PHASE II BRIEFING
GEOTHERMAL EXPLORATION
and
GEOTHERMAL POWER PLANT UPDATE FOR ASCENSION ISLAND, SOUTH ATLANTIC OCEAN

prepared for

UNITED STATES AIR FORCE
EASTERN SPACE AND MISSILE CENTER
PATRICK AIR FORCE BASE, FLORIDA

and

UNITED STATES DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE
IDAHO FALLS, IDAHO

by

EARTH SCIENCE LABORATORY
UNIVERSITY of UTAH RESEARCH INSTITUTE
and
EG&G, IDAHO, INCORPORATED

JULY 12, 1984

ASCENSION GEOTHERMAL PROJECT

PHASE II BRIEFING

AGENDA

• Introduction	**C.R. NICHOLS** (DOE/ID)
• Geothermal Exploration Results	**D.L. NIELSON** (ESL/UURI)
• Geothermal Power Plant Update	**J.F. WHITBECK** (EG&G)
• Recommendations, Costs, Schedule	**D.L. NIELSON**

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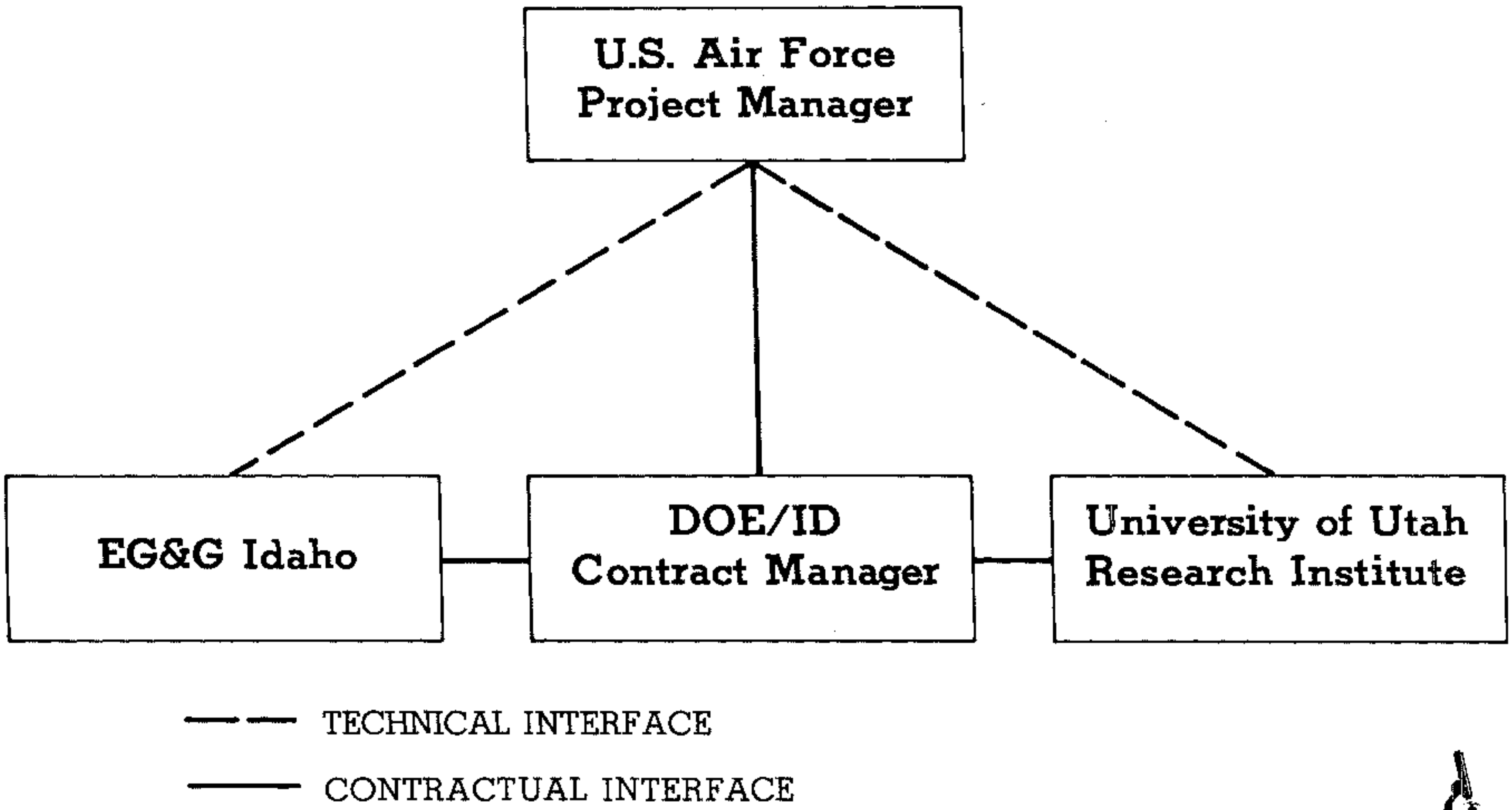
ORGANIZATIONAL STRUCTURE



ASCENSION GEOTHERMAL PROJECT
RESOURCE DEVELOPMENT

PHASE	ACTIVITY
I. Preliminary Examination	Geologic Mapping
→ II. Exploration	Geophysical Surveys Thermal Gradient Drilling
II(cont.) Resource Confirmation	Deep Tests
III. Production Drilling	Well Field Development

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PHASE II - GEOTHERMAL EXPLORATION

CONCLUSIONS

- Active geothermal system beneath Ascension
- Highest potential near Middleton Ridge
- Recommend deep hole to test and confirm resource

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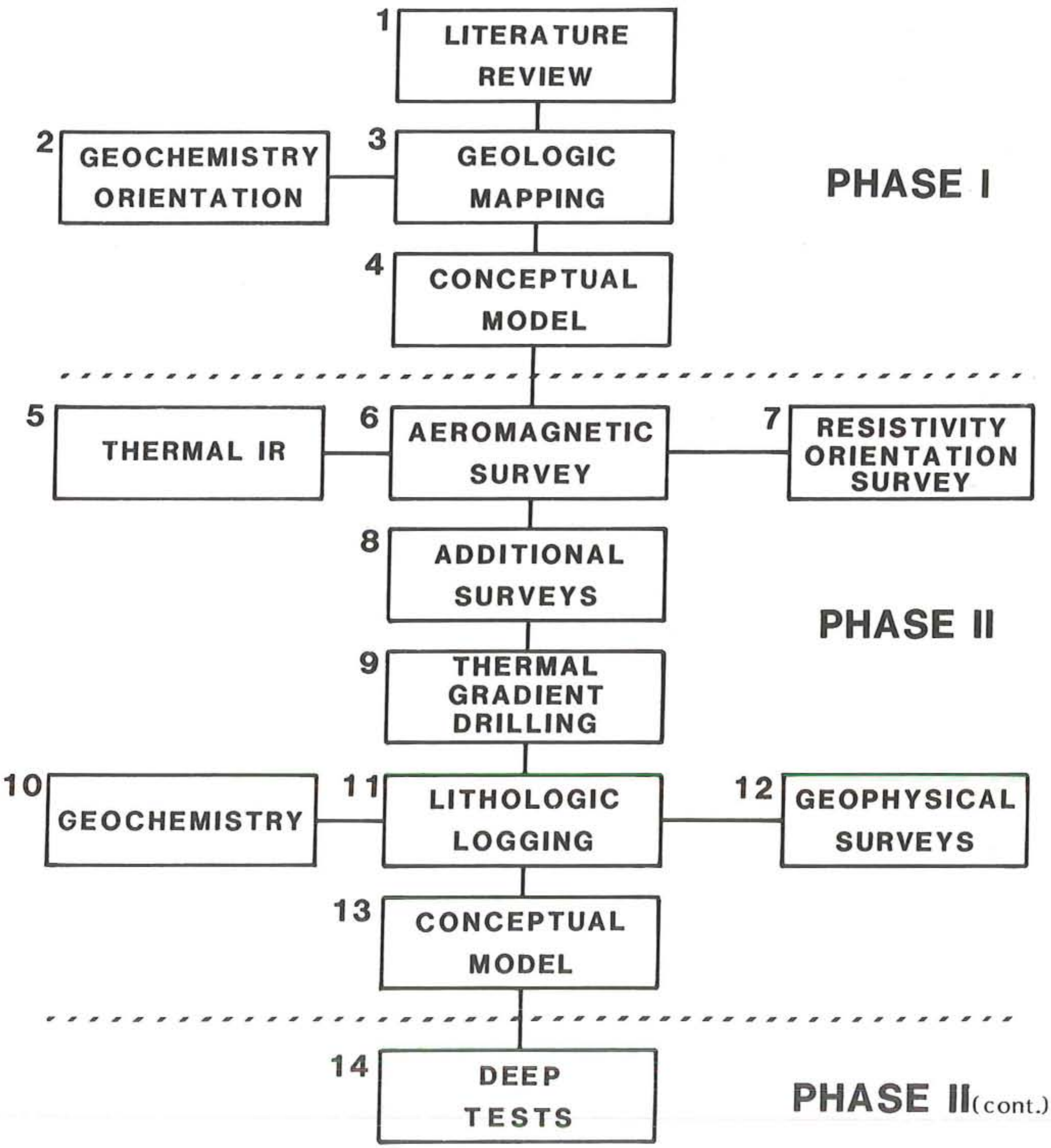
STRATEGY



