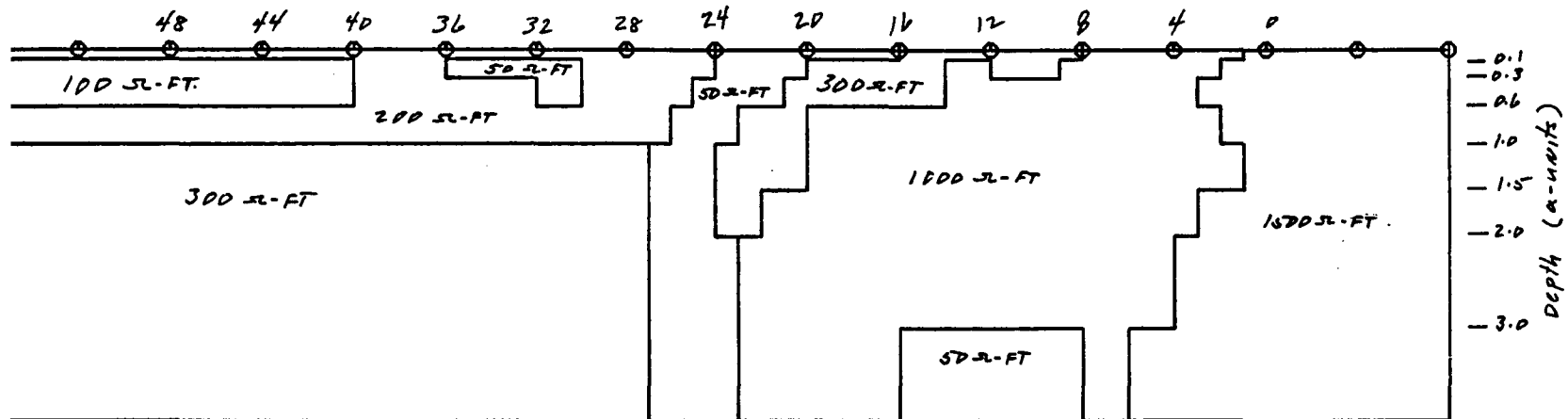




APPARENT RESISTIVITY - COMPUTED







SAN BERNARDINO, CALIFORNIA  
 LINE D-D' #2 (HARLEM SPRINGS)





DEPARTMENT OF CONSERVATION  
DIVISION OF MINES AND GEOLOGY  
SACRAMENTO DISTRICT OFFICE  
2815 O STREET  
SACRAMENTO, CA 95816  
(Phone 916-445-5716)



February 14, 1980

Dr. Duncan Foley  
Earth Science Laboratory  
420 Chipeta Way, Suite 120  
Salt Lake City, Utah 84108

Dear Dr. Foley:

Enclosed are six dipole - dipole electrical resistivity pseudo-sections from Calistoga, California to be modeled via your computer program. These are the sections that we discussed in regards to our low temperature geothermal resource investigation program pursuant to our D.O.E. contract. The electrode spacing is 200 feet and resistivity values are in ohm-ft. The data does not conform to your limitation of 6N spacing. Therefore, would you delete a portion of the values across the bottom of each pseudo-section or alternately select resistivity values throughout the section to conform to the 6N restriction? Also, enclosed is a 7½ minute quadrangle map indicating the location of each pseudo-section.

The geologic reference that we discussed covering this area is the Preliminary Geologic Map of Eastern Sonoma County and Western Napa County, California by K.F. Fox, Jr., J.D. Sims, J.A. Bartow, and E.J. Helley, USGS Miscellaneous Field Studies Map MF-483, 1973. A thumbnail analysis of the geology for the valley around Calistoga is an initial irregular surface composed of Franciscan Formation draped by the Sonoma Volcanics. Subsequent or partially concurrent erosion and alluvial deposition formed the present valley structure.

Our main interest in conducting the electrical survey is to delineate the hot water zones around Calistoga. There are many hot water wells in the City of Calistoga and surrounding area. The general temperature is perhaps 250°F. Well logs generally show that the depth to the hot water zones is over 100 feet below the surface. We initially suspect that the distribution of hot water is controlled by subsurface faulting.

