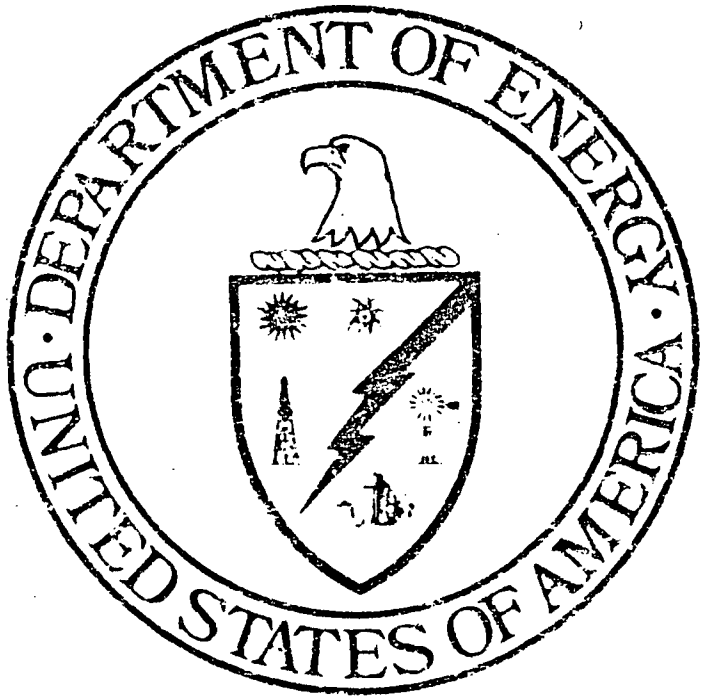
Assessment and Development of Geothermal Power at Ascension Island

- UURI - EG&G Idaho Team Qualifications
- Background
- Nature of Geothermal Resources
- Exploration and Resource Assessment
- Scenario for Project Assessment
- Scenario for Project Development
- Proposed Project Organization

S2 0317

GL00772

As presented
Patrick AFB
9 Feb '82



UURI - EG&G Idaho Team Qualifications

S2 0316

University of Utah Research Institute, Earth Science Laboratory Division Geothermal Experience

Contractor to DOE-ID

Provides primary technical support for:

- Industry Coupled Program - Nevada and Utah
- State Coupled Program - Western U.S.
- Exploration Technology Program - Nationwide
- User Coupled Confirmation Drilling Program - Nationwide

Provides technical support for:

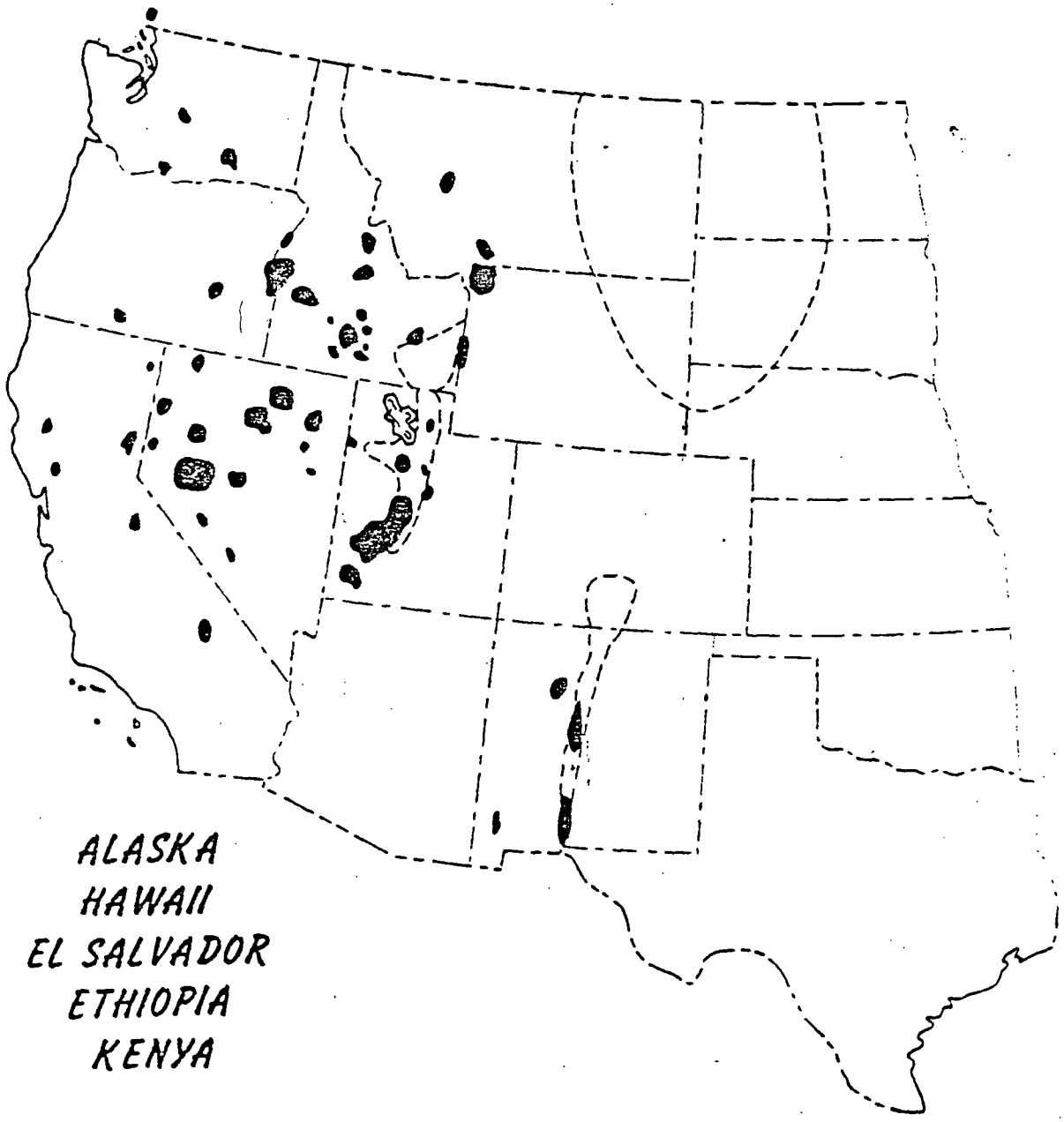
- Technology Transfer - Western U.S.
- Induced Seismicity - Roosevelt Hot Springs, Raft River
- Program Planning

University of Utah Research Institute
Earth Science Laboratory Division
Major Accomplishments

- High quality geologic mapping developed in nine geothermal areas
- Trace element geochemical techniques developed and tested
- Geochemical modeling programs implemented for fluid / rock interaction
- Unique geophysical modeling techniques developed
- Cost effective geothermal exploration architecture defined
- Major contributions made to geothermal science - 245 reports, papers, publications
- Management and technical assistance provided for $45M in DOE funded programs

S2 0349

UURI GEOTHERMAL EXPERIENCE



ALASKA
HAWAII
EL SALVADOR
ETHIOPIA
KENYA

ESL Staff

- Most earth science problems require interdisciplinary work for solution
- ESL has a balanced interdisciplinary staff

	PhD	MS	BS	Total
Geology	4	3	4	11
Geochemistry	2	1	1	4
Geophysics	5	0	1	6
Computer	0	3	1	4
Electronics	0	0	2	2
	11	7	9	27

S2 0344

EG&G Idaho Geothermal Experience

Provides primary technical support for:

- Raft River, ID, Geothermal Binary Electric Demonstration Plant
- User Coupled Confirmation Drilling Program
- Program Planning
- Direct Heat Feasibility and Field Demonstration Programs (PRDA's, PON's)

Provides technical support for:

- Reservoir Engineering
- Technology Transfer
- Geothermal Loan Guaranty Program
- Electric Conversion Technology

INEL-S-35 939

EG&G Idaho Programs

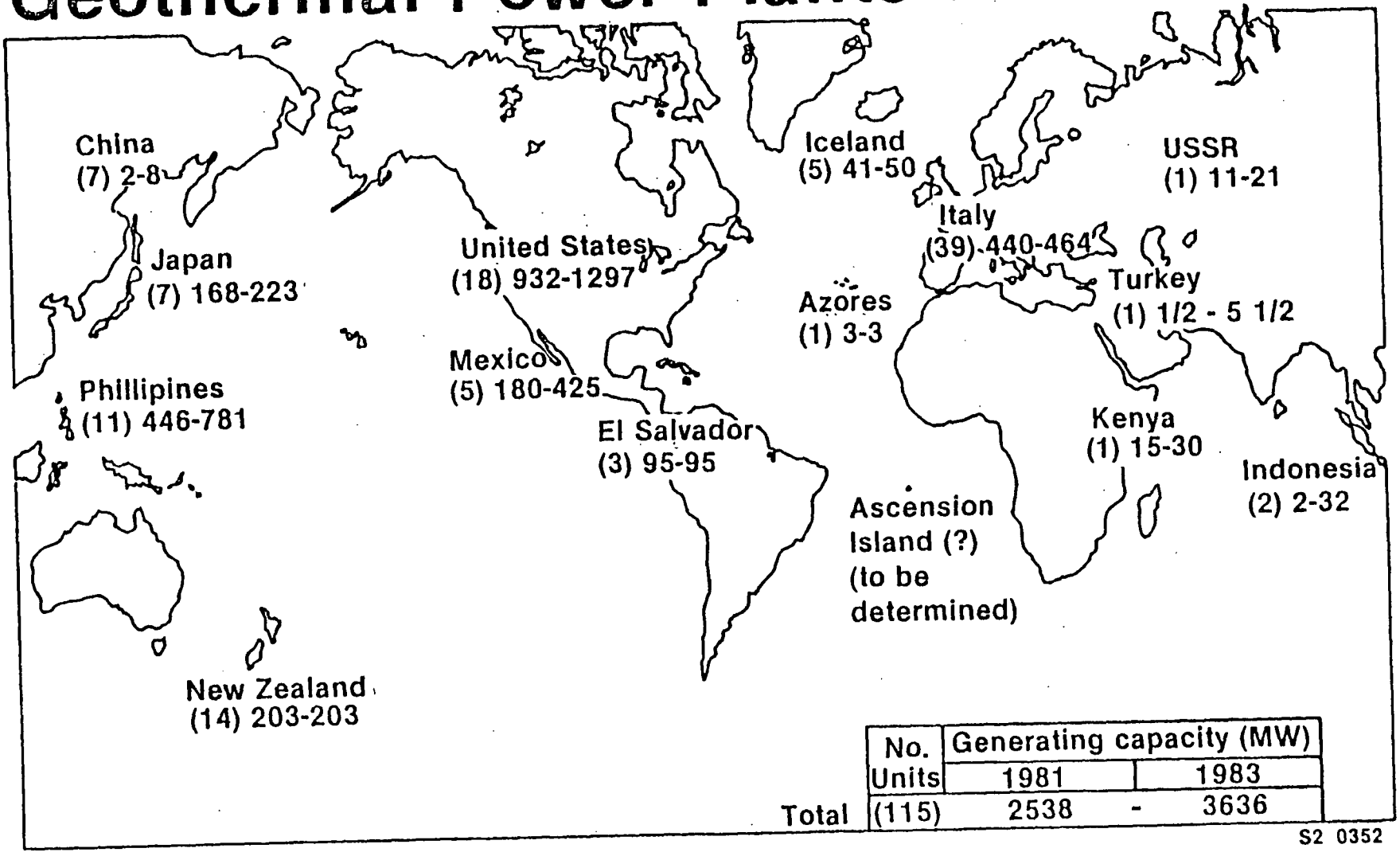
- Nuclear Energy
- Geothermal
- Low-Head Hydroelectric
- Water Reactor Safety Research
- Waste Management
- Environment and Safety
- Solar
- Industrial Energy Conservation
- Basic Scientific Research
- Test Reactor Facilities
- Alcohol
- Fusion Safety

Personnel Experienced in Geothermal Development

- Geologists
- Geochemists
- Geophysicists
- Biochemists
- All Engineering Disciplines
- Hydrologists
- Computer Scientists
- Safety Specialists
- Environmental Specialists
- Metallurgists
- Electronic Specialists
- Statisticians
- Analysts
- Instrumentation and Control Specialists
- Plant Operators
- Construction Specialists
- Project Managers
- Other Support

