

MAIL ME DOE4418 DOE1020 AR 'WEEKLY HIGHLIGHTS'

July 17, 1987

MEMORANDUM

TO: Department of Energy

FROM: Mike Wright

SUBJECT: Weekly Highlights

HEBER

Joe Moore and Mike Adams visited the Heber Geothermal Project last week. The purpose of the trip was to discuss the DOE-industry cooperative effort at Heber. A geochemical monitoring program was discussed in detail. In addition, the possibility of a time-domain SF survey at Roosevelt during shutdown was discussed.

CASCADES RESEARCH

California Energy still does not know whether or not they will be finishing the corehole near Crater Lake that they are drilling cooperatively with DOE this summer. The BLM has had an EA out on the street for comment, and it appears at the present time that no significant adverse comment has been received. However, the research program that the NPS is starting at Crater Lake may impact the coring program -- there may be pressure to delay drilling until the Lake is examined more closely. We can hope not, but we should be prepared for some delay here.

The BLM and GEO-Newberry are still in negotiation over the plug and abandon procedures that will be required for the GEO/DOE cooperative corehole N-3. The temperature profile in this hole furnished evidence that there is migration of water up the hole from as many as five inflow zones, the lowest of which is at about 3800 ft. The water appears to flow up and exit at about 1800 ft, which is believed to be the water table. GEO has wanted to simply leave gel in the hole, but the BLM may require cement to seal off the aquifers from inter-aquifer flow. The method chosen for P & A will impact the arrangements and, especially the cost of perforating the iron pipe in the hole and obtaining a water sample from the aquifer(s).

We have notified GEO that we want to obtain such a sample, and told them that the schedule will have to allow enough time for us to competitively procure services for the perforation and sampling. GEO has promised to notify us when the P & A

requirements are finally worked out with the BLM so that water sampling plans can be made that take into account the equipment that will be on site for the P & A work. If GEO needs and kind of a rig there, the sample will obviously be much easier and far cheaper to obtain.

CONGRESSIONAL TESTIMONY

On July 9, 1987, Mike Wright testified before the Energy Research and Development Subcommittee of the House Science, Space and Technology Committee regarding the federal geothermal research program and budget, as previously reported. This week, Wright finished an improved version of written testimony and FedEx'd it to the House Committee. Because there were only three working days available after the invitation to testify to get the written version together, Nancy Jeffrey, staffer on the Committee, allowed me to upgrade my original submission. Ten copies of the new version were also sent to Ted Mock for distribution in DOE/HQ. In addition, I have mailed copies to each of the Congressmen and Senators who are associated with either the authorization or the appropriation subcommittees concerned with the geothermal budget. Copies were also sent to the GRC, the GRA, SAN, ID, LBL, LLNL, EG&G, and Stanford. Additional copies are available.

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To: E.FEINAUER (DOE3401)
To: M.REED (DOE4418)
To: P.WRIGHT (DOE4433)
From: P.WRIGHT (DOE4433) Posted: Mon 22-Sep-86 10:01 EDT Sys 64 (59)
Subject: WEEKLY HIGHLIGHTS
Acknowledgment Sent

--More--

Sept. 19, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly HighlightNX(
ROSSTALK - XVI "IX11CRKOSSTALK 9- XVI 5-VC-2A

As of Friday morning, September 19, VC-2A had progressed to a depth of 760' with no major problems. The sedimentary breccia which the hole had penetrated at 218' last Friday (Sept. 12) persisted, along with interbedded volcanoclastic sandstone, to a depth of 268'. Below this depth, altered, densely welded, felsic ash-flow tuff has been penetrated to the present TD. This tuff, probably the Tshirege Member of the Quaternary Bandelier Tuff, contains disseminated pyrite and is sparsely cut by vuggy, stockwork quartz veinlets also containing pyrite and possibly other sulfides.

ASCENSION PROJECT

The drilling on Ascension Island continues to be on hold pending arrival of the rest of the cement and other materials and pending decisions as to the next steps. There are three Parker Drilling people on the island to check arrival of supplies and to keep the equipment in working order.

Dennis Nielson will be traveling to Patrick AFB the week of 22 Sept to brief the Air Force on the progress and on the funds needed to continue the project. The thermal gradient at the bottom of the hole is estimated to be about 7 deg F per 100 ft and the bottom-hole temperature at 4600 ft is roughly estimated to be 260 deg F. We are trying to get enough money to drill to about 6500 ft. Two things would hopefully be accomplished by this: 1) we would expect to gain more than 100 deg F, to put the temperature well into the range needed for electrical power generation, and 2) we would intersect at least one permeable horizon so that a good producer would result. If the briefing at Patrick is successful, Nielson and the Patrick people are planning to go to Washington DC for briefings to higher Air Force officials.

We are currently planning to resume drilling in mid October.

As of 18 Sept, the CECI drill hole at Mazama had reached a depth of 575 ft using rotary equipment, and the hole had been cased with 4 1/2 in casing and cemented. The project will remain idle until the core rig arrives on site.

Disposition: delete
CROSSTALK?

Disposition: delete

End of Scanned Mail.

MAIL ME DOE4418 DOE3401 AR 'WEEKLY HIGHLIGHTS'

Sept. 12, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

ASCENSION DRILLING

Drilling reached a depth of 4605 ft on Monday 8 Sept. Minor sloughing in the hole dictated no further drilling, but maintaining circulation until a cement shipment arrived, at which time the hole would be cased. Due to aircraft breakdown and other logistic problems only 96 bags of cement had arrived on Ascension on the Sept. 10-11 C-141 flight. The 96 bags plus 200 bags already on Ascension were much less than the cement required for a satisfactory casing job.

Schlumberger well logging equipment and personnel were mobilized to Ascension, arriving Thursday 11 Sept. Not all of the necessary logging equipment made the C-141 flight and the first logging run could not begin.

A non-equilibrium drill hole temperature of 200oF was recorded at 4500 ft twelve feet above the bottom of the hole on Sept. 8. After 29 hours to equilibrate (night of Sept. 9) a temperature measurement of 238oF was recorded at 4470 ft, some 30 ft off the bottom. We project a possible bht of about 260oF at 4600 ft. The large temperature recovery and favorable temperature gradient indicate proximity to a high temperature resource if adequate flow can be obtained when drilling resumes.

On Thursday 11 Sept. a decision had been made by the USAF to close down the drilling operation until logistics problems could be overcome and the equipment and supplies necessary to complete the project are in place on Ascension. The cost impact of the shut down is being evaluated by UURI.

STATE COOPERATIVE PROGRAM

Dr. Paul Damon, Univ. Arizona Laboratory of Isotope Geochemistry, is funded under the SCP to provide K-Ar dates for DOE programs but to date has not received samples for dating. He notes that the isotope laboratory is moving to new facilities but will remain operative throughout the move period. He has only a small backlog of samples and is ready to provide dating services on a rapid turnaround basis. Samples presently identified for dating include samples from the Cascades (DOGAMI), Ascension, and Cerro Prieto (Marshall Reed).

Drs. Chuck Wideman and Bill Sill of the Montana team report that two student theses are in the draft stage which detail the MCMST geothermal research in Montana. The theses describe CSAMT and gravity surveys and interpretative results for the Ennis geothermal area which is located north of West Yellowstone. Completion of the theses and the final SCP report is expected in December.

GEOCHEMISTRY

A manuscript entitled "Thermal and Chemical Evolution of the Caprock in the Salton Sea Geothermal Field, California" has been submitted to the Bulletin of the Geological Society of America for publication. The paper is coauthored by J. Moore and M. Adams. The following is a copy of the paper's abstract.

ABSTRACT

The Salton Sea geothermal field is the site of active greenschist facies metamorphism and base metal mineralization. Near surface circulation of the hypersaline reservoir brines is restricted by a cap of low permeability rocks that extends to a depth of several hundred meters. The caprock consists of two layers; an upper layer composed of impermeable lacustrine and evaporite deposits, and a lower layer of altered deltaic sandstones characterized by high initial permeabilities.

Fluid inclusion and chemical data from two high temperature wells indicate that evolution of the caprock can be divided into three stages. During the first stage, low grade metamorphism of the caprock converted gypsum to anhydrite and clays to chlorite. Simultaneously, downward percolating waters deposited anhydrite and calcite in the sandstones reducing their permeabilities. Downward percolation was limited to a depth of 400 m by a layer of low permeability shales and siltstones. Fluid inclusions contained in the anhydrite show that salinities of the early

fluids ranged from about 7 to 24 equivalent weight percent NaCl and that temperatures increased systematically downward through the caprock. The homogenization temperatures define a conductive gradient that averaged 0.67.C/m between the surface and 335 m. Below the caprock, homogenization temperatures in anhydrite average 280oC and are constant with depth. The change in thermal gradients indicates a transition from a conductive to a convective regime.

The second stage was marked by enrichments in potassium and base metals and depletions in sodium within the lower portions of the caprock. The high potassium/sodium ratios in the altered rocks indicates that this alteration was caused by the influx of cooled, high temperature saline brines.

The final stage records the development of fracture permeability in the caprock. During this stage, veins containing quartz, barite and base metal sulfides formed. Fluid inclusions in quartz and sphalerite indicate that these minerals were deposited from brines with salinities ranging from 13 to 18 equivalent weight percent NaCl at temperatures between 180 and 240oC.

CASCADES DRILLING

As has been previously reported, the coreholes by GEO and Thermal Power have been finished. We have not yet received all of the data from either contractor for release, and thus no date has been set for publication of the next Cascades newsletter, which will announce the release.

California Energy Co is tentatively scheduled to start their cost-shared drill hole near Crater Lake on the coming weekend-- September 14. They have been delayed in spudding because they have had drilling problems in their holes in the Newberry area, where the drill rigs will come from.

VC-2A--VALLES CALDERA

VC-2A, the second continental scientific corehole in the Valles caldera, has successfully penetrated to a depth of 231 ft as of Friday morning. This corehole, being drilled to investigate physical and chemical conditions as well as hydrothermal alteration and other aspects of the sulphur springs vapor dominated geothermal system should also furnish important new data on intra-caldera stratigraphy and oreforming processes at and beneath the deep vapor dominated/liquid dominated interface.

Between the surface and a depth of 30 ft, VC-2A penetrated

UNIVERSITY OF UTAH RESEARCH INSTITUTE



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MEMORANDUM

September 5, 1985

TO: Susan Prestwich
FROM: Bruce Sibbett
SUBJECT: Cascades Geothermal Newsletter

Enclosed is the first edition of the Cascades Geothermal Newsletter. Chan Swanberg has reviewed the letter in paper copy and given me a verbal approval once the section, township and range location was deleted to prevent too many tourists at the drill site during drilling. Chan asked about the possibility of GRI contributing news items to future editions of the newsletter.

