GL00977

8/11

f Here is what I sent to Sue.

Carl.

Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

August 11, 1982

TO: William Harrison
Oklahoma Geological Survey
University of Oklahoma
830 Van Vleet Oval, Rm. 163
Norman, OK 73019

FROM: Susan M. Prestwich, Program Manager

SUBJECT: State Coupled RA Program
Oklahoma Geothermal Map: Cost Share

Confirming your conversations with Ron Smith (NOAA) and Carl Ruscetta (ESL/UURI), DOE/ID is prepared to assist the Oklahoma RA team in the production and publication of a 1:500,000 scale geothermal resources map of Oklahoma. The total estimated cost of this map would be $15,000. Approximately one-half of this total cost ($7,500) would be associated with production details and plate preparation and the balance ($7,500), with the actual printing and distribution of the map. The production costs include the preparation of map printing plates and proofs by NOAA and the reviews, technical and editorial, which are provided by the review committee in cooperation with the state team.

DOE/DGE, Idaho Operations Office, is prepared to cost share this project by providing the estimated $7,500 production detail costs, which will be incurred primarily by NOAA. The state of Oklahoma would then provide the funds necessary for the printing and distribution of this map. The formal funding of this worthwhile project can be accomplished through a modification of your existing DOE contract.

The state geothermal maps which are being published in this series are considered to be one of the most visable and useful products of the resource assessment program. I am pleased that Oklahoma is considering the publication of such a map, adding significantly to the fund of information now available to aid in the development of this potentially valuable national energy resource.

Very truly yours,

Susan M. Prestwich

SMP:jp

cc: D. Foley/UURI
C. Ruscetta/UURI
R. Smith/NOAA

OKLAHOMA GEOLOGICAL SURVEY

Charles J. Mankin, Director

April 16, 1980

Gerald P. Brophy
U.S. Department of Energy
Division of Geothermal Energy, RA-233
M.S. 3344, Federal Building
12th and Pennsylvania, NW
Washington, D.C. 20461

Dear Jerry:

Enclosed is a copy of a pre-proposal describing a program to assess the geothermal potential of Oklahoma. Two of the three proposed phases rely heavily on industry holes-of-opportunity. Our program would provide a way to study areas by means of boreholes thousands of feet deep without incurring the $35-55 per foot drilling costs associated with wells in these areas. The proposal may seem a bit ambitious but we feel the opportunity afforded by current industry activity in areas of interest is unique and has much to offer a geothermal assessment program.

We think it may be possible to obtain partial funding for this work through the Continental Drilling for Scientific Purposes Program. Charlie Mankin has visited with that committee and he thinks we may be able to obtain support for certain activities related to actively-drilling wells.

Please examine our proposed program and advise us of your assessment. If you think it might be possible to pursue a program such as the one described, we would be happy to submit a formal proposal for consideration.

We look forward to hearing from you in the near future.

Sincerely,

Bill

William E. Harrison

WEH:lh

xc: Duncan Foley ✓
Roy Mink

THE UNIVERSITY OF OKLAHOMA / 830 VAN VLEET OVAL, ROOM 163 / NORMAN, OKLAHOMA, 73019 / PHONE (405) 325-3031

Introduction

The Oklahoma Geological Survey proposes to undertake a State-wide reconnaissance-level investigation of geothermal potential. We propose a three phase program two of which have multi-year provisions. Our proposed program is somewhat different for DOE-sponsored work in other areas. Regional subsurface geology is fairly well-known in most parts of Oklahoma due to the large number of wells that have been drilled in search of petroleum. Information gained through many decades of exploration efforts can be put to good use in evaluation of geothermal potential in the state.

We would like to pursue three types of activity. Initally we would like to gather and compile data for the construction of a geothermal gradient map of the State. A portion of this work has been finished although some of the most difficult and time-consuming work remains to be done. At another level, we would like to investigate site-specific areas which (on the basis of existing gradient information) appear to have potential for geothermal resources. This phase of our program will involve holes-of-opportunity which result from petroleum exploration and development activity. The third part of our program will be an enlightenment program to help facilitate the use of dry and abandoned industry boreholes for geothermal applications. Each of these phases is discussed in greater detail in the following sections.

Phase I. Preparation of a Geothermal Gradient Map

Enclosed is a copy of the most detailed geothermal gradient map available for the State. This map was made as part of a thesis project at Oklahoma State University. The North American Geothermal Gradient Map Data Base was obtained from the American Association of Petroleum Geologists and used in the preparation of this map. This data was supplemented by additional corrected

bottom-hole temperatures to yield the control base map (see enclosure). The faculty member at Oklahoma State University who supervised this work was involved in the preparation of the AAPG North American Geothermal Gradient Map and has considerable experience in this area. The Oklahoma State University work was based on a number of rather sophisticated correction factors which were applied to the bottom hole temperature measurements obtained by conventional wire-line logging techniques. We have contacted the faculty member who supervised this work and he has expressed an interest in gathering data for the northeastern, southwestern, and panhandle areas of the State and making an updated version of the geothermal gradient map for publication through the Oklahoma Geological Survey. Such a map would be invaluable for any type of geothermal program to rank or assess the potential of specific geographic areas. The final product of this project would be a three-fold package consisting of:

1) A geothermal gradient map of Oklahoma at a scale of 1:500,000
2) A text describing how the correction factors were determined and employed
3) An appendix containing all the raw data from which the map was constructed. Such an appendix would contain well name and location, depth, and temperature; information such as time since circulation, number of log runs, etc. will be included where possible.

Our program with Oklahoma State University is contingent on having access to the basic data used in making the enclosed map. Based on our most recent conversation, we think the data is available. The Oklahoma Geological Survey will work up this information as a GM (General Map) or Circular as described above.

Phase II. Detailed Studies of Specific Areas

The colored areas on the geothermal gradient map are those which we think warrant field confirmation. Additional areas of interest will probably evolve as mapping continues. Initially, we would like to study the areas in Pittsburgh and Haskell Counties indicated on the map. Both of these areas are currently experiencing moderate to high levels of drilling activity and we will capitalize on this activity to study these sites. Although wells being drilled in these areas are 6,000 to 14,000 feet deep, we have no intention of conducting investigations at these depths until we know considerably more about geothermal conditions at shallower depths.

Operators in Oklahoma are required to set cement plugs through the objective horizon and plugs above the below the fresh-water aquifers. the remaining intervals are usually left full of moderately heavy drilling mud. Preliminary contact with operators in the area lead us to believe that we can assume responsibility for a dry hole for our own purposes. In such a case, the operator would set the deep plug and turn the hole over to us for final plugging.

Field Project -Type A

Two types of field projects, which include (1) thermal equilibrium studies and (2) a temperature logging program, are proposed for areas that have the greatest geothermal potential in Oklahoma. The first type, type A, will require that a sacrificial downhole instrument package be installed in a well situated in or very near one of the areas of interest. Such a package would consist of two or more temperature sensors on multi-strand cable of the type used by commercial logging companies. One company has indicated they will donate several thousand feet of cable for this purpose (but we will budget this item as a precautionary measure). This will be cable taken

out of service at 10- to 12- month intervals and declared surplus. We will install temperature sensors on this cable and test/calibrate the system as soon as components become available. Thus we will have this system ready to transport to a well site on short notice. The downhole system will be cemented in place in accordance with State regulations (administered by the Oklahoma Corporation Commission) in such a way that surface electronic assemblies may be connected and disconnected at will. We will install continuous recording devices and will monitor the thermal equilibration of the borehole. This will provide basic information on the geothermal potential of site-specific areas. Operators have advised us that this plan is best implemented while the drilling rig is available to handle and implant the cable. We must be prepared to pay the rig time associated with this activity which is estimated at $4500 to $6000 per day (depending on the type of rig used). This expense plus surface hardware and logistics support will provide valuable information at relatively modest cost. To drill and complete such holes (2000 to 4000 feet) exclusively for geothermal purposes would cost several times our projected expenditures per site.

Communication with several workers in the DOE/DGE program leads us to believe that our proposed work would benefit the geothermal community in many ways. Our program will provide controlled experiments that will permit study of such things as: (1) the relation between industry log-heading temperatures and true formation temperatures, (2) the effect of lithology on thermal conductivity, and (3) variation in heat transmissivity as a function of petrophysical characteristics.

We propose two Type A projects based on our current geothermal gradient map, and possibly two or three sites elsewhere in the State. Work presented at

the Salt Lake City meeting suggests that northeastern and south-central Oklahoma may also offer geothermal potential. For each of the Type A sites, we plan to examine the well cuttings, prepare a lighologic log, and work out the stratigraphy. The Pittsburgh and Haskell County sites are areas where basement tectonics are virtually unknown, at least in the public domain. If these sites prove to have geothermal potential (based on Type A activity), perhaps a gravity and magnetics geophysics program would be in order. Speculation exists that Mesozoic intrusives may underlie a portion of the Arkoma Basin. If site confirmation or Type A work indicates a resource worthy of development, it behooves us to understand the controls on such a resource in order to explore them more efficiently.

The two proposed Type A sites are situated in a sparsely populated part of the State. The region does have significant coal and water resources, however. Several major industries have relocated to Oklahoma within the last 2 years (General Motors, Shaklee R. & D., and Totco Oil Field R. & D.). If low-cost geothermal energy could be developed in eastern Oklahoma, it might be sufficient incentive to help promote commerical and industrial activities.

Field Project - Type B

The second type of field activity will involve an operation similar to that of Dave Chapman at the University of Utah. This is a temperature logging program using a portable logging device. We will use this program to supplement our Type A installations and to investigate additional areas of interest. Under this plan, we will again use industry holes-of-opportunity in which objective horizons have been properly plugged. We can maintain open-hole conditions for 30 days without restrictions. Where conditions warrant longer study, we can apply to the Oklahoma Corporation Commission for permission to keep boreholes open for research purposes.

We will use a portable temperature logging device to obtain a series of downhole measurements. After temperature measurements have been made, we will contract with a workover company to bring in a small portable rig to set cement plugs to protect the aquifers. Operators advise us that such a program will cost approximately $4500 - $5500 per site.

The portable unit will permit us to determine the extent of areas which appear to have geothermal potential based on Type A work. Because of the portability of the system, we will be able to investigate many areas made available to us by industry, including areas with moderate potential which may be located near population centers.

The technology and feasibility of this type of program is currently being evaluated by Dave Chapman and we will rely heavily on his experience. Our program however would routinely involve measurements in holes which might be a few thousand feet deep. Contacts with local operators lead us to anticipate industry cooperation with this program. We will be able to provide this service for those who might be interested in geothermal applications for at least the duration of the contract (using a reasonable system of priorities) and possibly for some period after the contract ends.

