ESMERALDA ENERGY COMPANY
FINAL SCIENTIFIC TECHNICAL REPORT
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EMIGRANT SLIMHOLE DRILLING PROJECT
DOE GRED III (DE-FC36-04GO14339)

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1.0 Executive Summary

The Emigrant Slimhole Drilling Project ("ESDP") was a highly successful, phased resource evaluation program designed to evaluate the commercial geothermal potential of the eastern margin of the northern Fish Lake Valley pull-apart basin in west-central Nevada. The program involved three phases: (1) Resource evaluation; (2) Drilling and resource characterization; and (3) Resource testing and assessment. Efforts included detailed geologic mapping; 3-D modeling; compilation of a GIS database; and production of a conceptual geologic model followed by the successful drilling of the 2,938 foot deep 17-31 slimhole (core hole), which encountered commercial geothermal temperatures (327^{o} F) and exhibits an increasing, conductive, temperature gradient to total depth; completion of a short injection test; and compilation of a detailed geologic core log and revised geologic cross-sections.

Results of the project greatly increased the understanding of the geologic model controlling the Emigrant geothermal resource. Information gained from the 17-31 core hole revealed the existence of commercial temperatures beneath the area in the Silver Peak Core Complex which is composed of formations that exhibit excellent reservoir characteristics. Knowledge gained from the ESDP may lead to the development of a new commercial geothermal field in Nevada. Completion of the 17-31 core hole also demonstrated the cost-effectiveness of deep core drilling as an exploration tool and the unequaled value of core in understanding the geology, mineralogy, evolutional history and structural aspects of a geothermal resource.

2.0 Goals and Accomplishments

The proposed goals and objectives of the ESDP, which was proposed in 2004, were for the most part met or exceeded. Project objectives were laid out in three tasks.

2.1 Task 1: Resource Evaluation

This phase of the project was designed to involve: (1) Assembly and review of relevant published and proprietary literature and previous geothermal investigations in the region; (2) detailed geologic mapping (1 : 4,000 scale) of the Emigrant Miocene sedimentary basin and surrounding Paleozoic basements, with the aid of state-of-the-are remote-sensing technology; (3) analysis of 32 lithologic logs from U.S. Borax Chemical Corporation ("U.S. Borax") and Amax Exploration, Inc. ("Amax") mineral exploration and thermal-gradient drill holes; (4) synthesis of geologic mapping results and lithologic logs for 3-D geologic characterization of the prospect area; (5) themal anomaly mapping using remotely sensed thermal infrared data; (6) compilation of relevant data from the foregoing sub-activities into a Geologic Information Systems (GIS) database for use in knowledge-based modeling ; and (7) development of a refined conceptual geologic model to guide the site selection of the Emigrant core hole (Hulen, J.B., et al., 2005a; Hulen, J.B., et al, 2005b).

Each step of Task 1 was completed and the data used to choose the optimum location for the Emigrant core hole. The geologic model predicted the core hole would encounter the Green Monster Fault Zone ("GMFZ") at a depth between 2,000 and 3,000 feet. The model predicted temperatures in the GMFZ in the excess of 300^{o} F and a good probability of associated fracture permeability.

Two publications were generated during this Task (see **Attachments** - pg. 304):

> Hulen, J.B., Nash, G.D., Deymonaz, J.E., and Schriener, A., Jr., 2005a, Hot prospect – DE enables the Emigrant geothermal exploration and slimhole drilling project: Geothermal Resources Council Bulletin, v. 34 (July – August), p. 176 – 183.
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> Hulen, J.B., Nash, G.D., and Deymonaz, J.E., 2005b. Geology of the Emigrant geothermal prospect, Esmeralda County, Nevada: Geothermal Resources Council, Transactions, v. 29.

More detail on this Task can be found in **Appendix A** (pg. 11) -- **NOTE: All data from this phase, including the GIS database was submitted to DOE with the Phase I report.**

2.2 Task 2: Drilling and Resource Characterization

The highlight of the ESDP was to drill a core hole to a maximum depth of 4,000 feet (1,220 m) and recover core from the base of the surface casing to total depth for detailed study. The original drilling budget of $400,000 was proposed nearly 2 years before the drilling was able to begin due in large part to permitting delays and lack of availability of a suitable drilling rig. During the two year period, drilling costs escalated approximately 50 per cent (Personal communication, Steve Barnwell, Boart-Longyear, December 2006). Despite the significant increase in drilling costs, the Emigrant core hole was completed to a depth of nearly 3,000 feet (2,938 feet) which was 73 per cent of the maximum planned depth, and over 2,500 feet of core was collected, studied in detail and archived for future research. Reports and data supporting Task 2 can be found in **Appendix B** (pg. 52).

2.3 Task 3: Resource Testing and Assessment

Original planning involved a 48 hour flow test in the completed core hole. Due to environmental and permitting restrictions, the plan was modified to utilize an injection test to evaluate the characteristics of a small permeable zone near the bottom of the core hole with temperatures in excess of 320F. The injection test was successfully completed; however, the results indicated the zone had very limited permeability. Reports and data supporting Task 2 can be found in **Appendix C** (pg. 291).

3.0 Project Summary

The ESDP was proposed in 2004 in response to GRED III Program goals to develop collaborative cost-sharing efforts to support the exploration for, and definition of, new geothermal resources while mitigating the initial risk of confirming a reservoir. Both the original proposal and the results of the ESDP fulfilled the goals of the GRED III Program.

3.1 History of the Emigrant Geothermal Project

The thermal anomaly associated with the Emigrant Geothermal Project area has been known since the early-1980's. A minor sulfur deposit and small fumerole located at the center of the thermal anomaly had not been reported in public literature prior to that time. During the 1980's, over 50,000 feet of vertical drilling was completed in the Emigrant area by U.S. Borax and Amax, with some drill holes exceeding depths of 2,000 feet. U.S. Borax stated that their drilling defined the second largest deposit of boron in the United States (Deymonaz, J.E., personal communication with Dixie Hambrick, U.S. Borax, 1984). The deposit also contains elevated levels of lithium and strontium and the concentration of boron, lithium and strontium is believed to be directly associated with modern and fossil geothermal systems. According to the U.S. Borax geologic model, the sedimentary basins and thermal systems began to form about 6 Ma, concurrent with a period of eruptions which resulted in the nearby Silver Peak Caldera (Albers, J.P., et al., 1972) the initial formation of the Fish Lake Valley pull-apart basin (Deymonaz, J.E., personal communication with Dixie Hambrick, U.S. Borax, 1984).

Due to the nature of the mineral deposit, deeper drilling by U.S. Borax primarily targeted a series of small, deep lacustrine basins along the perimeter of the thermal anomaly. Temperature measurements made in U.S. Borax mineral exploration holes and shallow temperature gradient holes drilled by Amax defined an extensive shallow thermal anomaly. An area covering over 12 square kilometers (4.6 square miles) exhibits shallow thermal gradients in excess of 250 C/km (13.75 F/100 ft) and an area covering over 36 square kilometers (14 square miles) has shallow thermal gradients in excess of 100^{o} C/km (5.5^{o} F/100 ft). Nearly all drill holes exhibited "straight line" conductive thermal gradients to total depth. The maximum bottom hole temperature recorded in these early drill holes was 109^{o} C (228^{o} F). Amax collected hot water samples from two shallow temperature gradient holes near the center of the thermal anomaly for chemical analysis. Multiple chemical geothermometers applied to the two samples (dilute sodium-chloride-bicarbonate-sulfate fluids with ~0.3% TDS) yielded estimated deeper equilibration temperatures ranging from 129 – 213^{o} C (265^{o} - 415^{o} F), with SiO_2 (quartz) geothermometry indicating a temperature range of 158 – 169^{o} C (316^{o} - 336^{o} F) (Deymonaz, 1984).

Although early exploration results were extremely encouraging, they unfortunately occurred during the mid-1980's as geothermal exploration and development in the western U.S. slid into nearly two decades of inactivity. As a result, the initial exploration was not followed by a focused program to define the existence of a commercial geothermal resource at Emigrant, until GRED III provided the incentive for the Emigrant Slimhole Drilling Project.

3.2 Emigrant Slimhole Drilling Project Hypotheses

The ESDP was designed to fulfill the goals of the GRED III Program by: reviewing and evaluating the extensive data collected by various companies over the past two decades and compile this data in a GIS database; undertaking a detailed geologic mapping survey of the area; creating a comprehensive geologic model based on new and previous information; and selecting a location and drilling a core hole to evaluate the nature of the geothermal resource expected to occur at a depth of 2,000 - 4,000 feet.

To accomplish these goals ESDP was separated into three major tasks:

Task 1: Resource Evaluation
Task 2: Drilling and Resource Characterization
Task 3: Resource Testing and Assessment

3.3 Resource Evaluation

Initial endeavors of the ESDP involved collecting and reviewing the extensive published and proprietary data generated by geothermal and mineral exploration work by Amax and U.S. Borax in the 1980's and recent gravity surveys undertaken by Geo-Energy Partners, 1983 Ltd. ("Geo-83") and its wholly owned subsidiaries, Fish Lake Green Power Company ("FLGPC") and Esmeralda Energy Company ("EEC"). The information was evaluated and the data compiled into a Geologic Information Systems (GIS) database with the incorporation of "Fuzzy Logic" modeling capability. Field work involved detailed geologic mapping (1 : 4,000 scale) using state-of-the-art remote sensing, with particular emphasis on structures, alteration and secondary mineralization (Hulen, J.B., et al.,2005b). These efforts resulted in a conceptual geologic model which was used in selecting a location for the Emigrant core hole.

3.4 Permitting

Task 2 involved permitting, securing a drilling contractor and drilling of the Emigrant core hole (Kettleman location17-31, T1S, R37E MDBM). The permitting process involved securing the approval of the U.S. Bureau of Land Management ("BLM") and dealing with personnel from BLM District offices in Elko and Battle Mountain, Nevada, the BLM Tonopah, Nevada Field Station and the BLM Nevada State office in Reno, Nevada. Additional approvals were required by the Nevada Division of Minerals, Nevada Division of Environmental Protection and the Nevada Division of Water Resources. The Death Valley Timbisha Shoshone Tribe was also involved through a liaison from the Elko, Nevada BLM District office. Tribal members reviewed the project, visited the area and gave their approval to the proposed work. As requested by the Timbisha representatives, a Tribal Observer was funded by Esmeralda Energy Company and made periodic inspections of the 17-31 drill site and access roads prior to, and during the drilling operations.

Permitting efforts for the 17-31 core hole began in early February, 2006 and the final permit was approved over 8-1/2 months later on September 25, 2006, just 15 days before the drilling rig arrived on site. If the permit had been delayed a few more weeks, it would have had disastrous consequences for the project. Due to the scarcity of drilling rigs, if the permit had not been issued by the time the equipment was scheduled to arrive, the contractor would have moved on to the next scheduled project and the drilling rig may have been unavailable for months, or longer.

Although the ESDP was benign in regards to issues involving land use, environmental or cultural concerns, there was no public opposition of any kind, and no state of federal agency raised objections to the project, the permitting process was painfully slow and frustrating. None of the agencies involved share the same forms and, from our experience, appear to share very little information on an interagency basis. Each agency required essentially the same information, but in a slightly different format, different forms, etc. The BLM process was the slowest by far, extending over the entire period and at various times being put on hold until some other agency issued a permit. Following the preparation of an Environmental Assessment (which required approximately 2 months) and frequently being stalled due to a missing government "interdisciplinary team member" who was required to address pertinent questions so the process could move to the next step. This process was followed by a 30-day "public comment period" and an additional week for the paperwork to move from the BLM Tonopah Field Station to the Nevada State BLM office in Reno.

3.5 Drilling Contractor

Drilling a deep, hot core hole presents unique challenges and only contractors with extensive geothermal experience were considered. Boart-Longyear Drilling Company ("Longyear") and Major Drilling Company ("Major") were the only two drilling companies which met this criteria. Both companies submitted their bids in February, 2006.

Longyear proposed using a HD-600 drilling rig and Major proposed the use of a Universal 1500 drilling rig. Either rig would have been more than adequate for the proposed 4,000 foot core hole and both companies have a long and proven track record drilling core holes for geothermal exploration. In regards to qualifications, personnel and equipment, there was no bad choice.

Each company uses a different format for bidding and the equipment and services the client may choose to provide varies. The bids were evaluated using various assumptions regarding the number of days involved, drilling rates, stand-by and other non-drilling time, bit life, consumables, hourly rates vs. footage rates, rental vs. contractor provided equipment, etc. Several different scenarios were used and Longyear appeared to have a substantial cost advantage over Major Drilling.

Due to the extremely limited availability of drilling rigs, it was necessary to select a contractor seven months before drilling was to commence. Quotes are generally good for 60 days, and this resulted in two revised quotes from Longyear prior to drilling. Given the demand for drilling rigs during this period, the revised quotes seemed within reason and would have likely occurred regardless of the contractor chosen.

3.6 Drill Site Selection

Selection of the drill site was based on the evaluation of thermal gradients in the area combined with the geologic model which emerged during the Task 1 endeavors and in particular from the detailed geologic mapping performed by Jeffery Hulen and Gregory Nash (Hulen et al., 2005a, Hulen et al., 2005b). The goal was to drill the core hole at a location which would intercept the west dipping, high angle Green Monster Fault Zone at a depth of approximately 2,000 feet. This was done to minimize the possibility of encountering high temperatures (boiling point or above) and uncontrolled flow of geothermal fluid above the casing point at 400 feet, yet provide the greatest opportunity of encountering 150° – 200° C (300° – 400° F) temperatures at a depth between 2,000 and 4,000 feet. A temperature survey of the 17-31 core hole, run on April 13, 2007, revealed an equilibrated formation temperature of 158° C (136° F) at a depth of 400 feet and a temperature of 163.6° C (326.5° F) at a depth of 2,934 feet.

Due to the limited drilling budget, additional consideration was given to existing access and a location that would minimize construction costs and mitigate any environmental concerns. An area wide (approximately 640 acres) cultural resources study (Vierra, R.K., and Trudell, J., 2006) for the project had identified a previously undocumented small mining camp, dating back to the late 1800's, along the eastern margin of the area targeted for drilling. The ESDP site was located to ensure that drill site construction and traffic would have no impact on the mining camp site.

3.7 Drill Site Construction

The drill site was constructed on a gently sloping topographic high in a broad west-draining wash along an existing road. The sand-silt-gravel alluvial material was easily excavated, which reduced construction costs. The native material also provided an excellent finished surface which exhibited both good drainage and excellent compaction characteristics. The locations gentle slope reduced the amount of cut-and-fill necessary to construct the drill site, approximately 3-feet of cut and 3-feet of fill were required. In order to minimize surface disturbance, the drill site was designed to have as small a footprint as possible. Working within a limited space required considerable planning on the part of the contractor and EEC given the amount of equipment involved, including three 40-foot water tanks and two earthen pits. A number of equipment configurations were considered, for ease of rigging up/rigging down, efficiency while drilling, setting casing and testing, convenience and above all, crew safety. The final design was only a 100 foot by 150 foot (0.33 acre) site, yet met all of the required criteria.

The Esmeralda County Road Department graded the 15 mile access road (all of which are RS-2477 county maintained roads) to the drill site prior to the arrival of the drilling contractor. Arden Salvage Company ("ASC"), a local construction company, located about 16 miles from the 17-31 drill site, was contracted to construct the site. A D-4 dozer, grader and backhoe were used to construct the site in two days, at a cost of less than $2,000. ASC also transported three 21,000 gallon "Baker" water storage tanks from their facility in Fish Lake Valley to the drill site and then hauled 63,000 gallons of water to fill the tanks prior to the drilling contractor arriving at the site. Having water available on site served to speed the rigging up time when the contractor arrived and ensure that drilling operations were not delayed due to a lack of water.

3.8 Drilling Operations

Longyear crews and equipment arrived on October 10, 2006. The staging area was approximately 16 miles from the drill site and located at the ASC facility. ASC made their facility available for the storage of equipment and supplies at no charge throughout the project. Access to the drill site was over approximately 15 miles of gravel and dirt roads maintained by Esmeralda County. Several days of rain, which began a few hours after the Longyear equipment began to arrive, slowed the mobilization process and forced the use of an alternate route to transport much of the equipment. The alternate route added approximately one hour to each trip. Moving in and rigging up took slightly over three days.

Drilling commenced on October 13, 2006. A 12-1/4 inch hole was rotary drilled to a depth of 31 feet and 9-5/8 inch casing was set and cemented. On October 14, a 8-3/4 inch hole was rotary drilled to a depth of 406 feet and 4-1/2 inch casing was run in the hole and cemented using neat cement pumped through a tremmie pipe in the annular space. A small “bag type” blow-out-preventer with pipe and blind rams was then installed on the 4-1/2 inch casing and pressure tested.

Core drilling commenced on October 17, using HQ equipment. The HQ equipment produced a 3.782 inch hole with 2.50 inch core. The Tertiary tuffaceous sediments encountered were fractured and sheared. Intense argillic alteration of the sediments and the absence of any fluid loss resulted in increased viscosity of the drilling mud. Due to the increasing viscosity, which resulted in higher pump pressures and increased drilling rod torque, the mud system had to be disposed of in a reserve pit and fresh drilling mud mixed to continue drilling.

Despite the clay rich formation, extensive fracturing and numerous short core recovery runs, drilling progressed smoothly, averaging just over 189 feet per day for 4 days. On October 22, at a depth of 1,236 feet, the drill rods became stuck during a core recovery run. While attempting to work the drill rods free, they separated at 660 feet. In order to retrieve the equipment in the drill hole, NQ drill rods were trucked in for the fishing effort and after several attempts, the stuck drill rods were cut about 4 feet above the bit and recovered. The remaining bit and part of the core barrel were cored over with the next HQ bit and core drilling resumed on October 25.

From October 26 through November 5, a total of 1,551 feet was core drilled. Daily drilling ranged from 95 to 200 feet, with an 11-day average of 141 feet/day. At 2,812 feet, a small open fracture resulted in a total loss of circulation with a pumping rate of 20 – 25 gallons per minute (“gpm”). Core drilling continued with occasional fluid returns to a total depth of 2,938 feet at 8 AM on November 7, 2006. The crew then began breaking down HQ and NQ drilling rods into 10 foot lengths and ran HRQHP (3.5 inch) tubing open-ended with a core bit to 2,798 feet. A temperature log was run to 2,700 feet. Following the temperature survey, an injection test was performed.

While drilling, no fluid loss or gain was noted until the loss of circulation at 2,812 feet. The loss of circulation zone at 2,812 feet appears to have been a small open fracture, less than one inch across and sand filled, with minor permeability. Injection rates never exceeded 25 gpm and the fine cuttings from the core drilling likely reduced the permeability of sand filling the fracture. This was evidenced by the rising fluid level in the annular space as the hole was deepened 26 feet past the loss of circulation zone.

Upon completion of the injection test, the drilling crew attempted to run HRQHP tubing ("H-tubing") to the bottom of the hole, but it could not be lowered below a depth of 2,920 feet, 18 feet off bottom. The H-tubing with a drill bit was run to facilitate the deepening of 17-31 at a future date. If the hole is to be deepened, the H-tubing will be removed and core drilling will continue using HQ equipment. If the tubing cannot be removed, a cement plug will be set to secure the bottom of the drill string and then core drilling will resume using NQ core drilling equipment (2.98 inch hole with 1.88 inch core).

Rigging down and moving equipment off location occurred from November 8 to November 12, 2006. A second temperature log was run on November 10, to a depth of 2,900 feet, with a maximum recorded bottom hole temperature of 322^{o} F. A third temperature log was run 156 days after the hole was completed, on April 13, 2007, to a depth of 2,934 feet, yielding a maximum temperature of 327.4^{o} F.

3.9 Core Logging

Jeffrey Hulen undertook a detailed study of the recovered core and produced an extensive report covering the mineralogy, alteration, structures and interpretative history of the formations penetrated by the 17-31 core hole (Hulen, J.B.,2006a; Hulen, J.B., 2006b; Hulen, J.B., 2006c; Hulen, J.B., 2007) . Mr. Hulen also constructed three alternative geologic cross-sections which combine the extensive geologic mapping performed earlier in the project together with the results of his studies of the core. Fluid-inclusion microthermometry ("FIM") and X-ray diffraction ("XRD") was also run on selected core samples. The core from 17-31 has been washed and boxed and is archived for future reference at the FLGPC facility in Dyer, Nevada. Additionally, a split of all core and cuttings was delivered to the Nevada Bureau of Mines and Geology in Reno, Nevada for archived storage and public access.

The Emigrant Slimhole Drilling Project has yielded tangible results, greatly increased the understanding of the geothermal system and enhanced the possibility of commercial development of the Emigrant Project geothermal resource. Significant conclusions regarding the resource which were a product of the ESDP include:

1. The Emigrant geothermal system appears to be the result of a deep circulation system in which the geothermal fluids rise along northerly trending, west-dipping normal faults with the GMFZ serving as the primary conduit.

2. The Paleozoic section, below the Tertiary (1,034 feet) and above the lower plate (2,735 feet) of the Silver Peak Metamorphic Core Complex ("SPMCC"), exhibited a lack of any measurable permeability despite extensive fracturing, shearing and brecciation. This apparently results from pervasive alteration, high clay content and secondary mineralization above the SPMCC detachment zone (Craig, S.D., et al., 2003; Oldow, J.S., et al., 2003). Together with the impermeable Tertiary volcanic/sedimentary sequence they form a thick cap rock over the

underlying geothermal system and will provide an excellent medium for cementing casing on future geothermal production wells.

3. The SPMCC was encountered approximately 5,000 feet higher in the section than predicted in the original geologic model. The lower plate of the SPMCC, encountered at a depth of 2,735 feet, constitutes a dense, recrystallized, highly competent strata susceptible to maintaining open fractures (Hulen, J.B., 2006a; Hulen, J.B., 2006c) which could result in an excellent environment for a productive geothermal reservoir at economical drilling depths.

4. 17-31 exhibits a "straight-line" conductive thermal gradient to total depth, which is consistent with thermal gradients measured in the majority of shallower drill holes throughout the project area (Deymonaz, J.E., 1984). The uniformity of conductive thermal gradients over a broad area at Emigrant suggests that even relatively shallow thermal gradient measurements may be used with some degree of confidence to predict the depth to reservoir temperatures.

5. A maximum bottom hole temperature of 164^{o} C (327^{o} F) was recorded in 17-31. Various chemical geothermometers obtained from fluid samples collected in two nearby shallow drill holes by Amax yielded estimated deeper equilibrated temperatures ranging from 129^{o} – 213^{o} C (265^{o} – 415^{o} F) (Deymonaz, J.E., 1984). Recorded temperatures in 17-31 provided additional evidence that Emigrant geothermal reservoir temperatures of 164^{o} C (327^{o} F) and possibly considerably higher are present in the Emigrant Project geothermal system.

4.0 References

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APPENDIX A – Task 1 Resource Evaluation: Supporting Documents and Data

Phase One Completion Report for the Emigrant Geothermal Prospect,
Esmeralda County, Nevada GRED III Project DE-PS36-04GO94016 ………………………………. Page 12 – 51

Phase One Completion Report for the Emigrant Geothermal Prospect, Esmeralda County, Nevada

GRED III Project DE-PS36-04GO94016

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Abstract

At the western edge of the northern Silver Peak Range and the eastern margin of the active Fish Lake Valley pull-apart in southwestern Nevada, the Emigrant prospect has all the classical surface and shallow-subsurface indications of a deeper convective geothermal system capable of commercial electrical-energy production. Shallow boreholes completed to date at Emigrant have conductive thermal gradients as high as 700^{o}C/km – with bottom-hole temperatures up to 109^{o}C – over an area of at least 12 km^{2}. Preliminary silica geothermometry of hot waters from two of these boreholes suggests that deeper reservoir temperatures could reach at least 169^{o}C and probably higher. Obvious surface manifestations of the concealed system include a feeble fumarole, warm ground, incipient advanced argillic alteration, and a small elemental sulfur deposit.

The rocks within and around the Emigrant prospect occur in the fractured and attenuated upper plate of the middle to late Miocene Silver Peak-Lone Mountain metamorphic core complex. In the prospect area, folded and brittly-fractured limestones and calcareous siltstones of the Cambrian Emigrant Formation rest in thrust contact on the Ordovician Palmetto Formation, here essentially a sheared mélange with a matrix of calcareous shale and siltstone supporting scattered blocks and lithons of limestone and various other lithologies. Mesozoic or Tertiary granodiorite boudins in the Palmetto provide pervasive evidence for post-thrust shearing of the formation during core-complex evolution. The Emigrant and Palmetto are overlain, in succession, by: (1) early Miocene ignimbrite; (2) a tuffaceous and mostly lacustrine Pliocene sedimentary sequence; (3) Plio-Pleistocene fanglomerate; and (4) two ages of Quaternary alluvial fans. Altered, fractured, veined, and carbonate-leached Emigrant Formation and densely welded or silicified Miocene ignimbrite would be excellent geothermal reservoir rocks, as would portions of the Cambrian siliciclastic and carbonate sequence cropping out east of the prospect. Tuffaceous Pliocene sediments at Emigrant are widely and intensely argillized, and would make equally effective caprocks.

Deep thermal-fluid flow in the Emigrant geothermal system appears to be controlled mostly by (1) left-stepping, north- to northwest-trending, "major" range-bounding normal faults (Paleozoic basement on the east, Cenozoic cover on the west); and (2) northeast-trending high-angle faults that may have originated as strike- or oblique-slip structures. Shallower fluid ascent is likely channeled by younger, more valleyward, north-trending, moderate- to high-angle normal faults, including those along which the prospect's modern surface geothermal manifestations are located. Shallow subhorizontal aquifers may be provided by the core-complex-related, low-angle normal faults and fracture networks that disrupt early Miocene ignimbrites throughout the northern Silver Peak Range. An intermediate-depth (1-1.3 km) drilling target at the intersection of a major northeast-trending fault zone and a younger, north-trending, and sulfur-mineralized fault is believed to be optimum for discovery of the upper reaches of a commercially-producible geothermal upflow plume.

Introduction and Previous Investigations

The Emigrant area, on the west flank of the northern Silver Peak Range and the eastern margin of the Fish Lake Valley pull-apart in southwestern Nevada (Figs. 1 and 2), is among the most promising geothermal prospects yet to be meaningfully drill-tested in the western United States. Shallow thermal-gradient boreholes completed at Emigrant during the 1980s encountered hot water with temperatures as high as 109^{o}C at less than 300 m depth (Fig. 3), and static thermal gradients for these holes are as high as 700^{o}C/km. Results of a preliminary evaluation of the property by Geothermex, Inc. (2004), showed that an Emigrant geothermal system likely could support production of at least 1380 megawatt-years of electrical energy.

Based in part on this assessment, the U.S. Department of Energy in 2004 awarded a "GRED III" cost-shared grant to Esmeralda Energy Company ("EEC"), a wholly owned subsidiary of Geo-Energy Partners-1983 Ltd. ("GEO-83"). GEO-83 is the sole leaseholder at Emigrant. The GRED III grant is for (Phase 1), exploration drilling (Phase 2), and well-testing (Phase 3) at the prospect. A key component of Phase 1 is detailed geologic mapping, to help focus the drilling-target selection process on those areas of the property with the best chance for exploration success.

Previous investigations in the Emigrant area have varied widely in emphasis, scope and detail. Robinson et al. (1968) published a map of the entire Silver Peak Range and vicinity at an approximate scale of 1:155,000, noting that widespread Pliocene ignimbrites at the crest of the range might signal the cryptic presence of a large corresponding caldera (the Silver Peak caldera). Albers and Stewart (1972) mapped the area for their 1:250,000-scale geologic and mineral-resource maps of Esmeralda County, and Robinson et al. (1976) later completed 1:62,500-scale mapping of a 15' quadrangle encompassing the Emigrant area. U.S. Borax and Chemical Corporation (unpublished data; 1980s) mapped the region at 1:12,000, concentrating on Pliocene lakebeds hosting borax/lithium mineralization. Reheis (1991) and Reheis and Sawyer (1997) published 1:24,000-scale maps including Emigrant and emphasizing the area's tectonic history and unusually well-exposed late Cenozoic deposits. Oldow (1992) and Oldow et al. (1994, 2003) incorporated the prospect area into mostly $\leq$1:62,500 geologic maps highlighting the regionally important, middle to late Miocene, Silver Peak-Lone Mountain metamorphic core complex

(Fig. 1). Petronis et al. (2002) used paleomagnetic data to deduce that the entire core complex had been rotated clockwise and had ceased to evolve by about 6 Ma.

The Emigrant area's considerable geothermal potential was first realized by AMAX Exploration, Inc. (Deymonaz, 1984), from the high temperatures encountered in shallow U.S. Borax drill holes. AMAX entered into a cooperative agreement with Magma Power Company ("Magma"). Due to federal acreage limitations facing AMAX, the geothermal leases were held by Magma. AMAX later withdrew from geothermal development activities before a full-scale exploration effort could be implemented. Magma focused its efforts on the now proven geothermal field at nearby Fish Lake and exploration at Emigrant ceased. Magma was subsequently acquired by Cal Energy Company ("CalEnergy") which redeployed the former company's geoscientific staff to the latter's Salton Sea geothermal field in California's Imperial Valley. Magma dropped the primary Emigrant leases on which GEO-83, in December 2000, filed noncompetitive lease applications. BLM issued the leases effective June 1, 2002. GEO-83 and its operating company, Fish Lake Green Power Company ("FLGPC"), have undertaken exploration activities at Emigrant since that time. Under contract to Fish Lake Green Power Company, Ciancanelli et al. (2003) combined then-existing geologic maps with the AMAX thermal-gradient data and a new precision gravity survey by Fish Lake Green Power Company to formulate the generalized Emigrant conceptual model from which the model presented in this paper deviates only in detail. Geothermex, Inc. (2004), synthesized all contemporaneously available geoscientific data to report that the Emigrant property had a likely minimum electrical-generation capacity of 46 megawatts for 30 years.

The Fish Lake Valley pull-apart occurs within an extensional right overstep between two major dextral transcurrent fault zones – the Fish Lake Valley fault zone to the west, and the central Walker Lane, to the east (Fig. 1; Reheis and Dixon, 1996; Reheis and Sawyer, 1997; Oldow et al., 2001, 2003, 2004; Petronis et al., 2002; Stockli et al., 2003). This still-active pull-apart apparently began to form at about 6 Ma (Reheis and Sawyer, 1997), that is, at about the time the Silver Peak-Lone Mountain metamorphic core complex had apparently ceased its active growth phase (Petronis et al., 2002). Prior to that time (but after ~11Ma), displacement transfer at the overstep had been accommodated by regional, northwest-directed detachment faulting attending the rise of the complex itself (Oldow et al., 2001, 2003, 2004; Stockli, 2003).

In a geothermal context, it is important to note here that the Fish Lake Valley fault zone, with an integrated lateral displacement rate of 5 mm/yr (Reheis and Sawyer, 1997), is not only the single most active fault zone in the Great Basin, but in the entire United States is surpassed in this regard only by dextral transcurrent faults of the plate-bounding San Andreas system. Kinematically linked to the Fish Lake Valley fault zone is the Fish Lake Valley pull-apart, with which the Emigrant geothermal prospect is clearly and closely affiliated (Fig. 1).

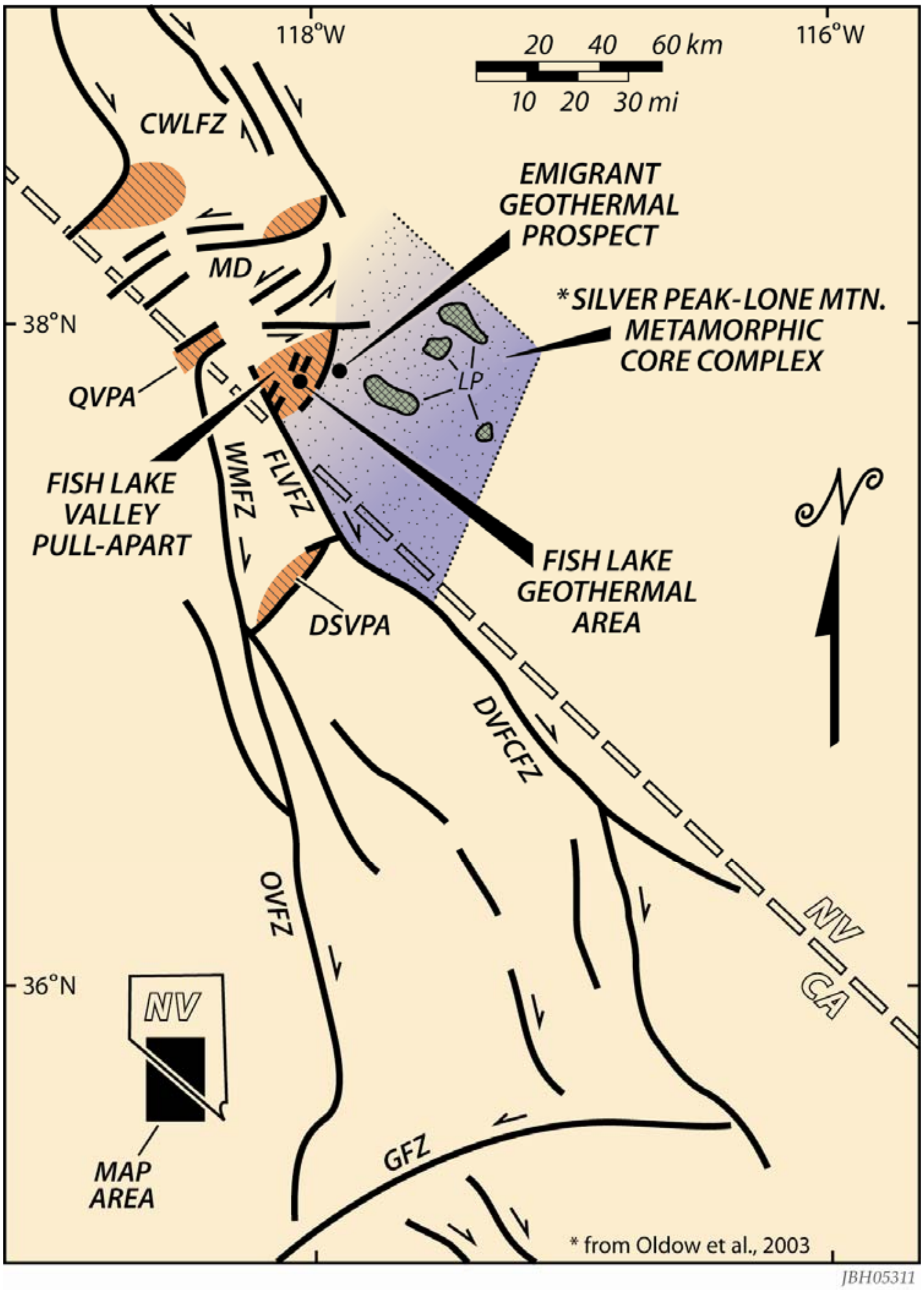

Figure 1. Location and index map showing position of the Emigrant geothermal prospect relative to major structural elements of west-central Nevada and adjacent southeastern California. Bold black lines signify major high-angle fault zones, with arrows showing relative displacements. Lightly hatched areas show selected pull-aparts. Densely stippled areas portray exposures of lower-plate (LP) tectonites in the Silver Peak-Lone Mountain metamorphic core complex (light stipple); Additional abbreviations are as follows: CWLFZ – Central Walker Lane fault zone; DSVPA – Deep Springs Valley pull-apart; DVFCFZ – Death Valley-Furnace Creek fault zone; FLVFZ – Fish Lake Valley fault zone; GFZ – Garlock fault zone; MD – Mina Deflection; OVFZ – Owens Valley fault zone; QVPA – Queen Valley pull-apart; WMFZ – White Mountains fault zone.

Phase I Objectives

The original objectives for Phase I were:

(**1**) Assembly and review of relevant published and proprietary literature and previous geothermal investigations in the region;

(**2**) detailed geologic mapping of the Emigrant Miocene sedimentary basin and surrounding Paleozoic basement rocks;

(**3**) analysis of the 32 extant lithologic logs from U.S. Borax and AMAX-Magma mineral-exploration and thermal-gradient boreholes;

(**4**) synthesis of geologic mapping results and lithologic logs for 3-D geologic characterization of the prospect area;

(**5**) compilation of relevant data from the foregoing sub-activities into a Geographic Information Systems (GIS) database for visualization and mapping, and to facilitate the development of an exploration model; and

(**6**) development of a refined conceptual geologic model to guide siting of the proposed slimhole.

Methods and Procedures

As noted above, the Emigrant property had been mapped many times prior to the current GRED III project. However, the Phase 1 governing goal of the project was selection of a high-quality, intermediate-depth (900-1300 m), geothermal drilling target. Accomplishing this objective called for detailed (1:4000-scale) geologic mapping focused on those features of the prospect most relevant to conceptual modeling of a geothermal system at depth – faults, fractures, fracture-amenable lithologies, active thermal phenomena, and hydrothermal alteration. This work was greatly facilitated by state-of-the-art remote-sensing and GIS technology.

