

GL00850

**BACKGROUND INFORMATION AND PLAN
FOR
MX MISSILE SYSTEM
GEOHERMAL RESOURCE ASSESSMENT
AND DEVELOPMENT
NEVADA AND UTAH**

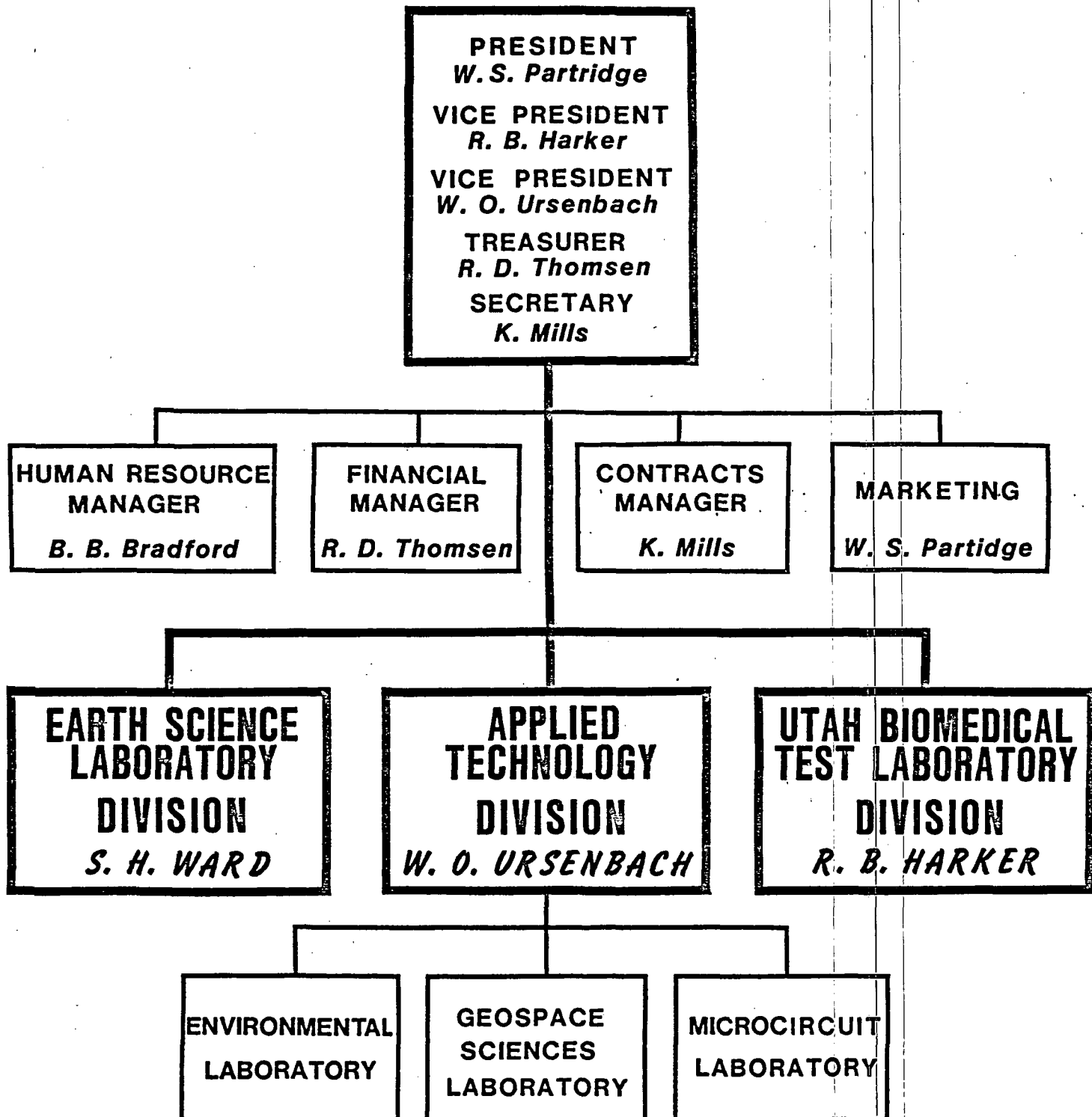
**DENNIS L. NIELSON
HOWARD P. ROSS**

**EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE
SALT LAKE CITY, UTAH**

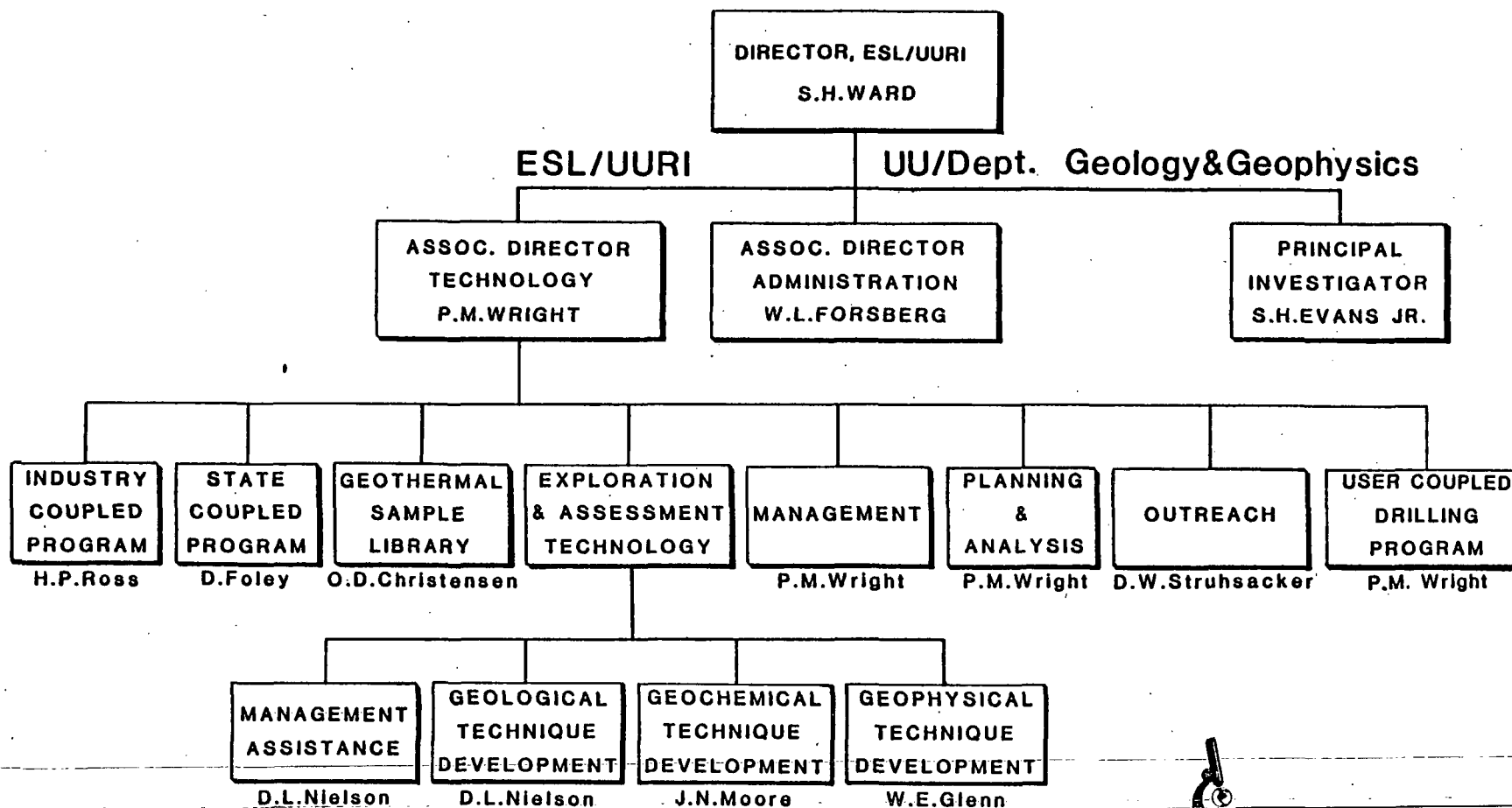
**AUGUST 25, 1980
LAS VEGAS, NEVADA**

UNIVERSITY of UTAH RESEARCH INSTITUTE

ORGANIZATIONAL CHART



**PROJECT MANAGEMENT
 ESL/UURI & UU (Subcontractor)
 DOE CONTRACT NO. DE-AC07-80ID12079**



ESL/UURI

DOE CONTRACT PERSONNEL

Prime support contractor for geosciences in the west

29 GEOSCIENTISTS

GEOLOGY

GEOCHEMISTRY

GEOPHYSICS

HYDROLOGY

30 SUPPORT STAFF



GEOHERMAL SAMPLE LIBRARY

TASKS

- * ACQUIRE, PREPARE, STORE & DISTRIBUTE GEOTHERMAL SAMPLES**
 - DRILL CORE AND CUTTINGS**
 - FLUIDS FROM WELLS & SPRINGS**
 - ROCKS AND SOIL COLLECTED OVER GEOTHERMAL RESOURCES AREAS**

 - * DEVELOP BASIC GEOLOGICAL GEOPHYSICAL & GEOCHEMICAL DATA SETS FOR ALL SAMPLES STORED IN LIBRARY**

 - * MAINTAIN AN OPEN - FILE FACILITY WHERE GEOSCIENTISTS CAN INSPECT & STUDY GEOTHERMAL SAMPLES AND ASSOCIATED DATA .**
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GEOHERMAL SAMPLE LIBRARY

SAMPLE HOLDINGS -JUNE 1980

DRILL CHIPS

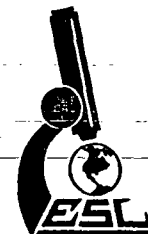
210,560 feet
21,980 pounds

CORE

6,180 feet
11,940 pounds

HAND SAMPLES

600 pieces



EARTH SCIENCE LABORATORY
UNIVERSITY OF UTAH RESEARCH INSTITUTE

PUBLICATIONS TO DATE

- Atwood, J. W., Killpack, T. J., and Glenn, W. E., 1980, Computer System for Digitizing, Analyzing and Plotting Well Log Data (A User's Guide to Wellog, Rev. 1): (DOE/ID/12079-1, ESL-31).
- Bamford, R. W., 1978, Geochemistry of Solid Materials From Two U.S. Geothermal Systems and Its Application to Exploration: 196 p. (IDO/77.3.2, ESL-6).
