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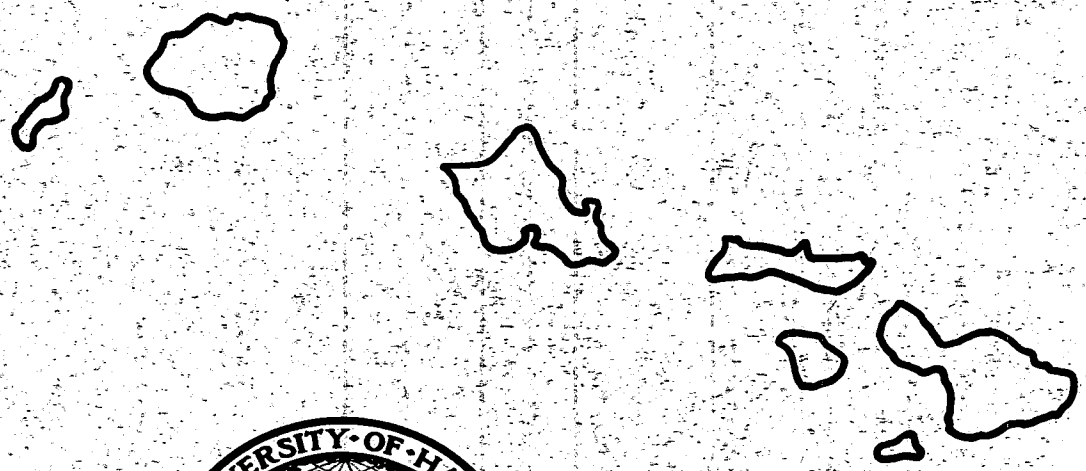
THE HAWAII GEOTHERMAL PROJECT

SUMMARY REPORT FOR PHASES I, II, III

September 1978



DISCLAIMER

HAWAII GEOTHERMAL PROJECT

SUMMARY REPORT FOR:
PHASE I, May 1973 - April 1975
PHASE II, May 1975 - June 1976
PHASE III, July 1976 - June 1978

PROGRAM DIRECTORS:

Management	John W. Shupe
Geosciences	Charles E. Helsley
Well Testing and Reservoir Engineering	Paul C. Yuen

SUPPORT FOR PROJECT PROVIDED BY:

Department of Energy, Contract EY-76-C-03-1093
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FOREWORD

The series of reports accompanying this summary document constitute a final report on the progress and accomplishments of the Hawaii Geothermal Project (HGP) during its first five years of operation. Although there has been continuity of support and administration throughout this five-year period, the Project has been divided rather arbitrarily into three phases:

Phase I, May 1973 - April 1975: Exploratory Surveys and Related Research

Phase II, May 1975 - June 1976: Experimental Drilling, Initial Well Testing, and Related Research

Phase III, July 1976 - June 1978: Well Testing and Analysis

The level of funding from all sources for these first three phases totaled $3,387,000 and resulted in the identification of a geothermal reservoir with high commercial potential. The Kapoho Geothermal Reservoir associated with the initial well, HGP-A, is one of the hottest hydrothermal systems in the world, and the quality of the fluid is excellent. An additional $6,268,000 has been allocated for installing a 3.5 MWe generator at the wellsite, and a parallel research program will be undertaken as Phase IV of the HGP. However, this summary report covers only Phases I, II, and III.

A decided strength of HGP from its inception has been the high degree of cooperation among all levels of government, the University, and the business community in assuring the success of this project. The U.S. Department of Energy and its predecessors, the Energy Research and Development Administration and the National Science Foundation, have provided the major funding and much of the technical input for the project. The State and County of Hawaii have contributed financial, technical, and moral support, as have the utilities and the drilling contractor. Consultants and advisory groups from throughout the State, the Mainland United States, and New Zealand have also assisted the project, while the University has provided the research and administrative focus. Continuing effort will be directed to retain this level of interaction and cooperation, as we move from R&D to demonstration and, ultimately, to commercialization of geothermal resources in Hawaii.

This summary document provides an overview of the first five years of the HGP and a brief report of the management and coordination activity. Additional reports in this series provide the scientific and technical results and analyses, and are listed as follows:

Geosciences Reports

"Preliminary Studies for Geothermal Exploration in Hawaii, 1973-1975."

"Geoelectric-Geothermal Exploration on Hawaii Island: Preliminary Results."

"Geoelectric Studies on the East Rift, Kilauea Volcano, Hawaii Island."

"Hydrology and Geochemistry of a Hawaiian Geothermal System: HGP-A."

Reservoir Engineering Reports

"Modelling of a Volcanic Island Geothermal Reservoir."

"HGP-A Reservoir Engineering."

