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**UTAH STATE PRISON SPACE HEATING
WITH GEOTHERMAL HEAT
FIRST SEMI-ANNUAL REPORT
FOR THE PERIOD
14 MARCH 1979 - 14 JUNE 1980**

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WITH GEOTHERMAL HEAT

Semiannual Report
For the Period
March 14, 1979 - June 14, 1980

C.K. Blair
July 1980

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ABSTRACT

Reported herein is a summary of the work conducted during the first year of the contract under a project to develop the Crystal Hot Springs geothermal resource to provide space and hot water heating for the Minimum Security Building portion of the Utah State Prison. Efforts during the project to date have been directed towards resource assessment. Progress includes completion of the environmental impact report, conclusion of resource geophysical surveys (gravity and magnetic), and preliminary modeling of the subsurface structural configuration in the vicinity of the resource based upon the results of the geophysical surveys.

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INTRODUCTION

Project Description

Utah State Prison Space Heating with Geothermal Heat is a three year project to develop the Crystal Hot Springs geothermal resource to provide space and hot water heating for the Minimum Security Building portion of the prison complex. It is anticipated that the system completed during the project will provide the nucleus of a system which could be expanded to provide the heating requirements of many existing and planned prison facilities.

The project has been subdivided into nine tasks. These are:

- TASK 1 - Environmental Report
- TASK 2 - Resource Assessment
- TASK 3 - Production Well
- TASK 4 - Investigation of Disposal Alternatives
- TASK 5 - Construction and Inspection of Demonstration
- TASK 6 - Planning for Expansion
- TASK 7 - Reporting
- TASK 8 - Publicity
- TASK 9 - Project Management

Summary of Technical Progress During Reporting Period

Studies completed have indicated that conducting the Utah State Prison Geothermal Project will impose only minor, temporary effects upon the environment. The development, to be confined to prison property, will be small in magnitude in comparison with existing facilities. Thus, the aesthetic quality

of the area will not be diminished. Disruption of surface soil occurring during drilling and construction will be minimized via proper excavation. Because spent geothermal fluid will be reinjected into the ground, no impact upon surface waters is anticipated. Injection horizons will be selected to maintain the quality of shallow ground water aquifers.

Geophysical assesment of the resource has been conducted both under the present program and under the DOE/DGE State Coupled Resource Assessment Program (Contract No. DE-AS07-77ET28393). Under the state coupled program, surveys directed toward characterization of the entire Crystal Hot Springs resource have been conducted. Recent work has included completion of a gravity profile and of a detailed aeromagnetic survey of the area. While modeling of the results of these surveys has provided instructive information regarding geologic and structural conditions in the vicinity of the springs, it did not provide detailed structural information required to site test or production wells. Efforts under the state coupled program are summarized in Reference 2.

Under the present program, a detailed gravity grid survey has been conducted and preliminary modeling of the survey results has been completed. This gravity survey was designed to provide detailed structural information in the area most likely to be targeted for drilling during the course of the prison project. Conclusions to date regarding the subsurface features in the vicinity of Crystal Hot Springs are as follows:

- 1) The springs are located over a small bedrock high that is within 80 feet of the land surface.
- 2) The high appears to be bounded on the north and south by faults.
- 3) The eastern edge is somewhat complex but is most likely bounded by a fault striking northwest.

- 4) Although a fault may be present along the western edge of the anomaly, the bedrock surface increases in depth more slowly to the west than to the north, east, and south.

ENVIRONMENTAL REPORT

Studies were conducted to determine if any adverse environmental effects would result from conducting the Utah State Prison Geothermal Project. The completed assessment has indicated that only minor, temporary environmental effects will result. The drilling and development will occur entirely on prison property; project efforts will be integrated into planned prison facilities construction and rehabilitation activities. Direct use of land will be approximately one acre (for the production well, injection well, and pipelines). Because the development is small compared to existing facilities and will be integrated with prison construction plans, the aesthetic quality of the area will not be diminished.

Temporary disruption of surface soil will occur during drilling of the wells and laying the pipelines. The surface impact is considered small compared to other prison construction activities that will be conducted concurrently with the geothermal development. With proper excavation, these short-term effects to the prison's environment will be minimal.

Care will be exercised during drilling and testing activities to avoid contamination of surface waters and ground water. Drilling fluids will be contained in impermeable mud pits or portable mud tanks. Well discharge during testing will be into local canals (with appropriate state and federal permits).