The sites for Type A and Type B work will be chosen by means of monitoring leasing and drilling activities in areas of interest. The Oklahoma Geological Survey has access to day-to-day drilling activity reports, locations of future drill sites, and completion data. We will go through this information on a daily basis until we find industry activity in or near areas of interest. At that point we will contact the owner/operator and solicit cooperation for our project.

Phase III. Enlightenment Program to Capitalize on Holes-of-Opportunity

About six thousand holes were drilled in Oklahoma last year in search of oil and gas. Of these, about one-half were nonproductive. This condition offers the possibility of developing geothermal energy from wells that would otherwise be plugged and abandoned. Potential users of geothermal energy would probably never bear the expense of drilling wells greater than a few hundred feet. With current drilling and completion costs, deep systems (a few thousand feet) might have a pay-out period of tens to hundreds of years. If however, a borehole drilled to ,say, 10,000 feet were made available for geothermal applications, the economics might be changed drastically. The cost of rig time at $4500-6000 per day has been absorbed by the petroleum industry thus a major expense of a deep geothermal application may be avoided. Such an example was noticed just 3 miles north of the Oklahoma Geological Survey building recently. A private school leased a commercial building in Norman near an oil field that is being developed. The depth of the field is such that spacing is on 160 acre units. Last year, a 12,000 foot dry hole was drilled within 400 yards of the private school. This provided a perfect opportunity to capitalize on petroleum industry activity in order to develop a geothermal system.

We propose to characterize typical "dry-holes" in areas of high geothermal gradients and in populated areas and present these data to firms which specialize in geothermal systems. Hopefully, we will find some degree of compatability between these holes-of-opportunity and existing systems. At that point, we would turn our findings over to an agency which would make potential users aware of opportunities in specific areas.

Summary

Much of the history and development of the petroleum industry is intertwined with that of Oklahoma. Many techniques developed in Oklahoma during the 1920's and 30's are routinely employed today on a world-wide basis. In

addition, several major oil and petroleum service companies have both their cooperate and R & D headquarters in Oklahoma. Thus, for many people, energy is synonymous with oil in Oklahoma. A moderately successful program in geothemal energy in Oklahoma could have a positive effect on national thinking about alternate sources of energy. The implication being that if regions with abundant fossil fuel resources can initiate and develop viable geothermal programs, then perhaps areas which are less endowed with sources of conventional energy should also consider such programs.

We believe the three phase program provides a good balance of (1) reconnaissance-level geothermal investigations, (2) site-specific field documentation of areas which appear to have geothermal potential, and (3) an attempt to make the public-at-large aware of geothermal potential via an enlightenment and "Chamber of Commerce" type campaign. We believe the position that Oklahoma enjoys with respect to the petroleum industry may help contribute to development of geothermal applications under conditions which would not be possible in other areas.

BUDGET FOR PHASE 1 (0-6 months)

		% FTE	Salary	Funds Requested
I.	Salaries & wages			
	A. Professional staff			
	(1) Geologist III (6 months)	50	$30,000	$15,000
	(2) Geologist I (3 months)	25	$21,000	$ 5,250
	B. Support personnel			
	(1) Map preparation			$ 1,200
	(2) Editorial processing			$ 200
	Total salaries & wages			$21,650
II.	Fringe benefits & overhead (approx.)			$17,105
III.	Equipment none			
IV.	Materials & supplies			
	A. Location maps (commercial service - 6 1:8000 panels @$150/ea.)			$ 900
	B. Xerox service (900 Logs, 4 feet each @$.20/foot)			$ 720
	C. Original (Blue-Line) logs (150 originals @$6.00/ea,)			$ 900
	D. Office supplies			$ 200
	Total Materials & supplies			$ 2,720
V.	Travel			
	A. Out-of-state			
	(1) Amarillo, TX - compile electric-log data (Texas Panhandle area) for projection into Oklahoma Panhandle			
	Meals & Lodging (10 working days)			$ 460
	Transportation			305

PHASE I - - continued

(2)	Wichita, KS - compile electric-log data (SW Kansas) for projection into Oklahoma Panhandle area	
	Meals & Lodging (10 working days)	$ 460
	Transportation	255
B.	In-State	
(1)	Norman - Oklahoma City	
	OCGS electric-log library (400 miles @0.17/mile	$ 68
(2)	Norman - Tulsa	
	TGS electric-log library	
	Meals & Lodging (10 working days)	$ 380
	480 miles @$0.17/mile	$ 82
	Total Travel	$ 2010
	TOTAL PHASE I BUDGET	$43,485

BUDGET FOR PHASE II (0-48 months)

Type A Field Activity - permanent temperature-monitoring stations in areas with maximum geothermal potential

		% FTE	Salary	Funds Requested
I.	Salaries & wages			
	A. Professional Staff			
	(1) Geologist III			
	1 - ¼ time for 4 years	100	$30,000	$34,300*
	1 - 1/3 time for 4 years	133	$30,000	$45,730*
	(2) Geologist I			
	1 - ½ time for 4 years	200	$21,000	$48,210*
	B. Support personnel			
	(1) Drilling Engineer (consultant) 2 days per site @$300/day			$ 1,200
	(2) Electronics technician 200 hours per site @$6.50/hr			$ 2,600
	(3) Secretary 1 - ¼ time for 4 years			$ 2,420
	(4) Editorial & drafting support (est.) 800 hours @$10/hr.			$ 8,000
	* projected 9% per year adjustment			
			Total Salaries & wages	$142,460
II.	Fringe benefits & overhead (approx.)			$112,542
III.	Equipment (rental) Rig cost (2 days/site @$4500-6000/day			$24,000
IV.	Materials & supplies (4 years)			
	A. Maps & completion data			$ 4,000
	B. Copy service & electric logs			$ 1,200
	C. Office supplies			$ 1,600
			Total materials & supplies	$ 6,800

PHASE II - - continued

V. Travel (4 years)

A. Out-of-state
National meetings, progress report sessions, etc. (1 meeting/year, 2 geologists) $ 8,000

B. In-state
(1) Norman-Type A sites
meals & lodging
(5 days/site, 2 sites, 2 geologists, 1 electronics technician) $ 960

10 site trips - 300 miles/trip @$0.17/mile $ 1,020

Total travel $ 9,980

TOTAL PHASE II (Type A) Budget $295,782

Type B Field Activity - monitoring temperature conditions of holes-of-opportunity via portable equipment

I. Salaries & wages

A. Professional staff - included in Type A work

B. Support personnel

Drilling Engineer (Consultant)
2 days/site @$300/day (15 sites) $9,000

Total salaries & wages $9,000

II. Fringe benefits & overhead

III. Equipment (rental)
Rig cost (workover rig @$120/hr)
24 hours/site - 15 sites (including expendable supplies & equipment) $43,200

IV. Material & Supplies - included in Type A work

V. Travel - partially incuded in Type A work

A. In - State
15 sites @$45/site/person for 2 people $1,350
15 trips - 300 miles/site @$0.17/mile 765

Total travel $2,115

TOTAL PHASE II (TYPE B) BUDGET $54,315

PHASE II FIELD EQUIPMENT BUDGET

Equipment required for Type A activity		
1)	(2) two-channel, AC-DC, strip-chart recorders @$750.00	$1,400
2)	Chart paper	500
3)	Digital voltmeter, AC-DC	1,000
4)	(4) Heavy duty, 12V marine storage battery, @$75.00	230
5)	8,000 feet of multi conductor cable @$1.00/ft	8,000
6)	(10) sacrificial temperature probes @$25.00	250
7)	(4) solid-state circuit boards @$100.00	400
Equipment required for Type B activity		
1)	Portable temperature logging device	$3,000
2)	Power winch assembly (with 5000' capacity)	$3,500
3)	Conductor/armour logging cable (4000' @$1.00/ft.)	$4,000
Miscellaneous		$2,000
	TOTAL EQUIPMENT BUDGET	$24,280

BUDGET FOR PHASE III (0-24 months)

		% FTE	Salary	Funds Requested
I.	Salaries & wages			
	A. Professional staff			
	(1) Geologist III 1-¼ time for 2 years	50	$30,000	$17.650*
	B. Support personnel			
	(1) Secretary 1-¼ time for 2 years	50		$ 1,210
	(2) Editorial & drafting support (est) 200 hours @$10.00/yr.			2,000
	* projected 9% per year adjustment			
			Total salaries & wages	$20,860
II.	Fringe benefits & overhead			$16,487
III.	Equipment - none			
IV.	Materials & Supplies			
	A. Office supplies			$ 600
V.	Travel			
	A. In-State 1000 miles/year (2 years) @$0.17/mile			$ 340
			TOTAL PHASE III BUDGET	$38,278

OKLAHOMA

M.2.25

STANDARD FORM 26, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41CFR) 1-16.101

AWARD/CONTRACT

PAGE 1 OF

1. CONTRACT (Proc. Inst. Ident.) NO.	2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST/PROJECT NO.	4. CERTIFIED FOR NATIONAL DEFENSE UNDER BDSA REG. 2 AND/OR DMS REG. 1. RATING:
DE-AS07-80ID12172	9-30-80	07-80ID12172.000	

5. ISSUED BY CODE
U. S. Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

6. ADMINISTERED BY (If other than block 5) CODE

7. DELIVERY
☐ FOB DESTINATION
☐ OTHER (See below)

8. CONTRACTOR NAME AND ADDRESS (Street, city, county, State, and ZIP code) CODE FACILITY CODE
The University of Oklahoma
Office of Research Administration
1000 Asp, Room 314
Norman, Oklahoma 73019
Attn: Taylor C. Anthony

9. DISCOUNT FOR PROMPT PAYMENT

10. SUBMIT INVOICES (4 copies unless otherwise specified) TO ADDRESS SHOWN IN BLOCK 5
Attn: Contracts Mgt. Div.

11. SHIP TO/MARK FOR CODE

12. PAYMENT WILL BE MADE BY CODE
See Block 5

13. THIS PROCUREMENT WAS ☐ ADVERTISED, ☐ NEGOTIATED, PURSUANT TO:
☐ 10 U.S.C. 2304 (a)( )
☒ 41 U.S.C. 252 (c)(5)

14. ACCOUNTING AND APPROPRIATION DATA
B&R: 35AM15 A/S: 89X0225.40 Obj. Cl.: 310
AM15-10 A/S: ID-05-40

15. ITEM NO.	16. SUPPLIES/SERVICES	17. QUANTITY	18. UNIT	19. UNIT PRICE	20. AMOUNT
1.	Contract with Schedule Articles				
2.	Appendix A, Contract Terms				
3.	Appendix B, General Provisions				
4.	Appendix C, Statement of Costs				
5.	Appendix D, Reporting Requirements				

21. TOTAL AMOUNT OF CONTRACT $ 118,981.00

CONTRACTING OFFICER WILL COMPLETE BLOCK 22 OR 26 AS APPLICABLE

22. ☒ CONTRACTOR'S NEGOTIATED AGREEMENT (Contractor is required to sign this document and return 2 copies to issuing office.) Contractor agrees to furnish and deliver all items or perform all the services set forth or otherwise identified above and on any continuation sheets for the consideration stated herein. The rights and obligations of the parties to this contract shall be subject to and governed by the following documents: (a) this award/contract, (b) the solicitation, if any, and (c) such provisions, representations, certifications, and specifications, as are attached or incorporated by reference herein. (Attachments are listed herein.)