- Bamford, R. W., and Christensen, O. D., 1979, Multi-element geochemical exploration data for the Cove Fort-Sulphurdale Known Geothermal Resource Area, Beaver and Millard Counties, Utah: 48 p. (DOE/ET 28392-28, ESL-19).
- Bamford, R. W., Christensen, O. D., and Capuano, R. M., 1980, Multi-element Geochemistry of Solid Materials in Geothermal Systems and Its Application, Part I: The Hot-Water System at the Roosevelt Hot Springs KGRA Utah: (DOE/ET/27002-7, ESL-30).
- Capuano, R. M., and Bamford, R. W., 1978, Initial Investigation of Soil Mercury Geochemistry as an Aid to Drill Site Selection in Geothermal Systems: 32 p. (IDO/78-1701.b.3.3., ESL-13).
- Christensen, O. D., Kroneman, R. L., and Capuano, R. M., 1980, Multi-element analysis of Geologic Materials by Inductively Coupled Plasma - Atomic Emission Spectroscopy: (DOE/ID/12079-2, ESL-32).
- Fox, R. C., 1978, Dipole-Dipole Resistivity Survey of a Portion of the Coso Hot Springs KGRA, Inyo County, California: 21 p. (IDO/77.5.6, ESL-2).
- Fox, R. C., 1978, Low-Altitude Aeromagnetic Survey of a Portion of the Coso Hot Springs KGRA, Inyo County, California: 19 p. (IDO/77.5.7, ESL-4).
- Fox, R. C., Hohmann, G. W., and Rijo, L., 1978, Topographic Effects in Resistivity Surveys: 33 p. (IDO/78-1701.b.3.2.1, ESL-11).
- Galbraith, R. M., 1978, Geological and Geophysical Analysis of Coso Geothermal Exploration Hole No. 1 (CGEH-1), Coso Hot Springs KGRA, California: 39 p. (IDO/78-1701.b.4.2, ESL-5).
- Glenn, W. E., and Hulen, J. B., 1979, Interpretation of Well Log Data from Four Drill Holes at Roosevelt Hot Springs KGRA: 74 p. (DOE/ET/28392-38, ESL-28).
- Glenn, W. E., Chapman, D. S., Foley, D., Capuano, R. M., Sibbett, B. S., Cole, D., and Ward, S. H., 1980, Geothermal Exploration at Hill Air Force Base, Ogden, Utah: (DOE/ET/28392-42, ESL-34).