Remote-Sensing and GIS for Geologic Mapping – Remotely sensed data can be highly effective for increasing the productivity and accuracy (in turn lowering the cost) of geologic mapping. For example, inexpensive multispectral imagery can be used to prepare provisional regional to sub-regional lithologic, alteration, and fault maps to guide subsequent field work. The trade-off in this economical approach is that these data sets – from the LandSat Thematic Mapper and Advanced Spaceborne Thermal-Emission and Reflection Radiometer (ASTER) – have 15-30 m spatial resolutions, less than ideal for large-scale mapping. The problem is and was not insurmountable. Comparably inexpensive panchromatic (gray-scale) data, available at spatial resolutions to 1 m, can be mathematically combined (fused) with the multispectral imagery to create new images retaining the distinct advantages of ASTER and the fine-scale panchromatic resolution.

For this project, fused imagery was created using ASTER data and USGS Digital Orthophoto Quandrangles (DOQs). The ASTER data have a spatial resolution of 15 m for the visible to infrared and near-infrared bands, and 30 m for shortwave-infrared bands; with a cost of $85.00 per 60 x 60 km image. The DOQs utilize a single gray-scale band with a 1-m spatial resolution. The cost per 7.5-minute quadrangle can range from nil to US$20. The foregoing approach is undeniably effective for detailed mapping projects with typically limited budgets. Where cost is of lesser concern, the writers would recommend data fusion using hyperspectral airborne imagery (for example HyMap, with 3-m spatial resolution) and Quickbird PCR data (0.6-m).

Data fusion for this project was accomplished using the Brovey method, a standard procedure found in most image-analysis software packages. For this method, three bands from the multispectral data set are chosen based upon appropriate spectral characteristics. These bands are then merged with the PCR data set as follows:

$$B1_{new} = (B1/[B1+B2+B3]) \times PCR$$

$$B2_{new} = (B2/[B1+B2+B3]) \times PCR$$

$$B3_{new} = (B3/[B1+B2+B3]) \times PCR$$

Where B1, B2, and B3 are the multispectral input bands.

This process generates a three-band data set that can be used to produce false-color composites (FCC; Fig. 2) readily usable for mapping at scales ranging to 1:4000 and greater. The fused imagery is overlain with a Universal Transverse Mercator (UTM) grid to facilitate field orientation. Color-printed on glossy paper, the imagery provides a distortion-free geologic-mapping base highlighting rock types, structural trends, thermal features, and hydrothermal alteration phenomena that might otherwise escape detection.

Geology of the Emigrant Prospect

Stratigraphy and Lithology

The Emigrant geothermal prospect flanks the western part of the northern Silver Peak Range, where that feature has narrowed northward from a high, broad, and rugged range of mountains to a subdued spine of hills only a few km in breadth. Within the prospect proper, Cambrian to Ordovician carbonate and siliciclastic rocks, almost always in fault contact with one another, are overlain, in succession, by Miocene felsic ignimbrite, Pliocene tuffaceous sediments, Plio-Pleistocene fanglomerate, and Pleistocene to Holocene alluvium. Some of the Paleozoic strata, and the more densely welded or silicified portions of the ignimbrite, would make excellent reservoir rocks in a concealed Emigrant geothermal system. The Pliocene sedimentary sequence is extensively argillized, and would provide an equally effective caprock.

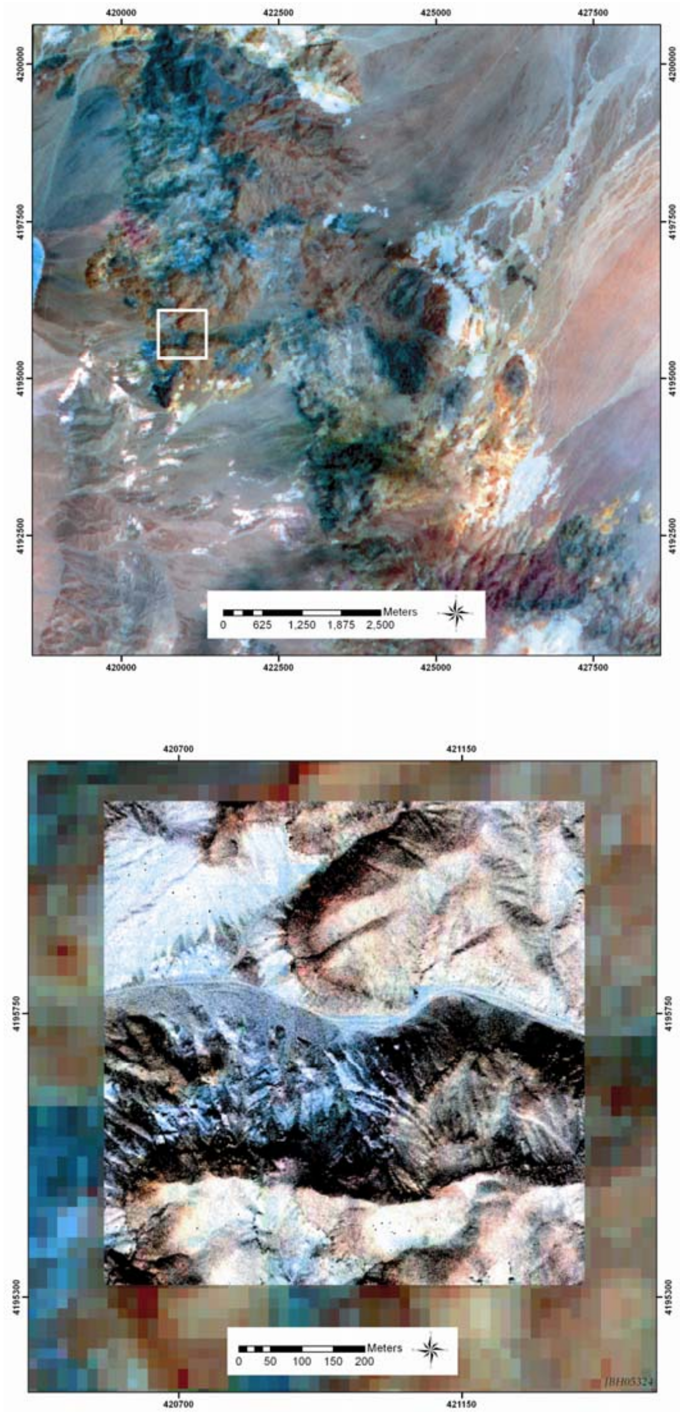

Figure 2. A 3-band false color composite of ASTER multispectral imagery (top) and a 1 m spatial resolution fused panchromatic/ASTER image inset on the ASTER FCC for comparison of resolution. The fused imagery is superior for geologic mapping as compared to standard color aerial photography.

Older Cambrian Formations – Several older Cambrian formations exposed at the eastern edge of the Emigrant prospect (Fig. 3), but not mapped in detail for this study, are likely to occur nonetheless in the deeper reaches of the envisioned Emigrant geothermal system (Fig. 5). The project's Phase 2 intermediate-depth drill hole may barely reach these rocks, but they should be mapped and characterized in detail in advance of deeper production drilling. From oldest to youngest, these units are: (1) The Cambrian Poleta Formation [limestone, siltstone, and quartzite]; (2) Cambrian Harkless Formation [shale, phyllite, siltstone, and quartzite]; and (3) the Cambrian Mule Spring Limestone. The Mule Spring, in particular, might be a particularly effective reservoir rock, as it is riddled with locally extensive carbonate-dissolution networks including caverns up to at least several meters in diameter.

Cambrian Emigrant Formation -- The Emigrant Formation crops out widely in the northern and eastern portions of the prospect (Figs. 3 and 4). In these areas, the formation has two members: (1) rhythmically interbedded, argillaceous limestone and calcareous shale to siltstone; and (2) papery-weathering shale and phyllite. The first-named member should be an excellent geothermal-reservoir host. Not only has the rock undergone widespread carbonate dissolution (and even small-cavern formation), it is also exensively fractured and veined. The impermeable shale member, fortunately, is of limited local distribution.

Ordovician Palmetto Formation – Underlying the Emigrant Formation in thrust contact on the prospect is the structurally dissected and deformed, Ordovician Palmetto Formation. The Palmetto in west-central Nevada has been described by Oldow (1984) as part of a highly disrupted, imbricate thrust stack emplaced as part of the regionally prevalent, Devonian-Missisippian Roberts Mountains allochthon. In the prospect area, the Palmetto is essentially a mélange, consisting of scattered blocks and lithons of limestone, cherty limestone, chert, and lesser sandstone and siltstone embedded in a variously sheared and chaotically folded matrix of calcareous shale to siltstone. The blocks are penetratively and densely fractured and hydrothermally veined; the matrix appears generally impermeable. Thus, the Palmetto as a whole would not be a particularly favorable geothermal reservoir rock. Even the fractured blocks, if no larger at depth than mapped at the surface, would provide unacceptably small reservoir volumes. Various types of hydrothermal alteration to be discussed would improve the formation's overall reservoir quality, but the presence and extent of such alteration in the subsurface cannot be predicted with confidence from the geologic mapping alone.

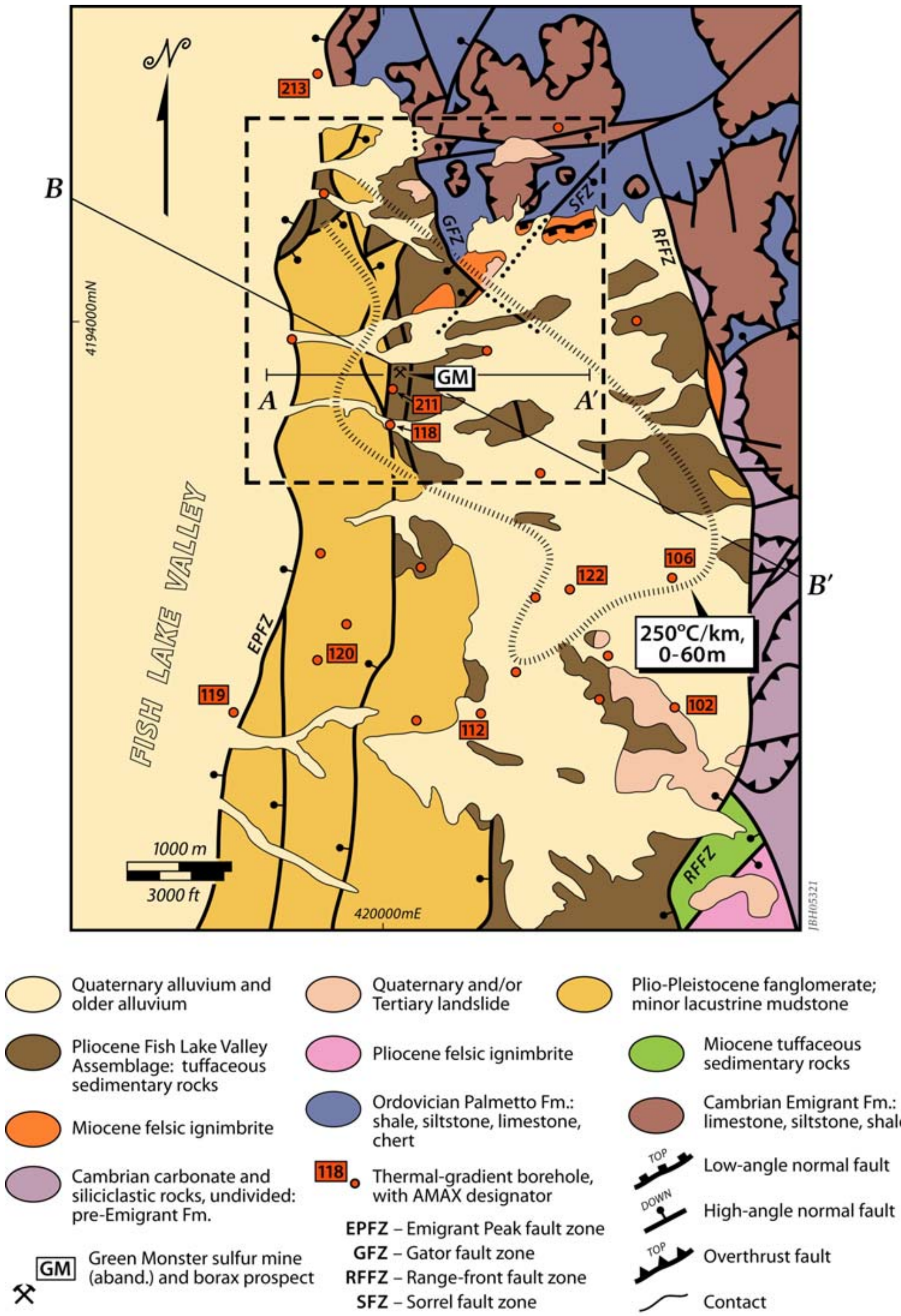

Figure 3. Generalized geologic map of the Emigrant geothermal prospect and vicinity, illustrating, relative to major mapped faults, the northwest-trending, high-temperature nucleus of a broad, shallow, static thermal-gradient anomaly. Dashed outline encloses that part of the prospect (1) considered most favorable for drilling into a commercially viable, moderate- to high-temperature geothermal up-flow plume in the depth range 900-1300 meters; and (2) mapped in detail [1:4000] for this investigation and seen in Figs. 4 and 7. Geology beyond the borders of the detailed-map area synthesized from Robinson et al. (1976; 1:62,500) and Reheis (1991; 1:24,000).

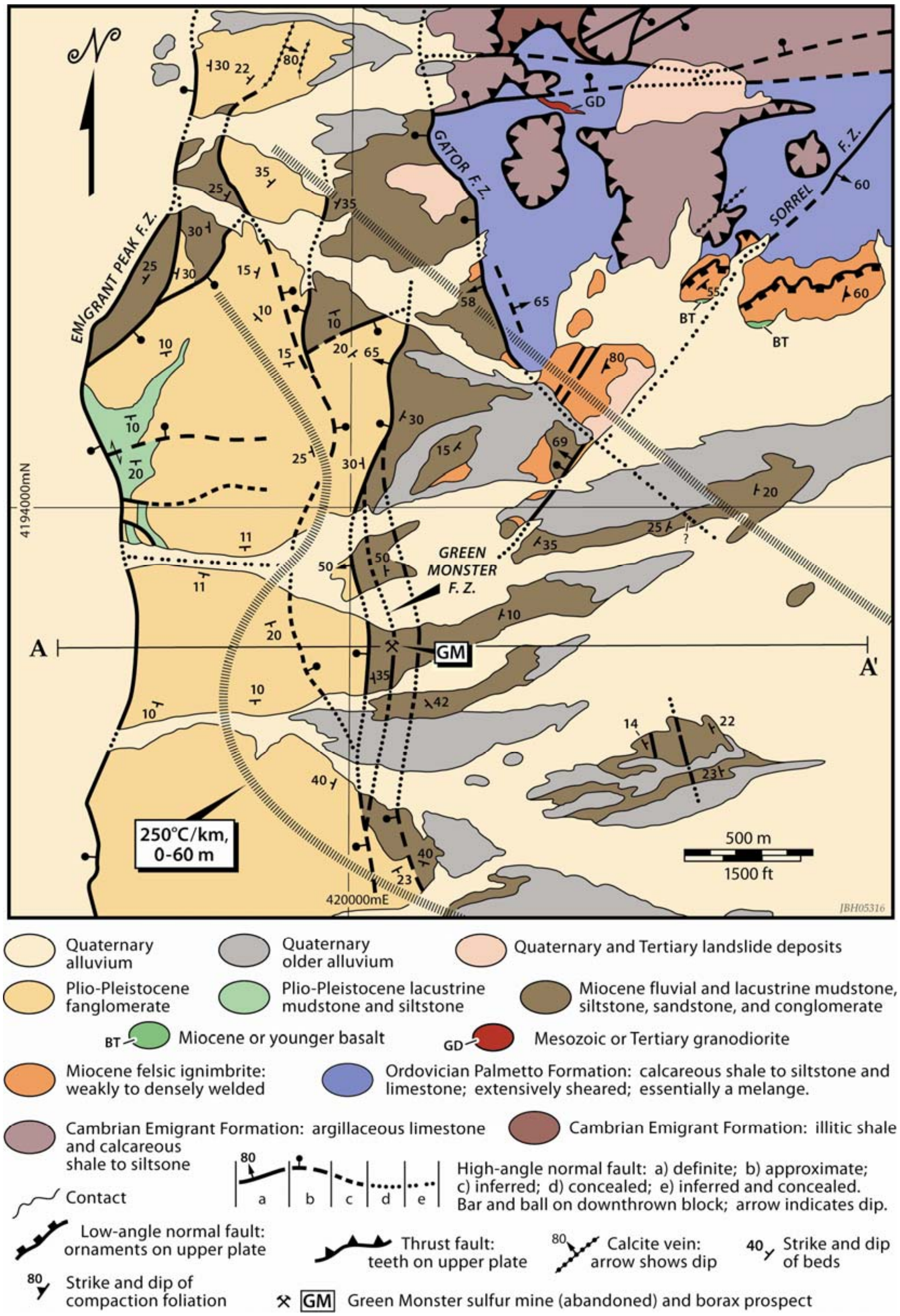

Figure 4. Summary detailed geologic map of the interior of the Emigrant geothermal prospect. Geology distilled from 1:4000-scale mapping. Please refer to Figure 3 for map location.

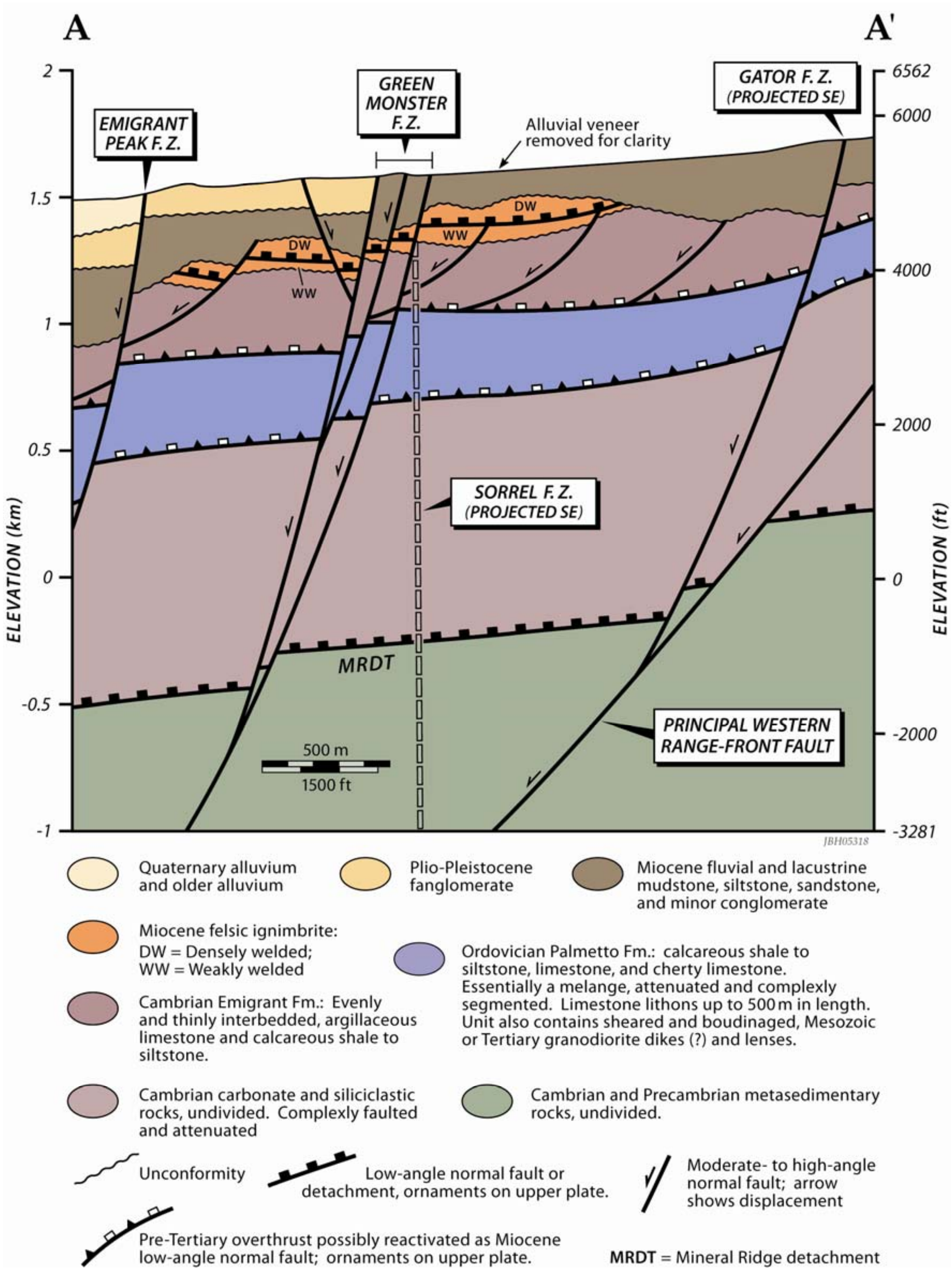

Figure 5. Detailed, east-west geologic section through the interior of the Emigrant geothermal prospect. Map features the Green Monster fault zone, along which the prospect's modern surface geothermal phenomena (e.g., a small native-sulfur deposit and feeble fumarole) are located.

Mesozoic or Tertiary Granodiorite – The Palmetto mélange in this part of the Silver Peak Range contains dozens of small granodiorite lithons (only one is large enough to show at the scale of the map; Fig. 4). These igneous rock bodies range in form and texture from sheared and offset dikes or sills, to chains of lensoid boudins entirely bounded by shear planes. There are apparently no such plutonic rocks in western Nevada older than Triassic (Stewart, 1980). The presence of these rootless, sheared granodiorite masses in the Palmetto thus indicates that one major shearing episode affecting the formation post-dated emplacement of the Roberts Mountains allochthon. If the granodiorite is younger than mid-Mesozoic, the shearing would also have taken place after the most recent (Jurassic) regional overthrusting (Oldow, 1984). The point to be made here is that the granodiorite permissively could have been sheared during Miocene extension and attenuation of the Palmetto in the upper plate of the Silver Peak-Lone Mountain metamorphic core complex. Radiometric age-dating of the granodiorite currently in progress should rigorously test this hypothesis.

Miocene Felsic Ignimbrite – The Emigrant and Palmetto Formations in the northeastern part of the geothermal prospect area (Fig. 4) are overlain, in depositional to structural contact, by early Miocene (21.5-22.8 Ma; Robinson et al., 1976) felsic ash-flow tuffs assigned by Oldow (2003) to the regionally distributed Icehouse Canyon Sequence. These ignimbrites are quartz-, feldspar, and biotite-crystal-rich, and form simple to compound cooling units (Smith, 1960) that are weakly to densely welded and intricately dissected by faulting.

In this area (and apparently throughout the northern Silver Peak Range), the Ice House Canyon ignimbrites occur mostly as structural tongues and slivers above multiple low-angle faults. The upper plates of these faults consist principally of fractured, brecciated, rotated, steeply-dipping and locally silicified blocks of moderately to densely welded tuff. The lower plates are made up of corresponding, commonly argillized, weakly welded tuffs that are also fractured and distended but overall more nearly intact.

The welded tuffs in the upper plates of these low-angle fault slivers are penetrative and densely fractured in conjugate sets, and along with the fault zones themselves, would clearly be high-quality geothermal-reservoir rocks if buried sufficiently deep. At the crest of the Emigrant thermal anomaly (Figs. 3 and 4), these rocks could host the shallowest hot-water entries in the intermediate-depth drill hole planned as Phase 2 of this project. On the other hand, weakly welded tuffs beneath the low-angle faults are commonly argillized, and could function at depth as aquitards.

Pliocene Tuffaceous Sedimentary Rocks – Unconformably overlying the Paleozoic rocks and Miocene ignimbrites in the prospect area are widespread tuffaceous sediments (Fig. 4) of the Pliocene Fish Lake Valley Assemblage (Oldow, 2003). These sediments, which accumulated in small structural and erosional basins of limited local extent, comprise basinal-facies, in part turbiditic, ashy lacustrine mudstones, siltstones, and sandstones flanked by pumiceous, basin-margin, fluvial sandstones and conglomerates. Based on radiometrically-determined ages of interstratified tephra, deposition of the Fish Lake Valley Assemblage spanned at least the time interval 4.8-2.6 Ma (Robinson et al., 1968, 1976; Reheis and Sawyer, 1997).

According to U.S. Borax lithologic logs (e.g., in Hambrick, 1985), the Fish Lake Valley Assemblage in the vicinity of the geothermal prospect ranges from a few tens of meters to at least 700 m in thickness. Greenish, tuffaceous, argillized lacustrine mudstones apparently making up the middle part of the assemblage were targeted by U.S. Borax for the sediments' elevated borax and lithium concentrations. These argillized sediments are ideally positioned to provide an impermeable and thermally-insulating cap on an underlying convective geothermal system.

<u>Miocene or Younger Basalt</u> – Porphyritic basalt was found intruding Miocene ignimbrite but no younger rocks in the Emigrant prospect area (Fig. 4). The basalt is dark olive-gray where fresh, but is generally argillized and pale greenish-gray. The rock is unlikely to figure prominently in a concealed Emigrant geothermal system.

<u>Plio-Pleistocene Fanglomerates and Lacustrine Sediments</u> – A key marker unit in the Emigrant prospect area is an upper Pliocene to middle Pleistocene sequence dominated by weakly-consolidated pebble to cobble and rarely boulder conglomerate, but also containing distinctive local lacustrine mudstones and siltstones (Fig. 4). Tephra are dramatically less abundant in this unit than in underlying Pliocene sediments, but include diagnostic eruptive debris from the Yellowstone caldera complex as well as the nearby, Pleistocene, Long Valley volcanic center (Reheis and Sawyer, 1997). The youngest dated tephra layer in this young fanglomerate/mudstone sequence clearly came from Plinian eruptions precursor to eruption of the voluminous, 0.76 Ma Bishop Tuff ash flows and resulting collapse of the Long Valley caldera.

<u>Quaternary and Tertiary Landslide Deposits</u> – There are three landslides within the detailed map area (Fig. 4). The largest and most conspicuous is a 0.1 km^2 mass of Emigrant Formation that collapsed from a high, east-west-trending fault scarp into a deeply eroded adjacent canyon. This landslide ranges in texture from nearly intact glide blocks to incoherent rock rubble. A second slide, just west of the Gator fault zone, is a fractured but mostly coherent glide block consisting of Palmetto Formation with a scab of Miocene ignimbrite. The third slide consists of rubblized but minimally-eastward-transported Miocene ignimbrite just north of the intersection of the Sorrel and Gator fault zones.

<u>Quaternary Surficial Deposits</u> – Older rocks throughout the Emigrant geothermal prospect (Figs. 3 and 4) are blanketed extensively by Quaternary alluvial fans of at least two ages; the older deposits overlain and incised by the younger. These fans are of marginal direct interest from a geothermal perspective, and have been removed for clarity from the interpretive geologic sections presented in this report (e.g., Fig. 5).

Structure

<u>Overview</u> -- The rocks of the Emigrant prospect (and the Silver Peak Range in general) have been folded, fractured, sheared, and brecciated repeatedly during their long and unusually intensive tectonic history. This is an ideal scenario for creating the enhanced permeability and deeply-penetrating thermal-fluid conduits required for a commercial geothermal system. The prospect is still tectonically active, as evidenced by faulted alluvium. Because of this fact, the inevitable "self-sealing" that takes place in all

hydrothermal systems (Facca and Tonani, 1967) is likely to be balanced by seismically-induced and frequently recurring fracture rejuvenation.

There are three principal types of faults in the prospect area, from oldest to youngest: (1) Overthrusts, affecting only Paleozoic rocks; (2) low-angle normal faults, in Miocene felsic ignimbrite; and (3) Moderate- to high-angle faults, including those of the current locus of tectonic activity here, the Emigrant Peak fault zone (Figs. 3, 4, and 5). Faults of all three types locally have thick "damage zones" that could focus or distribute thermal-fluid flow in a concealed Emigrant geothermal system.

Overthrust Faults – The Cambrian and Ordovician Formations of the Emigrant prospect are typically in apparent overthrust contact with one another (Figs. 3, 4, and 5), although Albers and Stewart (1972) take pains to explain that many of these "overthrusts" could just as readily be low-angle extensional features. The major overthrust separating the Emigrant and Palmetto Formations in the detailed map area (Fig. 4), as we have noted (see "Granodiorite" above), shows evidence permissive for low-angle extensional reactivation.

Low-Angle Normal Faults – The dominant structure of the Silver Peak Range (and of the Weepah Hills and Lone Mountain nearby and to the east) is the regional, low-angle detachment surface separating the upper and lower plates of the Silver Peak-Lone Mountain metamorphic core complex (Fig. 1; Oldow, 2003). This structure is not exposed in the Emigrant prospect area, but is sure to occur here at depth (Fig. 5). The drilling of future deep production wells at Emigrant should be preceded by careful mapping and measurement of the detachment where it crops out nearest to the prospect. Subsidiary low-angle structures in the upper plate of the detachment are locally exposed at Emigrant, and are likely to be penetrated at depth during Phase 2 drilling activities.

A remarkable series of core-complex-related, low-angle normal faults disrupts early Miocene ignimbrite of the Icehouse Canyon sequence not only within the prospect (Figs. 3, 4, 5, and 6), but – based on the writers' reconnaissance – throughout the northern Silver Peak Range. These faults, to our knowledge previously undocumented, occur over an area of at least 100 km^2 (and probably more). Rather than being part of a continuous regional break, they appear to cut the ignimbrite into multiple slivers and tongues individually reaching at most a few km^2 in area. The tongues (1) commonly coalesce laterally to form larger, composite nappes; but (2) are locally separated by "islands" and septa of sheared and segmented but overall relatively intact ignimbrite. The faults at the bases of the individual slivers have undulatory, typically slickensided surfaces (e.g., Fig. 6). With up to 25 m of structural relief, these surfaces, depending on location in the range, dip gently ($<30^o$) to the east, west, north or (as on the prospect) south, but locally may be near-vertical.

These ignimbrite-hosted, low-angle faults appear to have formed opportunistically at cooling-unit welding breaks. Typically, the breaks have occurred between a weakly welded zone below and a moderately to densely welded zone above. Denser tuffs of the upper plates have been displaced over the softer basal tuffs, and locally over Paleozoic rocks. In response to this motion, the upper-plate tuffs have been segmented into multiple local strike-slip- to normal-fault-bounded blocks, many of which have been rotated so that their compaction foliation dips steeply into – and terminates at – the damage zones above the principal subhorizontal displacement surfaces (Fig. 6).

The actual slip magnitude along these ignimbrite-hosted low-angle faults has yet to be determined, but, based on field evidence, does not appear to have been appreciable. However limited, the motion was sufficient to break the fault zones and the upper-plate tuffs into penetrative and commonly open fracture networks. The most porous of these networks, found between neighboring, subparallel, oblique-slip faults, are similar in form and texture to the fractured negative flower structures that are a characteristic feature of transtensional strike-slip fault zones (Sylvester, 1988).

<u>Moderate- to High-Angle Faults</u> – Overthrusts and low-angle normal faults at Emigrant are broken extensively by moderately- to steeply-dipping faults, the youngest of which show the most obvious surface expressions of ongoing major extension in the Fish Lake Valley pull-apart (Fig. 1). These high-angle structures can be grouped conveniently into three main orientations – northeast, east-west, and northerly (Figs. 3 and 4). The northeast-trending faults crop out along what we have designated the Sorrel fault zone. The most recent displacements along this fault zone have been pure normal dip-slip. However, the nearly straight trace of the zone suggests that it may have undergone earlier strike- or oblique-slip motion. East-west faults, confined to the northern part of the prospect (Figs. 3 and 4), parallel many of the major left-lateral, Walker Lane transfer faults of the "Mina Deflection" to the north (Fig. 1; Stewart, 1985, 1988).

Both the northeast- and east-west-trending faults at Emigrant are truncated by northerly-trending, moderate- to high-angle normal faults. Primarily down-to-the-west, these young faults cut all rock and deposit types on the prospect. The Emigrant Peak fault zone (Figs. 3, 4, and 5) is notable for west-facing scarps up to several meters high in all but the very youngest alluvial deposits. Synthetic to the Emigrant Peak fault zone are the high-angle, north-trending faults of the Green Monster zone (Figs. 4, 5, and 7). Occurring along this zone are the only obvious surface manifestations of the concealed geothermal system – warm ground, a feeble fumarole, incipient advanced alteration, and crusts of elemental sulfur.

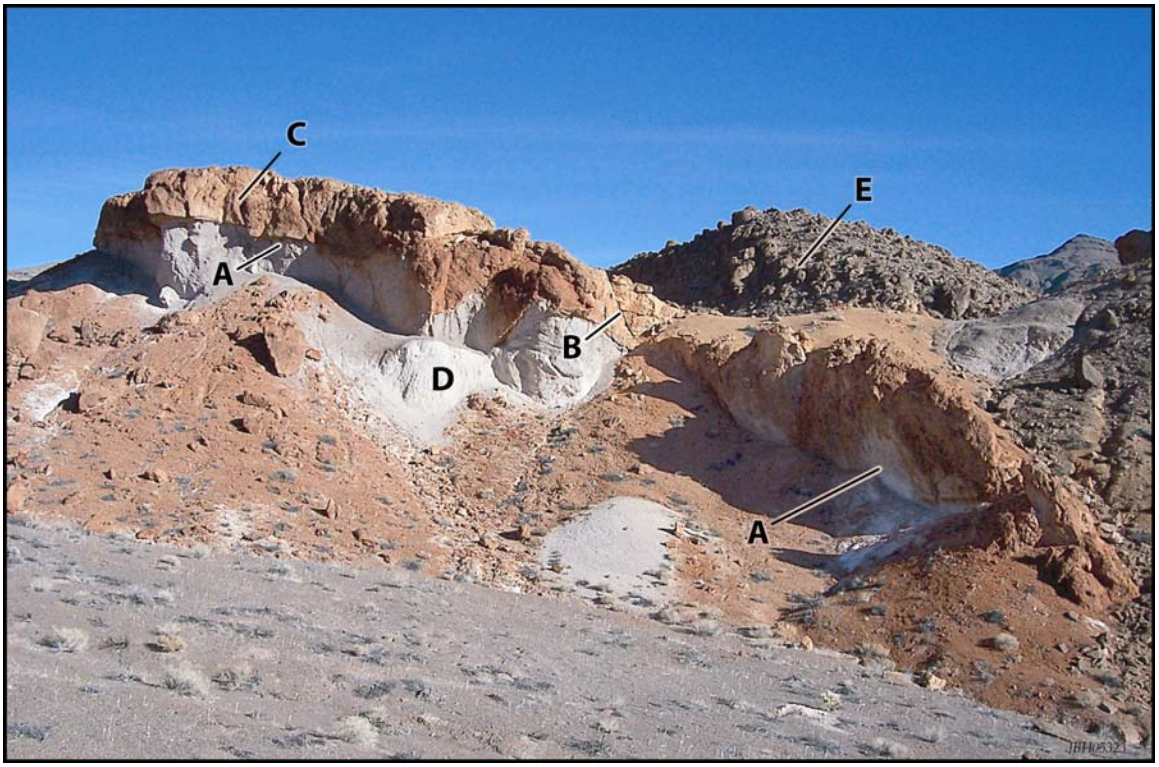

Figure 6. Photograph (looking south-southeast) of low-angle normal fault zone disrupting Miocene felsic ignimbrite in the northeastern part of the detailed geologic-map area (Fig. 5). Vertical ledge at left of image is ~5 m high. **A** – Undulatory, principal displacement surface (PDS), typically grooved, mullioned, and slickensided. At left, the PDS is subhorizontal; at right, it dips steeply south, oblique to and away from the picture plane. **B** – Subsidiary dip-slip and oblique-slip faults cutting the PDS, but extending no more than a few meters into that feature's upper and lower plates. These structures appear to have formed near-contemporaneously with the PDS itself. **C** – Intensely fractured, moderately silicified, and hematitic "limonite"-stained damage zone above the PDS. **D** – Argillized, weakly welded tuff in the lower plate of the PDS; **E** (in immediate background) – Fractured, locally rubblized, and small-normal-fault segmented, moderately to densely welded tuff in the upper plate of the PDS. Compaction foliation in this upper plate dips steeply toward the PDS. Photography by G.D. Nash.