26. ☐ AWARD (Contractor is not required to sign this document.) Your offer on Solicitation Number _____ including the additions or changes made by you which additions or changes are set forth in full above, is hereby accepted as to the items listed above and on any continuation sheets. This award consummates the contract which consists of the following documents: (a) the Government's solicitation and your offer, and (b) this award/contract. No further contractual document is necessary.

23. NAME OF CONTRACTOR University of Oklahoma
BY _____ (Signature of person authorized to sign)

27. UNITED STATES OF AMERICA
BY J. F. Marmo (Signature of Contracting Officer)

24. NAME AND TITLE OF SIGNER (Type or print)	25. DATE SIGNED	28. NAME OF CONTRACTING OFFICER (Type or print)	29. DATE SIGNED
Charles W. Goff, Director, Grants and Contracts Administration	9-29-80	J. F. Marmo	9/23/80

26-103-01

☆ U.S. GOVERNMENT PRINTING OFFICE : 1966 O—236-449

Contract No. DE-AS07-80ID12172

CONTRACT BETWEEN

THE UNIVERSITY OF OKLAHOMA

AND

THE DEPARTMENT OF ENERGY

THIS CONTRACT is between the UNITED STATES OF AMERICA (hereinafter referred to as the "Government"), acting through the U.S. DEPARTMENT OF ENERGY (hereinafter referred to as "DOE"), and The UNIVERSITY OF OKLAHOMA (hereinafter referred to as the "Contractor"). The parties hereto agree as follows:

ARTICLE I - THE RESEARCH TO BE PERFORMED

(a) The Contractor shall furnish personnel, facilities, equipment, materials, supplies, and services, except such as are furnished by the Government, necessary for the performance of the research provided for in Appendix A and shall perform the research and report thereon pursuant to the provisions of this contract. It is understood that Appendix A, a guide to the performance of this contract, may be deviated from by the Contractor subject to the specific requirements of this contract.

(b) This work shall be conducted under the direction of William E. Harrison or such other member of the Contractor's staff as may be mutually satisifactory to the parties.

ARTICLE II - THE PERIOD OF PERFORMANCE

The period of performance under this contract shall commence on September 30, 1980 and expire on October 1, 1981. Performance may be extended for additional periods by the mutual written agreement of the parties.

ARTICLE III - CONSIDERATIONS

(a) In full consideration of the Contractor's performance hereunder, DOE shall pay the Contractor the sum of One Hundred Eighteen Thousand Nine Hundred Eighty-One Dollars ($118,981.00), hereinafter called the Government "Ceiling," which sum shall be subject to adjustment as hereinafter provided.

(b) Payments to the Contractor shall equal the "cumulative Government cost" of the performance of this contract, as the term "cumulative Government cost" is defined in Article B-V, provided however, and notwithstanding any other provision of this contract, that the Government's monetary liability under this contract shall not exceed the Government ceiling or an amount equal to the cumulative Government cost, whichever is less. The Contractor shall be

ARTICLE III - CONSIDERATIONS

obligated to perform under this contract throughout the agreed-upon period of performance, and to bear all costs which DOE has not agreed to pay, provided however, that the Contractor shall have the right to cease to perform the research provided for in this contract, upon written notice to DOE to that effect, at any time, when or after the cumulative Government cost equals or exceeds the Government ceiling.

(c) The Government ceiling specified in paragraph (a) above may be increased unilaterally by DOE by written notice to the Contractor and may be increased or decreased by written agreement of the parties. In the event the stated period of contract performance is extended, the Government ceiling will be revised to reflect any increased DOE funding for the extended period or periods.

(d) Upon termination or expiration of the total period of performance, the Contractor shall promptly refund to DOE (or make such disposition as DOE may in writing direct) any sums paid by DOE to the Contractor under this contract, through direct payment or under letter of credit, in excess of the cumulative Government cost incurred in performance under the contract.

ARTICLE IV - GOVERNMENT PROPERTY

The following items of property procured or fabricated by the Contractor are hereby listed as "Government property":

1. (2) Two-channel, AC-DC, strip chart recorders
2. Digital Voltmeter, AC-DC.
3. (4) Heavy duty, 12 V marine storage batteries
4. 2000 ft of multi-conductor cable
5. 2 solid-state circuit boards
6. Portable temperature logging device
7. Power winch assembly (with 5000 ft capacity)
8. 4000 ft conductor/armour logging cable

ARTICLE V - APPENDICES

Appendix A, Appendix B - General Provisions, Appendix C, Statement of Costs, and Appendix D, Reporting Requirements are hereby attached to and made a part of this contract.

APPENDIX A

CONTRACTOR: The University of Oklahoma

For the contract period from September 30, 1980 through October 1, 1981.

Article A-I - RESEARCH TO BE PERFORMED BY CONTRACTOR

The scope of work under this contract is unclassified, and the Contractor under this contract with the Department of Energy will perform research consisting of the following:

The University of Oklahoma will begin a Geothermal Resource Assessment Program in Oklahoma. The work will include:

Task 1

Compile and interpret information on electric log headings for the preparation of the geothermal gradient map. The products generated through this activity will be:

a. A 1:500,000 geothermal gradient map for the State of Oklahoma.

b. A brief manuscript describing the interpretation of map data and the methodology employed in construction of the geothermal gradient map.

Task 2

Area-specific studies of the most promising geothermal prospects will be conducted in Oklahoma. Initially, the areas of Pittsburgh and Haskell Counties will be investigated, although additional areas of interest to the geothermal program will be identified. Two types of programs will support this study:

a. A thermal equilibrium study will be conducted in a geothermal prospect. A downhole thermistor will be cemented in a hole-of-opportunity in order to obtain a continuous record of thermal equilibration of the borehole. The hole will be plugged in accordance with state regulations. This study will provide information about the following areas: (1) the relation between industry log-heading temperatures and true formation temperatures, (2) effect of lithology on thermal conductivity, and (3) variation in heat transmissivity as a function of petrophysical characteristics. A report summarizing the results and recommendations of this experimental study will be provided as a product of this work.

b. A temperature logging program throughout Oklahoma will be initiated. Using a portable retrievable temperature logging device, a series of downhole measurements will be made on holes-of-opportunity throughout the state. Cement plugs will be set in those holes upon completion of the measurements. The product of this study will be a detailed report of the geothermal potential of each area-specific study. Information such as surface and subsurface structure, lithology, petrophysics, thermal conductivity, unit isopachs, cross sections, and facies maps shall be produced.

Article A-II - WAYS AND MEANS OF PERFORMANCE

(a) Items for which funding will be provided as indicated in A-III includes the following:

		PHASE I & II	
	DOE	Contractor	Total
Salaries			
Geologist III - 6 mo. @ 2,500/mo.	11,875	3,125	15,000
Geologist I - 12 mo. + 4.8 mo. @ 1666.67/mo.	28,000		28,000
Support Personnel:			
Map Preparer	1,200		1,200
Editing	200		200
Electronics Tech. 220 Hr. @ 6.50/Hr.	1,430		1,430
Consultants:			
Drilling Engr. 2 days @ 300/day	600		600
Fringe Benefits @ 23%	9,822	719	10,541
Indirect Cost @ 26% of total direct salaries for off-campus research	21,388	813	22,201
Travel, 4909 mi @ .20/mi.	982		982
Per Diem 48 @ 41.33/day	1,984		1,984

	DOE	Contractor	Total
Other Direct Costs			
Materials & Supplies	3,670		3,670
Equipment Rental 5 days @ 4500	22,500		22,500
Equipment	15,330		15,330
	118,981	4,657	123,638

(b) Items, if any, significant to the performance of this contract, but excluded from computation of Government Cost and from consideration in proportioning costs:

None

(c) Time or effort of principal investigator(s) contributed by the Contractor but excluded from computation of Government cost and consideration in proportioning costs:

None

Article A-III - FUNDING

The total cost of items under A-II(a) above for the contract period stated in this Appendix A is One Hundred Twenty-Three Thousand Six Hundred Thirty-Eight Dollars ($123,638) of which the Government share is One Hundred Eighteen Thousand Nine Hundred Eighty-One Dollars ($118,981). DOE will pay 100% of the actual costs of these items identified in Article A-II(a) above as its share which are incurred during the contract period stated in the Appendix A, subject to the provisions of Article III and Article B-V.

The estimated Government cost is funded as follows:

(a) Estimated unexpended balance from prior period(s) $ -0-

(b) New funds for the current period $118,981

Article A-IV - ADMINISTRATION AND REPORTS

(a) Principal Investigator - William E. Harrison
Oklahoma Geological Survey
The University of Oklahoma
830 S. Oval
Norman, Oklahoma 73019
(405) 325-2835

Technical Administrator - M. A. Widmayer
(DOE's Project Manager) U.S. Department of Energy
Energy and Technology Division
550 Second Street
Idaho Falls, ID 83401
(208) 526-1466

The Principal Investigator shall be responsible for directing the work within the scope of Article A-I above as outlined in discussions and in periodic letters from the Technical Administrator.

(b) The Principal Investigator is responsible for the preparation and submission of reports to the Technical Administrator in accordance with Appendix D, DOE Form CR-537, which is made a part hereof by this reference.