The multi-disciplinary nature of this project and the independent preferences of the major researchers are illustrated by the variety in publication format. The four geosciences reports appear as Hawaii Institute of Geophysics publications, while the reservoir engineering papers were prepared as HGP reports. Yet to be completed by Drs. Furumoto, Helsley, Takahashi, Yuen, and others is a summary document integrating the various exploratory and scientific data with observed conditions encountered during the drilling and well testing programs -- some which are still in progress. This synthesis report will be completed as part of the Phase IV study.

Key personnel during the five-year history of the project have been:

Agatin T. Abbott (deceased), Director, Experimental Drilling Program, May 1973 - July 1975.

Augustine S. Furumoto, Director, Geosciences Program, May 1973 - June 1976.

Charles E. Helsley, Director, Geosciences Program since July 1976.

Robert M. Kamins, Director, Environmental-Socioeconomics Program.

Gordon A. Macdonald (deceased), Director, Experimental Drilling Program since August 1975.

Barbara Z. Siegel and Sanford M. Siegel, Co-Directors, Geotoxicology Program.

Paul C. Yuen, Director, Engineering Program.

Unfortunately, those of us on the HGP have experienced the severe loss of two very able colleagues -- both outstanding gentlemen who have made major contributions to the project. The "A" in HGP-A, our initial well, stands for Abbott. As a part of the reservoir assessment program, we hope to drill another successful step-out well and designate it HGP-M for Macdonald.

John W. Shupe

John W. Shupe
Director

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OVERVIEW OF THE HAWAII GEOTHERMAL PROJECT
May 1973 through June 1978

The Hawaii Geothermal Project (HGP) was organized to focus the multi-disciplinary research resources of the University of Hawaii on the identification and utilization of geothermal energy resources in Hawaii. The Big Island of Hawaii is both the largest and youngest in the island chain, and is still growing from recent activity of the Mauna Loa and Kilauea volcanoes. Therefore, it is the island with the greatest amount of heat at or near the earth's surface. Consequently, the Big Island was selected as the appropriate site for initial geothermal exploration, with subsequent surveys to proceed throughout the island chain.

The HGP came into being when the 1972 Hawaii State Legislature allocated $200,000 for geothermal research, contingent on the University obtaining matching federal funds. This was well before the Middle East oil embargo and resulting energy crisis; so was a progressive step for a state legislature to take. From the beginning this has been a cooperative project involving all segments of government, the University, the electric utility, and the private sector. A budget summary of the total support of $9,655,000 that has been received to date, showing sources of funding for each of the four major phases of the project, is listed in Table 1.

Research got underway in the early summer of 1973, with separate programs established for Geophysics, Engineering, Environmental-Socioeconomics, and Experimental Drilling. The major emphasis of Phase I was on geophysical surveys, but support activity was begun in the other programs as well. It became evident in early 1974 that an exploratory drilling program would be

TABLE 1

BUDGET SUMMARY FOR HGP-A

		Figures in $1000	
Phase I -- Exploratory Surveys & Related Research (May 1973 through April 1975)			
State of Hawaii	FY 72	100	
County of Hawaii	FY 72	100	
National Science Foundation	FY 73-74	469	
ERDA	FY 75	119	
Other Public & Private Funds	FY 72-75	39	
	Subtotal		$ 827
Phase II -- Experimental Drilling, Initial Well Testing, & Related Research (May 1975 through June 1976)			
ERDA	FY 75-76	1,472	
State of Hawaii	FY 74	500	
Water Resources International	FY 76	60	
Hawaiian Electric Company	FY 75	45	
	Subtotal		$2,077
Phase III -- Well Testing & Analysis (July 1976 through June 1978)			
ERDA	Transition Period	147	
ERDA - DOE	FY 77	270	
State of Hawaii	FY 77	66	
	Subtotal		483
Phase IV -- Installation of Wellhead Generator & Assessment of Kapoho Reservoir (July 1978 through Dec. 1980--Initial Funding)			
DOE	FY 78-80	5,743	
State of Hawaii	FY 78	400	
County of Hawaii	FY 78	100	
Helco	FY 78	25	
	Subtotal		6,268
Total Funding to Date:			9,655

A Breakdown of This Funding by Category Follows:

Federal Support (NSF, ERDA, DOE)	$8,220,000
State & County Support	1,272,000
Utility and Private Funding	163,000
Total	$9,655,000

required to verify the subsurface conditions predicted by the surveys. Initially it was the intent to proceed with multiple drilling of both deep and shallow wells, but subsequent fiscal restraints limited the exploratory drilling "program" to one deep well.