During normal system operation, spent geothermal fluid will be reinjected into the ground. Because of this, no impact upon surface waters is anticipated. Injection horizons will be selected to maintain the quality of shallow ground water aquifers.

Sources of air pollution from the project - dust from cleared areas, engine emissions during drilling, and release of dissolved gases from the geothermal fluid - will be short-term. Release of dissolved gases from the geothermal fluid will occur only when surface disposal of the discharge is required.

Slight impact to flora and fauna will result from clearing of land for roads, drill sites, and piping. These activities will occur on prison property and will require only minimal removal of vegetation or displacement of fauna. The area anticipated for drilling and for pipeline routes is essentially void of vegetation and wildlife.

GEOPHYSICAL RECONNAISSANCE

Introduction

During the current reporting period, considerable progress has been made on the geophysical reconnaissance portion of the resource assessment effort at Crystal Hot Springs. Results of the following geophysical surveys (conducted during fall and winter of 1979) have become available:

- 1) detailed gravity grid (290 stations)
- 2) gravity profiles (257 stations)
- 3) detailed aeromagnetic survey (45 square miles, 1/8 mile separation).

The detailed gravity grid was funded under the present program. The gravity profiles and the detailed aeromagnetic survey were funded through the DOE/DGE State-Coupled Resource Assessment Program (Contract No. DE-AS07-77ET28393).

Aeromagnetism

Results of the aeromagnetic survey were modeled by personnel at the Earth Science Laboratory, University of Utah Research Institute. The modeling indicates that a series of three intrusive bodies striking almost east-west are present northwest, north, and northeast of the springs. The intrusives extend to depths of at least 7,500 feet; the uppermost portions come to within 250 feet of the surface. The results of the survey suggest that the intrusive body is in fault contact with the non-magnetic Paleozoic sedimentary rocks found beneath the springs. While the results of the modeling effort provide valuable information concerning the geologic and structural conditions in the vicinity of the

the thermal spring system, they do not provide detailed structural information required to site the test or production wells.

Gravity Surveys

Introduction

Gravity profiles were used to obtain coverage of an area that extends from Draper to the Jordan Narrows. Profile spacings in the survey were approximately one-half mile apart with stations spaced at 1,000 foot intervals. The conducted survey defines many of the major structural features of the southern Jordan Valley; however, no computer modeling of the results has been conducted to date.

The gravity grid survey was designed to provide detailed structural information in the area most likely to be targeted for drilling during the present program. The grid consisted of 290 stations spaced 350 feet apart, and was centered on the thermal springs and prison grounds. The entire grid covered an area approximately 8,500 feet long and 5,300 feet wide, with the major axis of the grid striking northeast, paralleling the strike of the East Traverse Range.

Results

The terrain-corrected Bouguer gravity surface for the area of the detailed grid is included as Figure 1. The gravity surface has a significant regional gradient which masks the effects of structures in the vicinity of the springs. Using a line smoothing process, the regional gradient was removed from the gravity surface resulting in the residual anomaly depicted in Figure 2.

The residual anomaly consists of two gravity highs separated by a slight gravity low. The total relief on the anomaly is approximately 2.0 mgals. The western-most high is centered beneath the eastern half of the hot springs property, while the eastern gravity high is centered beneath the maximum secur-

Figure 1. Bouguer Gravity Contour Map - Crystal Hot Springs Area

Figure 2. Residual Gravity Anomaly - Crystal Hot Springs Area

ity section of the prison. The western anomaly is the most intense of the two anomalies and rises approximately 1.2 mgal above zero. The eastern gravity high rises to approximately 0.75 mgals above zero, with a subsidiary high of approximately 0.5 mgals south of the main high. The two highs are separated by a north-south gravity low having an intensity that ranges from 0 to 0.25 mgals. A series of small enclosed lows strike north-northeast across the southern portion of the area. Maximum intensity of the lows is approximately -0.50 mgals.

The western gravity high is rectangular in shape, having relatively steep gravity gradients on the north, east and south sides. The intensity of the anomaly decreases much more slowly to the west. The eastern edge of the anomaly is made more complex than the other edges by a northwest trending feature that causes the gravity gradient along the edge to be steep to the south and less steep to the north. The eastern gravity high is also rectangular in shape but is not as intense as the western high.

Modeling

Work has been conducted to generate a bedrock/alluvium subsurface prism model which is consistent with observed gravity characteristics. In the effort, a density contrast between the bedrock and the overlying alluvium of 0.40 gm/cc was assumed.