F.le M.2.25

OKLAHOMA GEOLOGICAL SURVEY

7-22-81

- Mod no cost time extension 3 months
- Wrote a letter giving approval of the money. Doesn't increase A Mod

Charles J. Mankin, Director

July 2, 1981

Ms. Maggie Widmayer
U.S. Department of Energy
550 2nd Street
Idaho Falls, Idaho 83401

Dear Maggie:

The Geothermal Resources Appraisal Program being conducted under contract DE-AS07-80ID12172 calls for $22,500 in contract drilling and completion work. Such work was to have been conducted on industry holes-of-opportunity in order to install sacrificial downhole temperature sensors in areas where geothermal anomalies exist. Although we identified several wells in these areas and contacted several operators about emplacing our sensors, we have yet to make such an installation. The basic reasons for this situation are twofold. First of all, operators are currently completing wells which have initial potential as low as 70,000 cfgd. It is difficult to drill holes in some parts of southeastern Oklahoma and not encounter such quantitites of gas. On two occassions, we have missed holes-of-opportunity because of timing problems. Because we cannot interfere with field operations (rig costs are $4000-5000/day), we have been prepared to respond when contacted by operators. We missed one opportunity when operator personnel failed to contact us after the hole was declared to be noncommercial. We also missed a hole-of-opportunity when most of the Oklahoma Geological Survey staff members were attending a national meeting.

In order to exercise more control over our sacrificial probe installations, we request permission to make a minor change in our program. The Oklahoma Geological Survey is acquiring a truck-mounted rig capable of doing the drilling required for the installation of our temperature sensors. We propose to use OGS equipment to re-enter D&A (dry and abandoned) boreholes and thus not rely exclusively on currently-drilling wells for holes-of-opportunity. We would like to use the $22,5000 (originally identified as contract drilling funds) to support our own drilling operations (over which we would have absolute control).

It is unlikely that we could encumber these funds by the end of our contract period so we also request a 90-day no-cost extension for our existing program. We anticipate that the major components (gradient map and subsurface investigations) of our present program will be on schedule and the sacrifical probe exercise and the gravity and magnetics studies will be the only work not completed by October.

We would also like to reserve the right to pursue our sacrificial probe program sequentially. That is, follow up interesting results with additional installations. Under such conditions, the Oklahoma Geological Survey would bear drilling expenses in excess of the $22,500.

Please consider this minor change in our program and advise

us as to your thoughts on this matter. Contact us if you have questions or comments.

Sincerely,

Bill

William E. Harrison

WEH:mm

D. Foley

A Proposal to Renew

Contract DE-AS07-80ID12172

Entitled

Geothermal Resource Assessment in Oklahoma

Prepared by

Dr. William E. Harrison
Staff Geologist
Oklahoma Geological Survey

Submitted by

Office of Research Administration
University of Oklahoma
1000 Asp, Rm 314
Norman, Oklahoma 73019

July 1981

ENDORSEMENTS

William E. Harrison
Geologist
Oklahoma Geological Survey

Charles J. Mankin
Director
Oklahoma Geological Survey

Taylor C. Anthony
Director
Office of Research Administration

Date

The Oklahoma Geological Survey is currently working under Contract DE-AS07-80ID12172, to assess the geothermal potential of the state. The two major products which will result from this activity are (1) a 1:500,000 geothermal gradient map of Oklahoma and an accompanying short text and (2) site-specific evaluation of areas which appear to have geothermal potential. Except for some difficulties in our sacrificial probe installations, this work is approximately on schedule and we anticipate no serious difficulties in meeting our commitments.

The geothermal gradient map which is being prepared involves the use of industry log-heading temperature information, as well as data obtained from the Oklahoma Corporation Commission. The resultant map will be the best compilation currently available for the State of Oklahoma, but will still be subject to the inconsistencies of industry data. Because of this, we predict that a provence-by-province correction factor will have to be applied to the gradients determined from our map. We feel that such a correction will be somewhat systematic but we will have no way of being certain about this until we have done confirmation work via downhole sacrificial temperature probes. The basic reason for such an approach lies in the fact that our present project is based on non-equilibrated temperature measurements, i.e., industry data.

A geothermal gradient map based on equilibrated temperature data would be much more valuable than the map currently being prepared because regional corrections would not be necessary. Individuals and organizations interested in geothermal applications in Oklahoma would be able to make site-specific evaluations from such a geothermal gradient map.

The Oklahoma Geological Survey is in the process of acquiring a truck-mounted drilling rig which can operate at depths of 1600 feet. Such a rig would be capable of drilling out the surface cement plugs of D&A (dry and abandoned) boreholes throughout the State. Regulations require that operators leave surface casing in the ground and call for 50-foot cement plugs at the top and bottom of the casing. Wells in Oklahoma may have surface casing which varies in depth from a few hundred feet to a few thousand feet. We propose to re-enter D&A boreholes drilled within the last 5-15 years and obtain temperature measurements. Drilling out the surface plug should have no effect at lower horizons and

these wells will have had several years to come to equlibrated temperatures. Our program would involve the following:

1) Locating D&A boreholes by means of maps in our files and choosing holes with adequate depths of surface casing.

2) Using a metal detector to accurately locate the surface casing (which may vary from 9 1/2 to 12 1/2 inches in diameter). This method is currently being used by operators who re-enter D&A holes for testing deeper horizons.

3) We will attach a sleeve to the old casing to permit drilling out the surface plug.

4) We will lower a retrievable temperature logging device and obtain an equilibrated temperature measurement. We are using this logging unit (3000 foot capability) at present.

5) We will set another surface plug and restore the site in accordance with regulations.

We will gain valuable experience for the type of work described above later this year when we will install several sacrificial temperature probes. We will use OGS drilling equipment to make these installations and should be able to make a reliable estimate as to the time and effort involved in such a program.

We propose to obtain a minimum of one equilibrated temperature measurement per county (except where suitable boreholes are not present). Experience gained under our existing program may modify this program somewhat. We will also attempt to supplement the program by making temperature measurements in residential water wells. We will restrict such measurements to wells which have depths in excess of 200-300 feet.

In summary, we believe that a systematic program of obtaining equilibrated temperature measurements throughout the state will result in the best geothermal gradient map possible. Such a program will complement our current efforts, especially our sacrificial probe work, and provide a data base which potential users of geothermal energy may use with confidence (i.e., without correcting industry temperature information).

Athough we will be in a better position to make time and cost estimates in a few months, we presently feel such a program can be conducted as described on the following page.

BUDGET REQUEST
Year beginning October 1, 1981

		Cost
I.	SALARIES AND WAGES	
	A. Geologist III 11.5 mos @ $3,000/mo.	$ 34,500
	B. Geologist I 12 mos @ $1,750/mo.	21,000
	C. Support Personnel	
	1. Cartography - 150 hrs @ $10/hr.	1,500
	2. Electronics Technician - 400 hrs @ $6.50/hr	2,600
	3. Field Technician/Driller - 4 mos @ $1,500/mo.	6,000
	Total Salaries	$ 65,600
II.	FRINGE BENEFITS - 23% x Salaries and Wages	$ 15,088
III.	TRAVEL	
	A. Mileage - 10,000 miles @ 22¢/mi	$ 2,200
	B. Per Diem - 60 field days x 2 persons x $34/day	4,080
IV.	SUPPLIES - bits, hoses, cement and other expendibles	$ 2,960
V.	RIG TIME - based on current workover rig costs of $100/hr. 6 hrs/site x 77 sites (counties) x $100/hr	$ 46,200
	Total Direct Costs	$136,128
VI.	INDIRECT COSTS - 39% x Modified Total Direct Costs HHS Agreement of May 9, 1980	$ 53,090
	Total Project Costs	$189,218
	Less O.U. Cost Sharing	
	- Rig Time	- 46,200
	- Associated Indirect Costs	- 18,018
	Total Dept. of Energy Request	$125,000

Dept. of Energy Share = 66.1%
O.U. Share = 33.9%

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

PAGE 1 OF

1. AMENDMENT/MODIFICATION NO.	2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST NO.	4. PROJECT NO. (If applicable)
M001	10-1-81	07-81-ID12172.501	

5. ISSUED BY CODE
U. S. Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

6. ADMINISTERED BY (If other than block 5) CODE

7. CONTRACTOR NAME AND ADDRESS (Street, city, county, state, and ZIP Code) CODE FACILITY CODE
The University of Oklahoma
Office of Research Administration
1000 Asp, Room 314
Norman, Oklahoma 73019

8.
☐ AMENDMENT OF SOLICITATION NO. _____,
DATED _____ (See block 9)
☒ MODIFICATION OF CONTRACT/ORDER NO. DE-AS07-80ID12172
DATED 9-30-80 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning _____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10 ACCOUNTING AND APPROPRIATION DATA (If required)

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) ☐ This Change Order is issued pursuant to _____
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) ☒ This Supplemental Agreement is entered into pursuant to authority of mutual agreement of the Parties
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

Article II - THE PERIOD OF PERFORMANCE is hereby revised to extend the period from October 1, 1981 to December 31, 1981.

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13.
☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 2 COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR	17. UNITED STATES OF AMERICA
BY Taylor C. Anthony (Signature of person authorized to sign)	BY Preston B Brimhall (Signature of Contracting Officer)
15. NAME AND TITLE OF SIGNER (Type or print)	16. DATE SIGNED
Taylor C. Anthony, Director Office of Research Administration	10-7-81
18. NAME OF CONTRACTING OFFICER (Type or print)	19. DATE SIGNED
Preston B. Brimhall	10/1/81

30-101

☆ U.S.GPO:1980-0-311-153/5520

OKLAHOMA
U. OF
MOD - TASKS & $ & TIME
125 000 12/31/82

ROUTING AND TRANSMITTAL SLIP

Date 1-18-82

TO: (Name, office symbol, room number, building, Agency/Post)	Initials	Date
1. L. M. Prestwich		
2.		
3.		
4.		
5.		

Action	File	Note and Return
Approval	For Clearance	Per Conversation
As Requested	For Correction	Prepare Reply
Circulate	For Your Information	See Me
Comment	Investigate	Signature
Coordination	Justify	

REMARKS

Attached is copy of Modification No. A002
to Contract No. DE-AS07-80ID12172.

DO NOT use this form as a RECORD of approvals, concurrences, disposals, clearances, and similar actions

FROM: (Name, org. symbol, Agency/Post)	Room No.—Bldg.
E. M. Heptig R & D Contracts Branch	Phone No. 6-1229

5041-102

OPTIONAL FORM 41 (Rev. 7-76)
Prescribed by GSA
FPMR (41 CFR) 101-11.206

M2-25

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

PAGE 1 OF

1. AMENDMENT/MODIFICATION NO.	2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST NO.	4. PROJECT NO. (If applicable)
A002	1-1-82	07-82ID12172.501	

5. ISSUED BY CODE

U. S. Department of Energy
550 Second Street
Idaho Falls, Idaho 83401

6. ADMINISTERED BY (If other than block 5) CODE

7. CONTRACTOR NAME AND ADDRESS (Street, city, county, state, and ZIP Code) CODE FACILITY CODE

University of Oklahoma
Office of Research Administration
1000 Asp, Room 314
Norman, Oklahoma 73019

8.
☐ AMENDMENT OF SOLICITATION NO. _____,
DATED _____ (See block 9)
☒ MODIFICATION OF CONTRACT/ORDER NO. DE-AS07-80ID12172
DATED 9-30-80 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods: (a) By signing and returning _____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

89X0224.91	250	$125,000
ID-14-91	AM1510	

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) ☐ This Change Order is issued pursuant to _____
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) ☒ This Supplemental Agreement is entered into pursuant to authority of Public Law 95-91 et al.
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

1. Article I - THE RESEARCH TO BE PERFORMED is revised to add "and Appendix A1" whenever Appendix A is referenced.

2. Article II - THE PERIOD OF PERFORMANCE is revised to extend the performance period from December 31, 1981 to December 31, 1982.

