GL00905

LOW-TEMPERATURE GEOTHERMAL RESOURCES AND TECHNOLOGY TRANSFER

TECHNICAL PROPOSAL

Submitted to

EG&G IDAHO, INC.

In response to

RFP NO. C87-101314 Task Order 4

by

UNIVERSITY OF UTAH RESEARCH INSTITUTE
391 Chipeta Way, Suite C
Salt Lake City, UT 84108

Earth Science Laboratory

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January 24, 1992

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Project Duration: 2 years
Proposed Amount: $365,000

Phillip Michael Wright
Vice President
University of Utah Research Institute

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Treasurer
University of Utah Research Institute

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INTRODUCTION

Integrated-resource planning, being mandated by an increasing number of state public-utility commissions, can take advantage of renewable-energy and geothermal heat-pump technologies to provide indigenous and environmentally advantageous energy alternatives to the traditional fuels. Increased use of renewable energy resources has the potential to offset imports of foreign oil, and thereby decrease our nation's trade deficit, while mitigating generation of greenhouse and acid-rain gases significantly. There is a very large, nearly unused supply of low- and moderate-temperature geothermal resources in the United States that could be brought on line over the next decade.

One objective of this proposal is to compile information needed by potential developers of these resources and make it available to the public. A second objective is to collect and distribute a reliable data base on the potential of geothermal heat pumps to contribute to demand-side management of electrical power generation.

The work proposed herein will be performed by three primary organizations with considerable assistance from subcontractors in a number of individual states. The cooperating organizations are the Oregon Institute of Technology - Geo-Heat Center (OIT-GHC), the University of Utah Research Institute (UURI) and the Idaho Water Resources Research Institute (IWRRI).

The project will be divided into two parts: (1) work to further the use of low- and moderate-temperature hydrothermal resources; and, (2) work to further the use of geothermal heat pumps.

Hydrothermal resources tasks will include: (1) making an updated compilation of known resources; (2) correlating known resource areas with potential uses, especially with centers of population and other demographic data; (3) prioritizing areas for development based on resource viability and demographic considerations; (4) assessing exploration methods for locating new resources; (5) assessing well-testing and reservoir-engineering methods for evaluating resources; and, (6) active public outreach with project results.

Geothermal heat pump tasks will include: (1) assessing the potential contribution geothermal heat pumps can make to demand-side management in the U.S. and the economics of such installations; (3) determining what R&D is needed to make geothermal heat pumps even more efficient and economically attractive; (4) assessing and compiling resource information such as ground-water availability, regulations, temperatures and drilling conditions; and, (5) active public outreach with project results.

Outreach with include (1) brochures and fact sheets for public distribution; (2) a broadcast quality video; and, (3) networking with such organizations as the Geothermal Resources Council, the Geothermal Education Office, the National Association of Regulatory Utility Commissioners, the Edison Electric Institute, the Electric Power Research Institute, environmental-advocacy groups and special-interest energy-advocacy groups, among others.

This Technical Proposal for the Low-Temperature Geothermal Resources and technology Transfer program is a companion document to the Cost Proposal, which is given in a separate volume.

STATEMENT OF WORK AND DELIVERABLES

1.0 Hydrothermal Resources

Task 1.1 -- Resource Data Compilation. UURI will work with State Teams on gathering, documenting and assembly of low- and moderate-temperature hydrothermal resource data. OIT will establish subcontracts with the State Teams. However, UURI will assist in technical monitoring of the State Team efforts and publications.

UURI will update currently available data bases using the resource data delivered by the State Teams. The data will be archived on two different data-base systems, a Lotus-compatible system and a geographic information system (GIS) named ARC/INFO. Lotus will be the primary system, and will be used for simple data storage and retrieval. The use of ARC/INFO in this task will begin in the nature of a test to determine the utility of GIS systems in overlaying various data sets. UURI will select four states for the test.