Background

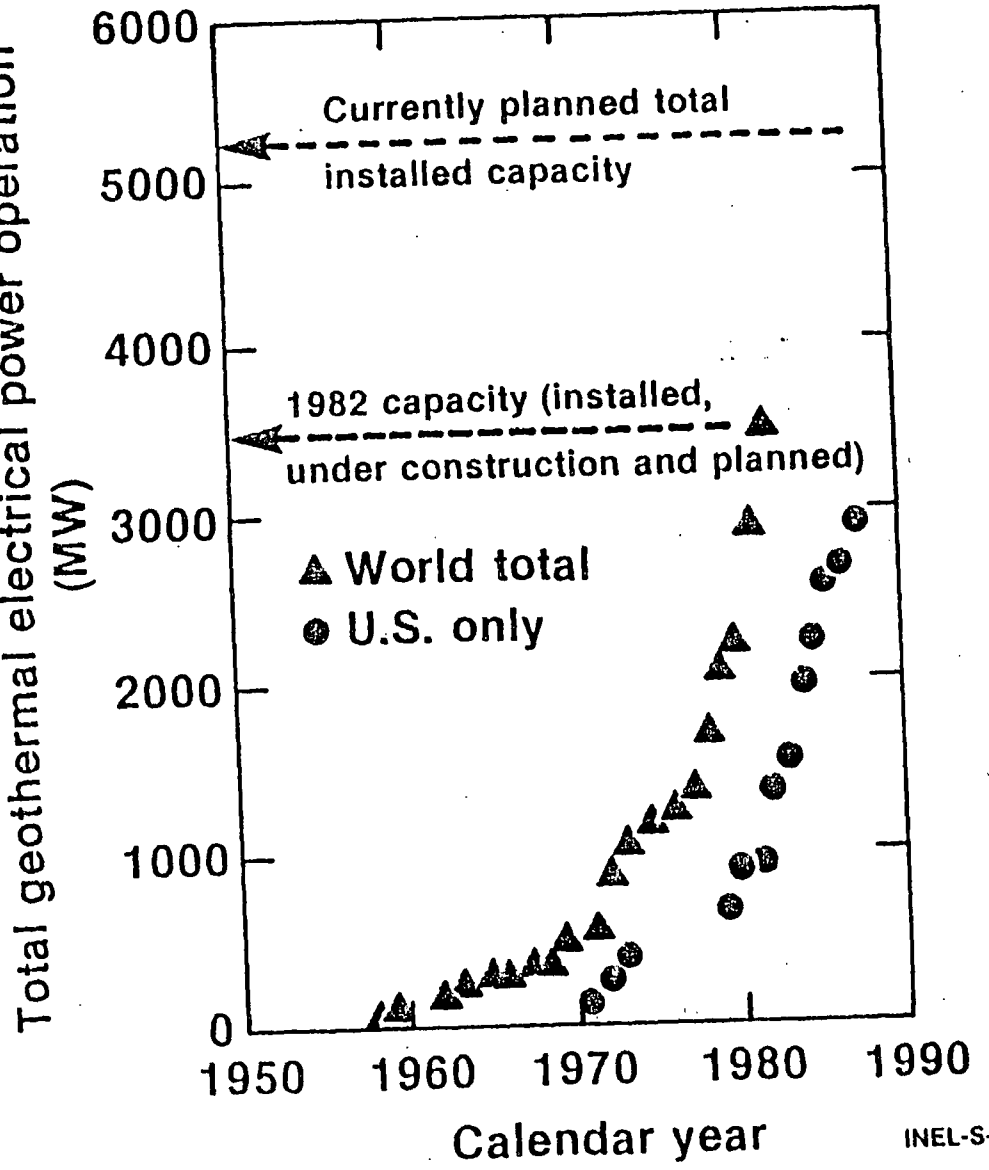
Geothermal Power Plants in the World



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

S2 0352

Growth of Geothermal Electrical Capacity



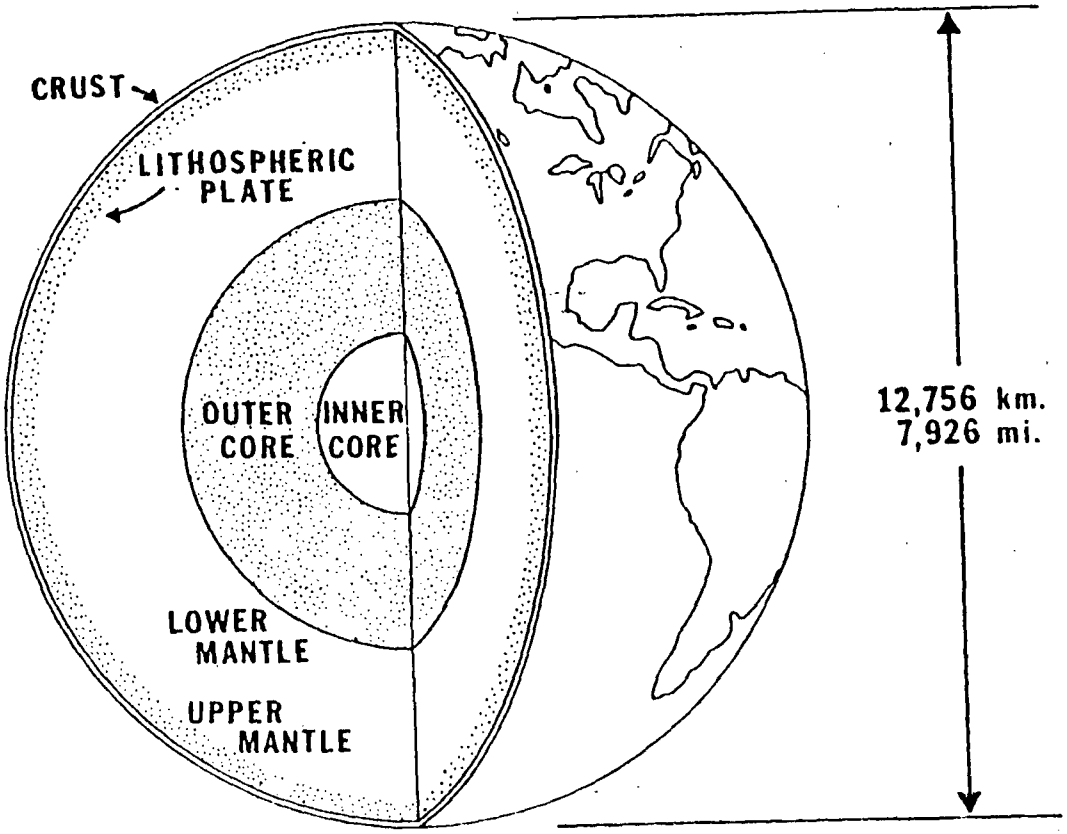
Nature of Geothermal Resources

S2 0368

Characteristics of Geothermal Resources

- Source of heat
  - — Volcanic activity
  - — Igneous intrusion
- Water to transfer heat
- Permeable rocks

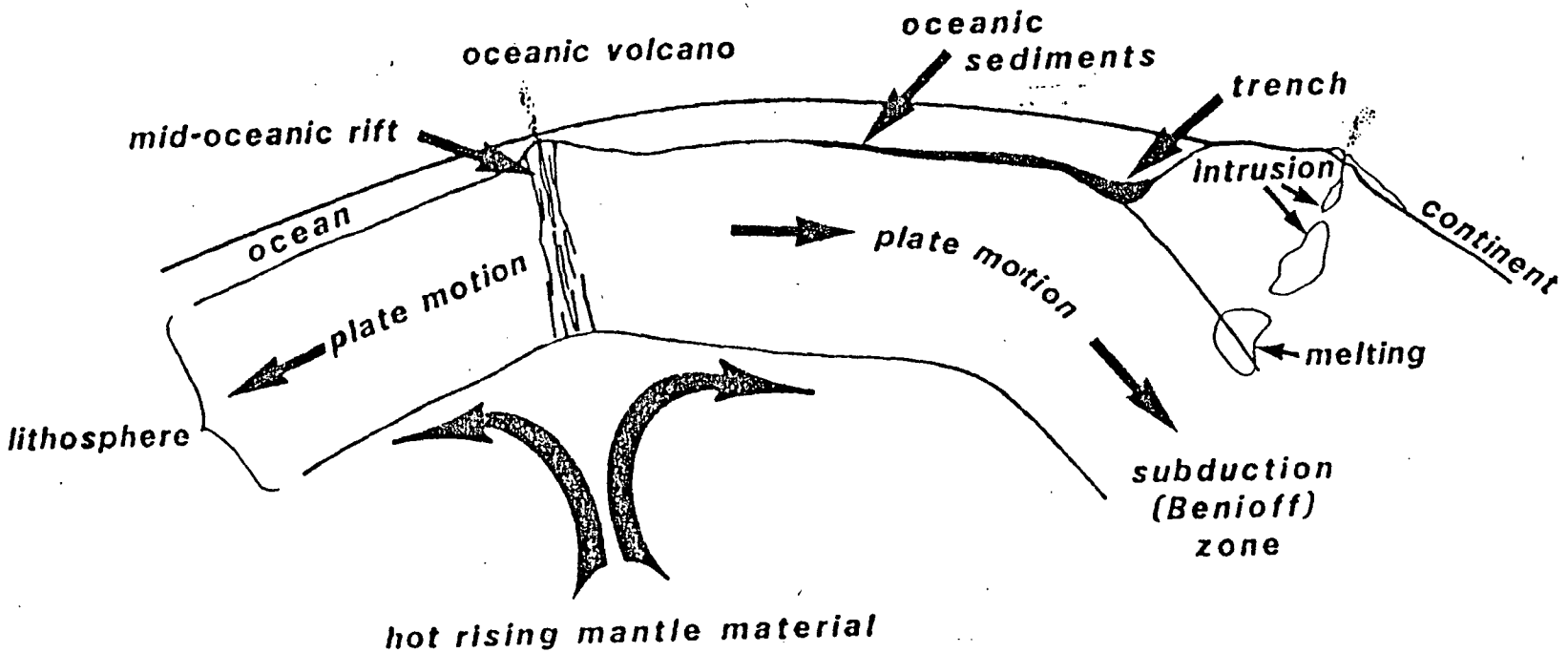
S2 0369


CRUST
LITHOSPHERIC PLATE
OUTER CORE
INNER CORE
LOWER MANTLE
UPPER MANTLE
12,756 km.
7,926 mi.

GG-005

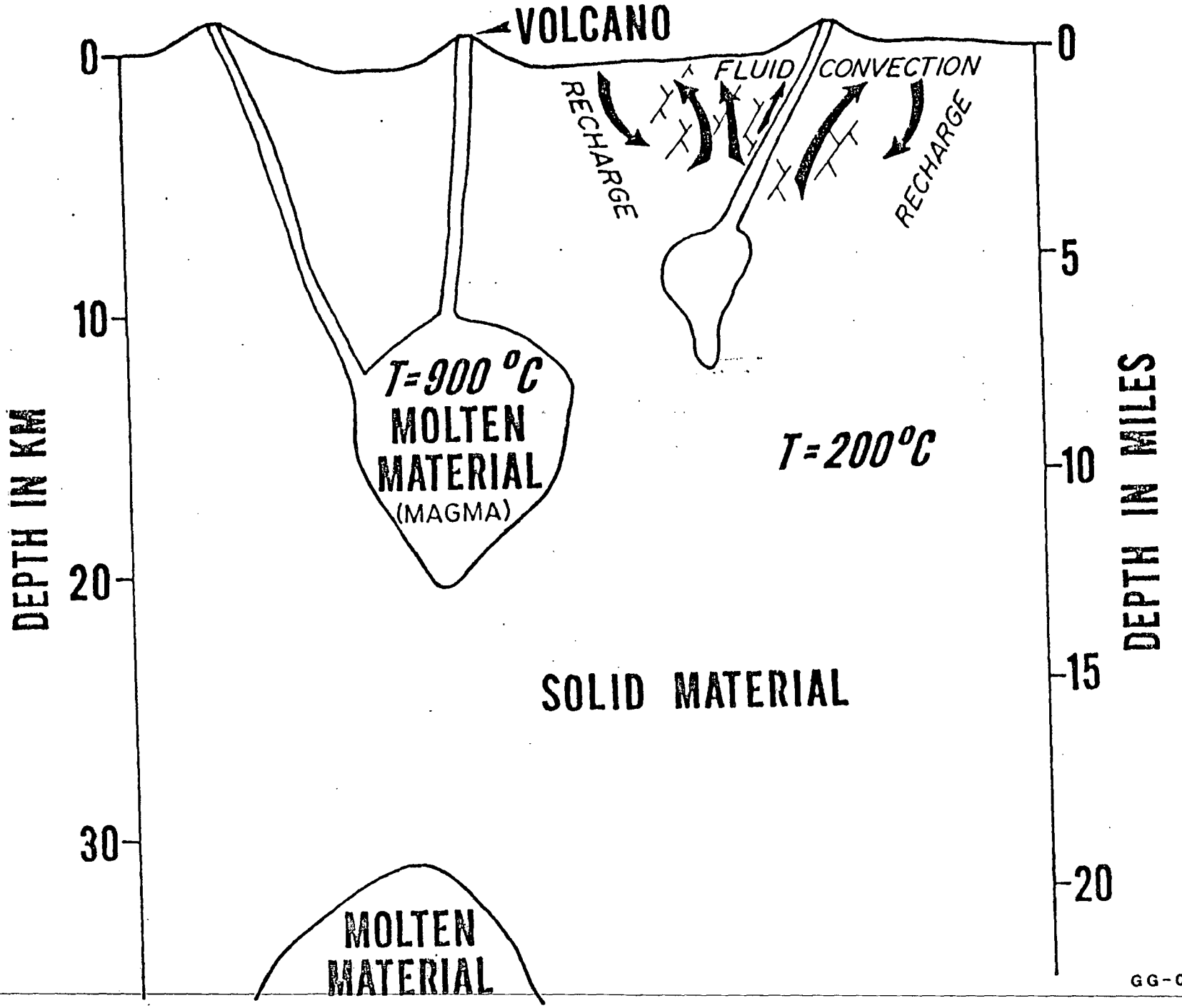
CONCEPT OF PLATE TECTONICS

(not to scale)

