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RESEARCH PROPOSAL

TO

DEPARTMENT OF ENERGY
GEOTHERMAL AND HYDROELECTRIC ENERGY BRANCH
IDAHO OPERATIONS OFFICE

ASSESSMENT OF THE LOW-TEMPERATURE GEOTHERMAL ENERGY RESOURCES OF ALASKA

Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

January 1978

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RESEARCH PROPOSAL TO:	Department of Energy, Geothermal and Hydroelectric Energy Branch, Idaho Operations Office
INSTITUTION:	Geophysical Institute, University of Alaska, Fairbanks, Alaska 99701
TITLE:	Assessment of the Low-Temperature Geothermal Energy Resources of Alaska
PRINCIPAL INVESTIGATOR:	Donald L. Turner Associate Professor of Geology S.S.N. 569-46-1429
CO-PRINCIPAL INVESTIGATOR:	Robert B. Forbes Professor of Geology S.S.N. 531-20-4474
DURATION OF PROJECT:	2 Years
STARTING DATE:	February 15, 1978
SUM REQUESTED FROM ERDA:	$275,000

ABSTRACT

We propose a program to assess the low temperature geothermal energy resources of Alaska. As envisioned, this would be a multi-phase, multi-agency program involving principal investigators from the Geophysical Institute with cooperation and support from the Alaska State Division of Geological and Geophysical Surveys, the U.S. Geological Survey and the Alaska Department of Energy and Power Development.

The objectives of this program are (1) to extend the inventory of geothermal resources in Alaska to include the low temperature reservoirs ($35° < T < 90°C$) most suitable for direct heat applications and (2) to stimulate reservoir confirmation studies at sites with an apparent but unquantified potential for direct heat applications development.

The proposed program would be implemented in two phases; the first dealing with a statewide survey of available data, and the second concerned with site-specific reservoir confirmation studies. Phase one

would involve the preparation of a preliminary report summarizing and synthesizing the available low-temperature data. This report would emphasize the known geographic distribution and geologic, geochronologic and geochemical data for the resources which appear suitable for direct heat applications. Phase one studies will also identify candidate sites for reservoir confirmation activities.

Phase two would involve field and laboratory studies designed to fill in gaps in geothermal resource information identified in phase one, as well as site-intensive studies of promising sites using geologic, geochronologic, geochemical and geophysical techniques.

INTRODUCTION

Alaska has more than 80 late Cenzoic volcanoes and at least 94 thermal springs. Most of Alaska's volcanoes have been active within the last million years and more than 40 have erupted during historic time. In spite of this obvious evidence for a substantial geothermal energy resource, almost no utilization of Alaska's geothermal resources has occurred to date. A major factor in this lack of utilization is the lack of public knowledge concerning the location, extent and quality of geothermal reservoirs. The proposed study is designed to stimulate public interest in the geothermal resource as a viable energy option for Alaska.

PREVIOUS WORK

Early Alaskan Geothermal Inventories

The earliest contribution to the geothermal framework of Alaska was G. A. Waring's "Mineral Springs of Alaska" (1917), a pioneering work with

included data on the geologic setting, chemistry, and thermometry of Alaskan hot springs which were known to the author in 1917. This work, and its accompanying spring location map, was the authoritative reference on Alaskan geothermal resources for over 50 years.

In 1971 Ms. Norma Biggar, Geophysical Institute, University of Alaska, compiled a revision of Waring's map under the direction of R. B. Forbes, which showed the location and temperature range of known Alaskan thermal springs as of that time. Subsequently, Biggar's updated thermal springs map, accompanied by tables of relevant data on thermal spring water temperatures and chemistry, was incorporated as an appendix in her M.S. thesis, "A Geological and Geophysical Study of Chena Hot Springs, Alaska" (Biggar, 1973). In those cases where adequate chemical data were available Ms. Biggar calculated estimated reservoir temperatures for the hydrothermal systems, using the silica and alkali geothermometers as developed by Fournier and Truesdale (1970) and White (1970).

T. Miller, Branch of Alaskan Geology, U. S. Geological Survey, had also been collecting data on previously known and newly discovered thermal springs during his widespread geological mapping activities in Alaska. Miller compiled an updated map of the thermal springs of Alaska, which was supplemented by additional data on the chemistry of spring waters as contributed by I. Barnes of the U. S. Geological Survey (Miller, 1973).

A National Geothermal Program

Interest in geothermal resources as alternate energy sources began to increase in 1972, when unfavorable fossil fuel consumption vs. production curves began to attract national attention. In August 1972, a report entitled "Assessment of Geothermal Energy Resources" (1972) was produced by the

Department of the Interior which summarized the state of knowledge of geothermal resources and potential in the United States. The report contained a preliminary outline of a national geothermal energy program and included funding recommendations.

Subsequently, the RANN program of the National Science Foundation awarded a grant to the University of Alaska to organize a geothermal resources research conference chaired by Walter J. Hickel, former Secretary of the Interior. The purpose of the conference was to produce the outline of a ten-year geothermal resource research program, including recommended funding parameters, to be presented to the Congress of the United States. The conference was held in September 1972, and "Geothermal Energy - A National Proposal for Geothermal Resources Research" was presented to the Congress that year (Hickel, 1972). This proposal, which is now known as the "Hickel Report", was the catalyst that activated the current national geothermal energy program. Alaska, due to its active volcanoes and numerous thermal springs, received early attention from U. S. Geological Survey and the Geophysical Institute researchers under the aegis of the national program.

Recent Geothermal Studies and Inventories

The U. S. Geological Survey's Alaskan geothermal reconnaissance program was initiated in 1974. This program has concentrated on thermal springs, volcanic geothermal systems and downhole heat flow measurements in available drill holes. To date, results from these investigations include a report on the "Geologic Setting and Chemical Characteristics of Hot Springs in West-Central Alaska" (Miller, et al., 1975) and U. S. Geological Survey Circular #726, "Assessment of Geothermal Resources of the United States - 1975", which contains the most current data on Alaska's geothermal resource potential, with particular attention to hot-water, vapor-dominated and igneous-related (volcanic) systems.

Based on the U. S. Geological Survey geothermal reconnaissance program, we have a preliminary understanding of the location and potential of hydrothermal systems which are related to thermal springs, and a good insight as to which of Alaska's volcanic fields and calderas may offer the best exploration targets. To date, however, no geothermal steam fields have been discovered in Alaska, and based on water chemistry, only four thermal springs (Geyser Bight, Hot Springs Cove, Shakes Springs, Hot Springs Bay) have reservoir temperatures high enough to produce economically significant steam at the well head.

The Geophysical Institute has been involved in several geothermal projects over the last seven years, as documented by the following publications:

Published Papers:

(1) Forbes, R. B., and N. Biggar, Alaska's geothermal resource potential, The Northern Engineer, Vol. 5, No. 1, p. 6-10, Geophysical Institute, University of Alaska, Spring 1973.

(2) Forbes, R. B., L. Leonard, and D. H. Dinkel, Total energy utilization potential of Alaskan thermal springs, Selected papers from the Proc. of the United Nationals Geothermal Symposium, San Francisco, California, May 1975, pp. 2209-2215, 1975.