3. Article III - CONSIDERATIONS, Paragraph (a) is revised to increase the Government ceiling from $118,981.00 to Two Hundred Forty-Three Thousand Nine Hundred and Eighty-One Dollars ($243,981.00).

4. Article V - APPENDICES is revised to add Appendix A1.

5. Paragraph (a), Article A-II of Appendix A is revised to read as follows:

(a) Items for which funding will be provided as indicated in A-III includes the following:

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 3 COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR	17. UNITED STATES OF AMERICA
BY _____ (Signature of person authorized to sign)	BY William C. Drake (Signature of Contracting Officer)
15. NAME AND TITLE OF SIGNER (Type or print) Charles W. Goff, Director, Grants & Contracts Admin.	16. DATE SIGNED 1-12-82
18. NAME OF CONTRACTING OFFICER (Type or print) William C. Drake	19. DATE SIGNED 12/31/81

UNIVERSITY OF OKLAHOMA

30-101

☆ U.S.GPO:1980-0-311-153/5520

	DOE	Contractor	Total
Salaries:			
Geologist III - 12 Mo. @ $2,500/mo.	$ 26,912	$ 3,125	$ 30,037
Geologist I - 20 Mo. @ $1,667/mo.	32,881		32,881
Support Personnel:			
Cartography	1,200		1,200
Editing	200		200
Electronics Tech. 598 hrs. @ $6.50/hr.	3,888		3,888
Clerical	124		124
Consultants:			
Drilling Engr. 2 days @ 300/day	600		600
Fringe Benefits @ 23%	9,822	5,894	15,716
Travel - 4,909 mi. @ .20/mi.	982		982
Per Diem 48 @ $41.33/day	1,984		1,984
Material and Supplies	3,670		3,670
Equipment	15,330		15,330
Indirect Cost @ 26% of MTDC	21,388	2,345	23,733
	$118,981	$11,364	$130,345

6. The attached DOE Form CR-537 is hereby substituted for that attached to the original Agreement as Appendix D.

Contract No. DE-AS07-80ID12172
Modification No. A002

APPENDIX A1

CONTRACTOR: The University of Oklahoma

For the contract period from January 1, 1982 through December 31, 1982.

ARTICLE A-I - RESEARCH TO BE PERFORMED BY CONTRACTOR

The scope of work under this contract is unclassified, and the Contractor under this contract with the Department of Energy will perform research consisting of the following:

An equilibrated temperature data base will be produced by re-entering a minimum of one dry and abandoned well per county and obtaining temperature measurements. The data obtained shall be used to determine a correction factor to equilibrate temperature data for the geothermal gradient map of Oklahoma.

ARTICLE A-II - WAYS AND MEANS OF PERFORMANCE

(a) Items for which funding will be provided as indicated in A-III includes the following:

	PHASE I & II		
	DOE	Contractor	Total
Salaries			
Geologist III - 11.5 mo. @ 3,000/mo.	$ 34,500		$ 34,500
Geologist I - 12 mo. @ 1,750/mo.	21,000		21,000
Support Personnel:			
Cartography 150 Hrs. @ $10/Hr.	1,500		1,500
Electronics Tech. 400 Hr. @ 6.50/Hr.	2,600		2,600
Field Tech. 4 Mos. @ 1,500/Mo.	6,000		6,000
Fringe Benefits @ 22%	14,432		14,432
Travel, 10,000 mi. @ .22/mi.	2,200		2,200
Per Diem 120 @ .34/day	4,080		4,080

ARTICLE A-II - WAYS AND MEANS OF PERFORMANCE (Cont'd)

	DOE	Contractor	Total
Other Direct Costs			
Materials & Supplies	3,616		3,616
Rig Time 462 Hrs. @ 100/Hr.		$ 46,200	46,200
Indirect Cost @ 39% of MTDC	35,072	18,018	53,090
Total	$125,000	$ 64,218	$189,218

(b) Items, if any, significant to the performance of this contract, but excluded from computation of Government Cost and from consideration in proportioning costs:

None

(c) Time or effort of principal investigator(s) contributed by the Contractor but excluded from computation of Government cost and consideration in proportioning costs:

None

ARTICLE A-III - Funding

The total cost of items under A-II(a) above for the contract period stated in this Appendix A1 is One Hundred Eighty-Nine Thousand Two Hundred Eighteen Dollars ($189,218) of which the government share is One Hundred Twenty-Five Thousand Dollars ($125,000). DOE will pay 100% of the actual costs of these items identified in Article A-II(a) above as its share which are incurred during the contract period stated in the Appendix A, subject to the provisions of Article III and Article B-V.

The estimated Government cost is funded as follows:

(a) Estimated unexpended balance from prior period(s)	$ -0-
(b) New funds for the current period	$125,000

ARTICLE A-IV - ADMINISTRATION AND REPORTS

(a) Principal Investigator - William E. Harrison
Oklahoma Geological Survey
The University of Oklahoma
830 S. Oval
Norman, Oklahoma 73019
(405) 325-2835

Technical Administrator - S. M. Prestwich
(DOE's Project Manager) U.S. Department of Energy
Energy and Technology Division
550 Second Street
Idaho Falls, ID 83401
(208) 526-1147

The Principal Investigator shall be responsible for directing the work within the scope of Article A-I above as outlined in discussions and in periodic letters from the Technical Administrator.

(b) The Principal Investigator is responsible for the preparation and submission of reports to the Technical Administrator in accordance with Appendix D, DOE Form CR-537, which is made a part hereof by this reference.

U. S. DEPARTMENT OF ENERGY

REPORTING REQUIREMENTS CHECKLIST

DOE Form CR-537 (1-78)

(See Instructions on Reverse)

FORM APPROVED OMB NO. 38R-0190

1. IDENTIFICATION Geothermal Resource Assessment in Oklahoma	2. OBLIGATION INSTRUMENT: Modification No. A002 to Contract No. DE-AS07-80ID12172

3. REPORTING REQUIREMENTS

A. PROJECT MANAGEMENT	Frequency
1. ☐ Management Plan	
2. ☐ Milestone Schedule & Status Report	
3. ☐ Cost Plan	
4. ☐ Manpower Plan	
5. ☒ Contract Management Summary Report	M
6. ☒ Project Status Report	M
7. ☐ Cost Management Report	
8. ☐ Manpower Management Report	
9. ☐ Conference Record	
10. ☐ Hot Line Report	

B. TECHNICAL INFORMATION REPORTING	Frequency
1. ☒ Notice of Energy RD&D Project (SSIE)	0
2. ☐ Technical Progress Report	
3. ☒ Topical Report	A
4. ☒ Final Technical Report	Y
C. PMS/MINI-PMS	
1. Cost Performance Report	
☐ Format 1 WBS	
☐ Format 2 Functional	
☐ Format 3 Baseline	
☐ Format 5 Problem Analysis	
2. ☐ Cost/Schedule Status Report	
3. ☐ Management Control System Description	
4. ☐ Summary System Description	
5. ☐ WBS Dictionary	

FREQUENCY CODES:
A – As Required
C – Contract Change
F – Final (End of Contract)
M – Monthly
O – One Time (Soon After Contract Award)
Q – Quarterly
S – Semi-Annually
X – Mandatory for Delivery with Proposals/Bid
Y – Yearly or Upon Contract Renewal

4. SPECIAL INSTRUCTIONS

A.5., A.6. - Copies are due within fifteen days after end of the calendar month.

B.3. - Submit in draft after completion of work as indicated in Statement of Work. After DOE approval is received, submit copies as required on attached "Report Distribution List."

b.4. - Submit 2 copies in draft forty-five days prior to completion date of contract term. After DOE approval is received, submit in final including one camera-ready copy.

5. ATTACHED HEREWITH:

☒ Report Distribution List ☐
☐ WBS/Reporting Category ☐

6. PREPARED BY (Signature and date): Elizabeth Hyster	7. REVIEWED BY (Signature and date):

ID F-129 (Rev. 08-79)
Ref. DOE 13302
(use with DOE CR-537)

U.S. DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE

REPORT DISTRIBUTION LIST

Contract No.

DE-AS07-80ID12172

Addressees	Milestone Schedule & Status Report	Management Plan	Contract Management Summary Report	Cost Plan	Project Status Report	Manpower Plan	Cost Management Report	Manpower Management Report	Conference Record	Notice of Energy RD&D Project (SSIE)	Hot Line Report	Technical Progress Report	Final Technical Report	Topical Report	Cost Performance Report	Cost/Schedule Status Report	Management Control System Description	Summary System Description	WBS Dictionary
	Number of Report Copies																		
U. S. Department of Energy Idaho Operations Office 550 Second Street Idaho Falls, Idaho 83401																			
Attn: Susan Prestwich, Program Mgr. Energy & Technology Div.					2	2									2	12			
Attn: E. M. Hyster Contracts Management Division					1	1								1	1	1			
Attn: E. G. Jones, Director Financial Management Division					1														
Charles Bufe U. S. Department of Energy, DGE 1000 Independence Ave., S.W. Forrestal Bldg., Room 5G-030 Mail Stop 6B-025 Washington, D. C. 20585					2	2									2	2			
Duncan Foley UURI 420 Chipeta Way, Suite 120 Salt Lake City, UT 84108					1	1									1	1			