- Hohmann, G. W., and Ting, S. C., 1978, Three Dimensional Magnetotelluric Modeling: 48 p. (IDO/77.3.1, ESL-7).
- Hohmann, G. W., and Jiracek, G. R., 1979, Bipole-dipole interpretation with three-dimensional models (including a field study of Las Alturas, New Mexico): 48 p. (DOE/ET 28392-29, ESL-20).
- Hulen, J. B., 1978, Geology and Alteration of the Coso Geothermal Area, Inyo County, California: 28 p. (IDO/78-1701.b.4.1, ESL-3).
- Hulen, J. B., 1978, Stratigraphy and Alteration, 15 Shallow Thermal Gradient Holes, Roosevelt Hot Springs KGRA and Vicinity, Millard and Beaver Counties, Utah: 15 p. (IDO/78-1701.b.1.1, ESL-9).
- Hulen, J. B., 1979, Geology and Alteration of the Baltazor Hot Springs and Painted Hills Thermal Areas, Humboldt County, Nevada: 21 p. (DOE/ET/28392-36, ESL-27).
- Killpack, T. J., and Hohmann, G. W., 1979, Interactive Dipole-Dipole Resistivity and IP Modeling of Arbitrary Two-Dimensional Structures (IP2D Users Guide and Documentation): 120 p. (IDO/78-1701.b.3.2.3, ESL-15).
- McKinney, D. B., 1978, Annotated Bibliography of the Geology of the Roosevelt Hot Springs Known Geothermal Resource Area and the Adjacent Mineral Mountains, March 1978: 15 p. (IDO/78-1701.b.1.1.4, ESL-10).
- Moore, J. N., 1979, Geology Map of the San Emidio, Nevada Geothermal Area: 8 p. (DOE/ET/28392-33, ESL-23).
- Moore, J. N., and Samberg, S. M., 1979, Geology of the Cove Fort-Sulphurdale KGRA with Bibliographic Annotations and Petrographic Descriptions by B. Sibbett: 44 p. (IDO/78-1701.b.1.1.5, ESL-18).
- Nielson, D. L., Sibbett, B. S., McKinney, D. B., Hulen, J. B., Moore, J. N., and Samberg, S. M., 1978, Geology of Roosevelt Hot Springs KGRA, Beaver County, Utah: 120 p. (IDO/78-1701.b.1.1.3, ESL-12).
- Nielson, D. L., 1978, Radon Emanometry as a Geothermal Exploration Technique; Theory and an Example from Roosevelt Hot Springs KGRA, Utah: 31 p. (IDO/78-1701.b.1.1.2, ESL-14).
- Nielson, D. L., ed., 1979, Program Review: Geothermal Exploration and Assessment Technology Program Including a Report of the Reservoir Engineering Technical Advisory Group: 128 p. (DOE/ET/27002-6, ESL-29).
- Ross, H. P., 1979, Numerical Modeling and Interpretation of Dipole-Dipole Resistivity and IP Profiles, Cove Fort-Sulphurdale KGRA, Utah: 39 p. (DOE/ET/28392-37, ESL-26).

Sibbett, B. S., 1979, Geology of the Soda Lake Geothermal Area: 27 p. (DOE/ET/28392-24, ESL-24).

Sibbett, B. S., and Nielson, D. L., 1980, Geology of the Central Mineral Mountains, Beaver County, Utah: (DOE/ET/28392-40, ESL-33).

Smith, C., 1979, Interpretation of Electrical Resistivity and Shallow Seismic Reflection Profiles, Whirlwind Valley and Horse Heaven Areas, Beowawe KGRA, Nevada: 43 p. (DOE/ET/28392-35, ESL-25).

Ward, S. H., Ross, H. P., and Nielson, D. L., 1979, A Strategy of Exploration for High Temperature Hydrothermal Systems in the Basin and Range Province: 42 p. (DOE/ET27002-5, ESL-22).