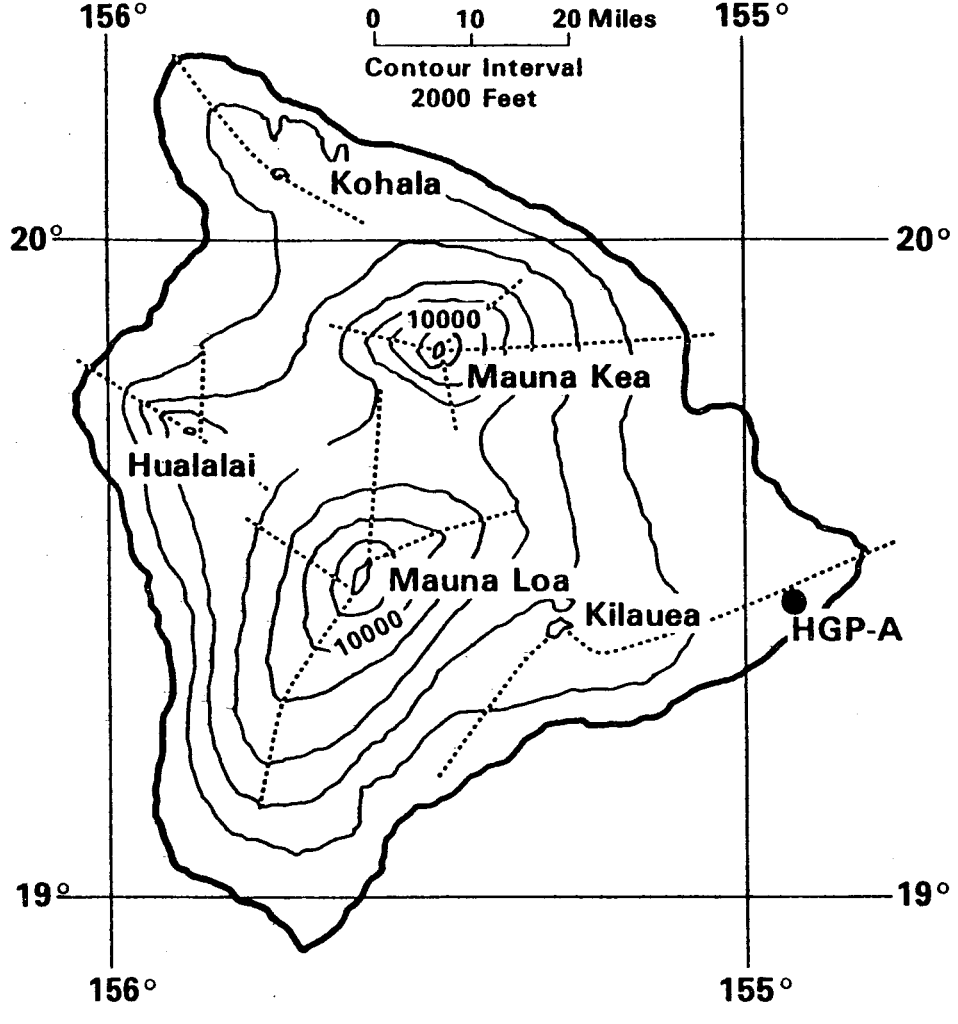
The Site Selection Committee for this well was chaired by the former Dr. Agatin T. Abbott, after whom the well was ultimately named -- HGP-A, for Abbott. The committee considered all geophysical, geological, and geochemical evidence and selected as the optimum site a location in the Puna District near the eastern rift of Kilauea Volcano. No State or County land suitable for drilling was available near the selected site, and after some negotiation with landowners in that area, permission was obtained from the Kapoho Land and Development Company to drill the well on a four-acre plot approximately three miles southeast of Pahoa. Figure 1 shows the location of the drill site, along with the volcanoes and rift zones on the island of Hawaii. The elevation of this site is just under 600 feet above sea level.

Specifications for drilling were drawn up and invitations to bid were sent in early June 1975 to 28 drilling companies on the mainland, in Canada, and throughout the Pacific area. The only bid submitted was by Water Resources International Inc. of Honolulu and, following extensive negotiations, the drilling subcontract was let in late-November 1975. A New Zealand geothermal consulting firm, KRTA, was commissioned to provide technical assistance and supervision of the drilling operation.

Drilling of this experimental well commenced on December 10, 1975. The well was completed to a depth of 6450 feet on April 27, 1976. Cores of the subsurface strata were taken at approximately 700-foot intervals and samples of cuttings were obtained every five to ten feet throughout drilling. The well was logged twice with Gearhart-Owen equipment, which measured resistivity, self-potential, natural gamma ray and slow neutron count, and cement bond. Depth of logging was

FIGURE 1

Locations of HGP-A, Volcanoes and Rift Zones on the Island of Hawaii



limited by high downhole temperatures.