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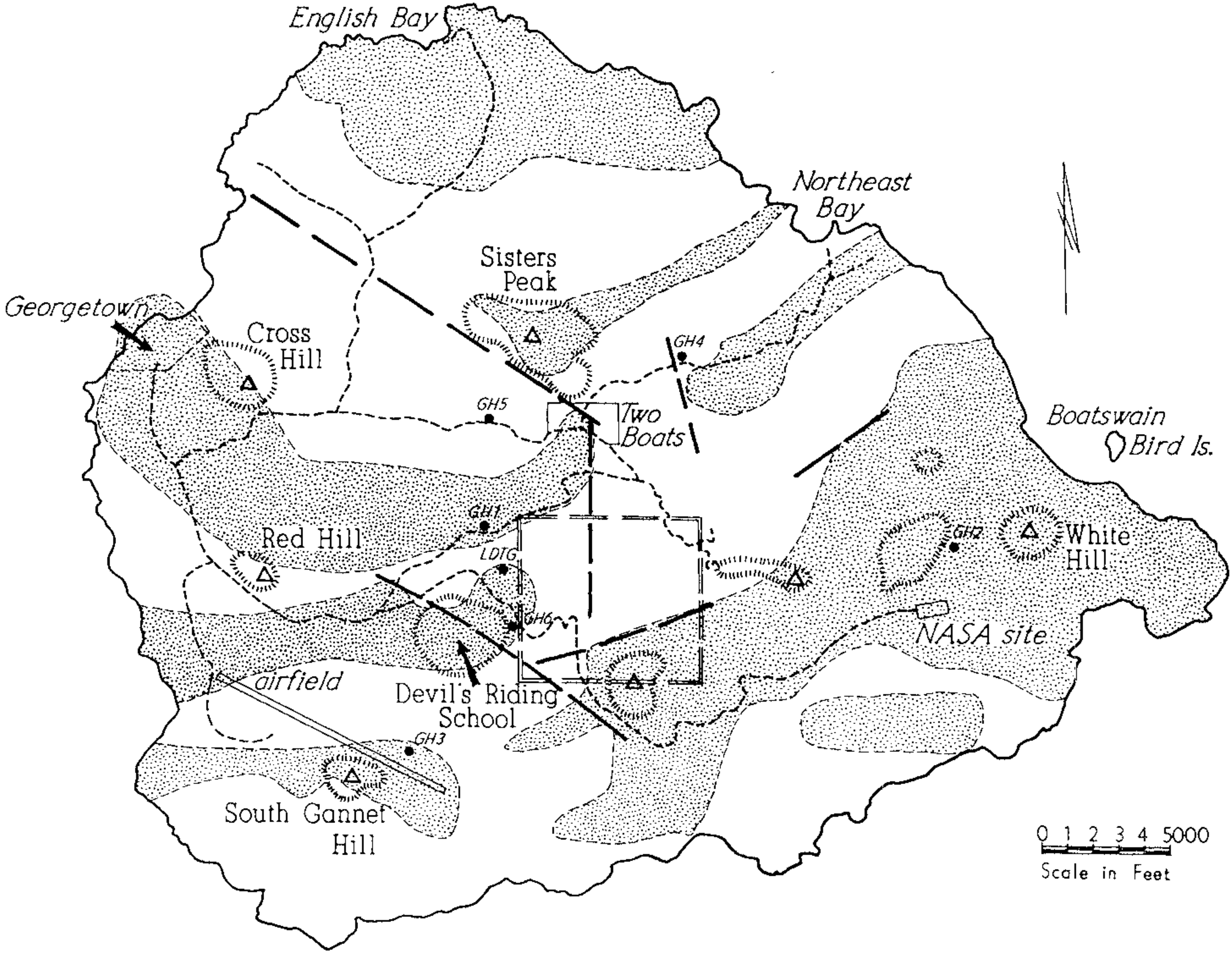
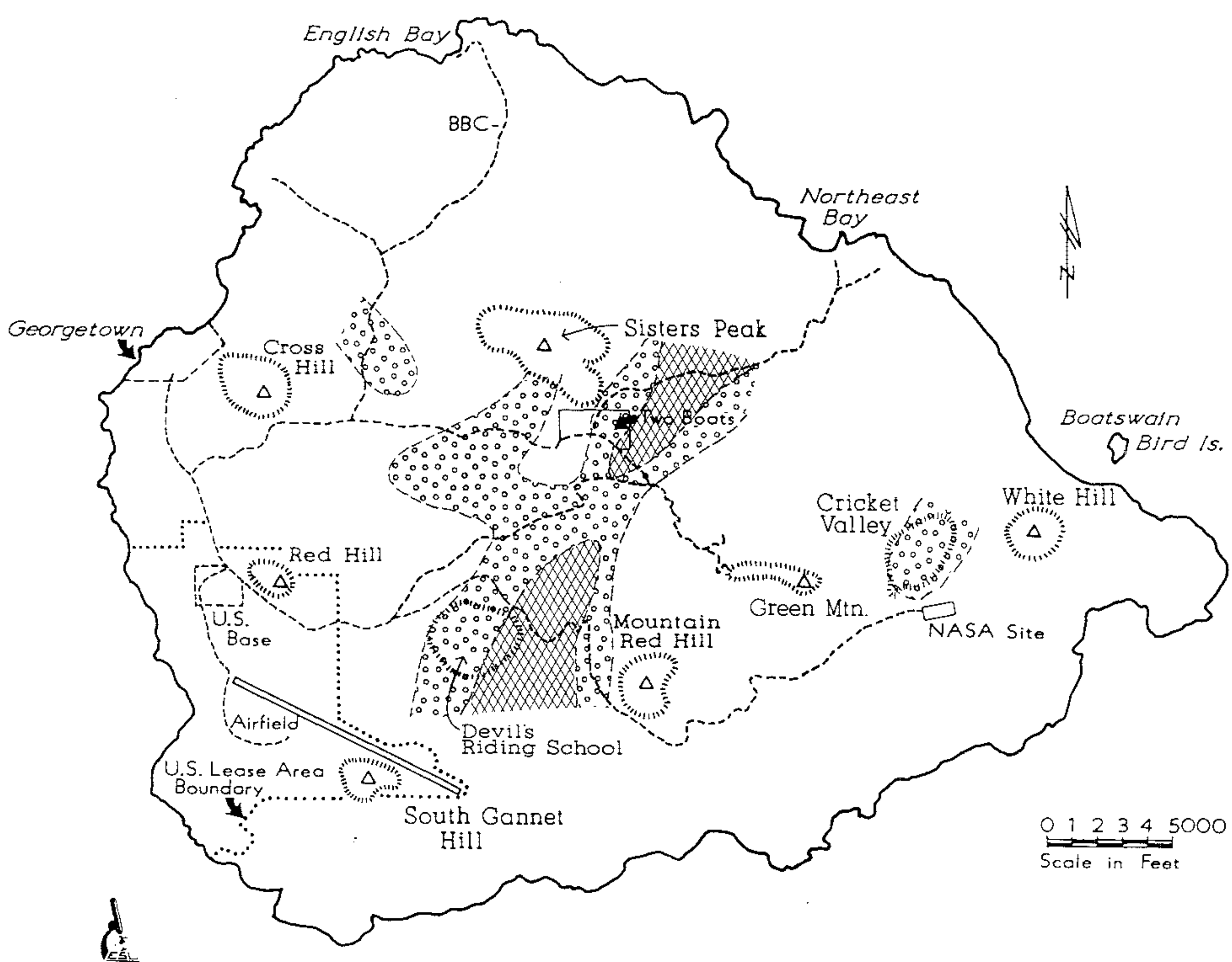

English Bay
Northeast Bay
Sisters Peak
Georgetown
Cross Hill
GH4
GH5
Two Boats
Boatswain
Bird Is.
GH1
Red Hill
GH2
White Hill
LDTG
GH6
NASA site
airfield
Devil's Riding School
GH3
South Gannet Hill
0 1 2 3 4 5000
Scale in Feet


English Bay
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Boatswain Bird Is.
White Hill
Cricket Valley
Red Hill
Green Mtn.
U.S. Base
Mountain Red Hill
NASA Site
Airfield
Devil's Riding School
U.S. Lease Area Boundary
South Gannet Hill
0 1 2 3 4 5000
Scale in Feet

