REPORT OF THE

ASCENSION ADVISORY COMMITTEE

Meeting of December 10,11, 1987
University Park Hotel
Salt Lake City, Utah

John R. Counsil
Joseph L. Iovenitti
Anthony J. Menzies
D. Stephen Pye

compiled by
Howard P. Ross
January 1988

INTRODUCTION

The first meeting of the Ascension Advisory Committee (AAC) was held at the University Park Hotel, Salt Lake City on December 10 and 11, 1987. The meeting was convened by Howard Ross as part of a University of Utah Research Institute (UURI) quality assurance (QA) program for the Ascension Island Geothermal Drilling Project. Mike Wright and Howard Ross indicated in introductory statements that this meeting was a QA function whose intent was to promote discussion, and to seek expert advice and technical opinion on the plans for operations in January, 1988. It was not a purpose of the meeting to conduct an in-depth technical review of past project activities. An agenda of the meeting and list of attendees is attached. Each of the review committee members signed an agreement to keep data and information confidential.

Dr. Mike Wright opened the meeting with a brief description of the status of the project and a charge of responsibilities for the AAC. He stated that the objectives of the meeting were to enable UURI, EG&G, and DOE to:

1) Achieve a better understanding of the reservoir(s) found by the present well; and
2) Determine the most favorable strategies for obtaining production from the well.

As a format for the meeting the DOE project team would present the results of exploration work accomplished to date, and would then seek suggestions and advice on the project. Wright indicated that the meetings should be informal, and that the review committee should:

1) Ask for any information not presented that was believed to be needed;
2) Feel free to question, think out loud, probe, or suggest alternatives;
3) Spend enough private and group thinking time to ensure a quality result; and,
4) Leave written comments and suggestions.

Presentations were then made by Dennis Nielson, Otis Day, and Susan Stiger to provide background information in addition to that received by mail in advance of the meeting.

PRELIMINARY COMMENTS, DISCUSSION AND CLARIFICATION

The AAC convened in the late evening for private Committee discussion following the presentations and dinner discussions of December 10. The following preliminary questions and the Committee's answers and comments were identified by the AAC for further discussion on December 11. These five items are quoted substantially as received in written form by Ross from the Committee:

1. Is there reason to continue (with the project)? Yes. The high temperature, epidote mineralogy, and possibility of a convective temperature gradient at the bottom of the hole all indicate the probability of a resource, but the location of the resource is unknown. Negative factors are that there is no significant permeability in the present hole, and there may be no convective temperature gradient in the hole. (The temperature versus depth data indicate the possibility of, but do not prove the existence of, a convective temperature gradient in the bottom portion of the hole. A convective gradient would be caused by large quantities of upward-moving hot waters, and would be a very positive factor.)[1]

2. Where is the target? The most likely location indicated to date is deeper, and the geologic risk could be reduced by drilling into the same postulated vertical fracture system that was encountered at 8000-9700 feet, but at a greater depth. The epidote argues for the system being deeper. The lack of a convective gradient would indicate that there is not a convective cell horizontally near the current wellbore, and therefore there is a low probability of encountering adequate permeability lateral to the present wellbore at the same depth as the current well bottom.

3. Are there data or interpretations that have not been presented or made yet that would change these conclusions? What is the current geologic model? What can be said about structural permeability and conductivity at depths > 10,000 feet? Do we need to be in the rift fracture system? Where are the rift boundaries relative to the well? What does the seismic data say about the target?[2]

4. What are the drilling constraints?
   a) Deeper along the current wellpath (i.e., 2000-3000 feet)
      1. Technical
         a) pipe strength
         b) foam/mud circulation
         c) rig capacity
      2. Logistical/Economic
   b) Target the 8000 foot fracture at 10,000 - 11,000 feet with the 9700 foot zone at 11,700-12,700 feet measured.
   c) Do we need 2000-3000 feet additional penetration?[2]

---

[1] Explanatory note in parantheses added by Ross.

[2] Answers to these questions were provided by the DOE Project team on December 11, 1988.