Task 1.2 -- Archiving Demographic Data. Selected portions of the demographic data collected by OIT-GHC will be input into the ARC/INFO GIS system by UURI. We will concentrate on the cities and towns identified by OIT-GHC and on the power-line grid.

Task 1.3 -- Resource Prioritization. UURI will work closely with OIT-GHC and IWRRI to compile prioritized resource data in light of potential for economic use. This prioritization will be developed in terms of resource characteristics, the certainty with which the resource production characteristics are known, and potential uses of the resource, including rough economic analysis.

Task 1.4 -- Exploration Analysis and R&D. UURI will compile and assess the exploration data available for selected resource sites, and will seek to determine which of the exploration methods is the most useful in locating and delineating resources. UURI will also identify items of missing data that would help in resource evaluation. UURI will work closely with OIT-GHC and IWRRI to define R&D that needs to be done in developing better methods of locating and delineating geothermal resources.

Task 1.5 -- Outreach. UURI personnel will work cooperatively and closely with organizations such as the Geothermal Resources Council (GRC), the Geothermal Education Office (GEO), the National Water Well Association (NWWA, with IWRRI taking the lead), Edison Electric Institute (EEI), the Electric Power Research Institute (EPRI), and other similar organizations in maintaining liaison with state and local agencies, energy offices and other public entities. This network will bring information on geothermal resources and their uses to the public and to potential geothermal developers. In the process, the contractors will establish ties with construction, energy, groundwater, and other trade and special-interest groups.

All outreach activities will be coordinated through INEL in order to avoid duplication of effort.

UURI will design and publish a color brochure about 16 pages in length on all aspects of geothermal energy. This brochure will be targeted for the informed public, including utilities, public utility commissioners, other regulators, potential developers of electrical generation and direct uses of hydrothermal energy and installers of geothermal heat pumps. UURI will form an advisory committee from appropriate members of the geothermal community to help design the brochure. UURI will seek sponsors to participate in printing costs for this brochure.

UURI will design and produce a video on all aspects of hydrothermal energy, earth heat and the use of ground-source heat pumps. This video will be approximately one-half hour in length and will be made to broadcast standards. UURI will form an advisory committee from appropriate members of the geothermal community to help design and provide other input to the video.

Task 1.6 -- Conceptual Models. UURI will assist IWRRI with the development of conceptual models of hydrothermal systems.

Deliverables. The following final deliverables will be the responsibility of UURI, who will take the lead for them. OIT-GHC and IWRRI will assist by providing information, data and analysis for these deliverables.

1.1. A technical report and a computerized data base of geothermal resource occurrences in the western contiguous United States and Alaska. The data base will be made available on PC disk in the Lotus 123 format. The ARC/INFO data will be provided to EG&G, Idaho.

1.2. A technical report on exploration techniques suitable for low- and moderate-temperature hydrothermal resources, and an assessment of R&D needs in this topic.

1.3. A color brochure of about 16 pages in length on applications of hydrothermal energy.

1.4. An outline of and a production schedule for a broadcast-quality video of about one-half hour in length on applications of geothermal energy.

1.5. A technical report describing the utility of ARC/INFO as an archiving tool.

2.0 Geothermal Heat Pumps

Task 2.1 -- Resource Data. UURI will assist IWRRI in the gathering and evaluation of data on shallow ground-water aquifers or major commercial GHP systems, and on soil and geologic conditions, and drilling conditions for selected portions of the U.S.

Task 2.2 -- Brochure. UURI will prepare a four-page brochure on geothermal heat-pump use.

Task 2.3 -- Integrated Resource Planning. UURI will interact with the National Association of Regulatory Utility Commissioners (NARUC) and with other such groups as the GRC, GEO, EPRI, EEA, EEI, American Association for an Energy Efficient Economy (AEEE), World Watch Institute (WWI) and others in the use of all types of geothermal energy, including direct-heat and GHP uses. UURI will make outreach efforts to NARUC and to member commissioners and utilities in promotion of geothermal energy. UURI will also work with three or four diverse utilities in their IRP efforts.