Below 4000 feet the drilling mud began to heat up rapidly, and subsequent mud temperature measurements approached 600°F. This high temperature was sufficiently encouraging to justify installing a slotted liner, flushing out the mud, and conducting a well testing program. The total budget for site preparation, drilling, casing and preliminary rig-assisted well testing came to just over $1.5 million, as summarized in Table 2.

Preliminary well testing proceeded through the summer of 1976. The well was first flashed to steam and permitted to flow briefly on July 2. The rate of discharge of steam was impressive but noisy -- roughly equivalent to that of a 747 jet aircraft at take off. Steam was discharged continuously for four hours on July 22, verifying that some natural flow into the wellbore was taking place. The quality of the fluid from HGP-A was generally good -- surprisingly low in chloride content, but with significant amounts of silica.

Because of the extremely high noise level generated during discharge a silencer-separator was constructed before proceeding with a more comprehensive testing program. A two-week flow test was performed from November 3 to 17 with wellhead temperature, pressure and other scientific measurements recorded throughout. Subsequently, instrumentation and procedure were perfected for obtaining downhole temperature and pressure measurements while the well was discharging steam. Temperature and pressure profiles throughout the full 6450-foot well depth were obtained during a six-day flow test conducted in mid-December, followed by a determination of the pressure build-up after the well was shut in.

Because the steam quality is so high, the initial silencer was only partially successful, and objections to the noise level continued to be raised by families in the area. In late December and early January, additional muffling and

TABLE 2

HGP-A

COST OF SITE PREPARATION, DRILLING,

AND RIG ASSISTED WELL TESTING

Site Preparation, Water Reservoir, and Cellar	$ 45,496
Mobilization	120,192
Labor and Rig Time	733,830
Consumable Materials and Misc. Services	673,995
Electric Logging	16,486
Demobilization	9,615
SUBTOTAL	$ 1,599,614
Less Credit for Returned Consumables	96,143
NET COST OF HGP-A	$ 1,503,471
Less Rig Rental Time Donated by WRI	60,000
TOTAL COST OF HGP-A TO THE PROJECT	$ 1,443,471

stiffening were built into the silencer, after which a series of throttled flow tests was conducted to provide a better assessment of the well and to obtain preliminary design data for a wellhead generator. The results of these preliminary tests were sufficiently encouraging that a 90-day flow test was planned to begin in late March. However, the nuisance effect of both the noise and the hydrogen sulfide emissions, combined with the fact that the pressure-time curves for the well seemed to stabilize early, led to the termination of the test after six weeks on May 9.

Test results show that HGP-A is one of the hottest geothermal wells in the world; the highest downhole temperature encountered has been 676°F. Well testing indicates that there is significant natural two-phase flow into the wellbore, and that HGP-A should maintain a reasonable flow rate of high quality fluid for the 30-year life expectancy of a generating plant. The Kapoho Geothermal Field associated with this first successsful geothermal well in Hawaii may have a capacity of as much as 500 MW of electrical energy for 100 years. Therefore, it exhibits great economic potential for the Island and for the State of Hawaii. The early installation of a wellhead generator, both to provide power for the Big Island electric grid and to obtain additional information on the nature and the extent of the geothermal resource, was the next logical step for developing the field.

To this end a consortium, the HGP-A Development Group (HGP-A/DG) was formed with the responsibility for constructing and operating an electrical generating plant using the steam from HGP-A. The consortium consists of the State of Hawaii as the lead agency, the County of Hawaii, and the University of Hawaii through the Hawaii Geothermal Project. Because of legal limitations, neither the Hawaii Electric Light Company (HELCO) on the Big Island nor the parent organization, the Hawaiian Electric Company (HECO) of Honolulu, are full members of the HGP-A/DG; but both utilities are active participants in the program.

Negotiations between the HGP-A/DG and the U.S. Department of Energy were completed on June 9, 1978, with the signing of a four-year $6,751,014 contract to install and operate a 3.5 MWe wellhead generator. A breakdown of the figure is as follows:

$5,743,256	Department of Energy (DOE)
400,000	State of Hawaii
100,000	County of Hawaii
25,000	HELCO-HECO
482,758	Estimated revenue from the generation and sale of electricity to HELCO
$6,751,014	Total

Current scheduling calls for electricity from geothermal energy to first come on line in Hawaii in July 1980. While the primary goal of the project is to generate electricity, the facility will also include a visitor information center and provisions to conduct reservoir assessment experiments, to test new geothermal devices and to investigate non-electric utilization of the resource. The project will be administered for the HGP-A/DG by the Research Corporation of the University of Hawaii (RCUH). Rogers Engineering, Inc. of San Francisco has been selected to undertake design and construction management of the generator.