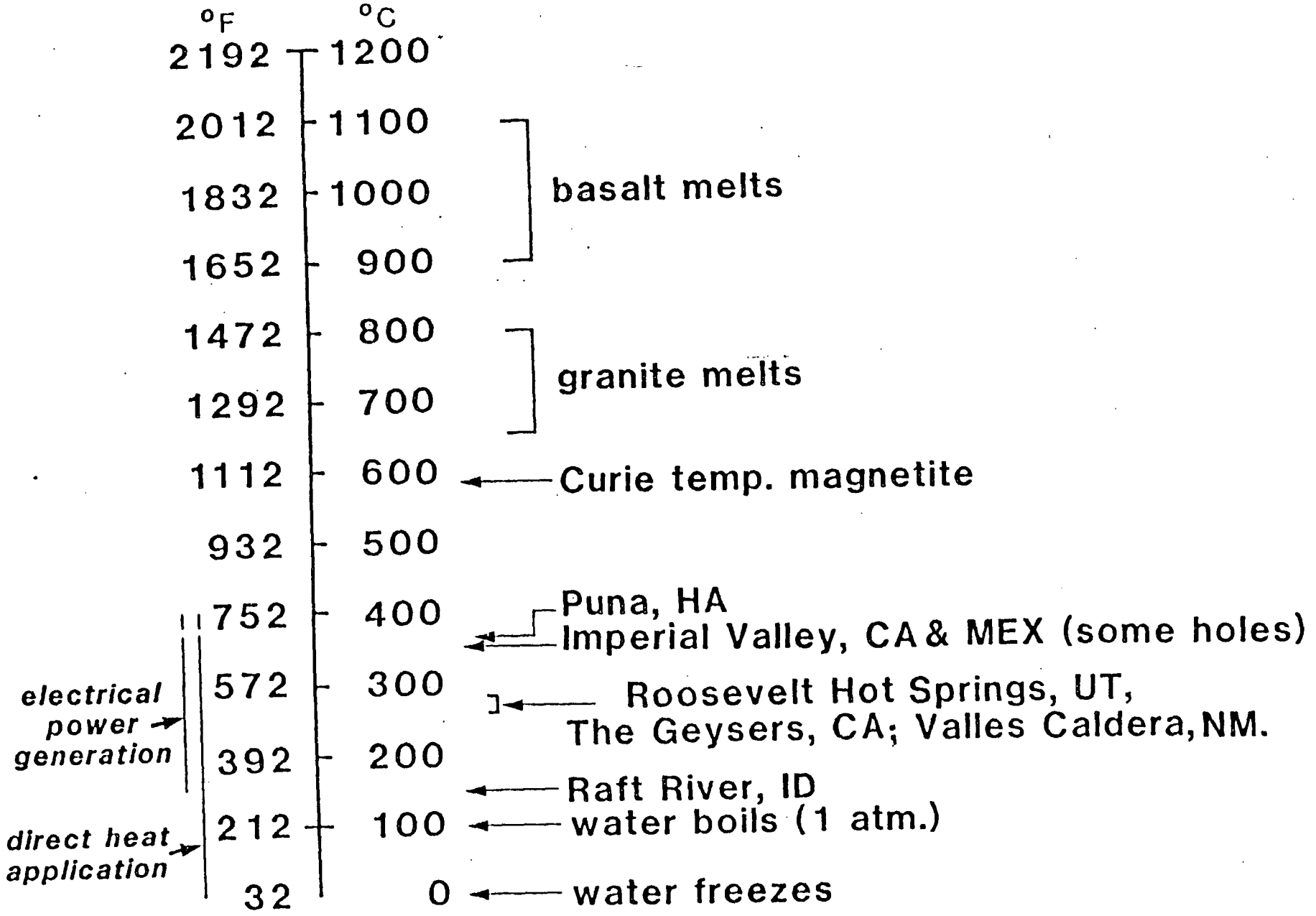


GG-006a
Revised 1/81

CRUSTAL INTRUSION

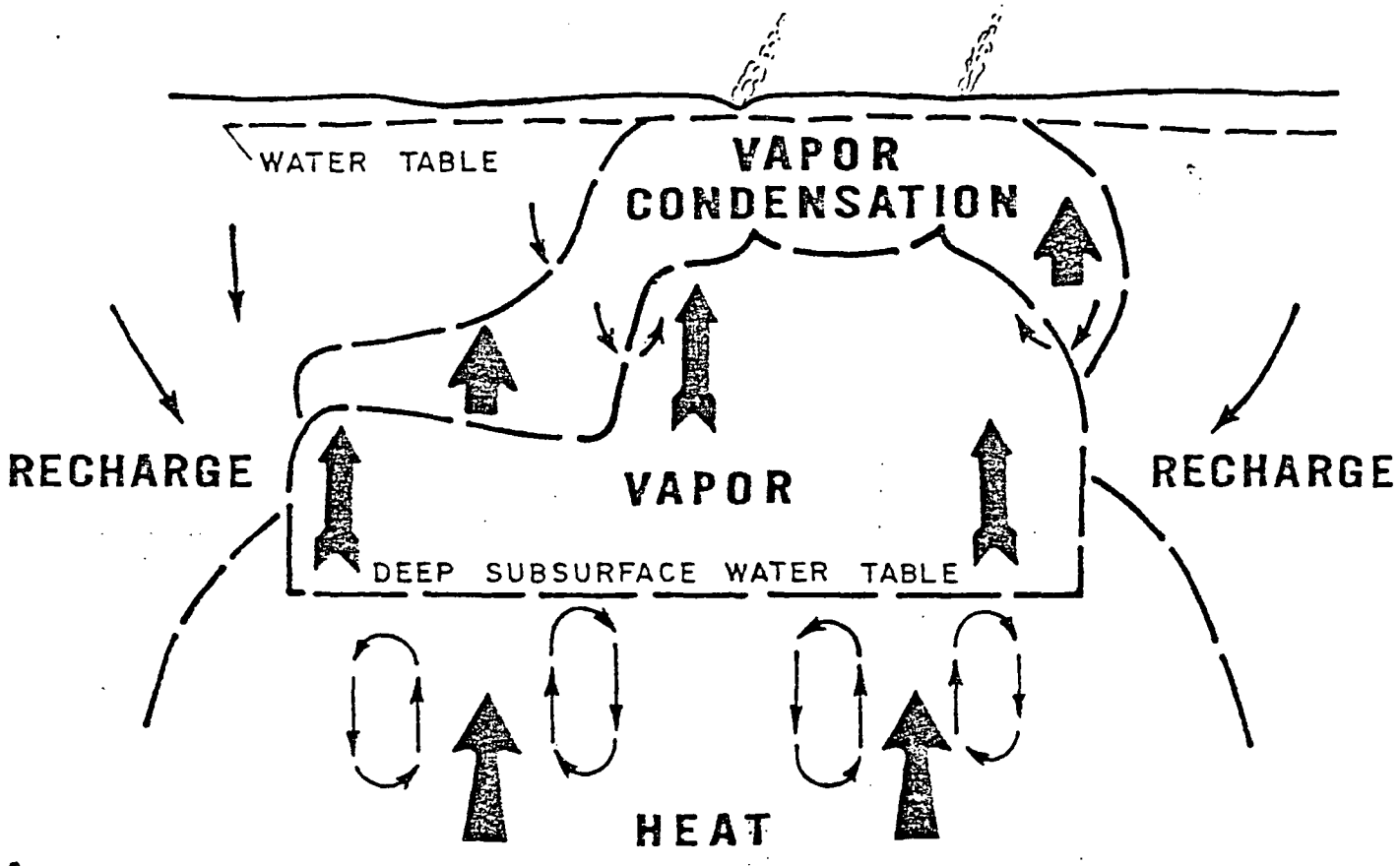


GEOTHERMAL TEMPERATURES

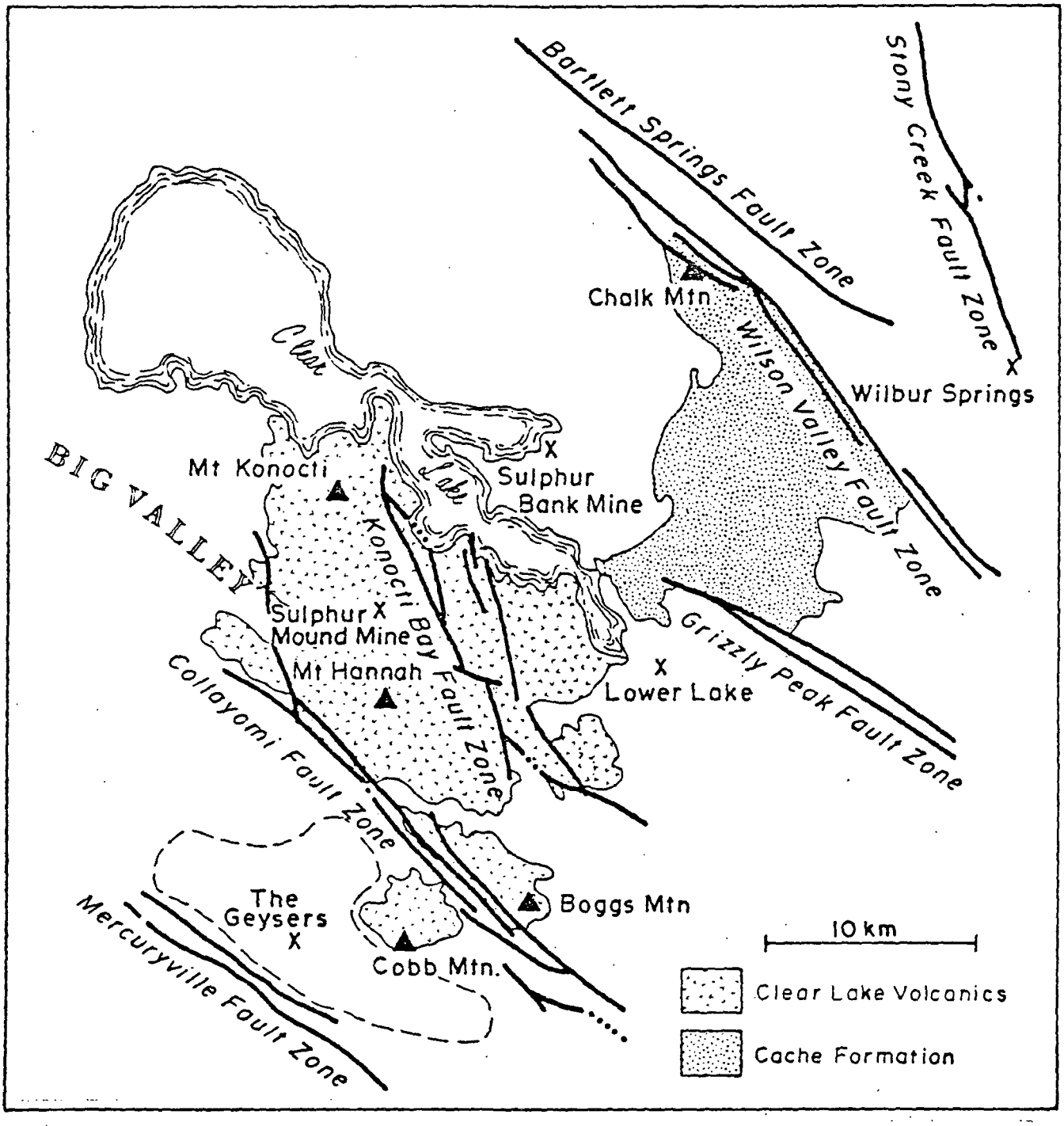


GG-026a
revised 1/81

VAPOR DOMINATED GEOTHERMAL RESERVOIR



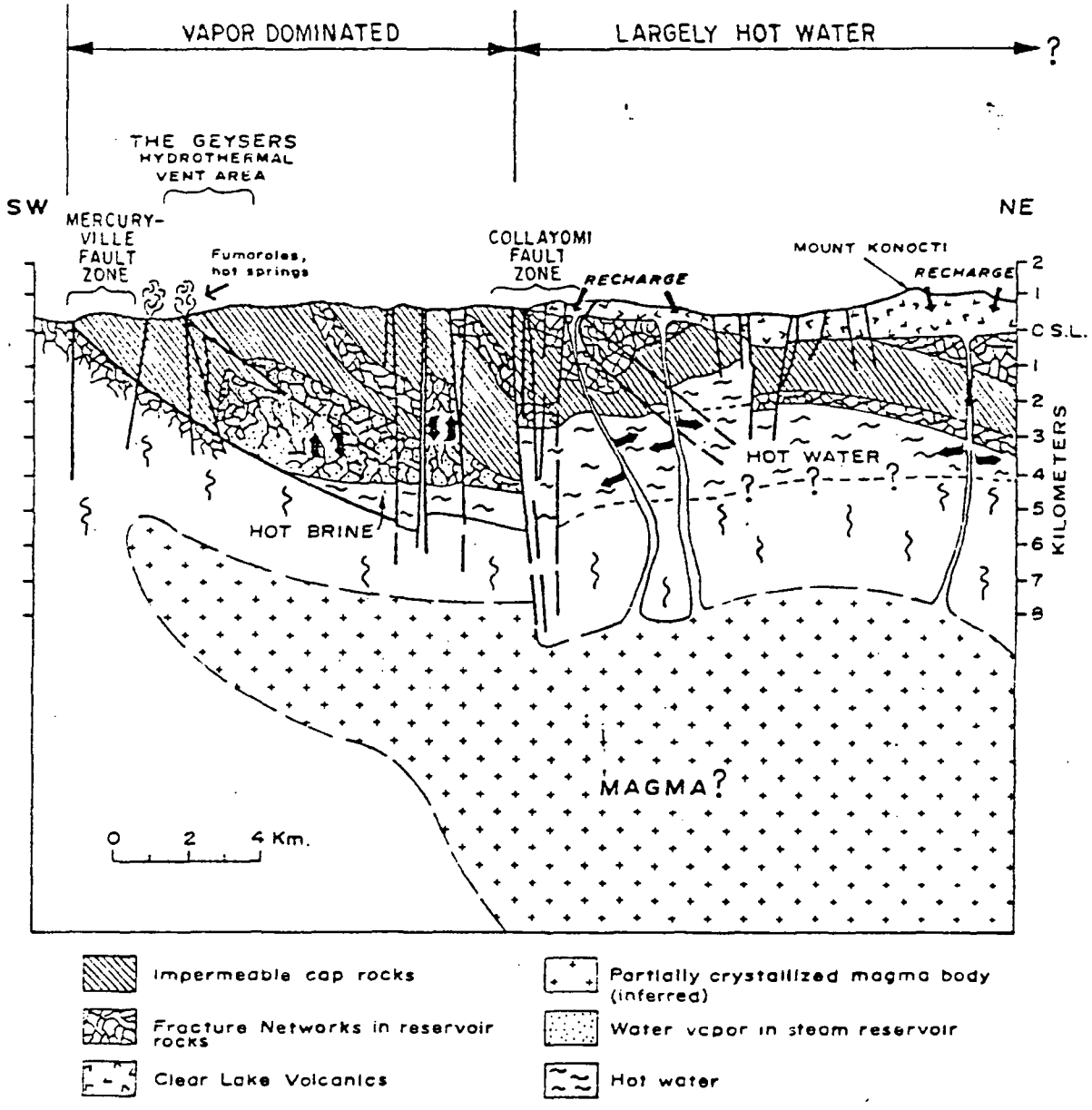
GG-011



MAJOR STRUCTURES in THE GEYSERS-CLEAR LAKE AREA

(After Goff, 1980)