CASCADES GEOTHERMAL NEWS

U.S. DEPARTMENT OF ENERGY/UNIVERSITY OF UTAH RESEARCH INSTITUTE

SEPTEMBER, 1985

Three geothermal companies that submitted proposals for deep thermal gradient holes in the Cascades in response to a Department of Energy solicitation have been selected to enter into negotiations for cooperative agreements. The three firms selected are GEO Operator Corporation, Thermal Power Company and Blue Lake Geothermal Company. Under the cooperative agreement DOE will share the cost of drilling four holes in the Cascade Volcanic Region of Oregon. The program will result in the release of data that will further define the geothermal potential of this active volcanic region. Data such as well logs, rock samples, fluid samples, and studies of these data will be transferred to the public to encourage further exploration and development of Cascade hydrothermal resources. Deep thermal gradient holes in the Newberry Crater area and within the High Cascades graben are needed to define the heat flow below the "cold groundwater current". Deep fluid samples will provide chemical data in the High Cascades where thermal springs are generally lacking. Core recovery planned for all of the holes will provide valuable data on the nature of possible reservoir rocks beneath the Cascades.

The first hole under the program is being drilled in the Newberry Crater area by GEO Operator Corporation. Surface casing has been set to 470 feet and coring has begun.

Other proposed holes would test the High Cascades graben in the Santiam Pass area and the Western Cascades-High Cascades transition near Breitenbush Hot Springs.

UURI

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August 30, 1985

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

GEOLOGY

This week, at the International GRC Symposium on Geothermal Energy, the geology group at UURI presented a poster session entitled "Structure and alteration of the Baca geothermal system, New Mexico."

Research in progress on core from well VC-1, the first Continental Scientific Drilling Program corehole in the Valles caldera, New Mexico, has shown that Paleozoic and Precambrian rocks in the well's deeper portions have been repeatedly brecciated, probably both tectonically and hydrothermally. The Pennsylvanian Sandia Formation and minor Precambrian granite gneiss in VC-1 have been disrupted into a spectacular sequence of heterolithologic breccias, some of which were clearly produced as rubble along fault zones. Others, however, which may be fluidized hydrothermal breccias, are conspicuous in being strongly hydrothermally altered and mineralized: pyrite, chalcopyrite, molybdenite, sphalerite, magnetite and hematite have been identified in veinlets cutting these breccias. Further work on the deep breccia zone in VC-1 should enable us to understand better the complex history of the Jemez fault zone, a major regional feature which has played a prominent role in development of the Valles caldera and its high-temperature geothermal systems.

GEOCHEMISTRY

The geochemistry group presented a paper and two poster sessions at the GRC convention. The paper was entitled "Fluid Flow in Volcanic Terrains - Hydrogeochemistry of the Meager Mountain Thermal System". The poster sessions were "Tracer Research" and "Chemical Behavior During Injection--Field Studies".

CASCADES DRILLING PROGRAM

GEO-Newberry Core Hole N-1 was spudded with a 5 5/8" tricone button bit at 9:00 PM, 8/23/85. Circulation was lost at 2 feet depth and never regained so no cuttings samples have been collected. Based on local stratigraphy and the hard and caving zones drilled, the hole is probably penetrating a sequence of basalt lava flows and flow breccias with possible minor ash beds. Drilling progressed slowly but uneventfully to a depth of 305' by Aug. 27, then the drill rods parted leaving 9 rods, sub and bit in the hole. The hole had to be cleaned out before the fish was pulled out with a tap during the morning of Aug. 28th. The rotary hole was drilled to a depth of 470', five feet into hard rock for setting the 4.5" casing. Casing was set on Friday, Aug. 30th.

The temperature check at 430' was less than 100°F. Cost estimate as of Aug. 29, at a depth of 375', was \$31,472.

STATE COUPLED PROGRAM

Two major reports from State Coupled Program projects were received this week. The first, from Southern Methodist University, summarizes the results of several years of research in heat flow in Washington. The highest anomalies are in the southern Cascade Range, but interesting anomalies also exist east of the southern Cascades and in east-central Washington.

The second major report received this week is about the Copper River area in south-central Alaska. The University of Alaska Geophysical Institute performed detailed geophysical studies and geochemical surveys in areas of interest that had been defined in an earlier reconnaissance program. The studies failed to confirm that geothermal systems are the cause of the anomalies detected. The nearby young volcanoes remain attractive targets, however.

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September 6, 1985

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM

The extensive series of maps published by the State Coupled Program state resource assessment teams has been partially reprinted in a new book "Great Hot Springs of the West." The book also contains tables from the maps, listing the springs in the western U.S. DOE is cited as the source of the maps (although as the Division of Mines and Geology of DOE). Data on the maps were originally compiled by the state teams, and the maps were published by the states, in conjunction with personnel from NOAA, ESL/UURI, USGS, and DOE.

GRC MEETING

Last week P. M. Wright, D. L. Nielson, J. N. Moore, and M. C. Adams of UURI attended the 1985 Geothermal Resources Council meeting in Kona, Hawaii. In addition to the papers discussed in last week's activity report, P. M. Wright presented a paper on Application of Geophysics to Exploration for Concealed Hydrothermal Systems in Volcanic Terrains. Wright also presented a session on the use of borehole electrical methods to define fractures in geothermal systems. In all, UURI scientists presented two papers and four poster sessions on their DOE-sponsored work. In addition, Nielson served as co-chairman for the technical session on Volcanic Environments.

CASCADES DRILLING PROGRAM

4 1/2 in. surface casing was set to a depth of 465 ft. and cemented with 40 ft³ pumped down the casing and 20 ft³ poured down the annulus. After pressure testing the BOP the BLM gave clearance to resume drilling. The top

of the cement in the casing was tagged at 210 ft. which indicates about 18 ft³ of cement was placed in the annulus at the bottom of the hole. This is equivalent to filling the annulus to about the same level as the cement filled the casing, but because of the lost circulation and extremely porous rocks, the amount of annulus actually cemented is uncertain.

By noon, Sept. 5, the hole was at a depth of 672 ft. coring 6 ft./hour of basalt. The bottom hole temperature is less than 100°F. Drilling costs as of Sept. 5 are \$60,835.

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September 12, 1985

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM - CURRENT EVENTS

The Washington state resource assessment team has completed six of the seven thermal gradient holes they plan to drill this summer. Five of the completed holes were targeted for 500 feet, and were completed to nearly this depth. The sixth hole was targeted for 1400 feet, but was completed instead to 1000 feet, due to drilling and cementing problems. Core recovery on this hole was very good. The seventh hole is just beginning. It is targeted to 1200 feet, and should be completed by the beginning of October, if the weather holds and no unusual problems are encountered. No thermal waters have been found in any of the holes. Preliminary thermal gradient measurements suggest, especially in the deep holes, that gradients increase with depth.

STATE COUPLED PROGRAM - UPCOMING EVENTS

The Gulf Coast Associated Geological Societies will be holding their annual meeting in Austin, Texas, in mid-October. One paper of geothermal interest is by Dr. C. M. Woodruff, a consultant in Texas, and Duncan Foley, ESL/UURI. This paper concerns use of thermal gradient data to interpret regional hydrologic flow paths along the Gulf Coast. This work was an outgrowth of Dr. Woodruff's work as the P. I. for the Texas State Coupled Program resource assessment team, and Dr. Foley's work on both the State Coupled Program and the Lackland Air Force Base, San Antonio, geothermal exploration program. An abstract of their paper is in the September, 1985, issue of the American Association of Petroleum Geologists Bulletin.

CASCADES DRILLING PROGRAM

The GEO-Newberry Core hole had reached a depth of 1,250 feet by noon Thursday at a cost of \$87,238. During 9 days of coring basalt flows, Tonto Drilling has averaged 86 feet per day with a coring cost of \$44/ft. Overall per foot average cost is \$70 thus far. Only 50 feet of drilling fluid is standing in the bottom of the hole, so the drilling appears to still be above the water table. The BHT is less than 100°F. Core recovery is about 87%.

GEOCHEMISTRY

A report was presented by the geochemistry group at the Department of Energy Program Review this week. The report was entitled "Development and Application of Tracers: Examples of Field and Experimental Studies" and was presented by Joe Moore, geochemistry group leader.

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September 20, 1985

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM - FUTURE EVENTS

The Utah Geological and Mineral Survey reports that they are nearing completion on two reports funded by the State Coupled Program last year. The first will be a comprehensive bibliography of geothermal resources in Utah. Many of their references will be annotated. UGMS is also including a list, with descriptions, of geothermal projects that have taken place in Utah. The second publication will be an analysis of geothermal systems in the Richfield 2 degree sheet area, which includes the high temperature geothermal systems in Utah.

CASCADES DRILLING PROGRAM

The GEO Newberry hole had reached a depth of 1830 ft. as of noon, Sept. 19th. Overall costs now average \$66.55/ft. with a total cost to date of \$121,790. The hole is still in basalt and the BHT is 54°F (12°C). The drilling is averaging 80 ft. per day. Next Monday Bruce Sibbett of UURI will fly to Oregon to visit the drill site.

GEOCHEMISTRY

Continued progress is being made on our investigation of the fluid chemistries in the Salton Sea geothermal field. Heating/freezing measurements on anhydrite samples from 550-1060 feet demonstrate the present cap on the system has not always been impermeable. The fluids that produced the cap were highly saline, up to 22 wt % NaCl, and hot (up to 250°C). Although homogenization temperatures increase regularly downward, the salinities do

not. Analyses of the gases indicate that the fluids are relatively oxidizing.

The fluids that deposited quartz and sphalerite were apparently unable to breach the cap. These fluids were generally less saline than those that deposited anhydrite. Homogenization temperatures indicate that quartz was deposited at higher temperatures than the sphalerite. The gases in these inclusions are relatively rich in hydrocarbons (particularly ethane and propane) indicating that this stage of mineralization occurred under more reducing conditions. The gas analyses are being performed at NASA by M. Sommer.

ASCENSION ISLAND GEOTHERMAL EXPLORATION

Funding has come through for the continuation of the effort to locate a geothermal resource under Ascension Island, South Atlantic Ocean. This project is being done for the U.S. Air Force through the Idaho Operations Office. The effort this next year will concentrate on the drilling of a 5000 foot test well to assess the potential of a zone which has been defined by electrical resistivity and thermal gradient drilling.

ABSTRACTS

This week the following abstracts were submitted for presentation at the Fall meeting of the American Geophysical Union.

"Altered Tectonic and Hydrothermal Breccias in Corehole VC-1, Valles Caldera New Mexico" by J. B. Hulen and D. L. Nielson.

"Scientific Drilling in a Vapor-Dominated Geothermal System, VC-2a, Sulphur Springs, Valles Caldera, New Mexico" by D. L. Nielson and F. Goff.

"Improvements in Finite Element Modeling of Two-dimensional Magnetotelluric Responses" by J. A. Stodt and P. E. Wannamaker.

"Electrical Conductivity of Water-Undersaturated Crustal Melting" by P. E. Wannamaker.

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October 4, 1985

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

GEOCHEMISTRY

Joe Moore reviewed UURI's current work on arsenic geochemistry and fluid inclusion research at the 3rd Industry Review held at LBL on Sept. 30. In addition, Moore and P. M. Wright participated in meetings with DOW/Magma on the East Mesa geothermal system and on the Long Valley system.

CASCADES DRILLING PROGRAM

The GEO-Newberry 1 hole was 2,996 feet deep on Oct. 3. The cost estimate is \$196,111 to date for an average of \$65.46/ft. The hole still appears to be cold.

GEO personnel are making a good lithologic log, photographing each box of core and splitting the core. The down-hole water sampler is not working due to an original bend in the tube and has been sent back to the supplier for a replacement.