I have also enclosed our preliminary complete Bouguer gravity map of the Calistoga, California 15 minute quadrangle.

Please contact me on any problems that may arise in your computer analysis of this data. We greatly appreciate your time and effort in helping us on this project.

Sincerely,

A handwritten signature in cursive script that reads "Leslie G. Youngs".

Leslie G. Youngs  
Geologist/Geophysicist

LGY:yo

enclosures

# UURI

EARTH SCIENCE LABORATORY  
420 CHIPETA WAY, SUITE 120  
SALT LAKE CITY, UTAH 84108  
TELEPHONE 801-581-5283

## MEMORANDUM

TO: Les Youngs  
FROM: Duncan Foley  
SUBJECT: Resistivity modeling - Calistoga, CA

The following comments on the resistivity data from your survey at Calistoga are by Bill Sill of the University of Utah Department of Geology and Geophysics staff.

If you have any questions, please contact Bill directly at 801-581-7205.



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Duncan Foley  
Geologist/Project Manager

Of the six lines of dipole-dipole data, the four in the vicinity of the geyser (R-3, R-5, R-7, R-8) show low resistivity zones (3-10 ohm-feet) that may be of interest. Line R-5 shows a limited low resistivity zone (10 ohm-feet) at intermediate  $n$  spacings. Near the intersection with line R-8, line R-7 may also show this zone, although it appears at larger  $n$  spacings and has a smaller apparent resistivity (3-6 ohm-ft.). On line R-7 this conductive zone continues almost to line R-3. At this point in the pseudo section there are some highly suspect values (i.e., 100's of ohm-ft. values next to 10's of ohm-ft.). These sort of changes in  $\rho_a$  for a unit change in  $n$  or a horizontal change of one dipole are generally impossible to model, at least with 2 dimensional models. Beyond this region there is again a suggestion of a low resistivity zone, at moderate  $n$  values.

Lines R-3 and R-8, which are roughly parallel and cross the above lines, show similar conductive zones at intermediate depths. The nature and extent of the zones in the intersecting pseudosections indicate that the region is not very two dimensional. However, the extent of the conductive zone in lines R-5 and R-7 suggests that the best choice for two dimensional

modeling would be the perpendicular lines R-3 and R-8. The modeling of these two lines is discussed in more detail below.

Line R-4 shows moderately high resistivity and a general trend of increasing resistivity to the NE. The contours and values suggest the possibility of a contact near 3200' SW. Line R-6 shows mainly a shallow more conductive zone to the west.