Task 2.4 -- Outreach. UURI will include the applications of geothermal heat pumps in the brochure and video described under Task 1.5. UURI will produce 12 fact sheets on leading commercial and residential GHP projects or programs from across the nation with assistance from OIT.

Deliverables. The following final deliverables will be the responsibility of UURI, who will take the lead for them. OIT-GHC and IWRRI will assist by providing information, data and analysis for these deliverables.

2.1. An informational report on the activities of NARUC, their efforts to implement least-cost planning within the utility industry, and how these activities affect development of hydrothermal resources in the U.S.

2.2. Inclusion of the application of geothermal heat pumps in the color brochure described in Task 1.5.

2.3. Inclusion of the application of geothermal heat pumps in the video described in Task 1.5.

2.4. A four-page color brochure on geothermal heat-pump use.

2.5. Twelve fact sheets on leading commercial and residential GHP projects or programs from across the nation.

Additional Deliverables.

1. Brief monthly status reports by telephone or facsimile transmission by the 20th of each month.

2. Information as requested for annual reports, program planning documents, etc, to support DOE programmatic needs.

3. Assistance, as needed, with preparations for DOE program reviews.

PROJECT PERSONNEL

The primary personnel who will work on the proposed project are listed in this section. In addition to those people listed herein, additional support personnel will be used for computer input, technical writing, secretarial and drafting work.

Key Personnel

The Key Personnel for this project are Phillip M. Wright and Howard P. Ross. Phillip M. Wright will be the project manager at UURI and will be heavily involved in all outreach efforts and networking with exterior groups. Howard Ross will be most heavily involved in geothermal data compilation, analysis and archiving. He will also perform technical monitoring of State Team work for this project.

Other Project Personnel

Other personnel whose specific expertise will be used from time to time on the project include Michael C. Adams and Jeffrey B. Hulen. Mike Adams is a geochemist whose expertise will be used to assess the quality and interpretation of chemical data on hot springs and calculation of geochemical thermometers. Jeff Hulen is a geologist with extensive experience throughout the western U.S. whose expertise will be used to help evaluate and incorporate geologic information.

Resumes

Resumes for these scientists are given below.

SUMMARY RESUME

Michael C. Adams

POSITION: Geochemist, University of Utah Research Institute, Earth Science Laboratory, Salt Lake City, Utah

EDUCATION: B.S., Geology, 1978, University of Utah
M.S., Geology, 1983, University of Utah

Michael C. Adams was employed as an organic geochemical technician during his undergraduate years at the University of Utah. Following graduation he worked in geothermal energy as a Geologist for Aminoil USA and as a Senior Research Technician for the Earth Science Laboratory, UURI. He was also employed as a Geologic Consultant for petroleum exploration.

Mr. Adams received his M.S. in Geology from the University of Utah in 1983 and has completed a thesis entitled "Structure and Stratigraphy of McCoy Geothermal area, Central Nevada". Since 1983, Mr. Adams has conducted numerous investigations on the geology and geochemistry of geothermal and mineral systems. His recent studies have focused on the isotope, organic, and inorganic geochemistry of geothermal fluids and gases. He has pioneered the application and development of organic compounds for use in tracing the injection flow paths in geothermal systems. Through laboratory experiments and field tests Mr. Adam's group has identified and tested 39 new compounds suitable for use as tracers in liquid-dominated geothermal systems. As a result of these studies, it is now possible to define the velocities, directions, and temperatures of the major injection flow paths independent of reservoir engineering model estimates. Mr. Adams is currently directing UURI's scientific research on the development of vapor-phase tracers for use at The Geysers.

Tracer tests conducted by Mr. Adams have also been used to define the stability of scale inhibitors and the water-rock reactions of injected fluid in geothermal reservoirs. These tests have been conducted at the East Mesa geothermal system in Imperial Valley, CA, and at the Pleasant Bayou geopressured system south of Houston, TX. He has published numerous papers on the topic of geothermal tracers, and has worked closely with domestic and foreign companies in the design and interpretation of their tracer tests.