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SUBSURFACE TEMPERATURE DATA

- Absolute Temperatures

- Temperature Gradients

- Chemical Geothermometers

ASCENSION ISLAND
THERMAL GRADIENT HOLES

HOLE	DEPTH[FT.]	Tmax[° F]
GH-1	583	108
GH-2	1750	114
GH-3	206	77
GH-4	723	104
GH-5	892	78
GH-6	1294	130
LDTGH	1115	119

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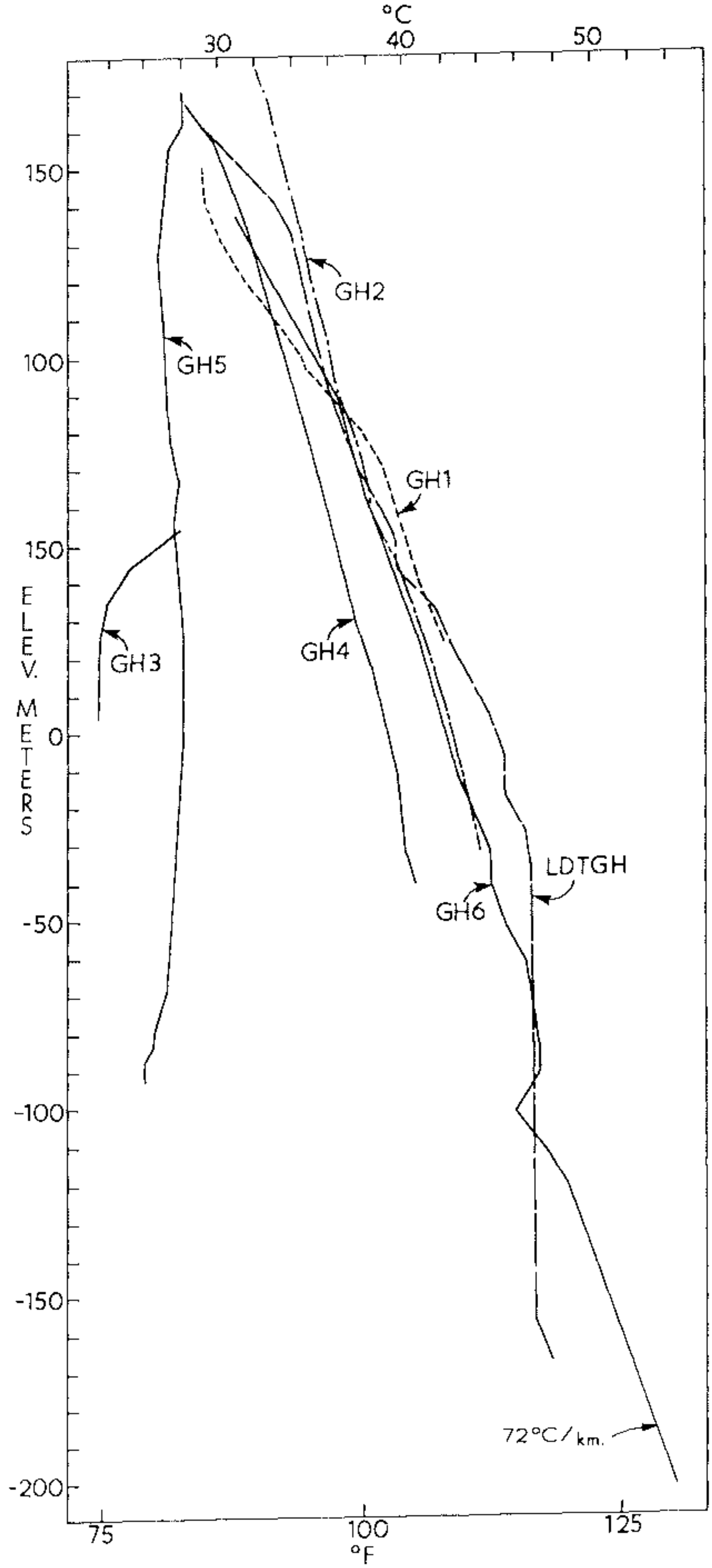

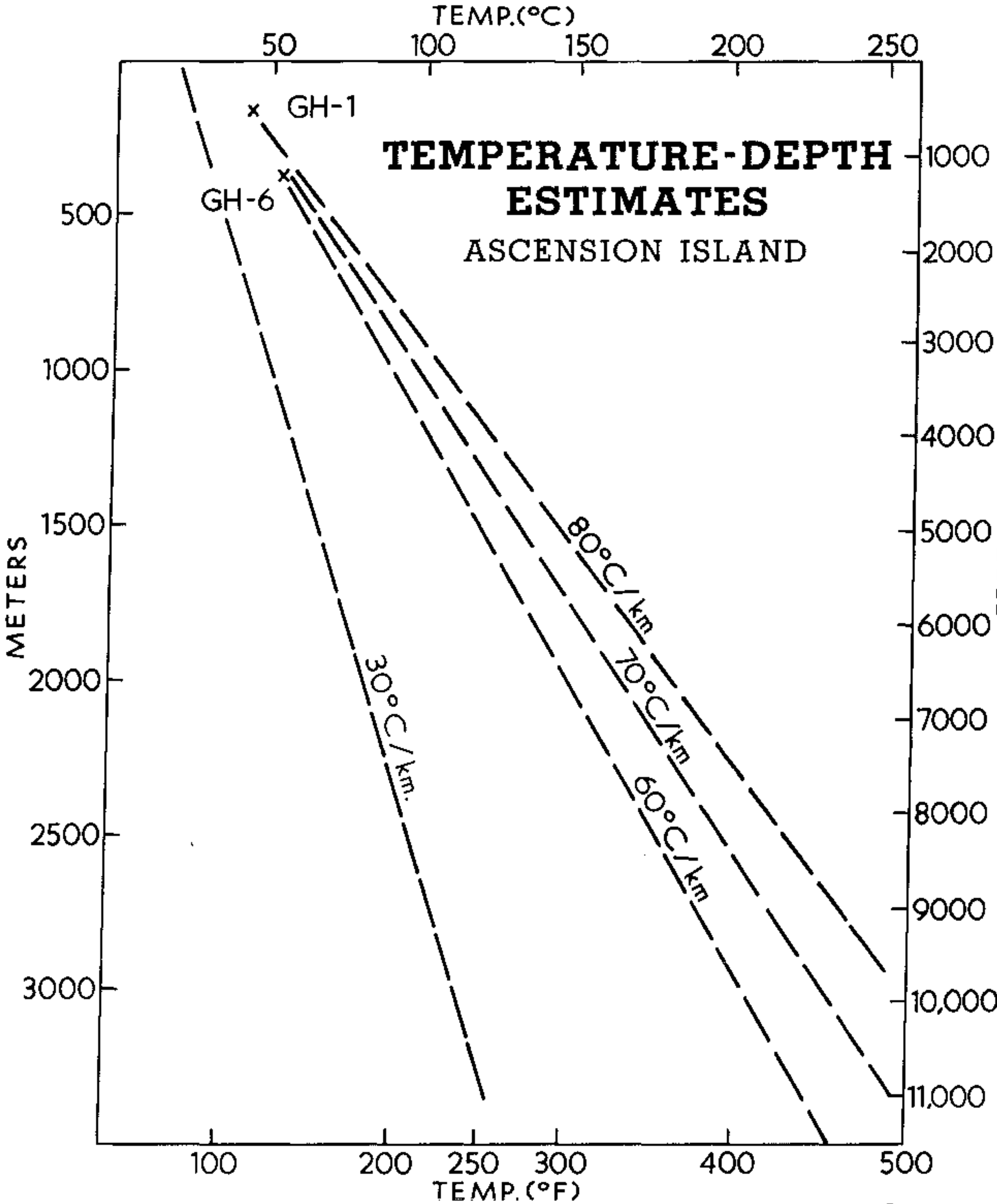

TEMPERATURE-DEPTH
ESTIMATES
ASCENSION ISLAND
TEMP.(°C)
50
100
150
200
250
GH-1
GH-6
500
1000
1500
2000
2500
3000
METERS
1000
2000
3000
4000
5000
6000
7000
8000
9000
10,000
11,000
FEET
80°C/km
70°C/km
60°C/km
30°C/km.
100
200
250
300
400
500
TEMP.(°F)

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CHEMICAL GEOTHERMOMETERS

- Fluids from LDTGH are Geothermal Fluids
- Have reacted with rocks at elevated temperatures