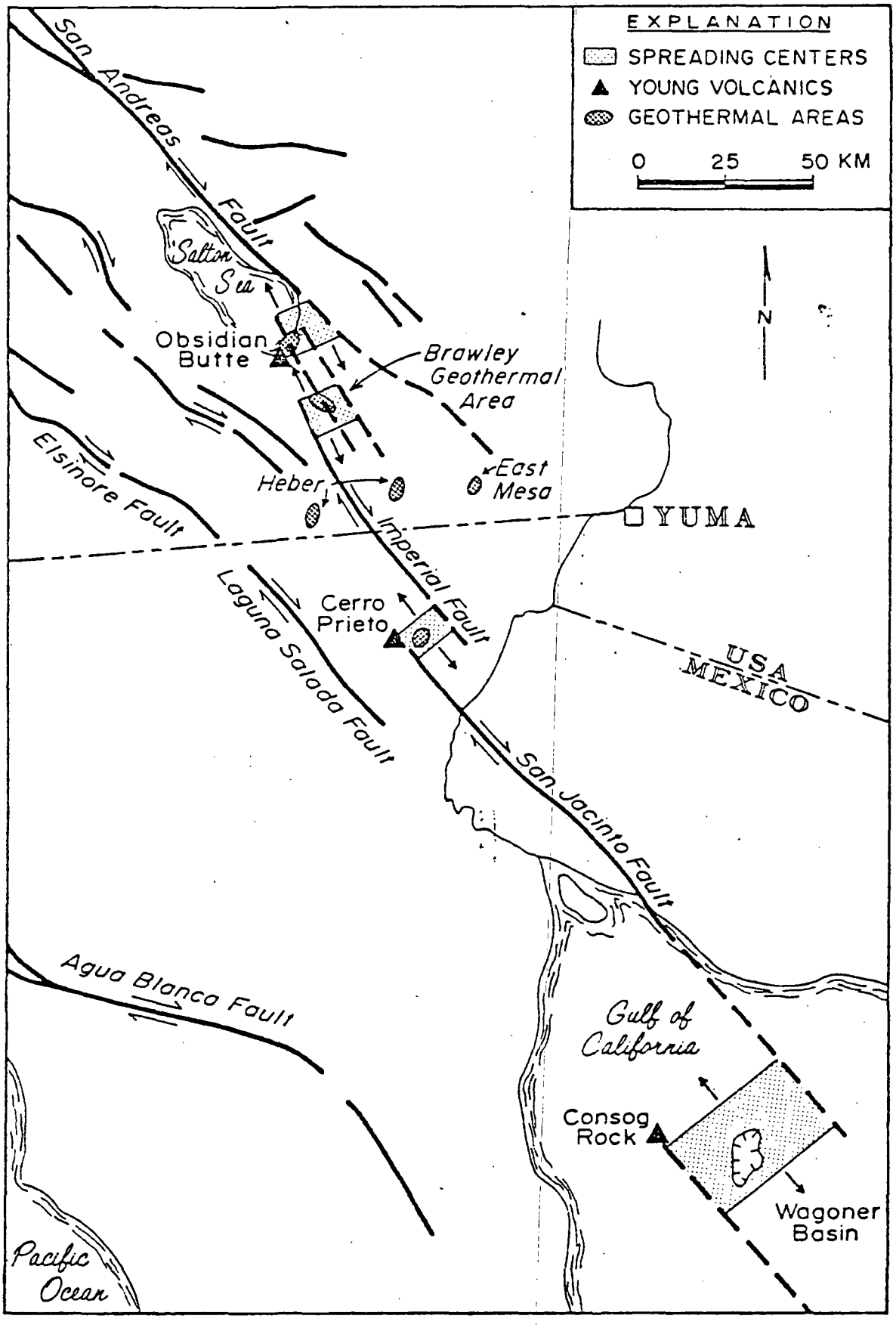
Ca/Ge-002



CRUSTAL MODEL FOR THE GEYSERS - CLEAR LAKE AREA, CA.

(after McLaughlin, 1977)

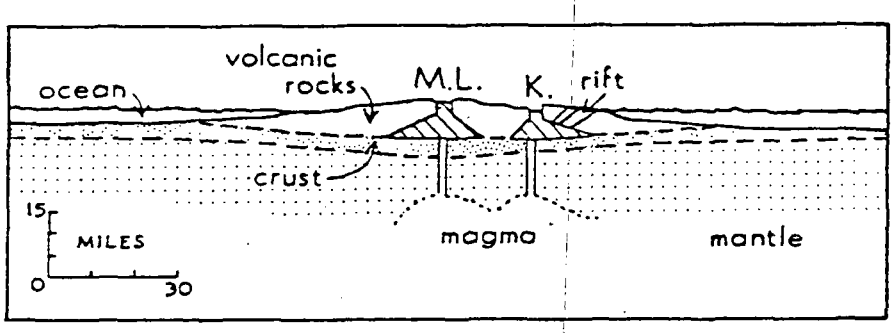
Ca/Ge-001

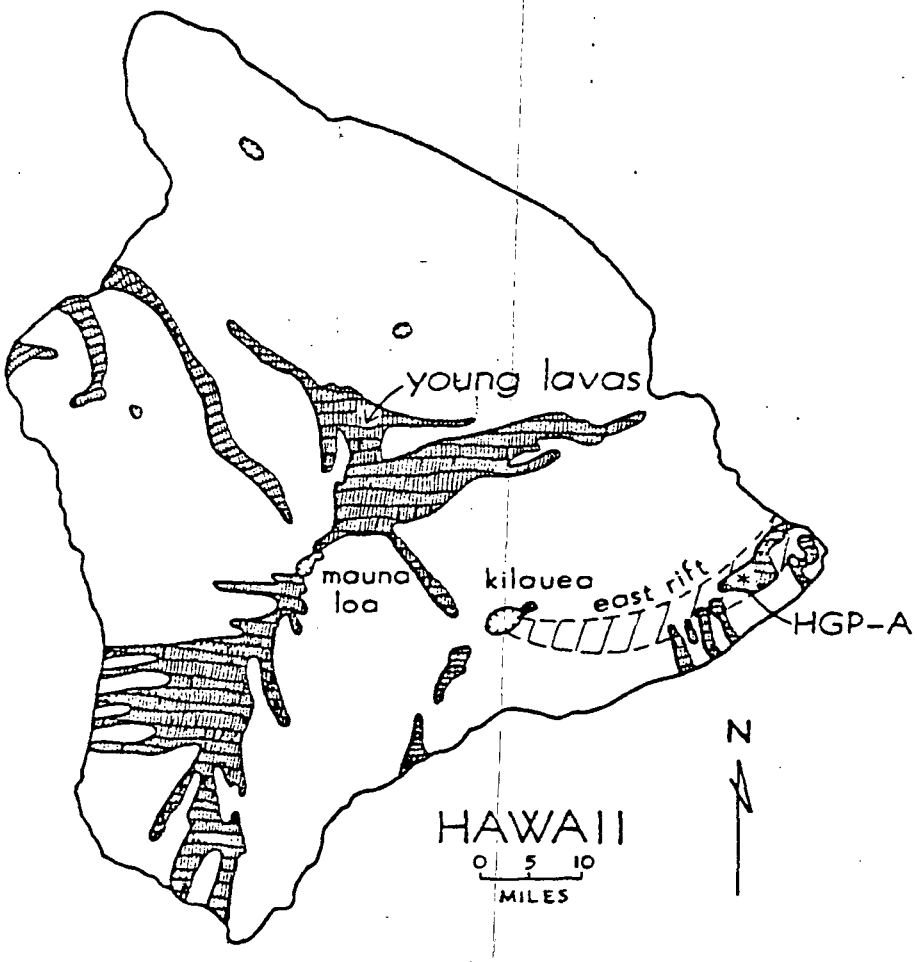


MAJOR STRUCTURES OF SALTON TROUGH

(after Palmer et al., 1975)

GG-086

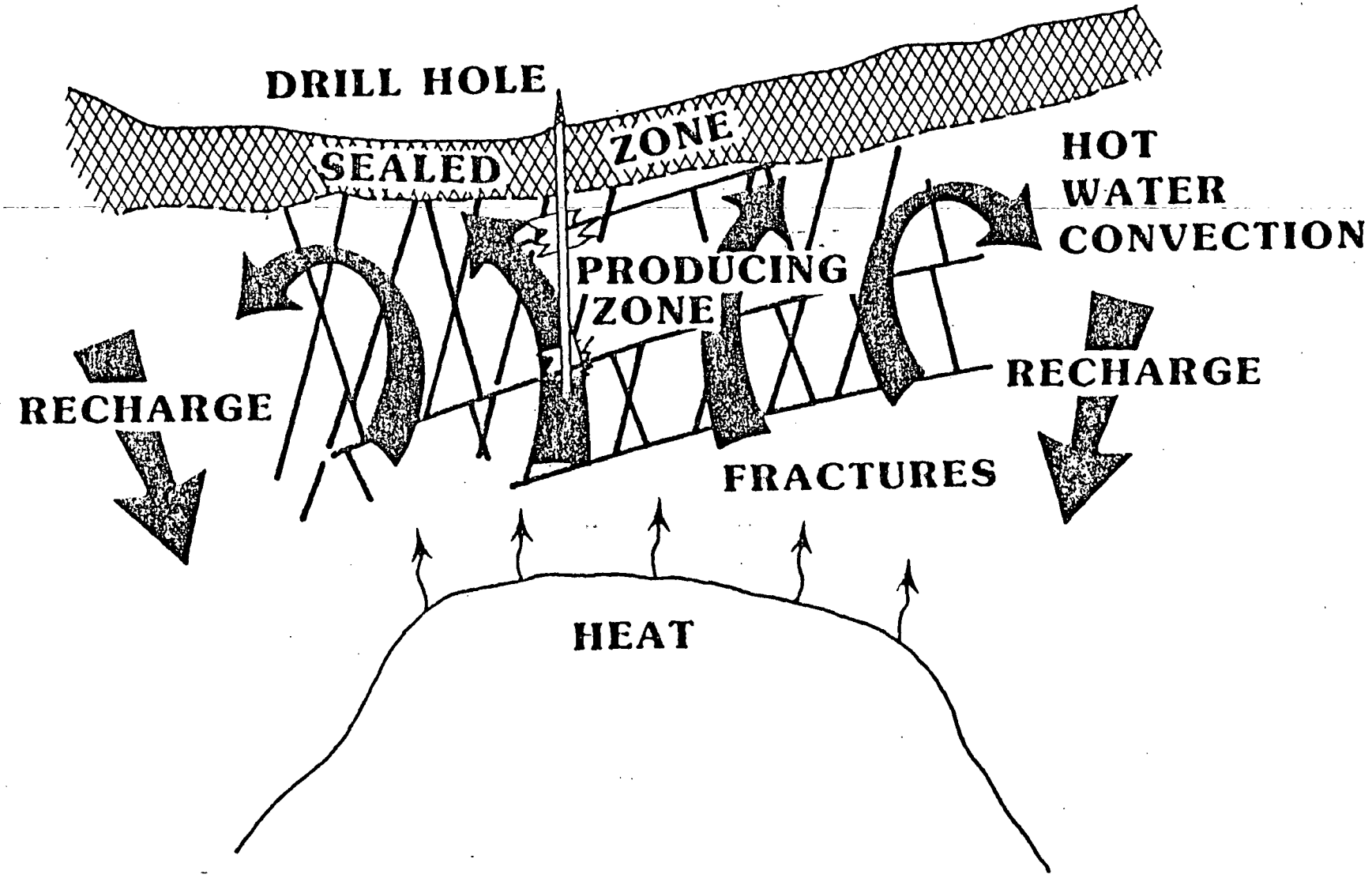




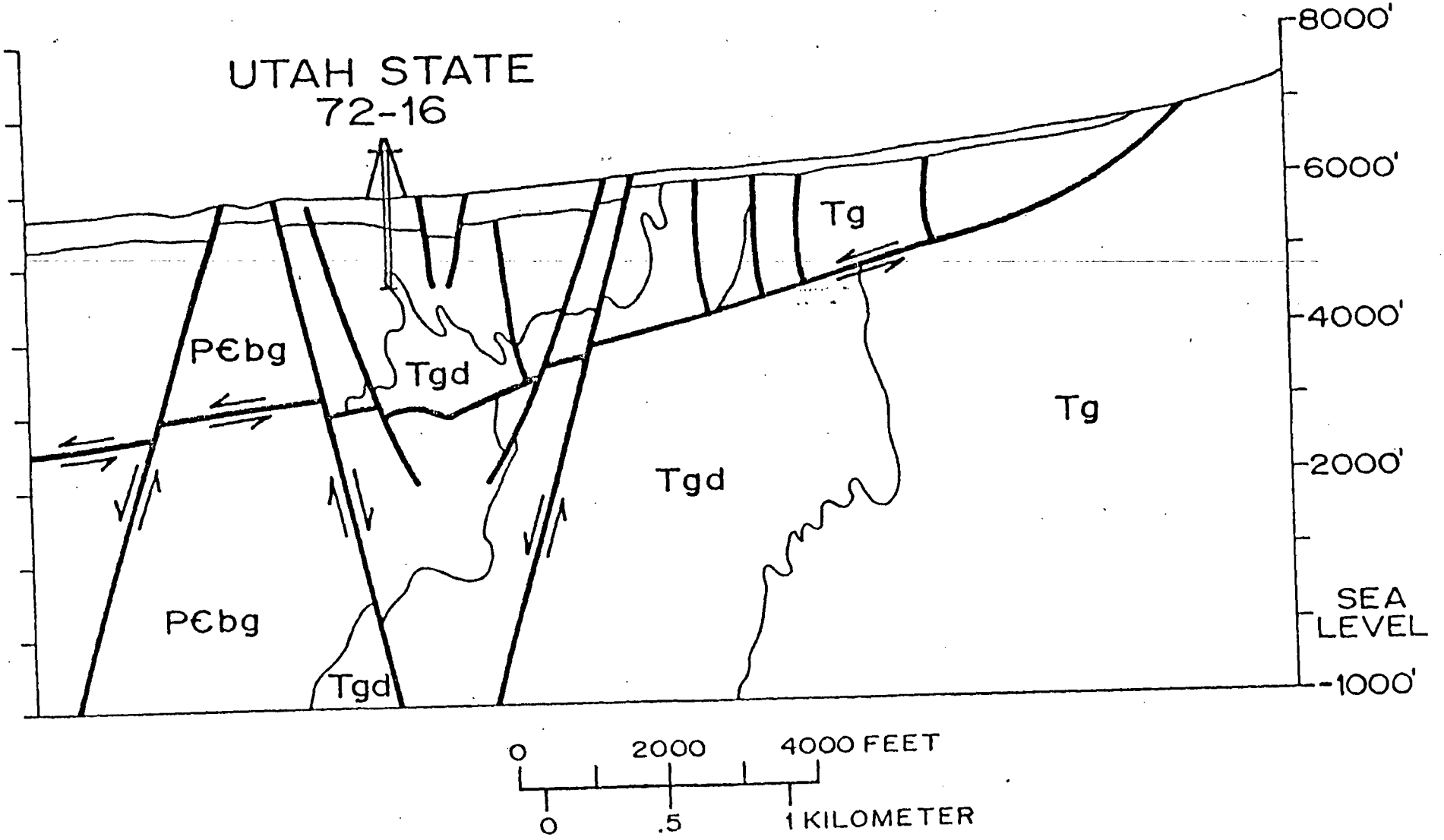
HAWAIIAN GEOTHERMAL SETTING

WATER DOMINATED GEOTHERMAL SYSTEM

FLOW CONTROLLED BY FRACTURES



GG-013a


UTAH STATE
72-16
8000'
6000'
4000'
2000'
SEA
LEVEL
-1000'
Tg
Tg
Tgd
Tgd
Tgd
PЄbg
PЄbg
0
2000
4000 FEET
0
.5
1 KILOMETER