(3) Forbes, R. B., The energy crunch...Alaska style, Proc. of the Public Meeting on a National Plan for Energy Research, Development and Demonstration; Transcript of the Proc., U. S. Energy Research and Development Administration, Washington, D. C., December 1975.

(4) Leonard, L. E., What's old in geothermal energy?, The Northern Engineer, Vol. 6, No. 4, Geophysical Institute, University of Alaska, Winter 1974-75.

Reports:

(5) Biggar, N. E., A geological and geophysical study of Chena Hot Springs, Alaska: Geophysical Institute (unpublished M. S. dissertation), University of Alaska, Fairbanks, Alaska 1973.

(6) Forbes, R. B., L. Gedney, D. VanWormer, and J. Hook, A geophysical reconnaissance of Pilgrim Springs, Alaska, Geophysical Institute Report, University of Alaska, UAG R-231, 26 pp., 1975.

(7) Forbes, R. B., L. Leonard, and D. H. Dinkel, Utilization of geothermal energy resources in rural Alaskan communities, Geophysical Institute Report, University of Alaska, UAG R-232, 83 pp., 1975.

(8) Forbes, R. B. (Editor), Geothermal energy and wind power...alternate energy sources for Alaska, Final Report to the National Science Foundation, Geophysical Institute, University of Alaska, April 1976.

Reports (7) and (8), above, are of special importance to the assessment of Alaskan geothermal resources. In 1975, through a contract from the Atomic Energy Commission, we completed a study entitled "Utilization of geothermal energy resources in rural Alaskan communities" (Forbes, et al., 1975). In this report we concluded that geothermal energy resources including thermal springs were potentially more important to the rural communities than to the larger cities, and that geothermal power was not presently competitive with electricity generated by natural gas, coal or hydroelectric facilities, unless a geothermal steamfield could be discovered near a major city. At that time, however, we did not consider the possible direct heat applications from hot water aquifers which might exist in the subsurface, in areas with thick sedimentary sections and normal geothermal gradients.

An Alaskan Geothermal and Windpower Planning Conference was held in Anchorage in July 1975. The conference was co-sponsored by the Office of the Governor, State of Alaska, and the Geophysical Institute, supported by a conference and planning grant from the RANN program of the National Science Foundation. 150 conferees from Federal and State Agencies and the private sector met for three days to define Alaskan energy problems as they existed at that time, and to explore the possible applications of geothermal energy and windpower to the more urgent of these problems.

Several recommendations from that conference have led to actual research programs including salmon aquaculture experiments, utilizing hot water from thermal springs and industrial outflow (State of Alaska, Division of Energy and Power Development); and a study to determine the feasibility of

extracting hot water from deep reservoirs in normal geothermal gradient terranes, as a source of heat for six Alaskan towns and villages (Pacific-Sierra Research Corp.). Both of these studies are being funded by the Geothermal Energy Division of ERDA.

The Need for an Extended Inventory of Alaskan Geothermal Resources

Previous assessments of Alaska's geothermal potential have concentrated on a search for relatively high temperature resources including vapor dominated and hot water systems. U. S. Geological Suvey Circular #726, "Assessment of Geothermal Resources of the United States -]975", identifies and discusses three types of hydrothermal systems:

(1) Vapor dominated systems with probable subsurface temperatures exceeding 200°C.

(2) Hot water convection systems with indicated subsurface temperatures above 150°C.

(3) Hot water convection systems with indicated subsurface temperatures between 90 and 150°C.

There is presently a need to extend the inventory of Alaskan geothermal resources to include the low temperature reservoirs ($35° \lesssim T < 90°C$) most suitable for direct heat applications.

Hot water, ranging in temperature from 60 to 90°C, can be used directly for space heating of towns and large buildings complexes, if sufficient volume is available, and pumping costs are not too high. The Icelandic models are well known, but we are more interested in the Paris Basin examples, where hot water is extracted from permeable sandstone aquifers in the underlying Tertiary basin sediments to heat hotels and building complexes. In this case, the geothermal gradient is a little higher than normal, but it may be economically feasible to extract hot water from such aquifers in sections with a normal

thermal gradient, if they can be found under Alaskan communities.

To date, only a few heat flow determinations have been published for Alaskan locations. Heat flow measurements have been made by the U. S. Geological Survey in test wells and exploratory drill holes provided by industry. Field data are being processed by the U. S. Geological Survey, and we expect to acquire many new heat flow determinations for Alaskan sites during the next two years. Downhole temperature measurements are made in all petroleum test wells, and these data are available from the logs which are on file with the Alaska Division of Oil and Gas.

There are several Tertiary and/or Mesozoic basins in Alaska which may contain hot water (or brine) bearing aquifers at reasonable depths. Although geothermal drilling has not yet occurred in Alaska, there is a vast amount of available subsurface information on these basins which can be extracted from the exploratory well logs and drilling reports which have been filed with the State of Alaska Division of Oil and Gas by the petroleum industry.

GEOCHRONOLOGY AND GEOTHERMAL PROSPECTING

Geochronology can play an important role in the search for geothermal resources, as geothermal anomalies are often associated with very young volcanic edifices including calderas and silicic domes, as well as with late Cretaceous to early Tertiary granitic plutons (Miller and others, 1975). Potassium-argon and fission-track dating techniques are the most effective methods for determining the age of volcanic and plutonic rocks, and these techniques can thus be used as prospecting aids in the search for geothermal resources.

Moreover, the technique of comparing age differences obtained by the apatite fission-track and K-Ar methods appears to hold great promise as a geothermal prospecting tool in crystalline terranes, where recent deformation (epeirogenic uplift, block faulting, rifting) has exposed crystalline rocks

which have been overprinted by recent thermal perturbations. Figure 1 illustrates the concept, and presents a model of one of the tectonic settings where anomalously young apatite fission-track ages may be the signature of subsurface geothermal anomalies.

We know of at least one area where anomalously young apatite fission-track ages from surface samples are related to recent perturbations in the thermal gradient, in a setting similar to that shown in Figure 1.

The Geophysical Institute Geochronology Laboratory

During the past seven years we have been using the K-Ar facilities of the Geochronology Laboratory of the Geophysical Institute in a coordinated study of Alaska's igneous and metamorphic terranes. During this time a substantial geochronologic data base has been developed for Alaska (e.g., Turner, 1974; Turner and Smith, 1974; Turner and others, 1975; Wilson and Turner, 1975a-3; Kienle and Turner, 1976; Forbes and others, 1977; Turner and others, 1977, 1978). There is much work, however, which is yet unpublished. Moreover, certain on-going dating programs are currently inactive due to a present lack of funding. Several of these dating programs are relevant to the proposed geothermal assessment in that they provide information on the time of emplacement and cooling of plutons and on the time of eruption of volcanic systems, both of which are important sources of geothermal energy.

An additional program of dating volcanic ash falls contained within Tertiary coals of the Cook Inlet basin is providing age control for the Kenai Group sedimentary section of this basin--a major petroleum reservoir rock, in addition to its potential for a geopressured geothermal energy resource (Triplehorn, Turner and Naeser, 1977).