STATE COUPLED PROGRAM

Duncan Foley of the Earth Science Laboratory visited the Idaho State Coupled Program resource assessment team last week, to sample geothermal wells and springs and evaluate geologic structures that are controlling geothermal systems along the Wood River Valley of central Idaho. One water sample was collected at a well that is slightly less than 40 degrees C. The Magic Hot Springs area was also sampled, at a cool (41C) seep that is presently flowing from below high water level in the reservoir. The sampled seep has a large

area of snowmelt during the winter. Results of the geochemical sampling should be available very soon. Several previously unmapped geologic structures were noted at some of the springs. The Idaho team has obtained a thermal log from a 6,000 ft. oil test well drilled in the northern Rocky Mountain province, near the Wood River. The log is interesting because it has a relatively low maximum temperature (about 130 degrees F.), and a major turnover, with the deepest portion of the well being much cooler than overlying strata. Detailed evaluation of the raw data on the log, to adjust for drilling time and other possible disturbances, has not yet been made.

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October 11, 1985

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

CASCADES DRILLING PROGRAM

By noon, Oct. 10 the Newberry N-1 hole was 3,545 deep with a BHT of 95°F at 3,518 ft. Total cost to date is \$238,098 for an average of \$67 per foot.

Fault breccia and basaltic dikes were encountered at depths of about 3160 ft. and 3300 ft. A BHT of 82°F was measured at 3312 ft. with temperatures still below 60°F above and below this small anomaly before 95° was measured at 3,518 ft. Rock alteration and the 82°F BHT in the 3300 ft. deep zone may relate to thermal fluids within the fault penetrated.

Bruce Sibbett is scheduled to fly to Oregon on Oct. 15th. This trip is planned to put him on site at Newberry 1 for the pre-TD temperature check, completion and logging of the hole. If possible Bruce will also meet with George Priest in Portland to discuss the Breitenbush hole and pick up some open file reports on the hole.

IMPERIAL VALLEY

Work on fluid inclusions from the Salton Sea is continuing. Inclusions in anhydrite from depths between 580 and 1200 feet in the second of the two wells provided by Union Geothermal have been studied. Heating and freezing measurements show that these inclusions display range of salinities similar to those in the first well studied. However, in contrast to our previous observations, inclusions in the second well are mainly secondary in origin.

STATE COUPLED PROGRAM

The Utah State Coupled Program team has delivered a review copy of "Annotated Geothermal Bibliography of Utah," by Karin Budding and Miriam Bugden. This bibliography contains over 500 references, many of which are annotated, a comprehensive list of DOE-funded projects, and a geographic index. The bibliography will be formally published in a few months, once reviews are completed.



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October 18, 1985

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM

The Geophysical Institute of the University of Alaska reports that they are making good progress compiling and interpreting data from their studies of the Mt. Spurr volcano this summer. Preliminary interpretations suggest that there is an area with overlapping mercury and helium geochemical anomalies, which also has self-potential and controlled source audiomagnetotelluric anomalies. This area may be the site of a geothermal system.

INJECTION

An abstract of a paper entitled "Tracer Development: Experimental Studies" has been submitted for presentation at the 11th Stanford Workshop on Geothermal Reservoir Engineering. The authors are M. Adams (UURI) J. Ahn (Univ. of Utah; UURI), H. Bentley (Hydrogeochem) and J. Moore (UURI). A copy of the abstract follows:

TRACER DEVELOPMENTS: RESULTS OF EXPERIMENTAL STUDIES

M. C. Adams, J. H. Ahn, H. Bentley, and J. N. Moore

Tracers can be used to monitor the movement of groundwaters and geothermal fluids and they can be used as a reference to quantify changes in fluid chemistry as a result of injection. Despite their potential importance to the geothermal operator, very few tracers are presently available and of those that are, little is known about their stability or behavior at the elevated temperatures that typify resources capable of electric power generation.

The ideal tracer should be detectable in small quantities, inexpensive, environmentally safe, and be absent from natural geothermal fluids and groundwaters. The tracers currently in use in high-temperature environments fall into three major categories: a) isotopes; b) salts of iodide, bromide or chloride; and c) the organic dyes (fluorescein and rhodamine). Each of these classes of tracers has significant limitations.

The fluorinated and sulfonated hydrocarbons are a relatively new class of tracers that do not appear to suffer from many of the limitations that plague other tracers. Indeed, because these compounds can be prepared as a homologous series, it is possible that fluid movement from a large number of wells could be studied. Hydrocarbons have been used as tracers in groundwater studies in low temperature environments but have not yet been field tested at high temperatures. Some of them are, however, expected to be stable at high temperatures.

In this paper, we describe the results of hydrothermal autoclave experiments on fluorescein and on various sulfonated and fluorinated hydrocarbons. The experimental runs were designed to evaluate the effects of four different parameters: temperature, time, solution chemistry, and the partial pressure

of oxygen. These experiments have been conducted at temperatures ranging from 100° to 200°C. As a result of our experiments to date, four hydrocarbons have been identified that are more stable than the organic dyes currently used by the geothermal industry. In addition, we have identified and quantified the stabilizing and destabilizing effects of the geothermal environment on the organic dye fluorescein. Increasing oxygen pressure and temperature have a destabilizing effect on fluorescein. In contrast, boron tends to stabilize fluorescein.

UURI

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October 25, 1985

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM

The Montana Tech State Coupled Program team reports that they had a successful field season in the Ennis Hot Springs area. Electrical studies were conducted over a detailed grid in a four square kilometer area around the springs, with scattered stations around the region. Preliminary reductions of the data look good. Gravity surveys were also run near Ennis, to fill in gaps in previous data, and provide ties with earlier studies of the Madison Range. Final reports on this project are due in the spring.

INJECTION PROGRAM

On Oct. 25 Mike Adams attended and participated in a workshop on sampling of geothermal brines held at LBL. Mike presented a short review of UURI's work on tracers at the meeting. The purpose of this workshop was to provide an informal forum for open discussions among scientists involved in geochemical studies of geothermal systems.

CASCADES PROGRAM

The corehole being drilled by GEO operator (under the name GEO-Newberry Crater, Inc.) on the south flanks of Newberry Volcano in Oregon reached 4000 feet in depth on Oct. 19. DOE elected to drop cost-shared participation in the coring at 4000 feet, as per the contract with GEO-Newberry, but GEO-Newberry is continuing to drill to a projected total depth of 4600 feet. When TD is reached, GEO-Newberry will do the geophysical well logging.

Temperatures in the hole are uncertain because no equilibrium temperature log has yet been possible. The hole will require several months to reach temperature equilibrium. Currently available temperature data have been taken with maximum-reading thermometers taped to the core-barrel picker. The resulting data give only an indication of subsurface temperature. Below about 3200 feet temperatures began to increase from <60°F, which was obtained for all readings at shallower depth. This is a tentative indication that the zone of surficial groundwater flow extends to this depth. Below 3200 feet, variable readings were obtained with the thermometers at varying distances above the hole bottom and after allowing varying equilibration times. The highest temperature recorded was 151°F at 3672 feet after a 14 hr wait. This value may be fairly close to rock temperature. Temperature data just prior to reaching 4000 feet are believed to be more reliable than those above (except for the value at 3672 ft) because the thermometers were placed closer to the bottom of the hole than was the case in previous measurements by using a device designed by UURI and built by Tonto Drilling Services. The following temperature readings have been obtained:

<u>Depth</u>	<u>Temperature</u>	<u>Estimated Reliability</u>
289 1	64°F	Low
3098	<60°F	Low
3208	<60°F	Low
33 12	82°F	Low
34 12	<60°F	Low
35 18	95°F	Low
3540	117°F	Low
36 15	97°F	Low
3672	151°F	Mod
3732	114°F	Low
3802	128°F	Low
3854	124°F	Mod?
3864	138°F	Mod?
39 14	140°F	Mod?
3964	142°F	Mod?
40 14	140°F	Mod?

We conclude that the temperature at 4000 feet (and at shallower depths) is much lower than observed temperatures at corresponding depths in the USGS hole in the crater at Newberry. It appears that the gradient between 3300 feet and 4014 feet may average 8°F/100 ft, equivalent to 146°C/km, which would indicate deeper depths to a resource of interest than the targeted 4600 ft TD. The gradient may also be lower than this figure.

The total estimated cost for the drilling to 4000 feet was \$286,500, for an average drilling cost of \$71.60/ft. This cost does not include setting liner, mud fill in the annulus, geophysical well logging or demobilization of the rig.

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November 1, 1985

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

CASCADES PROGRAM

GEO-Newberry Inc. is continuing to deepen the Newberry core hole, although the hole is now reported to be tight so the end may come soon. Because the State of Oregon requires surface casing to 10 percent of the total depth, Newberry 1 is limited to 4650 feet. If the average drilling rate below 3,500 feet depth of 51 feet per day has continued, the hole may be near the depth limit now.

A generalized lithologic log has been drawn and the BHT plotted next to the log. From this preliminary data it appears that the base of the rain curtain correlates with several thin but impermeable ash-flow tuff units between depths of 3330 to 3440 feet. The non-welded silicic tuff units have clay altered and compacted zones. A thick basalt cinders unit (3113 to 3211 feet depth) may also contribute to controlling the base of the rain curtain.

INJECTION PROGRAM

Several more tracers have been added to the tracer stability testing program at UURI this week. These are 3, 5 bis (trifluoromethyl) benzoic acid, 4-ethyl benzenesulfonic acid, and rhodamine WT. These tracers will be tested at temperatures above 150°C.

ASCENSION ISLAND PROJECT

On October 29 Dennis Nielson and Susan Stiger of EG&G briefed the US Air Force and their support contractor, Pan Am, on the status of the Ascension Project. This briefing was held at Patrick Air Force Base, Florida. The

discussions centered on logistical considerations for getting personnel and equipment to the island as well as the support which will be required from Pan Am while the drilling and testing program is underway. We also had the opportunity to brief the new Base Commander, Col. Sinclair, on both the history of the project and our activities this next year.

We have released an RFQ for the services of a drilling supervisor to help with the drilling program on Ascension Island. Responses to this RFQ are due next week. Otis Day, our drilling engineer, is completing his specifications for the well. We presently need to finalize the specifications for the pump. Sue Stiger is working on this and we expect a final answer this week. We are also preparing RFP's for both drilling services and geophysical logging services. These RFP's have been announced in CBD, and the RFP's can be released as early as next week.

CONTINENTAL SCIENTIFIC DRILLING

Dennis Nielson and Jeff Hulen have received funding from DOE's Office of Basic Energy Sciences for a study of hydrothermal alteration and structurally induced permeability in VC-1. This hole was drilled just to the south of the Valles caldera by Los Alamos. Preliminary results will be presented at the American Geophysical Union in December.

Our joint proposal with Los Alamos to drill VC-2a into an active vapor dominated system in the Sulphur Creek area of the Valles caldera is presently being reviewed by DOE/OBES. We continue to get encouragement that this project will also be funded this year.

On October 18, Dennis Nielson represented UURI at the annual meeting of DOSECC in Washington, D.C. This organization intends to support scientific drilling in the Creede caldera this year, and hopes to make progress toward deepening an existing hole in the Cahon Pass area of California to a depth of 16,000 feet.