UI/R-005b

Some geothermal systems have surface manifestation

- The Geysers, CA
- Roosevelt Hot Springs, UT
- Iceland
- New Zealand
- Italy

Others have none — geology, geophysics, geochemistry lead to discovery

- Imperial Valley, CA
- Humboldt House, NV
- Newberry, OR

S2 0370

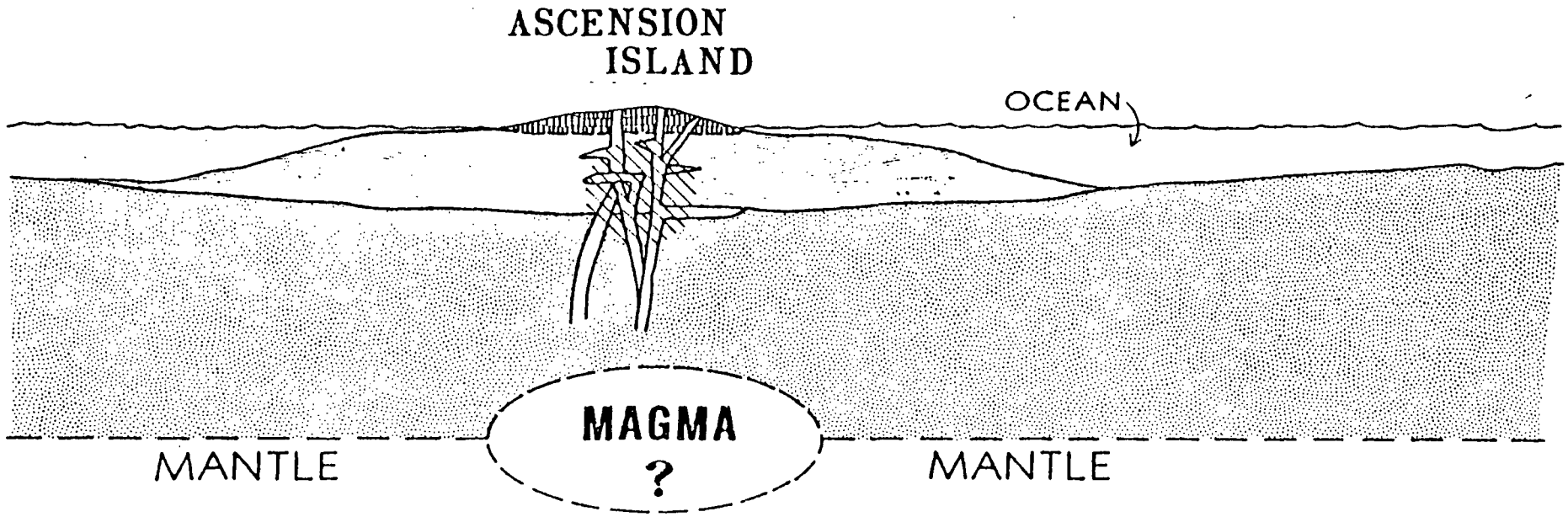
Exploration and Resource Assessment

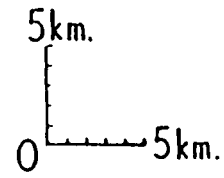
S2 0314

Ascension Island Geology

S2 0364

CONCEPTUAL THERMAL AND GEOLOGIC MODEL





FEEDER INTRUSIONS

SUBAERIAL EXTRUSIVE ROCKS

SUBAQUEOUS EXTRUSIVE ROCKS
(PILLOW LAVAS)

OCEANIC CRUST

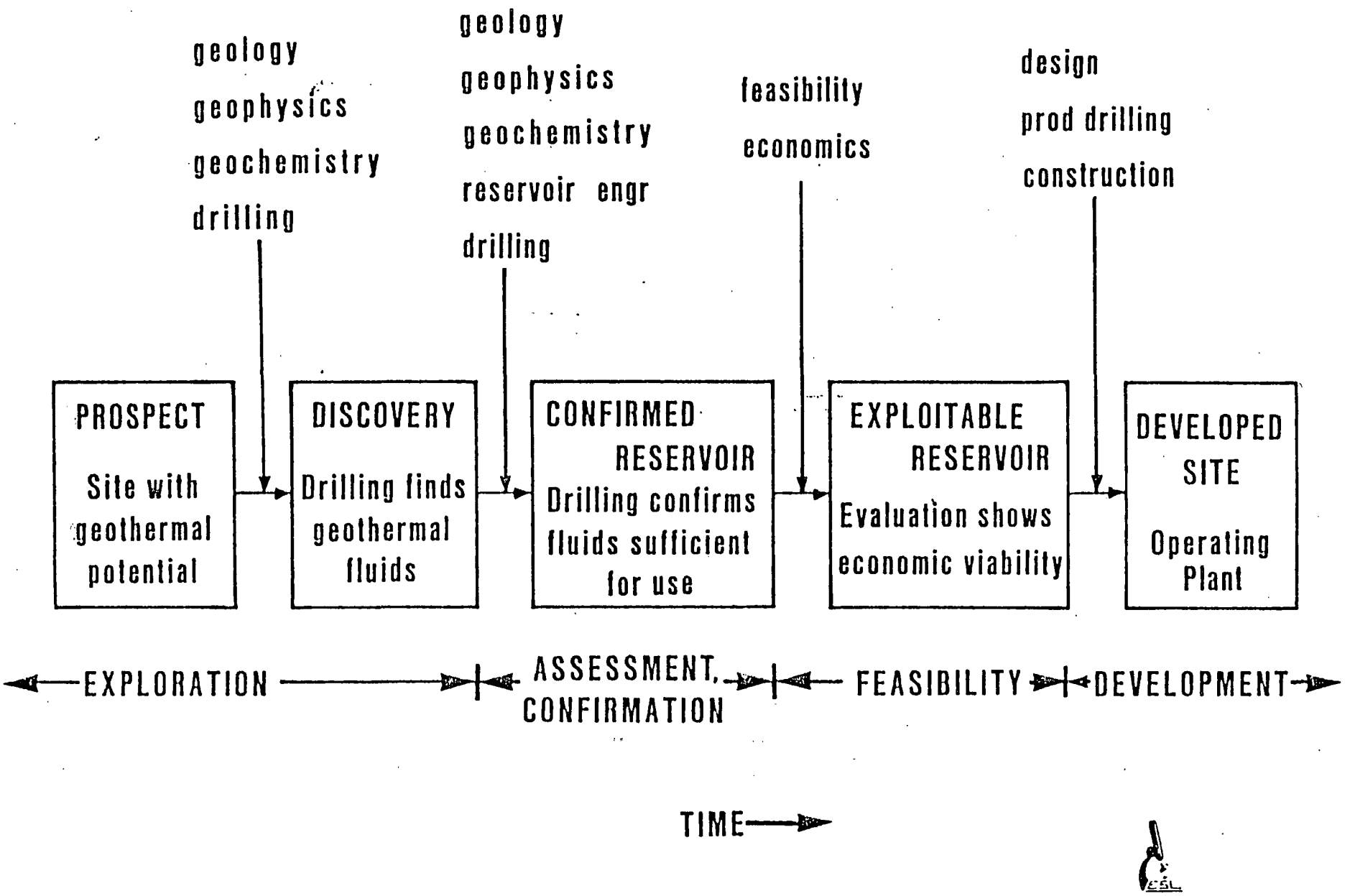
THERMAL RESERVOIR

Possible Characteristics of Ascension Resource

- Thermal input and recharge from volcanic heat
- Hydrologic recharge from sea
- Permeability in fractured volcanic rocks

S2 0366

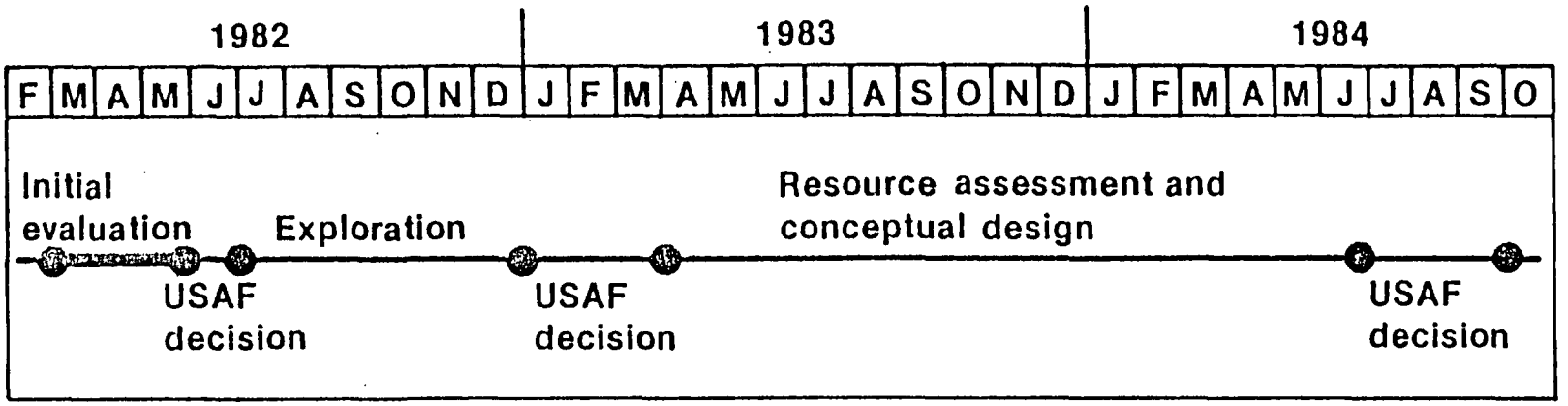
GEOTHERMAL DEVELOPMENT



Scenario for Project Assessment Ascension Island

- Initial evaluation
- Exploration
- Resource assessment and conceptual design

S2 0310



Initial evaluation

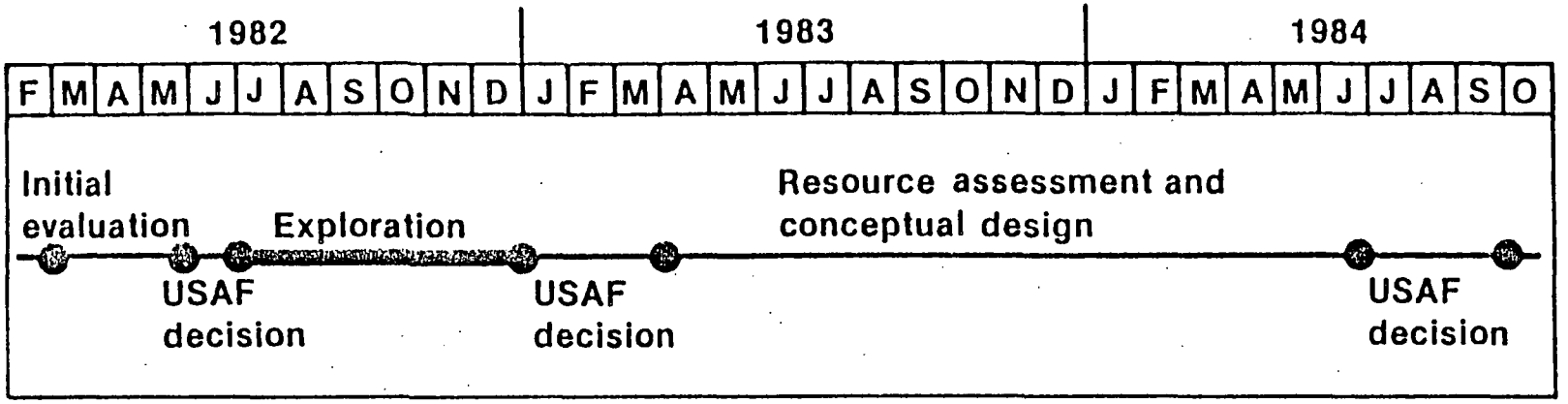
Activities

- Acquire available data
- Perform reconnaissance geologic work
- Perform geochemical modeling
- Determine site energy needs and applications
- Determine environmental / institutional needs
- Determine BBC interfaces and requirements
- Develop system concepts
- Prepare initial report
- Present data to USAF for decision