$T_{measured} = 113° F$

$T_{SiO_2} = 232° F$

$T_{mixing} = 232\text{-}356° F$

- Low pH suggests high CO_2 from geothermal system

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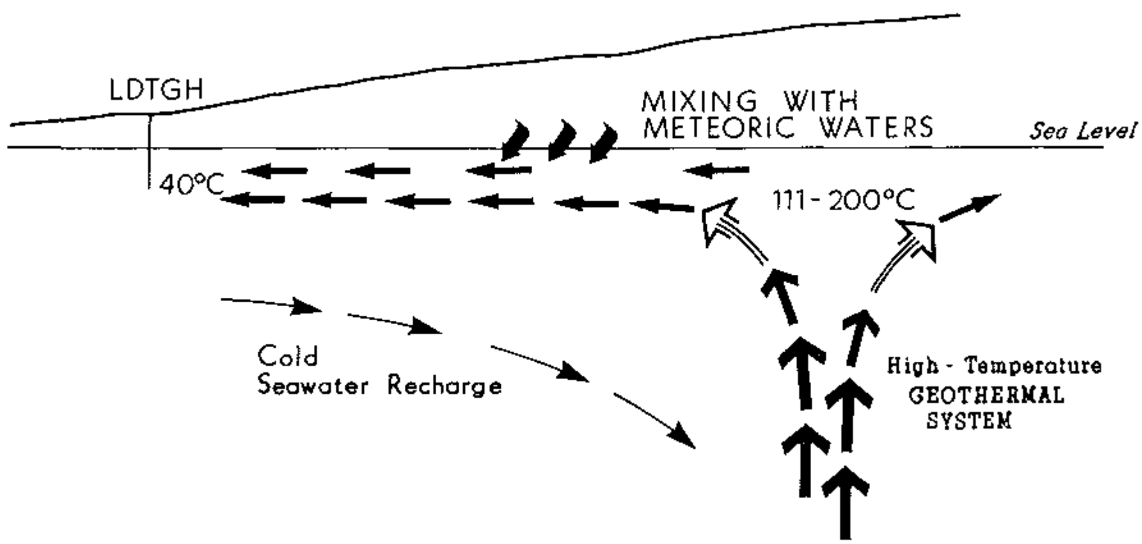
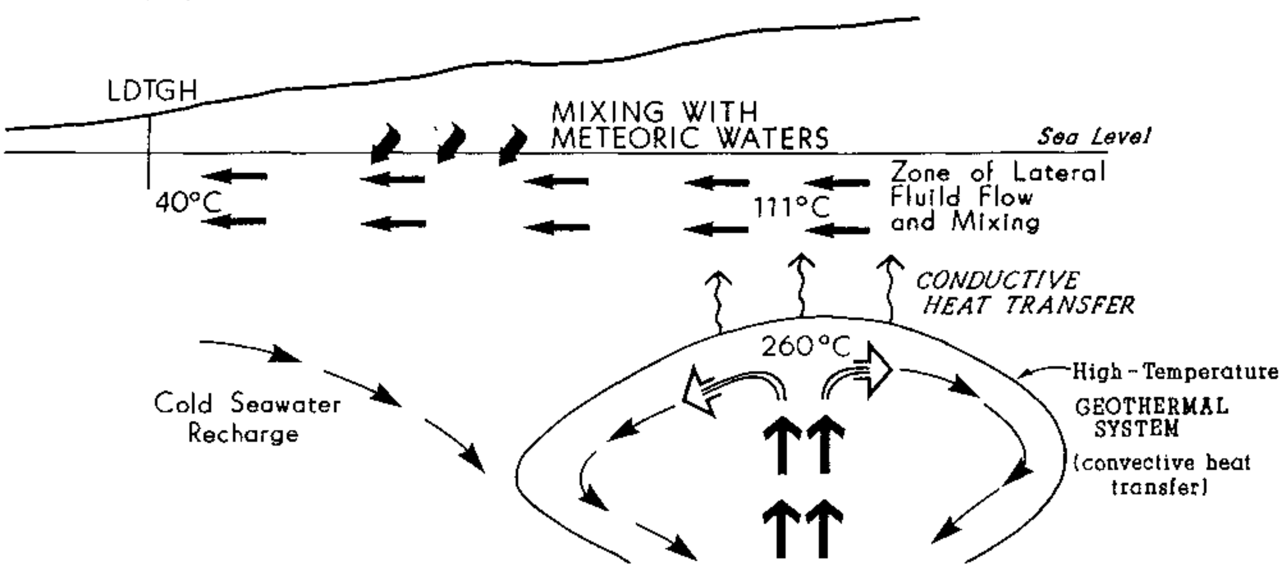
POSSIBLE MODELS

(a)



(b)



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PHASE II - GEOTHERMAL EXPLORATION

CONCLUSIONS

- Active geothermal system beneath Ascension
- Highest potential near Middleton Ridge
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RECOMMENDATION

USAF should drill deep hole[s] to test temperature and flow characteristics of the geothermal system prior to production well/power plant development.

Presentation Content

- Power system options
- Basis for selecting conceptual design temp.
- Conceptual design assumption, design, cost estimate
- Economic assumption, economic analysis results
- Conclusion

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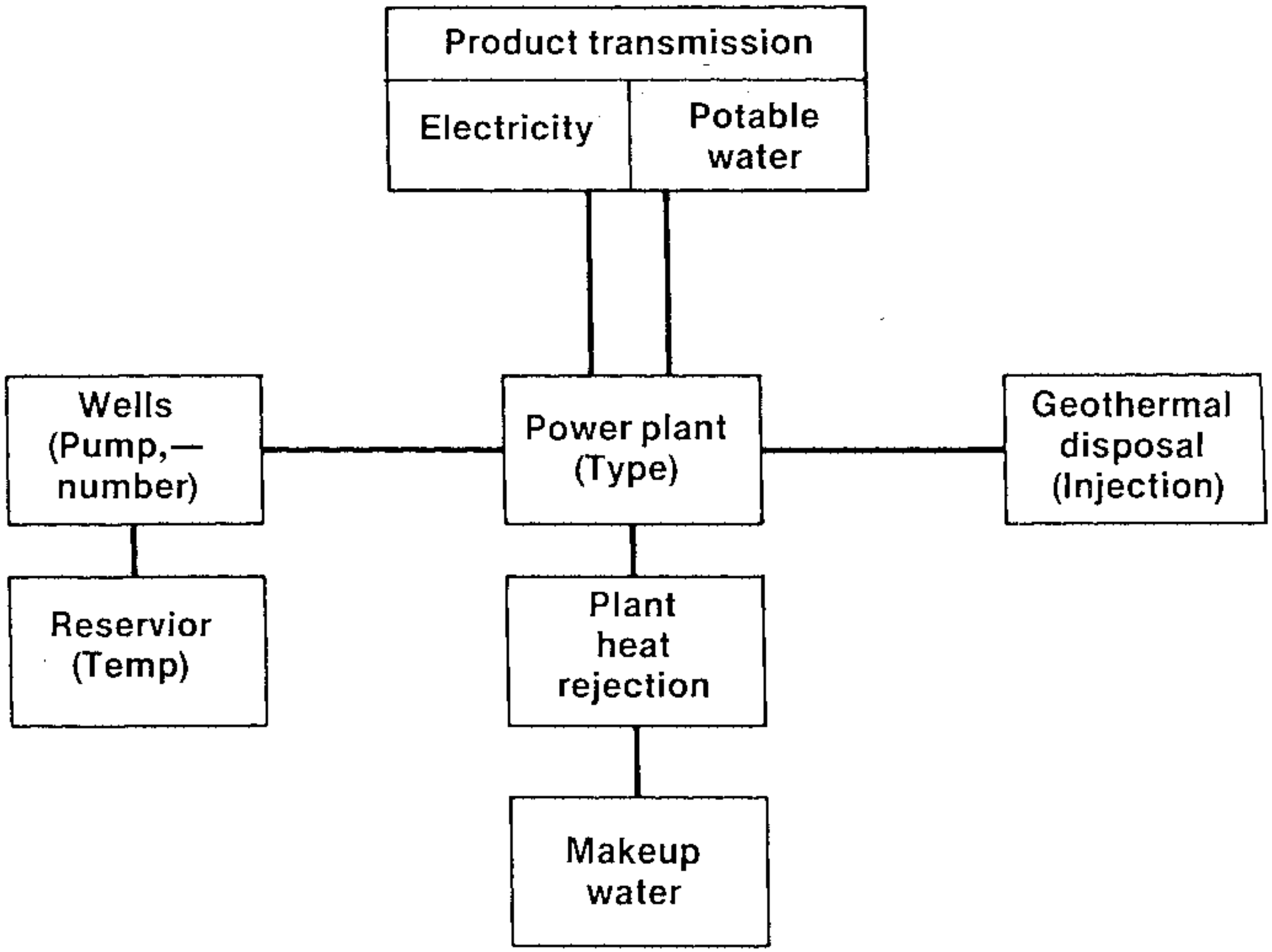
Geothermal Power Facility