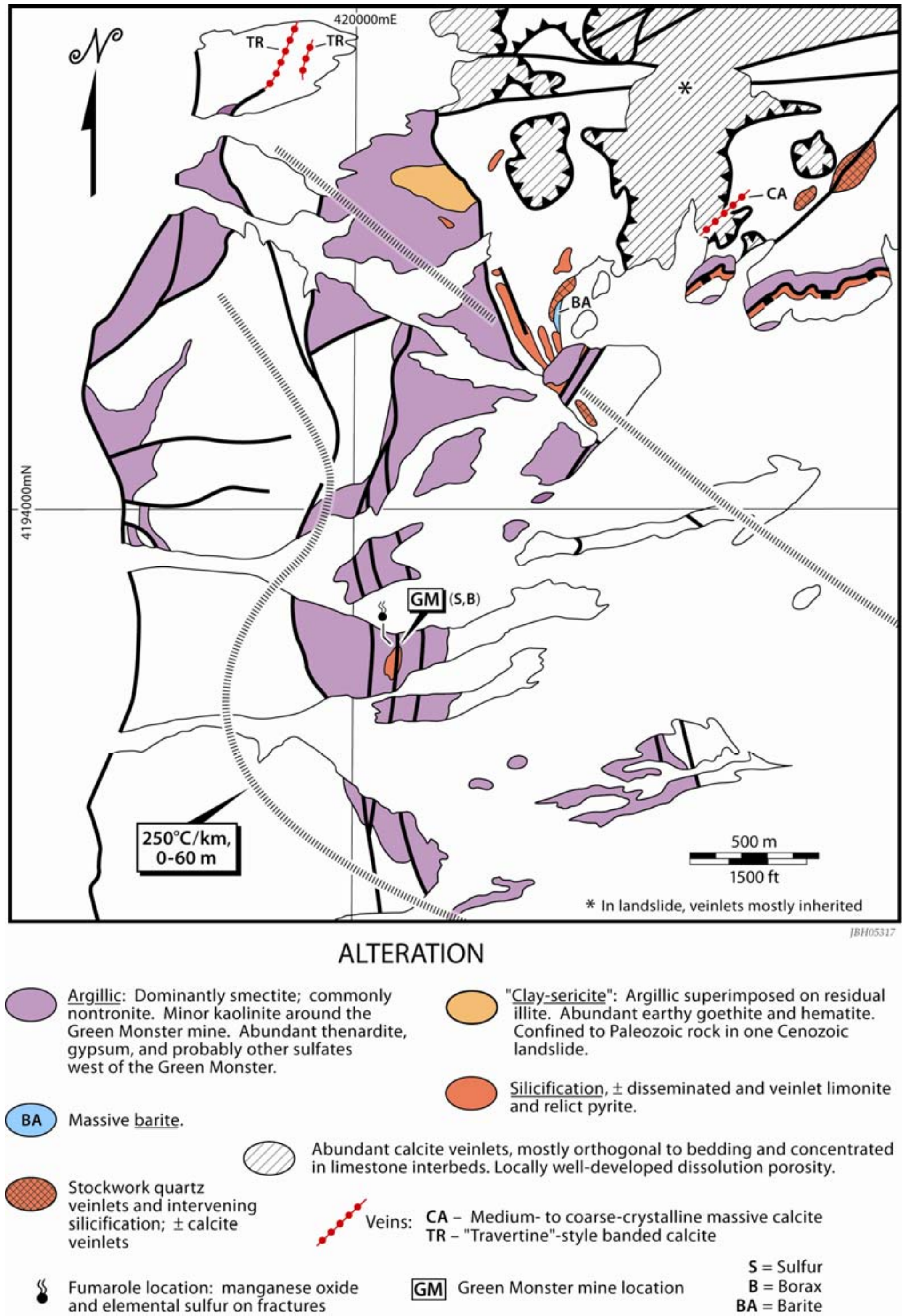

Figure 7. Detailed alteration and mineralization map of the interior of the Emigrant geothermal prospect. Area is the same as Figure 4.

Alteration

Paleozoic and most Cenozoic rocks at Emigrant are hydrothermally altered and mineralized to a greater or lesser extent (Fig. 7). A little of this alteration can be attributed unambiguously to a modern Emigrant hydrothermal system, and all of the alteration is variously useful for conceptually modeling past, recent, and contemporary thermal-fluid circulation deep in the prospect's subsurface.

The Emigrant and Palmetto Formations differ as much in alteration style as they do in structural disruption. The commonly sheared Palmetto hosts scattered patches of alteration and mineralization only locally large enough to show at the scale of the map (Fig. 7), but of many varieties and textures including: (1) massive barite; (2) cryptocrystalline silicification [jasperoid]; (3) stockwork quartz ± limonite [-pyrite] veining; (4) decalcification [hydrothermal carbonate-dissolution]; and (5) quartz-sericitization ± limonite [-pyrite]. The chaotic distribution as well as the highly variable composition and texture of this Palmetto-hosted alteration suggests that much of it may be rootless, dismembered from its point of origin and tectonically transported to its present location. Having said this, we note also that some alteration in the Palmetto is obviously and tightly controlled by major throughgoing structures like those of the Sorrel fault zone (Fig. 4).

Granodiorite lithons and dissected dikes/sills in the Palmetto Formation are invariably hydrothermally altered. The alteration ranges from propylitic, the most typical, to clay-sericite with limonitic quartz and/or calcite veinlets. The propylitic alteration, which includes minor epidotization of mafics and feldspars, is seemingly out of equilibrium with that prevailing in surrounding rocks (where there is no shortage of calcareous lithologies for the calc-silicate to replace). This disparity could also indicate that the igneous rocks have been tectonically moved from their original sites of emplacement.

In contrast to the Palmetto, the more structurally intact Emigrant Formation as a whole is more pervasively (but less conspicuously) altered and mineralized. The dominant limestone interbeds are typically cut by abundant grayish to brownish calcite veinlets (Fig. 7) that are locally only centimeters apart. These veinlets are mostly orthogonal to bedding, and appear to have formed in fractures created as intervening shale/siltstone layers were stretched, and the limestone itself was brittly ruptured. The limestone and the veinlets have been carbonate-leached locally to form networks ranging from hairline openings to small caverns up to a meter or more in diameter. The dissolution is most extensively developed close to major range-bounding normal faults, like those of the Gator fault zone (Figs. 3 and 4). At these locations, the formation can be cavernous and mineralized with goethitic to hematitic limonite, rendering the rock a bright reddish-brown.

Also distinctively reddish, at the prospect and regional scales, are the low-angle fault zones disrupting Miocene ignimbrites (Figs. 4, 6 and 7). These fault zones are weakly to moderately silicified, and contain abundant introduced limonite along with local veinlets and breccia cements of black manganiferous carbonate. More densely welded tuffs in the upper plates of these low-angle fault zones are erratically silicified and cut by quartz veinlets with or without disseminated hematite. Weakly welded tuffs in the lower plates of the fault zones are commonly altered to smectite. We speculate that some of this argillic alteration may have preceded and facilitated the widespread low-angle faulting.

Tuffaceous sedimentary rocks (particularly lacustrine mudstones) of the Fish Lake Valley Assemblage are also extensively smectite-altered. Much of the smectite is nontronite, which has weathered to a whitish "popcorn" texture but is actually greenish in cast. The Green Monster mine (Fig. 4 and 7), in fact, was named for the bright greenish knob from which sulfur was briefly extracted many years ago. Much of the nontronite and other smectite- family clays in these Pliocene sediments could be other than hydrothermal in origin. The poorly consolidated rocks are rich in pumice and ash, components which readily alter to smectite in a low-temperature burial-diagenetic environment (e.g., Wohletz and Heiken, 1992). U.S. Borax geologists believed that the nontronite and spatially associated borax mineralization resulted from the action of contemporaneous thermal springs discharging from beneath and into the sediments as they accumulated. In a case like this, the distinction between diagenetic and hydrothermal is blurred.

Just west of the Green Monster, even the Plio-Pleistocene fanglomerates are uncharacteristically but intensely argillized (Figs. 4 and 7). In this region, the clay-altered material also contains some kaolinite as well as thenardite, gypsum, and probably other hydrous sulfates. It seems likely that the formation here has been affected by low-temperature acid-sulfate leaching and incipient, advanced argillic alteration (e.g., Schoen and White, 1968; Schoen et al., 1974).

Several thick (i.e., mappable at 1:4000) hydrothermal veins crop out within and just north of the Emigrant prospect (Figs. 4 and 7). A calcite vein near and parallel to the Sorrel fault zone is massive, medium- to coarse-crystalline, and probably unrelated to the modern geothermal system. However, delicately-banded, "travertine"-style calcite veins cutting young fanglomerate in the northwest corner of the prospect are of the sort commonly found at shallow depths beneath calcareous spring deposits. Texturally identical veins in the Emigrant Formation just north of the map area are up to 0.5 km long and 5 m or more in thickness. These enormous veins occur in proximity to AMAX borehole 213 (Fig. 3), which had the highest temperature at the shallowest depth (51^{o}C at 32 m) yet recorded in the Emigrant area.

Geologic logs for many of the prospect's shallow borax-exploration and thermal-gradient holes record locally intense hydrothermal alteration and mineralization at depth. Of particular interest in this regard is the log for borehole 211 (Hambrick, 1985) near the Green Monster mine (Figs. 4 and 7). This hole reportedly encountered intensely silicified and pyritized tuff, tuffaceous siltstone, and sandstone between 195 m and the 296 m total depth (Hambrick, 1985). Pyrite was estimated to account for 5-10 vol.% of this interval, which also featured abundant "black stringer" and "SiO_2" veinlets. The cuttings for this and the other Emigrant boreholes were discarded long ago, but from the written descriptions it seems likely that the alteration and mineralization in borehole 211 could be genetically related to the active Emigrant geothermal system. Bolstering this assertion is the fact that the altered and mineralized interval hosted all three of the borehole's minor thermal-fluid entries. Hot water from these entries was geochemically analyzed to provide what few clues we have to the nature of fluids circulating deeper in the geothermal system.

Thermal-Fluid Geochemistry and Geothermometry

There are no thermal springs within the Emigrant prospect area, but unambiguously indigenous hot-water samples were collected from boreholes 211 (see above) and 112 (Fig. 3). These samples were analyzed for major and selected minor chemical components (Table 1; Pilkington, 1984). Hot water at 96^{o}C from borehole 211 was collected by airlifting from a depth of 123 m (water level) at a rate of 240 liters per minute. The corresponding parameters for borehole 112 were: 72^{o}C, 238 meters, and 400 liters per minute.

The two samples, collected from boreholes 5 km apart, were nonetheless similar geochemically. The sample from borehole 211 was a dilute (~0.3 wt.% TDS) sodium-chloride-sulfate-bicarbonate fluid with a pH of 8.7 (Table 1). A wide variety of chemical geothermometers (Truesdell, 1985) indicated subsurface equilibration temperatures for this fluid ranging from 146^{o}C to 214^{o}C; the quartz and chalcedony geothermometers, respectively, suggested reservoir temperatures of 158^{o}C and 146^{o}C. The deeper but cooler sample from borehole 112 was similarly alkaline but contained less chloride and more bicarbonate than the one from 211. Chemical geothermometry for this sample ranged widely from 129^{o}C to 231^{o}C, with the quartz and chalcedony geothermometers indicating, respectively, 169^{o}C and 160^{o}C.

It seems unwarranted to cede too much weight to these two shallow-water analyses in formulating an appropriate conceptual model for the Emigrant geothermal system. The chemistry would seem to point to a moderate-temperature system at depth, but since mixing cannot be discounted, higher subsurface temperatures are also distinctly possible. More and deeper thermal-fluid samples will be required to test these provisional possibilities, and retrieval of those samples must await implementation of Phase 2 drilling. In the meantime, integrated geological, geophysical, and shallow-temperature data collected from the prospect to date suggest strongly that the planned drill hole stands an excellent chance of discovering a viable geothermal resource at depth.

Thermal Anomaly Mapping

Thermal anomalies were mapped using ASTER kinetic temperature data juxtaposed with thermal inertia data also derived from ASTER imagery. Fig. 8 shows sub-regional Nighttime kinetic temperatures and Fig. 9 shows thermal inertia overlain with possible thermal anomalies. The possible thermal anomalies were derived by 1) locating areas of anomalous kinetic temperatures on the nighttime kinetic temperature image and second, 2) comparing spatially correlative areas on the thermal inertia image and, 3) disregarding areas on the nighttime kinetic temperature image with correlative high thermal inertia.

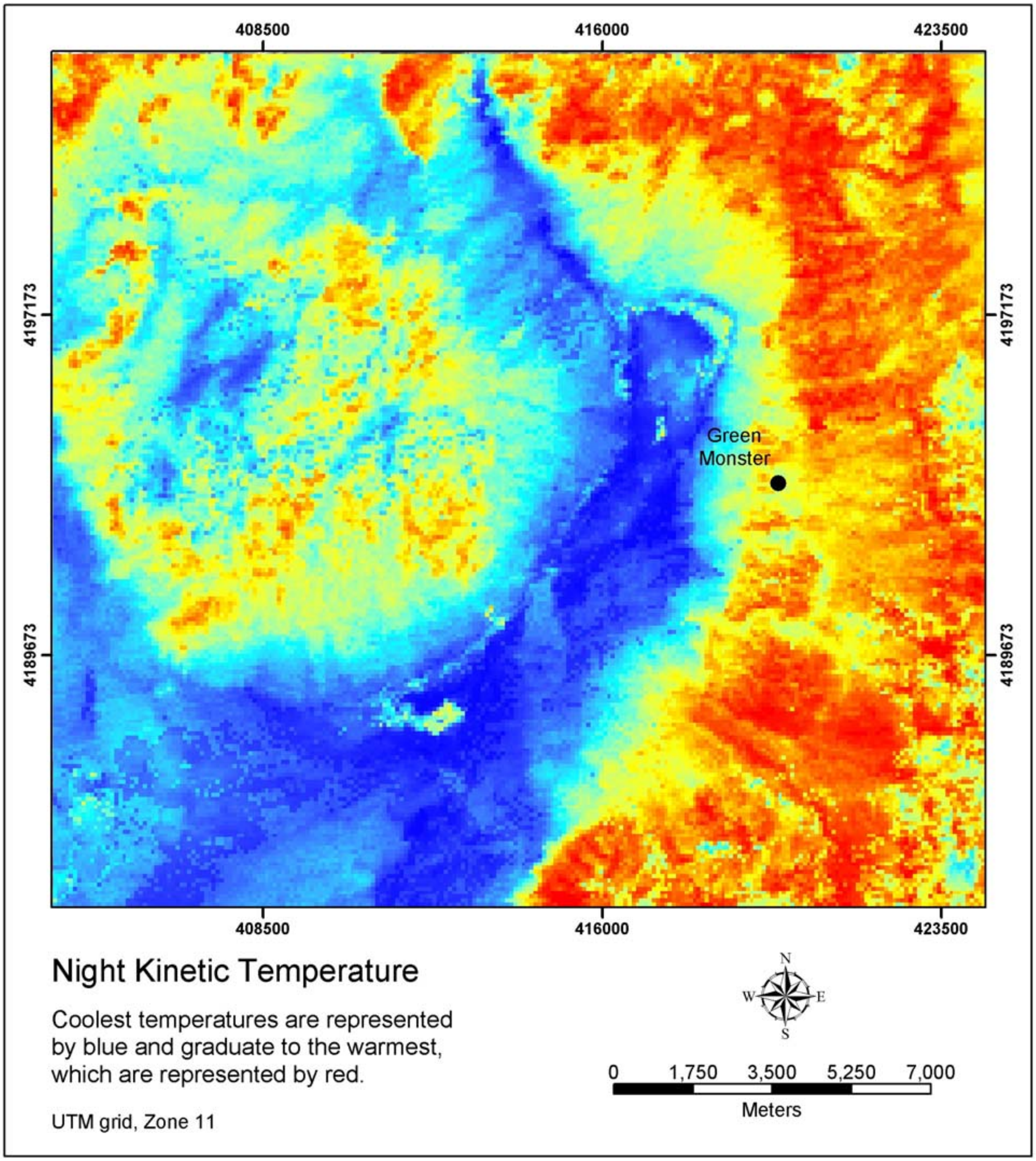

Figure 8. ASTER derived nighttime kinetic temperature image of northeastern Fish Lake Valley area, Nevada including the Emigrant Geothermal prospect near the Green Monster.

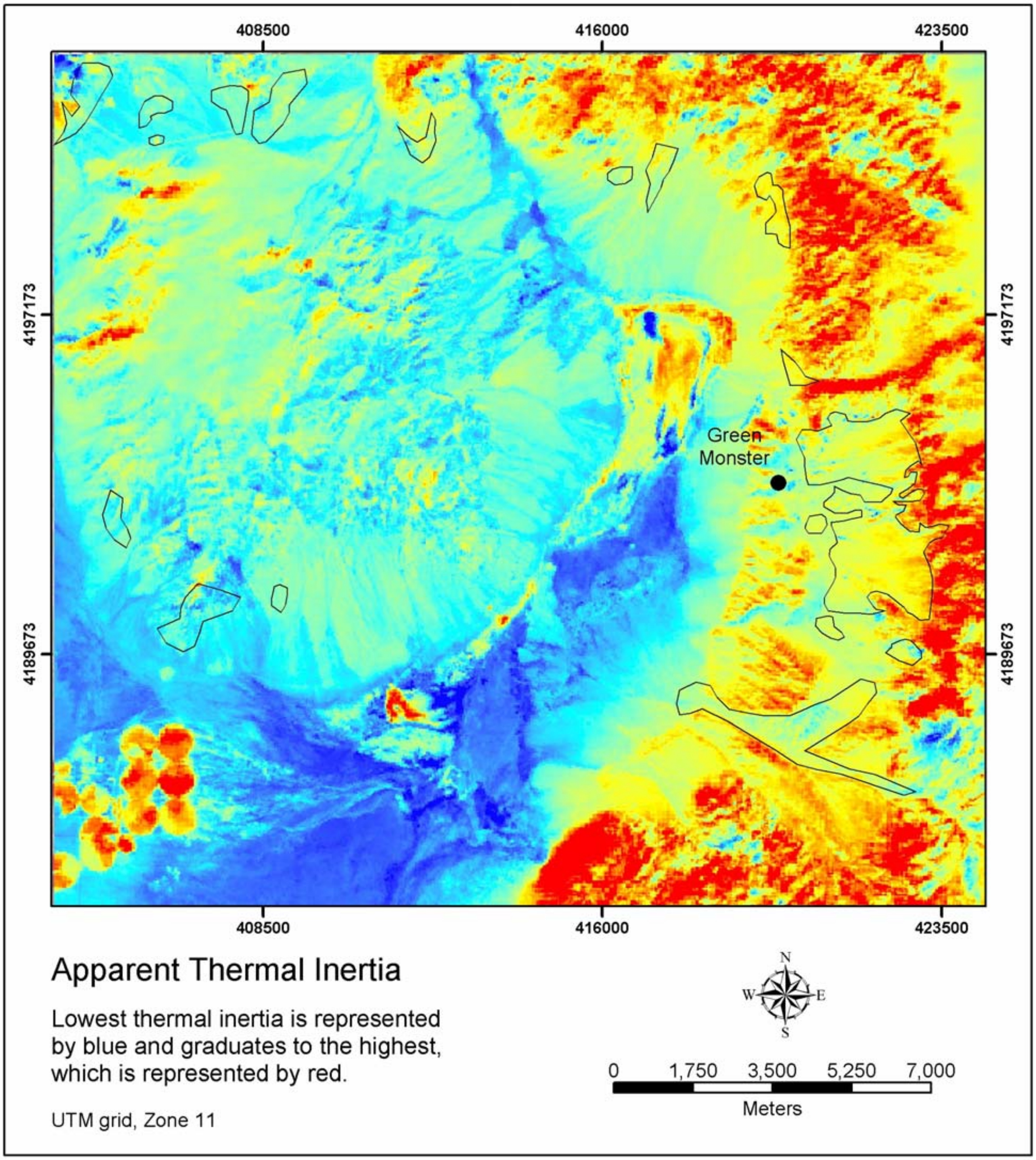

Figure 9. ASTER derived apparent thermal inertia image overlain with thermal anomalies (black polygon outlines). The area outlined to the east and southeast of the Green Monster is believed to represent hydrothermal convection up and out flow along and near the range-front fault. This area has medium to medium-low thermal inertia and medium to medium-high kinetic temperatures. Other anomalies may be useful in future exploration of the area.

Figure 10 shows a refined thermal anomaly probability map of the Emigrant prospect. This map accounts for both kinetic temperatures and apparent thermal inertia and is a spatial subset of Figures 8 and 9. It is suggested that ground temperature surveys be undertaken to provide ground truth prior to production well drilling.

GIS Development and Modeling

Several datasets have been incorporated into a GIS database for map production, data archiving, data visualization, and modeling. These include (1) geology map layers produced from field work done on this project; (2) previously drilled U.S. Borax exploration bore holes and ancillary data; (3) temperature gradients; (4) thermal anomalies; and (5) gravity data. Software for using this data has been installed at the Dyer, NV Fish Lake Green Power/Esmeralda Energy Company office with geologic data being transferred from the Energy & Geoscience Institute. This has facilitated visualization of multiple data sets and the development of statistical and three dimensional geologic models.

Figs. 11 and 12 show the the proposed location of the new GRED III exploration slimhole and the Emigrant Geothermal Prospect area. Figures 13, 14, 15, 16, 17, and 18, 3-D renderings of the Emigrant Geothermal Prospect including slimhole placement relative to strata modeled from U.S. Borax well logs and geological knowledge based on field observations. The 3-D figures were created using 3-dimensional kriging. 3-D modeling is to be continued to add better representations of faults in the subsurface before drilling begins. Software is currently being developed to handle this task.

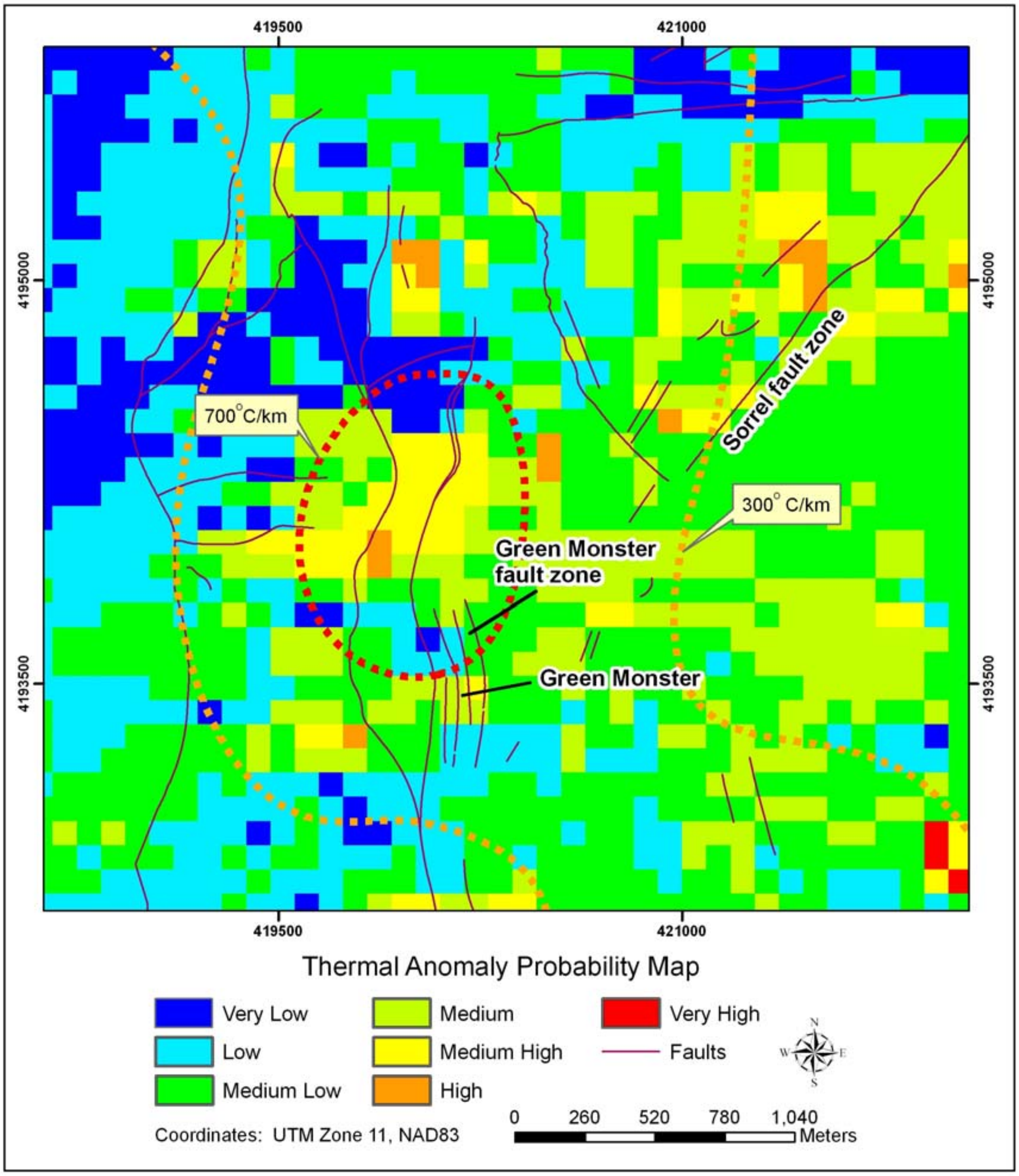

Figure 10. Refined thermal anomaly probability map with faults. This map accounts for the effects of thermal inertia. Areas with high apparent thermal inertia and high kinetic temperatures appear as low probability. Areas shown as high probability have high kinetic temperatures and low apparent thermal inertia. This map shows that thermal anomalies are often associated with faults in the Green Monster fault zone, just to the north-northwest of the Green Monster fault zone, and along the Sorrel fault zone; most notably the large yellow and orange patch north-northwest of the Green Monster fault zone, which is generally centered within the 700^{o} C/km contour. Thermal anomalies may indicate areas of high permeability in fault zones. This map covers approximately the same area as Figure 4 and is a subset of the area covered in Figures 8 and 9.

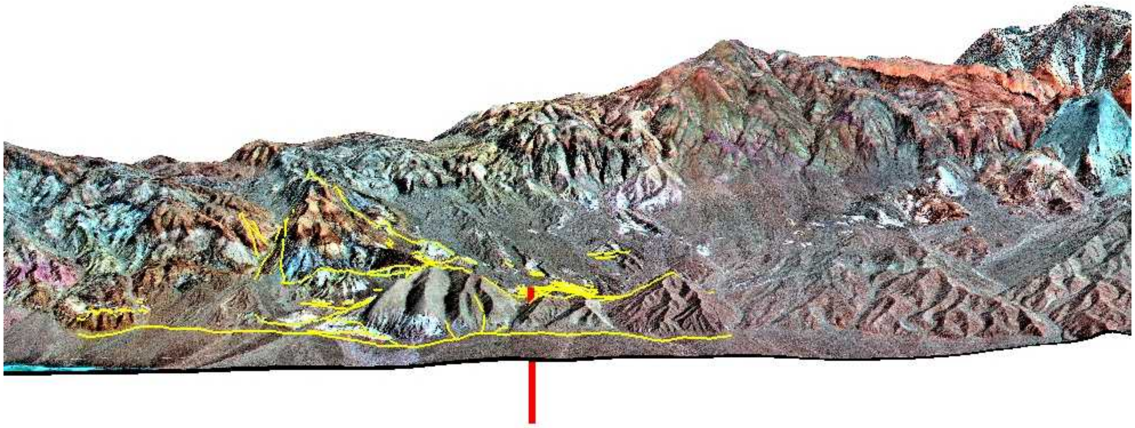

Figure 11. Emigrant Geothermal Prospect with faults (yellow) and proposed slimhole (red) superimposed. The north Silver Peak Range is the backdrop.

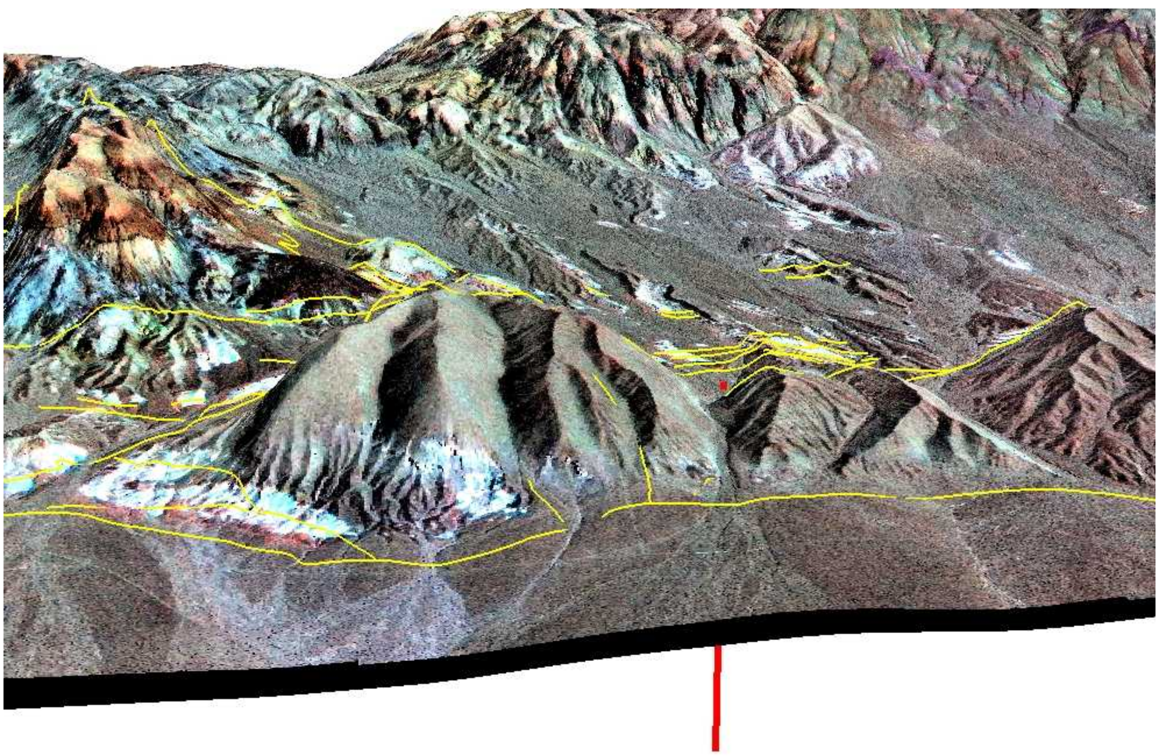

Figure 12. Zoom-in on Emigrant Geothermal Prospect and proposed slimhole (red). Yellow lines are faults.

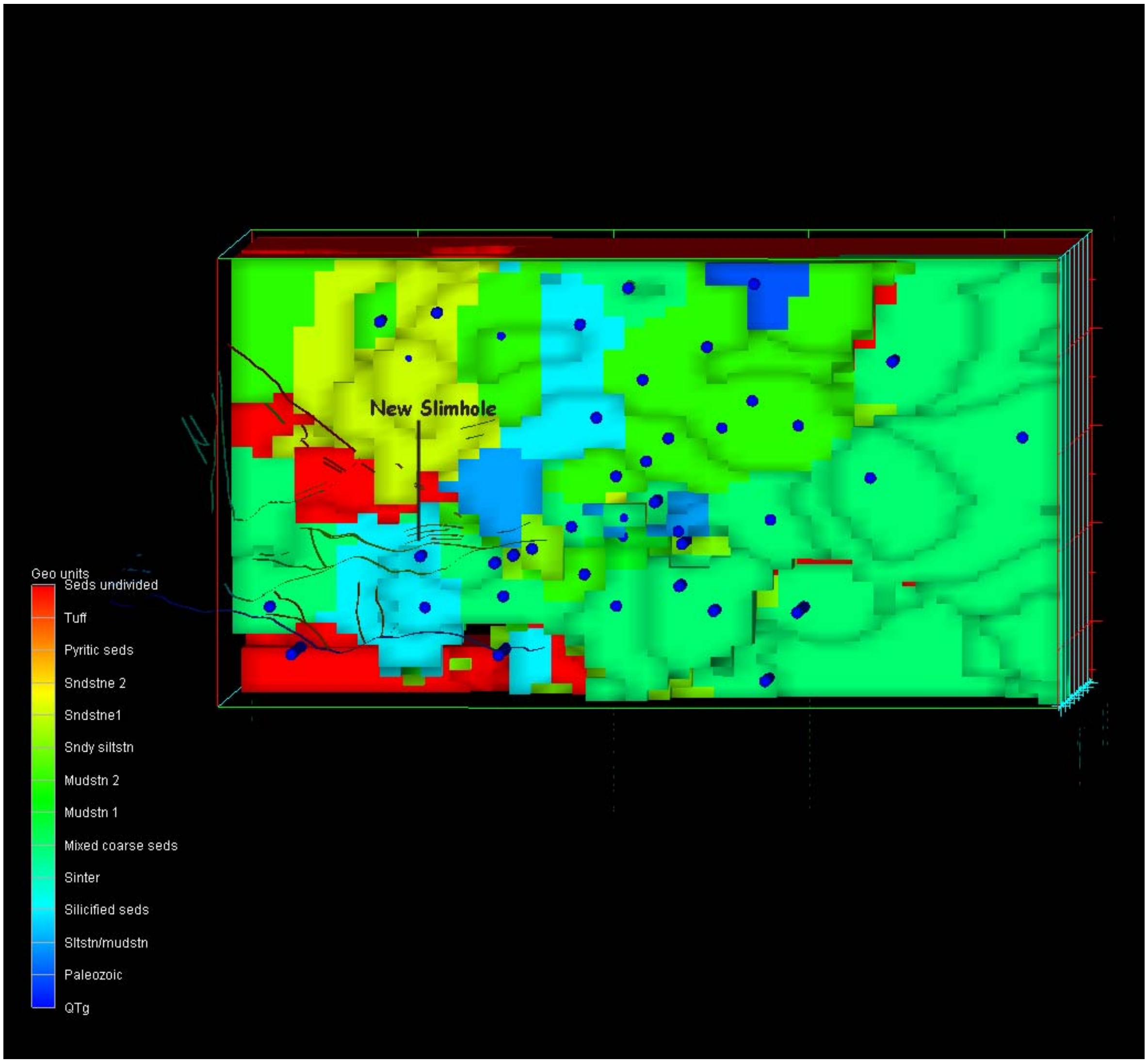

Figure 13. This is a plan view of a 3-D geologic block model of the Emigrant Geothermal Prospect with U.S. Borax boreholes and the proposed new slimhole shown as blue dots. Fault traces are shown as black lines.

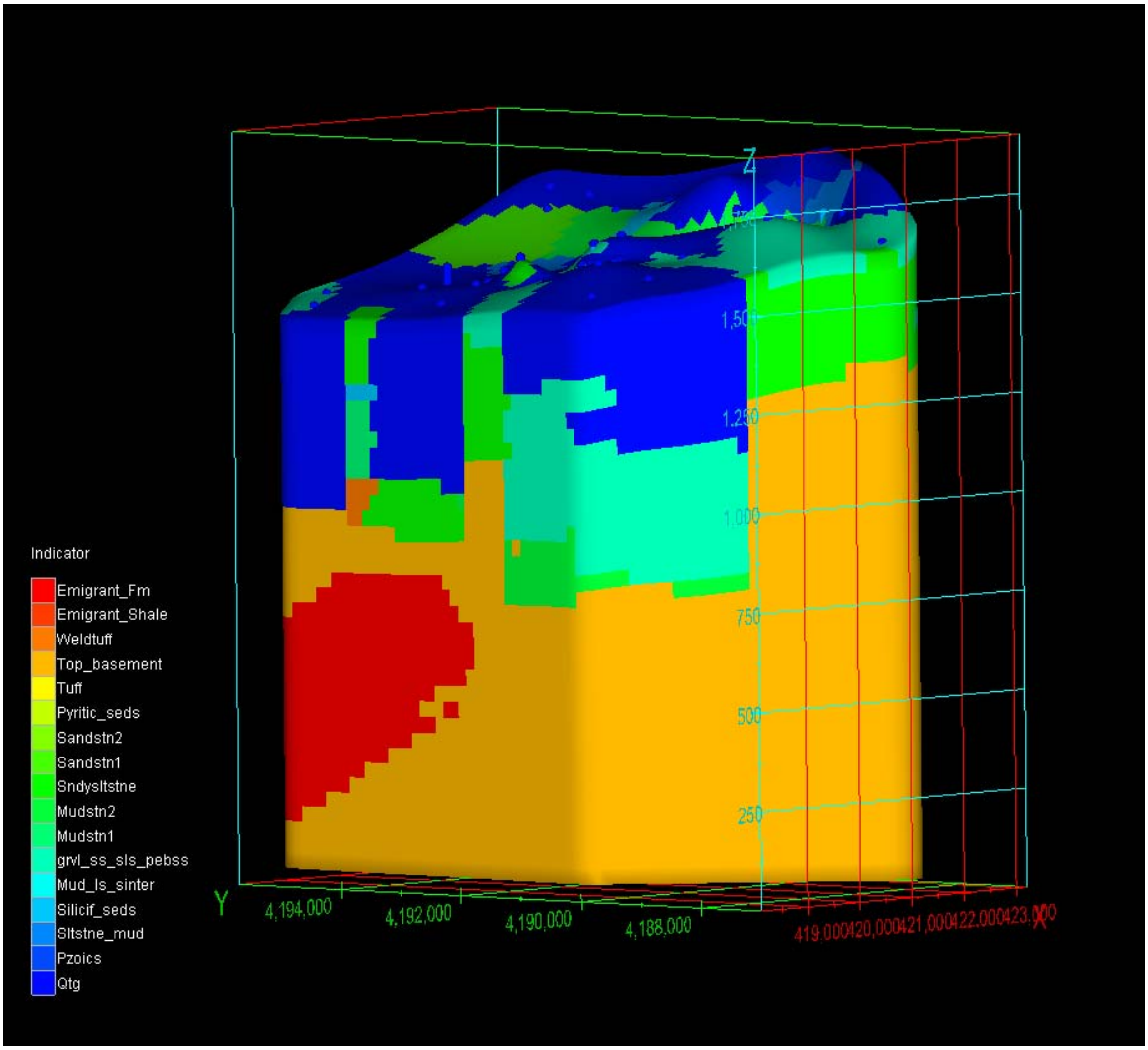

Figure 14. Side-view of 3-D geologic block model of Emigrant Geothermal Prospect area. The 3-D block modeling facilitates stripping areas away for detailed views as will be seen in following figures.