Mr. Adams has used the isotopic and chemical contents of geothermal fluids to define the chemical structure, fluid flow paths, and the effects of production in geothermal systems. Among his current interests is the interpretation of fluid inclusion data from geothermal systems. Computer programs written by Mr. Adams have been used to quantify the salt and gas contents of fluid inclusion data from several geothermal systems.

SUMMARY RESUME

Jeffrey B. Hulen

POSITION: Senior Geologist, Earth Science Laboratory, University of Utah Research Institute, Salt Lake City, Utah

EDUCATION: B.S., Geology, 1969, University of Utah

Jeffrey B. Hulen brings a broad background of applied mineral exploration and development to UURI. He completed detailed geologic, alteration, and sulfide distribution maps of portions of the Bingham Copper Mine while employed as an Assistant Geologist for Kennecott Copper Corporation. As a Research Assistant for Kennecott Exploration, Inc., Geologic Research Division, he assisted in alteration zoning studies of several western U.S. porphyry copper deposits while utilizing geochemical, XRD, and petrographic techniques.

As an Exploration Geologist with Bear Creek Mining Company from 1969-1973 he studied post-mineral ash-flow tuff stratigraphy in Nevada to select sub-areas within which potentially mineralized bedrock might occur at economically permissive depths. He explored western Nevada and eastern California for porphyry copper/molybdenum sulfide systems using XRD, petrographic, and alteration studies. He was responsible for geologically monitoring a 24- hour per day drilling program to evaluate a Precambrian volcanogenic massive sulfide deposit. As an Associate Research Geologist with Kennecott Exploration, Inc. from 1975 to 1977 he assisted in the development of new geochemical techniques for locating the high-grade centers of porphyry copper/molybdenum sulfide systems.

Mr. Hulen joined the Earth Science Laboratory, University of Utah Research Institute in 1977 and has been active in geologic studies of high-temperature geothermal systems since that time. He has mapped surface and subsurface geology and hydrothermal alteration for three systems, and conducted research in sampling and interpretation of drill cuttings from fractured, altered, crystalline igneous and metamorphic rocks. His studies include the Coso Hot Springs and The Geysers (California), Steamboat Hot Springs (Nevada), and the Valles caldera (New Mexico). Mr. Hulen served as the Acting Principal Investigator and Principal Investigator of coreholes in the Continental Scientific Drilling Program. Mr. Hulen is well known for his 3-D geologic sections to visualize complex structural blocks penetrated by variably inclined and oriented boreholes.

Other current topics of interest include the role of igneous-related hydraulic fracturing as a reservoir control for the oil fields of eastern Nevada, and the coordination of future scientific drilling in the Valles caldera and the Creede (Colorado) epithermal silver/base metal district.

Mr. Hulen is the author of numerous technical papers and reports dealing with the areas described above, and with geologic, alteration, well log, structural, stratigraphic, and permeability aspects of these resources.

SUMMARY RESUME

Howard P. Ross

POSITION: Section Head/Applied Geophysics Group and Project Manager, Earth Science Laboratory, University of Utah Research Institute, Salt Lake City, Utah

EDUCATION: B. A., Geology, 1957, University of New Hampshire
M. S., Geophysics, 1963, Pennsylvania State University
Ph. D., Geophysics, 1965, Pennsylvania State University

Dr. Howard P. Ross was employed as a geologist in mineral exploration and as a geophysicist in petroleum exploration before beginning his graduate studies in geophysics at the Pennsylvania State University. His graduate studies included course work in hydrogeology, geochemistry, geology and chemistry.

Dr. Ross was a Senior Geophysicist with Kennecott Exploration Inc. from 1967-1977 where he conducted research in the magnetic and electrical methods and completed induced polarization/electrical resistivity, aeromagnetic, and gravity surveys for porphyry copper and massive sulfide deposits. He was a major contributor to the discovery of two buried porphyry copper deposits and contributed to Kennecott's successful massive sulfide exploration program.