5. How will the well be evaluated?
   a) We feel that the evidence is conclusive that there is inadequate permeability in the current well, and more well testing is unnecessary except for shut-in surveys. Is there disagreement with this conclusion?
   b) What is the test program to evaluate the well after the next operations are completed? How are the current well testing equipment limitations going to be addressed during the next tests in order to better quantify the reservoir parameters?2

DISCUSSION

A broad discussion followed the presentation of these questions, answers and comments. Some new data were presented but most of the four-hour discussion related to interpretations, the geologic/reservoir model, and drilling methodology. Plans for future drilling and testing were presented by the project team and then discussed in considerable detail.

Numerous comments were made during discussions which are considered significant and are not stated in the Recommendations and Conclusions. They generally fall into two categories: comments and questions regarding the data presented, and those relating to drilling/testing options for future work.

The AAC concurs with UURI that a geothermal system is present on Ascension. The exploration program to date appears to have been well managed, in spite of difficult logistics. It appears that UURI has solved 65-70% of the exploration problem in finding high temperatures in the first deep well test, even though adequate permeability has not yet been intersected. The exploration has been completed in a systematic, professional manner and can point to good results to date. It is not unusual to drill several holes in a newly discovered geothermal system before commercial production is achieved.

Data presented to the Ascension Advisory Committee.

The thermal gradients are not that high, and the pH of fluids (at 6.2) is not that low. (JI)

Why the big hole size reduction in A #1? (JI) - A cost consideration made by the Air Force.

There should be a note on the mud logs where the CO_2 detector was defective. All inaccuracies with the mud log should be corrected (e.g., the notation of a limestone horizon below 8000 ft.). The log is a permanent record of the well- it must be as accurate as possible. (JI)

There appears to be no sustained production at these 8000 - 8500 foot CO_2 kicks. Therefore (this reservoir) is either of small volume or low permeability. (JC)

The pressure-temperature profile is similar to (some at) Baca- from static to flowing cools it off (in the production zone). (SP)

In Hawaii the (above mentioned) cooling phenomena results from flashing in the formation which is not solely a function of limited permeability. (JI)

Was the increase (to 30%) in epidote gradual? (TM) No, immediate. (DN)

Did you stop at 10172 feet because epidote decreased (from 30% to 10%)? (JC) - No, it was a funding limit. (DN)

The schematic diagram of the reservoir indicates that you aren't concerned about the decreasing epidote. (JC)

The schematic diagram is misleading- isn't the reservoir really fracture zones? (JI) - Yes. (DN)

Any significant upflow (in the hole) will be seen as isothermal. (JC,JI)

Any possibility that the tool got hung up at 8000 feet? (JC) Yes, don't know for certain. (DN)

If we ran a temperature survey now (shut in) it would indicate that the anomaly (at the CO_2 zones) has decreased. (TM)

The permeability is so low that we have not yet distinguished transient buildup from recharge. (JC)

The only real evidence for a convective gradient is at the bottom of the hole. (TM)

In many cases the epidote is a halo around the system - above and/or lateral. (SP)

Could the higher temperatures since epidote formation be due to the island sinking? (TM) It is a possibility that we have considered. (DN)

It appears that you (UURI) have solved 65-70% of the problem in finding high temperatures- but not yet the permeability. (JC)

Future drilling/testing options.

How much deeper can you get - to 2000 feet? (SP) - We can go about 1000 feet with foam; to go deeper (2000-3000 feet) we need to have fluid in the hole. (OD)

There are only two (reasonable) approaches (for seeking production) from the present hole- both involve going deeper. (SP)
a) enter fracture set (encountered earlier) at greater depth- there is some risk in dropping out of a 30 degree hole to go more vertical (the dogleg may decrease the depth that the rig can achieve).
b) continue along the present hole trend and take the geologic risk of hitting another fracture.