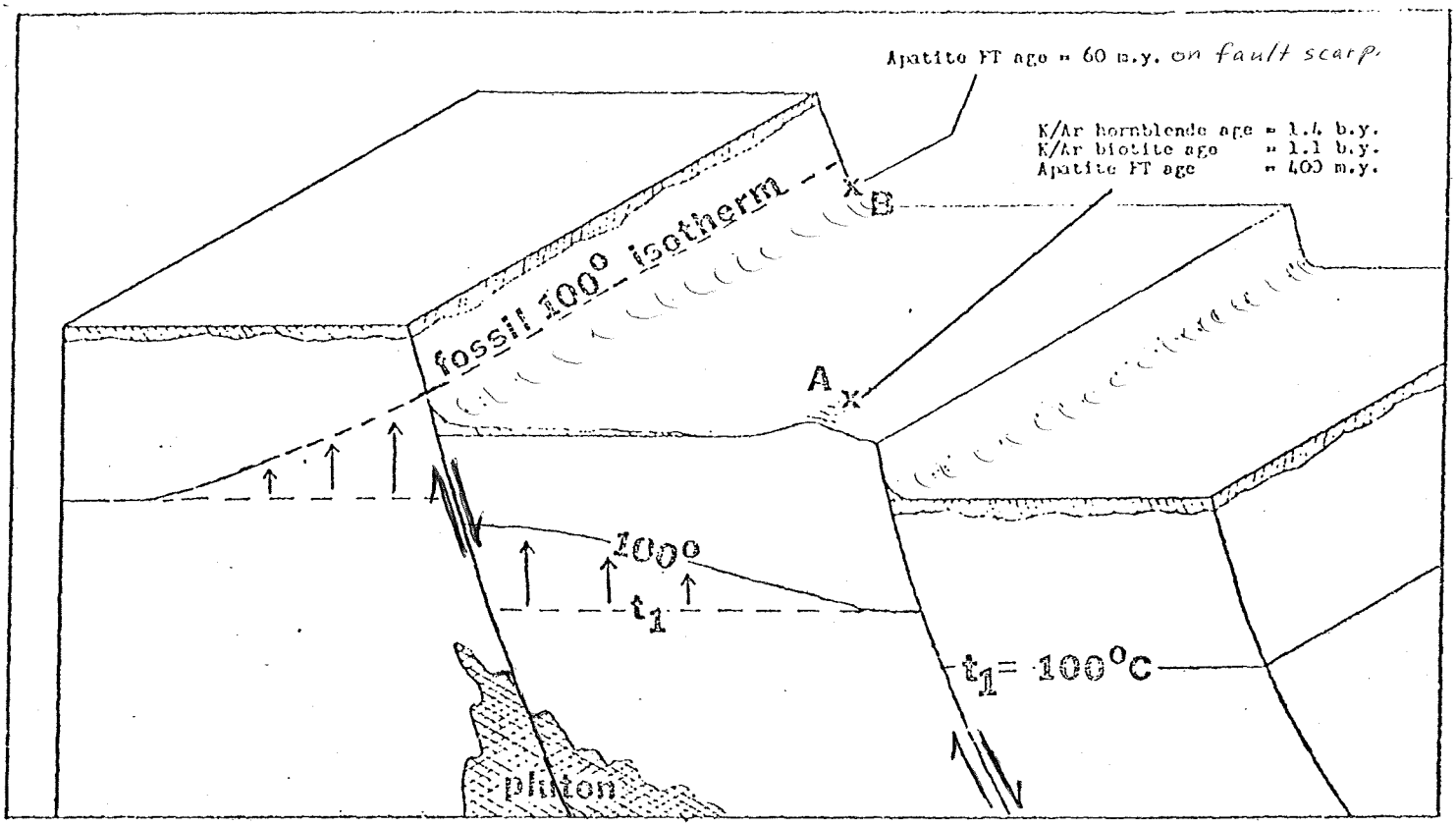

Figure 1. Highly generalized block diagram, illustrating a geothermal anomaly which could be signaled by anomalously young (partially annealed) apatite fission track ages. Events portrayed in the diagram are as follows:

(1) Precambrian basement rocks, with a thin veneer of sedimentary deposits. K/Ar and apatite fission track ages ranging from 1.4 b.y. to 400 m.y. represent cooling ages following regional Precambrian thermal event.

(2) A late Tertiary pluton (10 m.y.) rises to shallow depths in the subsurface, generating a thermal perturbation which locally displaces the 100°C isotherm upward to a new equilibrium.

(3) Apatite at locality (B) shown on fault scarp is exposed to temperatures averaging 135°C for approximately 9 m.y., due to displaced isotherms.

(4) High angle block faulting commences about 500,000 years ago, with a displacement rate averaging 1 cm/year. Rapid rate of upliift of fault block depresses isotherms and stops the apatite fission track annealing process.

(5) Apatite from rock sampled at fault scarp locality (B) gives FT age of 60 m.y., but hornblende and biotite will give the same K/Ar ages as those determined for rocks sampled at locality (A).

(6) Anomalously young apatite FT age is surface signature of geothermal anomaly.

Note: Isotherms will adjust to new surface profile of fault block topography, but no attempt has been made to illustrate this new equilibrium.

PROPOSED ASSESSMENT PROGRAM

General Description of Proposed Work

We propose a two-phase, interdisciplinary multi-agency, cooperative program involving principal investigators from the Geophysical Institute with the full cooperation and support of the Alaska Divison of Geological and Geophysical Surveys, the U. S. Geological Survey and the Alaska State Division of Energy and Power Development. The program may be expanded as appropriate to include direct participation by the Bureau of Land Management and/or Alaskan Native Regional and Village Corporations, depending on the status of sites nominated for phase two studies.

The proposed program would be implemented in two phases: the first dealing with a statewide survey of available data, and the second concerned with site-specific reservoir confirmation studies.

Specific Output for Phase One

Phase one of the proposed program is to be accomplished during the period January 1 - September 30, 1978. During this time, data describing low- and moderate-temperature resources in the state of Alaska will be assembled from existing U.S.G.S., University of Alaska, Alaska Divison of Geological and Geophysical Surveys, and Alaska Division of Oil and Gas reports and well log files; as well as from petroleum company sources, unpublished Geophysical Institute work and other geothermal data sources. Relevant Geophysical Institute geochronologic laboratory studies which have already been initiated, but are not completed due to lack of funding, will be completed during phase one and the results incorporated into the phase one data base.

These data will be published in a Geophysical Institute report designed for the use of energy planners, energy companies and potential users of non-electric geothermal energy. The report will emphasize the known geographic

distribution and the geologic, geochemical, geochronologic and geophysical data for the resources which appear suitable for direct heat applications.

The report will include a map of the state of Alaska showing the geographic distribution of these resources. Specific items to be included on the map are: population centers, thermal springs, granitic plutons, Tertiary and younger volcanic fields, sedimentary basins having potential for geopressured reservoirs and wells in which hydrothermal fluids were encountered during petroleum exploration. Temperature and radiometric age data will be shown in the cases where the appropriate data are available.

The report will also identify candidate sites for reservoir confirmation activities to be carried out in phase two, as well as sites for which basic geothermal data are lacking. Pertinent data from the report will be turned over the U. S. Geological Survey for incorporation into the U.S.G.S. Geotherm Data Base.