Since joining UURI in 1977 Dr. Ross has served as the Project Manager for the DOE Geothermal Division-Industry Coupled Program and for numerous geophysical studies for the mining and geothermal industry and for government agencies. He has been Project Manager for the DOE Geothermal Technology Division-State Cooperative Reservoir Analysis Program since 1986. Dr. Ross has completed geophysical interpretations for numerous geothermal areas in the western United States, and electrical resistivity, aeromagnetic, and gravity studies for geothermal resources on Ascension Island (South Atlantic Ocean), Hawaii, St. Lucia, Mexico (Los Azufres), Guatemala (Zunil), Kenya, and Ethiopia. He participated with Dr. J. N. Moore in siting the discovery wells for the Cove Fort and St. Lucia geothermal resources. Dr. Ross has served as the UURI Quality Assurance Officer and participated in drafting UURI's Quality Assurance Program Plans. He has completed geophysical studies at several hazardous waste sites.

Dr. Ross has been active as a Peer Reviewer for the DOE Nuclear Waste Isolation Program, and as a consultant to U. S. Mining and geothermal companies. He is the author of more than 20 journal publications and numerous reports concerning geophysics, geothermal energy, remote sensing, and environmental studies.

SUMMARY RESUME

Phillip M. Wright

POSITION: Technical Vice President of the University of Utah Research Institute and Director of the Earth Science Laboratory.

EDUCATION: B.S., Geological Engineering, 1960, University of Utah
Ph.D., Geophysics, 1966, University of Utah

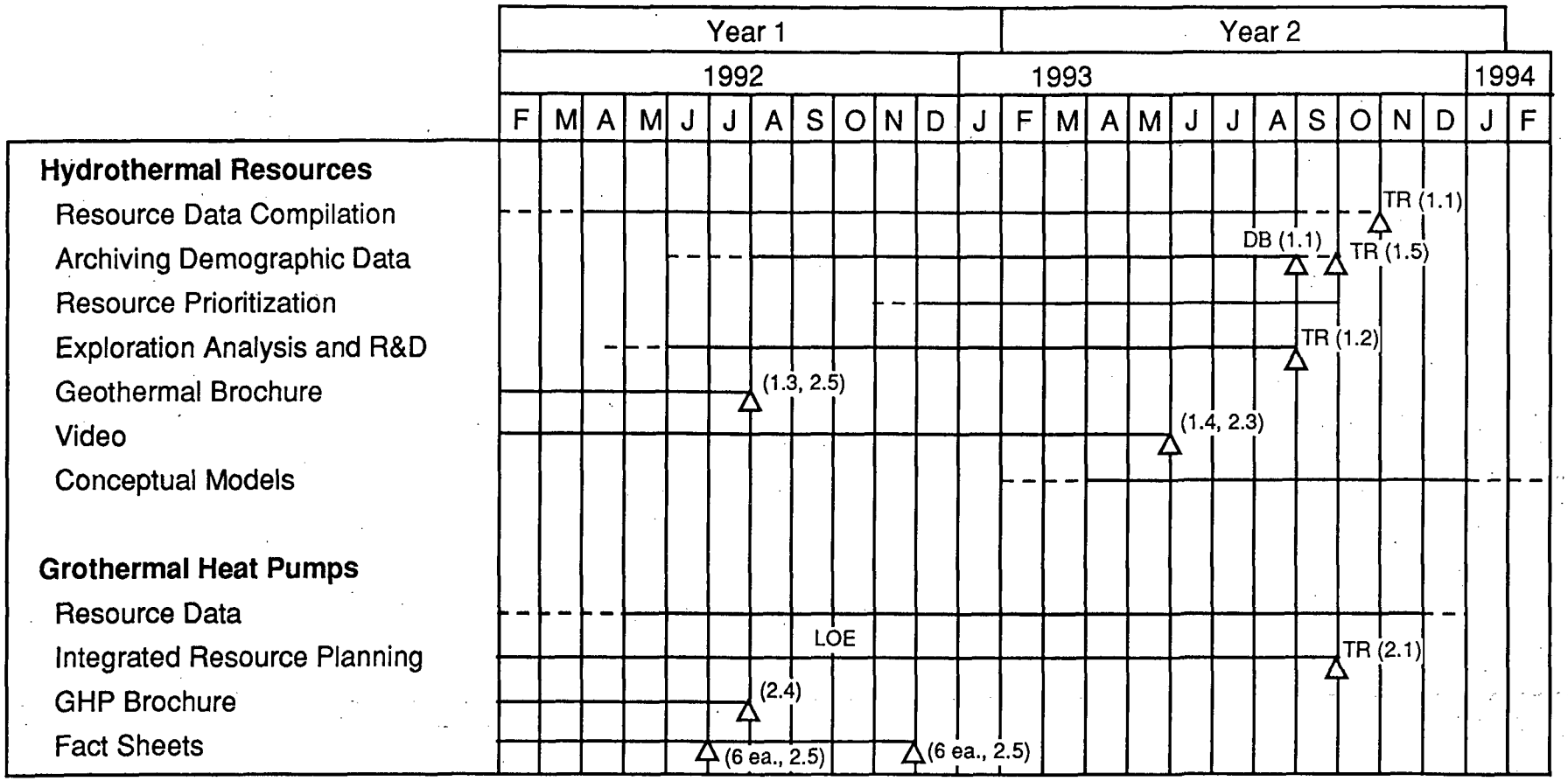
Dr. Phillip. M. Wright graduated from the University of Utah with High Honors and was elected to several honorary societies. He completed a Ph. D. Thesis titled "Heat Flow and Geothermal Gradients in Utah" in 1966. He worked as an underground miner and later as an engineer and geologist in the Park City District while an undergraduate and graduate student.