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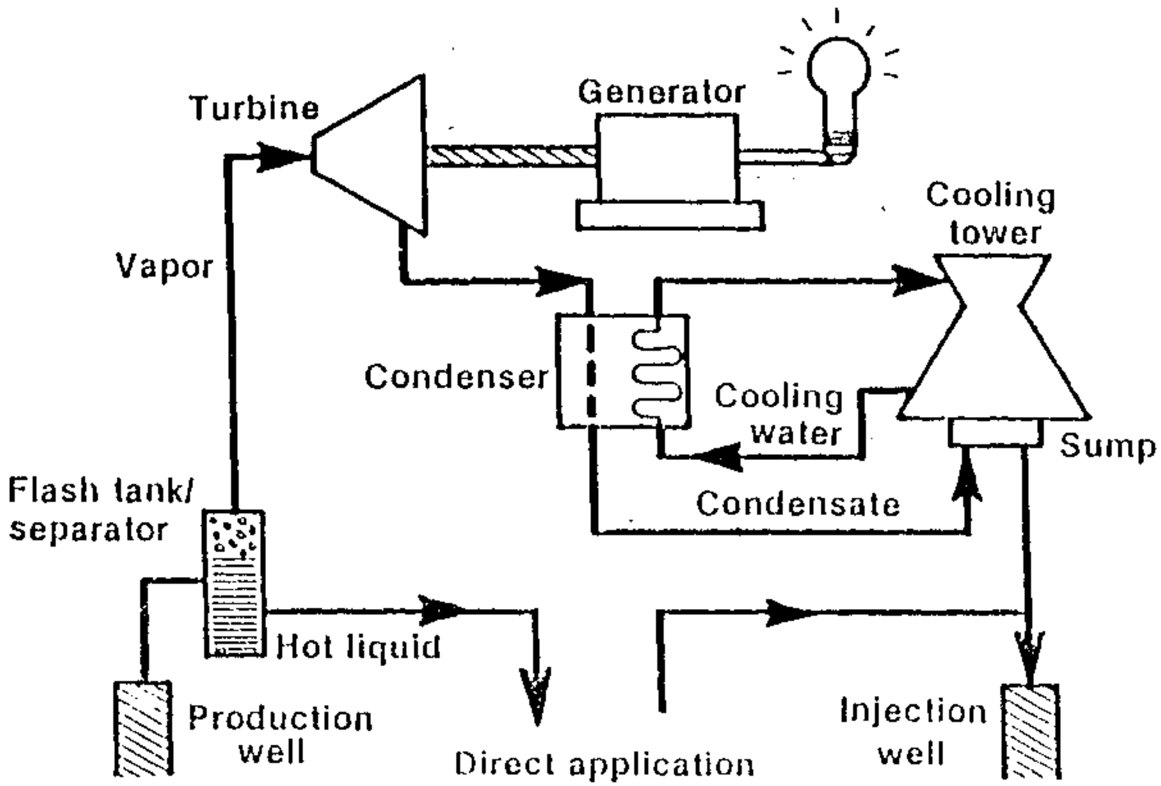
Flash Steam System



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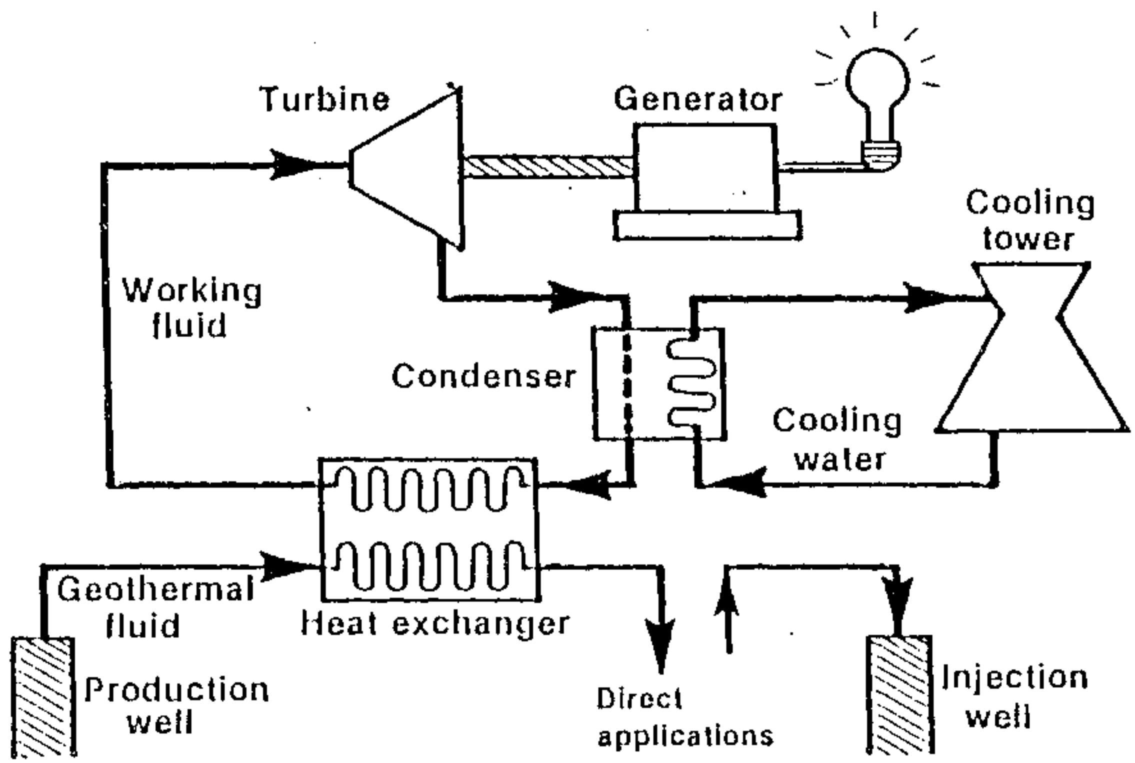
Binary System



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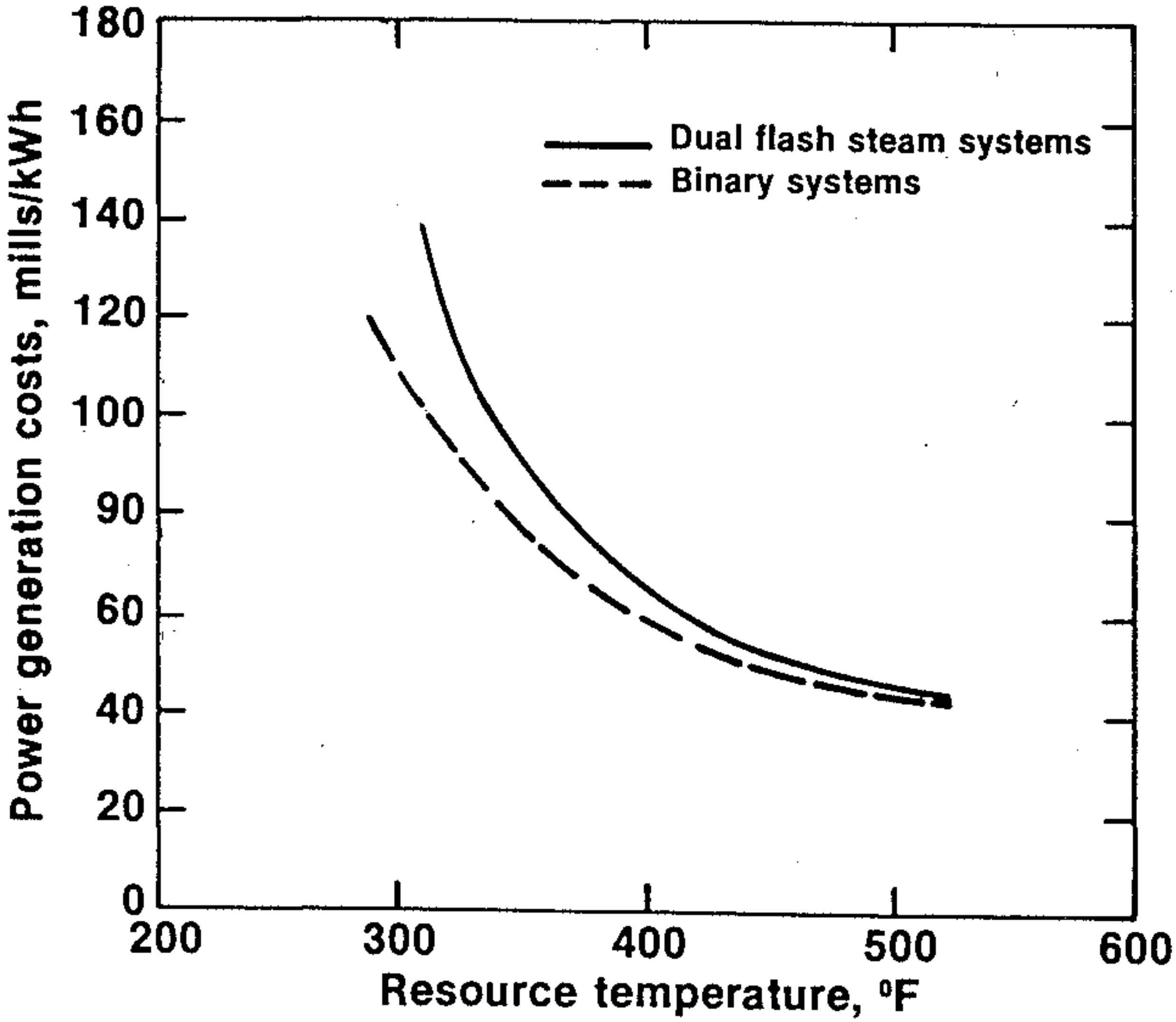
Geothermal Power Generation Costs