STATE COUPLED PROGRAM - CURRENT EVENTS

The Washington State Coupled Program team reports that they are working up data from their thermal gradient drilling program this past summer. The last hole they drilled was in the Trout Creek Hill area of the Wind River Gorge, between Mt. St. Helens and the Columbia River. The hole was drilled to 356.7m, with a bottom hole temperature of 363°C. Thermal gradients were approximately 90°C/km over most of the hole, but dropped in the bottom 20 m to about 40°C/km. The gradient of this hole will be remeasured soon. Preliminary results of the Washington drilling program will be presented in December at the Northwest Mining Convention in Spokane, WA.

REPORT PUBLISHED

Duncan Foley of the Earth Science Laboratory, and Charles Woodruff, formerly P.I. of the Texas State Coupled Program team, published "Thermal regimes of the Balcones/Ovachita trend, central Texas" in the transactions of the Gulf Coast Association of Geological Societies. A copy of the abstract from this paper is attached.

THERMAL REGIMES OF THE BALCONES/OUACHITA TREND, CENTRAL TEXAS

C.M. Woodruff, Jr.¹ and Duncan Foley²

ABSTRACT

Local groundwater temperatures and bottom-hole temperatures (BHTs) for oil and gas wells present two lines of evidence indicating positive regional geothermal anomalies along the Balcones/Ouachita trend in Central Texas. Analysis of the variables in the heat-flow equation, however, indicates that these anomalies are probably not due to conductive heat flow; most of the rock units for which data exist are limestones and sandstones, and thus, should have high thermal conductivities (and low geothermal gradients). Measurements of heat flow are few along this trend, but because the strata for which BHT data exist generally contain fluids, it is reasonable to assume that hydrodynamics plays a role in creating these apparent thermal anomalies. In short, Darcy's Law, not the heat-flow equation, may control thermal conditions: rocks having high thermal conductivities generally also have high hydraulic conductivities, so that upwelling warm waters may account for the observed thermal anomalies. Since upwelling waters also may be important conveyors of hydrocarbons, these geothermal/hydrodynamic anomalies also indicate promising areas for petroleum exploration.

Detailed investigations, however, demonstrate that these regional anomalies have high-frequency perturbations; local areas within a regional high may have anomalously low temperatures. Local faulting not discernible on a regional scale may control detailed hydrodynamic conditions, forming structural traps for hydrothermal fluids as well as for hydrocarbons. But they can also localize downwelling recharging waters that impart a low thermal anomaly. The radius of influence within which any well "senses" the ambient thermal regime is probably small within a fault zone, dictated by detailed stratigraphic dislocations. Although complex perturbations affect the prevailing thermal regime in ways not yet completely understood, some of these geothermal anomalies indicate general areas of long-term upwelling from deep within the Gulf Coast Basin. Thermal anomalies may prove to be indicators of economic geothermal resources. They also may indicate hydrodynamic petroleum traps, in which warm waters might have filtered through a trap zone during the process of petroleum accumulation. These thermal anomalies may point toward hydrocarbons in a downstructure direction.

Gulf Coast Association of Geological Societies Transactions, v. 35, pp. 287-292.

UURI

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November 8, 1985

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

CASCADES DRILLING PROGRAM

The Newberry N-1 core hole reached T.D. on Friday, Nov. 1 and was logged during the weekend. The logs ran included temperature, gamma, resistivity, SP, caliper from 1800-3420 ft and from 455-1240 feet and sonic, from 1800 ft to T.D. The interval between 1240 ft and 1800 ft was logged for temperature and gamma only through the drill pipe because of tight hole condition.

Five copies of the field logs are being sent to UURI. A copy of the tape logs and transparencies of the paper logs will be delivered in about a month.

The temperature measured at 4000 ft was 155°F (68°C at 1,219 m depth). Other temperatures reported are 138°F at 3700 ft, 146°F at 3800 ft, 152°F at 3900 ft. This suggests a gradient of 4.5°F/100 ft (82°C/km) for the 3800-4000 ft interval.

Arrangements are being made to divide the core and transport DOE's share to the UURI sample library.

INJECTION PROGRAM

A program to list, procure, and test 45 new derivitized hydrocarbon tracers was initiated this week. The program will be carried out in conjunction with Dr. Harold Bentley, and is designed to test tracers that are more amenable to the geothermal than the groundwater environment.

STATE COUPLED PROGRAM

Leah Street of the Idaho State Coupled Program team reports that they are continuing to monitor the Twin Falls and Banbury geothermal areas. In Twin Falls, the early pressure drop in the reservoir has leveled off during the past few weeks of warm weather. One well, which had a pressure of 28 psi 14 months ago is now at 11.9 psi, however. The rate of pressure drop will probably increase as the weather cools more. At Banbury, a drop in reservoir pressure is also being noted with the cooling season starting, and local geothermal entrepreneurs are considering forming a water users group to regulate the resource.



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November 15, 1985

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

INJECTION PROGRAM

One paper has been generated under this program for presentation at the 11th Stanford Reservoir Engineering Conference. It was coauthored by M. Adams (UUURI), J. Ahn (Univ. of Utah), H. Bentley (Hydrogeochem Inc.) and J. Moore (UUURI). The paper will describe results of our experimental tracer investigations on various fluorinated and sulfonated hydrocarbons as well as the organic dyes fluorescein and rhodamine. These studies show that the hydrocarbons have significant potential as geothermal tracers.

CASCADES DRILLING PROGRAM

Arrangements have been made to have the Newberry N-1 core divided next week and the DOE split transported back to Salt Lake City for storage in the UUURI sample library. Study and interpretation of the geophysical logs from the Newberry hole will proceed during the winter months.

STATE COUPLED PROGRAM - CURRENT EVENTS

Dr. Henry Heasler at the University of Wyoming reports that he has begun compilation of hydrologic and thermal data in the vicinity of Jackson, WY. These data will be used to develop a computer-based model of thermal spring and warm well occurrences both north and south of town. The model will provide valuable data to both people interested in geothermal development (a federal fish hatchery) and those concerned about potential environmental impacts of high-temperature resource exploitation.

STATE COUPLED PROGRAM - FUTURE EVENTS

Dr. William Gosnold, University of North Dakota, will be making a presentation on thermal regimes of sedimentary basins at the December meeting of the Interstate Oil and Gas Compact Commission.

RESERVOIR TECHNOLOGY PROGRAM

One paper by ESL scientists has been accepted for presentation at an upcoming professional meeting. Coauthored by J. Moore and D. Nielson, the paper will be presented at the regional meeting of the Society of Petroleum Engineers to be held in February. This paper will describe the application of various chemical and mathematical techniques that can be used to predict fracture and fluid flow patterns in geothermal reservoirs.

UURI

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November 22, 1985

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM

Leah Street, the State Coupled Program Principal Investigator in Idaho, reports that she has received the first report from subcontractors at Boise State University who are researching the Boise geothermal system. The news, on the basis of preliminary data, may not be encouraging. The Boise system did not recover as much during this summer as it has in past summers, and drawdown this fall is greater than at the same time last fall. Careful observations will be made through the upcoming heating season, to verify these trends and research their long-term nature.

GEOCHEMISTRY

A new high temperature autoclave purchased by the Dept. of Metallurgy at the University of Utah for UURI's tracer studies has been installed. The autoclave is capable of sustaining temperatures of up to 350°C. This autoclave will allow us to extend the present temperature limit of about 200°C up to temperatures more typical of high temperature geothermal fields. Experimental results obtained using this autoclave will be presented at the 11th Stanford Reservoir Engineering Conference.

CASCADES DRILLING PROGRAM

UURI personnel have divided the GEO-Newberry N-1 core and boxed it. The Department of Energy's half of the core will arrive in Salt Lake City on Saturday, Nov. 23 for storage in UURI's sample library where it will be available for interested investigators. An open file release of the

geophysical logs is in the planning stage and awaiting an adequate number of copies of the logs.



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November 27, 1985

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

CASCADES

Core from NC-1 drilled on the south flank of Newberry caldera has been shipped to the Geothermal Sample Library at UURI and is presently being sorted and filed. We are presently planning a data release at which time interested parties will be able to inspect both the core and the geophysical and lithologic logs from NC-1. The geophysical logs will be sent to Rocky Mountain Well Log so that copies will be available at a low cost. In addition, a new edition of the Cascades geothermal Newsletter is being prepared for release.

ASCENSION

Procurements for Geophysical Logging and Drilling Services are presently being reviewed by DOE. The project is approximately three weeks behind the initial schedule due to delays in the procurement process. We hope to be able to make up this time between now and the time the rig is mobilized to the island.

STATE COUPLED PROGRAM

The appropriateness of research conducted under the State Coupled Program to the needs of industry is well illustrated by the work of the Geophysical Institute at the University of Alaska and the Alaska Division of Geological and Geophysical Surveys. They have an ongoing project to perform basic research into the nature of the Mt. Spurr volcano and any associated geothermal systems that may exist there. The Alaska Division of Oil and Gas

is considering a lease at the area, which drew little previous leasing interest. Dr. Chris Nye of DGGs personnel reports that now there is current industry interest, and a desire by industry to obtain raw data from last summer's work. These data will be released through the DGGs Public Data File mechanism, once approval has been received from DOE. The data were contained in the recent quarterly report on the project.



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December 6, 1985

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

CASCADES DRILLING PROGRAM

UURI personnel are starting interpretation of the GEO-Newberry N-1 geophysical well logs. The gamma ray log has been correlated with the lithologic log, compiled by Mike Johnson (GEO-Newberry), and tentative revision of rock names has been made based on gamma ray log values. The interpretation of andesite or dacite lava flows, for example, will be refined by using whole-rock chemical analysis of some of the lithologic units to calibrate the gamma ray log. A study to determine what is producing the regional electrical conductor detected by surface geophysics is also in progress. Highly conductive horizons appear to be correlated with clay altered units. X-ray analysis and laboratory measurements of the physical properties of selected rock samples are planned. The acoustic logs appear to be quite valuable in picking flow boundaries and other contacts.

Compilation and analysis of data for a volcano model of plutons and thermal systems in the Cascades subvolcanic setting is continuing. Preliminary results suggest that typical intrusions under an andesitic stratovolcano are 1.5 to 3 km in diameter and 3 to 5 km below the surface or summit. Plutons examined in the Western Cascades are in this size range.

ASCENSION

The RFP for the Ascension drilling contract was released to 19 drilling companies on Dec. 4. Preliminary responses indicate about 12 companies are interested enough to send representatives to the preproposal meeting scheduled for 1:00 PM December 9, in Salt Lake City. A field site inspection for prospective drillers is planned for the week before Christmas.

The RFP for the geophysical logging of the exploration hole on Ascension is in final preparation and will probably be released on Dec. 6th.

GEOCHEMISTRY

Union Geothermal has agreed, as a result of the work done today on their Salton Sea wells, to provide ESL scientists with an additional well from the Salton Sea. Union Geothermal is particularly interested in obtaining isotopic fluid inclusion data. We anticipate receiving the cuttings at the end of January.