MX MISSILE SYSTEM GEOHERMAL RESOURCE ASSESSMENT AND DEVELOPMENT

OBJECTIVE

EVALUATE GEOHERMAL RESOURCES FOR SATISFYING
ENERGY REQUIREMENTS OF MX SYSTEM

→ **ELECTRICAL POWER**

180 MWe by 1989

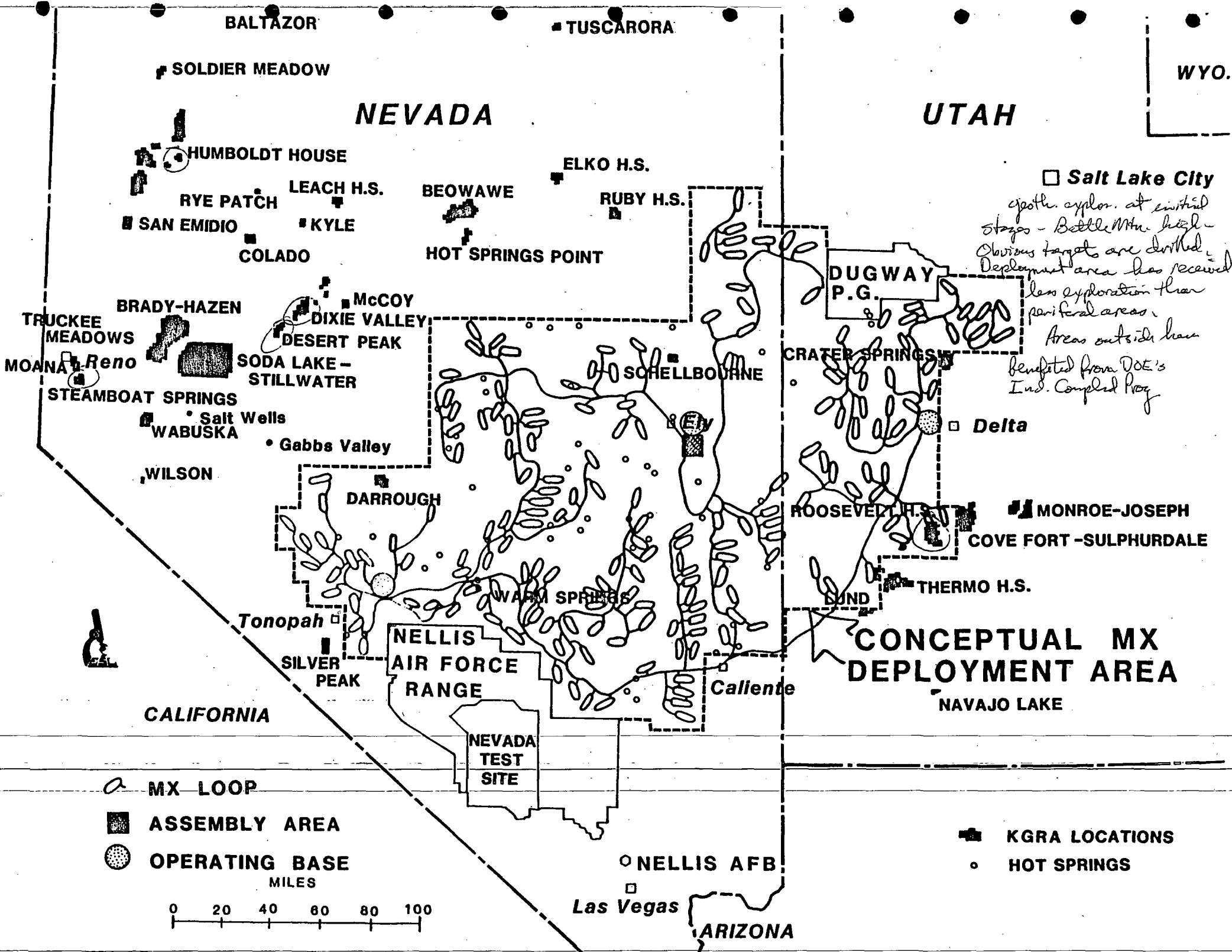
→ **SPACE and PROCESS HEAT**

?

DECISION POINT: APRIL, 1982

*Believe objectives can be met by
utilizing DOE programs which are already
in place - principally Ind. Coupl. Prog.
State Coupled Prog.
UCCOP.*





DOE/DGE INDUSTRY COUPLED PROGRAM

PROGRAM GOALS

Foster a viable geothermal industry

3,000 megawatts electricity by 1985
(0.2 quads/yr)

20,000 megawatts electricity by 2000
(1.3 quads/yr)

MECHANISM

Cost sharing with industry – exploration,
reservoir assessment,
reservoir confirmation

Release geologic data – improve
knowledge & understanding of
geothermal reservoirs