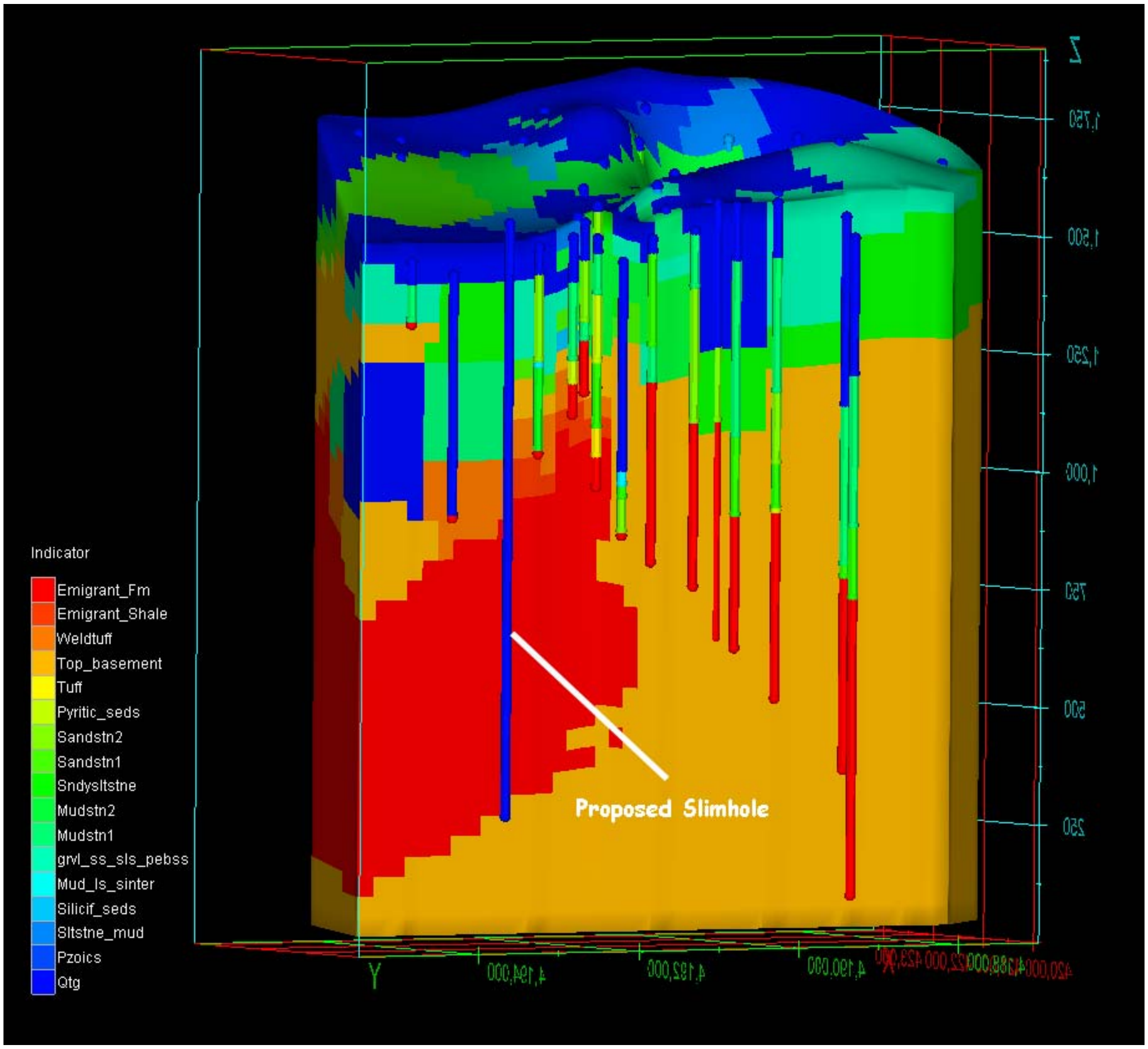

Figure 15. View to the ESE of the Emigrant Geothermal Prospect. The 3-D geologic block model has been sliced to reveal the proposed slimhole and relevant geology that can reasonably be expected to be encountered in the subsurface at this site. Tertiary tuff and Paleozoic rocks have been modeled locally and are not represented across the entire model. They are represented as red and dark orange. Light orange represents undivided sedimentary rocks that outlying the area of the proposed slimhole.

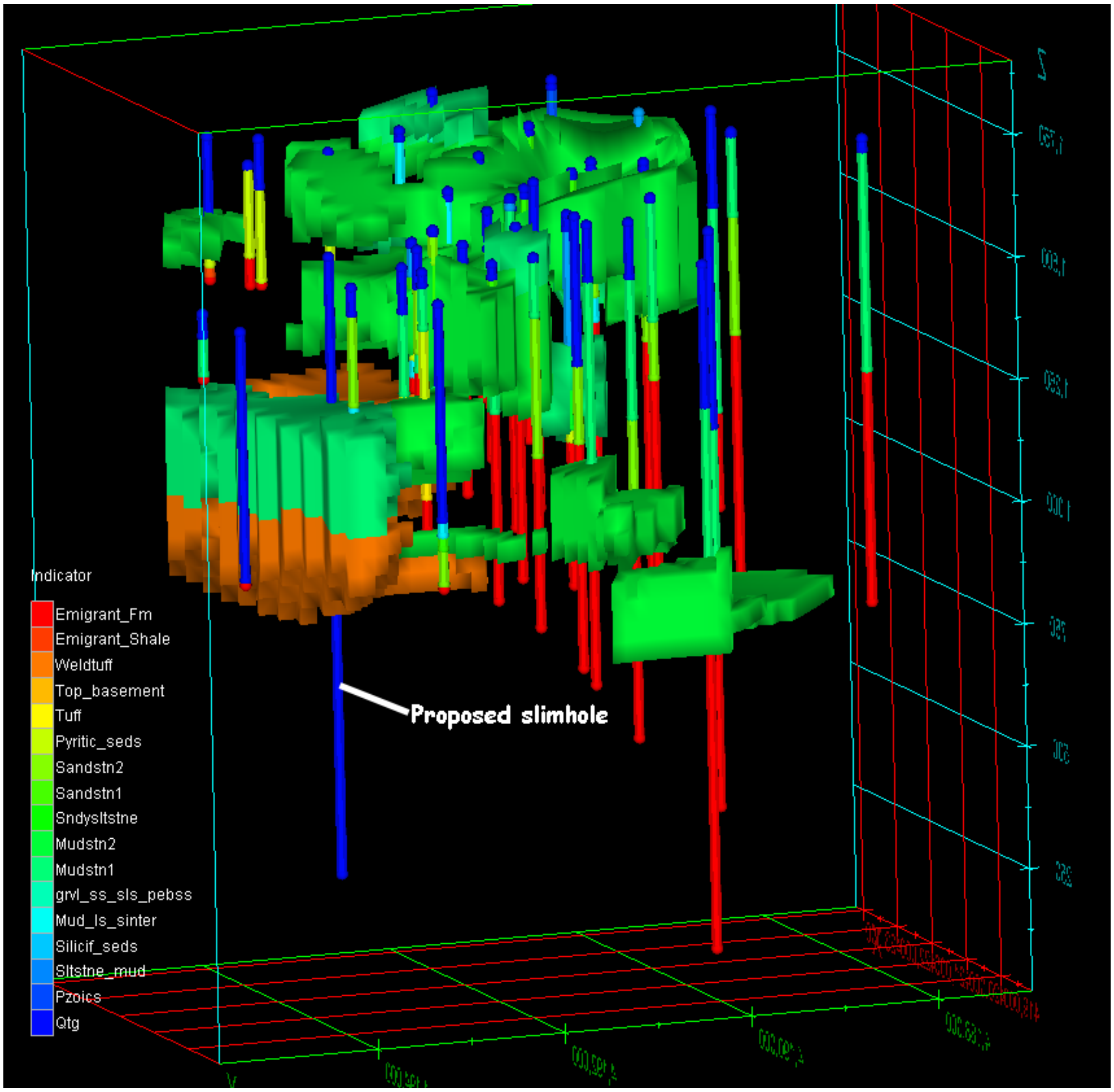

Figure 16. This view of the 3-D geologic block model shows the relationships of the proposed slimhole with potential shallow reservoir rock and seals. Claystone and mudstone is represented by green and orange represents predominately densely welded tuff that is often silicified. The densely welded tuff is highly fractured and abundantly faulted and is the upper-plate of a detachment which shows significant movement. Observations of nearby outcrops indicate that this unit will make good reservoir rock. It is underlain by highly fractured and faulted Paleozonic rocks (shown in Fig. 16), predominantly Emigrant Fm carbonates interbeded with relatively thin shale beds, which will also exhibit characteristics, in outcrop, of good reservoir rocks. The claystone and mudstone will make excellent reservoir seals and completely encase the area of the proposed slimhole.

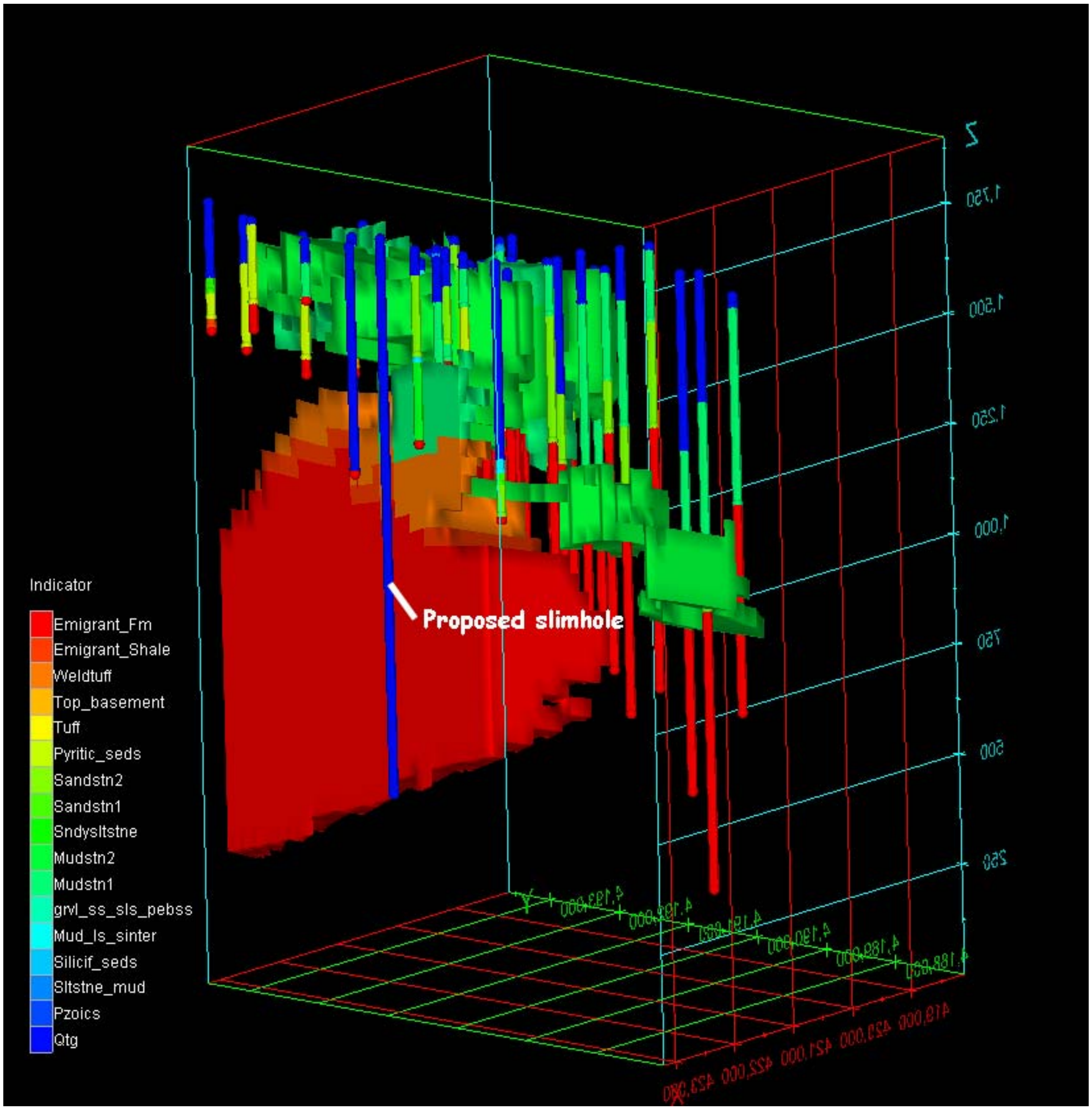

Figure 17. This view of the 3-D geologic block model has Paleozoic rock added (red) and has been sliced, vertically, back to the proposed slimhole to expose the complete sequence of potential reservoir rock (red through orange) and reservoir seal rock (green).

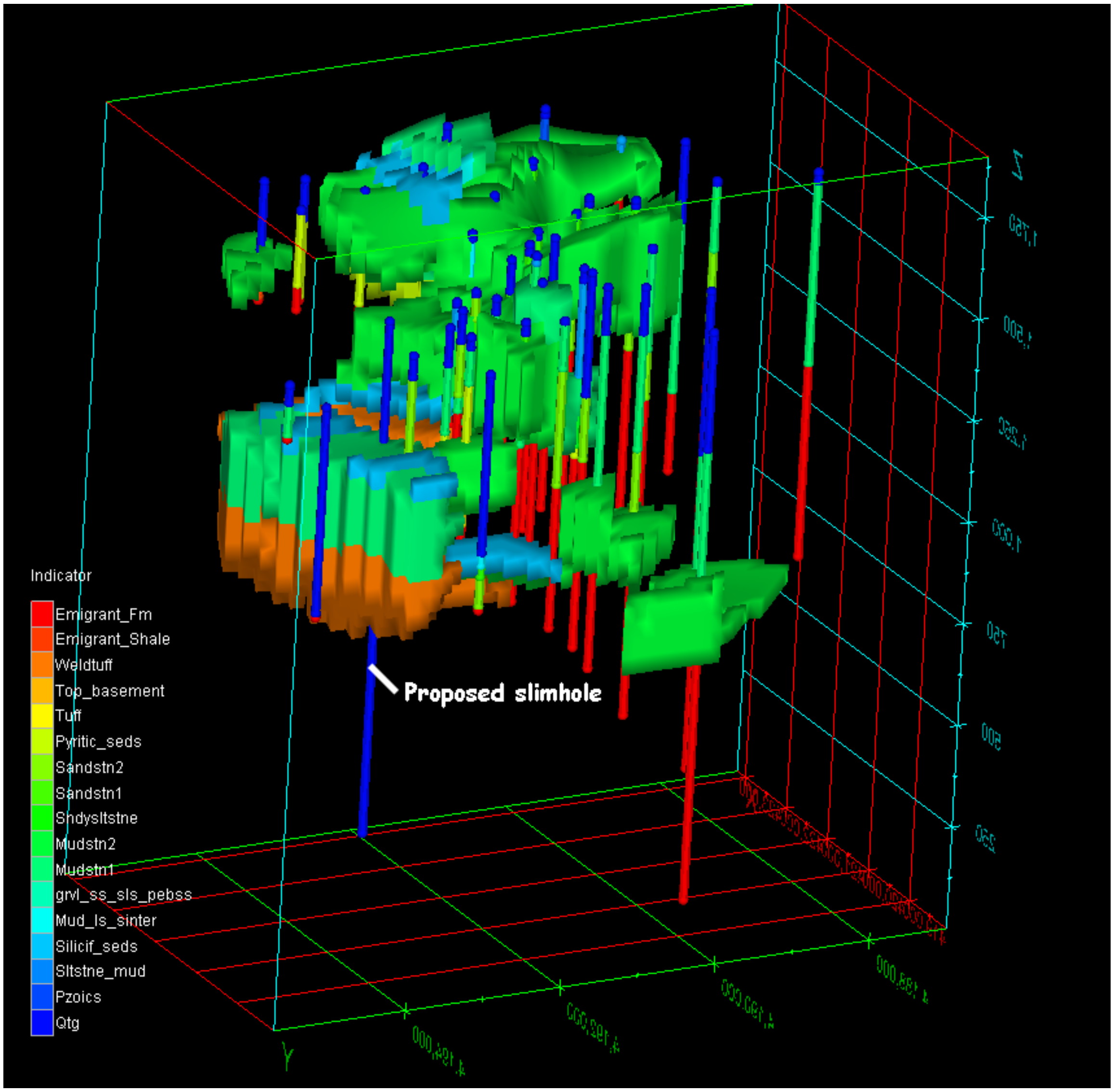

Figure 18. In this view silicificied Paleocene lacustrine sediments are shown in light blue. They are in close spatial juxtaposition with the proposed slimhole and are likely the products of the present hydrothermal convection system where fluids were migrating along the several nearby faults, perhaps through permeable damage zones, and sometimes perching on fine grain lacustrine sediments in overlying coarser grained rock. This raises the probability of an underlying reservoir. A fumarole is present not far from the proposed slimhole providing more evidence of hydrothermal convection.

Discussion and Conclusions

Overview

The Emigrant prospect's high shallow conductive thermal gradients must be tied to one or more convectively upwelling hot-water plumes. Otherwise, extrapolated to depth, the gradients would correspond to unrealistically high subsurface rock temperatures. The plumes must exist, so the key question becomes: Are the upflows hot enough, sufficiently transmissive, and supported by a large enough reservoir volume to sustain commercial geothermal power production? The bulk of the evidence gathered to date suggests that the answer is yes.

Reservoir temperature

Apart from the limited geothermometry (Table 1), we can gain some perspective on likely deeper reservoir temperatures at Emigrant by projecting the measured shallow conductive thermal gradients through a realistic caprock thickness. As a very rough first approximation, we can assume that the cap consists mostly of argillized Pliocene sediments. The thickness of this relatively low-density sequence should in theory match the "depth-to-dense rock" calculated by geophysicist John Maas (in Ciancanelli et al., 2003) by inverting data from his high-precision gravity survey of the prospect.

Along the axis of the Emigrant thermal anomaly, the estimated depth to dense rock ranges from nil to ~400 m. We assume for this exercise that the thicker portions of the cap will govern the shallowest reservoir temperatures. Projecting the core of the anomaly's "typical" conductive thermal gradient (for borehole 118) down to 400 m depth yields a temperature of ~150^{o}C at the top of an upwelling plume. A thermal gradient intermediate between those of boreholes 118 and 211 would increase the plume-top temperature to ~175^{o}C. This temperature range is compatible with that predicted by silica geothermometry. However, we reiterate that a more rigorous assessment of subsurface reservoir temperature at Emigrant can only be accomplished through deeper drilling and fluid sampling.

Permeability Architecture

The elongate shape of the Emigrant thermal anomaly (Figs. 3 and 19), in this geologic setting, strongly suggests that the feature is fault-controlled. Somewhat surprisingly, the anomaly bears no obvious relationship to the locus of modern tectonic activity, the Emigrant Peak fault zone. Instead, the anomaly follows a northwest-left-stepping progression of "major" range-bounding fault segments (that is, Paleozoic basement on the east; Cenozoic cover on the west) along the western margin of the northern Silver Peak Range. Of these segments, the axis of the anomaly mimics most closely the trend of the Gator fault zone (Figs. 3, 4, and 19). Alignment of the thermal anomaly's minor axes and protuberances suggests that the north-to-northwest-trending major range-bounding fault segments are offset to the left along deeply-penetrating, northeast-trending faults like those of the Sorrel fault zone. This left-stepping fault geometry, though differently

	Borehole 112	Borehole 211
Temperature (°C)	72	96
Collection depth (m)	238	123
Flow rate (liters/minute)	400	240
pH	8.5	8.7
Constituent and concentration (ppm)		
Cl	680.0	1310.0
F	8.8	9.2
SO_4	391.0	324.0
HCO_3	500.0	161.0
CO_3	3.0	67.0
SiO_2	203.0	168.0
Na	1012.0	1078.0
K	29.0	104.0
Ca	105.0	28.5
Mg	64.0	9.1
Li	6.4	4.3
B	133.0	33.6
TDS (ppm)	3135.2	3296.7
Geothermometry		
T, SiO_2 (quartz), °C	169	158
T, SiO_2 (chalcedony), °C	160	146
T, Na-K, °C	129	214
T, Na-K-Ca, °C	135	211
T, Na-Li, °C	213	169
T, Li, °C	231	213

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Table 1. Chemistry and geothermometry of hot-water samples from two shallow boreholes in the Emigrant geothermal prospect (from Pilkington, 1984; as reproduced in Deymonaz, 1984).

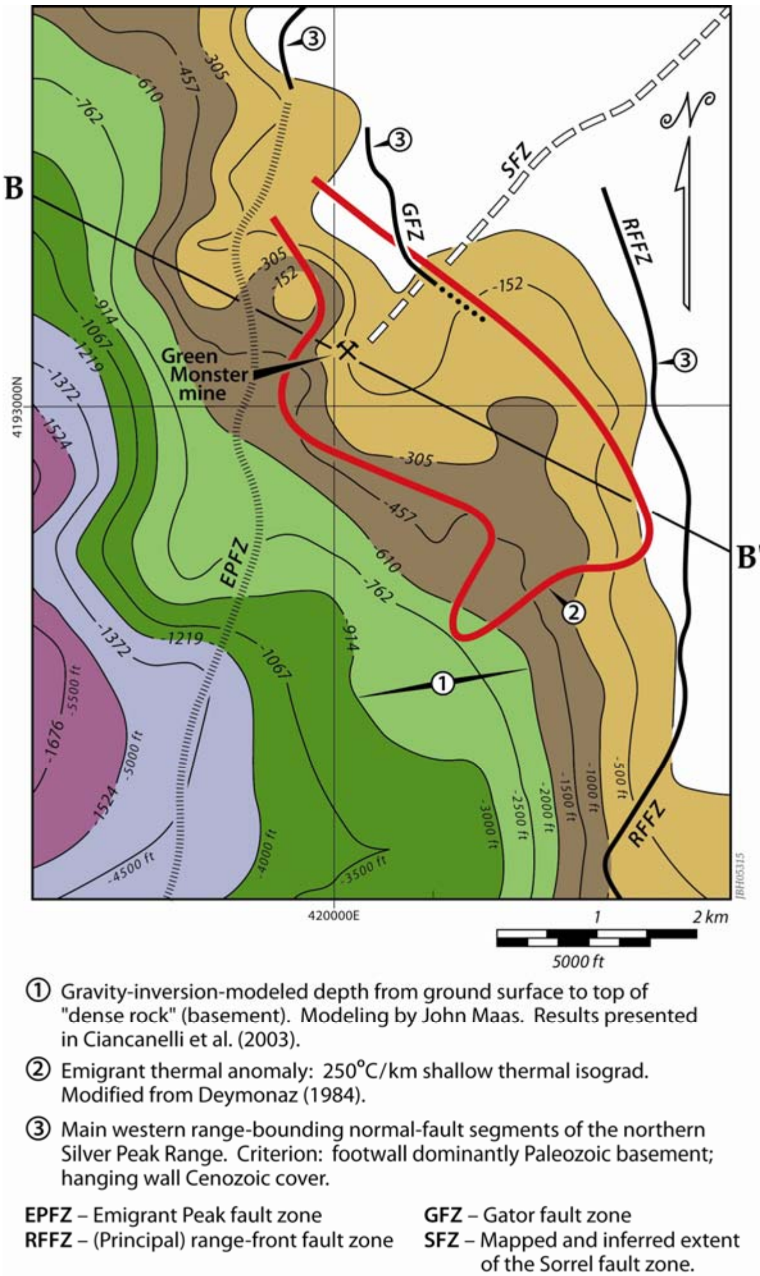

Figure 19. Map of the Emigrant prospect and vicinity, showing the surface traces of major, moderate- to high-angle fault zones relative to (1) the nucleus of the shallow thermal-gradient anomaly and (2) the gravity-modeled depth to "dense rock" [i.e., the basement]. Map area is the same as in Figure 2. Depth modeling by inversion of high-precision gravity data (by John Maas, *in* Ciancanelli et al., 2003). Note that in general the estimated-depth contours and the trend of the thermal anomaly bear no apparent spatial relationship to the locus of modern tectonic activity, the Emigrant Peak fault zone. The anomaly instead appears to be controlled by the northwest-left-stepping configuration of "major" range-bounding normal faults (Paleozoic basement to the east; Cenozoic cover to the west) at the western margin of the Silver Peak Range. Similar control of "deep-circulation" geothermal systems in northwestern Nevada has been documented by Faulds et al. (2003, 2004).

oriented, is essentially the same as that documented by Faulds et al. (2003, 2004) as governing the location of numerous "deep-circulation" geothermal systems (for example, Brady's and Desert Peak) in northwestern Nevada.

This is not to say that the prospect's northerly-trending faults have no influence at all on thermal-fluid ascent. Clearly, for example, the north-trending faults of the Green Monster fault zone provide channels for hot fluids like those tapped in borehole 211.

Although deep-seated structural controls at Emigrant may be northwest- and northeast-oriented, the shallower, northerly-trending, ancillary conduits could host the commercial- quality hot-water entries most readily reachable by the depth-limited Phase 2 drill hole.

Still, the best of these shallower entries will clearly be hydrologically tied to the principal conduits at depth. Therefore, we believe that the most favorable initial (intermediate-depth) drilling target at Emigrant should be (1) in the heart of the shallow heat anomaly; and (2) at or near the juncture of a recently altered and mineralized northerly-trending fault zone with one or both of the prospect's two other principal (and deeply-penetrating) fault sets. With these guidelines, a good choice would be the intersection of the Green Monster fault zone with the southwesterly projection of the Sorrel zone (Figs. 4 and 5).

There are other promising targets, but we believe the one cited is most likely to produce a discovery within the Emigrant project's practical and financial constraints.

Additionally, GIS based statistical modeling and 3-D geologic block models support this target as does the thermal anomaly mapping. The exploration drilling site chosen for this project is shown in Fig. 21.

A Conceptual Model

A geohydrologic model featuring our favored initial drilling target beneath the Green Monster mine is presented as Figure 20. According to the model, thermal waters heated by deep circulation buoyantly ascend along the Gator fault zone, the lengthier "principal" range-front fault zone that breaches the surface to the east, and the Mineral Ridge detachment, that is, the gently-dipping low-angle fault zone between the upper and lower plates of the Silver Peak-Lone Mountain metamorphic core complex. The rising fluids focus and accelerate upward at the Sorrel-Green Monster, Sorrel-Gator, and other major fault intersections. Beneath an impermeable caprock consisting principally of argillized Pliocene sediments, the fluids advect subhorizontally along subsidiary conduits ranging from carbonate-dissolution channels to flower structures in low-angle fault zones disrupting Miocene ignimbrites. Modern recharge for the system could emanate in part from (1) the Silver Peak range to the east; and (2) the lofty (>4000 m) White Mountains bordering Fish Lake Valley on the west. Over the productive life span of the geothermal system, however, such real-time recharge will surely be minimal. In common with other geothermal systems in the Great Basin, the bulk of the deeper thermal water at Emigrant will likely be "fossil" and older than 10,000 years (Flynn and Buchanan, 1992).

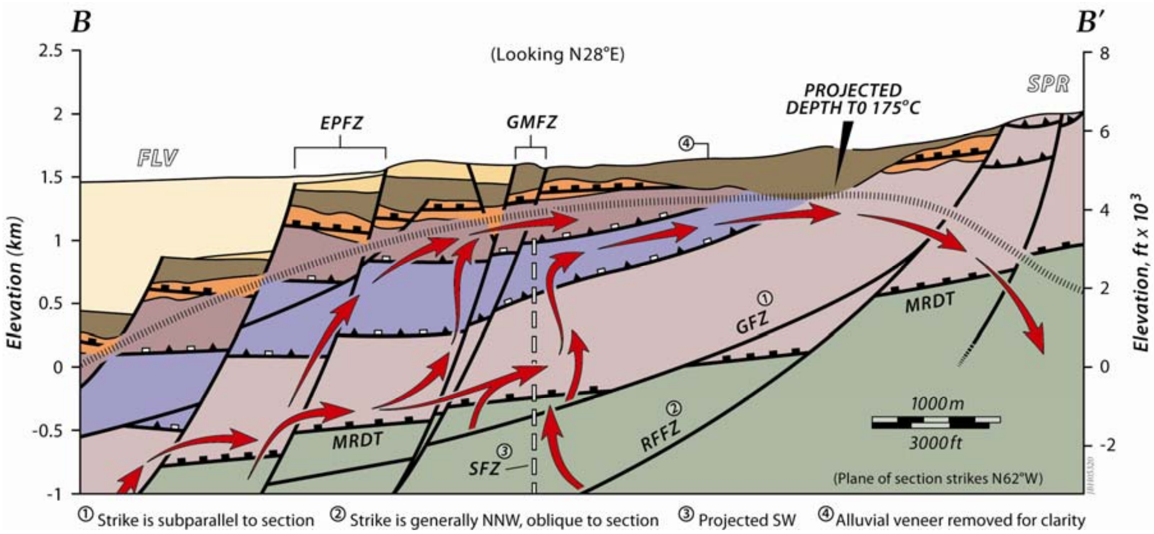

Figure 20. Conceptual geologic model of a moderate- to high-temperature convective geothermal system circulating beneath the heart of the Emigrant shallow thermal-gradient anomaly (Figs. 3 and 8). Red arrows schematically portray potential thermal-fluid pathlines. At the center of this section is the drilling target considered by us as optimum for penetrating, in the depth range 900-1300 m, the upper reaches of a commercially producible, moderate- to high-temperature geothermal upflow plume. The target encompasses (1) major fault intersections involving the Green Monster, Gator, and Sorrel fault zones (Figs. 3, 4, and 8); (2) the only modern geothermal surface manifestations, including a native sulfur deposit; and (3) the borehole with the second-highest shallow thermal gradient on the prospect (No. 211, at 700^{o}C/km; Fig. 3). EPFZ – Emigrant Peak fault zone; FLV – Fish Lake Valley; GFZ – Gator fault zone; GMFZ – Green Monster fault zone; MRDT – Mineral Ridge detachment; SFZ – Sorrel fault zone; SPR – northern Silver Peak Range. Rock units and symbols same as for Figure 4.

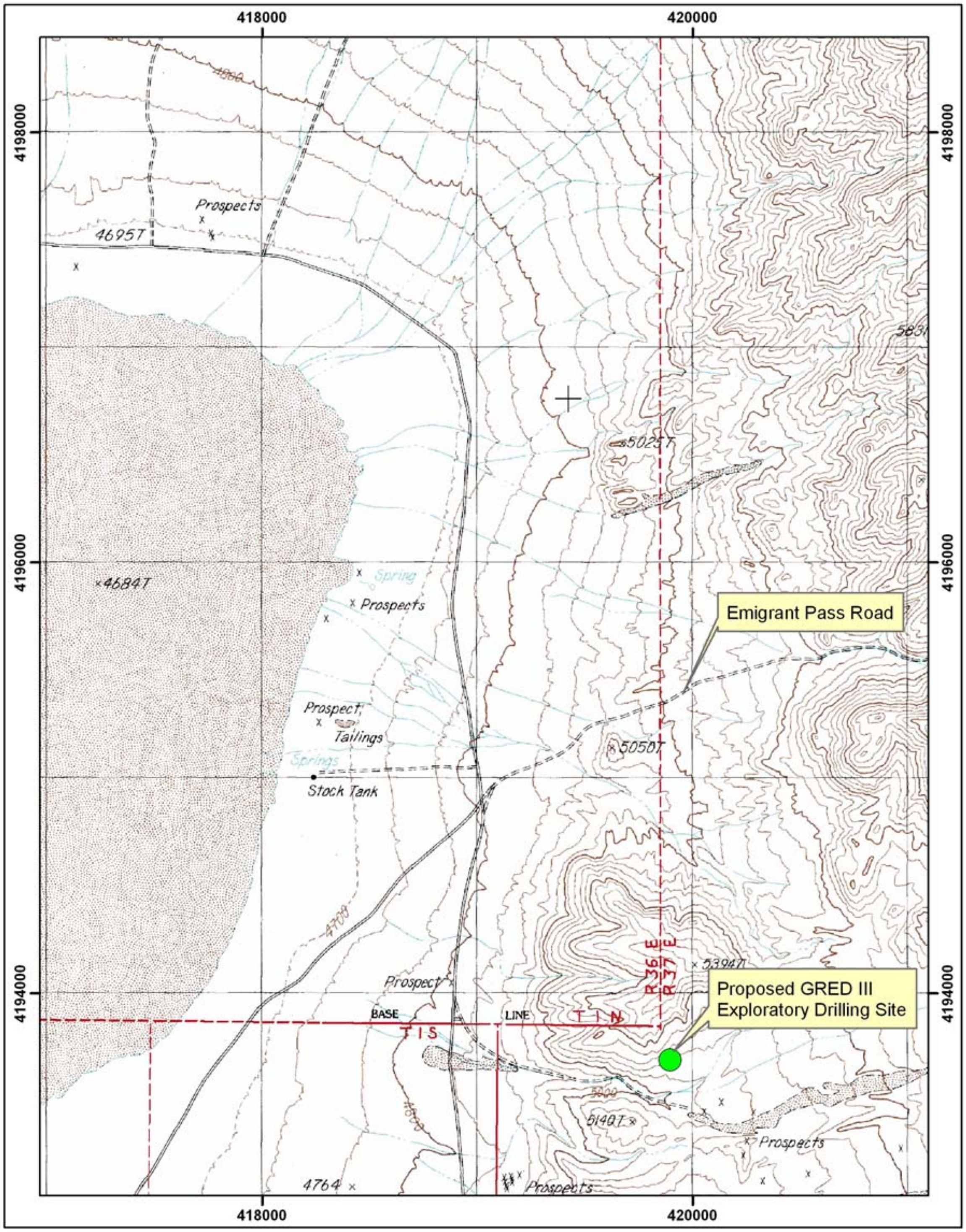

Figure 21. Southeast corner of Rhyolite Ridge Northwest USGS 7.5 minute quadrangle showing the location for the new GRED III exploration drilling.

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APPENDIX B – Task II Drilling and Resource Characterization: Supporting Documents and Data

Drilling Program ………………………………………………………………………………………………… 53 – 60

Operation Plan ………………………………………………………………………………………………… 61 – 68

A Cultural Resources Inventory of 640 Acre Proposed Geothermal
Exploration Project for the Fish Lake Green Power Company,
Esmeralda County, Nevada ……………………………………………………………………………. 69 – 135

A Cultural Resources Inventory of 640 Acre Proposed Geothermal
Exploration Project for the Fish Lake Green Power Company,
Esmeralda County, Nevada (Revised)………………………………………………………………. 136 – 181

Environmental Assessment NV065-EA06-177, Emigrant #17-31
Geothermal Drilling Permit, Esmeralda Energy Company ………………………………………. 182 - 208

Finding of No Significant Impact and Decision Record For
Emigrant #17-31Geothermal Drilling Permit Project Number: NV065-EA06-177 ……… 209 - 212

Boart Longyear Company Drilling Bid …………………………………………………………………… 210 – 213

Boart Longyear Company Rig specifications ………………………………………………………. 218 – 220

Major Drilling Bid ……………………………………………………………………………………………… 221 -227

Major Drilling Rig Specifications ………………………………………………………………………… 228

Hulen Letter and Summary – New Cross-sections, Significance of
Green Monster Fault Zone, XRD, Fluid-inclusion Microthermometry,
and Recommendations for Future Exploration and Development Drilling ……………….. 229 - 262

Descriptive geology of core and cuttings from drill hole EM 17-31,
Emigrant Geothermal Prospect, Esmeralda County, Nevada ………………………………….. 263 – 284

Drilling Summary………………………………………………………………………………………………… 285 - 286

Phase II Completion Report Esmeralda Energy Company
Emigrant Slimhole Drilling Project DOE GRED III (De-Fc36-04go14339) …………………….. 287 - 290

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*** DRILLING PROGRAM ***

EMIGRANT 17-31 SLIMHOLE DRILLING PROJECT
DOE GRED III (DE-FC36-04GO14339)

March 2006

INTRODUCTION

Esmeralda Energy Company ("EEC") intends to drill a core hole to a maximum depth of 4,000 feet on its Emigrant Project in Fish Lake Valley, Esmeralda County, Nevada. The drilling project is the key component in phased program of resource evaluation by EEC. The Department of Energy GRED III program is funding 80 per cent of the project.

The proposed Emigrant 17-31 drill site is located along the north-eastern margin of Fish Lake Valley in the foot hills of the Silver Peak Range approximately 17 miles north-northeast of the community of Dyer, Nevada (Fig. 1).

DRILL SITE

The Emigrant 17-31 drill site is located in a small valley in the western foothills of the Silver Peak Range (UTM Coordinates 11S419894mE and 4193690mN). The site will be approximately 100 by 140 feet in size, level and cover approximately 0.33 acres (Fig. 2). The site will be constructed in Quaternary alluvial sands and gravels with an average native slope of 6 per cent. Construction will consist of "cut and fill" and involve removing approximately 3 feet of material on the northeast side of the drill site and using the material to fill in approximately 3 feet on the southwest side. A small earthen mud pit approximately 20 feet long, 8 feet wide and 6 feet deep will be dug and an impermeable liner installed. Drilling fluids will be circulated through the pit to allow the fluids to cool and cuttings to settle out. An adjacent mud cleaning system will also deposit solids removed from the drilling fluids into the pit.