Radiometric dating programs to be completed and reported on during phase one are:

1. Geochronology of the Yukon-Tanana uplands, to include emplacement and cooling ages of the Chena Hot Springs, Cache Mountain, Mt. Prindle and other plutons, as well as K-Ar cooling ages from the enclosing metamorphic basement terrane. These results will be integrated with the radiometric data produced in our recent ERDA-supported Eielson deep basement drill hole study (Forbes and others, 1977).

   The Eielson drill hole, located near Fairbanks, penetrates schists of the Yukon-Tanana Complex to a depth of 9,774 ft. The measured geothermal gradient in this hole ranges from 34 to 41°C km. The radiogenic age/depth data we have obtained from the Eielson core

have led to a better understanding of the inter-relationship between cooling ages and the retreat of geotherms in response to the erosion of crustal cover. The Eielson model is thought to be representative of the geothermal history accompanying regional metamorphism, the emplacement of post-kinematic granitic plutons and the subsequent uplift and erosion of the overlying crust.

2. Geochronology of volcanism in Katmai National Monument. Our initial results on this project suggest that dated volcanism and intrusive activity in this area extends from 1912 to perhaps as far back as 2 million years ago. Many of our dated samples appear to fall in the 0-500,000 year range and have given us severe analytical problems due to their very high percentages of absorbed atmospheric vs. radiogenic argon.

   We believe, however, that an ERDA-suppored upgrading of our argon mass spectrometer which we have recently completed will make it possible to obtain much more reliable age measurements on rocks in this very young age range.

3. Geochronology of Granitic Intrusive activity along the southern margin of Alaska. Previous work by Kienle and Turner (1976) has documented a Paleocene series of granitic plutons extending from northeast Sanak Island to the Shumagin and Semidi Islands, on the Pacific side of the Alaska Peninsula. Radiometric dating studies now in progress suggest that the on-trend series of plutonic bodies on Kodiak Island and the southern Kenai Peninsula may be cogenetic with the previously dated Paleocene intrusives. K-Ar dating of these intrusive bodies will be completed under the proposed program, yielding emplacement and cooling ages for this important continental margin granitic intrusive system.

Specific Output for Phase Two

Phase two will involve field and laboratory studies designed to fill in gaps in geothermal resource information identified in phase one, as well as site-intensive studies of promising sites using geologic, geothermal, geophysical and geochronologic methods. This work will be accomplished during FY 1978-79, beginning October 1, 1978.

Following the inventory conducted in phase one, the most promising Alaskan sedimentary basin will be selected for detailed analysis. This study will include subsurface lithofacies relations, structural analysis and reservoir studies in addition to surface geology. Deep drilling costs are extremely high in Alaska, and any exploratory drilling for deep hot water aquifers must be preceded by a careful subsurface study of this type. Due to these extremely high costs, any deep drilling proposed for phase two would have to be funded by a supplemental appropriation to the enclosed budget.

Reservoir confirmation studies involving shallow drilling will also be carried out at a promising hot spring site, such as Manley Hot Springs, located about 90 air miles northwest of Fairbanks. These hot springs have been under study by the Geophysical Institute since 1973. They are of particular interest because they have supported commercial vegetable farming since the early 1900's (Leonard, 1974). Planning is underway at the Geophysical Institute for the installation of an experimental Rankine-Cycle low temperature unit for the generation of small amounts of electricity in a total utilization experiment at Manley. The springs are surrounded by a large expanse of warm ground, which has also been used for truck farming in addition to the greenhouses which have been constructed on the site. We propose to drill a grid pattern of test holes with a small

drill rig, to measure ground temperatures and gradients; and one 500 ft. hole to explore the shallow levels of the conduit system to see if exit water temperatures have been lowered by mixing with ground water.

In addition to the above studies we will carry out a regional program of dating selected Alaskan intrusive bodies and volcanic fields which are potential geothermal resources, but for which our phase one assessment shows that there is no radiometric age information available.

An environmental impact statement will be prepared if required by any of the projects discussed above.

Details of the budget for phase two will be negotiated with DOE upon completion of phase one and based on the recommendations of that study. It is understood that the total figure for the phase two budget (excluding possible deep drilling costs) will not exceed $175,000.

Coordination with other DOE Geothermal Programs

We anticipate that other DOE funded studies being conducted concurrently with phase one of the study proposed here will be of great assistance in helping to define the developmental potential and economic viability of sites selected for field investigation in phase two. A small project to assess the economic parameters of geothermal development in Alaska has been proposed by Leonard and Goldsmith of the Geophysical Institute and the Institute of Social and Economic Research, respectively. This project will begin in February, 1978, and will refine and supplement information being gathered on a regional basis by the Oregon Institute of Technology.

We plan to make every effort to coordinate our work with these and other ongoing geothermal programs in order to assure the most cost-effective use of available funds. We have held preliminary discussions with Don Markle, OIT coordinator for Alaska; Dr. Ross Schaff, Alaska State Geologist;

Dr. Thomas Ovenshine, Chief of the USGS Branch of Alaskan Geology; and Dr. Robert Christiansen, USGS Geothermal Program Manager. All of these individuals have promised the full cooperation of their respective agencies with our proposed geothermal assessment program.

Research and Reporting Responsibilities

Dr. Turner will be principal investigator and overall coordinator for both phases of the proposed project. He will be responsible for all geochronologic work, and all data compilation excluding the sedimentary basin studies. He will participate in the reservoir assessment studies in phase two, together with Dr. Bob Forbes and Mr. Lee Leonard, a Geophysical Institute Engineer, who will act as a collaborating scientist for shallow drilling and temperature profiling in phase two.

Dr. Bob Forbes will be responsible for all sedimentary basin and heat flow research and reporting in phase one. He will also conduct the sedimentary basin evaluation and participate in the reservoir assessment studies in phase two. He will co-author the final reports for both phases with Dr. Turner.

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Budget - Phase I
January 1978 - Sept. 30, 1978

Salaries		
Principal Investigator, D. Turner, Assoc. Prof. of Geology, 4 mo. @ $3,537	14,148	
Prof. Lab Technician, 4 mo. @ $2,296	9,184	
Laboratory Assistant, 2 mo. @ $1,178	2,356	
Electronics Tech., 1 mo. @ $2,130	2,130	
Student Assistant, 2 mo. @ $1,178	2,356	
Draftsman, 1/2 mo. @ $2,058	1,029	
Labor for preparation of reports and publications, 1 mo. @ $1,777	1,777	
Subtotal	32,980	
10% salary increment	3,298	
Subtotal	36,278	
Reserve for annual leave 12%	4,353	
Holiday and sick leave 9.5%	3,446	
Total Salaries		44,077
Staff Benefits		
Hospitalization, Social Security, Retirement 12% of total salaries		5,289
Overhead		
64.7% of total salaries		28,518
Laboratory Supplies		
Liquid nitrogen, heavy liquids for mineral separations, ultra-high vacuum valves, and other miscellaneous expendables		6,500
Travel		
1 round trip (Turner) to Miami for Spring AGU meeting, including 7 days subsistence @ $30/day	926	
1 round trip, Lopez-Menlo Park, Ca. (Forbes) including 5 days subsistence @ $30/day	364	
1 round trip (Turner) Fairbanks - Lopez, Wa.-Menlo Park, including 5 days @ $30/day	630	
1 round trip (Turner) Fairbanks - Idaho Falls - Menlo Park, Ca., including 7 days @$30/day	707	
2 round trips (Forbes) Lopez - Fairbanks, including 5 days subsistence each @$30/day	912	
4 round trips, Fairbanks - Anchorage, including 5 days subsistence each @ $30/day	988	
		4,527
Other Direct Costs		
Co-Principal Investigator/Consultant, R. Forbes, 2 mo. @ $4,393/mo.	8,786	
Communications	800	
Freight	453	
Xeroxing	450	
Computer usage	600	
		11,089
Total Budget - Phase I		100,000

Budget - Phase II
Oct. 1, 1978 - Sept. 30, 1979

The detailed budget for phase 2 will be negotiated with the DOE upon completion of phase 1, and based on the recommendations of the phase 1 study. It is understood that the total figure for the phase 2 budget will not exceed $175,000.