In addition to holding full partnership with the State and County on the HGP-A/DG -- in which overall responsibility for the wellhead generator program resides -- the Hawaii Geothermal Project (HGP) will maintain its separate identity and functional role. HGP will continue to serve as the research component for the project and will retain responsibility for the well testing and reservoir assessment analyses throughout the design, construction and operational phases of the program. Over and above the relatively small figure of $218,000 listed in the four-year contract for reservoir assessment, HGP has just received $100,000 from DOE (FY 78) for this purpose and is actively negotiating for subsequent support -- including funds for one or more step-out wells to facilitate assessment of the Kapoho Geothermal Reservoir once operation of HGP-A commences.

In summary, the development of geothermal energy in Hawaii continues to enjoy the strong support of all segments of government and the scientific community. The 1978 Hawaii State Legislature passed enabling legislation to provide an additional $1,280,000 for geothermal research, development and demonstration on both electric and non-electric applications. As the 3.5 MWe wellhead generator at Puna begins to feed the first electricity from geothermal energy into the Big Island grid, as better understanding of the nature and extent of the Kapoho Reservoir unfolds, as University geoscientists continue with resource assessments throughout the Island chain, and as private capital begins to accept its recognized role in resource development, geothermal energy can make a significant contribution in Hawaii's quest to move from a position of near-total dependence for energy on imported oil to an appropriate level of energy self-sufficiency through effective utilization of its indigenous natural energy resources.

THE HAWAII GEOTHERMAL PROJECT

MANAGEMENT-COORDINATION

A. OVERVIEW OF PROJECT MANAGEMENT

The Hawaii Geothermal Project has involved more than forty researchers and support staff from throughout the University of Hawaii system. The two major campuses on Oahu and the Big Island are represented, along with over a dozen research institutes and academic units. Many of the State and County agencies and their staffs are directly involved in the HGP, in addition to consultants from the mainland United States and New Zealand, electric utilities, engineering and drilling subcontractors. Because of its potential importance, both for the University and the State, effective coordination among the wide variety of technological, socioeconomic and political interests at all educational, private and governmental levels is essential. The Management Program was developed with these diverse interests in mind.

Principal Investigator for the HGP and Director of the Management Program is John W. Shupe, Dean of Engineering, assisted by Administrative Officer Diane Sakai. Charles E. Helsley, Director of the Hawaii Institute of Geophysics, is Co-P.I. and coordinator for all geosciences activity. Paul C. Yuen, Associate Dean of Engineering, is Director of the well testing and reservoir engineering programs, and served as Acting Director of HGP during the 1977-78 academic year while Dr. Shupe was on leave of absence. Both Drs. Helsley and Yuen have direct technical supervisory and budgetary authority for their respective programs.

To provide interaction at the local and national levels, the National Liaison Board (consisting of eleven of the nation's leading geothermal scientists and engineers) and the Hawaii Advisory Committee (seventeen key representatives of government, industry, the scientific community, and citizens' groups,

whose support is essential to development of geothermal power in Hawaii) were formed. Members of these two groups are listed in Tables 3 and 4. The initial evaluation session of the National Board was held in February, 1974, and a joint meeting of the national and local advisory committees was held February 27-28, 1976, in Hilo, Hawaii. Prior to this past year, the local advisory group has met on a semi-annual basis, and will be reconstituted shortly as a component of the Governor's Advisory Committee on Alternate Energy Development. The collective interest, advice and support of both groups over the years has been a decided asset to the HGP.

Close liaison has been maintained with all four congressional delegates, who are kept informed of the progress of the HGP. Excellent support, information and advice are provided by our congressional delegates on any shifts in organizational structure and funding philosophy of federal agencies.

Local interest in the HGP has been high. Encouragement, endorsement, assistance, and/or interaction has taken place with the following organizations, many of whom are represented on the Advisory Committee.

State Departments and Offices

Department of Planning and Economic Development
Department of Land and Natural Resources
Department of the Attorney General
Office of Energy Resources
Office of Science Policy
Office of Marine Affairs
Office of Environmental Quality Control
State Task Force on Energy Policy

State Legislature

Senate Committee on Energy and Natural Resources
Senate Ways and Means Committee
House Committee on Energy and Transportation
House Finance Committee

County of Hawaii

The Mayor's Office
Department of Research and Development
Hawaii County Council

TABLE 3

HGP NATIONAL LIAISON BOARD

Mr. David N. Anderson, Geothermal Officer
State of California Resources Agency
Department of Conservation
Division of Oil and Gas
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TABLE 4

HGP ADVISORY COMMITTEE

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Mr. Christopher Cobb
Chairman of the Board
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President
Congress of the Hawaiian People
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Dr. John P. Craven
Dean
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Chamber of Commerce of Hawaii
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Quality Control
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Dr. Robert I. Tilling
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Hawaiian Volcano Observatory
U.S. Geological Survey
Hawaii National Park, Hawaii 96718