You should probably kick off deeper rather than laterally and shallower. (TM)

Would you stop at 1000 feet with no significant production? (SMP)

I would rather continue 3000 feet than go 1000 to 2000 feet laterally. (SP)

There is no evidence for more permeability laterally along strike. (JI)

There is no evidence for higher temperatures by going laterally; the problem is this is a single shot. You should maximize the probability (of intersecting higher permeability, temperature) by going deeper. (TM)

Won't you loose permeability by going deeper? (SMP)

It depends where you are - not necessarily true in the Imperial Valley (Republic's wells near the Salton Sea). (SP)

It sounds like there is some interest in crossing the cold-hot contact at the edge of the system- does this satisfy the present aim of the hole, or just geologic interest? (JC)

Does anyone really want to drill laterally, or is this issue resolved? A convective system off to the side would be indicated in the temperature logs. Subcommercial wells on the subcommercial edge of a commercial reservoir with a productive capacity of only a few thousand pounds per hour that are a few thousand feet from commercial production wells have been observed to show convective temperature gradients. The limits of application of this field observation could be tested by numerical modeling. (JC)

The best evidence for a convective gradient is near the bottom of the hole. (JC)

So, for the purposes of the present well, the chances are better to go deeper than off to the side; if there were two or more holes left in the program, one might prefer to drill laterally to better define the geology. (TM)

What about cementing off the CO_2 zone? (DN)

Not necessary- the permeability is too low. (TM)
Probably would not hold, would only be a band aid across it. (SP)
Enough cement for 1150 linear feet of hole went into the earlier cement job. (OD)

It is a matter of differential permeability- the bigger fractures took the cement. (JI)
You can't get cement particles to go back into the narrow fractures. (SP)

Any reason not to plug off the hole at depth? (LA)

Time, money, risk- you may cement yourself in; Have to fill hole with sand or mud to get cement in. (SP)

Not enough permeability to worry about. (TM,SP)

It is not a major thief zone. (JC)

What about testing before we start? (SS, PMW)

First do a shut in temperature/pressure survey as a baseline. (TM)
Open up valves- gradually. (Rapid production of the hole fluid could cause wellbore collapse). (SP)
Probably won't be able to get a good fluid sample. (TM,JC)

There hasn't been a good pressure transient test yet- should be done. (TM)

Has equipment on site been modified to permit a good flow test? (SP)

Yes. (SS)

How much time should we spend to try to get the well to flow? (DN)

You may be unable to drill ahead further if you get commercial flow. If you aren't stopped, you haven't got it. No sense in trying to stimulate flow when you are air drilling and don't have production. (SP)

If you could drill hole A #2 why not put it at the intersection of the N-S structures and the rift fracture set? (JI)

This is the steepest topography on the island. (DN)

In attempting sidetracking at about 6000 feet, be aware of temperature problems with the Dynadrill. You have a better chance with a turbine drill than with a whipstock. (SP)

The well position should have been surveyed more frequently to know what the angle was. (SP)

In Hawaii the perceived rift margins are not that productive; diking cuts down on permeability; the margin is too far away. (JI)

RECOMMENDATIONS AND CONCLUSIONS

The AAC was asked to provide a handwritten summary of principal conclusions and recommendations at the conclusion of discussions and prior to departing from Salt Lake City. These thoughts would then be prepared in report form and distributed to the AAC for editing and revision. The Committee's principal conclusions and recommendations follow.

1. We recommend drilling deeper to confirm the existence of a commercial geothermal resource. The temperature, CO_2 zone, epidote mineralogy, the two low-productivity zones, and the possible rollover in temperature gradient toward a convective gradient below 8200 feet indicate that a geothermal system may exist. The most probable location for the system is at depths greater than 9700 feet. However, the possibility of intersecting a commercial resource lateral to the present hole above 9700 feet is low.

2. Ignoring potential budget impacts, we would recommend:
   a) Running a static pressure/temperature survey before proceeding.
   b) Deepening the current well while holding or slightly dropping angle. The well should be deepened until the geology indicates there is no longer any potential for a resource, or the mechanical limitations terminate the drilling. At this time, additional temperature/pressure surveys should be conducted before sidetracking.

c) If no production is found, sidetrack the well at an appropriate depth to intersect the 8200 and 9700 foot zones 2000 to 3000 feet deeper. We do not feel that this well is the appropriate place, from a risk standpoint, to do more testing or coring, although these would be important during later development.