UURI

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December 13, 1985

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM

Dr. Duncan Foley has been contacted by an editor of a guidebook that will be published in conjunction with the 1986 annual meeting of the Geological Society of America in San Antonio, Texas. He will be contributing an article on the thermal regime of the San Antonio area. This article will be based on the geothermal research done under the State Coupled Program, and a geothermal well drilled by the Earth Science Laboratory at Lackland Air Force Base in San Antonio. The Air Force has granted permission for release of all data from the well.

ASCENSION ISLAND PROGRAM

Representatives from seven drilling companies attended the proposal meeting in Salt Lake City, Utah on December 9th. These seven companies plus two other companies submitted qualification statements. The U.S. Air force was able to schedule only six people for a site visit to Ascension Island on Dec. 16 through Dec. 18. Those going on the 16th include Bruce Sibbett, leading the trip, Otis Day, project drilling supervisor, and four drilling company representatives. A second site visit is being arranged for the other five drilling companies in January.

CASCADES DRILLING PROGRAM

Study of the GEO-Newberry N-1 logs is continuing. The next step will be to select clay intervals for X-ray and chemical analysis to determine what is producing the SP change in the interval in which the temperature gradient

sharply increases.

GEOCHEMISTRY

Thirty-nine hydrocarbon, fluorocarbon, and sulfonated hydrocarbon tracers are currently being tested as potential geothermal tracers. The tracer/distilled water solutions are being heated to 250°C for up to one week in a nitrogen as well as in an oxygen gas phase. This experimental design should rapidly eliminate unsuitable tracers. Those tracers that do prove stable will be tested under a variety of other conditions.

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December 20, 1985

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM

The Oregon team reports that they are making good progress in their geologic mapping of the High Cascade-Western Cascade transition zone. They are in the process of studying about 200 thin sections from the areas, to verify lithologic correlations. Data from Sunedco thermal gradient studies has been delivered to Dr. David Blackwell of SMU, for inclusion in his data files. These data, which are from about a dozen holes, will be open-filed for use by industry in spring. Oregon will be publishing their scientific plan for drilling in the Cascades in two parts. Part 1 will be a general description of the program, and Part 2 will be an open-file of detailed technical data. These should also be available in spring.

GEOCHEMISTRY

Twenty-six potential hydrocarbon tracers have been tested at 250°C for one week to simulate geothermal conditions. The tracers tested include various fluoro-, methyl-, and trifluoromethyl-isomers of benzoic and phenylacetic acids. Sulfonic and diacid isomers have not yet been tested. Preliminary results of the tests indicate that many of the compounds degraded under atmospheric oxygen conditions. The structure of those compounds that did survive the test conditions will be used to search for other stable tracer compounds.

ASCENSION ISLAND

A field trip to Ascension was made this week by Otis Day, project drilling supervisor, and representatives of Loffland Drilling, Willbros

Drilling and Eng Inc., prospective drilling companies for the project. The trip was led by Bruce Sibbett. Everyone had a good opportunity to see the conditions on the island. It was determined that several logistical problems and support needs remain to be solved before mobilization for the drilling. The number of unresolved issues as to how some support needs will be met adds uncertainty and therefore costs to the project.

GEOLOGY

Two papers were presented by ESL geologists at the 1985 Fall Meeting (December 9-13) of the American Geophysical Union (AGU) in San Francisco, California, as part of a special session on VC-1, the first Continental Scientific Drilling Program Corehole in the Valles caldera. The first paper, by Jeff Hulen and Dennis Nielson, was entitled "Altered Tectonic and Hydrothermal Breccias in Corehole VC-1...". The second, by Nielson and Fraser Goff (Los Alamos National Laboratory) detailed plans for drilling several additional coreholes in the caldera.

Discussions were held with California Energy Company geologists at the AGU meeting concerning fieldwork by ESL to be completed in January 1986. The fieldwork will be an initial phase in characterization of the Wheeler mercury prospect, in the Coso Hot Springs KGRA, California.

GEOPHYSICS

Two papers also were presented by ESL geophysicists at the 1985 Fall Meeting of the AGU in the special session on Electromagnetic Induction in the Crust and Mantle. The first, by John A. Stodt and Philip E. Wannamaker, detailed recent improvements in finite element modeling of 2D MT responses, including stabilization of responses to ultralow frequencies and the incorporation of topography. The second, authored by Wannamaker, presented a model for electrical conductivity of water-undersaturated crustal melting including quantities and temperatures of first appearance of H₂O-CO₂ fluids in the deep crust as a function of composition and metamorphic grade.

An invited paper by ESL geophysicists was published in the Golden Anniversary Issue of GEOPHYSICS (December). The paper titled "State-of-the-art-Geophysical Exploration for Geothermal Resources" is authored by Phillip M. Wright, Stanley H. Ward, Howard P. Ross, and Richard C. West.

UURI

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January 3, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

CASCADES

A study of fluid inclusions from stocks and veins in the western Cascades is in progress to determine temperatures and salinities of hydrothermal systems in the Cascade volcanic province. Alteration samples selected from the GEO-Newberry N-1 core will be analyzed to determine alteration minerals and try to relate the alteration to the geophysical logs.

ASCENSION ISLAND PROJECT

Bids for drilling materials and support services are being solicited from interested suppliers. As bids come in near the end of January the cost of the project components will be better defined. Bids for the geophysical logging of the hole are due next week on January 7th.

GEOCHEMISTRY

We continue to make good progress on our investigation of the Salton Sea geothermal systems.

Heating and freezing measurements on approximately 100 fluid inclusions in anhydrite from two wells provided by Union Geothermal have been conducted. Homogenization temperatures increase systematically with depth and there appears to be little difference in the homogenization temperatures of primary and secondary inclusion from any given depth or between wells. The shape of the thermal profile defined by the fluid inclusion measurements is similar to profiles that characterize the present geothermal field. However,

the temperatures are higher than the present temperatures found at the same depth in other high temperature wells.

In contrast, the salinities vary by several percent between inclusions from the same intervals. In addition, although the data display a pattern of increasing salinity with depth, the pattern is less regular than for temperature. Anhydrite is known to recrystallize easily and thus inclusions which petrographically appear to be primary may actually be secondary. Some of the anhydrite may have recrystallized repeatedly during incursion of different fluids.

Together, the temperature and salinity measurements suggest that 1) the temperature profile preserved within the caprock is primarily the result of conductive heating by the geothermal system below, 2) the caprock has always been a zone of low permeability, and 3) despite relatively large variations in the salinities of the fluids that migrated through the caprock these fluids have apparently not substantially affected its thermal structure.

STATE COUPLED PROGRAM

The Utah State Coupled Program team reports good progress on two major deliverables. An annotated bibliography of geothermal resources is being typeset. The report on high-temperature resources will be ready for review next week. This report concludes that several areas are good targets for high-temperature resource exploration, beyond the presently producing Roosevelt Hot Springs and Cove Fort sites.

UURI

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January 10, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

ASCENSION GEOTHERMAL PROJECT

Only two bids for geophysical logging were received. The RFP was sent to twelve companies. However, the bids were from leaders in the logging industry, Schlumberger and WellEx, and were within original cost estimates. The selection committee has reviewed the bids and the selection officer will clear his decision with DOE, Idaho.

Next week Dennis Nielson will lead the second site visit to Ascension for potential drilling contractors. Six companies will be represented on this trip. Dennis will also meet with Pan Am and Air Force officials in Florida to further resolve logistical and support issues.

CASCADES RESEARCH

Study of alteration minerals in the GEO-Newberry N-1 core is continuing at a slow pace as time is available from other programs. Limited data has been obtained on the drilling capability of a Portland, Oregon based drilling company which can rotary and wireline core drill with their modified Portadrills. This company, Janssen Well Drilling, may be the driller for the Thermal Power and Blue Lake holes.

INJECTION RESEARCH

Results on the hydrothermal testing of 26 hydrocarbon tracers were received this week. The data indicate that six of the tracers are stable at 250°C for one week. Preliminary interpretation of the results demonstrate that the primary factor in stability is the placement and identity of the aromatic substitutions, rather than steric (size and shape) factors of the molecules.

UURI

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January 17, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM

The Idaho state team reports that they have obtained cuttings from a 1250' hole north of Filer. Cuttings from this hole, which was drilled by the U.S. Geological Survey, have not been previously logged. Water flows from the well at 37°C, and it apparently bottoms in rhyolitic volcanic rocks. These are similar characteristics to the adjacent Twin Falls geothermal system. Logging the Filer well should provide great insight to our understanding of the nature of the Twin Falls system.

INJECTION

This week interpretation continued on the results of the sulfo-fluoro-hydrocarbon (HsFc) tracer tests. Our preliminary findings are that the systematics of decay are more predictable in non-oxygenated solutions. HsFc compounds in oxygenated solutions display a more rapid decay rate and the species that survive show little systematics.

ASCENSION PROJECT

Dennis Nielson returned from the site visit for the drilling contractors on Wednesday and met with the U.S. Air Force and Pan Am people in Florida on Thursday. Slow headway is being made on resolving logistical problems for the project.

A few proposals for support services for the drilling have been coming in and other potential suppliers are promising proposals.

Next week Otis Day, the drilling supervisor, and Bruce Sibbett will visit and inspect most of the proposed drill rigs.



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January 24, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

ASCENSION ISLAND PROJECT

Bruce Sibbett and Otis Day have spent this week inspecting drilling rigs in the Texas-Oklahoma area in preparation for evaluation of drilling proposals. Nielson met last week with USAF transportation people at Patrick AFB. They stated that the USAF will make a decision on the transportation method to be used to mobilize the rig and equipment to Ascension Island. This will include a decision on the use of an ocean-going landing craft or the mobilization from some port other than Port Canaveral. The principal limitation on the mobilization of the equipment remains the 35,000 lb capacity of the off-loading facilities on the island.

Nielson will meet with Sue Stiger of EG&G this week to brief her on last week's trip to the island. Nielson and Wil Forsberg will meet with DOE personnel in Idaho Falls next Monday to review contracting procedures for the project.

Schlumberger has received the recommendation for award of the geophysical logging contract on Ascension. Negotiations are now underway.

GEOCHEMISTRY

Preparation of samples for fluid inclusion studies from the Coso geothermal field is underway. The samples were collected by J. Hulen from a core hole drilled by California Energy. The samples being prepared are late-stage fillings of calcite and quartz that occur in open fractures. The results of this work will be used to help map the fluid flow patterns and distribution of fluid types in this geothermal system.

INJECTION

Mike Adams presented a series of papers on tracers at conferences held in Stanford this week. The first, entitled Tracer Development: Results of Experimental Studies, was presented at the 11th Stanford Reservoir Engineering Conference. The paper is coauthored by J. Ahn (Univ. of Utah), H. Bentley (Hydro Geo. Chem), J. Moore (Univ. of Utah Research Institute) and S. Veggeberg (Hydro Geo Chem). The second paper was presented at a special symposium on chemical interactions in reservoirs that followed the conference. This paper, titled Hydrocarbons as Geothermal Tracers, describes the chemistry and potential applications of hydrocarbon species as tracers in liquid and vapor dominated geothermal systems.

GEOLOGY

Jeff Hulen spent the week of January 13 mapping in detail the surface geology and hydrothermal alteration of the Wheeler mercury prospect in the Coso geothermal area, California. The mapping, as well detailed logging of a 2000' corehole recently completed on the prospect by California Energy Company (CEC), is being completed in close cooperation with T. J. Echols, CEC's Coso site geologist. Characterization of Wheeler, centered on cinnabar-rich siliceous sinter mounds, will improve understanding of the entire Coso geothermal reservoir, a high-temperature liquid-dominated system which CEC has only begun to develop with at least five commercially productive wells.