Dr. Wright was employed by Kennecott Exploration, Inc. from 1966 to 1977. His first position was that of Senior Geophysicist responsible for geophysical exploration programs in Arizona, Nevada, and Utah. In this position he designed, supervised, and interpreted geophysical surveys and generated targets for porphyry copper exploration. From 1969 to 1977 Dr. Wright was the Chief, Geophysics Division - U.S. Operations for Kennecott Exploration, Inc. In this role he reported to the Vice President-Exploration and to the Director, Exploration Services. He supervised the professional geophysical staff, field geophysical crews, and contract geophysical services. He interacted with worldwide exploration offices to provide geophysical input to a broad variety of mineral exploration programs. He was the project manager for a reconnaissance induced polarization project in the Western U.S. and Canada which led to the discovery of a new, major covered porphyry copper sulfide system. His field experience and interpretative work include the western United States, the north-central states, British Columbia, South Africa, and Botswana.

Since 1977 Dr. Wright has been with the Earth Science Laboratory Division, UURI where he has been a Senior Geophysicist/Project Manager, the Associate Director for Technology (1978-1984) and finally the Director, Earth Science Laboratory, and Technical Vice President, University of Utah Research Institute. Dr. Wright has been the Project Manager for the State Coupled Geothermal Resource Assessment Program, and for a Solution Mining and Hydrometallurgy project. Dr. Wright is responsible for the development and maintenance of technical and scientific capabilities within UURI.

Dr. Wright is a well known proponent of geothermal energy, and is known worldwide as an expert on the nature and occurrence of geothermal energy. He is a Director of the Geothermal Resources Council and frequently serves on DOE review panels. Dr. Wright is the author of numerous papers dealing with geothermal energy, mining geophysics,and geothermal technology, and is a frequent speaker at national and international meetings.

Table 1
Project Schedule - Phase I



△ = Delivery Date

TR = Technical Report

DB = Data Base

(xx) = Deliverable Number