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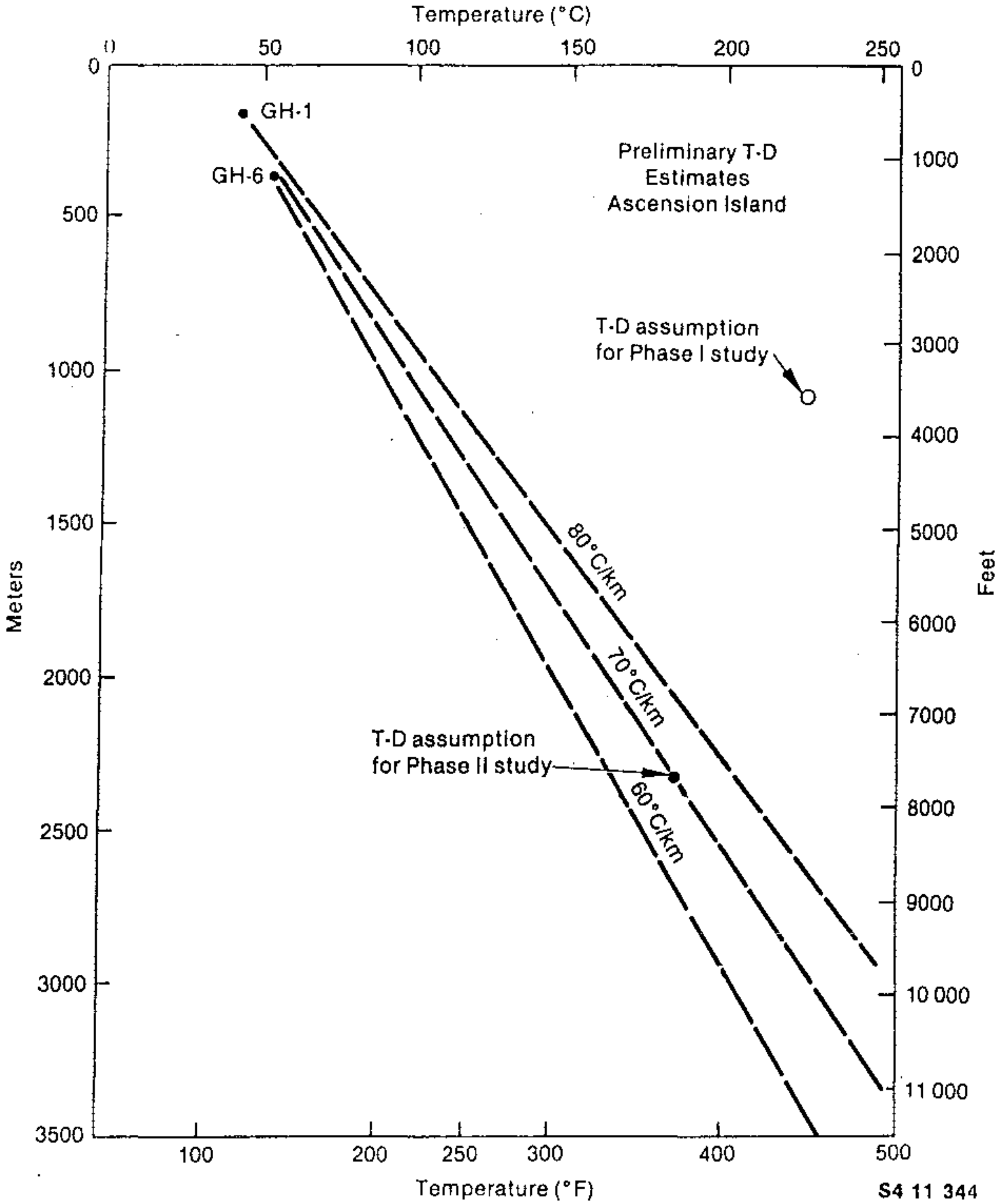
Preliminary Temperature Depth Estmates



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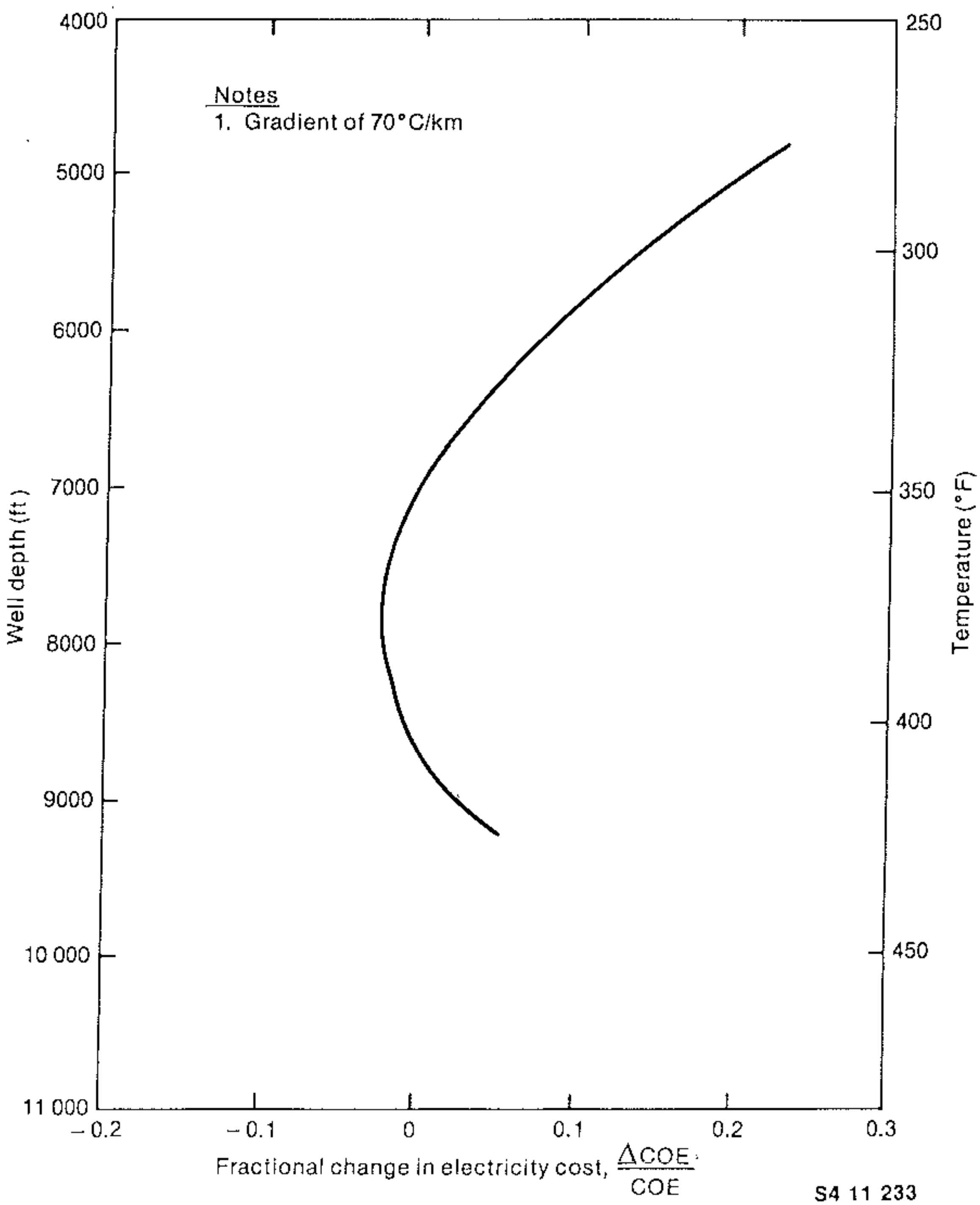
Well Depth vs Fractional Change in Cost



Ascension Island Geothermal Development Design Assumptions

- Four 1 MW(e) geothermal units are required to supply power (3 MW (average), 3.5 MW (peak))
- Two production wells are required to supply geofluid (380 gpm/unit)
- New geothermal units are located about 2½ miles from existing AF power plant
- Potable water requirement (47,000 gpd) is supplied from geofluid

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Ascension Island Geothermal Development Design Assumptions

- Power cycle best suited to a low temperature geothermal resource is the organic Rankine or flash - binary cycle
- Cooling water is supplied from Well LDTGH and excess potable water
- Spent fluids are discharged to ocean for disposal (or to an existing crater)