Products

- Preliminary resource model
- Design of exploration and resource assessment program
- Identified site needs
- Report with recommendations

S2 0357



Exploration evaluation

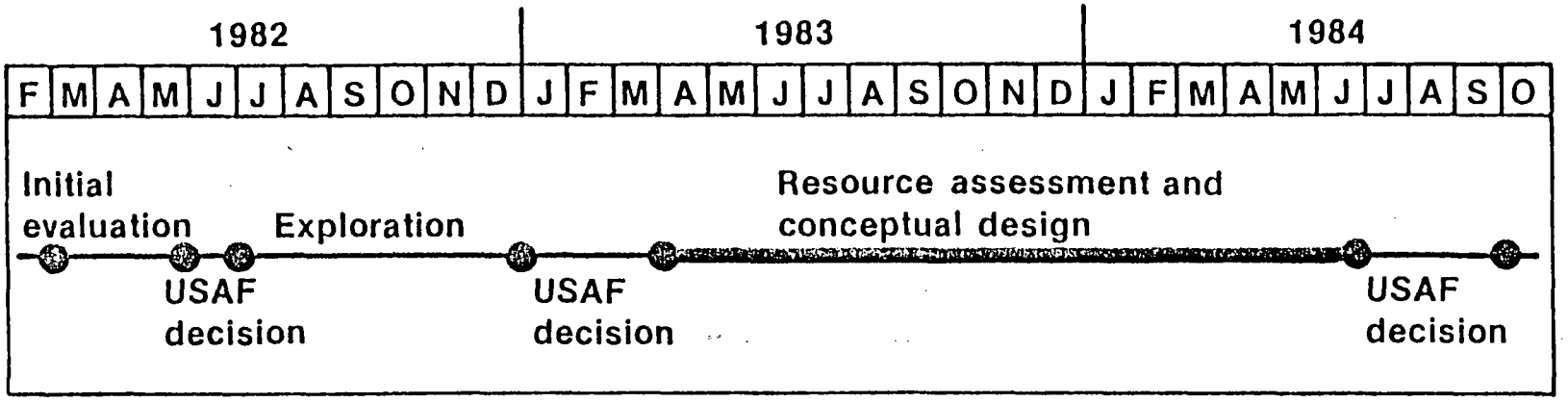
Activities

- Perform geochemical surveys
- Perform electrical resistivity surveys
- Perform aeromagnetic surveys
- Perform thermal gradient drilling
- Select best reservoir confirmation drilling site
- Develop preliminary economics for most promising concepts
- Initiate preliminary design
- Prepare report including probabilities of success
- Present data to USAF for decision

Products

- Integrated survey data and analysis
- Geothermal target model
- Drill site selected
- Preliminary economics and design defined
- Report with recommendations

S2 0358



Resource assessment and conceptual design

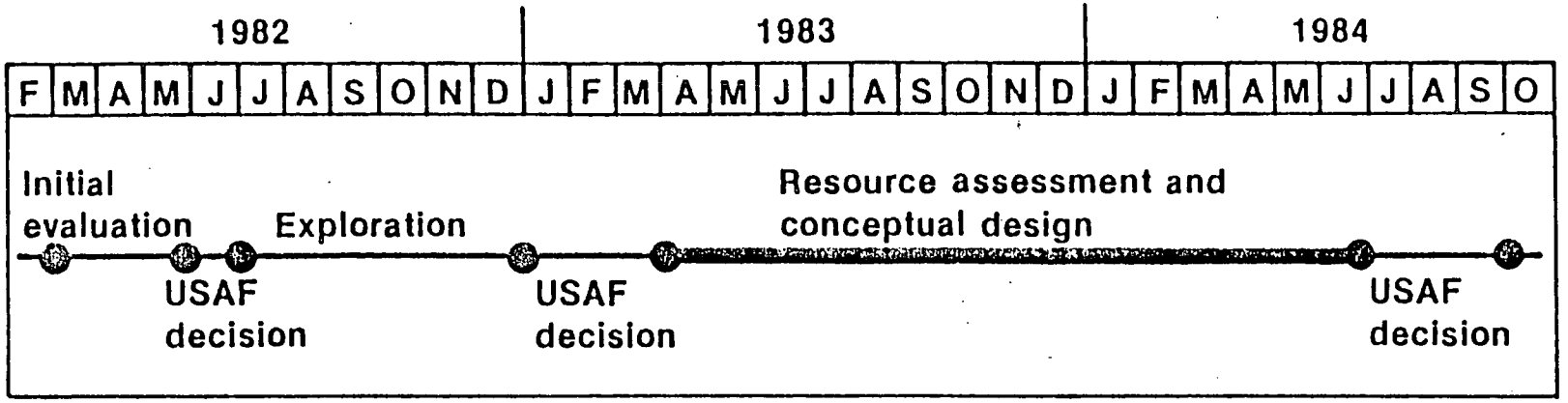
Activities

- Comply with environmental requirements and secure permits
- Award drilling contract
- Drill confirmation well
- Perform well logging operations
- Flow test well
- Perform reservoir engineering analyses to determine
  - Potential reservoir size
  - Production temperatures
  - Long term production flow rates
  - Production field design
  - Study input

Products

- Confirmation well drilled, logged and tested
- Reservoir analysis

S2 0359



Resource assessment and conceptual design (cont'd)

Activities

- For the most promising system concepts
  - Perform power cycle analyses
  - Calculate required number of production and injection wells
  - Size system components
  - Estimate system costs and economics
- Recommend best power generation system concept in formal report
- Select site for (additional) production well(s)

Products

- Conceptual design
- Formal report
- Production well sites

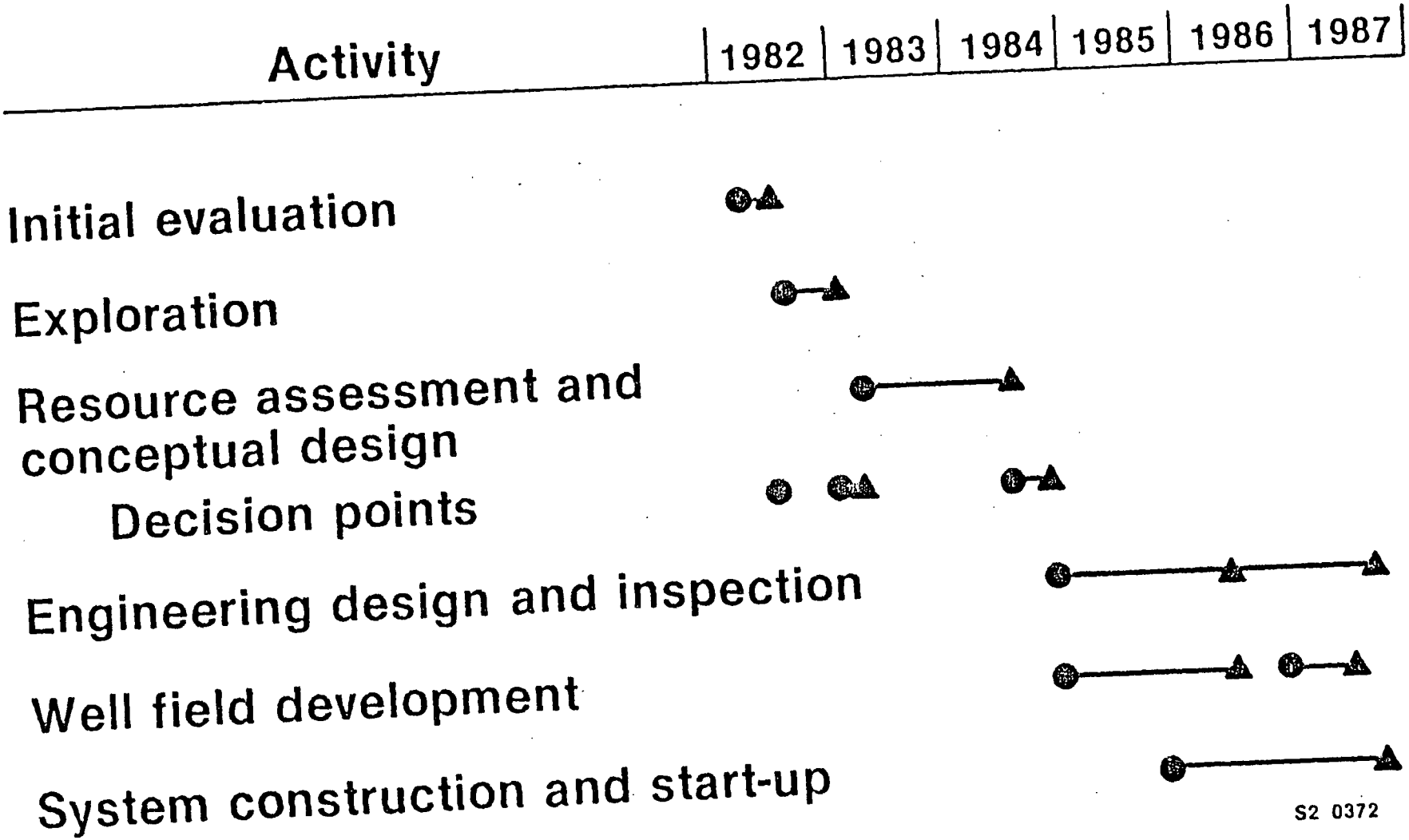
S2 0360

Scenario for Project Development
Ascension Island

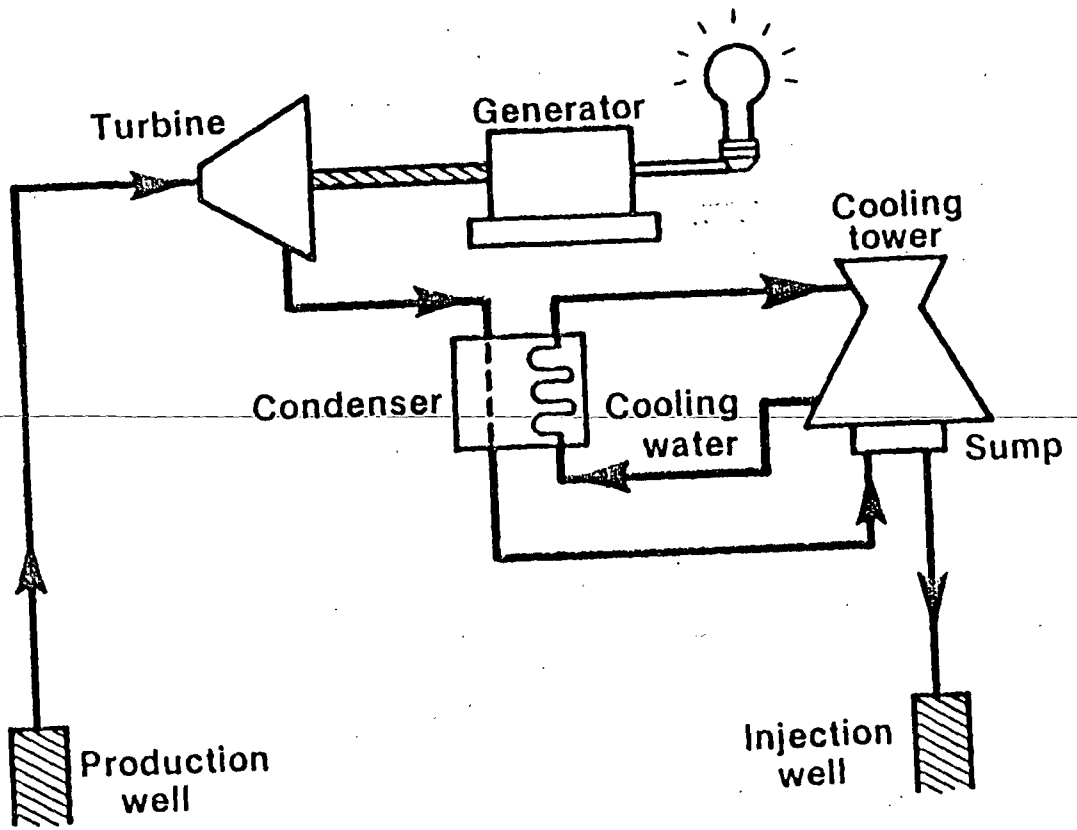
- Engineering
- Well field development
- System construction