Budget - Phase I	$100,000
Budget - Phase II	175,000
Total Budget	$275,000

CONTRACT PRICING PROPOSAL
(RESEARCH AND DEVELOPMENT)

APPENDIX B

PAGE NO | NO. OF PAGES

NAME OF OFFEROR	SUPPLIES AND/OR SERVICES TO BE FURNISHED
Geophysical Institute	
HOME OFFICE ADDRESS University of Alaska Fairbanks, Alaska 99701	
DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED Fairbanks	TOTAL AMOUNT OF PROPOSAL $100,000
GOVT SOLICITATION NO	

DETAIL DESCRIPTION OF COST ELEMENTS

			EST COST ($)	TOTAL EST COST	REFERENCE
1 DIRECT MATERIAL *(Itemize on Exhibit A)*					
a. PURCHASED PARTS			6,500		
b. SUBCONTRACTED ITEMS					
c. OTHER—(1) RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS *(At other than cost)*					
TOTAL DIRECT MATERIAL				6,500	Budget
2. MATERIAL OVERHEAD *(Rate %X$ base=)*					
3 DIRECT LABOR *(Specify)*	ESTIMATED HOURS	RATE/HOUR	EST COST ($)		
TOTAL DIRECT LABOR				44,077	Budget
4 LABOR OVERHEAD *(Specify Department or Cost Center)*	O.H. RATE	X BASE=	EST COST ($)		
	64.7%	44,077	28,518		
TOTAL LABOR OVERHEAD				28,518	
5 XXXXXXXX *(Including field work at Government installations)*			EST COST ($)		
Staff Benefits 12% of total salaries					
Staff Benefits					
TOTAL XXXXXXXXXX				5,289	
6 SPECIAL EQUIPMENT *(If direct charge) (Itemize on Exhibit A)*					
7 TRAVEL *(If direct charge) (Give details on attached Schedule)*			EST COST ($)		
a. TRANSPORTATION			2,907		
b. PER DIEM OR SUBSISTENCE			1,620		
TOTAL TRAVEL				4,527	Budget
8 CONSULTANTS *(Identify—purpose—rate)*			EST COST ($)		
TOTAL CONSULTANTS					
9 OTHER DIRECT COSTS *(Itemize on Exhibit A)*				11,089	Budget
10 *TOTAL DIRECT COST AND OVERHEAD*					
11 GENERAL AND ADMINISTRATIVE EXPENSE *(Rate % of cost element Nos.)*					
12 ROYALTIES					
13 *TOTAL ESTIMATED COST*				$100,000	
14 FEE OR PROFIT					
15 *TOTAL ESTIMATED COST AND FEE OR PROFIT*					

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE	SIGNATURE
Neta Stilkey Business Manager	Neta Stilkey
NAME OF FIRM Geophysical Institute, University of Alaska	DATE OF SUBMISSION 12/20/77

EXHIBIT A--SUPPORTING SCHEDULE *(Specify. If more space is needed, use reverse)*

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST *($)*
	See Attached Budget	

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

[X] YES [ ] NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL	TELEPHONE NUMBER/EXTENSION
DCAA, Suite 400, 2525 C St., Anchorage, Ak.99503	907-276-4566 Ext.284

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

[ ] YES [X] NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

[ ] YES [X] NO *(If yes, identify):* [ ] ADVANCE PAYMENTS [ ] PROGRESS PAYMENTS OR [ ] GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

[ ] YES [ ] NO *(If yes, identify.)*:

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

[X] YES [ ] NO *(If no, explain on reverse or separate page)*

INSTRUCTIONS TO OFFERORS

1. The purpose of this form is to provide a standard format by which the offeror submits to the Government a summary of incurred and estimated costs *(and attached supporting information)* suitable for detailed review and analysis. Prior to the award of a contract resulting from this proposal the offeror shall, under the conditions stated in FPR 1-3.807-3 be required to submit a Certificate of Current Cost or Pricing Data (See FPR 1-3.807-3(h) and 1-3.807-4).

2. In addition to the specific information required by this form, the offeror is expected, in good faith, to incorporate in and submit with this form any additional data, supporting schedules, or substantiation which are reasonably required for the conduct of an appropriate review and analysis in the light of the specific facts of this procurement. For effective negotiations, it is essential that there be a clear understanding of:

a. The existing, verifiable data

b. The judgmental factors applied in projecting from known data to the estimate, and

c. The contingencies used by the offeror in his proposed price.

In short, the offeror's estimating process itself needs to be disclosed.

3. When attachment of supporting cost or pricing data to this form is impracticable, the data will be described *(with schedules as appropriate)*, and made available to the contracting officer or his representative upon request.

4. The formats for the "Cost Elements" and the "Proposed Contract Estimate" are not intended as rigid requirements. These may be presented in different format with the prior approval of the Contracting Officer if required for more effective and efficient presentation. In all other respects this form will be completed and submitted without change.

5. By submission of this proposal the offeror grants to the Contracting Officer, or his authorized representative, the right to examine, for the purpose of verifying the cost or pricing data submitted, those books, records, documents and other supporting data which will permit adequate evaluation of such cost or pricing data, along with the computations and projections used therein. This right may be exercised in connection with any negotiations prior to contract award.

FOOTNOTES

1. Enter in this column those necessary and reasonable costs which in the judgment of the offeror will properly be incurred in the efficient performance of the contract. If less any of the costs in this column have already been incurred (e.g., on a letter contract or change order), describe them on an attached supporting schedule. Identify all sales and transfers between your plants, divisions, or organizations under a common control, which are included at other than the lower of cost to the original transferror or current market price.

2. If less space in addition to that available on Exhibit A is required, attach separate pages as necessary and identify in this "Reference" column the attachment in which the information supporting the specific cost element may be found. No standard format is prescribed; however, the cost or pricing data must be accurate, complete and current, and the judgment factors used in projecting from the data to the estimates must be stated in sufficient detail to enable the Contracting Officer to evaluate the proposal. For example, provide the basis used for pricing materials such as by vendor quotations, shop estimates, or reference prices; the reason for use of overhead rates which depart significantly from experienced rates (reduced volume, a planned major re-arrangement, etc.); or justification for an increase in labor rates (anticipated wage and salary increases, etc.). Identify and explain any contingencies which are included in the proposed price, such as anticipated costs of rejects and defective work, or anticipated technical difficulties.