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Hawaiian Electric Company
Post Office Box 2750
Honolulu, Hawaii 96803

Dr. George P. Woollard, Director
Hawaii Institute of Geophysics
University of Hawaii, HIG 131
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Electric Utilities

Hawaiian Electric Company (HECO) of Honolulu
Hawaii Electric Light Company (HELCO) of Hilo

Business and Industrial Concerns

AMFAC
Bishop Estate
Campbell Estate
C. Brewer and Company, Ltd.
Pacific Resources International
Honolulu Chamber of Commerce
Water Resources International
Hilo Chamber of Commerce
Geothermal Exploration and Development Corporation

B. PHASE I, EXPLORATORY SURVEYS AND RELATED RESEARCH

May 1973 through April 1975

During Phase I of the HGP the Management Program provided the following: (1) coordination of activities among the research programs; (2) administrative services to assist with implementation of the research; and (3) promotional efforts at the university, state, and federal levels to help assure adequate visibility and support for the HGP.

Under Principal Investigator John W. Shupe there were four Co-Principal Investigators, each reponsible for the planning and for the direct technical supervision of his research or service program, and who was assigned a separate budget for carrying out his respective program.

Geophysical Program -- Augustine S. Furumoto, Professor of Geophysics

Engineering Program -- Paul C. Yuen, Associate Dean and Professor of Electrical Engineering

Environmental-Socioeconomic Program -- Robert M. Kamins, Professor of Economics

Experimental Drilling Program -- Agatin T. Abbott, Professor and Chairman of Geology and Geophysics

One of the major management decisions was whether and when to proceed with a drilling program. From the early stages of the HGP, there had been a lack of unanimity on this issue. The proponents for geophysical testing had advocated that funds could be used most effectively in conducting geophysical surveys for analysis and interpretation. Drilling proponents had countered that the volcano area of the Big Island is one of the most extensively studied geological areas in the world, and that drilling was essential to prove out theories and models based upon geophysical-geological-geochemical data.

It was the general consensus at the initial meeting of the National Liaison Board -- which was held in Hilo, Hawaii, in February 1974 -- that the HGP should move rapidly on planning for a research drilling program. The Board also endorsed the concept that a Site Selection Committee be established to advise on all aspects of the drilling program. Dr. Abbott proceeded effectively to establish this committee and coordinated its activities.

The decision to proceed with a drilling program was strongly supported by the Hawaii Advisory Committee and assistance was provided by this group in obtaining an appropriation from the 1974 State Legislature of $500,000 for exploratory geothermal drilling, contingent upon additional federal matching funds.

Initially the drilling program was planned as a series of intermediate and deep holes covering multiple sites. Subsequent negotiations with program managers from NSF, and later with ERDA, limited initial support to one research hole.

C. PHASE II, EXPERIMENTAL DRILLING, INITIAL WELL TESTING, AND RELATED RESEARCH

May 1975 through June 1976

Federal and state funds were identified for drilling of the experimental well. In addition, Hawaiian Electric Company and Hawaii Electric Light Company contributed $45,000 for the drilling effort.

The firm of Kingston, Reynolds, Thom & Allardice, Ltd. (KRTA) of New Zealand was selected to provide direction and supervision to the drilling program. KRTA has had extensive experience with geothermal drilling in New Zealand, the Philippines, and Central America. The firm was first recommended to the HGP by Mr. Ken Brunot, who served at one time as NSF program manager for the HGP and was well aware of the limited geothermal experience of project staff. Extensive investigation at the United Nations Geothermal Conference in San Francisco in May, 1975 verified Mr. Brunot's recommendation, and an agreement was reached with R. Kingston, Managing Director of KRTA, for his firm to provide geothermal consulting services.

Invitations to bid were sent to 28 potential drillers in the mainland U.S. and throughout the Pacific area in early June, with bid documents to be opened July 1, 1975. The only bid submitted was from Water Resources International (WRI) of Honolulu, the firm which had drilled a 4137-foot research hole in the Hawaii National Park. The University, after thorough review of the bid and upon the favorable advice of KRTA, recommended that it be approved, so that WRI could begin to mobilize for the project.

On July 31, 1975, following a short illness, Dr. Agatin Abbott passed away. To help fill the appreciable void created by Dr. Abbott's death, Dr. Gordon A. Macdonald, Senior Professor of Geology and Geophysics, agreed to serve as Co-P.I. and Director of the Drilling Program.