S2 0311

Dual Flash Plant Schedule

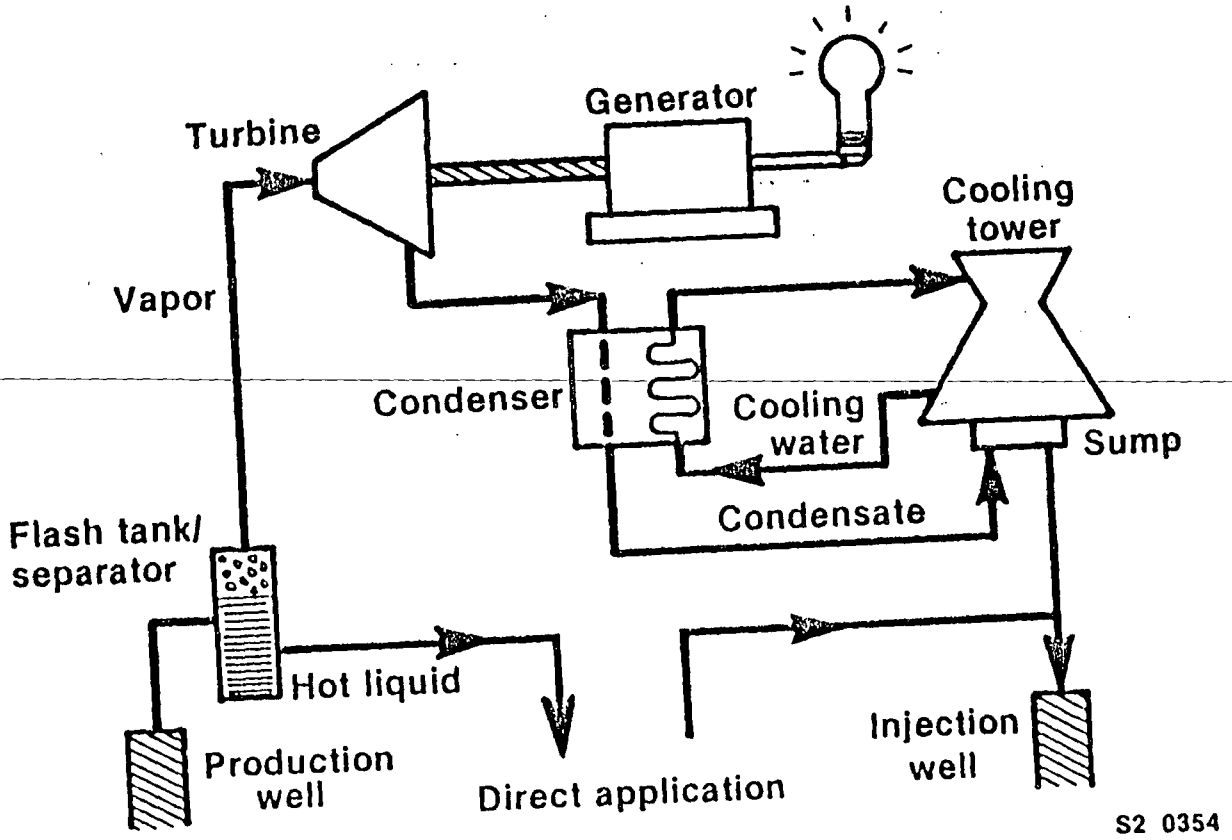


Dry Steam System

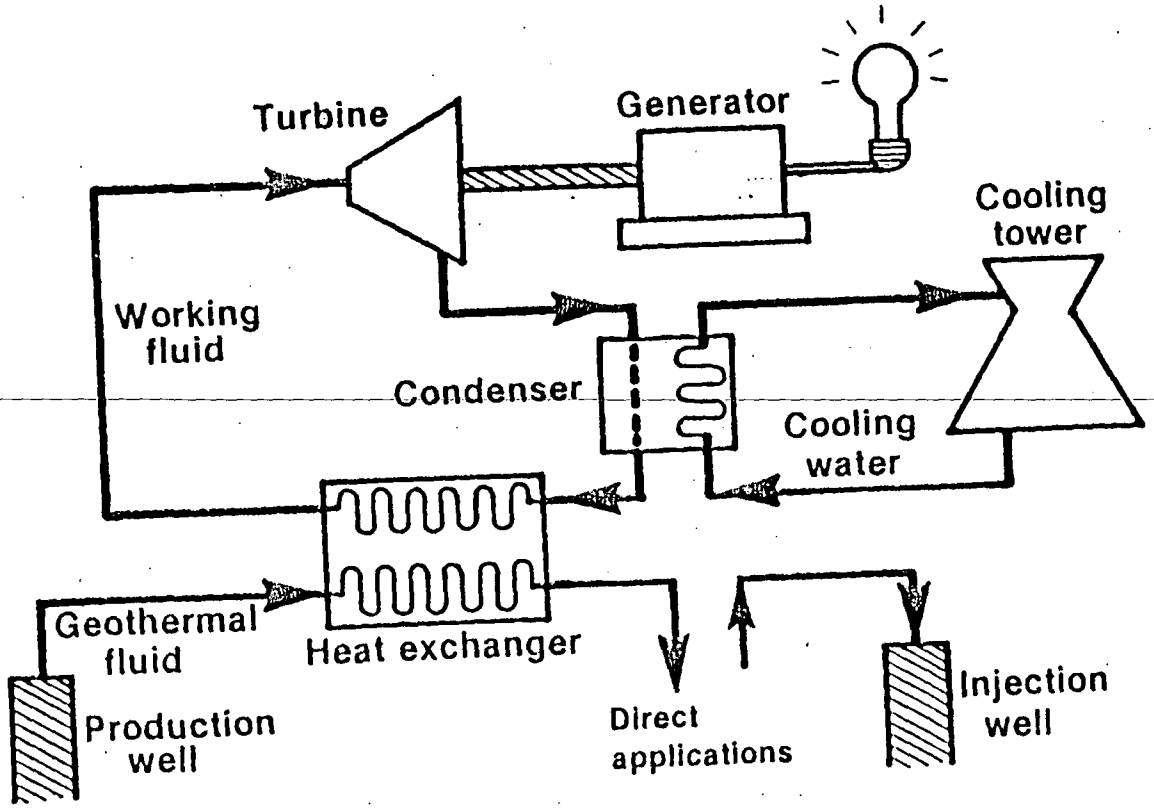


S2 0353

Flash Steam System

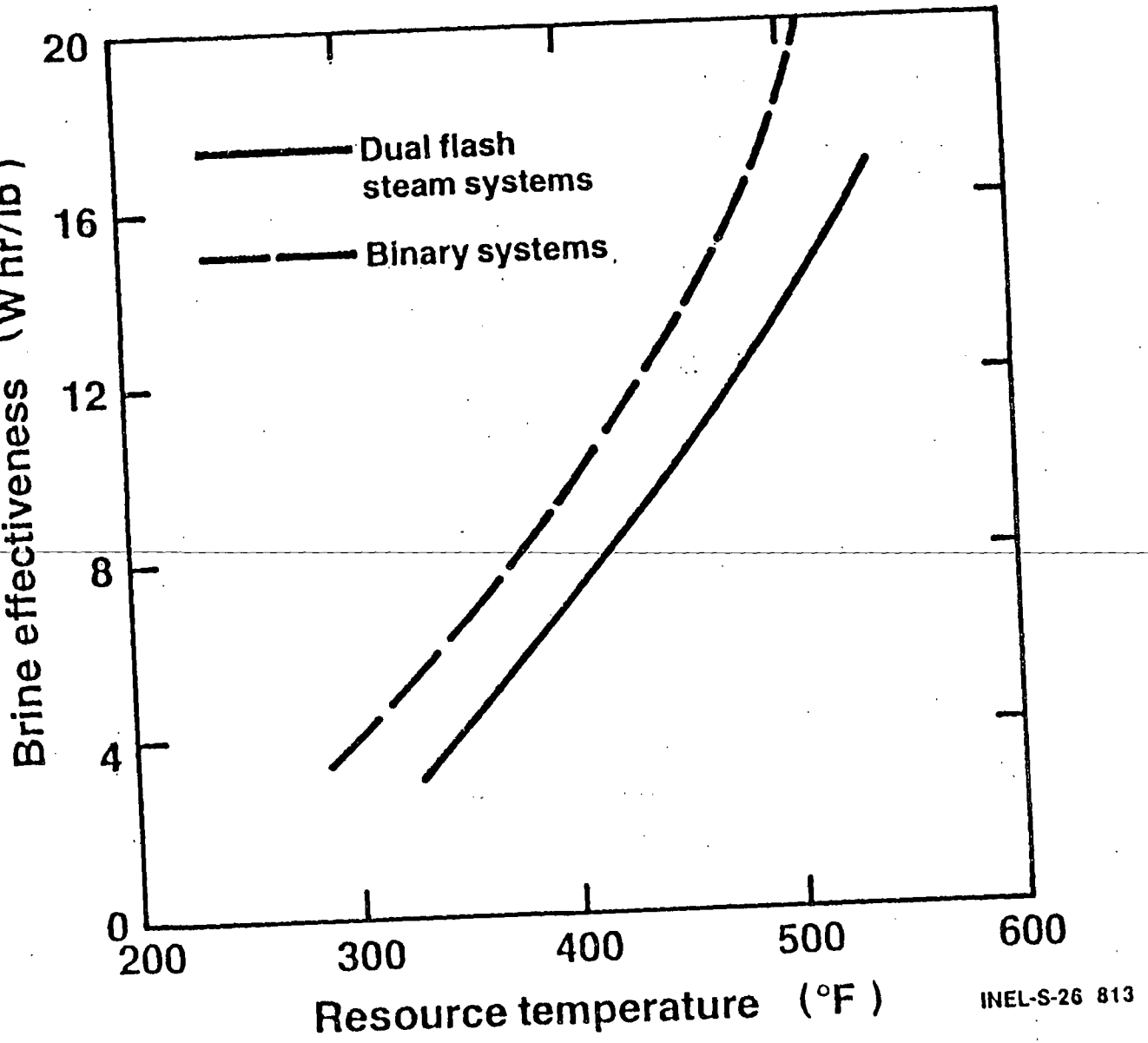


Binary System

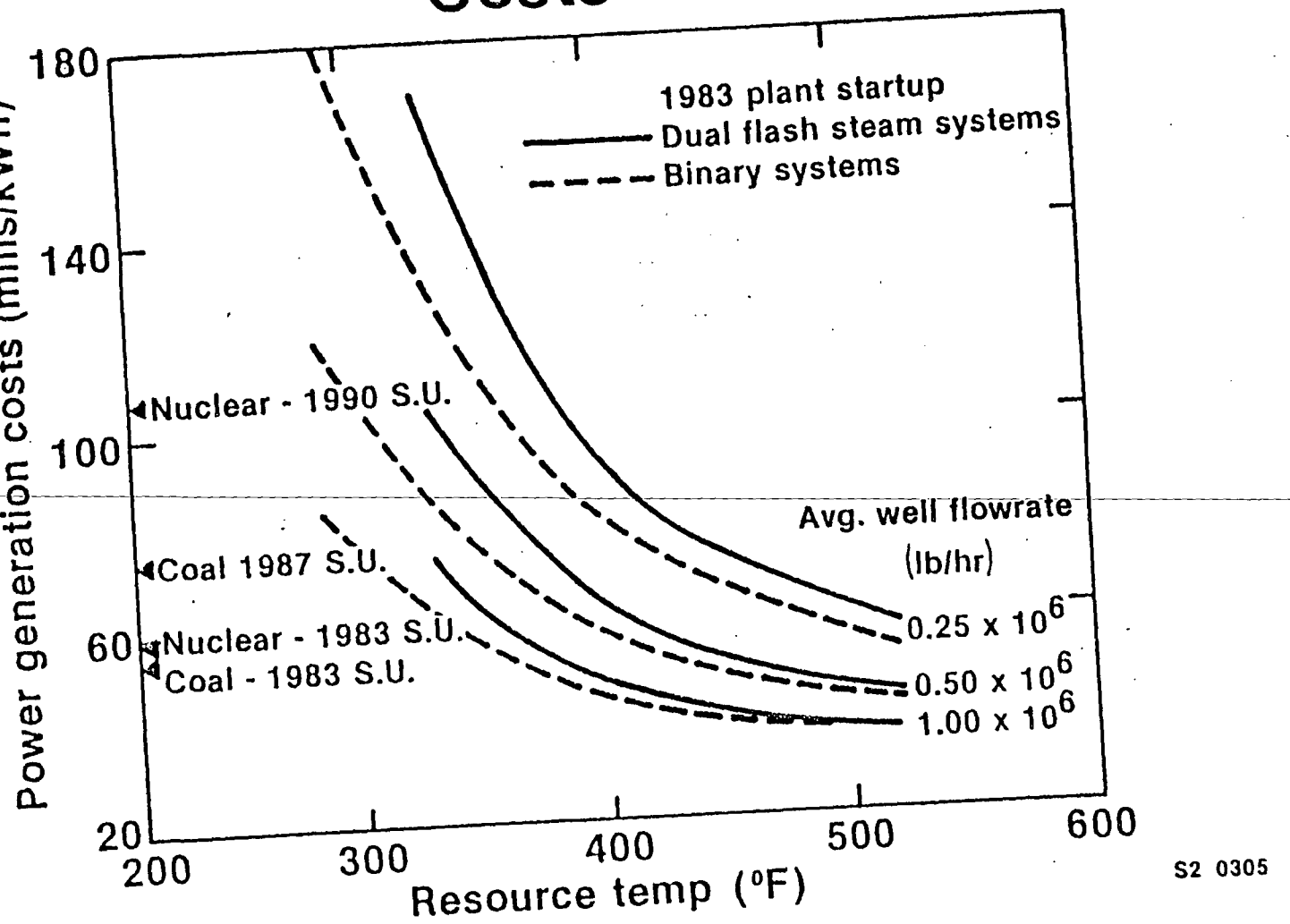


S2 0355

Net Brine Effectiveness



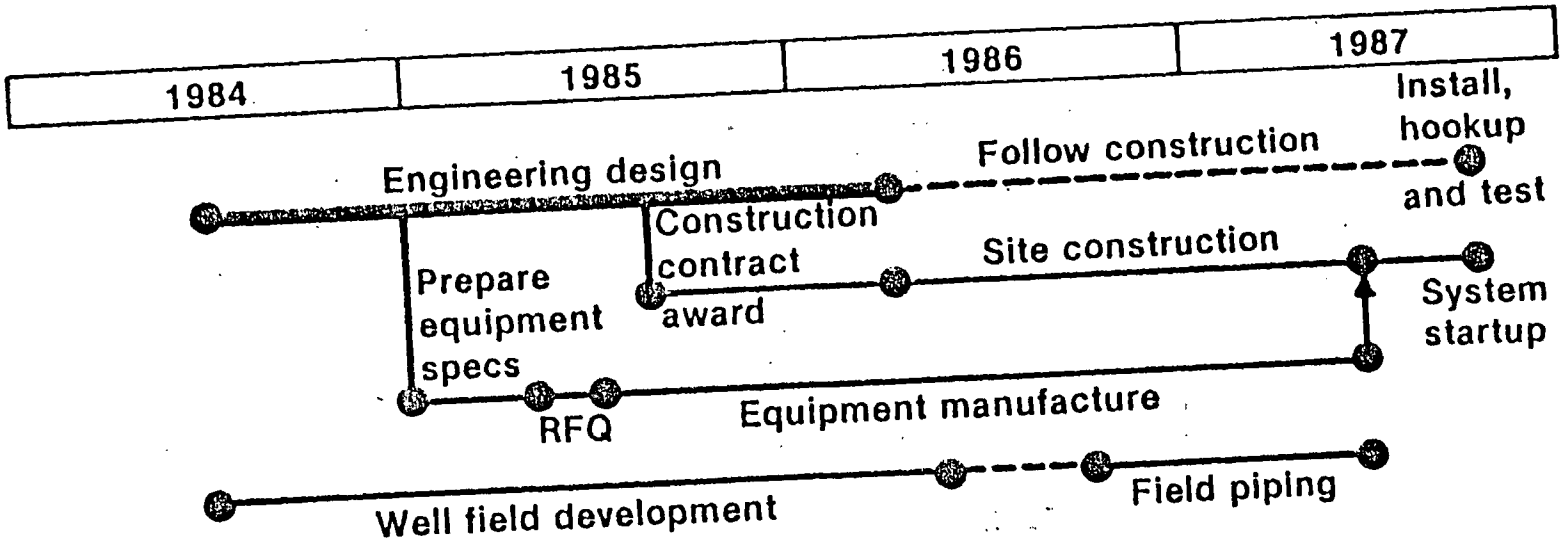
Geothermal Power Generation Costs



Geothermal Energy Direct Applications

- Desalination
- Space conditioning
- Refrigeration
- Food processing
- Aquaculture
- Potable water
- Industrial processing
- Greenhousing
- Meat packing
- Agriculture
- Drying