3. Indicate the rates used and provide an appropriate explanation. If less agreement has been reached with Government representatives on the use of forward pricing rates, describe the nature of the agreement. Provide the method of computation and application of your overhead expense, including cost breakdown and showing trends and budgetary data as necessary to provide a basis for evaluation of the reasonableness of proposed rates.

4. If the total cost entered here is in excess of $250, provide on a separate page the following information on each separate item of royalty or license fee: name and address of licensor, date of license agreement, patent numbers, patent application serial numbers, or other basis on which the royalty is payable, brief description, including any part or model numbers of each contract item or component on which the royalty is payable, percentage or dollar rate of royalty per unit, unit price of contract item, number of units, and total dollar amount of royalties. In addition, if specifically requested by the contracting officer, a copy of the current license agreement and identification of applicable claims of specific patents shall be provided.

5. Provide a list of principal items within each category indicating known or anticipated source, quantity, unit price, competition obtained, and basis of establishing source and reasonableness of cost.

Appendix E

UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
OPERATIONS, DIVISION OF PROCUREMENT

OFFEROR REPRESENTATIONS AND CERTIFICATIONS

THE OFFEROR REPRESENTS AND CERTIFIES AS PART OF HIS OFFER THAT: (Check or complete ALL applicable boxes or blanks. The term "offer" means bid where the procurement is advertised, and proposal where the procurement is negotiated.)

1. SMALL BUSINESS CONCERN
He [ ] is, [X] is not, a small business concern. If offeror is a small business concern and is not the manufacturer of the supplies offered, he also represents that all supplies to be furnished hereunder [ ] will, [ ] will not, be manufactured or produced by a small business concern in the United States, its possessions, or Puerto Rico. (For definition of "small business concern", see (i) Code of Federal Regulations, Title 41, Subpart 1-1.7, section 01 and (ii) the "Small Business Concern Size Standard" set forth in this solicitation, if any.)

2. MINORITY BUSINESS ENTERPRISE
He [ ] is, [X] is not, a minority business enterprise. A minority business enterprise is defined as a "business, at least 50 percent of which is owned by minority group members, or in case of publicly owned businesses, at least 51 percent of the stock of which is owned by minority group members." For the purpose of this definition, minority group members are Negroes, Spanish-speaking American persons, American-Orientals, American-Indians, American-Eskimos, and American-Aleuts.

3. LABOR SURPLUS AREA CONCERN
He [ ] is, [X] is not, a labor surplus area concern. (For definition of "labor surplus area concern", see Code of Federal Regulations, Title 41, Subpart 1-1.8, section 01.)

4. REGULAR DEALER—MANUFACTURER (Applicable only to supply contracts exceeding $10,000.)
He is a [X] regular dealer in, [ ] manufacturer of, the supplies offered.

5. TYPE OF BUSINESS ORGANIZATION (Check all applicable boxes)
He operates as [ ] an individual, [ ] a partnership, [ ] a joint venture, [ ] a nonprofit organization, [ ] a not-for-profit organization, [ ] an educational institution, [ ] a State or local government agency, [X] a corporation, incorporated under the laws of the State of Alaska.

6. AFFILIATION AND IDENTIFYING DATA (Applicable only to advertised solicitations. For further clarification, see paragraphs 16 and 17 on Standard Form 33A.)
(a) He [ ] is, [X] is not, owned or controlled by a parent company.
(b) If the offeror is owned or controlled by a parent company, he shall enter in the blanks below the name and main office address of the parent company:
Name of Parent Company and main office address _____

(Include Zip Code) _____

(c) Employer's identification number 87-0282770 _____
(Offeror's E.I. No.) (Parent Company's E.I. No.)
(For definition of "parent company", see Code of Federal Regulations, Title 41, Subpart 1-1.16, section 05.)

7. CONTINGENT FEE
(a) He [ ] has, [X] has not, employed or retained any company or person (other than a full-time bona fide employee working solely for the offeror) to solicit or secure this contract, and (b) he [ ] has, [X] has not, paid or agreed to pay any company or person (other than a full-time bona fide employee working solely for the offeror) any fee, commission, percentage, or brokerage fee contingent upon or resulting from the award of this contract. (If answers to foregoing information relating to (a) and (b) above, as required by the Contracting Officer. For interpretation of the representation, including the term "bona fide employee", see Code of Federal Regulations, Title 41, Subpart 1-1.5).

8. BUY AMERICAN CERTIFICATE
The offeror hereby certifies that each end product, except those listed below, is a domestic source end product (as defined in the clause entitled "Buy American Act") and that components of unknown origin have been considered to have been mined, produced or manufactured outside the United States.

Item No.	Country of Origin
None	

9. CLEAN AIR AND WATER CERTIFICATION
(Applicable if the offer exceeds $100,000, or the Contracting Officer has determined that orders under an indefinite quantity contract in any year will exceed $100,000, or a facility to be used has been the subject of a conviction under the Clean Air Act (42 U.S.C. 18570-8(c)(1))or the Federal Water Pollution Control Act (33 U.S.C. 1319(c))and is listed by EPA, or is not otherwise exempt.)

The offeror certifies as follows:

(a) Any facility to be utilized in the performance of this proposed contract has ☐ , has not ☒ , been listed on the Environmental Protection Agency List of Violating Facilities.
(b) He will promptly notify the Contracting Officer, prior to award, of the receipt of any communication from the Director, Office of Federal Activities, Environmental Protection Agency, indicating that any facility which he proposes to use for the performance of the contract is under consideration to be listed on the EPA List of Violating Facilities.
(c) He will include substantially this certification, including this paragraph (c), in every nonexempt subcontract.

10. EQUAL OPPORTUNITY
He ☒ has, ☐ has not, participated in a previous contract or subcontract subject either to the Equal Opportunity clause herein or the clause originally contained in section 301 of Executive Order No. 10925, or the clause contained in section 201 of Executive Order No. 11114; that he ☒ has, ☐ has not, filed all required compliance reports; and that representations indicating submission of required compliance reports, signed by proposed subcontractors, will be obtained prior to subcontract awards. (The above representation need not be submitted in connection with contracts or subcontracts which are exempt from the clause.

11. AFFIRMATIVE ACTION PROGRAM
(a) By submission of this offer, the offeror certifies that where he or any of his subcontractors have 50 employees or more and his or their offer(s) hereunder are $50,000 or more, each such organization will develop and maintain a written equal employment affirmative action program for each of their establishments as required by the rules and regulations of the Secretary of Labor pursuant to 41 CFR 60.1 and 60.2, unless the contract or subcontract is otherwise exempt.

(b) He ☒ has developed and has on file, ☐ has not developed and does not have on file, at each establishment affirmative action programs as directed above, or ☐ he has not previously had contracts where such programs were required. (This representation (b) need not be submitted where the offer is less than $50,000, the offeror has less than 50 employees, or the offer is otherwise exempt.

12. CERTIFICATION OF NONSEGREGATED FACILITIES
(Applicable to (1) contracts, (2) subcontracts, and (3) agreements with applicants who are themselves performing federally assisted construction contracts, exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause.)