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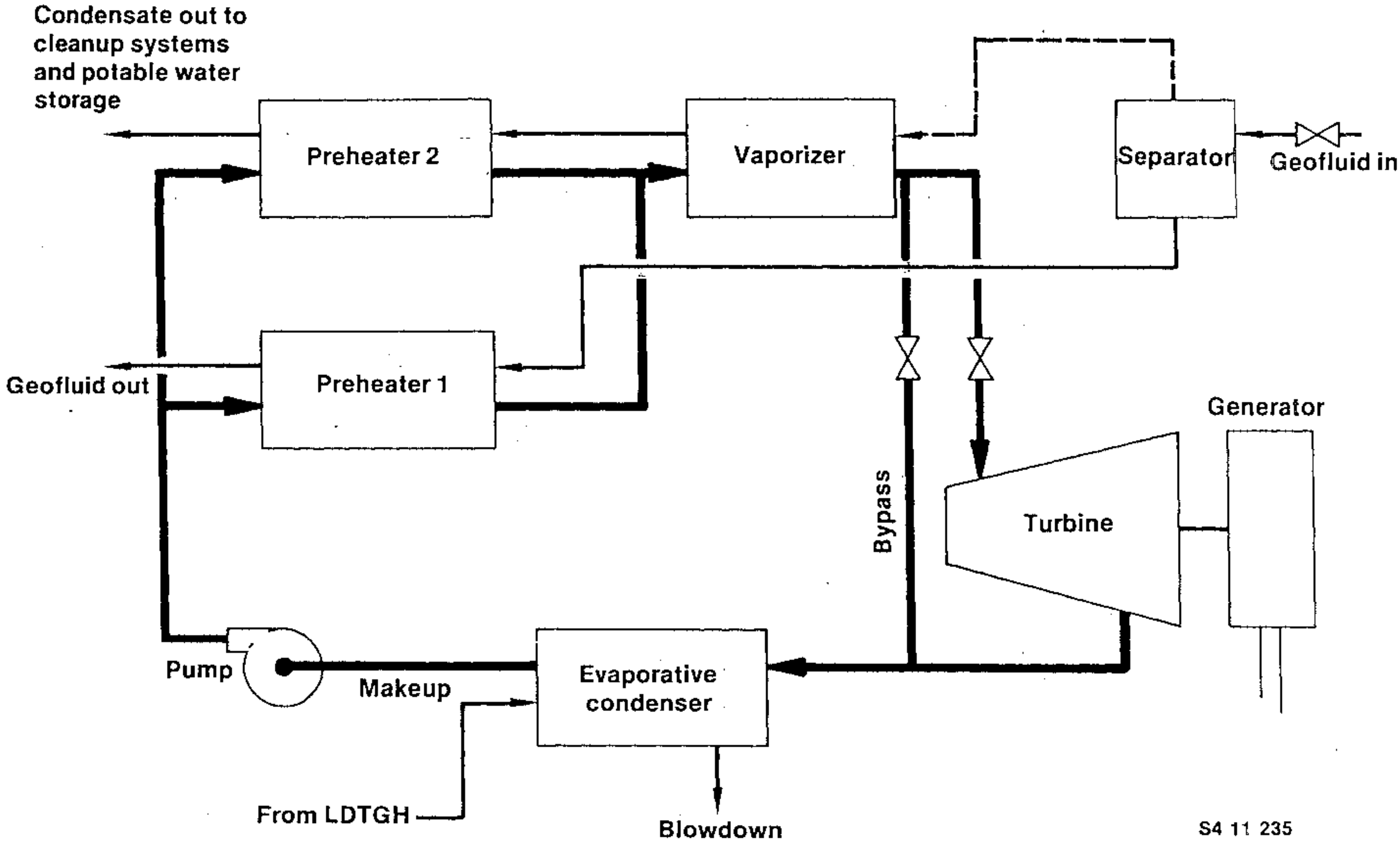
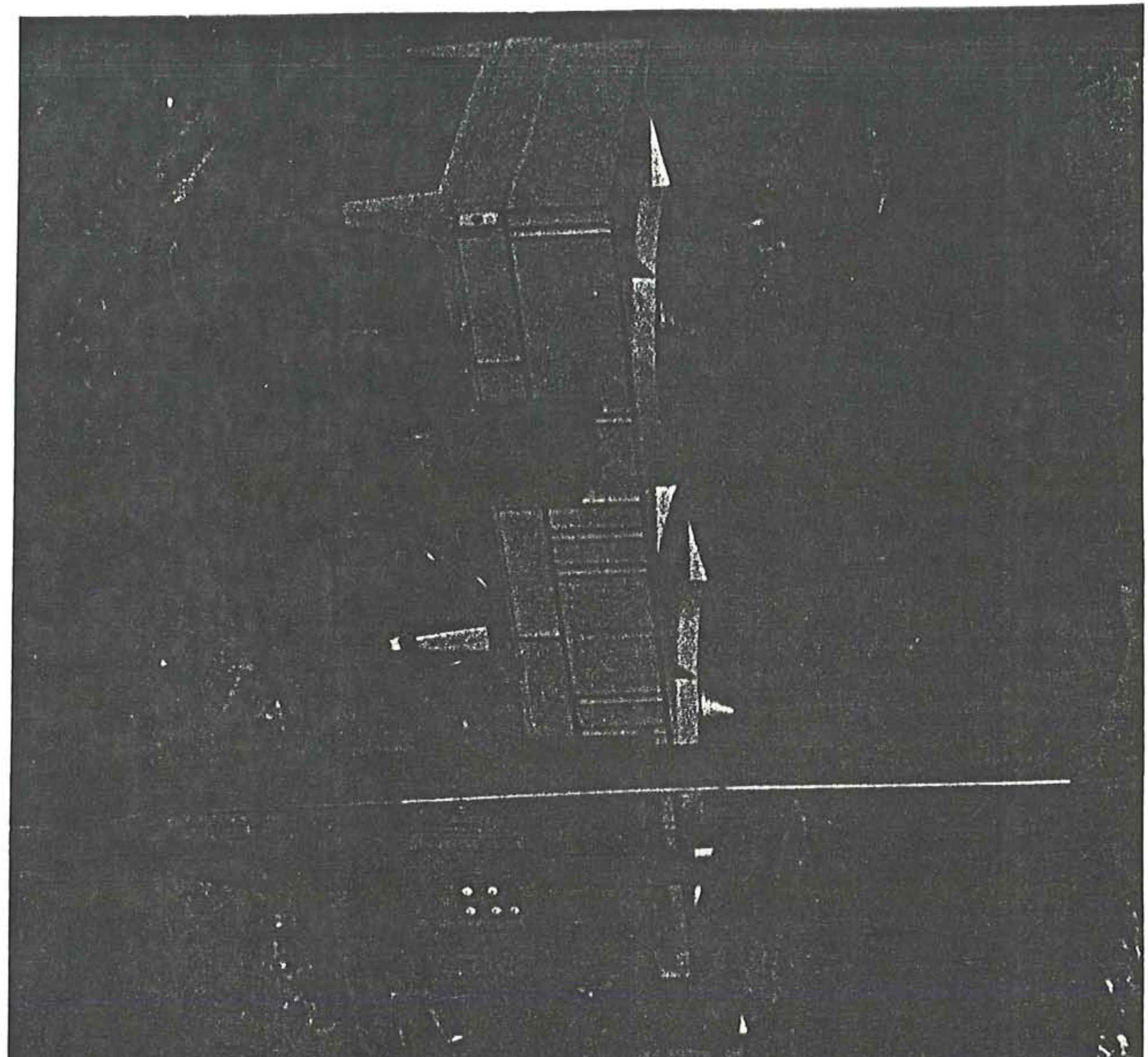
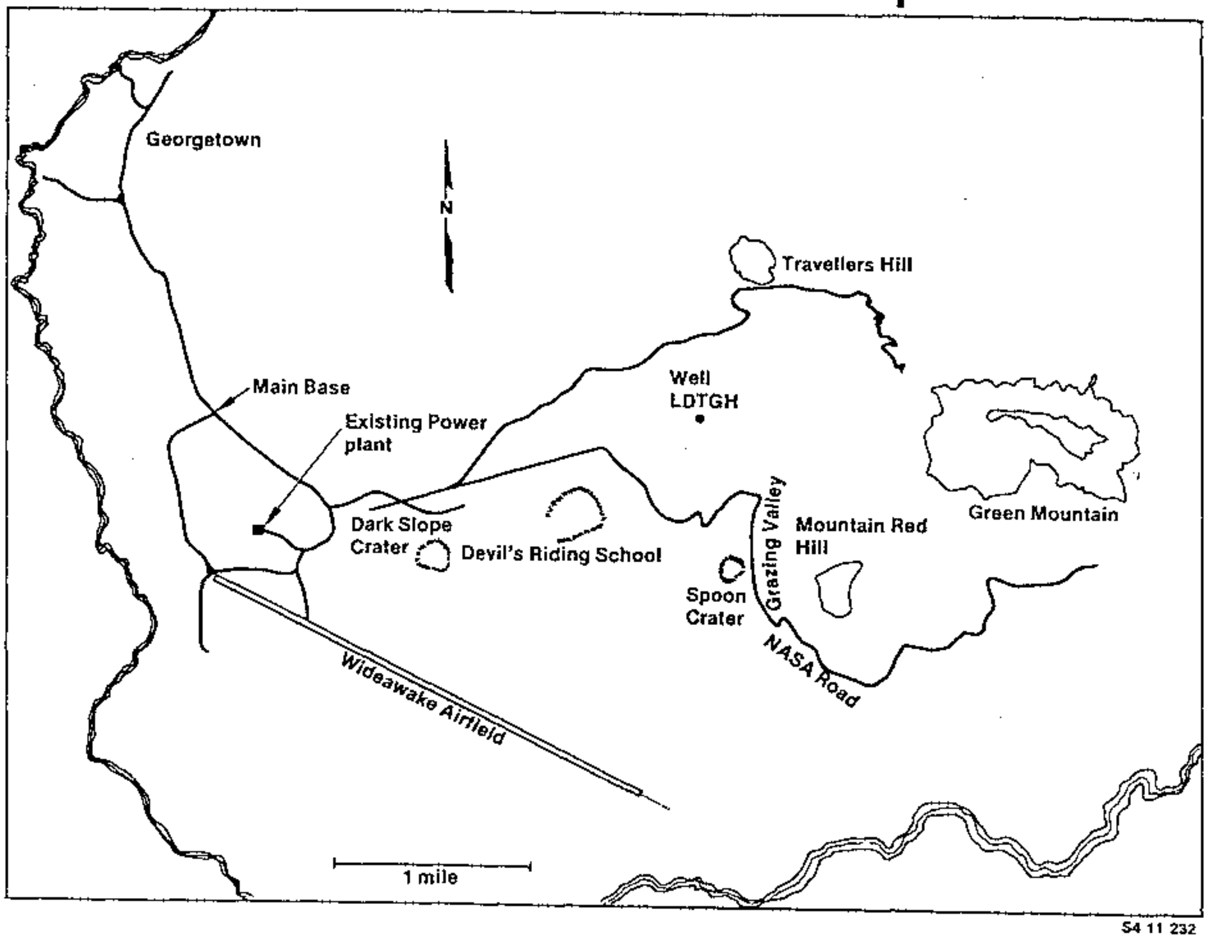
Power Cycle Schematic