The mud pit will have a total volume of approximately 500 cubic feet (3,700 gallons). The drill hole if completed to the full 4,000 feet will have a total volume of approximately 315 cubic feet (2,360 gallons) assuming no reductions in hole diameter and no drill rods or tubing in the hole.

An area of disturbance may extend up to 50 feet outward from the drill site and be impacted by tracked and wheeled equipment used to construct and reclaim the site.

ACCESS ROAD

Access to the drill site will be along existing roads. The roads are maintained by the Esmeralda County Road Department. The final 0.5 miles of road to the drill site is in a sandy wash with a grade of approximately 6 per cent. The drill crew to make frequent runs along this portion of the road to keep "washboards" to a minimum will use a "drag".

DRILLING EQUIPMENT AND MATERIALS

Equipment on site will consist of a drilling rig, pipe trailer, mud pump/cleaner system, 4,000 gallon water truck and three 21,000 gallon water (Baker frac) tanks. Maximum water storage on site will be 67,000 gallons.

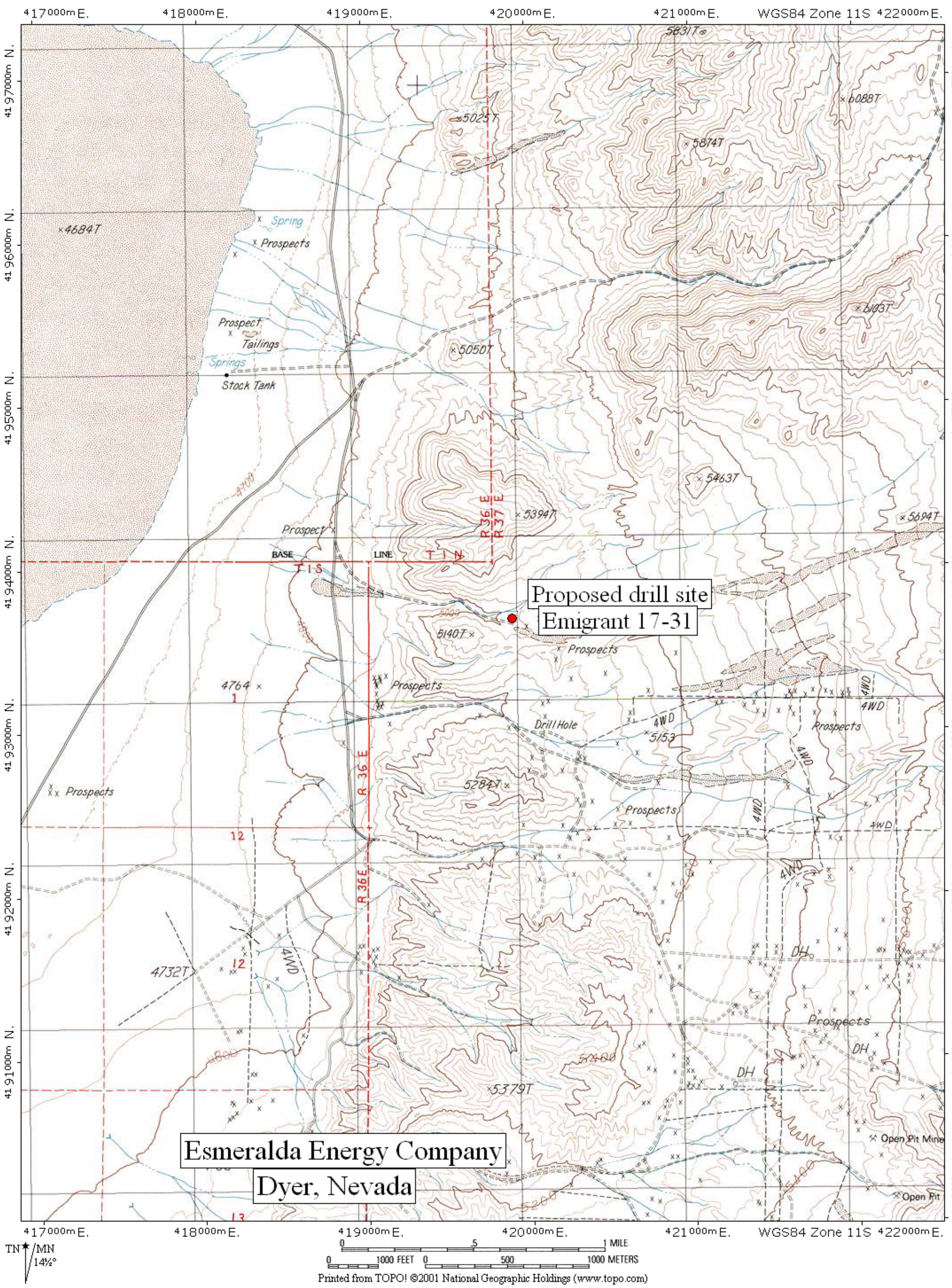

Figure 1. Drilling site for 17-31.

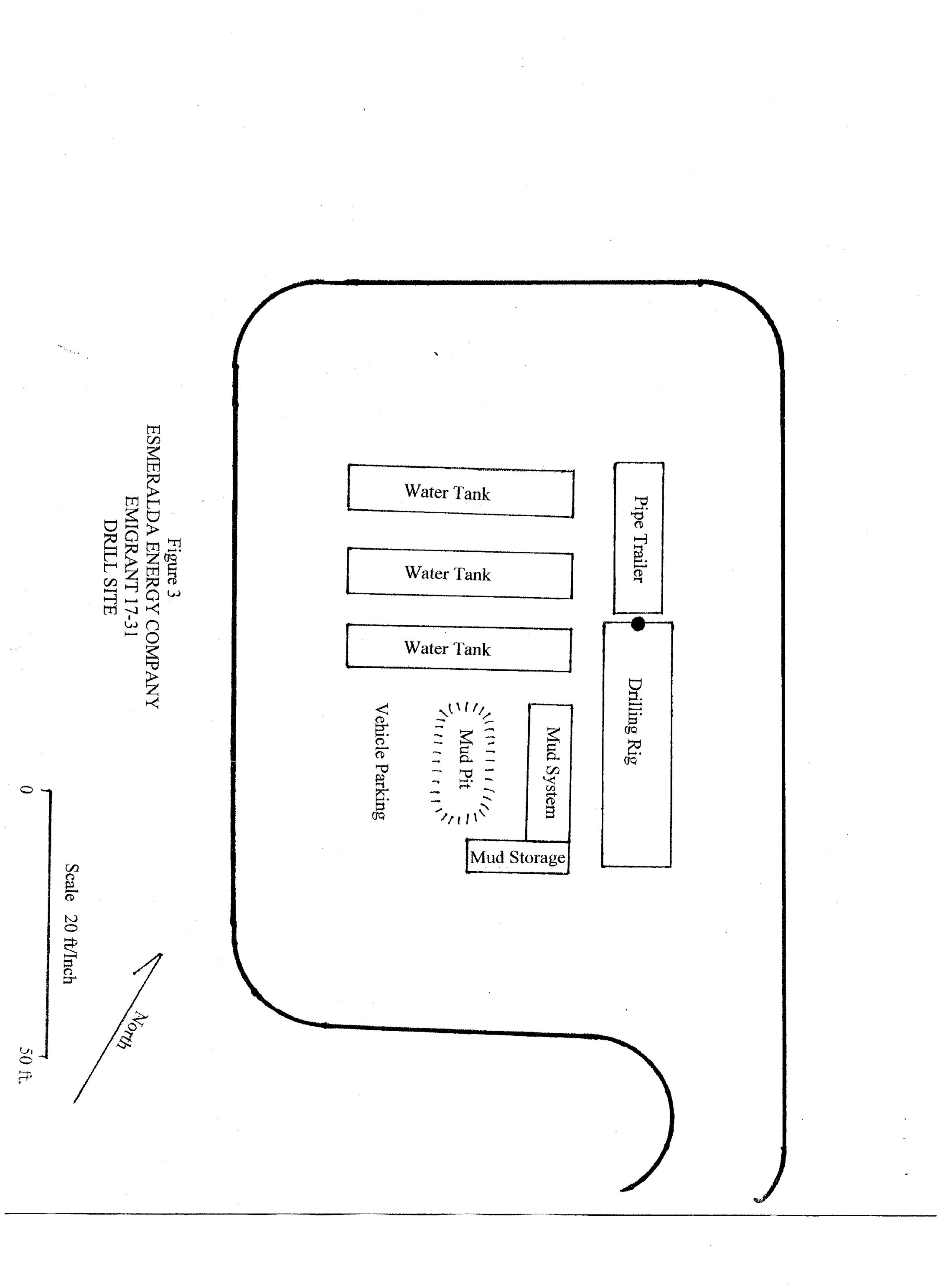

Figure 2. Drilling plan for 17-31.

Rig specifications:

Boart-Longyear HD-600 rotary/core drilling rig

Rig weight: 77,400 pounds

Lift capacity, crown block rating: 120,000 pounds

Lift capacity, hook load: 100,000 pounds

Mast length: 58 ft 4 in.

Power plant: Cummins 325 HP @ 2100 RPM

Top head drive

Max RPM: 1007

Max torque: 13,080 ft/lbs

Feed length: 22.5 feet

Mud pump: FMC model L1622BCD (2 each)

GPM: 58.7 @ 985 RPM

Max discharge pressure: 1,325 PSI

The circulating medium will consist of a bentonite-polymer based drilling fluid and will contain varying quantities of additives depending on the drilling conditions. All materials used are non-toxic including the vegetable based grease used on the drilling rods. A general list of materials to be used includes, but is not limited to:

Quick Gel EZ Mud Plus

DrisPac DrisPac Superlow

Pac R Pac L

Potassium Chloride Soda Ash

DRILLING PROGRAM

Rotary drill a 12-1/4 inch hole to 40 feet, set 9-5/8 inch 32#/ft surface conductor and cement using a tremmie pipe and neat cement. Rotary drill 8-1/2 inch hole to 400 feet and set HQ (4-1/2 inch) 11 #/ft flush joint casing with cement shoe. Cement with neat cement pumped through a tremmie pipe run in the annular space.

While waiting on cement to cure, construct a 3-foot deep cellar using a five-foot diameter of steel or poly culvert. Install wellhead flange with two 2-inch valves. One valve will serve as the kill line and be connected to the mud pump. The second line will be piped to the mud pit and serve as a flow line. Wellhead equipment will consist of a 4 inch full opening manual valve and a Triple M 1,000 psi annular hydraulic BOP. Wellhead equipment will be pressure tested to 300 psi for 30 minutes.

Drill out of the 4-1/2 inch casing with HQ core bit (3.782 inch bit and 3.50 inch drill rods) and complete hole to 4,000 feet. If drilling conditions warrant, leave HQ drill rods in hole to serve as temporary casing and continue coring with NQ (2.98 inch bit and 2.75 inch drill rods) to 4,000 feet.

Down hole temperatures will be monitored by running three maximum reading thermometers ("MRT's") in separate pressure vessels in a cage at the top of the overshot used to retrieve and set the core barrel. The MRT's will record temperatures approximately 12 feet from the bottom of the hole approximately 30 minutes after circulation has ceased. The MRT's will be run at intervals of no greater than 100 feet. This technique has proved to provide reasonably accurate formation temperatures during similar core drilling during the past 25 years. Drilling fluid in and out temperatures will also be continuously monitored while drilling.

After reaching TD a temperature log will be run in the hole. This will be followed by a short multi-step injection test, which will be performed using the same water used for the drilling fluids. Capillary tubing run in the drill hole will provide pressure data during the test. After testing is completed, 2-inch steel tubing (sch. 40 steel pipe), capped on the bottom, will be run in the hole to TD inside the drill rods. Remove drill rods and hang tubing on a steel plate welded to the 4-1/2 inch casing with a 2-inch gate valve. The 2-inch valve will be secured with a locking device and the cellar filled in.

PROPOSED WELL DEPTH

A maximum depth of 4,000 feet. A shallower completion may occur if sufficient temperatures and permeability are encountered.

LOGS

While drilling, maximum reading thermometers will be used to monitor formation temperatures as discussed above. Upon completion of the drilling a temperature log will be run inside the drill rods to TD. If equipment and personnel from Sandia Labs can be coordinated, additional electrical logs may be run. Paper and electronic copies of all logs will submitted to the Nevada Division of Minerals. A major advantage of core drilling is that continuous core will be retrieved from 400 feet to TD and the density, electrical properties and fracturing can be studied in the lab.

Cuttings will be collected at 10-foot intervals while rotary drilling the upper 400 feet. Four cuttings samples will be collected and two sets will be submitted to the Nevada Bureau of Mines and Geology. A split of the core will also be submitted to the Nevada Bureau of Mines and Geology.

DIRECTIONAL DRILLING

No directional drilling will be undertaken.

LOST CIRCULATION ZONES

Temperature, drilling and lithologic data has been collected from 57 drill holes in the Emigrant Project area which total over 50,000 feet of drilling. Drill holes have ranged in depth from 167 to 2,500 feet. Based on this data, loss of circulation should not be a significant problem in the upper 1,000 feet unless permeable gravel intervals are encountered in the upper few hundred feet.

If loss of circulation is encountered while rotary drilling the upper 400 feet of the hole, loss circulation materials ("LCM") such as cottonseed hulls and paper will be used to regain circulation. If the use of LCM is not successful, cement plugs will be spotted in the problem intervals. Cementing the 4-1/2 inch casing using the tremmie pipe method greatly increases the probability of obtaining am excellent cement job abound the casing even in zones with loss of circulation.

At greater depths loss of circulation may be encountered in fractured Tertiary silicic volcanics and a low-angle Tertiary detachment zone. Paleozoic carbonates, siltstones and shales combined with the projected intersection of two fault zones should be encountered at a depth of about 2,000 feet and loss of circulation is likely. One advantage of core drilling is that the volume of drilling fluids necessary in lost circulation situations is minimal compared to rotary drilling and the small size and volume of cuttings generated do not create a sticking problem with the drill rods. Core drilling will continue without returns to the surface.

GROUND WATER

Based on pervious drilling the first ground water should be encountered at an estimated depth of 400 – 500 feet. The water will have a temperature of approximately 130 - 140 degrees F and will have moderate amounts of sodium and calcium.

ANTICIPATED TEMPERATURES

Temperature measurements have been made in 39 drill holes in the Emigrant area at depths ranging from 105 to 2,411 feet. Temperature gradients in nearly all of these holes are conductive, resulting in nearly straight-line gradients to temperatures as high as 226 F. Based on gradients measured in the nearest 6 drill holes, the temperature at 400 feet is estimated to be approximately 130 F.

Deeper temperatures are estimated by chemical geothermometers from fluid samples collected and analyzed during earlier drilling operations. Various chemical indicators suggest temperatures ranging from 330 to over 400 F. The most reliable chemical indicators suggest temperatures in the 340 – 370 F range.

A 971 foot U.S. Borax drill hole located approximately 2,500 feet to the south had a gradient of 16.74 F/100 ft. A 200-foot temperature gradient hole drilled 5,000 feet to the north had a gradient of 15.26 F/100 ft. A 200 foot temperature gradient hole drilled 3,000 feet to the east had a gradient of 21.14 F/100 ft.

Using the most simplistic model based on temperature gradient modeling of the area, a temperature gradient of 17 F/100 feet with some decline due to increasing formation thermal conductivities with depth and no isothermal zones, a formation temperature of 350 F can be expected at a depth of approximately 2,000 feet. Geologic mapping and modeling indicates the top of the reservoir rock (Paleozoic carbonates, siltstone and shale) at this location to be at a depth of about 2,000 feet.

A more realistic model involves one or more convective zones with intervals of isothermal temperature gradients, which would place the 350 F temperature isotherm at a greater depth.

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*** OPERATIONS PLAN ***

EMIGRANT 17-31 SLIMHOLE DRILLING PROJECT
DOE GRED III (DE-FC36-04GO14339)

March 2006

INTRODUCTION

The Emigrant Geothermal Project is located along the north-eastern margin of Fish Lake Valley in the foot hills of the Silver Peak Range approximately 17 miles north-northeast of the community of Dyer, Nevada (Fig. 1). Fish Lake Valley extends approximately 35 miles to the south and has a population of about 320 residents scattered among numerous farms and small residential subdivisions. The nearest residences to the project area are located at the Arlemont Ranch, approximately 11 miles west of the Emigrant 17-31 drill site.

Esmeralda County maintained gravel roads provide access into the area. No road construction will be required and only minor blade work on the existing roads will be required. Esmeralda County maintained gravel roads connect with Nevada State Highway 264, approximately 12 miles to the west, and U.S. Highway 6, approximately 10 miles to the north and Nevada State Highway 265 approximately 11 miles to the northeast.

During the 1980's and early 1990's U.S. Borax drilled 44 mineral exploration holes and Steam Reserve Corp. drilled 13 temperature gradient holes in a roughly 15 square mile area of elevated subsurface temperatures now referred to as the Emigrant Geothermal Project. Total drilling footage exceeded 50,000 feet. Several of these drill holes reached depths of over 2,000 feet. Temperatures were measured in 39 of these holes. Although temperatures were not measured in18 of the mineral exploration holes EEC has obtained the lithologic, drilling, geologic and geochemical data for all 44 mineral exploration hole drilled by U.S. Borax in addition to all drilling, lithologic, temperature geochemical data for the 13 gradient holes drilled by Steam Reserve Corp.

Drill hole data outlined a broad area of elevated temperature gradients, often exceeding 15 – 20 F/100 feet with nearly all holes reflecting straight-line conductive gradients with no isothermal intervals. Four bottom hole temperatures exceeded 200 F. The maximum recorded temperature was just over 226 F.

Water chemistry from fluids collected while drilling several of the holes suggest reservoir temperatures in the range of 330 to over 400 F. The most reliable chemical indicators suggest reservoir temperatures in the 340 – 370 F range.

An extensive gravity survey has been completed, adding to previous work in the Fish Lake/Emigrant area. Data from over 1,000 stations has been modeled to provide insight into the structure and depth of Paleozoic basement formations, which appear to form the geothermal reservoir at depth.

Part of the GRED III project involved detailed geologic mapping of the project area and construction of both 2-D and 3-D geologic models. Geologic mapping and models, interpretation of the gravity data, temperature gradient information and lithologic data have been combined in a Geologic Information Systems ("GIS") database which was utilized to assist in choosing the Emigrant 17-31 drill site.

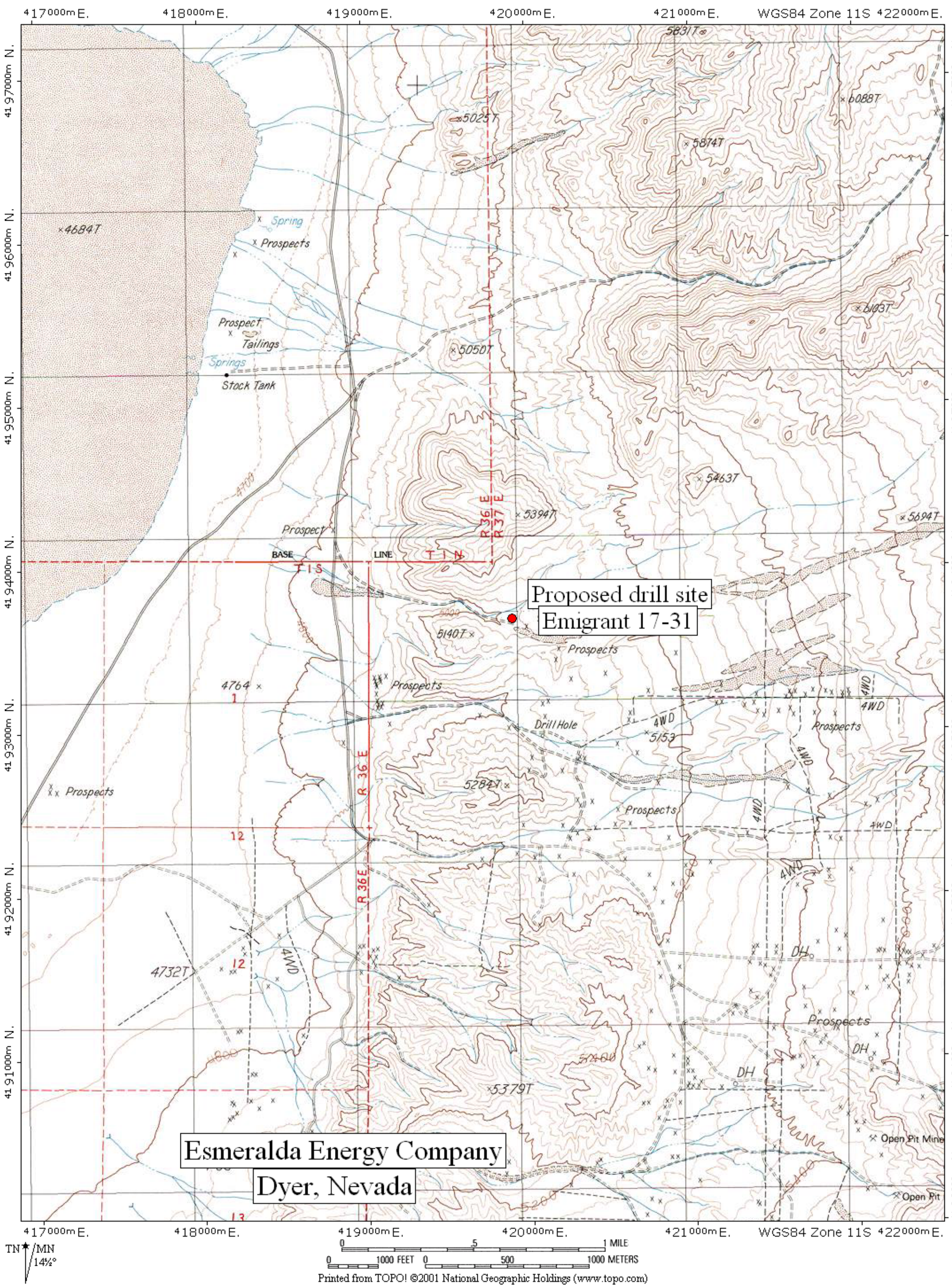

Figure 1. Site map for proposed drilling site 31-17.

PROPOSED WORK

Esmeralda Energy Company ("EEC") proposed to drill a core hole to a maximum depth of 4,000 feet. The hole has been sited to reach the geothermal reservoir at a minimum depth of 2,000 feet and intercept with two converging fault zones, which apparently control the movement of geothermal fluids at depth.

Work will involve rotary drilling a 12-1/4 inch hole, setting and cementing 9-5/8 inch casing to a depth of 40 feet. Rotary drill an 8-1/2 inch hole to 400 feet, set and cement 4-1/2 inch casing. Below 400 feet core drilling will be utilized to obtain continuous core down to and into the geothermal reservoir.

Upon completion of drilling, a short injection test will be performed to establish the permeability and other characteristics of the geothermal reservoir, 2 inch tubing installed in the well to TD and temperature measurements made over a 6 – 12 month period.

SURFACE OWNERSHIP

Drilling operations will be conducted on Public Lands managed by the Bureau of Land Management ("BLM") Battle Mountain District. The drill site will be located on federal geothermal lease N-74097 issued to Geo Energy Partners 1983 Ltd. of which EEC is a wholly owned subsidiary.

ACCESS

The area is crossed by Esmeralda County maintained roads and other long established RS-2477 dirt roads and trails. All vehicle movement will utilize existing roads. Only minor blade work will be required to provide access to the drill site.

WATER SUPPLY

Drilling operations will utilize water from ponds at the VRS-1 flowing well (NW-NE Sec. 16, T1S,R36E) also known as Hot Box Park, which is maintained by Esmeralda County. The water will be transported approximately 5 miles using a 4,000-gallon water truck. Arrangements are being made with Esmeralda County for the purchase of this water. A back-up water source is located on the Arlemont Ranch, Section 28, T1S,R35E from privately owned wells and/or surface reservoirs.

DRILL SITE

The drill site (Fig. 1) will consist of a level area 100 feet by 140 feet (0.33 acres) cut into recent alluvial material having a 6 per cent slope. The slope will require the removal of approximately 3 feet of material on the upper eastern end of the drill site and building up the lower western end by approximately 3 feet. The "cut and fill" construction will not require any foreign material to be transported for the project. Tracked and wheeled vehicles may impact an area extending approximately 50 feet from the drill site during construction and reclamation of the drill site.

A mud pit with dimensions of approximately 20 feet long, 8 feet wide and 6 feet deep will be excavated and 6-mil polyethylene liner installed to prevent fluid loss. Drilling fluids will be circulated through the pit to drop solids. The drilling fluids will then pass through a mud cleaning system, which will also discharge the removed solids into the mud pit.

ABANDONMENT AND SITE RESTORATION

When drilling and testing are completed, 2 inch tubing (sch 40 pipe) capped on the bottom will be run in the hole to TD and filled with water to facilitate future temperature measurements (Fig. 4). The tubing will be suspended from a steel plate welded to the top of the 4-1/2 inch casing with a 2-inch valve and a locking device. The mud pit will be fenced and allowed to dry. After drying, as much of the impermeable liner as possible will be removed and the pit filled with native material.

In 6 – 12 months the well will be abandoned. Abandonment work will include removal of the 2 inch tubing and setting a 200-foot cement plug at the base of the 4-1/2 inch casing (100 feet above and 100 feet below the casing shoe). A second cement plug will be set in the upper 50 feet of the 4-1/2 inch casing. The casing will be cut off below ground level. The drill site will then be re-contoured to the original 6 per cent slope using the native materials used to construct the drill site. All fencing and trash will be removed and surface disturbance (vehicle tracks, etc.) dragged and raked. Trash will be deposited at the Esmeralda County drop box facility in Fish Lake Valley. If required, the site will be reseeded per BLM specifications.

EMERGENCY PROCEDURES, MEDICAL

In the event of a medical emergency, the individual will be transported either by drilling personnel or by the Fish Lake Valley Ambulance Service to Nye General Hospital, Tonopah, Nevada, which maintains 24-hour emergency service. The hospital is approximately 60 highway miles from the project. The Fish Lake Valley Ambulance Service provides 24-hour service and is staffed by trained volunteer Emergency Medical Technicians. In the event of a medical emergency the FLGPC representative will notify both the Tonopah BLM field station and the Nevada Division of Minerals of the situation and action taken.

EMERGENCY PROCEDURES, ACCIDENTAL SPILLS

Drilling fluids and additives to be used are the same used in the drilling of domestic water wells, are non-toxic and pose no risk to the local environment. Even the grease currently used on the exterior of the drilling rods is a vegetable based product.

Spills involving contaminants such as diesel fuel, hydraulic fluid, oil, etc. are unlikely and less than 350 gallons of such potential contaminants will be on site during drilling operations (contained in various vehicle fuel and hydraulic reservoir tanks). If a spill should occur, the drill crew shall use all available means at their disposal to contain the spill and isolate the contaminated soil. If the spill is 25 gallons or more, NDOM and NDEP shall be notified and clean up and disposal will be performed per their instructions.

ENVIRONMENTAL, SURFACE

The drill site is located to minimize surface impact. The site is on gently sloping (6 per cent) alluvial material on an elevated area adjacent to a dry wash. Construction of the site will involve removing approximately 3 feet of material from the upper northeastern end and using it to fill in approximately 3 feet on the lower southwestern end of the drill site. When the site is reclaimed, the same material will be used to rebuild the original contour of the area. No foreign material will be imported to the site.

The area is arid, with an average precipitation of 5.07 inches per year (Western Regional Climate Center data, 1948 – 2000) in Fish Lake Valley. No surface streams or permanent lakes exist in the area. The dry wash adjacent to the site occasionally has flowing water after thunderstorms or heavy snowmelt. The drill site is approximately 5 feet above the wash and the elevated area shows no signs of past flood damage.

Given the low annual rainfall and sandy-gravel soil the drill site will be constructed on there should be little if any soil erosion resulting from the construction of the drill site or drilling operations

ENVIRONMENTAL, FLORA

Vegetation in the vicinity of the drill site is sparse and generally consists of greasewood, shadscale, greasewood, sage, rabbit brush, hopsage, pencil choya and other forbes and grasses.

ENVIRONMENTAL, FAUNA

Fauna in the vicinity of the proposed drill site includes feral horses, coyotes, jackrabbits, small rodents, lizards and a limited variety of birds.

ENVIRONMENTAL, NOISE

The project will cause a temporary increase in noise levels from vehicles moving along the roads and the drilling equipment. However, due to the remote location of the drill site there should be no disturbance to local residents given that the nearest residence is over 11 miles away. A water truck will be seen and heard by recreational users at the Hot Box Park (VRS-1 flowing well) located in the NW-NE Sec. 16, T1S,R36E while loading water for the drilling operation. These events will be brief and noise levels will not be excessive. The author is not aware of any complaints being filed during the numerous drilling operations, which have occurred in the area during the past 25 years of exploration.

ENVIRONMENTAL, AIR

There will be intermittent dust caused by vehicle traffic. Given the frequent winds and dust storms, dust resulting from local farming operations and recreational vehicle use, the effect of the drilling operations on local air quality should be very minimal.

ENVIRONMENTAL, WATER QUALITY

The drilling of approximately 100 mineral and geothermal holes in the area and various flow tests, have had no reported effect on the local ground water quality or quantity, nor has this activity affected springs and seeps in the lower portions of the valley. The nearest surface water discharges consist of some brackish seeps around the perimeter of the Fish Lake Playa 2 – 5 miles northwest of the drill site. Gap Springs is located approximately 8 miles to the northwest.

The Hot Box artesian well is approximately 4 miles to the west and small springs and an artesian water well at the Lower McNitt Ranch are located over 5 miles west of the drill site. A 1984 report (Hydrologic Control of the Shallow Heat Flow Anomaly on the Fish Lake Project, Esmeralda County, Nevada, Steam Reserve Corporation, 1984) of the shallow warm water aquifer feeding the Hot Box well and the Lower McNitt well revealed that the warm waters originate from around the southern and eastern margins of the hills lying to the north and west of the Hot Box well (4 – 8 miles west of the Emigrant 17-31 drill site) and flow outward to the east, southeast and south. The warm aquifer system is restricted to the west side of Fish Lake Valley and is mapped no closer than 2 miles from the Emigrant 17-31 drill site.

A review of static temperature logs from past drill holes in the area shows no evidence of inter-zonal flow between water bearing strata within the well bore. The bentonite based drilling mud and additives are the same materials often used in the drilling of domestic and commercial water wells providing water for human consumption. The drilling of the proposed core hole will have no adverse affect on local ground water quality.

LAND USE

Current land use will not be impacted by the proposed actions. Current use in the project area is limited to recreational activities.

ROADLESS & WILDERNESS AREAS

The proposed Emigrant 17-31drill site and access roads are not located in or near existing or proposed Wilderness Areas, Wilderness Study Areas or Roadless Areas. The nearest Wilderness Study Area is in the Silver Peak Range approximately 5 miles south of the project area.

AESTHETICS

Impacts on visual resources will be minor and temporary in nature. The drill site is located in a small, remote canyon and the drilling equipment will only be visible to persons traveling up the rarely used, dead end road. Drilling operations are expected to be completed within a 30-day period.

SOCIO-ECONOMIC

The drilling crew will consist of 5 people and will have no long-term impacts on the local economy, population or community services. However, the purchase of food, hardware, fuel, lodging, use of local contractors and miscellaneous items will provide short-term positive benefits to the local economy.

CULTURAL RESOURCES

The Emigrant 17-31 drill site was selected to avoid cultural resources in the area. Nevada archaeological service, R.K. Vierra and Associates, Inc., completed a Cultural Resources Inventory of a 640-acre area surrounding the drill site (BLM Report Number 6-2501(P)). Copies of the report were forwarded to the Tonopah BLM Field Station in August 2005. The results of that report were used to locate the drill site. Tonopah BLM Field Station Archaeologist Susan Rigby has also inspected the site. Site construction, drilling and testing will have no impact on cultural resources in the area.

R.K. Vierra and Associates, Inc.

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A CULTURAL RESOURCES INVENTORY OF 640 ACRES PROPOSED GEOTHERMAL EXPLORATION PROJECT FOR THE FISH LAKE GREEN POWER COMPANY, ESMERALDA COUNTY, NEVADA

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BLM Cultural Resource Permit Number N-54136
BLM Report Number 6-2601(P)

August, 2005

MANAGEMENT SUMMARY

Between June 29, 2005 and July 4, 2005, a crew from R. K. Vierra & Associates performed a Class III Archaeological Inventory of approximately 640 acres in Esmeralda County, Nevada, for Fish Lake Green Power Company.

A total of one site and 32 isolated historic artifacts were recorded during the inventory. The site consists of historic mining features. The isolated artifacts consist 15 rock cairns (some with claim posts) 13 claim posts (with no cairn), two prospect pits, one bladed road segment, and one two-track road segment. Site CrNV-61-11408 is deemed eligible for the National Register of Historic Places (NRHP). It is recommended that this site be avoided which will result in no adverse effect.

TABLE OF CONTENTS

MANAGEMENT SUMMARY ii

1.0 INTRODUCTION AND PROJECT AREA DESCRIPTION 1

2.0 ENVIRONMENTAL SETTING 5

3.0 CULTURAL RESOURCES SUMMARY 6
- 3.1 PREHISTORIC OVERVIEW 6
- 3.2 ETHNOGRAPHIC BACKGROUND 7
- 3.3 HISTORIC OVERVIEW OF THE REGION 8
- 3.2 ETHNOGRAPHIC

4.0 LITERATURE REVIEW AND EXPECTATIONS 11
- 4.1 NATIONAL REGISTER REVIEW 13

5.0 FIELD METHODS 14

6.0 RESEARCH QUESTIONS 15
- HISTORIC CONTEXT 15
- REGISTRATION REQUIREMENTS FOR HISTORIC SITES 16
- MINING RESEARCH DOMAIN QUESTIONS 16

7.0 INVENTORY RESULTS AND DISCUSSION 17
- 7.1 SITE CrNV 61-11408 17
- 7.2 ISOLATED ARTIFACTS 18
- 7.3 SUMMARY 22

8.0 SUMMARY AND AVOIDANCE RECOMMENDATIONS 24

9.0 LITERATURE CITED 25

LIST OF FIGURES

Figure 1: Project Location 2
Figure 2: Project Area and Site Location 3
Figure 3: Isolate Location Map 23

LIST OF TABLES

Table 1: Isolated Artifacts 20

APPENDICES

Appendix A: IMACS Forms and Photos

1.0 INTRODUCTION AND PROJECT DESCRIPTION

Between June 29, 2005 and July 4, 2005, a crew from R. K. Vierra & Associates performed a Class III archaeological inventory of approximately 640 acres in Esmeralda County, Nevada, for Fish Lake Green Power Company at the request of John Deymonaz. R. K. Vierra served as Principal Investigator, Jana Trudell served as Field Supervisor. The field crew consisted of Lila Lindsay and Lee Duryee. The report was prepared by Bob Vierra and Jana Trudell. Site documentation and data compilation was completed by Jana Trudell. The site map was prepared by Lila Lindsay.

The project location is shown in Figure 1. The survey area is shown in Figure 2. The Isolated artifacts are described in Table 1 and an Isolate location map is shown in Figure 3. The block survey will allow Fish Lake Green Power Company to drill at specific locations and adjusted accordingly after preliminary results within the survey area.

This report discusses the location of the project area, provides background information on the environment and cultural resources reported close to the project area, reviews field methods, summarizes the survey results, and provides recommendations pertaining to cultural resources identified within the survey area. The Intermountain Antiquities Computer System (IMACS) forms and photographs are presented in Appendix A.