Presented in Figure 3 is the currently envisioned configuration of subsurface conditions in the vicinity of the Crystal Hot Springs (based upon gravity modeling). Depicted on the figure is the depth to bedrock (or the thickness of the alluvium formation). Superimposed onto the figure for information is the prison property boundary. The gravity anomaly computed using the generated bedrock/alluvium subsurface model is presented in Figure 4.

Figure 3. Bedrock/Alluvium Subsurface Mode (Based upon Gravity Survey) - Crystal Hot Springs Area

Figure 4. Residual Gravity Anomaly (Computed using Bedrock/Alluvium Subsurface Model) - Crystal Hot Springs Area

Conclusions of the modeling efforts conducted to date area as follows:

- 1) The springs are located over a small bedrock high that is within 80 feet of the land surface.
- 2) The high appears to be bound on the north and south by faults.
- 3) The eastern edge is somewhat complex but is most likely bound by a fault striking northwest. East of the fault, the bedrock surface probably dips to the southeast.
- 4) Although a fault may be present along the western edge of the anomaly, the bedrock surface increases in depth more slowly to the west than to the north, east, and south.

The location of the Utah State Prison on the northern and eastern edges of the anomaly dictates further detailed modeling in these areas to further define the subsurface structural configuration. Comparison of the actual gravity anomaly (Figure 2) versus the anomaly computed using the subsurface model (Figure 4) also reveals the need for additional modeling in these critical areas of interest.

Discussion

Geophysical reconnaissance conducted to date has indicated that the thermal anomaly in the vicinity of Crystal Hot Springs is associated with a fractured quartzite bedrock formation. Gravity modeling and gradient hole lithologies indicate that this formation is within 80 feet of the land surface in the vicinity of the springs.

Shown in Figure 5 is a map of the locale in the vicinity of the Utah State Prison. Denoted on the map are the location of Crystal Hot Springs and of existing wells in the area. Depicted in Figure 6 is the cross-sectional geological configuration of the area in the vicinity of the resource (the section location is indicated in Figure 5) inferred from gradient hole drilling and from gravity modeling conducted to date. Superimposed onto the figure are temperature profiles determined from gradient hole measurements. In comparing temperature profiles with the subsurface structural configuration, it can be seen that peak temperatures coincide with the fractured quartzite bedrock formation, thus supporting the conclusion that the resource is associated with this formation.

Because the resource is associated with the bedrock formation, there is a strong correlation between thermal gradient data and the residual gravity anomaly in the vicinity of the resource. Presented in Figure 7 is a plot of the residual gravity anomaly onto which measured near-surface temperature gradients have been superimposed. As shown in the figure, peak temperature gradients coincide with gravity highs in the area.

Since the correlation between thermal gradients and the western residual Bouguer gravity anomaly is so striking, it is of interest to consider the possible significance of the eastern gravity high that is centered under the maximum security building. There do not appear to be any obvious surface manifestations that would be indicative of a shallow thermal anomaly. However, if it is assumed

FIGURE 5. Map of Utah State Prison/Crystal Hot Springs Area

FIGURE 6. Cross-Sectional Geological Configuration - Crystal Hot Springs Area

Figure 7. Near-Surface Thermal Gradient Data Plotted on Residual Gravity Anomaly - Crystal Hot Springs Area

that the gravity high is caused by a near surface extension of the same fractured quartzite body responsible for the western gravity high, there would be a finite possibility of encountering hot water at reasonable depth. For this reason, it would be appropriate to consider implacing one or more shallow temperature gradient holes to determine whether a thermal anomaly is associated with the eastern gravity high.

In view of the assessment conducted to date, it appears that the best location for siting a test well for the current program is along the northern boundary of Utah Roses/Utah State Prison property in the vicinity of existing well SF-1. It is anticipated that the expected hot water-bearing quartzite formation will be intersected at a depth of approximately 250 - 300 feet in this location. The existing subsurface model will be refined to further define structural features in this area to enable final selection of a test well drilling site.

PROJECT MANAGEMENT - SCHEDULE AND DELAYS

Background

A proposal for P.O.N. funding of the direct application space heating project at the Utah State Prison was submitted to DOE in July, 1978. A grant was awarded and a contract between the state and DOE was signed in March, 1979.