By the submission of this offer, the offeror, applicant, or subcontractor certifies that he does not maintain or provide for his employees any segregated facilities at any of his establishments, and that he does not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. The offeror, applicant, or subcontractor agrees that a breach of this certification is a violation of the Equal Opportunity clause in this contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion or national origin, because of habit, local custom, or otherwise. He further agrees that (except where he has obtained identical certifications from proposed subcontractors for specific time periods) he will obtain identical certifications from proposed subcontractors prior to the award of subcontracts exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause; that he will retain such certifications in his files; and that he will forward the following notice to such proposed subcontractors (except where the proposed subcontractors have submitted identical certifications for specific time periods):

NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENT FOR CERTIFICATIONS OF NONSEGREGATED FACILITIES

A Certification of Nonsegregated Facilities must be submitted prior to the award of a subcontract exceeding $10,000 which is not exempt from the provisions of the Equal Opportunity clause. The certification may be submitted either for each subcontract or for all subcontracts during a period (i.e., quarterly, semi-annually, or annually).
NOTE: The penalty for making false statements in offers is prescribed in 18 U.S.C. 1001.

13. DISCLOSURE STATEMENT - COST ACCOUNTING PRACTICES AND CERTIFICATION

Any contract in excess of $100,000 resulting from this solicitation except (1) when the price negotiated is based on (a) established catalog or market prices of commercial items sold in substantial quantities to the general public, or (b) prices set by law or regulation, or (2) contracts which are otherwise exempt (see 4 CFR 331.30(b) and FPR §1-3.1203(a)(2)) shall be subject to the requirements of the Cost Accounting Standards Board. Any offeror submitting a proposal, which, if accepted, will result in a contract subject to the requirements of the Cost Accounting Standards Board must, as a condition of contracting, submit a Disclosure Statement as required by regulations of the Board. The Disclosure Statement must be submitted as a part of the offeror's proposal under this solicitation (see (I) below) unless (i) the offeror, together with all divisions, subsidiaries, and affiliates under common control, did not receive net awards exceeding the monetary exemption for disclosure as established by the Cost Accounting Standards Board (see (II) below); (ii) the offeror exceeded the monetary exemption in the Federal Fiscal Year immediately preceding the year in which this proposal was submitted but, in accordance with the regulations of the Cost Accounting Standards Board, is not yet required to submit a Disclosure Statement (see (III) below); (iii) the offeror has already submitted a Disclosure Statement disclosing the practices used in connection with the pricing of this proposal (see (IV) below); or (iv) post award submission has been authorized by the Contracting Officer. See 4 CFR 351.70 for submission of a copy of the Disclosure Statement to the Cost Accounting Standards Board.

CAUTION: A practice disclosed in a Disclosure Statement shall not, by virtue of such disclosure, be deemed to be a proper, approved, or agreed to practice for pricing proposals or accumulating and reporting contract performance cost data.

Check the appropriate box below:

☐ I. CERTIFICATE OF CONCURRENT SUBMISSION OF DISCLOSURE STATEMENT(S)

The offeror hereby certifies that he has submitted, as a part of his proposal under this solicitation, copies of the Disclosure Statement(s) as follows: (i) original and one copy to the cognizant Contracting Officer; and, (ii) one copy to the cognizant contract auditor.

Date of Disclosure Statement(s)	Name(s) and Address(es) of Cognizant Contracting Officer(s) where filed

The offeror further certifies that practices used in estimating costs in pricing this proposal are consistent with the cost accounting practices disclosed in the Disclosure Statement(s).

☐ II. CERTIFICATE OF MONETARY EXEMPTION

The offeror hereby certifies that he, together with all divisions, subsidiaries and affiliates under common control did not receive net awards of negotiated national defense prime contracts totaling $30 million or more during Federal fiscal year 1971; and did not receive net awards of negotiated national defense prime contracts subject to Cost Accounting Standards totaling more than $10 million in any of the Federal fiscal years 1972, 1973, 1974, or 1975; and net awards of negotiated national defense prime contracts and subcontracts subject to Cost Accounting Standards totalling more than $10 million in Federal fiscal year 1976, or in any subsequent Federal fiscal year preceding the year in which this proposal was submitted.

CAUTION: Offerors who submitted or who currently are obligated to submit a Disclosure Statement under the filing threshold established by the Cost Accounting Standards Board for a Federal fiscal year prior to the one immediately preceding the year in which this proposal was submitted may be eligible to claim this exemption if they have received notification of final acceptance of all deliverable items on all their prime contracts and subcontracts containing the Cost Accounting Standards clause.

☐ III. CERTIFICATE OF INTERIM EXEMPTION

The offeror hereby certifies that (i) he first exceeded the monetary exemption for disclosure, as defined in (II) above, in the Federal Fiscal Year immediately preceding the year in which this proposal was submitted, and (ii) in accordance with the regulations of the Cost Accounting Standards Board (4 CFR 351.40(f)), he is not yet required to submit a Disclosure Statement. The offeror further certifies that if an award resulting from this proposal has not been made by March 31 of the current Federal Fiscal Year, he will immediately submit a revised certificate to the Contracting Officer, in the form specified under (I) above or (IV) below, as appropriate, to verify his submission of a completed Disclosure Statement.

CAUTION: Offerors may not claim this exemption if they are currently required to disclose because they exceeded monetary thresholds in Federal Fiscal Years prior to fiscal year 1976. Further, the exemption applies only in connection with proposals submitted prior to March 31 of the year immediately following the Federal Fiscal Year in which the monetary exemption was exceeded.

☐ IV. CERTIFICATE OF PREVIOUSLY SUBMITTED DISCLOSURE STATEMENT(S)

The offeror hereby certifies that the Disclosure Statement(s) were filed as follows:

Date of Disclosure Statement(s)	Name(s) and Address(es) of Cognizant Contracting Officer(s) where filed

The offeror further certifies that practices used in estimating costs in pricing this proposal are consistent with the cost accounting practices disclosed in the Disclosure Statement(s).

14. ADDITIONAL COST ACCOUNTING STANDARDS APPLICABLE TO EXISTING CONTRACTS - CERTIFICATION

(a) Cost accounting standards will be applicable and effective as promulgated by the Cost Accounting Standards Board to any award as provided in the Federal Procurement Regulations Subpart 1-3.12. If the offeror presently has contracts or subcontracts containing the Cost Accounting Standards clause, a new standard becomes applicable to such existing contracts prospectively when a new contract or subcontract containing such clause is awarded on or after the effective date of such new standard. Such new standard may require a change in the offeror's established cost accounting practices, whether or not disclosed. The offeror shall specify by an appropriate entry below, the effect on his cost accounting practice.

(b) The offeror hereby certifies that an award under this solicitation ☐ would, ☒ would not, in accordance with paragraph (a)(3) of the Cost Accounting Standards clause require a change in his established cost accounting practices affecting existing contracts and subcontracts.

NOTE: If the offeror has checked "would" above, and is awarded the contemplated contract, he will also be required to comply with the clause entitled Administration of Cost Accounting Standards.

15. COST ACCOUNTING STANDARDS-EXEMPTION FOR CONTRACTS OF $500,000 OR LESS - CERTIFICATION
If this proposal is expected to result in the award of a contract of $500,000 or less and the offeror is otherwise eligible for an exemption, he shall indicate by checking the box below that the exemption to the Cost Accounting Standards clause (FPR 1-3.1204) under the provisions of 4 CFR 331.30(b)(2) (see FPR 1-3.1203(2)) is claimed. Where the offeror fails to check the box, he shall be given the opportunity to make an election in writing to the Contracting Officer prior to award. Failure to check the box below or make such an election shall mean that the offeror cannot claim the exemption to the Cost Accounting Standards clause or that the offeror elects to comply with such clause.