Evaluate techniques & methods



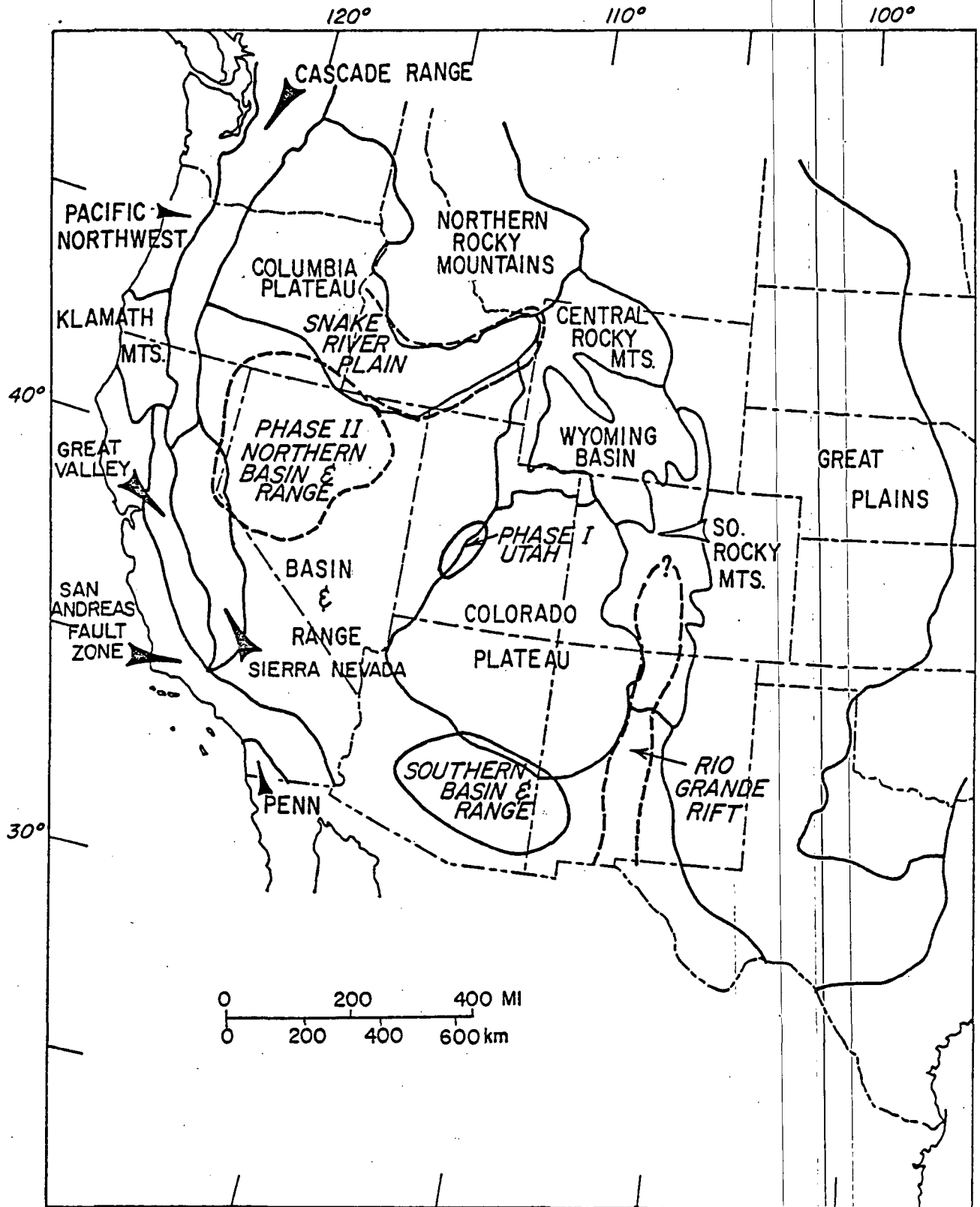
DOE/DGE INDUSTRY COUPLED PROGRAM

- 1 Identify geothermal province input from:
Industry, USGS, DOE/DGE, academic
institutions, ESL-UURI
- 2 Hearing by DOE/DGE
- 3 Request for proposals (RFP) DOE/DGE
- 4 Evaluate proposals
- 5 Contracts with industry
DOE/DGE cost sharing at 20-50%
Geologic, geophysical, geochemical,
reservoir data to DGE
- 6 Contract tracking DOE/oper.&ESL-UURI
Receive & evaluate data
Open file data
- 7 Develop case studies ESL-UURI
- 8 Publish & distribute geologic/reservoir
studies ESL-UURI



DOE/DGE INDUSTRY COUPLED PROGRAM

*Use as intro
to Ind. Coupl. Prog.*



INDUSTRY COUPLED PROGRAM

PHASE I CASE STUDIES UTAH

RFP PERIOD	MAR-MAY '77
RESPONSES TO RFP	9
CONTRACTS AWARDED	6
TOTAL AMOUNT	\$4,027,000
PERFORMANCE PERIOD	FY-77 TO FY-80

PHASE II CASE STUDIES NORTHERN BASIN & RANGE

RFP PERIOD	MAR-MAY '79
RESPONSES TO RFP	22
CONTRACTS AWARDED	12
TOTAL AMOUNT	\$9,920,000
PERFORMANCE PERIOD	FY-78 TO FY-81



PHASE I - CASE STUDIES - UTAH

RFP PROCESS

JAN '77 - SEPT '77

FUNDING (Thousands)	FY-78	FY-79	FY-80	FY-81
INDUSTRY	2,530	1,500		
ESL	330	110	40	15*

PROGRAM

ROOSEVELT HOT SPRINGS

Thermal Power Co.
 Getty Oil Co.
 ☆ Geothermal Power Corp.

Seismic Explorations, Inc.
 Denver Research Inst.

COVE FORT - SULPHURDALE

Union Oil Co.

☆ still active;
 contract modifications

EARTH SCIENCE LAB. - ACTIVITIES

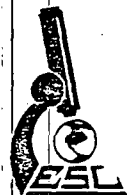
• MANAGEMENT

Contract Tracking
 Approve Ind. Deliverables

Information/Coordination
 Data Releases

• TECHNICAL

Geological Mapping
 Lithologic Studies-Cuttings
 Geophysical Interpretation
 Log Interpretation
 Review Hydrology, Reservoir Data
 Reporting



PHASE II - CASE STUDIES - NORTHERN BASIN & RANGE

RFP PROCESS NOV. '77-SEPT. '78

FUNDING	FY-78	FY-79	FY-80	FY-81	FY-82
INDUSTRY	1,300K	^{+336K} 8,600K	☆	☆	☆
ESL	30K	370K	550K	260K	30K*

PROGRAM

CHEVRON RESOURCES - BEOWAWE, SODA LAKE, SAN EMIDIO

GETTY OIL CO. - BEOWAWE, COLADO

PHILLIPS PETROLEUM - DESERT PEAK, HUMBOLDT HOUSE

AMAX EXPLORATION - McCOY, TUSCARORA

UNION OIL CO. - STILLWATER

SOUTHLAND ROYALTY (& MCKAY SCHOOL OF MINES) -
DIXIE VALLEY

EARTH POWER PRODUCTION - BALTAZOR

EARTH SCIENCE LAB. - ACTIVITIES

- MANAGEMENT

Contract tracking

Data Releases

Approve deliverables

Information center

- COORDINATION

DOE/DGE, DOE/NVO, DOE/IDO, MACKAY SCHOOL MINES,
NEVADA BUREAU MINES & GEOLOGY, LBL, USGS, LASL,
COMPANIES, CONTRACTORS, ROCKY MTN. WELL LOG.