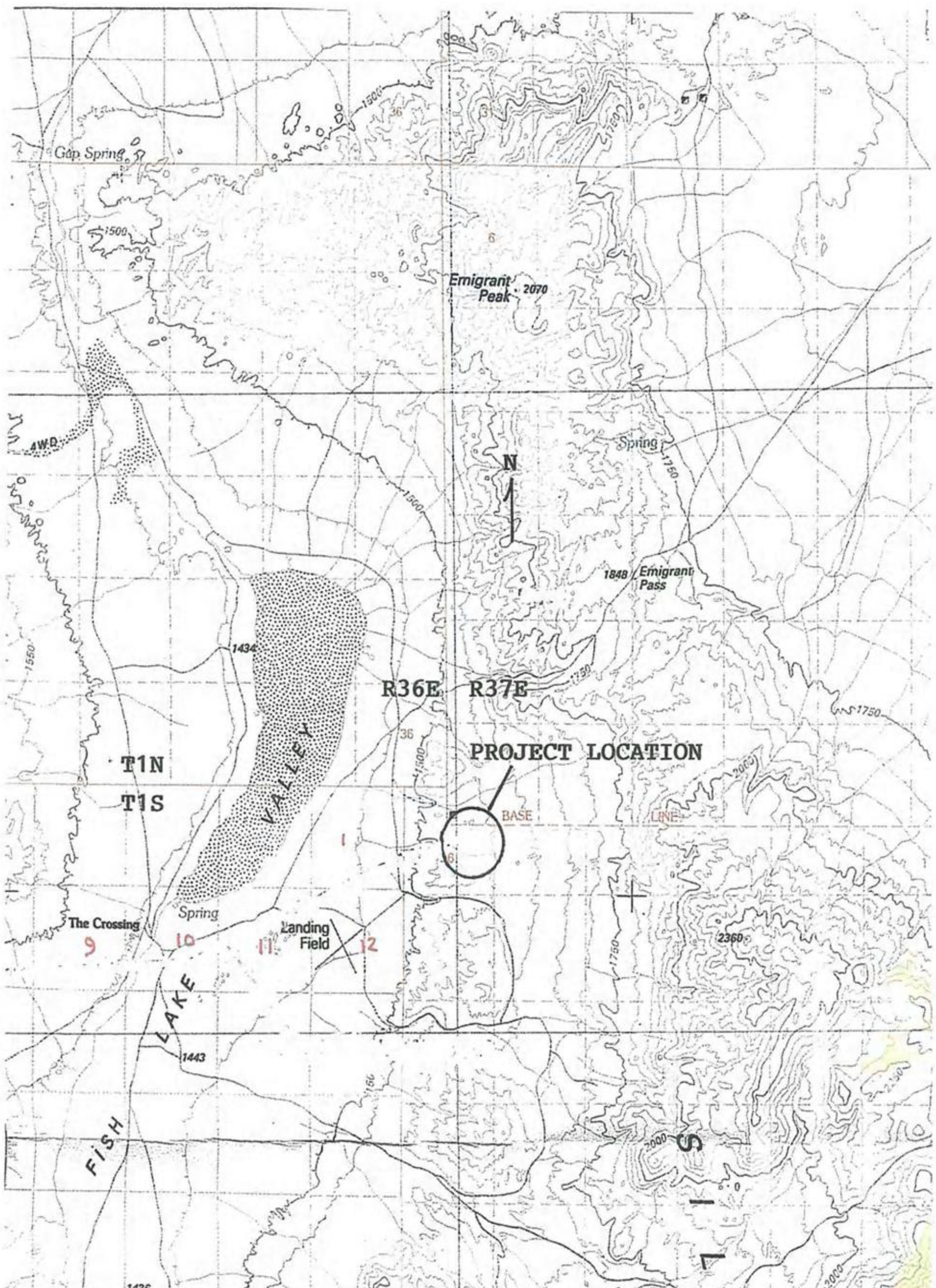

Figure 1: Project Location. Goldfield Nevada-California Scale 1:100,000, 1985 BLM Report #6-2601(P).

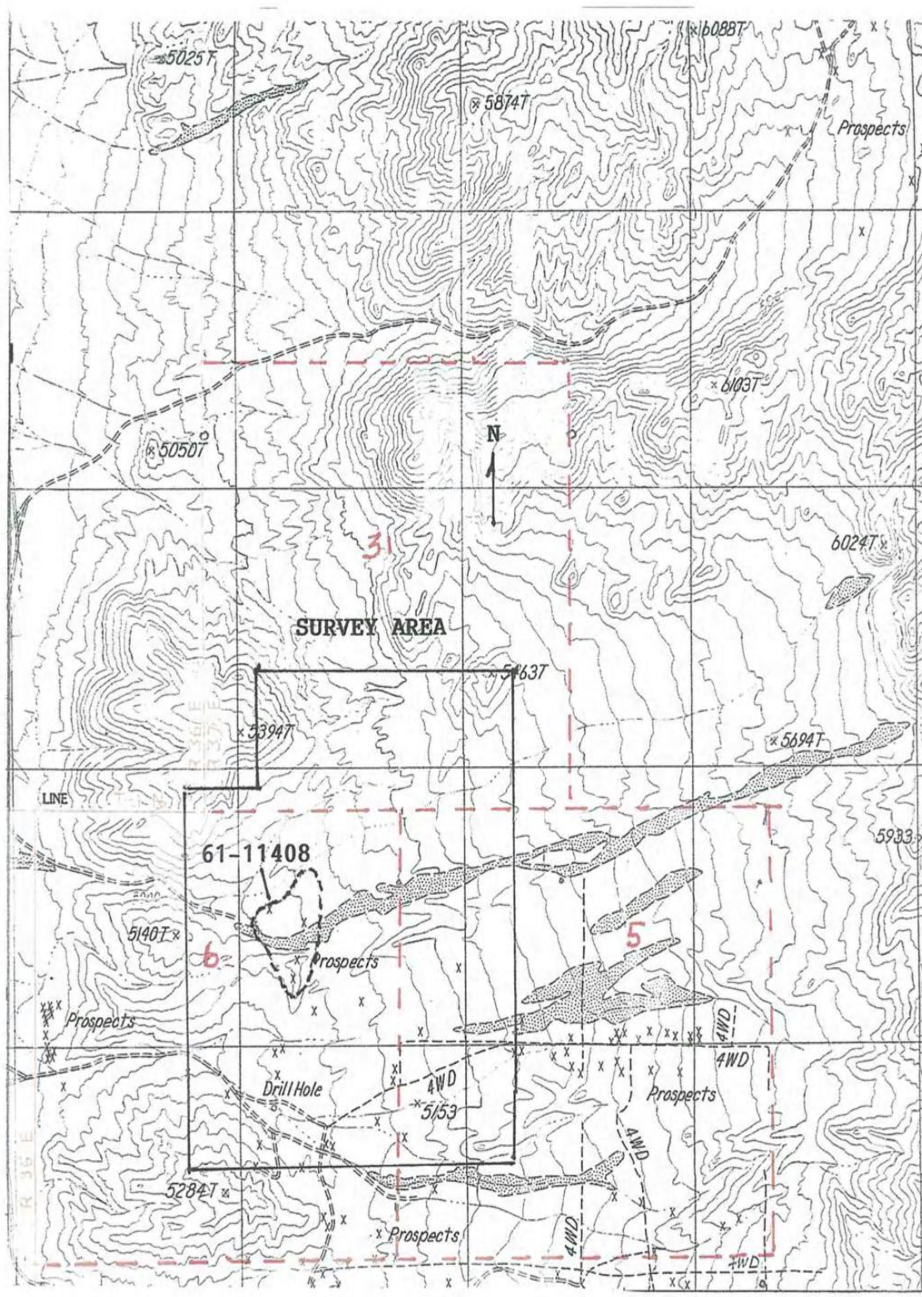

Figure 2: Survey Area and Site Location. USGS Rhyolite Ridge, NW, Nev 1987, BLM Report #6-2601(P).

Legal Description For The Proposed Geothermal Exploration Project

NE ¼ of Section 6 T1S R37E
E ½ of the NE ¼ of the NW ¼; E ½ of the SE ¼ of the NW ¼;
E ½ of the NE ¼ of the SW ¼; NE ¼ of the SE ¼ of the SW ¼; N ½ of the SE ¼;
NW ¼ of the SW ¼ of the SE ¼; NE ¼ of the SW ¼ of the SE ¼;
NW ¼ of the SE ¼ of the SE ¼; NE ¼ of the SE ¼ of the SE ¼ of Section 6 T1S R37E

W ½ of the NW ¼ of Section 5 T1S R37E
NW ¼ of the NE ¼ of the NW ¼; SW ¼ of the NE ¼ of the NW ¼;
NW ¼ of the SE ¼ of the NW ¼; SW ¼ of the SE ¼ of the NW ¼; NW ¼ of the SW ¼;
NW ¼ of the NW ¼ of the SW ¼; SW ¼ of the NE ¼ of the SW ¼;
NW ¼ of the SE ¼ of the SW ¼; NE ¼ of the SW ¼ of the SW ¼;
NW ¼ of the SW ¼ of the SW ¼ of Section 5 T1S R37E

SE ¼ of the SW ¼ of Section 31 T1N R37 E
E ½ of the SW ¼ of the SW ¼; SE ¼ of the NW ¼ of the SW ¼; SW ¼ of the SE ¼;
S½ of the NW ¼ of the SE ¼; SW ¼ of the NE ¼ of the SE ¼;
W½of the SE ¼ of the SE ¼ of Section 31 T1N R37 E

SE ¼ of the SE ¼ of the SE ¼ of Section 36 T1N R36E

2.0 ENVIRONMENTAL SETTING

The survey area is located in Fish Lake Valley, Esmeralda County, Nevada, about 23 miles northeast of the community of Dyer on the lower west facing flank of the Silver Peak Range. As reported by Clay and Young (1994:5), "The valley is enclosed by mountains except at The Gap. The White Mountains on the west side of Fish Lake Valley form a bold range extending south-southeast from Boundary Peak near the Nevada-California border in the northwest part of the valley. At an altitude of 13,150 ft, Boundary Peak is the highest point in Nevada, and slightly south of Boundary is White Mountain Peak, the third highest peak in California at an elevation of 14,246 ft. North and east from Boundary Peak, the terrain declines rapidly into Fish Lake Valley. On the east side of the valley is the irregular crest of the Silver Peak Range, which does not exceed 10,000 ft; to the southeast are the Palmetto Mountains. An alluvial divide connects the Sylvania Mountains with the southeast extension of the White Mountains to close the valley at the south end. The area included within the drainage boundary of Fish Lake Valley is about 965 sq mi. Precipitation on the floor of the valley is generally less than 5 inches per year. Melted snow supplies, by far, a greater amount of water than rain (Eakin 1950:8-9; Rush and Katzer 1973:5,16)."

The proposed Geothermal Exploration is located within an alluvial drainage at the lower west facing flank of the Silver Peak Range. The elevation ranges in between 5140-5394 feet. No Pluvial Lakes have been identified in Fish Lake Valley (Mifflin and Wheat 1979). Also, no springs were noted within the project area.

Vegetation in the project area that was noted includes greasewood, rabbit brush, shadscale, hopsage, russian thistle, swollen stalk buckwheat, ephedra, teddy bear cacti, pencil choya, white top, seepweed, feathered finger grass, wild aster, prince's plume, halogeton glomeratus, globe mallow, astragalus, and other forbes and grasses.

Fauna directly observed during the study include black-tailed jackrabbit, wild horses, and numerous lizards. Indirect evidence of fauna observed include scats of coyote. A good synthesis of prehistoric Great Basin environments has been prepared by Mehringer (1986) and a review of historic environmental change has been summarized by Harper (1986).

3.0 CULTURAL RESOURCES SUMMARY

3.1 PREHISTORIC OVERVIEW OF THE REGION

Archaeological investigations in the Great Basin have been summarized elsewhere (Busby et al. 1979; Davis 1964; Elston 1982; McGonagle and Waski 1978; Pendleton et al. 1982; and Thomas 1982.) A brief chronological overview and regional synthesis is presented below:

Pre-Archaic (9000 B.C. - 6000 B. C.)

The Pre-Archaic period represents the earliest well documented evidence of man's presence in the Great Basin. Most Great Basin Pre-Archaic sites are surface lithic scatters located on pluvial lakeshore features and gravel bars or on ancient river terraces (only a few have buried components); there was apparently a heavy reliance on lacustrine resources. These sites lacked structural remains or other archaeological features. Lithic technology of this period is highly distinctive, reflecting an emphasis on the hunting of big game; it resembles that of the megafauna-hunting Paleo-Indians of the Great Plains much more that it does the later Archaic cultures of the Great Basin. Assemblages typically contain large stemmed, and concave base projectile points (Touhy and Layton 1977), large bifacial knives, crescents, gravers, punches, scraper/planes and choppers; seed processing implements (manos and metates) are very rare or absent.

Early Archaic (5000 B.C. - 1500 B. C.)

The origins of the Early Archaic in the Great Basin are obscure; sites are rare and generally poorly dated. Diagnostic artifacts include Pinto and Gypsum projectile points (both subsumed in the Gatecliff Series), atlatl dart points and Humboldt Series projectile points. Sites typically are located in valley bottoms near permanent water sources or, less frequently, near springs in upland settings. Although hunting is emphasized, there is an increased reliance on plant and seed food resources processed with manos and metates.

Middle Archaic (2000 B.C. - A.D. 500)

The transition between the Early Archaic and the Middle Archaic periods is gradual and not marked by large technological changes. The Middle Archaic is distinguished by major shifts in settlement and subsistence strategies and stylistic elaboration. Population density appears to have increased significantly and a much greater diversity of resources were exploited during this period. While there was a continued reliance on hunting, seed processing tools are much more abundant. Both winter residential sites and seasonal field camps in target resource areas were utilized and consistently re-occupied. Diagnostic projectile points of this period are Elko Series and Martis Series; medium to large-sized bifacial tools (knives) are common. Trade in exotic materials such as marine shell and obsidian becomes important.

Late Archaic (A.D. 500 to White Contact)

The Late Archaic is marked by shifts in technology and further changes in settlement/subsistence patterns. Plant food resources (especially pine nuts) were emphasized. Small game, such as rabbits, rodents, and birds, were hunted instead of big game; the atlatl (spear thrower) and dart were replaced by the bow and arrow. Diagnostics of this period are Rose Spring and Eastgate (Rosegate) points and Desert Series points (Desert Corner-notched, Cottonwood Triangular, and Cottonwood Leaf-shaped). After A.D. 1100, brownware pottery appears (Western Shoshone made pottery but is was rare with the Paiute). Plant and seed processing equipment became more elaborate and there was an increased emphasis on the production of simple, expedient flake tools. These technological changes accompanied the adoption of a subsistence strategy that entailed an increase in both the diversity of resources used and in the number of ecozones exploited. Sedentism increased as reflected by the construction of sequential houses and the occurrence of large village sites. Present understanding of the archaeological record in the transition from the Middle to the Late Archaic are those that eventually culminated in the patterns observed for the ethnographic Numic speakers (Western Area in the Handbook of North America Indians (D'Azevedo 1986:135-148)); a detailed prehistoric overview is presented by Jennings, Elston, Thomas, and others in the above cited reference.

3.2 ETHNOGRAPHIC BACKGROUND

As reported by Hause and Clay (1993:7-8) "At the time of Euro-American contact the native inhabitants of the valley were the Fish Lake Valley Paiute, a group of Numic speakers. Much of what is known about them was compiled by Steward in his classic study of Basin-Plateau groups (Steward 1938).

Much like their neighbors to the west, the Owens Valley Paiute, a varied, relatively rich resource patch allowed the Fish Lake Valley Paiute to develop a hunting and gathering subsistence practice, seasonally directed from a centrally-based semi-permanent site. These residential base camps were probably occupied most regularly in the winter, but Steward (1938:62) states they were more or less permanent, except during the summer and fall. In Fish Lake Valley, eight such sites were well situated near a variety of resources along the valley edge, especially the western (White Mountain) edge. These settlements were clusters of one to four families with a total valley population comprising approximately 100 individuals (1870 estimate) camped along streams or around springs. Economic pursuits emphasized gathering a number of greens, roots, seeds, berries, and nuts, especially pine nuts. Hunting was of secondary importance.

Bettinger (1991:484) contends that aboriginal occupation of the higher elevations of the White Mountains was a "pressure gauge" for the burgeoning population of adjacent Owens Valley. This pattern started about 4500 B.P. and continuing until contact with Europeans in the 1850s. At that time, population reduction by disease and the disruption of the aboriginal economy occurred. By 1870 the aboriginal population density in Owens Valley was about 0.5 persons per square mile (Steward 1938:48). Liljeblad and Fowler (1986:415) calculate that the precontact population density was close to 1.0 person per square mile. Hence, European contact caused a population reduction of about 50 percent by some means.

Fish Lake Valley is much less fertile than Owens Valley (Steward 1938:61) and had an 1870 population density of 0.1 persons per square mile, one-fifth that of Owens Valley (Steward 1938:48). It is likely that the natural environment of Fish Lake Valley limited the population to a greater extent than the effects of European contact, and that decimation due to disease and conflict was less of an influence than in Owens Valley. This assumes that the frequency of aboriginal/European and aboriginal/aboriginal contact was less, diminishing the communication of disease and the likelihood for conflict. If so, precontact population in the valley may have been close to the 100 population figure related by Steward (1938:62).

Steward reports greater mobility and less permanent village associations among the Fish Lake Valley group than among their Owens Valley neighbors; moreover, they did not share the same distinct territorial ownership whereby bands owned seed areas, pine nut territories and irrigated plots of land. Additionally, the Fish Lake Valley groups had no band names or communal sweat house. These groups did gather to conduct drives for antelope, deer and rabbit, and held dances, especially in the fall. In contrast, mourning observances were held strictly on the village level (Steward 1938:62)."

3.3 HISTORIC OVERVIEW OF THE REGION

This overview is a brief description of the historic themes pertinent to Fish Lake Valley, namely, Exploration, Mining, and Ranching.

Exploration Theme:

As reported by Palmer in Hause and Clay (1993:A2) "The first white people to enter Fish Lake Valley and the project areas were surveyors on their way to Death Valley in the fall of 1853 looking for a railroad route across the continent (Lingenfelter 1986:80-81). These men were transients who left no permanent settlements (Mordy and McCaughey 1968:78). The party of seventeen explorers was led by "Major" John Ebbetts who had come to California originally in 1849 as leader of the Knickerbocker Exploring Company. Ebbetts Pass in the Sierra Nevada is named for him. Funded by a group of San Franciscans, the Ebbetts railroad route expedition was fitted out in little over a month, and they set out from Stockton, California on October 7. They headed for the Vegas de Santa Clara on the Old Spanish Trail at Meadow Valley Creek, but took a wandering course and never reached their goal (Lingenfelter 1986:80-81).

Crossing the Sierra Nevada over the Sonora Trail, they turned north along the Walker River to Walker Lake before heading southeast toward their intended destination. The quest for water, however, brought them much farther south to the base of the White Mountains in Fish Lake Valley. From there they continued down into the basin of Eureka Valley, just missing numerous springs in the Sylvania Mountains. On November 7, 1853, after two waterless days, they crossed eastward in desperation over the Last Chance Range and into Death Valley where they found water at Last Chance Spring (Lingenfelter 1986:80-81)."

Mining Theme:

The history of mining in the vicinity of the project area is very extensive as reported by Palmer in 1993. For the purposes of this report, a brief discussion of mining only for Fish Lake Valley is provided here. The following excerpts are taken directly from Palmer (1993).

"South of the project area, the Dyer Mining District was first prospected for silver and lead in 1863 and 1864. It was located east-northeast of Dyer's Ranch in the foothills of the west flank of the Silver Peak Range. The community of Dyer which subsequently grew up around Dyer's Ranch, as well as the mining district, was named for a pioneer of Esmeralda County, Alex P. Dyer, the community's first postmaster (Carlson 1974:102; Leigh 1964:83).

In 1875, the Pacific Borax Company was moved into Fish Lake Valley from Columbus to accelerate borax mining operations on Fish Lake Marsh (Lincoln 1982:66; Mordy and McCaughey 1968:78; Albers and Stewart 1972:61). As Columbus declined, the borate deposits on Fish Lake Marsh continued to be worked for several years by two plants. The borax was extracted from ulexite in salty ground along the east margin of the marsh until the operations ceased in the 1880s when the price of borax dropped rendering the operations less profitable (Mordy and McCaughey 1968:78; Lincoln 1982:66; Albers and Stewart 1972:61). As late as 1939, however, 200 tons of borax extracted from ulexite was mined from deposits 3 mi east of the Fish Lake Marsh deposit (Albers and Stewart 1972:61).

The Fish Lake Valley Mining District, also known as the White Mountain District, came into existence to the northwest of the project area in 1916 to develop some mercury (also known as quicksilver or cinnabar) mines (Bailey and Phoenix 1944:66; Albers and Stewart 1972:66). Workings began during World War I and peaked in 1927 with only small scale operations conducted after 1932."

The Riek Property was a mercury mine in Sec. 11, T.1S, R35E and is located north of the proposed powerline. "This mine had no recorded production and no discovery date or surface refining equipment was revealed in the historic record of this mine (Albers and Stewart 1972:67). This mine is likely to be associated with Carl Reik, a notorious Goldfield gambler who was originally from Pueblo, Colorado (Hanson and Hanson 1972:43). Reik later owned a store at Coaldale (Shamberger 1978:186). It is possible that prospects and debris from this operation could be found in the project area."

Ranching Theme:

The following is taken directly from Palmer (1993). "The first ranch in First lake Valley was established by Chester and Ira Hale in 1860. Their homestead later became known as the Lower McNett Ranch. The McNetts freighted hay and produce to Candelaria, Blair, Silver Peak and the borax works.

The McAfee Ranch was first established by Samuel, Daniel and Dudley McAfee, Scottish immigrants, who later bequeathed it to Angus and Sara McAfee.. Angus raised alfalfa, timothy, wheat, barley and corn instead of the wild hay that his neighbors sold. In 1940, E.L. Cord, developer of the Cord automobile, purchased this ranch and renamed it to the Circle L (Hanson and Hanson 1972:13,26).

Francis Marion "Borax" Smith, who cornered the international borax market for a period of time, also established a ranch in Fish Lake Valley. In 1878, this operation was managed by Frank and Camilla Stewart (Hanson and Hanson 1972:27).

John Chiatovich, another Fish Lake Valley rancher, heard rumors of wealth to be made in the salt marshes to the south and traveled to the Fish Lake Valley area. He established his ranch on what became known as Chiatovich Creek in 1865 (Hanson and Hanson 1972:29; Zeier 1992:9). The Chiatoviches also constructed a sawmill in the White Mountains above Indian Creek. The mill produced lumber of a rough grade suitable for corrals and barns in Fish Lake Valley. The Chiatovich ranch later become known as Arlemont and was the site of a post office in 1910 (Hanson and Hanson 1972:29,31).

Another ranch previously mentioned was established at the site of a natural spring on the eastern side of the valley by Alex P. "Papa" Dyer (Hanson and Hanson 1972:11). This ranch was located in Sec. 18, T.2S, R.36E, and the modern community of Dyer is to the west of the ranch site. He married a Fish Lake Valley Paiute woman who subsequently abandoned him (Hanson and Hanson 1972:11). By 1908, the community of Dyer claimed a population of sixty with nine residents listed as farmers and livestock producers. A semi-weekly stagecoach made the trip to Coaldale for $5.00 (Polk 1908:338).

A school was established in Fish Lake Valley for the ranchers' children, but like the post office, it migrated. First established at the Chiatovich Ranch, it later moved to the McNett Ranch until a school building was constructed between the two ranches. This building was subsequently moved to the Dyer Ranch and then the Smith Ranch (Hanson and Hanson 1972:20). Today, the Dyer School building is along State Route 264 in Sec. 4 T.3S, R.33E, outside of the project area."

4.0 LITERATURE REVIEW AND EXPECTATIONS

A total of 14 cultural resource surveys were conducted within a mile radius of the current project area in Fish Lake Valley between 1975-2002. These are briefly described below.

CRR 5-133(N) 1975, H.A. Wirtz surveyed a number of proposed wells for Magma Power Company covering an area of about 1200 acres. No cultural resources were noted.

CRR 5-997(P) 1982, Alvin McLane of the Desert Research Institute conducted a survey of six geothermal test wells for GeothermEx covering an area of about 10 acres. Four sites were found: CrNV 05-4236 is a multi-component site consisting of a small lithic scatter and fragments of purple, green, brown, and aqua glass. The site was not evaluated for the NRHP. CrNV 05-4237 was noted as a chert flake and biface. CrNV 05-4238 is an isolated white chert flake. CrNV 05-4239 is a chert uniface and two chert flakes.

CRR 6-581(P) 1984, J. Jackson (DRI) surveyed three proposed geothermal test wells for AMAX Exploration covering an area of about 9 acres. Two sites were found: CrNV 64-3486 is an isolated Elko Corner-notched point base and CrNV 64-3487 is an isolated obsidian Gypsum point base.

CRR 6-593(N) 1984, D. Eddy (Tonopah BLM Geologist) surveyed about 1.4 acres for the Bob Jamison Gravel sale for a geothermal well pad. No sites were found.

CRR 6-652(N) 1985, Kurt Wallof of Archaeological Research Services (ARS) conducted a survey of five drill pads covering an area of about 38 acres for the Steam Reserve Corporation. No sites were found.

CRR 6-1004(N) 1986, Vickie Clay (ARS) surveyed two drill pad sites covering 4.5 acres for the Steam Reserve Corporation. No sites were found.

CRR 6-1288(N) 1990, M. Waski and D. Ross (Tonopah BLM Archaeologists) surveyed 10 acres for an Esmeralda County R&PP lease on a hot water artesian well. No sites were found.

CRR 6-1438(P) 1992, J. Carter and R. Werner (Archaeological Services, Inc.) carried out a survey of a proposed 26-mile long Fish Lake Valley to Silver Peak geothermal power transmission line for Geo-Energy Partners. Twenty-one previously unrecorded sites, two previously recorded sites, and 30 isolated artifacts were found. Those sites located within a mile radius of the current project area are described below. CrNV 64-6235 consists of 33 discreet flake concentrations and 13 cores. The site was regarded as a quarry and considered eligible for the NRHP. CrNV 64-6236 is a dense lithic scatter with 500+ flakes, three concentrations, one Desert Side-notched point and one metate fragment. Buried deposits are likely and the site is deemed eligible for the NRHP. CrNV 64-6237 is a lithic scatter with 150+ primary flakes considered to be a chipping station/workshop. The site is eligible for the NRHP. CrNV 64-6238 is a small diffuse lithic scatter with two biface fragments. The site is not eligible for the NRHP. CrNV 64-6239 is a diffuse lithic scatter with 100+ flakes, one Rosegate point, and one biface. The presence of rhyolite flakes and rhyolite raw material suggest a chipping station/workshop or small quarry. The site is deemed eligible for the NRHP. CrNV 64-6240 is a lithic scatter with four flake concentrations and one Rosegate point. Buried deposits are possible and the site is eligible for the NRHP. CrNV 64-6241 is a lithic scatter with 800+ biface reduction flakes and possible buried deposits. The site is deemed eligible for the NRHP. CrNV 64-6242 is a diffuse lithic scatter with 150+ flakes, one biface fragment, and one core. The site is not eligible for the NRHP. CrNV 64-6243 is a diffuse lithic scatter with 35+ flakes and one core. The site is not eligible for the NRHP. CrNV 64-6244 is a diffuse lithic scatter with 1000+ flakes, one Rosegate point, and three cores. The site is deemed eligible for the NRHP. All of the above sites deemed eligible for the NRHP were concurred by the BLM and the SHPO.

CRR 6-1451(P) 1992, Pat Hicks and G. Pine (BLM Archaeologists) conducted a survey of six geothermal well pads covering about 20 acres for Magma Power. Eight sites were located several miles north of the current project area; none in the vicinity of this project.

CRR 6-1478(P) 1993, Vickie Clay (ARS) conducted a survey of a proposed plant site and access road for Fish Lake Valley Power. Only three Isolates were found; an obsidian point fragment, an obsidian core, and an obsidian biface fragment. No sites were found.

CRR 6-1482(P) 1993, L. Hause and V. Clay (ARS) conducted a survey of 10 geothermal drill sites and access roads covering about 75 acres for Magma Power Company. Two sites and two Isolates were found. CrNV 64-7355 is a sparse lithic scatter with seven lithic reduction loci, cores, one biface, one perforator, and one metate. Also present are fire-cracked rock partially buried, and a possible hearth feature. The site is deemed eligible for the NRHP. CrNV 64-7356 is a lithic scatter with two lithic concentrations, four bifaces, one core, and one modified flake. Lacking definite boundaries, the site remains unevaluated. The two Isolates consist of a flake and a bottle.

CRR 6-1483(P) 1993, R. Reno, V. Clay, and L. Hause (ARS) surveyed 9.2 miles of pipeline and access roads covering an area of 119 acres for Magma Power Company. Two sites and two Isolates were found. CrNV 64-7359 is a small core reduction site with one core and two primary flakes. The site is not eligible for the NRHP. CrNV 64-7360 is a habitation site with possible buried deposits. Spatial patterning consists of five separate loci: Locus 1 with two hearths, Locus 2 has a possible hearth, a metate, and a biface, Locus 3 is a possible hearth, Locus 4 is a possible hearth with flakes, and Locus 5 consists of two possible hearths eroding out of a small dune. The site is deemed eligible for the NRHP. The two Isolates are one flake and one core.

CRR 6-1485(P) 1994, Vickie Clay and B. Young (ARS) conducted a survey of four proposed transmission corridors and two proposed power plant locations for Magma Power Company. A total of 31 sites were recorded during the survey; however, none of these sites were located within a mile radius of the current project area.

CRR 6-2223(N) 2001, R. K. Vierra and Assoc., Inc conducted a survey of 14 proposed geothermal well pads covering an area 3.21 acres for the Fish Lake Green Power Company. No sites were found.

CRR 6-2236(P) 2002, R. K. Vierra and Associates, Inc., conducted a survey of an eight mile proposed powerline for the Fish Lake Green Power Company. Five sites and five isolates were found. CrNV 64-10804 is a diffuse lithic scatter consisting of one metate and about 300+ flakes. CrNV 64-10805 is a small lithic scatter consisting of eight flakes. CrNV 64-10806 is a small lithic scatter consisting of a Stage III biface and about 100+ flakes. CrNV 64-10807 is a small lithic scatter consisting of one metate and four flakes. CrNV 64-10808 is a secondary deposit of historic trash consisting of a glass debris concentration. The site dates between 1900-1954. None of the above sites were deemed eligible for the NRHP. The five isolates consist of a chert secondary flake, three prospect pits, and one claim post.

Expectations: Based on the literature review discussed above, the following kinds of sites are expected to be found within the project area. Prehistoric sites should consist of mostly small to moderate lithic scatters and Isolates. In areas where toolstone is available, lithic reduction sites such as chipping stations and workshops may be encountered. Habitation sites with fire-cracked rock concentrations, buried deposits, and hearth features are unlikely to be found. These kinds of sites were reported south of the proposed powerline closer to the playa edge in sand dune deposits. Historic sites that can be expected include prospect pits, and trash scatters associated with mining in the area. Since most of the current project area is located along the valley floor, historic sites will most likely relate to borax mining activities or possibly ranching. Sites associated with mining activities for quicksilver and other precious minerals at the higher elevations are unlikely to be encountered.

4.1 NATIONAL REGISTER REVIEW

The Goldfield Historic District is the closest NRHP listed property in Esmeralda County. Several sites within the vicinity of the project have been determined to be eligible for the NRHP: these are CrNV 64-6235, 64-6236, 64-6237, 64-6239, 64-6240, 64-6241, and 64-6244 as described above.

5.0 FIELD METHODS

The field methods were designed toward the identification, recordation, and evaluation of all cultural resources located within the surveyed area. Data were collected so as to make these goals possible and to provide information which could be applied toward research topics pertinent to the region and the immediate area. Particular attention was given to eligibility potential for the NRHP. In addition, eligibility determinations are made in a regional context addressing significant research questions. Significant research questions addressed have been outlined in An Archaeological Element for the Nevada Historic Preservation Plan (Lyneis 1982), and the Nevada Comprehensive Preservation Plan (Bernstein and James 1991).

On June 15, 2005, a project authorization was filed with the Tonopah Resource Area of the BLM. A literature review of the previous archaeological surveys conducted within the vicinity of the study area was carried out at that time.

The survey of the 640 acres of proposed geothermal exploration was performed by Robert K. Vierra (PI), Jana Trudell, Lila Lindsay, and Lee Duryee. John Deymonaz of Fish Lake Green Power Company met us in the field on June 29, 2005, to show us the location of the project area. The survey started at the southeastern end of the project area. Each person walked a 30 meter transect interval to ensure full coverage of the survey area. When cultural materials were encountered, the surrounding area was intensively examined for associated materials. When a site was identified, it was plotted on a USGS 7.5' topographic map using a Garmin 60CS GPS unit with accuracy no less than four meters. NAD 27 was used as the coordinate system.

The first step in recordation was to determine the extent and nature of the site. Cultural materials were pin flagged so that the boundaries could be determined and concentrations or internal features could be identified. The site was mapped, using compass and pace, and artifacts were identified and recorded. The data were recorded on IMACS recording forms to Battle Mountain District/Tonopah Resource Area standards. Any evidence of potential buried deposits was noted. Site overview photographs were taken for all sites to aid in the futures relocation of the site.

In the case of isolated artifact, they were recorded, described, and plotted on a USGS 7.5' topographic map.

6.0 RESEARCH QUESTIONS

Since no prehistoric resources were identified during the survey, only an historic context is required to evaluate any historic sites found in the survey area.

HISTORIC CONTEXT:

The historic context presented below is relevant to only the historic site found within the project area. Only one major theme, **Mining**, is relevant to the project area under the research domain of Industry and Commerce as described in the Nevada Comprehensive Preservation Plan (Bernstein and James 1991). Specifically, since the project area is mostly confined to the lower flank of the Silver Peak Range and part of the valley floor , the history of mining for borax is most relevant here.

As reported by Carter and Werner (1992) "Borax mining began in Nevada at Big Soda Lake, near Fallon, in the late 1860's. Within a few years, however, rich deposits of borax were discovered in Teels, Rhodes, Columbus, and Fish Lake marshes in the vicinity of the town of Columbus. Between 1873 and 1883 the near-surface accumulations of borax and other borates from these four marshes provided the world's principle source of borates (Papke 1976:18). Archaeological evidence for borax production between 1873-1887 in the Fish Lake Valley is scant.

It was later in 1872 that the rich deposits at Teels Marsh were discovered by F. M. "Borax" Smith, a native of Richmond, Wisconsin. Overnight, a rush for borax claims in Esmeralda County, which at that time included the Mineral County, was on. The Fish Lake Valley deposits were discovered during this period, and by 1873 Griffing and Wyman were mining borate deposits at the upper end of the playa. The borates mostly occurred on the east side of the marsh as near-surface cottonball nodules of ulexite, but with some efflorescence rich in borax (Papke 1976:22).

Within a few years five borax deposits were being mined in Fish Lake Valley. Mott and Piper, Griffing and Wyman, and James M. Kane, who operated a mine on the upper end of Fish Lake Valley, were joined in mid-1875 by the Pacific Borax Company in concentrating borax.

In 1882 a larger concentrating plant was established on the southeast edge of the Fish Lake playa by the Smith Brothers. More than 100 local businessmen attended the official opening of this plant on 25 July 1882. Early enthusiasm faded quickly with the drop in the price of borax in the early 1880's and the operation is mentioned infrequently in subsequent issues of the Borax Miner. As late as 1939, however, 200 tons of borax extracted from ulexite was mined from deposits 3 mi east of the Fish Lake Marsh deposit (Albers and Stewart 1972:61)."

The Pacific Borax Co. Mill site is shown on the 1877 GLO Plat in the NW 1/4 of Section 11, T1S/R36E approximately 2 miles southwest of the project area.

REGISTRATION REQUIREMENTS FOR HISTORIC SITES

CRITERION A: The site is associated with an important series of events that have made a significant contribution to the broad patterns of our history.

CRITERION B: The site is associated with the lives of persons significant in the history of Nevada.

CRITERION C: The site has distinctive characteristics of a type, period, or method of construction.

CRITERION D: The site can provide important information about the history of the area as outlined in the research questions described below for the following relevant research domain.

MINING RESEARCH DOMAIN

Research questions pertaining to mining in Nevada were derived from An Archaeological Element for the Nevada Historic Preservation Plan (Lyneis 1982) and the Nevada Comprehensive Preservation Plan (Bernstein and James 1991). Under criterion (d), the following research questions were proposed:

QUESTIONS

Research Question 1: Is the property associated with a specific event important to the history of mining in Nevada or the history of mining in general?

Research Question 2: Does the resource have significant interpretive value or potential becaus of a variety of surviving elements?

Research Question 3: Does the property contain several elements which are illustrative of a specific type of operation or function performed by miners in Nevada?

Research Question 4: Does the site have the potential to provide information about changes in the technology of mining and industrial activities in the area through time?

7.0 INVENTORY RESULTS AND NRHP EVALUATIONS

The Cultural Resource Inventory of 640 acres of proposed geothermal exploration on land administered by the Tonopah Resource Area of the Battle Mountain District of the BLM resulted in the identification and recordation of one cultural resource. This include one historic site, and 32 Isolated artifacts. A table listing the Isolated artifacts including the agency number, legal description and UTMs is presented in Table 1. Isolate location maps are shown in Figure 3. A brief summary of the archaeological site is presented below. A more detailed description is presented in the IMACS site record.

7.1 SITE CrNV 61-11408

The site is located on a highly erosional alluvial drainage on the western side of the lower flank of the Silver Peak Range. The site is a mining/mineral exploration complex measuring 440 m north-south x 260 m east-west. Vegetation within the site area is a shadscale community with lesser amounts of greasewood, cacti and other forbes and grasses The deposition consists of a sandy silt alluvium intermixed with gravels and pebbles. The site has 31 mining features which include one ore chute, one open cut mine pit, five loading/staging platforms, six road cuts, four prospect pits, one collapsed structure, one structural debris scatter, one water tank, one dugout, five wooden claim posts, three rock cairns with claim post, one possible tent platform, and two wooden slat alignments. This site may have been an area for borax exploration, but after examination of the open cut pit, it has evidence of sulfur layering the waste rock and sulfur emits from the outcrop. The open cut pit is small and possibly the mining was short term. After encountering the sulfur deposit the miners may have ceased operation of the exploration. The site contains a variety of debris which include diagnostic can technology (1900's-1950's), milled lumber, galvanized sheet metal, nails, hardware, glass fragments (some with embossing), ceramics (some with trademarks), and domestic items.