Special Instructions

X 2/16/83

DOE FORM PR-799A (TEST)
20 AUGUST 1978

U. S. DEPARTMENT OF ENERGY

PROCUREMENT/FINANCIAL ASSISTANCE REQUEST - AUTHORIZATION

1. TO CMD

2. FROM INITIATING OFFICE E&T Geothermal

3. INITIAL: [Y] UPDATE: [ ] 4. PROCUREMENT: [ ] FINANCIAL ASSISTANCE: [ ]

5. PR NUMBER: _____ 6. PR CORRECTION LETTER: _ 7. RELATED PR NUMBER: _____

ACTION IDENTIFICATION

8. TITLE: Oklahoma State Resource Assessment
NCTE modification to DE-AS07-80ID12172

9. UNSOLICITED PROPOSAL NO: _____ 10. PROJECT NO: _____ 11. CFDA NO: _____

12. PRODUCT OR SERVICE:* ____ 13. SUPPORT SERVICES: YES [ ] NO [ ] 14. CONSULTANT AWARD: YES [ ] NO [ ]

15. CONTROLLED DELIVERABLE:* ___ 16. REPORT/DRAWING REQ: YES [ ] NO [ ] IF YES, ATTACH DETAILS.

17. CLASSIFICATION OF MATERIALS/WORK: _ U — UNCLASSIFIED C — CONFIDENTIAL S — SECRET T — TOP SECRET

18. GOVERNMENT PROPERTY: _ F — FURNISHED P — PURCHASED N — NOT INVOLVED * IF CODE F OR P, ATTACH DETAILS.

AWARD PLANNING

19. AWARD AS ORDER UNDER BIN: _____ IF CODE T, ATTACH DETAILS.

20. DESIRED AWARD DATE: __ (MONTH) __ (DAY) __ (YEAR) 21. KIND OF AWARD ACTION:* __ 22. TYPE OF AWARD:* _

23. IF MULTI-YEAR AWARD, INDICATE NUMBER OF YEARS: _ 24. TYPE SOLICITATION INSTRUMENT: * __

25. EXTENT OF COMPETITION:* __ IF COMPETITIVE, ATTACH TECHNICAL EVALUATION PLAN. IF NON-COMPETITIVE, ATTACH JUSTIFICATION. REF: DOE-PR 9-3.805.51 or 9-4.909(f).

26. SOURCE SELECTION PROCEDURE: _ 1 — A-E 2 — SEB 3 — OTHER 4 — NONE

27. FOR A-E, SHOW ESTIMATED CONSTRUCTION COST IN DOLLARS: _____

AWARDEE

IF COMPETITIVE, HAS LIST OF SOURCES BEEN ATTACHED? YES [ ] NO [ ] IF NON-COMPETITIVE, COMPLETE 28 - 31.

28. NAME: University of Oklahoma 29. ADDRESS: Norman, OK
ATTN PI KEN LUZA

30. DIVISION: Oklahoma Geological Survey

31. GOCO/LAB: _ A — GOCO/LAB B — GOCO/NON-LAB C — NON-GOCO/LAB D — NOT APPLICABLE

FINANCIAL

AWARD VALUE

	DOLLAR AMOUNT
32. GOV'T SHARE	-0-
33. TOTAL	

34. CONSIDERATION IN KIND, LOAN, OR LOAN GUARANTEE DATA REPORTED ON PR—799C: [ ]

35. PROJECT PERIOD: FROM 12 (MONTH) 31 (DAY) 82 (YEAR) THRU 6 (MONTH) 30 (DAY) 83 (YEAR)

CURRENT FY FUNDS COMMITTED

36. B&R NUMBER	37. FUND CLASS	38. DOLLAR AMOUNT
_____	_	-0-
_____	_	_____
_____	_	_____

39. FROM PR—799B (PART A) _____

40. TOTAL THIS PR -0-

41. FUNDING PERIOD: FROM __ (MONTH) __ (DAY) __ (YEAR) THRU __ (MONTH) __ (DAY) __ (YEAR)

42. APPROPRIATION SYMBOL: _____

43. ALLOTMENT SYMBOL: _____

44. OBJECT CLASS: ____

* SEE BACK OF FORM FOR CODES

PROJECT MANAGER

45. NAME: S.M. Prestwich

46. SIGNATURE: S.M. Prestwich

47. DATE: 12 (MONTH) 15 (DAY) 82 (YEAR) 48. OFFICE CODE: _____

49. FTS TELEPHONE NUMBER: _____

PROGRAM OFFICIAL

50. NAME: R.E. Wood

51. SIGNATURE: _____

52. DATE: __ (MONTH) __ (DAY) __ (YEAR)

CERTIFYING OFFICIAL

53. NAME: F. S. Smith

I HEREBY CERTIFY THAT THE FUNDS CITED IN ITEM 40 ARE AVAILABLE.

54. SIGNATURE: _____

55. DATE: __ (MONTH) __ (DAY) __ (YEAR)

The University of Oklahoma at Norman

Office of Research Administration

November 16, 1982

Department of Energy
Contracts Management Division
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

Attention: William C. Drake
Contracting Officer

Subject: Contract No. DE-AS07-80ID12172

Gentlemen:

We respectfully request that the subject contract entitled "Geothermal Resource Assessment in Oklahoma" be extended at no cost to the Department of Energy, to June 30, 1983. The extension will allow completion of the temperature confirmation objective as stated in the contract.

The delay will be needed to redesign our long term temperature probes as well as identify abandoned well sites for our reentry program.

No additional funds will be required for this time extension.

Sincerely yours,

Taylor C. Anthony
Director

Kenneth V. Luza
Oklahoma Geological Survey

cc: Susan Prestwich, DOE/DGE
Carl Rusectta
Earth Science Laboratory/UURI
William E. Harrison

1000 Asp Avenue, Room 314, Norman, Oklahoma 73019 (405) 325-4757

The
University of Oklahoma at Norman

Office of Research Administration

November 16, 1982

Department of Energy
Contracts Management Division
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

Attention: William C. Drake
Contracting Officer

Subject: Contract No. DE-AS07-80ID12172

Gentlemen:

We respectfully request that the subject contract entitled "Geothermal Resource Assessment in Oklahoma" be extended at no cost to the Department of Energy, to June 30, 1983. The extension will allow completion of the temperature confirmation objective as stated in the contract.

The delay will be needed to redesign our long term temperature probes as well as identify abandoned well sites for our reentry program.

No additional funds will be required for this time extension.

Sincerely yours,

Taylor C. Anthony
Director

Kenneth V. Luza
Oklahoma Geological Survey

cc: Susan Prestwich, DOE/DGE
Carl Rusectta
Earth Science Laboratory/UURI
William E. Harrison

6/20/83

GEOTHERMAL RESOURCES OF OKLAHOMA

1983

Geothermal data for the map were compiled and interpreted by

Kenneth V. Luza
William E. Harrison
George A. Laguros
Oklahoma Geological Survey
Norman, Oklahoma 73109

M. Lynn Prater
E-Systems
Greenville, Texas 75401

Paul K. Cheung
Tangram Resources LTD
Calgary, Alberta T2P 1J2

originals

INTRODUCTION

A number of shallow (300 m or less) fresh-water aquifers are suitable for ground-water heat-pump applications. Several two-well systems, which utilize 16.7°C (62°F) water, are in use for space heating and cooling of residences and small businesses in central Oklahoma. Because of the lack of reliable temperature data, as well as economic uncertainties, deep, low-temperature geothermal waters have not been developed.

Temperature-gradient calculations indicate that eastern Oklahoma exhibits the greatest potential for low-temperature thermal applications. The U.S. Geological Survey defines low-temperature geothermal resources as those usable concentrations of geothermal energy with temperatures of less than 100°C where the geothermal gradient is greater than 25°C/km (1.37°F/100 ft) and the wellhead- or spring-water discharge temperature is a minimum of 10°C (18°F) above the local mean annual temperature (Reed and Sorey, 1981).

Several thousand holes are drilled each year in search of oil and gas. Of these, about one-half prove nonproductive. This condition offers the possibility for developing geothermal energy from wells that would otherwise be plugged and abandoned. Thus, potential users of geothermal energy would probably never bear the expense of drilling wells greater than a few hundred meters. With current drilling and completion costs, deep systems (1 km or more) might have payout periods of tens to hundreds of years. If, however, a borehole drilled to, say, 3,000 meters were made available for geothermal applications, the economics might be changed drastically.

EXPLANATION

Temperature-Gradient Determinations

Temperature data from bottom-hole-pressure tests and temperature logs were used to help assess the geothermal-resource potential of Oklahoma. The most reliable temperature data are derived from bottom-hole-pressure tests. Temperature

measurements taken from different tests during the production history of a particular well usually vary no more than 1°C from the average. Also, temperature logs and bottom-hole-temperature determinations in air-drilled wells are considered to be reliable data. These two kinds of data are available only for the Arkoma Basin, however. The most abundant and readily available temperature data (log-heading temperatures) are unreliable, as they usually record temperatures lower than the true formation temperatures because of the cooling effect of the mud. Depending on the availability of the types of data, the gradient was determined by one of the following methods: (1) reliable temperature data at different depths, (2) one reliable value at depth and assumed near-surface temperature, (3) corrected bottom-hole temperatures and assumed near-surface temperature. The temperature gradient determined from one of the above techniques was posted in the center of each township, the basic area for control-point spacing. The map shows some representative control points.

Where shut-in-gas-well temperatures are available, at two or more significantly different depths, or where temperature logs are available, the gradient can be determined with confidence. Gradients from 130 townships were obtained using this method.

Where reliable temperature data are available only for essentially one depth, a temperature measurement at some shallow depth is needed to determine the gradient. The mean annual surface temperature was not used as the control point, because surface temperature may be affected by soil type, moisture content, vegetation, climate, topography, and (or) ground water. From the gradient plots of reliable temperatures, an average temperature of 20.6°C (69°F) at 152 m (500 ft) below the surface was established. This average is used as a control point for constructing a linear gradient where subsurface temperatures are available for a single depth.

In more than half of the townships, bottom-hole temperatures are the only available data. A correction factor was applied to the calculated average bottom-hole temperature at a specific depth to compensate for the cooling effect of the drilling mud. Within a township, a number of bottom-hole temperatures are used to determine an average temperature at a certain depth. The temperature gradient of a township was obtained from the assumed near-surface temperature and the corrected temperature at depth.

High-Pressure Zone

In the deep part of the Anadarko Basin and in the Ardmore Basin (fig. 1), the Morrow-Springer (Lower Pennsylvanian-Upper Mississippian) section is abnormally pressured. The top of the abnormally pressured zone occurs between 3,350 and 4,570 m (11,000 to 15,000 ft) below the surface. This zone is readily identified on logs generally by abrupt increases in mud weight because the temperature gradients change abruptly as pore pressure becomes abnormal. Temperature gradients within the high-pressure zone range from 20°C/km to 101°C/km.