☐ Certificate of Exemption for Contracts of $500,000 or Less.

The offeror hereby claims an exemption from the Cost Accounting Standards clause under the provisions of 4 CFR 331.30(b)(2) and certifies that he has received notification of final acceptance of all items or work on (i) any prime contract or subcontract in excess of $[illegible] which contains the Cost Accounting Standards clause, and (ii) any prime contract or subcontract of $[illegible] or less awarded after January 1, 1975, which contains the Cost Accounting Standard clause. The offeror further certifies he will immediately notify the Contracting Officer in writing in the event he is awarded any other contract or subcontract containing the Cost Accounting Standards clause subsequent to the date of this certificate but prior to the date of any award resulting from this proposal.

16. CERTIFICATION OF INDEPENDENT PRICE DETERMINATION
(Applicable only to contracts over $10,000.)
(a) By submission of this offer, the offeror certifies, and in the case of a joint offer, each party thereto certifies as to its own organization, that in connection with this procurement:
(1) The prices in this offer have been arrived at independently, without consultation, communication, or agreement, for the purpose of restricting competition, as to any matter relating to such prices with any other offeror or with any competitor;
(2) Unless otherwise required by law, the prices which have been quoted in this offer have not been knowingly disclosed by the offeror and will not be knowingly disclosed by the offeror prior to opening in the case of an advertised procurement or prior to award in the case of a negotiated procurement directly or indirectly to any other offeror or to any competitor; and
(3) No attempt has been made or will be made by the offeror to induce any other person or firm to submit or not to submit an offer for the purpose of restricting competition.

(b) Each person signing this offer certifies that:
(1) He is the person in the offeror's organization responsible within that organization for the decision as to the prices being offered herein and that he has not participated, and will not participate, in any action contrary to (a)(1) through (a)(3) above; or
(2) (i) He is not the person in the offeror's organization responsible within that organization for the decision as to the prices being offered herein but that he has been authorized in writing to act as agent for the persons responsible for such decision in certifying that such persons have not participated, and will not participate; in any action contrary to (a)(1) through (a)(3) above, and as their agent does hereby so certify; and (ii) he has not participated, and will not participate, in any action contrary to (a)(1) through (a)(3) above.

17. SUBCONTRACTOR REPRESENTATIONS AND CERTIFICATIONS
By submission of this offer, the offeror certifies that he /__/ has obtained and included with this offer, /__/ will obtain and provide to the Contracting Officer prior to award of the applicable subcontracts, the following numbered representations and certifications from all non-exempt subcontractors at any level (numbered in accordance with the foregoing): 9,10,11,12,13,14.

18. SIGNATURE
By signature hereto, or to an offer incorporating these representations and certifications, the offeror certifies that they are accurate, current, and complete and that he is aware of the penalty prescribed in 18 U.S.C. 1001 for making false statements in offers.

RFP NO. _____ Signature _____

Date of Offer _____ Typed Name _____

Name of Offeror _____ Title _____

_____ Date Signed _____

*U.S. GOVERNMENT PRINTING OFFICE: 1977 723-013/2226 1-3

PERSONAL DATA

NAME: Robert B. Forbes

DATE OF BIRTH: March 14, 1924

PLACE OF BIRTH: Aberdeen, Washington

EDUCATION:

University of Oregon, Eugene, Oregon, 1941-1942
1946-1948
B.S. Geology, University of Washington, Seattle, Washington
1948-1950
Graduate work, University of Washington, 1950-1951
Ph.D. Geology, University of Washington, 1957-1959

POSITIONS HELD & EXPERIENCE:

Geologist and Executive Officer, Juneau Ice Field Research Project, (spring-summer) 1949-1950.
Consultant, Mountain Environment Project, Department of Army, Washington, D.C., 1951-1953.
Chief, Field Observation Branch, OQMG, Department of Army, Washington, D. C., 1952-1953.
Department of Army Expeditions Project Supervisor, 1953-1955.
Assistant and Acting Chief, Research Branch, Office of Research Development, OQMG, Washington, D. C., 1955-1957.
Research Associate, Department of Geology, University of Washington, 1957-1959.
Assistant Professor, Geology Department, University of Alaska, 1959-1961.
Associate Professor of Geology, Geophysical Institute and Geology Dept., University of Alaska, 1961-1963.
Visiting Research Professor in Petrology, Geophysical Institute, University of Tokyo, Tokyo, Japan. (NSF Science Faculty Fellowship), 1963-1964.
Associate Professor of Geology, Geophysical Institute and Geology Department, University of Alaska, 1964-1965.
Professor and Head, Geology Department, University of Alaska Geology Dept. and Geophysical Institute, 1965-1969.
Visiting Research Geologist, Alaskan Geology Branch, U.S.G.S., Menlo Park, California, 1969-1970. (Temporary appointment; Sabbatical Leave academic year 1969-70).
Professor of Geology, Geophysical Institute and Geology Department, University of Alaska, 1970-1976.
Senior Geologic Consultant, Geophysical Institute, University of Alaska, 1976-present.

HONORS:

Department of Army Outstanding Performance Award (Special award for Antarctic research), Jan., 1957.
National Science Foundation Science Faculty Fellow in Geology (Geological Institute, Tokyo University, 1963-1964).
Vice President, Section of Volcanology, Geochemistry and Petrology, American Geophysical Union, 1970-1972.

PROFESSIONAL ORGANIZATIONS:

Fellow, Geological Society of America
Fellow, Arctic Institute of North America
Fellow, American Association for the Advancement of Science
Member, American Geophysical Union
Member, American Association of Petroleum Geologists
Member, Sigma Xi
Member, American Polar Society

PRESENT RESEARCH INTERESTS:

Petrology and geochemistry of igneous and metamorphic rocks, with current emphasis on andesitic volcanism and the petrology of blueschist and eclogite facies metamorphic rocks; volcanology, including geophysical and geochemical studies of Alaskan volcanoes; exploration and utilization of Alaskan geothermal and uranium resources.

PUBLICATIONS:

Published Papers

Forbes, R. B., Field research and expeditionary mountaineering, American Alpine Journal, 1954.

Forbes, R. B., Operation Deepfreeze I: Parts I, II, III, IV, The Quartermaster Journal, May-December, 1957.

Forbes, R. B., Ultrabasic inclusions from the basalts of the Hut Point area, Ross Island, Antarctica, Bull. Volcanologique, 26, 13-21, 1963.

Forbes, R. B. and D. W. Ester, Glaciation of Observation Hill, Hut Point Peninsula, Ross Island, Antarctica, J. Glaciol., 5, 87-92, 1964.

Forbes, R. B., The comparative chemical composition of eclogite and basalt, J. Geophys. Res., 70, 1515-1521, 1965.

Forbes, R. B. and H. Kuno, The regional petrology of peridotite inclusions and host basalts, Upper Mantle Volume; Selected papers from the Proceedings of the 22nd International Geological Congress, New Delhi, India, 161-179, 1965.

PUBLISHED PAPERS (Cont'd)

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