Bruse

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January 31, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

INDUSTRY SUPPORTED RESEARCH

This week P. M. Wright and D. L. Nielson visited a number of geothermal companies in the Bay area to discuss problems, research objectives and the concept of industry participation in geothermal research projects. This trip was supported through UURI funds, and companies included GEO, Freeport, California Energy, and Thermal Power. Additional discussions are planned with Chevron and Oxbow. The interviews were similar to those which we formerly conducted through the Exploration Technology Program. Discussions focused on the problems facing geothermal companies at the present time. The concept of joint projects was generally supported; however, many companies have tight finances and would only be able to participate in the research through the contribution of data.

ASCENSION ISLAND

D. L. Nielson and W. L. Forsberg discussed procurement and contracting with DOE representatives in Idaho Falls on Monday. We also summarized project developments and anticipated events. The activities of the next month will principally concern the contracting for drilling services and support equipment and supplies. The USAF will make decisions concerning the method of transportation of equipment to the island, and this may well affect the choice of a drilling contractor.

GEOLOGICAL RESEARCH

Mapping of the Wheeler mercury prospect and vicinity in the Coso

geothermal area, California, by Jeff Hulen and Tom Echols (California Energy Company) has revealed several interesting features which furnish new insight into the thermal history and development of reservoir controls in the high-temperature Coso geothermal system. Dense, fine-crystalline felsic intrusives at Wheeler are almost invariably far more fractured or rubblized than the basic meta-igneous rocks which host them, and are commonly much more extensively hydrothermally veined and altered. Field estimates of fracture porosity on these rocks are as high as 7 volume percent, vs <0.5% in the basic-composition host rocks. Presence of such "flinty" felsic intrusives at depth in the Coso system would almost certainly help focus thermal fluid flow. Also of interest at Wheeler: siliceous sinter has been found encrusting a 234,000 year-old basalt flow formerly believed to post-date the sinter. The sinter, in turn, is plastered with coherent pyroclastic surge debris believed most likely to have been erupted from 40,000 year-old Sugarloaf Mountain; at least some of the sinter is therefore bracketed on age between 40,000 and 234,000 years.

Union Oil Company has provided well logs for several additional wells in the Sulphur Springs area, Valles caldera, New Mexico. Data from these wells (Baca 1, 2, 3, 7 and Bond No. 1) allow better definition of the thicknesses and distributions of Valles/Toledo intra caldera sandstones, a manuscript concerning which is nearing completion. The sandstones are sensitive recorders of the development of the Valles and Toledo calderas and related geothermal systems.

CASCADES PROJECT

GEO Newberry plans to release their data for the N-1 corehole at Newberry caldera to UURI on 1 Feb 86. UURI already has possession of most of DOE's split of the core. We will advertise the availability of the data and core for 2 weeks and then release these items to the public in mid-February.

The N-1 corehole was highly successful in its scientific objectives. The temperature log shows clearly that the bottom of the rain curtain is at 3267 feet. The boundary is very abrupt and appears to correlate with a fracture zone in the middle of a non-porous dacite unit. The geophysical well logs contain a wealth of data that will be correlated with core studies over the next few months, and this will enable us to calibrate the logs.

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February 7, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

INJECTION RESEARCH

Analyses of 39 potential geothermal tracers have been interpreted with respect to stability and implications for other potential tracers. Of the 39 tracers tested, 16 survived the 250°C, 1 week experiment at greater than 80% of their initial concentration. These 16 will be tested further. Recommendations for other tracers are:

- 1) Methylated monofluorinated benzoic acids
- 2) monofluoro sulfonic acids
- 3) other aliphatic substituted sulfonic acids
- 4) monomethylated benzoic acids
- 5) perfluorinated aliphates (vapor phase tracers)

ASCENSION ISLAND PROJECT

Proposals have come in from the drilling contractors and these will be opened Friday, Feb. 7th. The review committee will meet on Monday, Feb. 10, to start formal review and make recommendations for selection of the drilling company.

Otis Day and Sue Stiger will be in Salt Lake for the review process.

Proposals and bids for all the support services and expendible materials have been received and cost comparisons worked up. Selection of source companies will probably be started next week.

CASCADES

The data package from Geo-Newberry Crater Inc. arrived this week. A second Cascades Geothermal Newsletter has been prepared and will announce the open filing of the data on Feb. 24. Highlights of the data from the Newberry Core hole are given in the newsletter.

STATE COUPLED PROGRAM

The Montana team reports that they are making good progress on their study of the Ennis geothermal system. They have analyzed their gravity data, and are now completing additional field work to fill in crucial gaps. The Montana team has completed a 1-D inversion of their electrical data, and are now starting a 2-D interpretation. Results of the Ennis studies will be available in late spring.



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February 14, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

GEOCHEMISTRY

Petrographic studies of calcite from Coso core hole 64-16 indicate that micron size fluid inclusions are abundant. The inclusions are secondary in origin; thus they provide a record of the temperatures and fluid compositions since the growth of the calcite. Preliminary heating and freezing measurements indicate that the fluids were low in salinity, near .5 weight percent equivalent NaCl, and low in temperature. The calcite occurs as a late stage mineral that partially fills voids in brecciated rock.

ASCENSION ISLAND

Proposals for drilling services for the Ascension Island project were reviewed this week at UURI. The top contender for the contract is a TBA 2000 rig from Parker Drilling Co. of Tulsa. This rig is presently in Manaus, Brazil, and is helicopter transportable which eliminates many of the handling problems which result from the crane capacity on Ascension. Our drilling consultant Otis Day has left for an inspection of the rig. We have initiated contract discussions with Parker and a draft contract has been sent to DOE/ID for approval. Contingent upon the favorable outcome of the site visit and contract negotiations, we anticipate signing a contract with Parker.

The USAF has changed the schedule for transportation by ship to Ascension. This week we were informed that ships would leave from Savannah, GA every week. Cargo would be transferred in the U. K. and sent on to Ascension every twelve days. This presents a much more flexible shipping schedule, but the voyage will require 5-6 weeks in contrast with the two weeks in the previous schedule. In addition, it increases the likelihood that cargo

will be lost. We are presently working closely with Patrick AFB on this change.

Sibbett and Nielson will leave for Ascension on Feb. 24. This will provide an opportunity to brief Stiger of EG&G and a Parker representative concerning operation on the island. In addition, we will finalize the drilling site and instruct Pan Am on the construction of the drill pad. We will also take care of a number of other logistical considerations.

GRC SHORT COURSE

Wright gave about 3 hours of presentation to the GRC Short Course on Feb. and 6 on the topics of nature of geothermal resources and exploration for them. The course was entitled "An Introduction to Geothermal Resources," and was attended by about 80 people, a surprisingly high number. It is apparent that there is a great deal of interest in geothermal resources in spite of the downturn in oil prices.

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February 21, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM

Leah Street of the Idaho Department of Water Resources presented a talk at the Pacific Northwest section meeting of the Geothermal Resources Council this week. Her talk was on the role of groundwater in geothermal developments in Idaho. The Banbury and Twin Falls geothermal systems have been declared by the State of Idaho to be groundwater management areas. This means that development in these regions is controlled. Leah's talk documented the change from optimistic projections of the potential of geothermal development that existed in the late 1970's, to the atmosphere, which is subdued and, in some cases, litigious.

Ms. Street is also the author of an article on greenhouse applications of geothermal energy in southern Idaho. This article appears in the latest issue of the Oregon Institute of Technology Geo-Heat Center Quarterly Bulletin, along with several other articles on greenhouses.

CASCADES

Requests for the open-file data on the Geo-Newberry N-1 hole are already arriving at UURI.

Terry Keith and Keith Barger of the USGS have come to Salt Lake to look at the core and collect samples for secondary mineral and alteration studies.

ASCENSION

Dennis Nielson, Sue Stiger and Bruce Sibbett will fly to Ascension Island on Monday to site the hole and check final logistical factors prior to mobilization of the drill rig. The drill site will be layed out and construction will begin as soon as Pan Am can arrange it in their work schedule.

GEOCHEMISTRY

Fluid inclusions are fluid filled micron sized cavities that are found in geothermal minerals such as quartz, calcite and anhydrite. By heating and freezing these inclusions, information on the composition and temperature of the geothermal brines occurring in the reservoir rocks can be obtained. However, this heating may cause the cavities to stretch inelastically, and the laboratory measurements made will not be accurate. No stretching data has yet been published for anhydrite, one of the more commonly used minerals for fluid inclusion work. Our initial measurements indicate that the amounts of overheating (heating above the temperature of deposition) needed to stretch fluid inclusions in this mineral is highly variable. Large, elongate inclusions (20-40 microns long) will stretch when overheated by about 10-35°C while small cubic inclusions (1 to 3 microns on a side) must be overheated by 30-70°C before stretching occurs. We will use this data to guide the amount of heating the inclusions are subjected to.

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February 28, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

GEOCHEMISTRY

A manuscript entitled "Geothermal systems in mountainous terrains - an example from Meager Mountain" by M Adams and J. Moore has been submitted to the American Journal of Science for review and publication. The paper describes the geochemical relationships at Meager Mountain and suggests that fluid flow is driven by hydraulic head differences, rather than convection. The consequences of this model are discussed. A copy of the abstract is given below.

ABSTRACT. Drilling for geothermal fluids at Meager Mountain, in southwestern Canada, has provided an opportunity to study hydrothermal processes and fluid flow beneath an active stratovolcano. The drill holes encountered temperatures as high as 264°C in altered crystalline basement rocks that act as the geothermal reservoir. Petrographic, mineralogic and trace element studies have been used to establish the paragenetic relationships among the several thermal events that have affected these rocks as well as the geologic controls on fluid flow related to the present geothermal system. Together these observations indicate that fault and fracture zones control lateral flow of the thermal fluids whereas steeply dipping dikes and hydrothermal breccias related to recent volcanic activity have been important in focusing vertical and upward movement of the fluids.

Four chemically distinct groups of thermal fluids occur at Meager Mountain. Three are NaCl in character and are associated with a well-defined thermal anomaly on the southern flank of the volcano. The fluids range from low-temperature, high-salinity brines to high-temperature moderately saline waters. The deep, high-temperature fluids display extreme shifts in both their deuterium and oxygen-18 contents compared to the other thermal waters. These shifts were used to calculate an equilibrium water-rock weight ratio of 0.045 at 150°C for the deep fluid. The close fit of the data to an equilibrium model indicates a long flow-time for the deep fluid.

NaHCO₃(-SO₄) water discharges from a hot spring on the northern flank of the volcano and is spatially associated with H₂S fumaroles and acid-altered rocks in a nearby drill hole. This fluid has formed by steam-heating of local groundwater accompanied by the condensation of H₂S and CO₂ in it. The data indicate that the steam-heating originated from a fluid that is isotopically distinct from the deep fluid found under the south flank of the stratovolcano.