The nine months that ensued were frustrating and at times very discouraging. Plagued by a number of unforeseen management and organizational problems, procedural delays created by the state, and extended delays in obtaining work that was subcontracted out, the Prison P.O.N. has had difficulty in trying to keep up with cost and task schedules. During the period, the environmental report was rejected by DOE on two occasions. Also, Terra Tek, Inc., the prime engineering and resource consultant for the project, had its contract with the Utah Energy Office disapproved by Utah's Board of Examiners. It was not until February 29, 1980, almost one year from the time the contract between the Utah Energy Office and DOE was signed, that the contract between Terra Tek and the Utah Energy Office was approved. The effect of this delay was to place responsibility on the State to fill the temporary void left by Terra Tek; responsibilities the State had neither manpower or expertise to assume. This in turn led to reports not being submitted in a timely fashion and lead to a certain amount of hesitation in making management decisions for specific tasks on the part of the State personnel overseeing this project.

In addition to these problems, land that the P.O.N. had originally sited for drilling and development of the geothermal resource at Crystal Hot Springs was sold to another party. This precluded access to the prime resource area

targeted for development by the state. Limited to drilling on prison property, it was necessary to examine and reassess the approach to the resource assessment program, thus causing further delays.

The net effect of these delays has been a slippage of seven to nine months in the originally outlined project schedule.

Lessons Learned

The most significant problem areas have been an ill-defined management structure and a relative lack of coordination between agencies in the State of Utah. Almost every major delay can be traced to these two items.

During the conceptual stages of the project's development, improper coordination led to oversights on the part of the project's management in adequately assessing the ability of the proposed organizational framework to respond to the needs of the program. There was no evaluation to determine the most efficient means of managing the project. The resulting selection of the organizational vehicle for project management reflects this oversight in the choice of a management team instead of a single agency to provide a centralized management structure.

The organizational framework under which the project is being managed indicates that the three different state agencies are responsible for managing various aspects of this project:

1. The Utah Energy Office - Program Director
2. Department of Social Services - Program Manager
3. Utah Building Board - Construction Manager

As conceived in the original proposal, the Utah Energy Office, as prime contractor, was to act as overall program director. The Utah Department of Social Services, having responsibility for the State Prison, was to administer the program's day to day activities and manage the efforts of the team members. The Utah State Building Board, which has responsibility for construction and renovation of state facilities, was to oversee the construction aspects of the program and in addition, manage the financial and administrative aspects of the project.

Experience suggests that the organizational structure was ill-conceived. The chosen management structure has fragmented roles and dispersed management responsibilities among the identified agencies. The management team concept has led to confusion regarding management roles and responsibilities and has unnecessarily complicated project management. At times this has led to inter-agency conflicts as to how the project should be managed.

A notable exclusion from the management team is the Division of Corrections or a representative from the Utah State Prison. Not one of the agencies making up the existing management team have a vested interest in the Prison Space Heating Project. During the decision making process, agency concern has often times been directed at maintaining the interest of the individual agency at the expense of the Prison Space Heating Project. Accordingly, the program has remained at the periphery of their normal functions and in the past has not received the attention it might have under the direct authority of the Utah State Prison or the Division of Corrections. Steps have been taken to correct the previously outlined management deficiencies. Firstly, the Utah State Prison has become more closely involved in management decisions concerning

the project. Secondly, stability has been brought to the position of program director. The Energy Office has assumed full responsibility as program director for managing the day to day operations and the financial and administrative aspects of the project. The Energy Office has assigned one individual to devote the amount of time required to conscientiously manage the project and to ensure necessary coordination between agencies.

ACTIVITIES IN UPCOMING QUARTER

During the upcoming project period, the existing bedrock/alluvium subsurface prism model will be refined (based upon gravity survey results) to accurately reflect subsurface conditions in the areas targeted for test hole and production well drilling. Based on the results of this modeling, sites for test hole drilling will be selected. Other activities during the upcoming quarter will include completion of the test hole drilling specifications, solicitation of bids for test hole drilling from competent contractors, and initiation of the resource monitoring program.

ACKNOWLEDGEMENTS

The geophysical reconnaissance and assessment work reported herein was conducted by Peter Murphy of the Utah Geological and Mineral Survey.

REFERENCES

1. "Environmental Report, Utah State Prison Geothermal Project", Terra Tek, Inc. Report No. TR 80-25, March 1980.
2. Murphy, P. and Gwynn, J. W., "Geothermal Investigations at Crystal Hot Springs, Salt Lake County, Utah," Utah Geological and Mineral Survey Report of Investigation No. 139, October, 1979 (DOE/ET/28393-16).