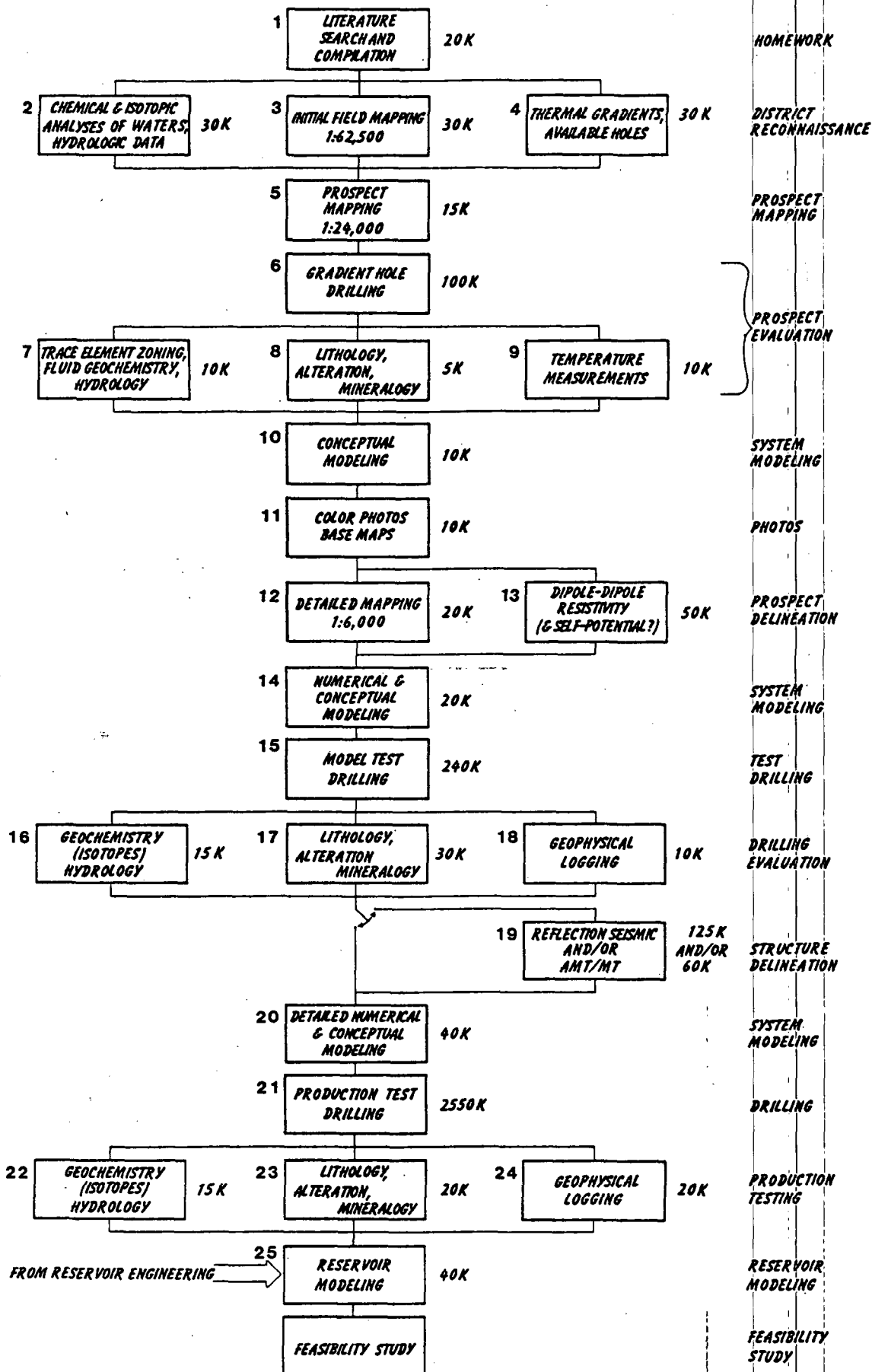
- TECHNICAL

Case Studies

Topical Studies



SUGGESTED HIGH TEMPERATURE HYDROTHERMAL EXPLORATION STRATEGY





USER COUPLED CONFIRMATION DRILLING PROGRAM



THE U.S. DEPARTMENT OF ENERGY, DIVISION OF GEOTHERMAL ENERGY (DOE/DGE) SPONSORS THE USER COUPLED CONFIRMATION DRILLING PROGRAM TO REDUCE PARTIALLY THE HIGH RISK AND HIGH COST OF CONFIRMING HYDROTHERMAL RESERVOIRS FOR DIRECT HEAT APPLICATION.

OBJECTIVES

- * TO OFFSET PARTIALLY THE CHARACTERISTICALLY HIGH RISKS AND COSTS OF RESERVOIR CONFIRMATION BY SHARING EXPENSES FOR:

EXPLORATION TO SITE DRILL HOLES

DRILLING

FLOW - TESTING

RESERVOIR ENGINEERING

INJECTION WELL DRILLING (IF REQUIRED)

- * TO DEVELOP AN EXPERIENCED INFRASTRUCTURE IN THE PRIVATE SECTOR, ENCOURAGING A CONTINUED HIGH RATE OF DEVELOPMENT AFTER THE FEDERAL PROGRAM IS PHASED OUT.

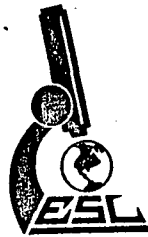
IMPLEMENTATION

- * PRIVATE INDIVIDUALS OR COMPANIES AND STATE AND LOCAL GOVERNMENT AGENCIES OFFER PROPOSALS TO DOE/DGE TO PARTICIPATE IN THE PROGRAM.
- * SUCCESSFUL PROPOSERS NEGOTIATE A CONTRACT WITH DOE/DGE INCORPORATING AN ACCEPTABLE COST-SHARE PLAN BASED ON DEGREE OF SUCCESS OF PROJECT.
- * UPON COMPLETION OF THE PROJECT (AFTER FLOW-TESTING), DEGREE OF SUCCESS IS DETERMINED AND DOE PAYS COST-SHARE.

MANAGEMENT

- * THE PROGRAM WILL BE MANAGED BY THE IDAHO OPERATIONS OFFICE OF DOE WITH ASSISTANCE FROM THE EARTH SCIENCE LABORATORY AND FROM EG&G, IDAHO INC.