The chemical and isotopic compositions of the NaCl waters show that little mixing of the different fluid types has occurred. In contrast, extensive fluid mixing is a common feature of highly productive geothermal systems in other volcanic terrains. In these systems, mixing is generally believed to result from convectively driven fluid flow in rocks of high permeability. We suggest that the lack of mixing at Meager Mountain reflects fluid flow through a few discrete fracture zones in a matrix of low permeability and that fluid movement is driven by topographically-controlled head differences. This model may be generally applicable to geothermal systems characterized by low permeabilities in mountainous terrains.

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March 7, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

ASCENSION ISLAND

Nielson and Sibbett along with Sue Stiger of EG&G spent last week on Ascension Island. This gave us the opportunity to acquaint Sue with the island, and it gave us the time to run some additional temperature measurements and site the 5000 ft well. The site chosen is adjacent to LDTGH. A New temperature profile measured in this well has a gradient of 138°C/Km which is higher than that measured two years ago. If projected to 5000 ft, this would result in a bottom hole temperature of about 200°C. The site was visited by Mr. Harry James, the Pan Am manager, and he provided the USAF with an estimate of time required for the site preparation. We visited the Island Administrator, Mr. Blick, with Lt. Col White, and they agreed on the required paper work to secure permission for the drilling of the well. Site preparation will begin on March 17. Sibbett will return to Ascension to supervise construction.

Back at Patrick AFB, Nielson briefed the USAF on the progress of the project. In addition, we discussed the transportation possibilities available to transport the rig and supplies to Ascension. The USAF Will be completing meetings this week to decide on transportation alternatives. In the mean time, we are purchasing supplies and sending them to Port Canaveral for shipping to Ascension. We still don't know the mechanism or timing of mobilization of the drilling rig from Manaus, Brazil.

Nielson participated on the technical review panel for well testing proposals at EG&G on Thursday.

INJECTION

Experiments testing the stability of derivatized hydrocarbon tracers in the presence of silicate minerals are being prepared this week. The solid phases of the tests will be smectite-silica mixtures and altered quartz-diorite.

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March 14, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM

The Oregon Department of Water Resources, in a surprise move, has written Peggy Brookshier of DOE/ID to tell her that they are not going to participate in the State Coupled Program. They are apparently concerned that working on the federal program would cause them to lose more than equivalent state funds. Personnel from Water Resources had proposed a program to test and monitor thermal aquifers.

INJECTION

Hydrothermal experiments were initiated this week to examine the effects of rock-water interactions on tracer concentrations. The tracer fluorescein was tested at 250°C for 114 hours in distilled water and dilute geothermal fluid that was allowed to react with drill chips from a production zone in a granitic host rock. The rock is composed of quartz, plagioclase, illite, chlorite, and epidote. Experiments are planned to test the effects of clay and hematite on tracer concentrations.

Preliminary results indicate that 1) The concentration of fluorescein decreased by 20% and 10% in distilled water and geothermal brine respectively, and 2) Similarly there were no significant differences in samples heated with and without rocks. These data suggest that the tracer lower in hot dry rock experiments in New Mexico and England are due to thermal decay rather than dispersion or adsorption.

ASCENSION ISLAND PROJECT

Purchase orders for most of the support services and materials for the drill have been sent out. A few details are yet to be resolved however. On Monday Otis Day, Sue Stiger, Dennis Nielson and Jack Frost will meet in California to discuss the well head and pump. Also next Monday Bruce Sibbett will fly to Ascension to supervise construction of the drill pad.

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March 21, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

INJECTION

A data package was received from Magma Electric Co. this week. The data was provided as support for the Magma DOE Injection Program cooperative project at East Mesa. The package consists of several years of fluid analyses, geophysical well logs, and graphic or digital pressure, temperature, and directional drilling reports. The chemistry data is being entered into a computerized database in preparation for detailed examination and interpretation.

ASCENSION ISLAND

D. L. Nielson, Otis Day, and Susan Stiger held a meeting with Jack Frost of Johnston Pump in Asuza, CA to coordinate the drilling of the well with the setting and testing of the pump. Among the topics discussed were that the pumps are fairly reliable and it is unlikely that it will have to be pulled for repair after the initial testing is satisfactorily completed. In addition, the best way to store the pump while it is not being used is to leave it in the well. A maintenance schedule will be provided so that Pan Am can keep it in operating condition after the pump test. As a result of these two factors, we have decided to demobilize the rig rather than have it on site during the testing. This will save approximately \$100,000.

Bruce Sibbett is on Ascension supervising the construction of the drilling pad. Supplies have been ordered and have started to show up in Port Canaveral. The USAF is still uncertain about shipping arrangements, but we expect a determination by them next week.

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March 28, 1986

MEMORANDUM

TO: Department of Energy

FROM: Mike Wright

SUBJECT: Weekly Highlights

INJECTION

The results of 39 potential geothermal tracers were received last week. The experimental conditions of this run were less harsh than the last run, i.e., 250°C vs. 200°C. Many more tracers were stable in this batch. Out of the 39, only six lost more than 10%. Most of those that decayed were in the perfluorinated and phenylacetic categories. These results are very encouraging with respect to the East Mesa injection tests scheduled for late 1986.

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April 4, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM

Two major reports were received from State Coupled Program participants this week. The Utah team has published an Annotated Geothermal Bibliography of Utah, by Karin Budding and Miriam Bugden. This 82 page report has hundreds of bibliographic citations, a comprehensive list of government-funded geothermal projects and geothermal developments in Utah, a list of currently developed geothermal areas, and a geographic index. The second major report is from the Washington team. The 1985 geothermal gradient drilling project for the state of Washington, by Brent Barnett, reports on the results of drilling 7 holes. The deepest hole, which was drilled at Trout Creek, reached 356 meters, had a bottom hole temperature of 36°C, and a gradient of approximately 83°C/km.

GEOCHEMISTRY

Joe Moore presented a summary paper this week at the Society of Petroleum Engineers Conference in Oakland, California. The subject of the paper was a review of geologic and geochemical techniques developed at UURI for mapping fractures and fluid flow patterns in geothermal reservoirs, and was coauthored by Dennis Nielson.

ASCENSION ISLAND

Bruce Sibbett is supervising the construction of the drilling pad. Most of the supplies have been mobilized to Port Canaveral and are presently being shipped to Ascension through the U. K. The USAF is negotiating for a ship to

take the rig from Manaus, Brazil to Ascension, and we will hopefully have a decision on the transportation question soon. We anticipate spudding the well in early May.

EAST MESA/MAGMA COOPERATIVE RESEARCH - INJECTION PROGRAM

A data package was received from Magma that contained the geophysical well logs and fluid chemistry from selected wells at East Mesa. We are compiling the chemistry data and beginning an interpretation of it. Magma has promised us chip samples from the wells soon.

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April 11, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM

Ms. Leah Street, of the Idaho Department of Water Resources, has been invited to present two talks at an upcoming symposium on geothermal applications at the Oregon Institute of Technology. Her first talk will be "Reservoir problems - case history and reservoir problems at Twin Falls, Idaho." She is currently performing research on the geologic controls of the Twin Falls reservoir. Her second talk will be "Cutting costs in geothermal greenhouses in southern Idaho." In this talk, she will synthesize many of the efficiency practices used in Idaho greenhouses.

INJECTION PROGRAM

One of the requirements for a fluid tracer is that there be no interaction with the minerals in the formation. Our program has thus far investigated the effects of temperature and oxygen concentration on tracer stability. During the last week we have begun to explore the effects of mineral-tracer reactions during the experimental runs. During this start-up phase of our rock-water experiments we are using fluorescein as the tracer because of the inexpensive analysis and rapid turnover time. As soon as the method is perfected we will test the derivatized hydrocarbon tracers.

Initially our data indicated that there was a significant reaction of fluorescein with rock at 250°C. However, it now appears that this was due to atmospheric oxygen adsorbed onto the drill chips used to simulate formation rock. We are currently testing a sonic cell disrupter to see if it will dislodge the adsorbed oxygen.

GEOLOGY

Preliminary characterization of stratigraphy and hydrothermal alteration in borehole B-8, in the Sulphur Springs area of the Valles caldera, has been completed and will be summarized in a manuscript for submittal to the Geothermal Resources Council.

B-8 is the only one of five intermediate-depth Sulphur Springs area boreholes for which cuttings remain available; thus providing a unique preview of the intracaldera volcanic stratigraphy and alteration likely to be encountered in Continental Scientific Drilling Program corehole VC-2a, proposed for drilling at Sulphur Springs later this year. B-8 is situated near the western "hinge" of the trapdoor Valles-Toledo caldera complex. The intracaldera volcanic sequence penetrated in the borehole is thus only about half as thick as in the Redondo Creek area, near the medial graben of the caldera's resurgent dome. Most of the units identified at Redondo Creek, however, are readily recognized in B-8, and should allow more detailed reconstruction of the geologic history of the entire caldera complex.

Alteration in B-8 consists of a high-level argillic/phyllic cap above a thick zone in which quartz, sericite, adularia, epidote, pyrite and rare fluorite are the important secondary phases. Silver bromide (bromyrite) has been identified tentatively in one quartz-adularia vein. The B-8 alteration zoning and mineralogy are even more similar to Creede-type epithermal silver/base metal deposits than are those encountered in the Redondo Creek boreholes.

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April 18, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM

Henry Heasler at the University of Wyoming reports that he is making good progress in developing a finite element model of the low-temperature thermal systems in the west side of Jackson Hole. He has completed a literature search to define the basin shape, and is presently investigating the question of how close a well needs to be to detect a linear heat source. A preliminary indication of Henry's modeling is that the thermal anomaly in the area may require greater than the conductive heat flow; there may be a heat source in the area of Jackson Lake. Henry will continue to gather data and refine the model to test this hypothesis.

ASCENSION ISLAND PROJECT

The drill pad was completed last week and Bruce Sibbett returned to Florida where he checked the supplies arriving at Port Canaveral for shipment. The supplies were being loaded in containers last Thursday and Friday. All of the supplies have now reached Florida except the cement materials and equipment which will be going to Savanna, Georgia for shipment. The time of the supplies' arrival on Ascension Island and shipment of the drill rig from Brazil are both still uncertain.

GEOCHEMICAL TECHNICAL DEVELOPMENT

Geothermal alteration in Coso Well 64-16, located on the margin of the system has resulted in the deposition of calcite between depths of 300 and 525

feet. The temperatures and salinities of the fluids that produced this alteration have been determined from a study of fluid inclusions found at depths of 326, 506 and 516 feet. The data show that the fluids had temperatures ranging from 150-170°C and salinities of about .5 weight %. The narrow range of temperatures and salinities indicate that the fluids were able to circulate freely in this zone. The fluids were below the boiling point curve at these depths.

VALLES CALDERA CSDP

We have been informed by DOE/OBES that the VC-2a corehole in the Sulphur Springs area of the Valles caldera has been funded. This is a cooperative project between UURI and Los Alamos, who will be responsible for the scientific investigations, and GDO at Sandia who will manage the drilling. The corehole will be about 500 meters deep. It is being drilled to sample a small vapor-dominated zone which is thought to underlie an area of acid-sulfate alteration. The hole and samples will allow scientific studies and monitoring of this vapor-dominated zone.