3. <u>If budget constraints force one option,</u> then sidetrack the well at the shoe and direct it to intersect the 8200 and 9700 foot zones 2000 to 3000 feet deeper.

4. <u>The following drilling parameters should be considered:</u>
a) Turbines should be used for sidetracking if sidetracking is to be attempted at circulating temperatures higher than 225 degrees, instead of Dynadrills.
b) Sidetracking in the vertical hole section near the shoe is preferred. Deeper sidetracking increases the risk of losing the hole, but decreases the footage that needs to be drilled.
c) Direction and deviation should be monitored systematically, and bottom hole assemblies should be modified as necessary to prevent doglegs and maintain desired angle.
d) If foam/air is unusable, drill with water/polymer/mud depending on material availability. The preferred system would depend on the productivity encountered: 1) low productivity could be handled with viscosified water- full returns with water. 2) High productivity- lost circulation could be handled with prehydrated bentonite and high temperature dispersants and fluid loss additives. With the current logistical problems, it may be more prudent to quit drilling in the high productivity case, and test the well.

5. <u>The test program following completion of the well</u> should include both production and injection testing. After a brief clean-out production period while coming out of the hole, conduct an injection test and run a temperature survey while injecting, a pressure falloff test, and a post-injection temperature survey. Permeability-thickness product and skin factor should be calculated from the pressure falloff test results. Subsequent production testing should include, if practical, step rate deliverability testing, as well as pressure buildup tests to identify permeability-thickness product, skin factor, and initial reservoir pressure. Spinner surveys may be useful at a later date to characterize changes in individual zone contribution over time. Following the production test, or if the well is not productive, conduct static pressure and temperature surveys to identify the temperature gradient.

ASCENSION GEOTHERMAL DRILLING PROJECT

MEETING OF ASCENSION ADVISORY COMMITTEE

University Park Hotel, Research Park, Salt Lake City, UT

Agenda

Thursday, December 10, 1987 - Oak Room, 3rd Floor

8:00 - 12:00	Travel; meet at UURI
12:45 - 1:45	Lunch
2:00 - 2:15	Welcome and Introduction; Mike Wright
2:15 - 2:45	Geology of Ascension Island; Dennis Nielson
2:45 - 3:15	Geothermal Exploration Program; Dennis Nielson
3:15 - 3:45	Drilling of Ascension No. 1; Otis Day
3:45-3:55	Break
3:55 - 4:20	Interpretation of Drilling Results and Geologic Model; Dennis Nielson
4:20 - 4:45	Reservoir Model; Susan Stiger
4:45 - 5:30	Discussion
5:30 - 6:00	Plans for New Drilling/Testing; Dennis Nielson, Otis Day, Susan Stiger
6:45 - 8:00	Dinner at Bird's Cafe (1355 E 2100 S)

Friday, December 11, 1987 - Pine Room, 6th Floor

8:30 - 9:30	AAC - Discussion and Preparation of Response
9:30 - 10:00	Open Questions and Discussion
10:00 - 11:30	Presentation of Findings and AAC Recommendations (w/ coffee break)
12:00 - 1:00	Lunch
1:00 - 5:00	Travel

Ascension Advisory Committee[3]

John R. Counsil
Engineering Consultant
1148 Shadyoak Place
Santa Rosa, CA 95404
(707) 538-2288

Joseph L. Iovenitti
Diamond Shamrock/Thermal Power
601 California Street
San Francisco, CA 94108
(415) 981-5700

Tony Menzies
Geothermex, Inc.
5221 Central Ave., #201
Richmond, CA 94804
(415) 527-9876

Steven Pye
UNOCAL Geothermal
1201 West 5th St.
Los Angeles, CA 90017
(213) 977-6262

EG & G Idaho: Susan Stiger

DOE/ID: Susan Prestwich

ESL/UURI: Mike Adams, Dennis Nielson, Lee Allison, Jospeh Moore, Otis Day, Howard Ross, Mike Wright, Wilford Forsberg

---

3 Resumes for the Committee members are on file at UURI.