Following four months of negotiations, including a special trip from New Zealand by Mr. Kingston to meet with federal auditors, approval was obtained for finalizing the subcontract in mid-November. The drilling site was dedicated on November 22, 1975 and drilling commenced on December 10. On April 27, 1976 the well was completed to a depth of 6,450 feet. For details of the drilling, the reader is referred to "Well Completion Report for HGP-A", which was prepared by KRTA.

During Phase II, the Management Program continued with its coordination, administrative and promotional duties as in Phase I. In addition, Management assumed the responsibility of administering the drilling program -- subcontract negotiations; consultant selection and coordination; refereeing differences among the consultant, driller and the HGP; and monitoring drilling progress.

D. PHASE III, WELL TESTING AND ANALYSIS

July 1976 through June 1978

The well, HGP-A, was first flashed briefly to produce steam on July 2, 1976. On July 22 steam was discharged continuously for four hours, verifying that natural fluid flow into the wellbore was taking place. The discharge of steam at supersonic velocity resulted in an extremely high noise level: DBA readings of 120.

In order to proceed with a testing program, a silencer/separator was installed to muffle the noise and also to separate the steam from the water, so that the amount of each component could be measured. In late December and early January, muffling and stiffening were added to the silencer to reduce the noise further, after which a series of throttled flow tests was conducted to provide a better assessment of the well's possible output and to obtain

preliminary design data for an electrical generator which could be connected to the well to produce electricity. The reader is referred to "HGP-A Reservoir Engineering", September 1978, for details of well testing studies and results.

Much of the administrative effort during this phase related to the preparation, submission and follow-up on the proposal submitted to the U.S. Department of Energy by the HGP-A Development Group (HGP-A/DG) to install a wellhead generator at the test site. HGP-A/DG consists of: 1) The State of Hawaii, represented by Hideto Kono, State Energy Resources Coordinator; 2) The County of Hawaii, represented by John Keppeler, Managing Director, County of Hawaii; and 3) The University of Hawaii, represented by John Shupe, HGP Director. Hideto Kono serves as Executive Director of the Development Group, with the State assuming the lead agency role. Although not legal members of the HGP-A/DG consortium, the Hawaii Electric Light Company and the Hawaiian Electric Company are active participants in the program.

TRW, Inc. was granted a $38,500 contract by the State to assist in preparation of the proposal for a wellhead generator, with supporting research and testing facilities. This proposal for establishing a "Geothermal Electric and Nonelectric Research Facility Utilizing the HGP-A Well on the Island of Hawaii" was submitted to the U.S. Department of Energy on April 6, 1977. Different types of wellhead generators were considered, along with alternate possibilities for reinjection and research capability.

On August 1, 1977, Dr. John Shupe, the HGP Project Director, began a leave of absence from the University to spend a year on an Intergovernmental Agreement assigned to the office of the Assistant Administrator for Solar, Geothermal and Advanced Energy Systems in the U.S. Energy Research & Development Administration. With the formation of the Department of Energy in October 1977,

he became Scientific Advisor to the Assistant Secretary for Energy Technology. In his absence, Program Directors Paul Yuen and Charles Helsley shared the responsibility for administering HGP, with Dr. Yuen assuming the acting directorship of the Project.

During Phase III, management activities of the Director and Acting Director included:

1. Over thirty trips to the Big Island to observe and advise on the project, confer with county officials, and to discuss the project with planning commissions and citizens groups; 2. Participation in five mainland U.S. meetings and conferences to discuss immediate and long-range aspects of the HGP, including an ERDA-DGE coordinating group meeting; 3. Conducting a meeting of the HGP Hawaii Advisory Committee; 4. Presentation of oral reports on the status of the project to over a dozen governmental, scientific and citizens groups throughout the state; and 5. Discussions on the future of geothermal energy in Hawaii with:

The State Energy Resources Coordinator
County of Hawaii administrators
County of Hawaii council members
State legislators
Hawaiian Electric Company
GEDCO, Natomas, Chevron
Office of Naval Research
TRW
Rogers Engineering Company
Batelle Pacific Northwest Laboratories
ERDA/DOE Division of Geothermal Energy
ERDA/DOE San Francisco Operations Office

E. PUBLICATIONS

Publications generated by the Management Program through June 1978 include:

1. "The Hawaii Geothermal Project: Quarterly Progress Report," nos. 1-4 June 1, 1973 through June 30, 1974.

2. Shupe, J., "Geothermal Power for Hawaii -- Phase I," Geothermics, Vol. 2, nos. 3-4, 1973, pp. 101-104.

3. Shupe, J., et al., "The Hawaii Geothermal Project: Summary Report for Phase I," HGP Report, Honolulu, Hawaii, May 1975.

4. Shupe, J., et al., "The Hawaii Geothermal Project: Initial Phase II Progress Report," HGP Report, Honolulu, Hawaii, Feb. 1976.