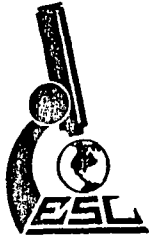
STATE COUPLED PROGRAM



THE STATE COUPLED PROGRAM IS SPONSORED BY THE U.S. DEPARTMENT OF ENERGY/DIVISION OF GEOTHERMAL ENERGY (DOE/DGE) TO ENABLE INDIVIDUAL STATE AGENCIES TO MAINTAIN COOPERATIVE AGREEMENTS WITH DOE/DGE TO ASSESS LOW AND MODERATE TEMPERATURE GEOTHERMAL RESOURCES. THE EARTH SCIENCE LABORATORY (ESL) PROVIDES TECHNICAL ASSISTANCE TO STATE RESOURCE ASSESSMENT TEAMS AND MANAGEMENT ASSISTANCE TO DOE/DGE.

PROGRAM OBJECTIVES

- * TO COLLECT AND PUBLISH REGIONAL AND AREAL GEOTHERMAL DATA.
- * TO ENCOURAGE DEVELOPMENT BY PROSPECTIVE USERS.
- * TO ASSIST THE U.S. GEOLOGICAL SURVEY (USGS) IN GEOTHERMAL RESOURCE INVENTORY . (CIRCULAR 790 UPDATE)



STATE COUPLED PROGRAM



PROGRAM OBJECTIVES

- * TO COLLECT AND PUBLISH REGIONAL AND AREAL GEOTHERMAL DATA.
- * TO ENCOURAGE DEVELOPMENT BY PROSPECTIVE USERS.
- * TO ASSIST THE U.S. GEOLOGICAL SURVEY (USGS) IN GEOTHERMAL RESOURCE INVENTORY . (CIRCULAR 790 UPDATE)

ESL TASKS

- * PROVIDE MANAGEMENT ASSISTANCE TO DOE/DGE BY COMMUNICATING PROGRAM OBJECTIVES AND LIAISON AMONG STATE CONTRACTORS , USGS, AND THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA).
- * ~~PROVIDE TECHNICAL EXPERTISE (GEOLOGICAL, GEOPHYSICAL, AND GEOCHEMICAL) AS REQUESTED BY STATE AGENCY DOE CONTRACTORS AND OTHERS.~~
- * DOCUMENT AND PUBLISH TECHNICAL ASPECTS OF THE STATE COUPLED PROGRAM THAT ARE NOT OTHERWISE DOCUMENTED.

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)

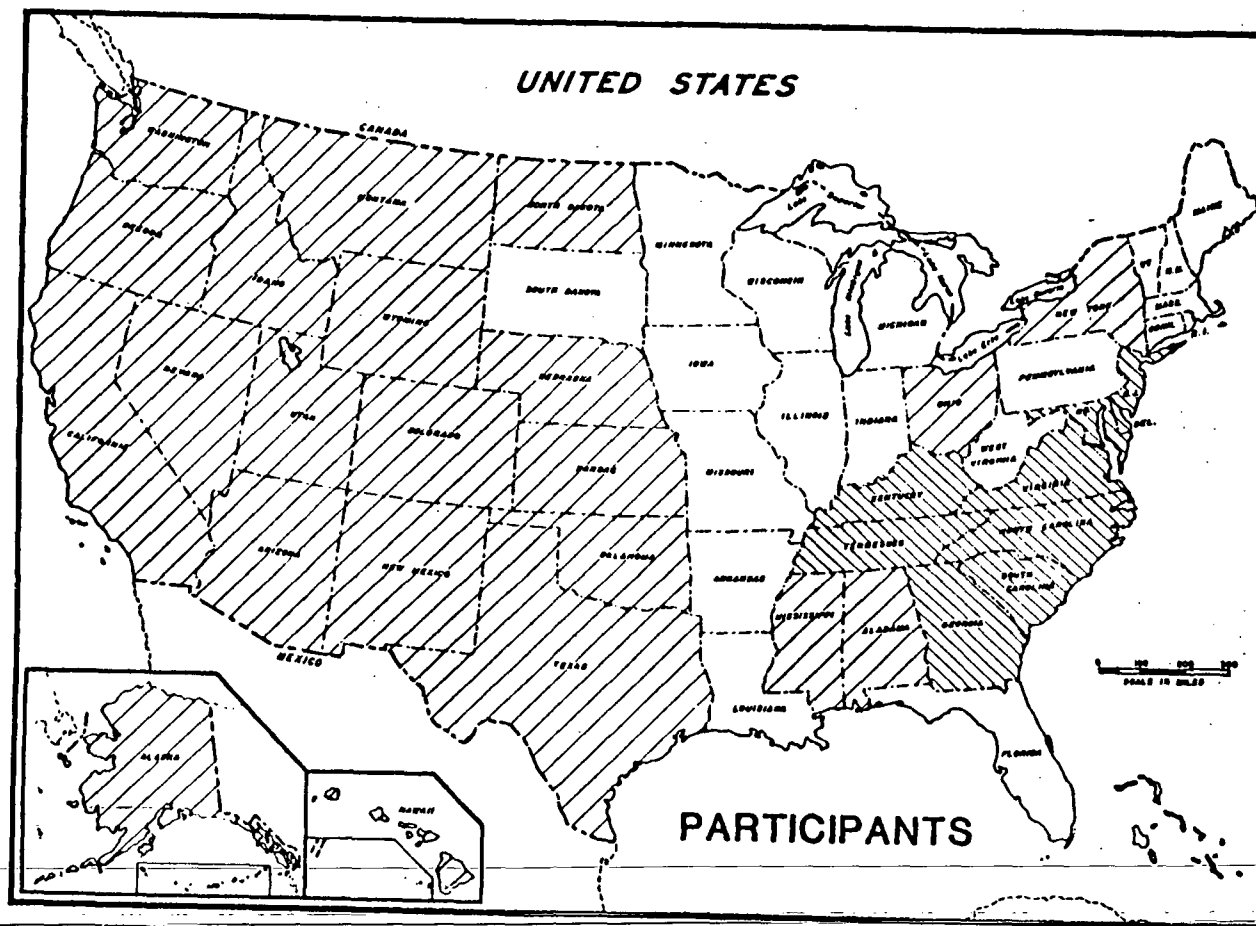
Publishing State Resource Maps



U.S. GEOLOGICAL SURVEY (USGS)

U.S. Resource Assessment and Computer Storage



STATE COUPLED PROGRAM



-  Individual State Contracts
-  University Contracts covering several states

STATE COUPLED PROGRAM

NEVADA

NEVADA BUREAU OF MINES AND GEOLOGY

DENNIS TREXLER, P.I.