Site CrNV 61-11408 is a historic mineral extraction site containing 31 mining features. The site appears to be associated with an important series of events that have made a significant contribution to the broad patterns of our history, that is the production of borax in Fish Lake Valley, hence, the site is deemed eligible for the NRHP under criterion (a). However, the 1877 GLO shows no mining of borax in the survey area. Given that the Pacific Borax C Mill is shown on the 1877 GLO approximately 2.5 miles southwest of the survey area, it is likely that this site is related to the mining of borax. There is no evidence that the site is associated with the lives of persons significant in the history of Nevada, hence, the site is not eligible for the NRHP under criterion (b). The site shown no distinctive characteristics of a type, period, or method of construction, hence, the site is not eligible for the NRHP under criterion (c). The site does have the potential to provide important information about the history of the area. The mining complex appears as it was during the time the area was in operation for mineral exploration. The transportation and movement of materials from the open cut mine to the ore chute are clearly visible and remain intact where they were originally constructed. The surrounding landscape and the physical remains of the site contain information on mining activities and the mineral exploration of borax in Esmeralda County, as well as the technology of architectural mining features and road systems. This particular mining area may have been short term. The open cut pit has evidence of sulfur layering the waste rock and sulfur emits from the outcrop. After encountering the sulfur deposit the miners may have ceased operation of the mineral extraction. The collapsed structure and variety of associated historic debris including the can technology ranges in dates from 1900s-1950s. The mining features have not been altered by newer or additional reconstruction. Thus, all of this combined contains data pertinent to the archaeological record. In terms of research question 1, the site appears to be associated with the mining of borax, an important event in the history of mining in Nevada. In terms of research question 2, the complex does have a variety of surviving elements with 31 features as noted above that have interpretive value. In terms of research 3, it is likely that the site is associated with the mineral extraction of borax given other known borax operations in the vicinity. In terms of research question 4, changes in the technology of mining cannot be answered at this time given the lack of diachronic base-line studies. The integrity of setting, location, design, materials, workmanship, feeling, and association have not been compromised. Given the amount of cultural material and construction of mining features, the site has the potential to answer research questions 1-3 outlined above under the Mining Research Domain. The site is eligible for the NRHP under criterion (d).

7.2 ISOLATED ARTIFACTS

A total of 32 historic isolates were recorded. The UTM's and legals are presented below in Table 1. An Isolate location map is shown in Figure 3. A brief description of the isolates is discussed below.

EIF 11408A: Prospect trench measuring 49' x 19' x 4' deep, with an associated push pile at the west end of the trench that measures 72' x 19' x 6' tall.

EIF 11408B: Rock cairn consisting of seven boulders stacked one course high measuring 3' x 1', with a fallen 4" x 4" claim post.

EIF 11408C: Circular prospect pit 19' diameter and 6' deep, with a 3' berm encircling the pit.

EIF 11408D: Rock cairn consisting of 18 boulders stacked one course high measuring 3' x 1', with a 4" x 4" claim post.

EIF 11408E: Rock cairn consisting of 14 boulders stacked two courses high measuring 1' x 1' , without a claim post.

EIF 11408F: Claim post made from a split rail road tie measuring 6' long, with a 6" x 6" post. The post is not upright, however the placement hole is still visible.

EIF 11408G: Claim post 4" x 4" x 3' long, it is fallen but two large boulders remain at it's original placement.

EIF 11408H: Claim post 4" x 4", which stands 3' above the ground. The upper portion of the post is wrapped with 10" wide cut, rusted sheet metal.

EIF 11408I: Rock cairn consisting of seven boulders stacked one course high measuring 3' x 3', with a 4" x 4" fallen claim post in two pieces and approximately 3' in length. The cairn is infested with a pack rat midden.

EIF 11408J: Rock cairn consisting of 17 boulders stacked one course high measuring 3' in diameter, with a 4" x 4" x 3' tall claim post. The upper portion of the post is wrapped with 10" wide cut, rusted sheet metal.

EIF 11408K: Bladed road approximately 13' wide, trending east/west, with a slight berm (~ 6") on either side.

EIF 11408L: Claim post 4" x 4" x 2.5' long and is sharpened at the end. The upper portion of the post is wrapped with 10" wide cut, rusted sheet metal. The claim post is fallen and has no associated boulders.

EIF 11408M: Rock cairn consisting of seven boulders intermixed with small cobbles stacked one course high measuring 3' in diameter, with a 2" x 4" claim post that has a large wire nail at the top.

EIF 11408N: Claim post 4" x 4" x 3' high, with 12 small dispersed cobbles.

EIF 11408O: Claim post 4" x 4" x 3' high, with 10 small dispersed cobbles.

EIF 11408P: Circular rock cairn with three boulders, one course high. Fallen claim post measuring 4" x 6" x 5' long.

EIF 11408Q: Rock cairn consisting of 24 boulders stacked one course high measuring 3' x 1' , with a 4" x 4" x 3' fallen claim post. The upper portion of the post is wrapped with 10" wide cut, rusted sheet metal attached with wire nails.

EIF 11408R: Fallen claim post measuring 2' long consisting of two 2" x 4" nailed together, with a sharpened ends.

EIF 11408S: Rock cairn consisting of nine boulders stacked two courses high measuring 1' x 1', with no claim post. Approximately nine feet southwest of the cairn is a 1" x 12" plank cut 1.5' long, a painted sheet metal sign attached with wire nails, reads " Big Hill // W. . . T"

EIF 11408T: Rock cairn consisting of six boulders stacked one course high measuring 1' x 1', with a 4" x 4" x 3' claim post. The upper portion of the post is wrapped with 10" wide cut, rusted sheet metal.

EIF 11408U: Two-track road measuring 9' wide, that trends northeast-southwest for approximately

656' and then washes out in alluvial drainage.

EIF 11408V: Fallen 4" x 4" x 5' long claim post with a rusted rectangular Band-Aid tin with a hinge lid, attached to the top with a wire nail.

EIF 11408W: Rock cairn consisting of five boulders stacked one course high measuring 1' x 1', with a 4" x 4" x 4' long fallen claim post.

EIF 11408X: Claim post 6" x 8" x 5' tall, located on the edge of a finger ridge on the northwest side of the project area.

EIF 11408Y: Rock cairn consisting of seven boulders stacked one course high measuring 1' x 3' with a 4" x 4" x 2' long fallen claim post.

EIF 11408Z: Rock cairn consisting of five boulders stacked one course high measuring 1' x 1' with a 4" x 4" x 4' long fallen claim post.

EIF 11408AA: Claim post measuring 4" x 4" x 4' tall.

EIF 11408BB: Rock cairn consisting of 16 boulders stacked one course high measuring 3' x 1', with a 4" x 4" x 4' long fallen claim post. The post has two side strip coffee can lids (1lb) nailed to the top with wire nails; at the bottom of the cairn is an upright pocket tobacco tin with a hinged lid, inside the tin is a location claim. The paper is too deteriorated to read, but the claim ticket was produced in Tonopah.

EIF 11408CC: Two claim posts measuring 4" x 4" x 4' tall, standing side by side.

EIF 11408DD: Claim post 4" x 4" x 3' tall. The upper portion of the post is wrapped with 10" wide cut, rusted sheet metal

EIF 11408EE: Two claim posts that are 1' apart. One post is an 8" x 8" railroad tie standing 4' tall, the other is a 4" x 4" x 4' tall post with a rusted metal hinged lid, Band-aid tin nailed to the top.

EIF 11408FF: Rock cairn consisting of six boulders stacked one course high measuring 1' x 1', with a 4" x 4" x 2' tall claim post.

TABLE 1: ISOLATED ARTIFACTS

ISOLATE #	LEGALS	UTM'S
11408A	NE NW SW Sec. 5 T1S, R37E	420949 mE, 4192888 mN
11408B	SE SE NE Sec. 6 T1S, R37E	420516 mE, 4192894 mN

11408C	SE SE NE Sec. 6 T1S, R37E	420562 mE, 4193233 mN
11408D	SE SW NE Sec. 6 T1S, R37E	420228 mE, 4192996 mN
11408E	NW NE SE Sec. 6 T1S, R37E	420461 mE, 4192865 mN
11408F	NE NW SE Sec. 6 T1S, R37E	420168 mE, 4192753 mN
11408G	NW NE SE Sec. 6 T1S, R37E	420364 mE, 4192846 mN
11408H	NE NW SE Sec. 6 T1S, R37E	420300 mE, 4192867 mN
11408I	NW NW SE Sec. 6 T1S, R37E	420062 mE, 4192867 mN
11408J	NE SW NW Sec. 5 T1S, R37E	421037 mE, 4193841 mN
11408K	begin: NW NE NWSec.5 T1S,R37E end: NE NW NW Sec. 5 T1S, R37E	begin: 421187 mE, 4193825 mN end: 420948 mE, 4193827 mN
11408L	NW NW NW Sec. 5 T1S, R37E	420733 mE, 4193715 mN
11408M	NE SW SE Sec. 31 T1N, R37E	420877 mE, 4194171 mN
11408N	NE SE SW Sec. 31 T1N, R37E	420334 mE, 4194047 mN
11408O	SW SE SW Sec. 31 T1N, R37E	420648 mE, 4194090 mN
11408P	NW SE NE Sec. 6 T1S, R37E	420471 mE, 4193363 mN
11408Q	SE NE NE Sec. 6 T1S, R37E	420606 mE, 4193570 mN
11408R	NW NE NE Sec. 6 T1S, R37E	420449 mE, 4193665 mN
11408S	NW SW NE Sec. 6 T1S, R37E	420060 mE, 4193352 mN
11408T	NW SW NE Sec. 6 T1S, R37E	419985 mE, 4193398 mN
11408U	NW NW NE Sec. 6 T1S, R37E	begin: 420620 mE, 4193807 mN end: 420501 mE, 4193712 mN
11408V	NE NW NE Sec. 6 T1S, R37E	420268 mE, 4193677 mN
11408W	NE NW NE Sec. 6 T1S, R37E	420204 mE, 4193792mN
11408X	NW NW NE Sec. 6 T1S, R37E	420067 mE, 4193690 mN
11408Y	SW NW NE Sec. 6 T1S, R37E	420008 mE, 4193538 mN
11408Z	SW NW NE Sec. 6 T1S, R37E	419990 mE, 4193534 mN
11408AA	NE SE NW Sec. 6 T1S, R37E	419886 mE, 4193425 mN

11408BB	NW SW NE Sec. 6 T1S, R37E	420064 mE, 4193360 mN
11408CC	SW SW NE Sec. 6 T1S, R37E	419957mE, 4193225mN
11408DD	SW SW NE Sec. 6 T1S, R37E	420055mE, 4193182mN
11408EE	SW SW NE Sec. 6 T1S, R37E	420056mE, 4193235mN
11408FF	SW SW NE Sec. 6 T1S, R37E	420001mE, 4193185mN

7.3 SUMMARY

Expectations were advanced earlier pertaining to historic sites to be found within the project area. As expected, the one historic site recorded appears to be a borax exploration mining area. In general, our expectations were well met.

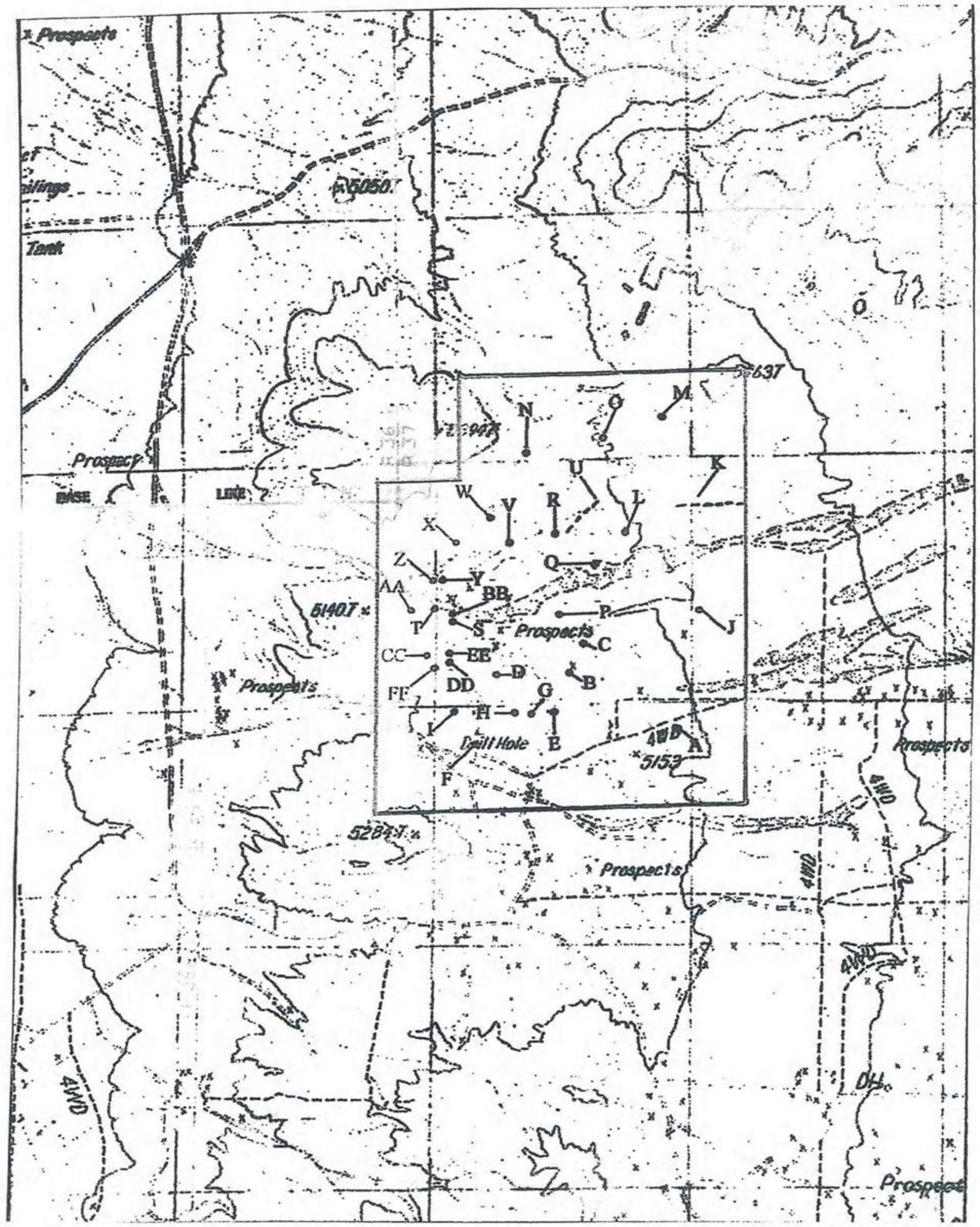

Figure 3: Isolate Location Map. Isolate 11408A-11408FF: USGS 7.5' Rhyolite Ridge,NW Nevada 1987, BLM Report #6-2601(P)

8.0 SUMMARY AND AVOIDANCE RECOMMENDATIONS

One historic site, and 32 Isolates were recorded during the course of this survey. Site CrNV 61-11408 is a short term mineral exploration site. The site is eligible for the NRHP under criterion(a) (a) as it is associated with an important series of events that have made a significant contribution to the broad patterns of our history, such as the production of borax, and criterion (d) as it has the potential to answer several research questions under the Mining Research Domain given a variety of surviving cultural elements. It is recommended that the site area be avoided. Fish Lake Green Power Company will not be conducting any exploration activities in this area.

It should be noted that the methods and procedures used throughout the survey were such that all cultural resources located within the project area should have been found and recorded. If, however, cultural resources are subsequently discovered that could be adversely affected by project-related activities, the latter should immediately cease operations and the Tonopha Resource Area of the Bureau of the Bureau of Land Management should be immediately notified.

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APPENDIX A

IMACS SITE RECORD

AND PHOTOS

To be completed for each site form.
For instructions and codes, see IMACS Users Guide.

Encoders Name ____

A

1 ___-___-_______ State Site Number

2 61-1140̸8 Agency Site Number

6 CRR62601̸ Agency Report Number

10 0̸5153 Elevation

11 11 (Zone) 420̸244 (Easting) 4193339 (Northing)

12 NE (1/4) NW (1/4) SE (1/4) 0̸6 (Sec.) T1 S (T.) R37 E (R.)

13 7 Merid.

14 RHYOLITE RIDGE NW USGS Map

17 LM Owner

18 ___ Forest BD Dist./Park

19 ___ Loc. Curated Materials

21 D Cond.

22 ER MN RD Impacts

23 C N.R.

26 RH Organ.

28 0̸6-29-0̸5 Survey Date

29 98 Slope 0̸0̸0̸ Aspect

30 0̸29 A Water: distance/type

31 BPH Geog. Unit

32 G (1st) I (2nd) Topographic Location

33 H Dep.

34 E 000 (1 2 3) Vegetation

35 ___ Misc. Text, Site Name

B

2 ___ ___ Culture/Dating Method

3 ___ Area

4 ___ Collect

5 ___ Depth

6 ___ Excav. Status

7 ___ Prehistoric Artifacts

8 ___ Lithic Tools: # / type

9 ___ # ___ Flaking Stages

11 ___ Ceramics: # / type

13 ___ Features: # / type

14 ___ Architecture: # / material / type

C

2 MN ___ Historic Themes

3 EAF ___ Cultures / Dating Method

4 190̸0̸ 195 0̸ Dates

5 89849 Area

6 A Collect.

7 A Depth

8 C Excav. Status

9 TH TC WD ME GL TO CS CM NC Artifacts

14 6TR 4PH 3AI Features: # / type

15 0̸1BE 0̸1AR 0̸1AK 0̸1DA 0̸60A ___ Architecture: # / material / type

LETTERING GUIDE A B C D E F G H I J K L M N O P Q R S T U V W X Y Z 1 2 3 4 5 6 7 8 9 0̸

IMACS SITE FORM

Part A - Administrative Data

INTERMOUNTAIN ANTIQUITIES COMPUTER SYSTEM

1. State No.

2. Agency No. CRNV-61-11408

3. Temp. No. J1

4. State: Nevada County: Esmerelda

5. Project: Fish Lake Green Power Co.

6. Report No: BLM 6-2601 (P)

7. Site Name: none

8. Class: Historic

9. Site Type: Mining/Mineral Extraction (MN)

10. Elevation (ft): 5,153'

11. UTM Grid: Zone 11 420244 mE, 4193339 mN Datum NAD 27

12. Legal Description:
NE 1/4 of NW 1/4 of SE 1/4 of Sec. 6 T1S/R37E

13. Meridian: Mt Diablo (7)

14. Map Reference: USGS 7.5:

15. Aerial Photo: None Used

16. Location and Access: The site is located on a highly erosional alluvial drainage on the western side of the lower flank of the Silver Peak Range. Access is from Hwy 264 in Fish Lake Valley turn east onto Hot Ditch Road fo 7.9 miles to fork in the road, take right fork for 0.3 mile, go left for 3.6 miles turn right trending south for 0.5 mile take left fork for 0.8 mile trending east into the site area.

17. Land Owner: Administered by the Bureau of Land Management (LM)

18. Federal Administrative Units: Bureau of Land Management (BD)

19. Location of Curated Materials: N/A

20. Site Description: The site is located on a highly erosional alluvial drainage on the western side of the lower flank of the Silver Peak Range. The site is a mining/mineral exploration complex measuring 440 m north-south x 260 m east-west. Vegetation within the site area is a shadscale community with lesser amounts of greasewood, cacti and other forbes and grasses The deposition consists of a sandy silt alluvium intermixed with gravels and pebbles. The site has 31 mining features which include one ore chute, one open cut mine pit, five loading/staging platforms, six road cuts, four prospect pits, one collapsed structure, one structural debris scatter, one water tank, one dugout, five wooden claim posts, three rock cairns with claim post, one possible tent platform, and two wooden slat alignments. This site may have been an area for borax exploration, but after examination of the open cut pit, it has evidence of sulfur layering the waste rock and sulfur emits from the outcrop. The open cut pit is small and possibly the mining was short term. After encountering the sulfur deposit the miners may have ceased operation of the exploration. The site contains a variety of debris which include diagnostic can technology (1900's-1950's), milled lumber, galvanized sheet metal, nails, hardware, glass fragments (some with embossing), ceramics (some with trademarks), and domestic items. The site is eligible for the NRHP under criterion (a) and (d).

21. Site Condition: Poor (D)

22. Impacting Agent(s): Erosion (ER), Mining (MN), Road (RD), Structural Decay (SD)

23. National Register Status: (C)

Justify: This is a historic mineral extraction site containing 31 mining features. The site appears to be associated with an important series of events that have made a significant contribution to the broad patterns of our history, that is the production of borax in Fish Lake Valley, hence, the site is deemed eligible for the NRHP under criterion (a). There is no evidence that the site is associated with the lives of persons significant in the history of Nevada, hence, the site is not eligible for the NRHP under criterion (b). The site shown no distinctive characteristics of a type, period, or method of construction, hence, the site is not eligible for the NRHP under criterion (c). The site is associated with an important series of events that have made a significant contribution to the broad patterns of our history. The mining complex appears as it was during the time the area was in operation for mineral exploration. The transportation and movement of materials from the open cut mine to the ore chute are clearly visible and remain intact where they were originally constructed. The surrounding landscape and the physical remains of the site contain information on mining activities and the mineral exploration of borax in Esmeralda County, as well as the technology of architectural mining features and road systems. This particular mining area may have been short term. The open cut pit has evidence of sulfur layering the waste rock and sulfur emits from the outcrop. After encountering the sulfur deposit the miners may have ceased operation of the mineral extraction. The collapsed structure and variety of associated historic debris including the can technology ranges in dates from 1900s-1950s. The mining features have not been altered by newer or additional reconstruction. Thus, all of this combined contains data pertinent to the archaeological record. Therefore, integrity of setting, location, design, and association have not been compromised. Given the amount of cultural material and construction of mining features, the site has the potential to answer any of the research questions under the Mining Research Domain. The site is eligible for the NRHP under criterion (d).

24. Photos: 1-38

25. Recorded by: Jana Trudell

26. Survey Organization: R. K. Vierra and Associates (RH)

27. Assisting Crew Members: Lila Lindsay, Lee Duryee

28. Survey Date: June 29th 2005

List of Attachments: __Part B _X_Topo Map _X_ Site Sketch __Feature Sketch(s)
_X_Part C _X_Photos _X_ Artifact Sketch(s)

Part A - Environmental Data

29. Slope (degrees): 98 Aspect (degrees): 0
Distance to Permanent Water (29 x 100 meters): 2,900m
Type of Water Source: Spring/Seep (A)
Name of Water Source: Unknown

31. Geographic Unit: Fish Lake Valley (BPH)

32. Topographic Location: Primary Landform: Canyon (G)
Secondary Landform: Multiple Secondary Landforms (I)

Describe: The site is situated on a highly erosional alluvial drainage, slopes, and finger ridges on the western side of the lower flank of the Silver Peak Range.

33. On-site Depositional Context: Alluvial Plain (H)

Description of Soil: The soil is a sandy silt alluvium intermixed with gravels and pebbles.

34. Vegetation: a. Life Zone: Upper Sonoran (E)
b. Community: Primary On-Site: Shadscale (O)
Secondary On-Site: Shadscale (O)
Surrounding Site: Shadscale (O)

Describe: Vegetation is a shadscale/greasewood community intermixed with, rabbit brush, hopsage, russian thistle, swollen stalk buckwheat, ephedra, teddy bear cacti, pencil choya, white top, seepweed, feathered finger grass, wild aster, prince's plume, halogeton glomeratus, globe mallow, astragalus, and other forbes and grasses.

35. Miscellaneous Text: N/A

36. Comments/Continuations: N/A

Part C - Historic Sites

1. Site Type: Mining

2. Historic Theme(s): Mineral Extraction (MN)

3. Culture:

	AFFILIATION	DATING
	Euro-American (EA)	Artifactual Cross-Dating (F) Can Technology

4. Oldest Date: 1900s   Recent Date: 1950s
    How determined: Can Technology (striker-plate tobacco tins, milk cans)

5. Site Dimensions: 260 m. EW X 440 m. NS   89,849Area (sq. m.): approximately

6. Surface Collection Method: None (A)
    Sampling Method: N/A

7. Estimated Depth of Fill: Surface (A)
    How estimated: The site is confined to the surface with no evidence of buried deposits. Possible alluvial deposits from flooding, but would be out of context.

8. Excavation Status: Unexcavated (C)
    Testing Method: N/A

9. Summary of Artifacts and Debris: Historic artifacts and debris include: ceramics, porcelain, glass fragments, bottle glass fragments, window glass fragments, tin cans, a teaspoon, various sizes of milled lumber, tar paper fragments, concrete slab fragments, various galvanized and corrugated sheet metal, scrap iron, metal strapping, metal springs, cable, wire mesh bands, an iron leaf spring, galvanized banding, cut nails, wire nails, spikes, metal rods, hardware, bailing wire, barrel hoops, window frame fragments, a hand-made aluminum picture frame (drawn), a set of bed box springs, arm chair fragments, battery end caps, and a rubber shoe.

10. Ceramic Artifacts:

#	Paste	Glaze/slip	Decoration	Pattern	Vessel form
4	WIE				plate fragments

1	WIE	plate bottom
1	WIE	saucer
1	WIE	saucer
20±	WIE	fragments
1	Porcelain	bowl

Describe: The ceramic assemblage consists of four white improved earthenware plate fragments, a white improved earthenware plate bottom trademark "RONSTONE CHINA/J & G MEAKIN/MANLEK/ENGLAND", a white improved earthenware saucer with black print "ROYAL IRO.../JOHNSON BROS/ENGLAND" with sheild and crown, lion "L", a white improved earthenware saucer with green print "KROKUS/...INA", 20+ white improved earthenware fragments, and a white porcelain bowl fragment embossed on bottom "CHINA//LEAKA...".

11. Glass:

#	Manufacture	Color	Function	Trademarks	Decoration
1		clear			
10±		clear		yes	yes
15±		amethyst			yes
100±		aqua			
1		amethyst		yes	
15±		amethyst			
5±		aqua			
10±		amber			
1	automatic	aqua		yes	
3		olive			

Describe: a clear glass gallon size jug with aluminum screw cap finish and circular handle, 10+ clear glass fragments some are embossed with alternating arrowhead and chevron pattern with "...LON UNAUTHORIZED USE PRO..." UNDER PATTERN, large body fragment of jug has logo ".../AND//...RITA//...RS. INC", ANOTHER FRAGMENT HAS "OHIBITED", 15+ amethyst panel bottle glass fragments, one fragment embossed with two circles and an anchor with the circle, 100+ window glass fragments with aqua tint, a small amethyst bottle base embossed with "REDCROSS" (a "B" above the S), 15+ amethyst glass fragments, 5+ aqua bottle glass fragments, 10+ amber glass fragments, an aqua automatic bottle maker mark ("AB") base, three olive green glass fragments.

12. Maximum Density-#/sq. m. (Glass and Ceramic):15±

13. Tin Cans:

#	Type	Opening	Size	Modified	Label/Mark	Function
1	TH	p38	4 ½" x 3 3/8"			
1			5 3/16" x 3 2/8"			External friction
1	TO		4 1/2"			tobacco
6	TH	KS	3 ½" X 3" X 2		yes	meat

1	TH	KS	4 5/16" x 2 15/16"				meat
15		KC	2 ½" x 2 ½"				milk
1		p38	2" x 3 3/4"				meat
1		KC	4 3/8" x 3"				milk
1	TC	KC	4" x 2 3/4"				
1	cap					yes	syrup
2	HPTT					yes	tobacco
3	HPTT						tobacco
1	CE				yes	yes	coffee
1		CK					beer
1	TC		5" x 6 ½"				
3	TC	RO					
1	TH	PH	3 3/4"x 9"				
1	square		10" x 10"				
2	HPTT		4 1/2"				
1	lid		4 5/8"				Internal friction
10±	TC	KC	4" x 2 11/16"				
2		p38	6 ½" x 4 ½" x 1 ½"			yes	fish
3	HPTT		4 1/2"				tobacco
1		KS				yes	fish
1				yes			flashing
1	CU		22" diameter	yes			unknown
4	HPTT		4 1/2"				tobacco
20±	TC	KC	4 5/8" x 4"				
25±	TH	KC	4 ½" x 3 3/8"				
12±			4 3/8" x 3"				milk
2			5" x 2 3/4"				External friction
1	TC	KC	2" x 3 7/16"				
2		KS					meat
1	square		5 1/4" x 4 3/8" x 3 3/16"			yes	
1	TC		4 ½" x 3 3/8"				
1		pull-tab					beer
1	CE	KS					Lid

Describe: hole-in-cap can p38 opened 4 ½" x 3 3/8" diameter, an external friction lid can 5 3/16" x 3 2/8" diameter, three kidney tobacco tins with striker plate on bottom, six hole-in-cap meat tins key wind opened with embossed "ESTAB 32A" 3 ½" x 3" x 2", hole-in-cap meat tin lid with key wind attached 4 5/16" x 2 15/16", 15 solder dot milk cans knife cut 2 ½" x 2 ½", p38 opened meat tin 2" x 3 3/4", milk can knife opened 4 3/8" x 3", sanitary can knife opened 4" x 2 3/4", a tin cap with three sided tabs embossed "...SYRUP CO," two "Prince Albert" upright hinge tobacco tins, a 1-lb side strip coffee can, a steel beer can church key opened, a lapped seam sanitary can with friction lid 5" diameter 6 ½" tall, three sanitary can lids rotary opened, a cylindrical hole-in cap 9" tall x 3 3/4" diameter with a 2" cap punched can, a 10" x 10" square can with a 1 ½" pour cap (1" inside), two upright tobacco tins with hinge lid (one crushed), an internal friction lid 4 5/8", 10±

sanitary cans 4" x 2 11/16" knife cut, two fish tins 6 ½" x 4 ½" x 1 ½" p38 cut and folded opened with indented circle at bottom, three tobacco tins flat hinge with striker plate on bottom, a key wind top fish tin with "NOVEGE" embossed on bottom, a flattened tin can with circle cut out for stove pipe flashing, a 22" diameter circular tin in waffle pattern, 6" hole cut in center, four flattened hinge tobacco tins, 20+ sanitary cans 4 5/8" x 4" knife cut, 25+ hole-in-cap cans 4 ½" x 3 3/8" knife cut, 12+ solder dot milk cans 4 3/8" x 3", two external friction top cans 5" x 2 3/4", a sanitary can 2" x 3 7/16" knife cut, two meat tins key strip opened, a square can 5 1/4" x 4 3/8" x 3 3/16", a knife cut sanitary can 4 ½" x 3 3/8" diameter embossed on the bottom "OJD56//5216A," a steel top beer can with a pull tab, and a coffee can lid.

14. Landscape and Constructed Features: Road Cut/Bladed-Graded Road (TR), Prospect hole (PH), Rock Cairn (AI), Claim Post/Staging Platform (OT)

Describe:

Feature 3 road cut trending east-west approximately 216' long x 10' to 19' wide. Located between Features 2 and 4. A 1' x 10" plank 1 ½' long is nailed to an upright 2" x 4" protruding from the ground on the east end of the road cut along with another upright 2" x 4" in front of it. No writing visible on the plank.

Feature 4 is a road cut located below the chute. It is trending east-west then northeast-southwest at the eastern end. It measures 557' long x 16' wide with a small segment of twisted cable lying within it. Associated debris include a clear glass gallon size jug with aluminum screw cap finish and circular handle, 10+ clear glass fragments some are embossed with alternating arrowhead and chevron pattern with "...LON UNAUTHORIZED USE PRO..." UNDER PATTERN, large body fragment of jug has logo ".../AND//...RITA//...RS. INC", ANOTHER FRAGMENT HAS "OHIBITED".

Feature 5 rock cairn with six boulders, one course high, 3' x 3'. It has a 4" x 4" wooden claim post standing 4' tall with 10" wide cut, rusted sheet metal wrapped around the upper portion.

Feature 7 small circular pit 10' north-south x 13' east-west x 6" deep, bermed on the east and west sides. Located at the southwest portion of the pit is a pile of slabbed brown/yellow layered stone stacked one course high 3' x 2' with an upright 2" x 4" that is 6" tall, sharpened at bottom. The layered stone may have come from Feature 8 (pit). Associated debris include hole-in-cap can p38 opened 4 ½" x 3 3/8" diameter, an external friction lid can 5 3/16" x 3 2/8" diameter, a kidney tobacco tin with striker plate on bottom, six hole-in-cap meat tins key wind opened with embossed "ESTAB 32A" 3 ½" x 3" x 2", hole-in-cap meat tin lid with key wind attached 4 5/16" x 2 15/16", lengths of bailing wire, metal strapping 3/4" wide, heavy galvanized banding 4" wide approximately 20' in length, a fish tin with key strip across the top 4" x 3" x 3/4" deep, 15 solder dot milk cans knife cut 2 ½" x 2 ½", p38 opened meat tin 2" x 3 3/4", milk can knife opened 4 3/8" x 3", sanitary can knife opened 4" x 2 3/4", a hand made picture frame approximately 5" x 7" aluminum with twisted aluminum on outer edge raised into two loops for hanging, 15+ amethyst panel bottle glass fragments, one fragment embossed with two circles and an anchor with the circle, a teaspoon, and a tin cap with three sided tabs embossed "...SYRUP CO."

Feature 8 small pit located on the south facing slope on a small finger ridge. The pit is dug into a brown/yellow layered stone outcrop measuring 3' x 3' x 1' deep.

Feature 12 standing wooden claim post 8" x 8" x 5" tall.

Feature 15 wooden 8" x 8" claim post 5' long, fallen with a "Prince Albert" upright hinge tobacco tin.

Feature 16 circular prospect pit 16" x16" x 6" deep surrounded with a 3' berm.

Feature 17 oblong prospect pit 36' north-south x 22' east-west a 5' deep with a 5' berm on the east and west sides. Associated debris include a kidney upright tobacco tin with striker plate on bottom, located 22' south of the pit.

Feature 19 two 8" x 6" wooden claim post standing side by side, one is 4' tall the other 5' tall. Four small cut nails are embedded in the 4' post.

Feature 20 rock cairn with 10 boulders, one course high 1' x 1'. It has a 4" x 4" wooden claim post standing 4' tall with 10" wide cut, rusted sheet metal wrapped around the upper portion attached with wire nails.

Feature 21 staging platform located above Feature 1 (chute). It is triangular in shape with the west end 19' wide and the east end 3' wide and 55' in length trending east-west.

Feature 22 rock cairn with six boulders, one course high 1' x 1'. It has a 4" x 4" wooden claim post standing 4' tall with a 1-lb side strip coffee can lid nailed to the top.

Feature 23 narrow bladed road cut located between Feature 21 (platform) and Feature 28 (platform). It is 6' wide and 196' long cut into the northwest slope with a 1' to 2' berm on the east side. The road trends northeast-southwest.

Feature 24 bladed road cut located above Feature 23 (road cut) and south of Feature 25 (platform). It is 6' wide and 65' in length with a 1' to 2' berm on each side and trends north-south.

Feature 25 triangular platform/turnaround located above Feature 24 (road cut) and directly east of Feature 26 (road cut). It is 16' wide at the west end and 3' wide at the east end and 42' in length. It trends east-west.

Feature 26 bladed road cut that trends east-west across the top of a ridge line west of feature 25 (platform). The road is 6' wide and extends to the west for 295' then drops downslope 196' to the main access road at the north side of the site area.

Feature 28 platform staging area 16' wide x 62' long trending northeast-south-west. Located in front of Feature 27 (open cut). The waste rock fans 98' downslope of the platform to the northwest. Associated debris include a 4" x 4" wooden claim post 4" long lying on the waste rock.

Feature 29 two wooden 8" x 8" claim post standing 5 ½' tall side by side.

Feature 30 wooden 8" x 8" claim post standing 5" tall with 11 large wire nails embedded in the post. Remnants of a rock cairn 22 boulders has been dispersed to the northwest.

Feature 31 graded road with turn around located at the base of femoral 49' x 98'. The southwest side is eroding into several sharp runoff drainage. The road trends north-south 246' until it is washed out in drainage. Associated debris include 20+ milled lumber fragments of 2" x 4", 1" to 2" in length, 1" x 12" boards fragments with finishing nails and 5" wire nails, two 9' in length 1" 12" all located on both sides of the road.

15. Buildings and Structures: Ore Chute (BE), Collapsed Structure (AR), Collapsed Dugout (AK), Tent Platform (DA), Open Cut Mining/Loading Platform/Water Tank/Wood Alignments (OA).

Describe:

Feature 1 ore chute constructed on a steep north facing slope on a east-west trending, highly erosional finger ridge. The chute is built with 6" x 6" beams cut into the slope at right angles and supported by a stair stepped series of descending recycled rail road tie cribbing and upright 6" x 6" beams. The upper portion of the chute is sided with close fitting vertical 1" x 12" planks. Metal ½" diameter metal rods extend out from center of chute on either side of support beams. Large nails and spikes were used in the construction of the chute. The 1" x 12" planks are missing at the lower elevation of chute structure sides and sheets of corrugated metal roofing are scattered along the sides and bottom of the chute. The chute measures approximately 49.8' long x 8' wide. Associated with Features 2-4, and Features 21-28.

Feature 2 loading platform is constructed of 7' long horizontal 8" x 8" beams and vertical 3' tall 8" x 8" beams trending east-west with horizontal 8" x 8" beams trending north-south protruding from overlaid fill dirt. The east-west ends have one horizontal beam with a vertical beam on either side and three north-south horizontal beams spaced 3' apart between the vertical beams. Then two stacked horizontal beams with vertical beams on either side and three north-south horizontal beams spaced 3' apart. The center of the platform has three stacked beams with vertical beams on either side and three north-south horizontal beams spaced 3' apart. The top of the beams are covered with 135' long x 16' wide dirt and built up from the surface 6' up to the bottom of the beams. Associated debris located approximately 100' west of the chute includes scrap dimensional wood a 1" x 12", two 2" x 4", four 6" x 8", scrap iron 1' long, and concrete slabs broken into pieces.