5. Shupe, J., "Hawaii Geothermal Project Well A," Proc. First Nat'l Geothermal Conf., Palm Springs, 1976.

6. Shupe, J., et al., "Geothermal Energy in Hawaii -- Hydrothermal Systems," Eleventh I.E.C.E.C. Transactions, 1976.

7. Kingston, Reynolds, Thom, Allardice (KRTA, Auckland, New Zealand) "HGP-A Well Completion Report," September 1976.

8. Shupe, J., et al., "Phase III - Well Testing and Analysis: Quarterly Progress Reports," Nos. 1-3, Jan. 1 through July 1, 1977.

9. Shupe, J. & Yuen, P., "Geothermal Energy in Hawaii -- Present and Future," for presentation at the Circum-Pacific Energy & Mineral Conference, Honolulu, August 2, 1978.

CHRONOLOGY OF THE HAWAII GEOTHERMAL PROJECT (HGP):
(April 1972 through June 1978)

- April 1972 -- The Hawaii State Legislature allocated $200,000 for geothermal research, contingent on Federal matching funds, with $100,000 of these funds to be administered by the County of Hawaii.

- May 1973 -- The National Science Foundation provided its initial grant of $252,000 to the HGP and Phase I got underway.

Phase I -- The two-year period from May 1, 1973 through April 30, 1975 was the exploratory geophysical survey phase, with support from the Engineering, Environmental and Socioeconomic Programs.

- February 8 - 9, 1974 -- At the initial meeting of the HGP National Liaison Board in Hilo, Hawaii, there was general consensus that HGP should establish a research drilling program as soon as possible.

- May 1975 -- Based on geological and geophysical data, the Site Selection Committee chose the location for the first research hole near the Puna rift zone of Kilauea Volcano, three miles ESE of Pahoa, at an elevation of approximately 600 feet above sea level.

Phase II -- The research drilling program began on May 1, 1975, initially with $1,064,000 from ERDA, $500,000 from the State, and $45,000 from the Hawaiian Electric Company.

- July 1975 -- KRTA, New Zealand geothermal consulting firm, was selected to specify and supervise the drilling program.

- July 1975 -- Water Resources International, Inc., of Honolulu, Hawaii, was chosen as drilling contractor.

- July 31, 1975 -- Marked the death of Dr. Agatin T. Abbott, Co-P.I. and Chairman of the Site Selection Committee -- a great personal and professional loss to the Project. Dr. Gordon A. Macdonald, Senior Professor of Geology, replaced Ag as Director of the Drilling Program.

- November 22, 1975 -- The drillsite was given the traditional Hawaiian dedication and blessing.

- December 10, 1975 -- The well was spudded in and drilling commenced.

- February 27 - 28, 1976 -- Joint meeting of HGP National Liaison Board and Hawaii Advisory Committee in Hilo.

- April 27, 1976 -- Drilling of HGP-A was completed to a depth of 6450 feet and preliminary well testing with the rig in place was conducted.

Phase III -- July 1976 through June 1978 involved well testing, analysis, and planning for development of the resource.

- July 2, 1976 -- Utilizing airlifting to evacuate the cold water from the wellbore, initial flashing of HGP-A was achieved and sustained briefly before shutting in the well.

- July 22, 1976 -- A four-hour flow test was conducted during which extensive measurements were taken of various reservoir parameters.

- October 1976 - January 1977 -- A silencer/separator was installed and periodic flow tests conducted of up to two weeks duration.

- March 28 to May 9, 1977 -- A 1000-hour (42 day) flow test was conducted; the test was terminated when it appeared that the pressure time curve for the well had stabilized.

- April 1977 -- The HGP-A/DG (Development Group) was organized with the State (lead agency), County and University, and a preliminary proposal for a wellhead generator was submitted to ERDA.

- April 12, 1978 -- Governor Ariyoshi accepted the Environmental Impact Statement for a Geothermal Research Station utilizing HGP-A as adequate for assessing the proposed project.

- May 19, 1978 -- The Geothermal Regulations for the State of Hawaii, approved by the Department of Land and Natural Resources, became effective.

- June 20, 1978 -- Marked the death of Dr. Gordon A. Macdonald, Scientific Director of the HGP-A drilling program -- the second tragic loss of a key HGP staff member.

Phase IV -- July 1978 through 1980 -- activity will include installation of the wellhead generator and assessment of the Kapoho Geothermal Reservoir.

- June 1978 -- Negotiations between DOE and HGP-A/DG were completed and a four-year wellhead generator contract signed for $6,268,256 of local and Federal support, plus an agreement for the utility to purchase an estimated $482,758 of electricity generated by steam from the well during that period.