RESOURCE ASSESSMENT

- EMPHASIS IN POPULATED REGIONS
- IDENTIFIED OVER 1000 THERMAL SPRINGS AND WELLS
- 28 FAVORABLE AREAS SHOWN ON USGS CIRCULAR 790 MAP
- STATE MAP PUBLISHED
- NUMEROUS REPORTS AVAILABLE



STATE COUPLED PROGRAM

UTAH

UTAH GEOLOGICAL AND MINERAL SURVEY

PETER J. MURPHY, P.I.

RESOURCE ASSESSMENT

- EMPHASIS ALONG WASATCH FRONT
- IDENTIFIED OVER 1500 THERMAL SPRINGS AND WELLS
- 8 FAVORABLE AREAS SHOWN ON USGS CIRCULAR 790 MAP
- STATE MAP AVAILABLE SEPT. 1980
- NUMEROUS REPORTS AVAILABLE



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 SERVICES

- **GENERAL INFORMATION DISSEMINATION**

- **PRELIMINARY GEOLOGIC INVESTIGATION**

 - Literature Review

 - Site Visit

- **WATER SAMPLING → GEOTHERMOMETRY**

- **COORDINATE WELL TEMPERATURE LOGGING**

- **Suggest Exploration Program**

- **INTERFACE BETWEEN USER AND CONSULTANT**

 - Interpret Consultant's Work

 - Consultants List



MX MISSILE SYSTEM

GEOTHERMAL RESOURCE ASSESSMENT AND DEVELOPMENT

PROGRAM PLAN -- DOE/DGE, UURI

PHASE I. FEASIBILITY AND RESOURCE INVENTORY

*Emphasize surface ~~drilling~~ studies - shallow drilling
Electric feasibility of sites discovered by industry outside MX area*

E-1 FEASIBILITY STUDIES (Outside MX area)

TASKS: 1. WRITE AND ISSUE RFP

2. RESPONSE BY PROPOSERS

3. PROPOSAL REVIEW AND AWARD(S)

4. CONTRACT NEGOTIATIONS

5. COMPLETION OF STUDY

6. CARRY ON (PHASE 2)

*Engineering a economic
feasibility to assess methods,
costs a schedule of delivery
electricity to MX*

*Desert Peak
Steamboat
Dixie Valley
Humboldt House
RHS*

*Could be sole source
contract*

E-2 RECONNAISSANCE EXPLORATION PROGRAM

(Inside MX area)

*1. Broaden search of area
2. select sites for additional
expl.*

TASKS: 1. COMPILATION OF LEASE DATA

2. COMPILATION OF GEOSCIENCE DATA

3. AIR PHOTO INTERPRETATION

4. SURFACE GEOLOGIC MAPPING

5. GEOCHEMICAL SAMPLING OF WELLS

6. SURFACE AND AIRBORNE GEOPHYSICAL
EXPLORATION

7. INTEGRATE HYDROLOGIC DATA

8. SITING OF THERMAL GRADIENT HOLES

9. ONGOING INTERPRETATION PRIORITIZATION

*To be done by DOE
contractors already
involved in
such*



PHASE I - (continued)

E-3 EXPLORATION DATA PURCHASE (Inside MX area)

- TASKS:**
- 1. WRITE AND ISSUE RFP**
 - 2. RESPONSE BY PROPOSERS**
 - 3. PROPOSAL REVIEW AND AWARDS**
 - 4. CONTRACT NEGOTIATIONS**
 - 5. DATA DELIVERY**
 - 6. DATA DISSEMINATION, INTEGRATION**

*Data already in company files
- save time &
much like present Ind. Corp Prog*

E-4 RESERVOIR CONFIRMATION DRILLING (Inside MX)

- TASKS:**
- 1. WRITE AND ISSUE RFP**
 - 2. RESPONSE BY PROPOSERS**
 - 3. PROPOSAL REVIEW AND AWARDS**
 - 4. CONTRACT NEGOTIATIONS**
 - 5. RESERVOIR CONFIRMATION DRILLING**

*Ind. Corp. Prog approval to
aid industry in evaluating
resource w/in MX area.*



PHASE II RESERVOIR CONFIRMATION AND PRODUCTION DRILLING

E-1 PRODUCTION DRILLING (Outside MX)

- TASKS:
1. COMPANY SELECTION
 2. CONTRACT NEGOTIATION
 3. DRILLING
 4. CONTRACT MONITORING

To speed up development at areas identified in engineering and economic feasibility studies (Phase I/Element I)

E-2 EXPLORATION RECONNAISSANCE PROGRAM (Inside MX)

TASKS: AS PER PHASE I, E-2

E-3 DETAILED SITE EXPLORATION (Inside MX)

Done by DOE contractors

AT sites not leased by industry. -

E-4 COST-SHARED DRILLING (Inside MX)

Confirm reservoirs discovered by Ph.I/El. 2 and Ph.II/El. 2, 3 and cost share production drilling at sites discovered by Ph.I/El. 4

Identified by Ph.I/El. 2, Ph.II/El. 2



MX MISSILE SYSTEM

GEOHERMAL RESOURCE ASSESSMENT AND DEVELOPMENT NEVADA AND UTAH

PROPOSED SCHEDULE