Tectonic Features

Temperature-gradient data correlate well with major Oklahoma tectonic and geologic features (fig. 1 and figs. 2 and 4). The low gradients of the Anadarko and Ardmore Basins reflect their thick sedimentary rock section. The presence of abnormally pressured formations within these basins may restrict the upward movement of heat flow, thus producing lower than normal temperature gradients. As a whole, the Arkoma Basin is characterized by higher than normal gradients. These high gradients may be a result of the intensive thrusting and folding of the sedimentary strata. For areas outside the Arkoma Basin, geothermal gradients appear to be related to basement configuration

and fluid migration. Generally, the temperature gradient increases as depth to basement rock decreases.

(5)

Table 1. Summary of Formation Characteristics and Minimum Water-in-Place Estimates For Hartshorne, Spiro, and Cromwell Sandstones (Harrison and others, 1983)

Formation	Average Depth (m)	Average Thickness (m)	Average Porosity (%)	Water-Saturation Range (%)	Average Temperature (°C)[a]	Minimum Water in Place (bbl)[b]
Hartshorne	780	21.3	10	12-58	39.4	640,896,000
Spiro	1,609	11.3	14	10-98	66.1	771,727,000
Cromwell	1,745	13.1	18	5-39	70.	761,424,000

[a]Calculated from uncorrected bottom-hole temperature.

[b] 159 l/bbl or 42 gal/bbl

GEOTHERMAL POTENTIAL

Area most favorable for development of low-temperature (lower than 100°C) geothermal resources as indicated by above-normal thermal gradients, bottom-hole temperatures, and (or) known and inferred presence of favorable reservoir rocks. Temperature gradients within this area generally exceed 34°C/km. Three Pennsyvlanian sandstone units—the Spiro, Cromwell, and Hartshorne—have potential for geothermal development. A preliminary summary of formation characteristics and minimum water-in-place estimates for the Hartshorne, Spiro, and Cromwell sandstones are listed in table 1.

Physical characteristics and in-place water-volume estimates are only approximations. Site-specific areas, which may be considered for geothermal applications, should be subjected to detailed studies.

WELL-GRADIENT INFORMATION

◆

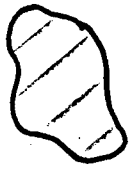
Gradient determined from reliable temperature data at different depths

■

Gradient determined from one reliable value at depth and assumed near-surface temperature

●

Gradient determined from corrected bottom-hole temperatures and assumed near-surface temperature



Abnormal-pressure zone

□

Abnormal-temperature gradient determined from bottom-hole temperatures only

○

Abnormal-temperature gradient determined from reported shut-in-pressure tests

(Gradient given in °C/km; shown next to symbol)

REFERENCES

Cheung, P. K., 1978, The geothermal gradient in sedimentary rocks in Oklahoma: Oklahoma State University master's thesis, 55 p.

_____, 1979, Geothermal gradient mapping—Oklahoma: Presented in 7th Formation Evaluation Symposium of Canadian Well Logging Society in Calgary, Canada, October 1979, 15 p.

Harrison, W. E., Luza, K. V., Prater, M. L., and Chung, P. K., 1983, Geothermal resource assessment in Oklahoma: Oklahoma Geological Survey Special Publication SP 83-1, 42 p.

Johnson, K. S., Branson, C. C., Curtis, N. M., Jr., Ham, W. E., Harrison, W. E., Marcher, M. V., and Roberts, J. F., 1972, Geology and earth resources of Oklahoma: Oklahoma Geological Survey Educational Publication 1, 8 p. (Reprinted with minor revisions 1979.)

Jordan, Louise, 1967, Geology of Oklahoma—a summary.: Oklahoma Geology Notes, v. 19, p. 102-105.

Reed, M. J., and Sorey, M. L., 1981, Low-temperature geothermal resource assessment of the United States: A progress report; Geothermal Resources Council Bulletin, v. 10, no. 6., p. 11-14.

Schoeppel, R. J., and Gilarranz, S., 1966, Use of well log temperatures to evaluate regional geothermal gradients: Journal of Petroleum Technology, v. 18, p. 667-673.

Shelton, J. W., compiler, 1976, Geothermal gradient map of North America: American Association of Petroleum Geologists and U.S. Geological Survey, scale 1:5,000,000.

Fig. 1

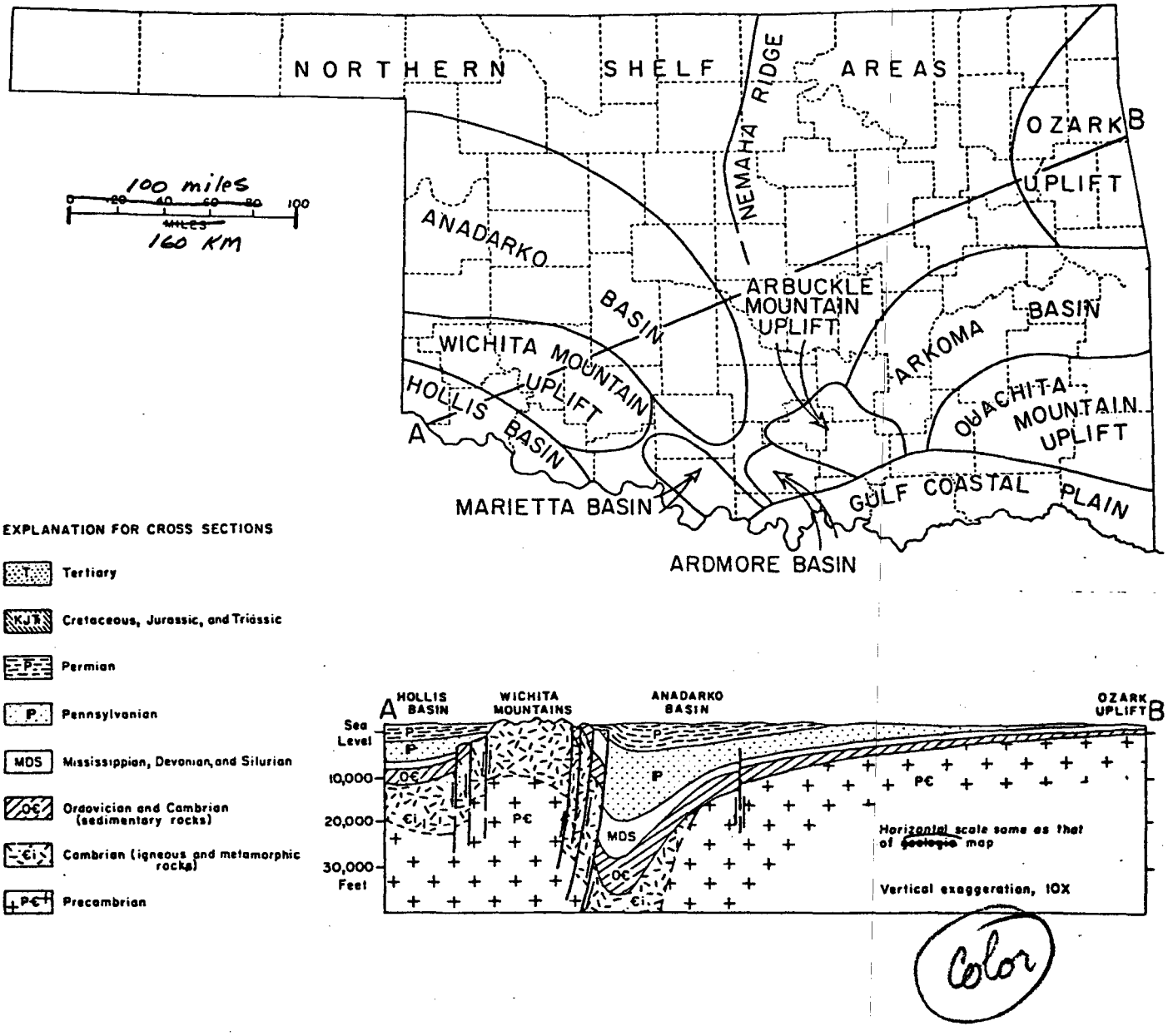


Figure 1. Major geologic and tectonic provinces of Oklahoma.

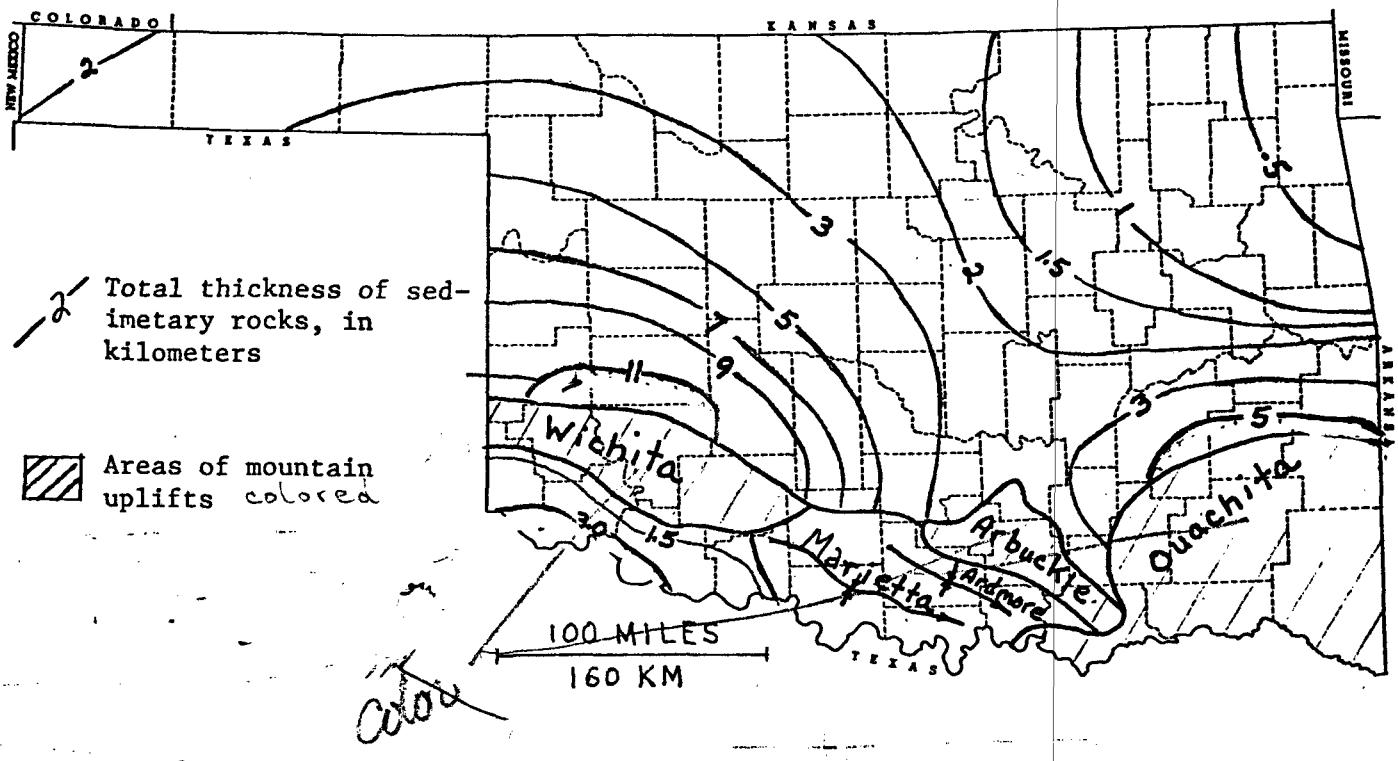


Figure 2. Generalized map showing total thickness of sedimentary rocks in Oklahoma. Sedimentary rocks overlie a basement of Precambrian and Cambrian igneous and metamorphic rocks (modified from Jordan, 1967). Sedimentary rocks over Wichita Mountain Uplift are generally thin (0-600 m thick); sedimentary rocks over Arbuckle Mountain Uplift range from 0 to 4 km thick; sedimentary rocks in Ouachita Mountain Uplift are 6-9 km thick; sedimentary rocks in the Ardmore and Marietta Basins are 6-9 km and 3-6 km thick, respectively.