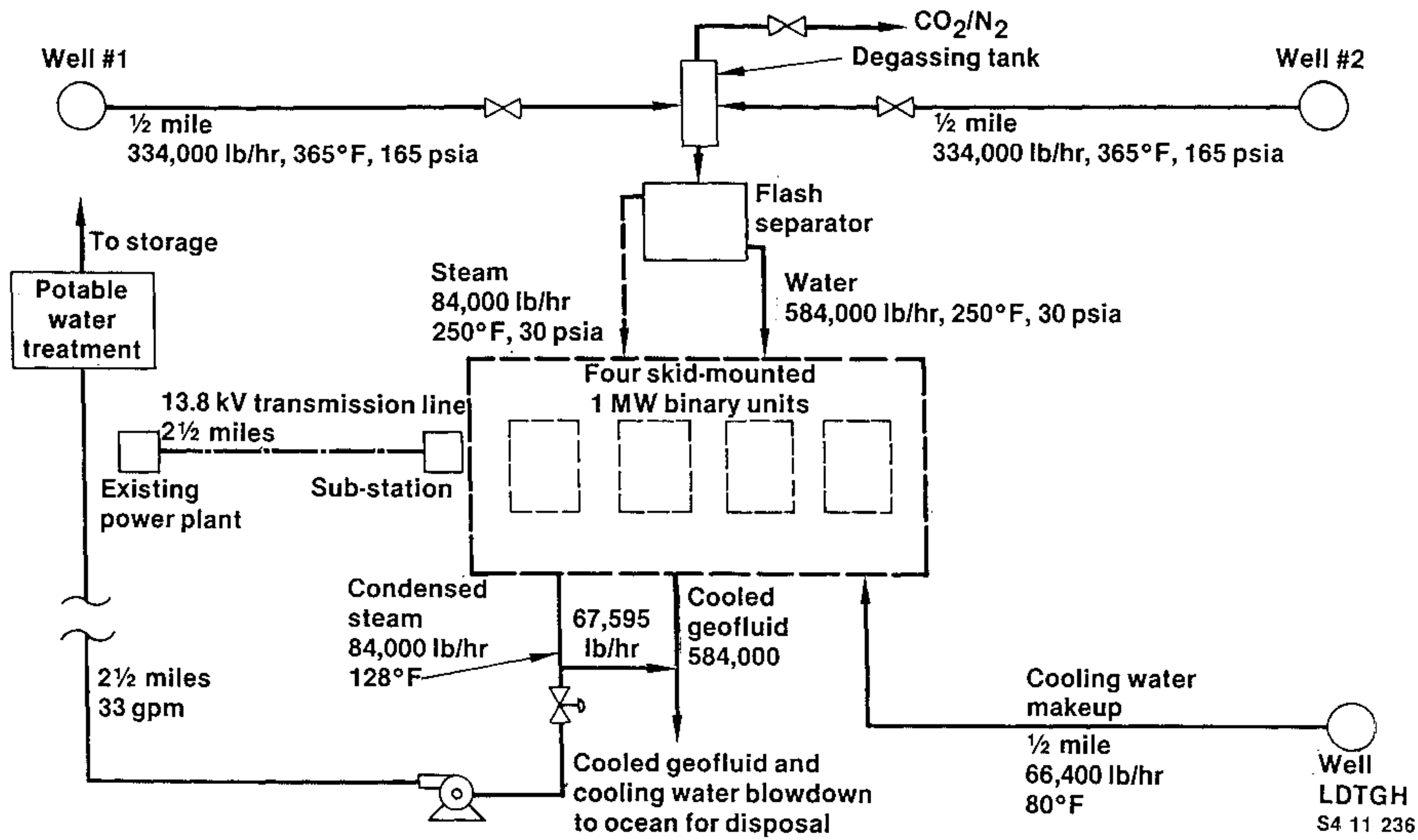




Ascension Island Area Map



Baseline System Flow Schematic



Ascension Island Geothermal Development Cost Assumptions

- All construction materials must be brought in
- Construction material costs are Stateside cost plus shipping
- Construction equipment is available on the island
- Construction labor and equipment costs are same as Stateside
- Materials and equipment are shipped by boat
- The production wells and binary cycle turbine/generators are GFE

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Ascension Island
Geothermal Development
Project Costs ($K)

Production wells (2 wells)	$ 6,860		
Generator modules (4-1MW(e) units)	4,000		
		$10,860	
Structures and improvements	321		
Geothermal supply system	776		
Power plant	650		
Cooling water system	167		
Waste system	753		
Shipping	200		
		2,867	
Indirect costs	430		
Profit	330		
Construction management	435		
Design	260		
Project management	250		
Contingency	1,143		
		2,848	
Total project			$16,575

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Ascension Island Geothermal Development Project Economics

Present plant (FY-83 data):

Power produced — $15{,}884 \times 10^3$ kWh/yr

Diesel fuel	— $1{,}254 \times 10^3$ gal at \$1.62/gal =	\$2,031,000/yr
Lube oil	— 9.4×10^3 gal at \$3.35/gal =	32,000/yr
Unit cost for fuel & lube oil = \$0.13/kWh		\$2,063,000/yr

Potable water produced — 37,200 gal/day

Unit cost for fuel, maintenance, and misc. materials — \$23.54/thousand gal

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Ascension Island
Geothermal Development
Project Economics (Cont'd)

Geothermal plant (four 1 MW(e) binary units)

	Case 1*	Case 2*
Capital cost (1984 dollars)	$16,575K	$16,575K
Power produced	23,652 x 10^3 kWh/yr	30,660 x 10^3 kWh/yr
Potable water produced	47,000 gal/day	47,000 gal/day
7% discounted payback	4.45 yrs	3.49 yrs
10% discounted payback	4.84 yrs	3.73 yrs
Fuel escalation rate	4.6%	4.6%

*Case 1 assumes that 3 of the 4 units are used 90% of the time, and Case 2 assumes that all 4 units are used 87½% of the time.

S4 11 323

Conclusions

- Payback times appear reasonable ~4-5 yrs
- A flash binary system will provide potable water
- Extrapolated linear gradient - adequate temps/depth
- Well LGDTH probably can be utilized - makeup source

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RISK ANALYSIS

<u>Exploration Risk</u>

- Is system present?
- Are temp. and flow rates sufficient?
- Can you drill into reservoir?

<u>Development Risk</u>

- Development well success?
- Can you produce reservoir?
- Economics?

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ADDITIONAL PHASE II OPTIONS

1. Deep Slim Hole	$1,450k
2. Resource Confirmation	$2,225k
3. Conversion to Production	$2,500k

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SCHEDULE - PHASE II (cont.)