#### Models of lines R-8 and R-3

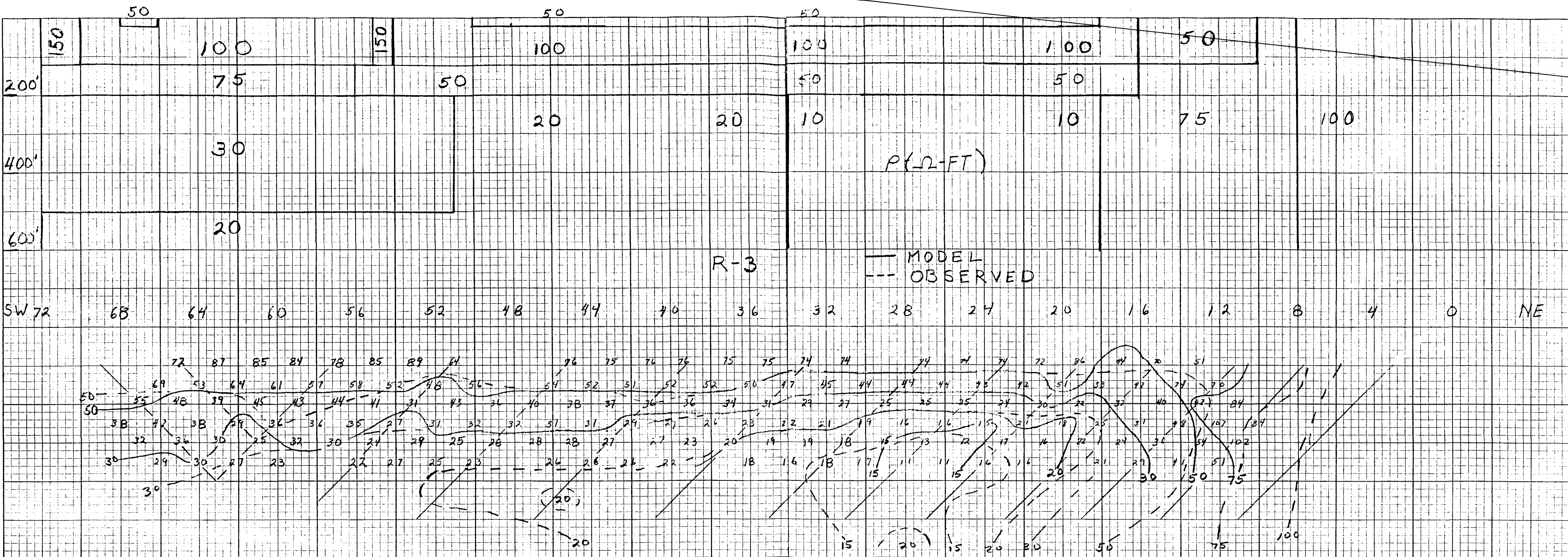
The model for line R-8 and the calculated results and the observed data (contours) are shown in Figure 1. The diagonals show the locations of the lines of observed data. There is generally good agreement between the model results and the observed data except for the region below 3200' SW. Here again, there are some suspicious observed data, with very low values next to very large ones.

The model shows a very broad conductive region (<20 ohm-ft.) centered roughly on the geyser. The most conductive region (5 ohm-ft.) is at the surface right at the geyser and seems to be shifted to the NE at depth. Looking at the model-observed comparison below 2200' SW (the model has larger apparent resistivity) suggests that we might get somewhat better fit by expanding the width of the 5 ohm-ft. zone at depth. The data used in the modeling ( $n < 6$ ) does not really limit the depth extent of this zone.

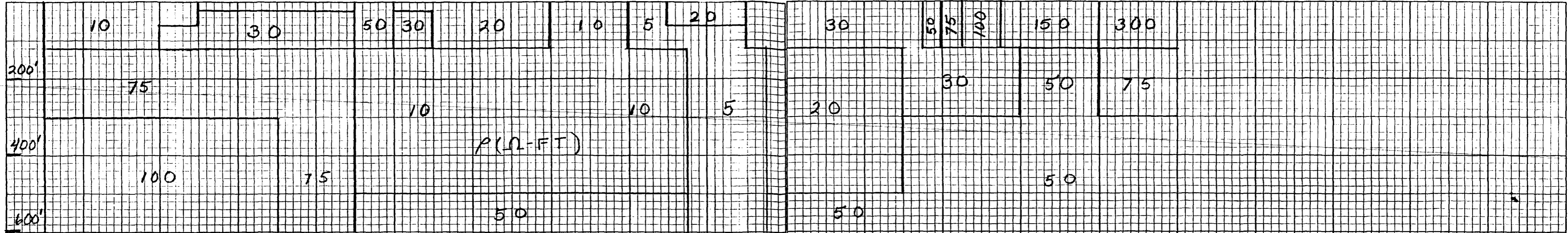
Figure 2 shows a similar display of model and observed data for line R-3. Here the data quality seems to be better and the agreement is quite good. Line R-3 shows a conductive zone (10-20 ohm-ft.) similar to line R-8 but the conductive zone does not extend to the surface. Also, R-3 shows a moderately conductive zone (20-30 ohm-ft.) extending much further to the SW than is seen in the model R-8. Have again, the depth extent of the lower layers in the model are not restricted by the data.

DF/hb





20



SW

R-8

MODEL  
OBSERVED

NE

56 52 48 44 10 36 32 28 24 20 16 12 8 4 0