Fig. 3

10

color

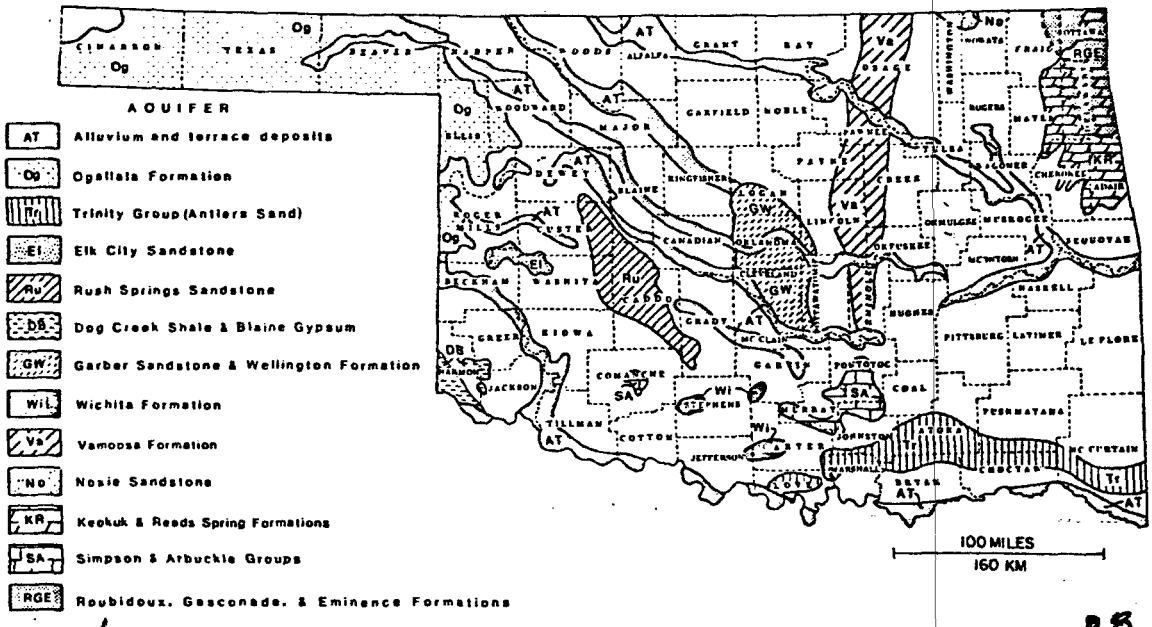


Figure 3. Map showing major sources of ground water in Oklahoma (modified from Johnson and others, 1972, p. 8).

Fig. 4

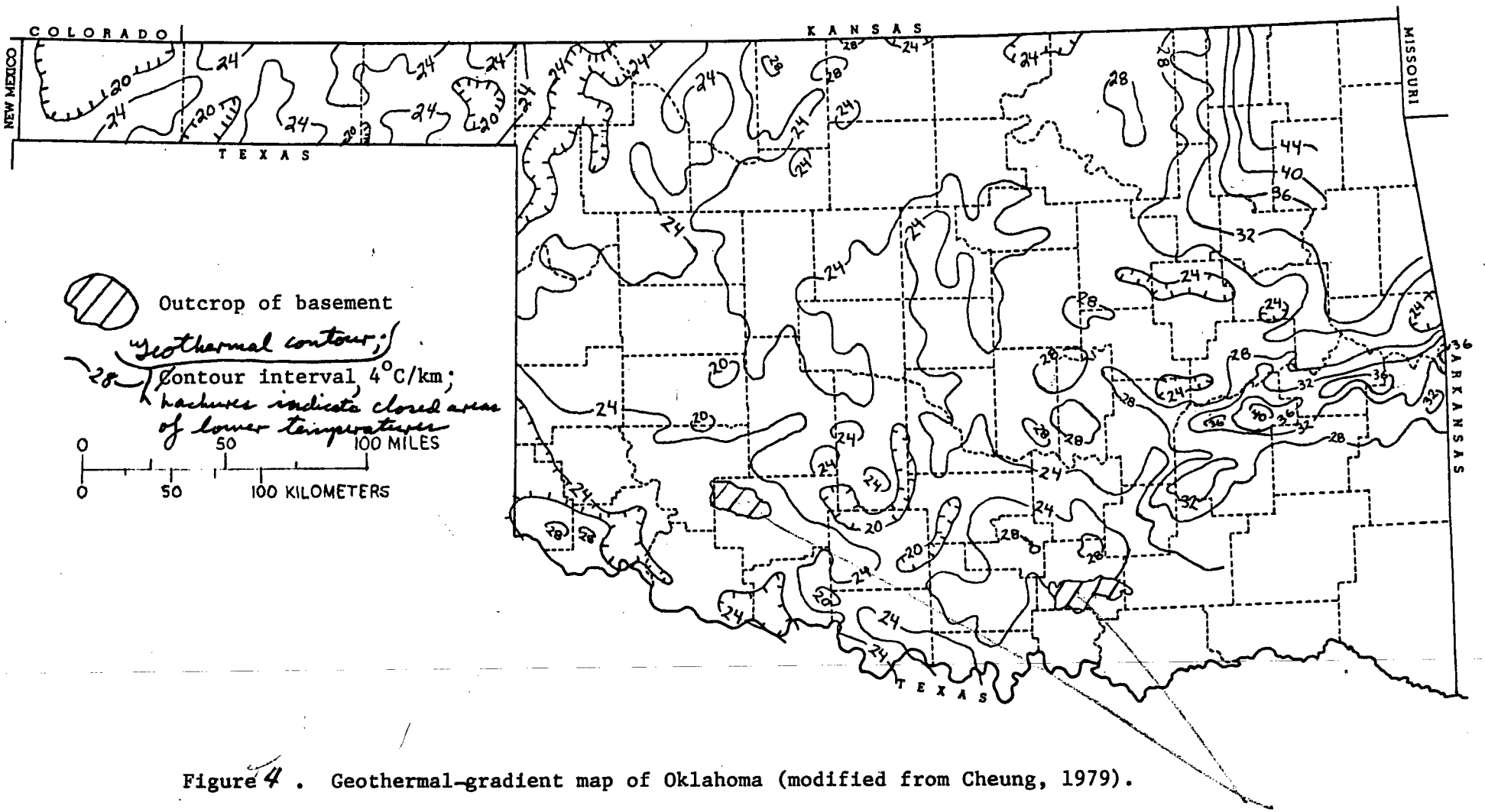
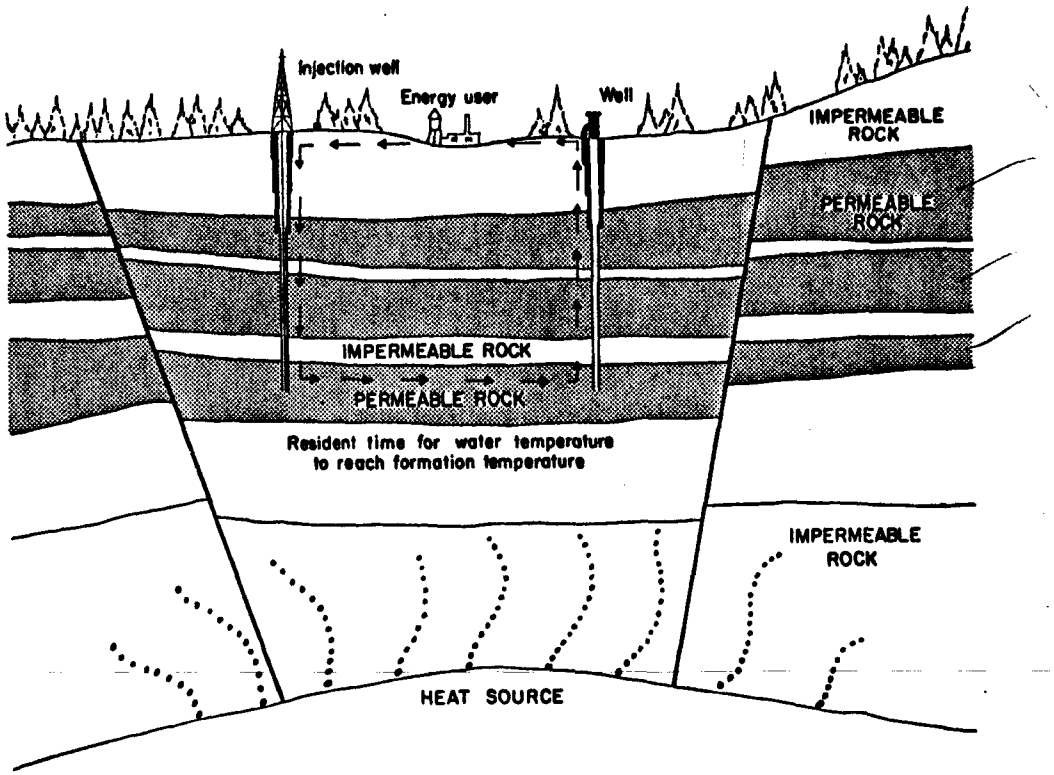


Figure 4 . Geothermal-gradient map of Oklahoma (modified from Cheung, 1979).

Color

Fig. 5 Potential application



Some color.

Figure 5. Schematic diagram illustrating possible development of a low-temperature geothermal resource using abandoned oil and (or) gas wells.