S2 0374

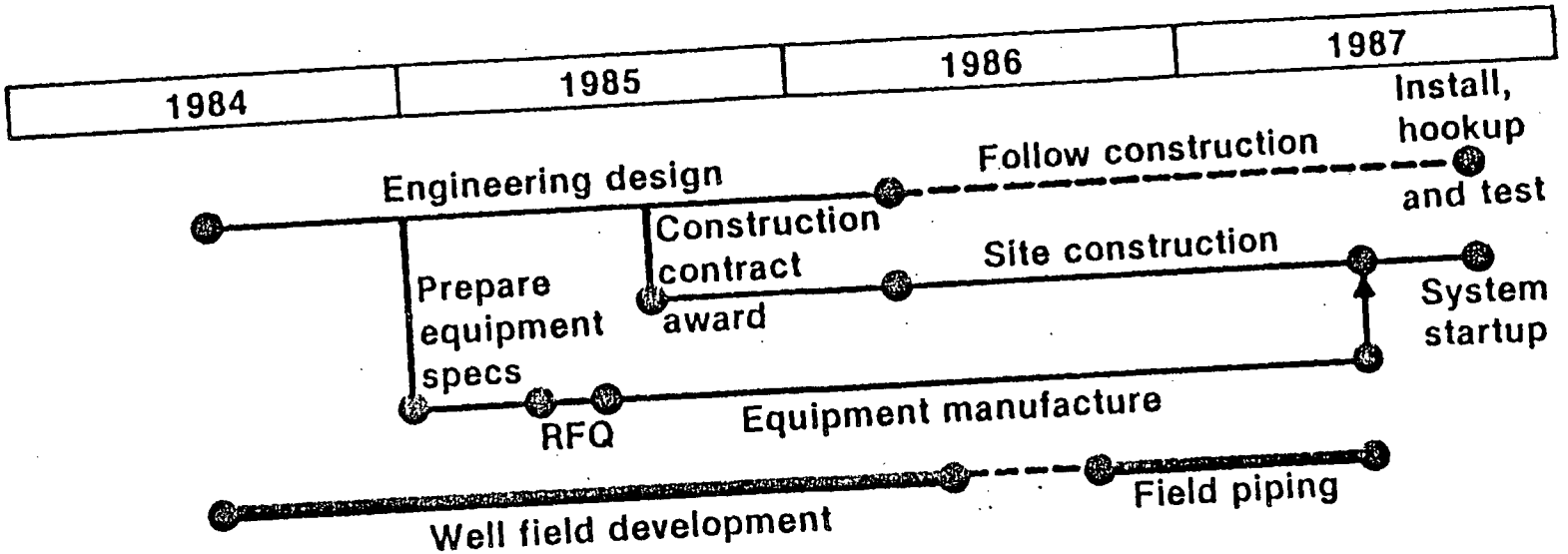


Engineering design

Based upon selected cycle concept

- Finalize cycle design
- Prepare system schematic drawings
- Prepare equipment specifications
- Prepare request for quotations
- Evaluate bids
- Order power equipment
- Develop plant layout
- Perform test borings for foundations
- Prepare foundation, piping and electrical drawings
- Follow construction
- Train operators
- Test and startup system

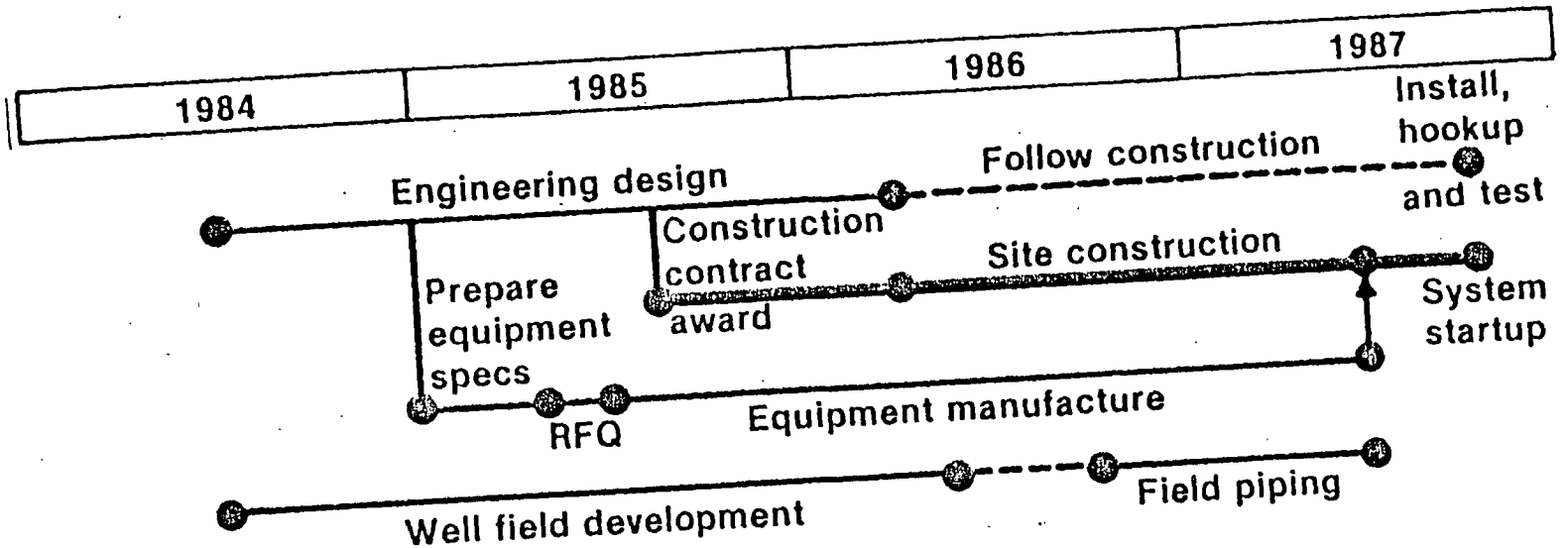
S2 0361



Well field development

- Select second well site
- Award drilling contract
- Drill and test second well
- Perform reservoir engineering
- Determine need for additional well
- Hookup field piping

S2 0362



System construction and startup

- Award construction contract
- Perform site preparation
- Construct equipment foundations
- Install equipment
- Complete piping and electrical hookups
- Test equipment and systems

S2 0363

Estimated Time to Power on Line

Skid mounted single flash unit*	1985
Site constructed dual flash plant	1987
Site constructed binary plant	1988

*Currently advertised unit

S2 0373

Potential Costs
2.2 MW Geothermal Power Plant

	Cost ($1000)	Time (months)
Initial evaluation	80[1]	3 plus 1
Exploration	650[2]	6 plus 3
Resource assessment	3500[2]	15 plus 3
Well field development[2]	400[3] to 10,000[4]	15 to 40
Plant	3,000[5] to 15,000[6]	
Total	~ 8,000 to 30,000	46 to 71

1. Cost estimate
2. Estimated labor, typical construction, double drilling
3. First resource well adequate, plus piping and controls
4. Four resource wells
5. Good resource, skid mounted plant
6. Less quality resource, binary plant

S2 0371

Summary

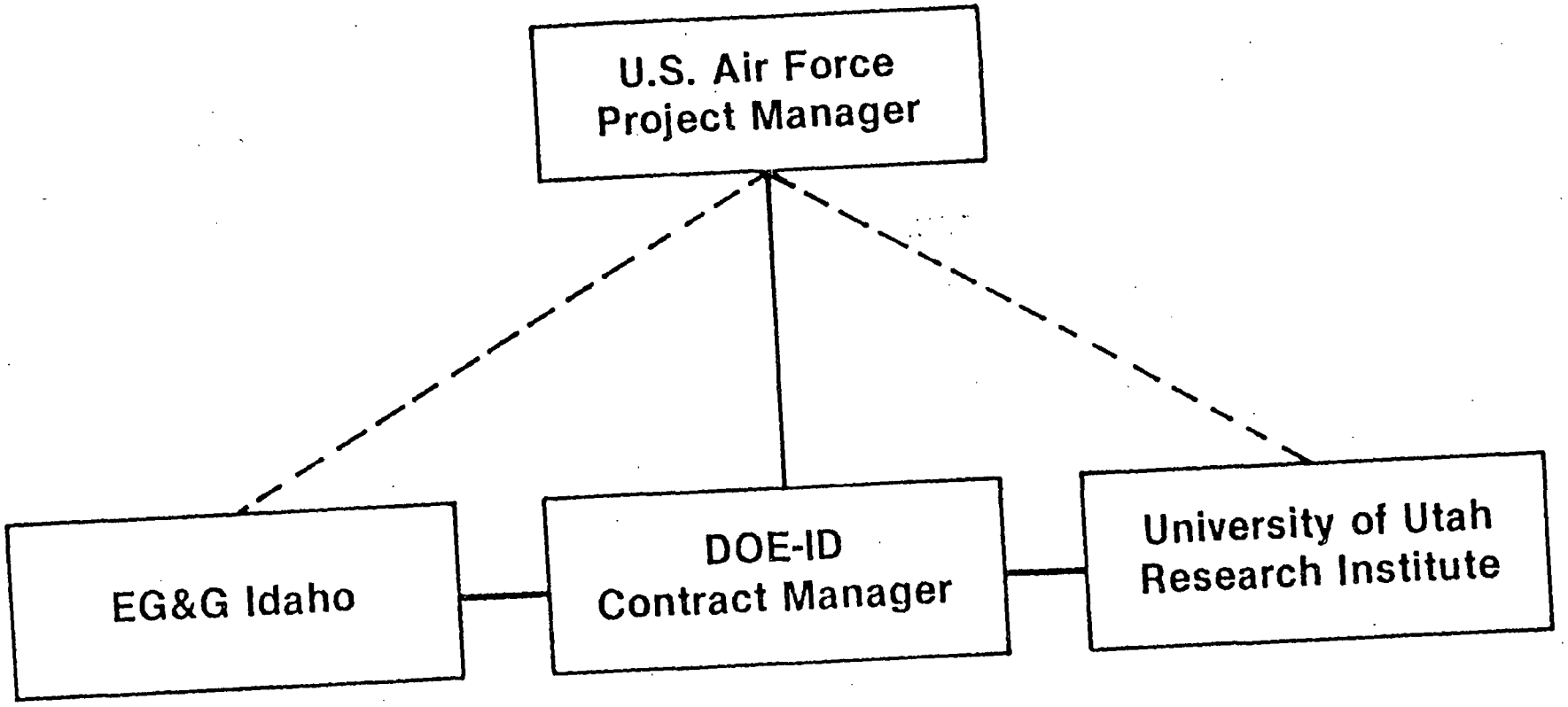
Assessment and Development of Geothermal Power at Ascension Island

- Good potential for geothermal resource
- Two low cost initial evaluations recommended
- Potential for power on line by 1985
- Cost will depend primarily on resource
- EG&G Idaho-UURI team capable of managing project from assessment through operation

S2 0367

Proposed Project Organization

Organizational Structure



S2 0350

Responsibilities

- U.S. Air Force - establishes program direction and directs project management
- DOE-ID - provides contract management of EG&G Idaho and UURI support
- EG&G Idaho - provides project management and technical and economic analysis for reservoir engineering and systems
- University of Utah Research Institute - provides project management and exploration and resource evaluation

INEL-S-35 937

9 Feb 1982 Presentation to USAF & Pan Am at NCO club, Patrick AFB, FL.

- ~~USAF spends $2.3M in fuel to generate electric power~~
- Desalinization - 500 gpm sea water to plant, [illegible] to boil, exchange [illegible] [illegible], [illegible].
  [illegible] to [illegible] - the plant [illegible] 9" Hg [illegible].
- British charge 22¢/KWH for their power -
- Dramatic costs for a tanker to Ascension [illegible]!
- C5A sized aircraft can land @ Ascension
- Energy goal to meet [illegible] by 1985 -
- food is cheap - good food -
- best worldwide fishing - water is very rough - lost two guys [illegible] [illegible] [illegible] [illegible].
- USAF would fly us there, put us up - no helicopters, but USAF would furnish [illegible] -
- USAF will get us permission to ~~[illegible]~~ get a UK [illegible] to do [illegible].
- Get set topo maps + aerial mosaics.
- pretty good air photos - George will reproduce, send us negatives -
- other imagery - Landsat - Dr. Fraiden said [illegible] letter stating what we want - when they become avail. we could buy - we should try to order Landsat.
- Antigua, Grand Bahama, Grand Turk (small). Antigua is prime site, also.
- Infra red - Landsat only -
- Other - no wells, except [illegible] top. Rich no one has ever [illegible] there.