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April 25, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM

Studies by the Idaho Department of Water Resources are greatly expanding the known area of thermal manifestations at Guyer Hot Springs in Ketchum, Idaho. Thermal gradient measurements, water level recording, and collection of samples for chemical analyses, have identified many previously undocumented thermal features around the hot springs. These data will be included in a paper on geothermal systems in the Wood River district that is currently being prepared by Leah Street of IDWR and Duncan Foley of ESL/UURI.

INJECTION PROGRAM

M. Adams presented an overview of the experimental studies being conducted on derivitized hydrocarbons at ESL/UURI to a panel of industry representatives on April 24. To date, the thermal stabilities of 39 compounds have been determined to temperatures up to 250°C. The results of these studies indicate that hydrocarbons will be good geothermal tracers. A paper describing the experimental investigation has been prepared for the annual GRC meeting. The paper is coauthored by M.C. Adams (ESL/UURI), J. H. Ahn (Univ. of Utah), H. Bentley (Hydro Geo Chem Inc.), J. N. Moore (ESL/UURI) and S. Veggeberg (Hydro Geo Chem).

ASCENSION ISLAND PROJECT

The word from Florida indicates that the drilling materials left Port Canaveral this week on their way to Savanna, GA on the first part of their journey to Ascension Island. The cement materials are scheduled to arrive in

Savanna by April 30th and sail on the America-California freighter on May 3rd. It is assumed that the materials previously trucked to Florida will be on the same ship.

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May 9, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM

The New Mexico team reports that state-funded drilling at New Mexico State University, on which DOE is cost-sharing geological, hydrological, and engineering research, has been completed. The plan had been to deepen an existing well by 525 feet, to test seismic models of reservoir structure. The well was actually deepened 3 ft, when a lost circulation zone (probably a fault or a limestone cavern) was encountered. No resistance to drilling was felt in this zone, and no returns could be obtained. The zone was air lift tested for 8 hours, and produced 700 gpm of 140-145°F water, with only 5-6 ft of drawdown; full recovery was 20 seconds. This compares with other thermal wells in the area, which typically have 1 ft drawdown per gpm. Interpretation of the results of this well, including revised reservoir models, are being prepared for the final report.

GEOCHEMISTRY

Several new potential geothermal tracers have been ordered from our suppliers. These compounds should be more stable at temperatures >200°C than those previously tested. These compounds are:

3,5 Dichlorobenzoic acid	3,4 Dihydroxybenzoic acid
3,5 Dichlorosalicylic acid	3,5 Dihydroxybenzoic acid
3,5 Difluorobenzoic acid	Salicylic acid
3-Chlorobenzoic acid	3,5 Dichloro-4-hydroxybenzoic acid
5-Fluorosalicylic acid	3,5 Dibromo-4-hydroxybenzoic acid
2,3 Dihydroxybenzoic acid	5-Bromosalicylic acid
2,4 Dihydroxybenzoic acid	3-Bromobenzoic acid
2,5 Dihydroxybenzoic acid	5-Iodosalicylic acid
2,6 Dihydroxybenzoic acid	

The purpose of the -OH, -Br, and -Cl substitutions is to decrease nucleophilic substitutions on the ring structure.

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May 2, 1986

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM

Henry Heasler, principal investigator for the Wyoming State Coupled Program, reported that last weekend's editions of the Billings, Mont. Gazette discussed the drilling of a geothermal well at LaDuke Hot Springs, which are 7 miles north of Mammoth Hot Springs in Yellowstone National Park. The Church of Universal Triumphant drilled the well to intercept normal spring flow and use it for space heating and a swimming pool. They plan to produce less than 100 gallons per minute, which does not require a permit in Montana. Yellowstone Park personnel have expressed concern about any geothermal drilling this close to the park.

GRC PAPERS

UURI has submitted 5 papers to the GRC for the fall meeting and Transactions. The titles, authors and abstracts follow:

SURFICIAL ALTERATION AND SPRING DEPOSITS OF THE WHEELER MERCURY PROSPECT, WITH INITIAL RESULTS FROM WHEELER COREHOLE 64-16, COSO GEOTHERMAL AREA, CALIFORNIA, by T. J. Echols, J.B. Hulen, and J. N. Moore.

ABSTRACT

The Wheeler prospect is centered on the only known siliceous sinter in the Coso geothermal field. Active, acid-sulfate

kaolinization affects the sinter and nearby bedrock and alluvium. Silicified felsite and quartz latite at the prospect are probably subsurface equivalents of sinter; associated carbonate stockworks and travertine appear to be similarly affiliated.

Corehole 64-16 penetrates pre-Cretaceous metadiorite intruded by Cretaceous granitic rocks, felsites and quartz latites. Alteration consists of widespread chloritization and sericitization (illite and mixed-layer illite-smectite), development of a smectite cap, and selective silicification of felsites and quartz latites. Chlorite and epidote veinlets are widespread; late-stage calcite appears above 158m. The illite-smectite was probably developed at 175°-200°C, perhaps contemporaneously with sinter deposition. Fluid inclusions in subsequently deposited calcite homogenize at 150°-170°C, suggesting a post-sinter cooling trend.

BOREHOLE GEOPHYSICAL TECHNIQUES FOR DEFINING PERMEABLE ZONES IN GEOTHERMAL SYSTEMS, by P.M. Wright and S.H. Ward.

ABSTRACT

Borehole electrical geophysical methods have considerable potential for helping to define hot and permeable zones in geothermal systems. Borehole geophysics differs from geophysical well logging and has a much greater area of search around a borehole. Very little developmental work has taken place in borehole electrical methods to date. UURI has been developing computer methods to model various electrical arrays for borehole configurations. We plan to compare the many possible survey methods and then design a field system based on the method that appears from the computer studies to be optimum.

DERIVATIZED HYDROCARBONS AS GEOTHERMAL TRACERS, by M. C. Adams, J. H. Ahn, H. Bentley, J.N. Moore, and S. Veggeberg.

ABSTRACT

Thirty-nine potential geothermal tracers have been tested for thermal stability at temperatures up to 250°C. The tracers were aromatic hydrocarbons with moieties of trifluoromethyls, sulfonates, methyls, fluorides, or carboxyls. Significant decay of these tracers, except for the perfluorinated compounds, was noted only between 200°C and 250°C. At 200°C, 32 of the 39 tracers survived for one week; at 250°C, 15 survived. The perfluorinated tracers decayed completely at all temperatures tested. These results show that certain derivatized hydrocarbons are potentially suitable as geothermal tracers. Future research will include testing these tracers in the presence of solid, liquid and gas phases that are common in geothermal reservoirs.

ELECTRICAL RESISTIVITY ANOMALIES AT NEWBERRY VOLCANO, OREGON;
COMPARISON WITH ALTERATION MINERALOGY IN GEO COREHOLE N-1, by P.M.
Wright and Dennis L. Nielson.

ABSTRACT

Corehole N-1, drilled on the south flank of Newberry volcano in Oregon by GEO Operator Corp under a cooperative agreement with DOE, encountered about 15 separate horizons between 2800 ft. and 4000 ft. that are good electrical conductors as shown by an induction log. These conductors correlate with horizons of altered basaltic, andesitic and lacitic ash and tuff in a lithologic section composed predominately of basaltic andesite flows. X-ray diffraction and scanning electron microscope analyses show the dominant alteration type to be calcium smectite and we believe that the alteration is low temperature in origin. Surface electrical geophysical surveys have detected a widespread resistivity low in the Newberry area. A portion of this resistivity low is believed to be associated with the high-temperature hydrothermal system in Newberry caldera, whereas other portions of the low appear to be caused by the altered horizons on the flanks of the volcano. Delineation of the high-temperature system by electrical surveys may be difficult or impossible because of effects from the altered rocks.

STRATIGRAPHY AND HYDROTHERMAL ALTERATION IN WELL BACA-8, SULPHUR
SPRINGS AREA, VALLES CALDERA, NEW MEXICO, by J.B. Hulen and D.L.
Nielson.

ABSTRACT

Union Oil Company borehole Baca-8 (B-8) is a 1336 m geothermal well in the Sulphur Springs area, near the western "hinge" of the trapdoor Valles-Toledo caldera complex. B-8 penetrates essentially the same Pleistocene intracaldera rhyolite ash-flow tuff sequence as the wells along Redondo Creek, on the Valles caldera's resurgent dome. The sequence in B-8, however, is only about half as thick, and lacks the areally restricted "Upper Tuffs" of Redondo Creek. Alteration zoning in B-8 is characterized by a mixed-layer illite/smectite cap above an illite zone in turn overlying a K-feldspar + epidote zone. Comparison of these assemblages with contemporary temperatures in the well suggests that the rocks of Sulphur Springs have undergone a more complex thermal history than those of Redondo Creek, and that fluids responsible for alteration in the two areas were of different compositions.

CSDP REVIEW MEETING - BERKELEY

On Thursday, D. L. Nielson attended a meeting of the DOE Continental Scientific Drilling Review Group at Berkeley. This meeting was convened as to review current OBES drilling proposals for CSDP-Thermal Regimes. Nielson gave a presentation on the Valles drilling project which is a cooperative effort between UURI and LANL. In addition, he gave a presentation on DOE's Cascades drilling project. The comments from the panel centered on the scientific opportunities available in the Cascades and the need for more publicity to inform the scientific community about the location and availability of the samples. A similar presentation will be presented at a workshop in Rapid City in June.

ASCENSION

The USAF is having problems with shipping of the drilling supplies out of Port Canaveral. It will be as much as two more weeks before all of our materials have been shipped. They are in negotiations for a ship to carry the rig from Brazil to Ascension, and expect to be able to give us a shipping date within two weeks.

UURI

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September 27, 1985

MEMORANDUM

TO: Department of Energy
FROM: Mike Wright
SUBJECT: Weekly Highlights

STATE COUPLED PROGRAM

The Oregon Department of Geology and Mineral Industries reports that they are completing the geologic mapping of quadrangles along the high Cascades-western Cascades transition zone. Field work on the quadrangle has been completed, and the second should be finished in a few weeks. They plan to complete petrologic studies and map compilation by the end of December. Preliminary interpretations of the data suggest that major revisions in the chronology of geologic events in the western Cascades may be required, including the timing for a major sequence of rocks and the timing of a deformation episode.

ABSTRACTS

An abstract entitled "Geological and Geochemical Techniques for Fracture Mapping in Geothermal Reservoirs" by J. N. Moore and D. L. Nielson has been submitted to the Society of Petroleum Engineers for presentation at their 1986 California Regional Meeting.

ASCENSION ISLAND

A meeting was held in Idaho Falls with representatives of EG&G and DOE/ID to kick off the Ascension geothermal project. We are now formulating budgets for various aspects of the work. We are also making decisions on a drilling engineer for the project and are preparing CBD announcements in preparation for the release of RFP's for drilling and geophysical logging services. A follow-up meeting is scheduled for October 7 in Idaho Falls.

CASCADES DRILLING PROGRAM

Bruce Sibbett has been on site at the GEO-Newberry Core Hole N-1 this past week. Thursday's report indicated the depth was 2452' with a bottom hole temperature of less than 100°F. Bruce will make a more extensive report upon his return.

The first issue of a newsletter on the Cascades project was sent out to UURI's mailing list. It describes the deep thermal gradient drilling program and indicates the progress on the GEO-Newberry N-1 hole to date.