Feature 6 remnants of three structure floor sections placed here from another location. The floors are constructed of 1 ½" x 8" frames with1 ½" x 6" joist spaced 2" apart with ½" x 6" tongue and groove over the joist. All of the floors measure 10' long x 8" wide and laid in a 42" diameter area. They are located directly north of the main access road on the east side of the site. Associated debris a steel beer can church key opened, a lapped seam sanitary can with friction lid 5" diameter 6 ½" tall, and three sanitary can lids rotary opened.

Feature 9 circular water tank is crushed on top center. Constructed of 5 ½' long x 2 ½' wide lengths of galvanized sheet metal attached together by welding and 3/4" bolts that run horizontally and vertically on the edges of the sheet metal. The tank is approximately 9 ½' diameter x 5' tall. A 3" diameter pipe extends 1' from the upper portion of tank on the west side. Bailing wire is attached and twisted through portions of the top edges of the tank and the pipe. The bailing wiring appears to be for repairs to hold the top to the siding together. A door located on the northwest side of the tank is lying dorsal side down on the ground. The door is constructed of 1" x 6" milled lumber form the frame and galvanized sheet metal for the dorsal side of the door. The galvanized sheet metal is attached with bailing wire and square nails. A 2" x 4" is attached to the door with a large hinge and cut nails. Next to the door is a 13' diameter shallow depression surrounded by a 1' berm. It appears that the tank once stood where the depression is located. Associated debris consists of ±10 segments of deteriorated milled lumber including a 4" x 4", a 2" x 4", and a 1" x 6", ±6 various size galvanized sheet metal sections, four white improved earthenware plate fragments, a cylindrical 9" tall x 3 3/4" diameter with a 2" cap punched can, a 10" x 10" square can with a 1 ½" pour cap (1" inside), two upright tobacco tins with hinge lid (one crushed), and a 12" diameter circular cut galvanized smoke stack section with rectangular holes throughout.

Feature 10 collapsed structure constructed of a built up dirt mound 39' north-south x 19' east-west surrounded by a s1' berm. The walls and floor are scattered to the north of the structure with milled lumber within the mounded area. Three boulders are aligned on the northwest berm and one large boulder remains on the east berm. A small floor section is intact. The dimensional lumber for the floor is 1" x 12" planks and 5' in length. The planks are attached to 1' x 6' with wire nails. A small wall 5' x 5' section is also intact constructed of ½" x 8" planks attached to 2" x 4" and 4" x 4" with wire nails. Associated debris consists of a 6' x 4 ½' bed box spring framed with 2" x 4" and dimensional wood attached together at corners with 4" long carriage bolts. Metal coiled springs are overlaid with wire mesh. The cross slates (5) are 1" wooden dowels. A wooden two vertical pane window frame 32" tall x 32" wide with ½" x ½" framing, 100+ window glass fragments with aqua tint, a white porcelain bowl fragment embossed on bottom "CHINA//LEAKA...", a white improved earthenware plate bottom embossed "RONSTONE CHINA/J & G MEAKIN/MANLEK/ENGLAND" around center shield with crown on top, lion on "L" unicorn on "R", wooden arm chair fragments with twisted brace wire on dowel legs, 20+ white improved earthenware fragments, an internal friction lid 4 5/8", a grey rubber shoe sole, an iron leaf spring fragment embossed "FORD", 10± sanitary cans 4" x 2 11/16" knife cut, two fish tins 6 ½" x 4 ½" x 1 ½" p38 cut and folded opened with indented circle at bottom, three tobacco tins flat hinge with striker plate on bottom, tar paper fragments, barrel hoops, a key wind top fish tin with "NOVEGE" embossed on bottom, a flattened tin can with circle cut out for stove pipe flashing, a 22" diameter circular tin in waffle pattern, 6" hole cut in center, four flattened hinge tobacco tins, a white improved earthenware saucer with black print "ROYAL IRO.../JOHNSON BROS/ENGLAND" with sheild and crown, lion "L", a white improved earthenware saucer with green print "KROKUS/...INA", a small amethyst bottle base embossed with "REDCROSS" (a "B" above the S), four 1" wide x 2-3" long wire mesh bands, 15+ amethyst glass fragments, 5+ aqua glass fragments, 10+ amber glass fragments, an aqua automatic bottle maker mark ("AB") base. Tin frying pan handle, 20+ sanitary cans 4 5/8" x 4" knife cut, 25+ hole-in-cap cans 4 ½" x 3 3/8" knife cut, 12+ solder dot milk cans 4 3/8" x 3", two external friction top cans 5" x 2 3/4", a sanitary can 2" x 3 7/16" knife cut, two meat tins key strip opened, three olive green glass fragments, 5 aluminum battery end caps, and a square can 5 1/4" x 4 3/8" x 3 3/16".

Feature 11 collapsed dugout located on the northwest slope of a small hill 98' from Feature 10 (structure). The feature is dug into the slope with a 7' x 7' milled lumber frame built up from the surface 1 ½'. It is constructed with 2" x 4" for outside frame with 1" x 6", 1" x 12", 1" x 3" milled lumber and 1/8" x 8" slats nailed across the top north-south with wire nails. The lumber is splintered and deteriorating. Tar paper is visible on one 2" x 4". It is difficult to determine depth due to cave in.

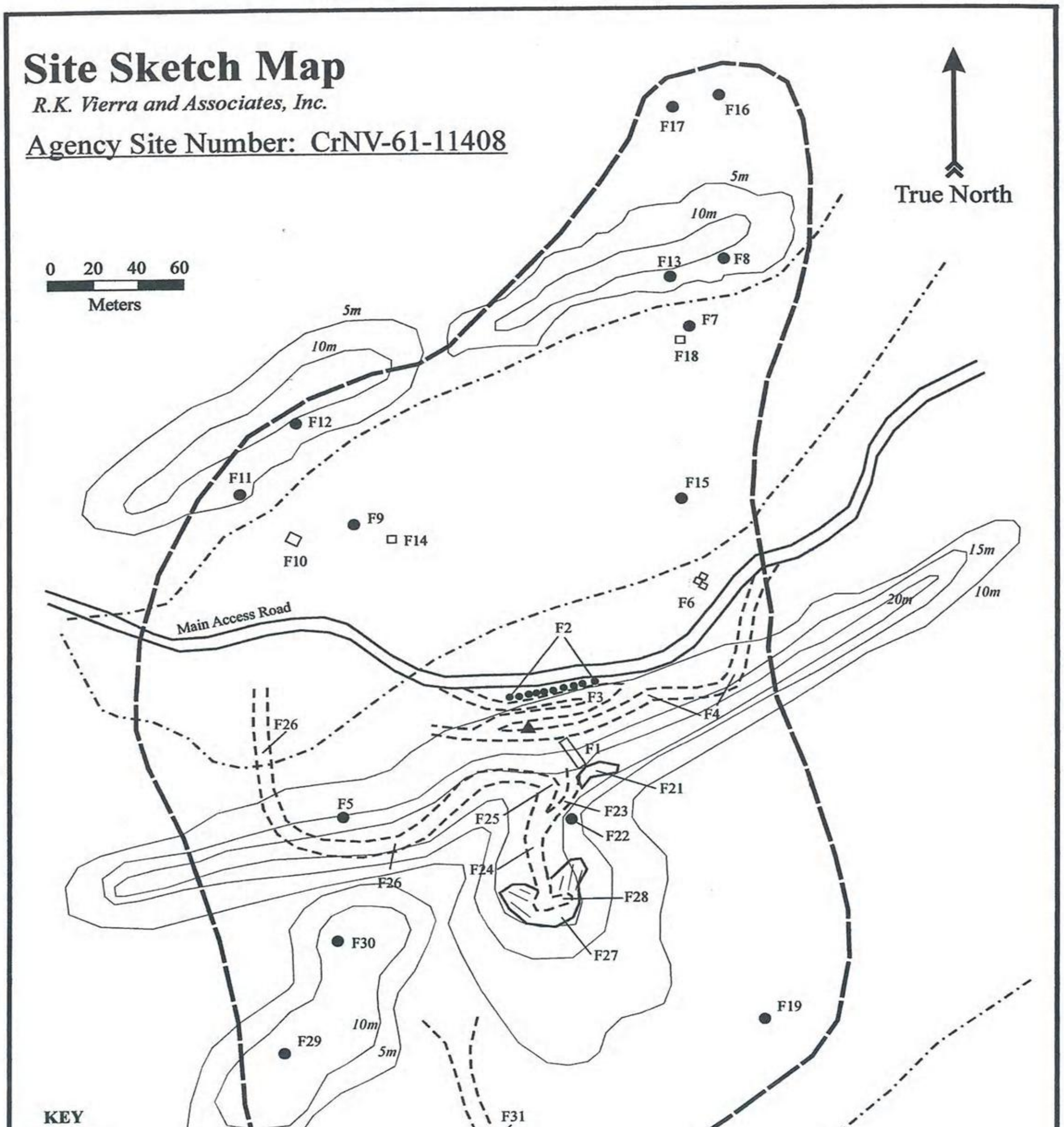
Feature 13 wood alignment built into the lower south facing slope of a small finger ridge near Features 7-8. The alignment consists of two rows of six 1" x 4" vertical slats pounded into the ground with two slats in the middle 16' north-south x 13' east-west. Possibly start of dugout. Associated debris a 1" x 10" board.

Feature 14 wood alignment located 49' east of Feature 9 (water tank). The alignment consists of six rows of small ½" x 2" wooden slats pounded into the ground 16' north-south x 13' east-west on a relatively flat surface. Possibly the start of a tent platform. Associated debris include a knife cut sanitary can 4 ½" x 3 3/8" diameter embossed on the bottom "OJD56//5216A" and a steel top beer can with a pull tab.

Feature 18 remnants of a possible tent platform 9' north-south x 9' east-west with small wooden pegs at four corners. Located in a relatively flat area 16' from Feature 7 (pit).

Feature 27 open cut mining pit located at the top and south facing slope of a mineral outcrop. The pit is 29' wide x 10' tall. The outcrop is white/grey with green/yellow sulfur layered on the rock. Sulfur emits from the outcrop.

16. Comments/Continuations: none

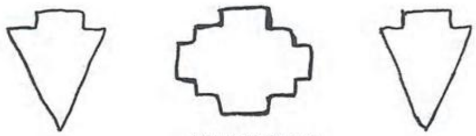


Site Sketch Map
R.K. Vierra and Associates, Inc.
Agency Site Number: CrNV-61-11408
True North
0 20 40 60
Meters
Main Access Road
5m
10m
15m
20m
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F11
F12
F13
F14
F15
F16
F17
F18
F19
F20
F21
F22
F23
F24
F25
F26
F27
F28
F29
F30
F31
KEY
Datum
Drainage
Site Boundary
Bladed Cut
F# Feature (see Feature List)
BLM Report Number: 6-2601(P)

CrNV. 61-11408
FEATURE 4

Loren Huddleson

Not to scale



ALTERNATING
ARROWEAD + CHEVRON EMBOSSED PATTERNS
AROUND BOTTLE BASE FRAGMENTS

"... LON UNAUTHORIZED USE PRO..."

ANOTHER FRAGMENT HAS ARROW PATTERN

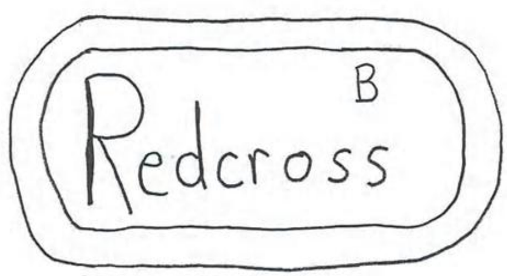
"...HIBITED"

LARGE MIDSECTION FRAGMENT
WITH LOGO

CrNV-61-11408
FEATURE 10
Loren Huddleson

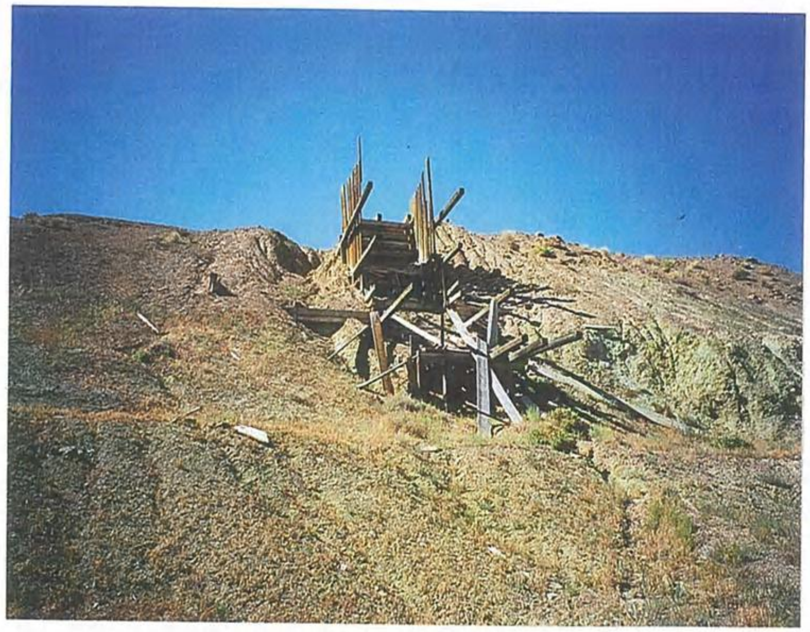
FADED GREEN LOGO
ON WHITE GLAZE
CERAMIC BOWL

Not to SCALE

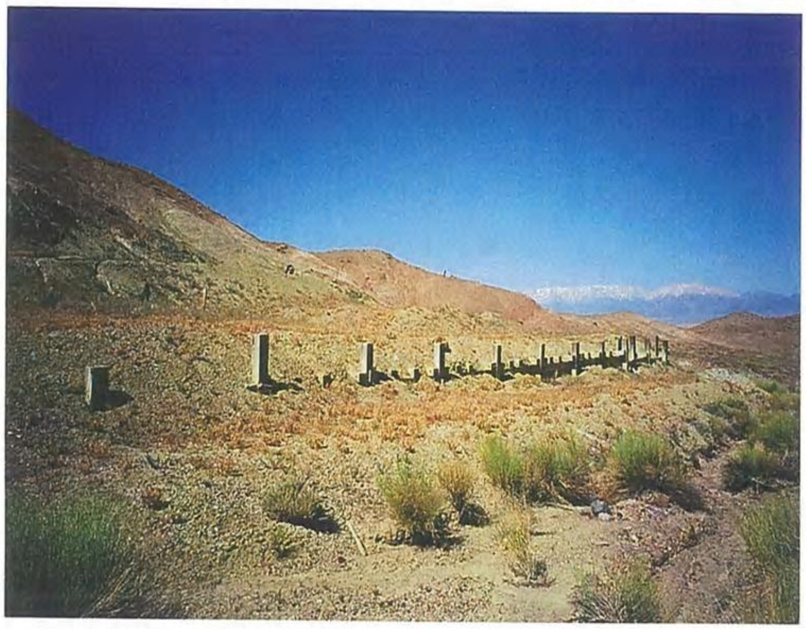


SMALL AMETHYST
BOTTLE BASE

Not to SCALE



Site CrNV 61-11408, Photo 1, Feature 1, Looking S, BLM Report 6-2701 (P).



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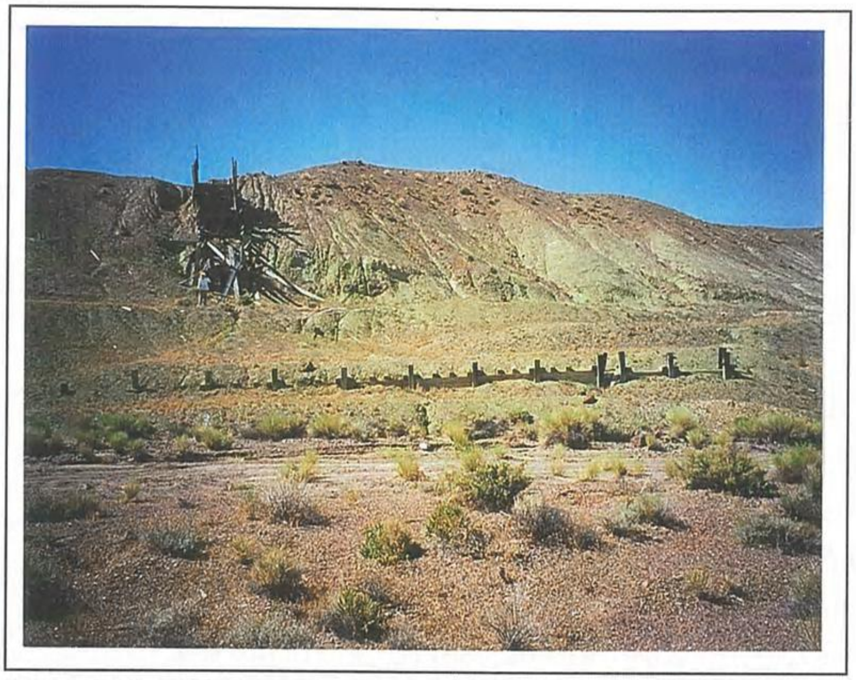
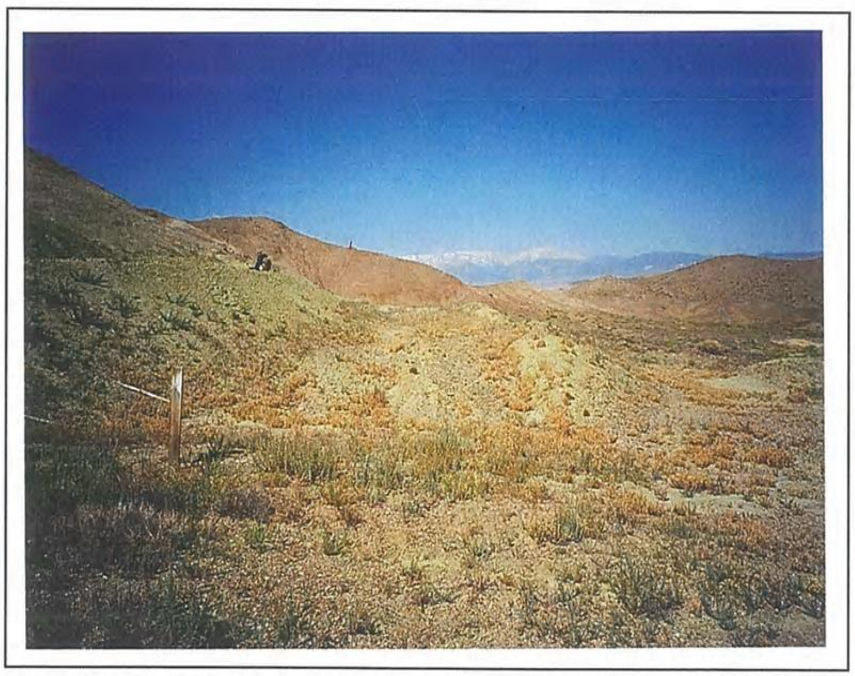
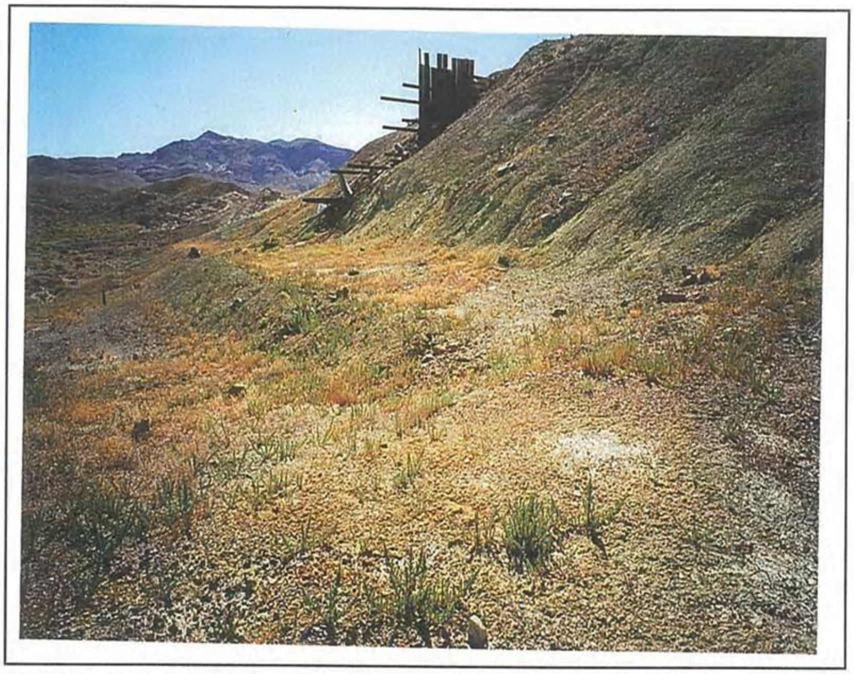


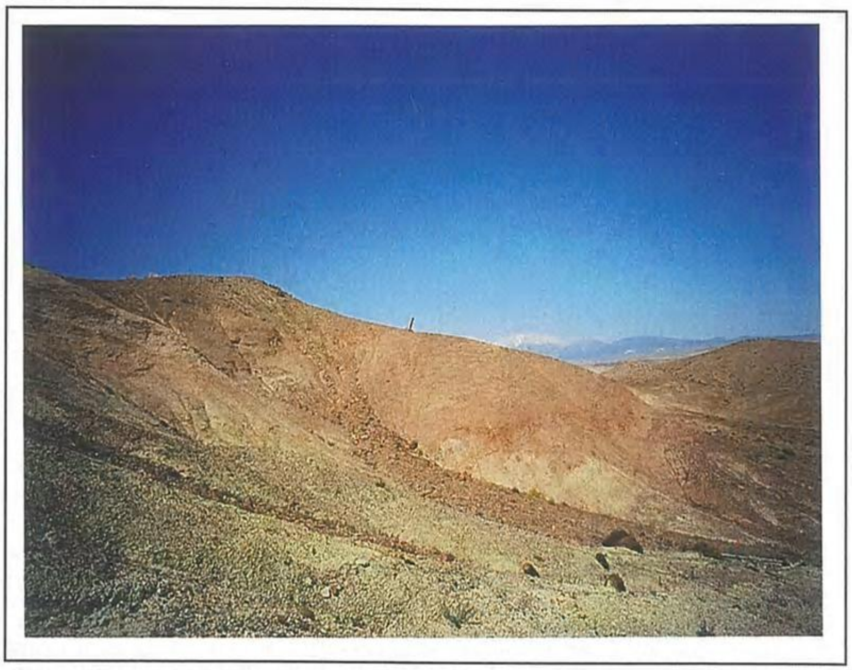
Site CrNV 61-11408, Photo 3, Feature 2, Looking S, BLM Report 6-2701 (P).



Site CrNV 61-11408, Photo 4, Feature 3, Looking W, BLM Report 6-2701(P).

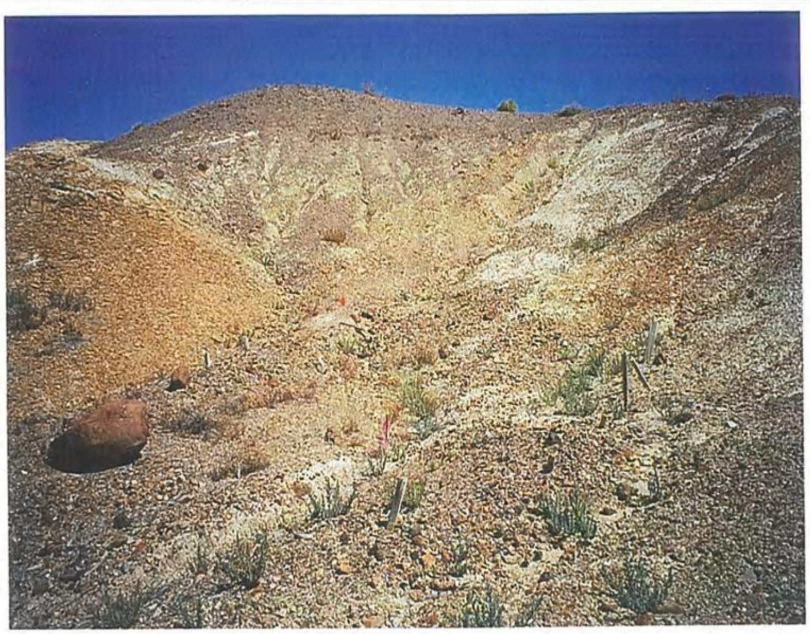


Site CrNV 61-11408, Photo 5, Feature 4, Road, Looking S, BLM Report 6-2701 (P).

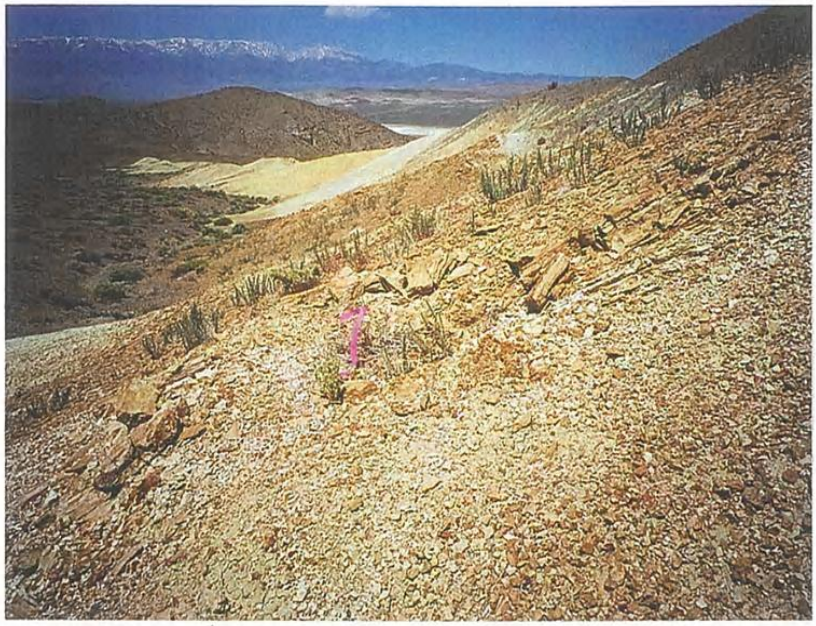


Site CrNV 61-11408, Photo 6, Feature 5, Claim Marker, Looking N, BLM Report 6-2701(P).

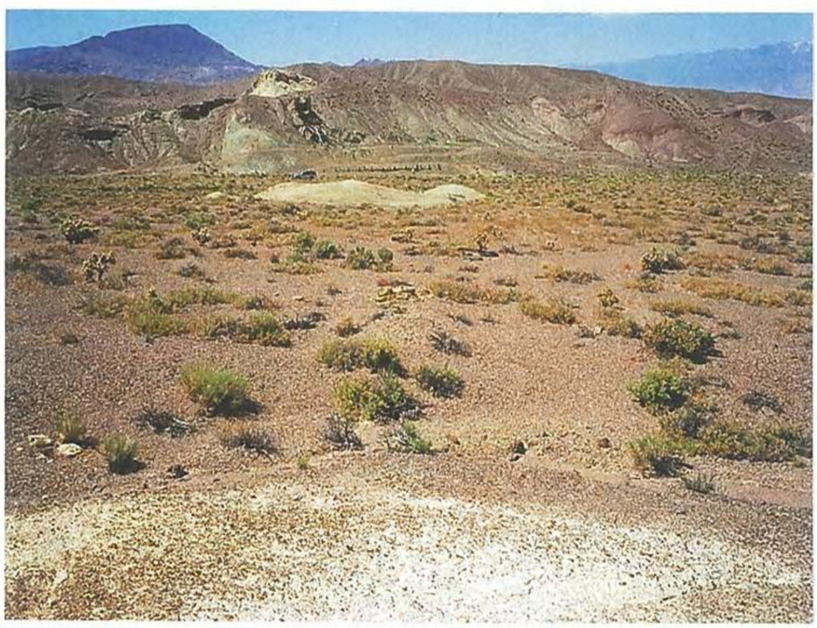
Site CrNV 61-11408, Photo 7, Feature 6, Flooring, Looking S, BLM Report 6-2701 (P).



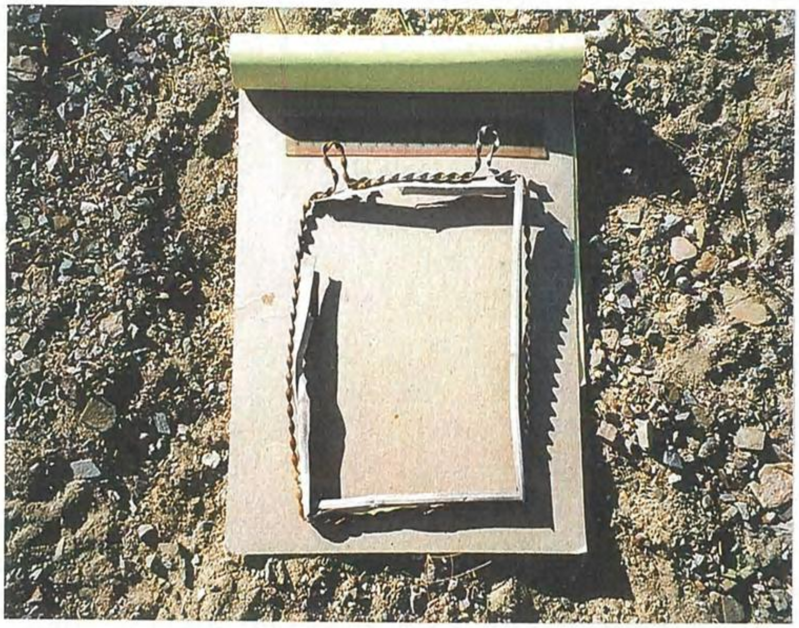
Site CrNV 61-11408, Photo 8, Feature 13, Posts, Looking NW, BLM Report 6-2701(P).



Site CrNV 61-11408, Photo 9, Feature 8, Looking W, BLM Report 6-2701 (P).



Site CrNV 61-11408, Photo 10, Feature 7, Looking S, BLM Report 6-2701(P).



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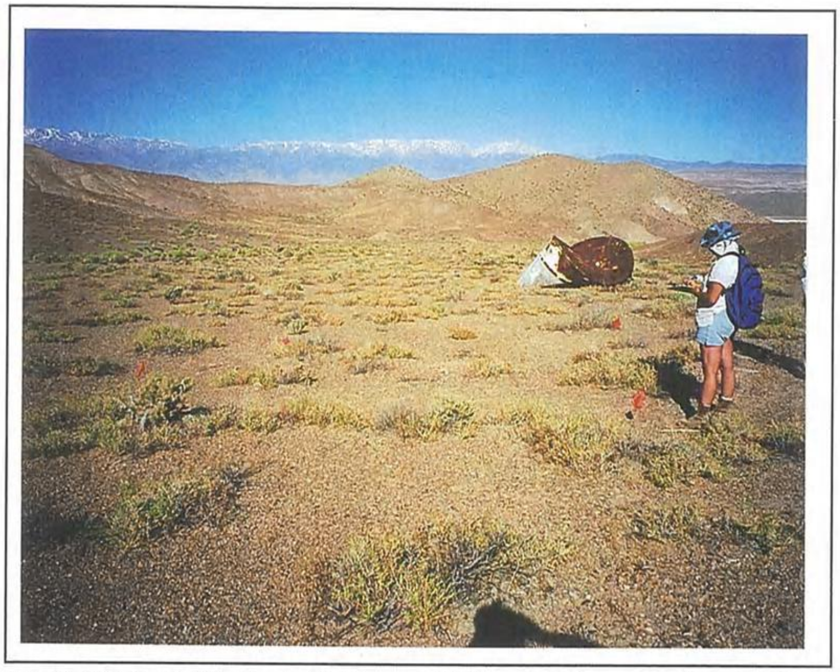

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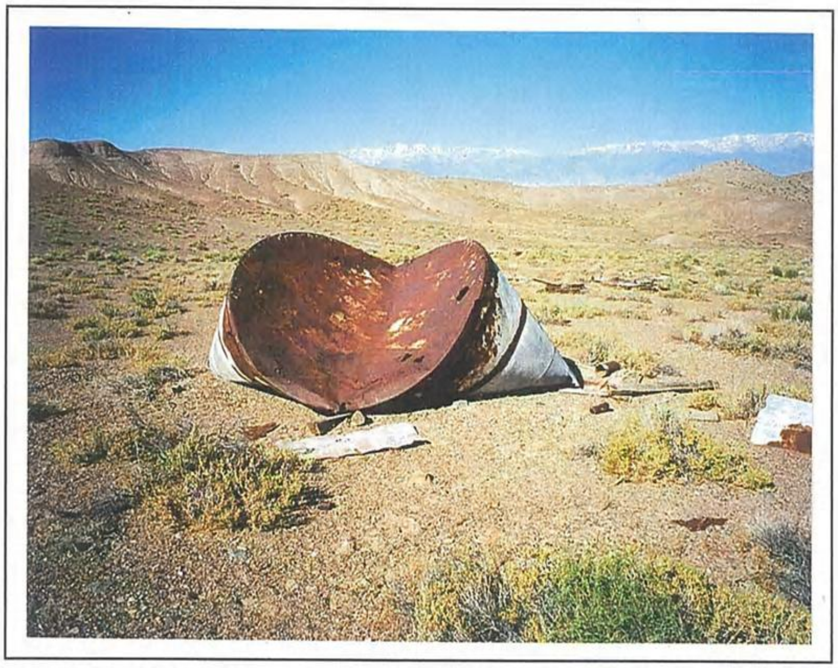

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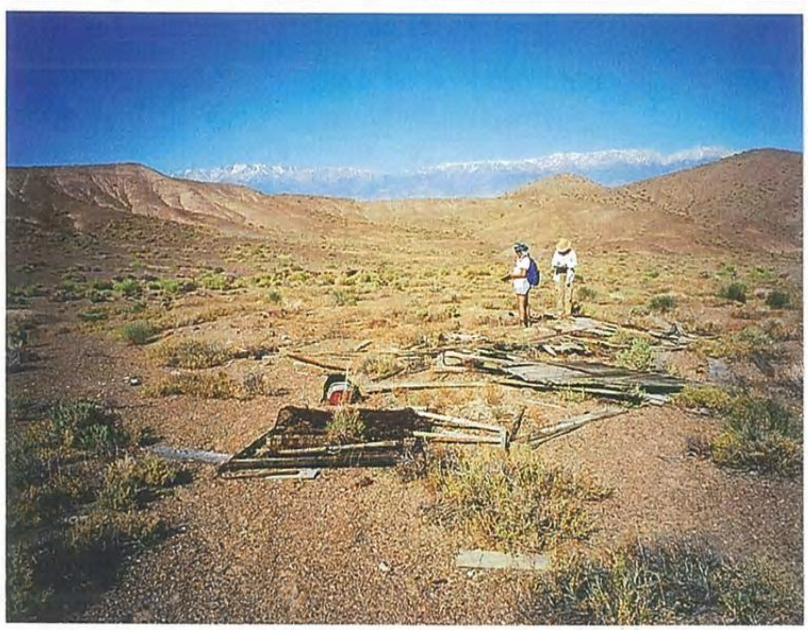

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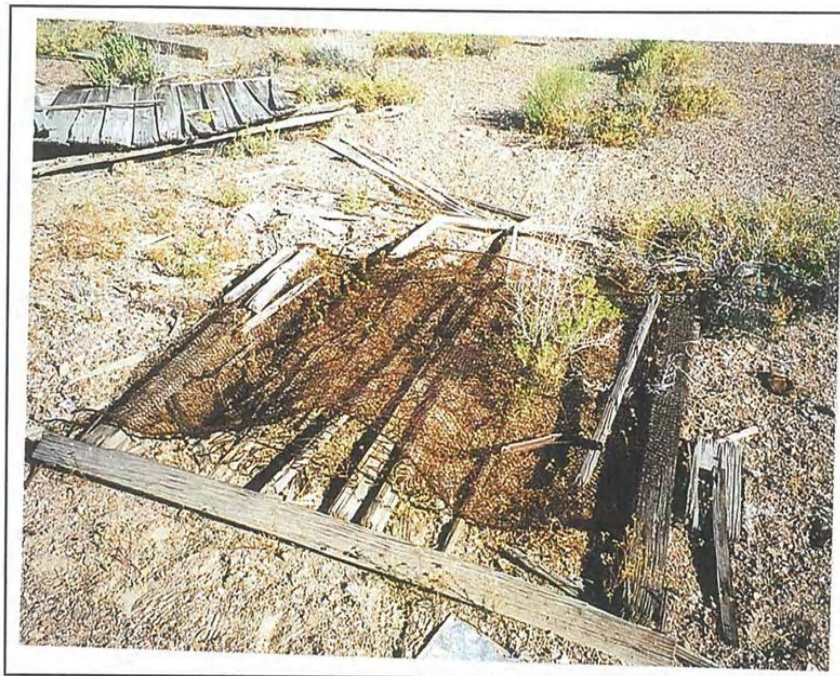

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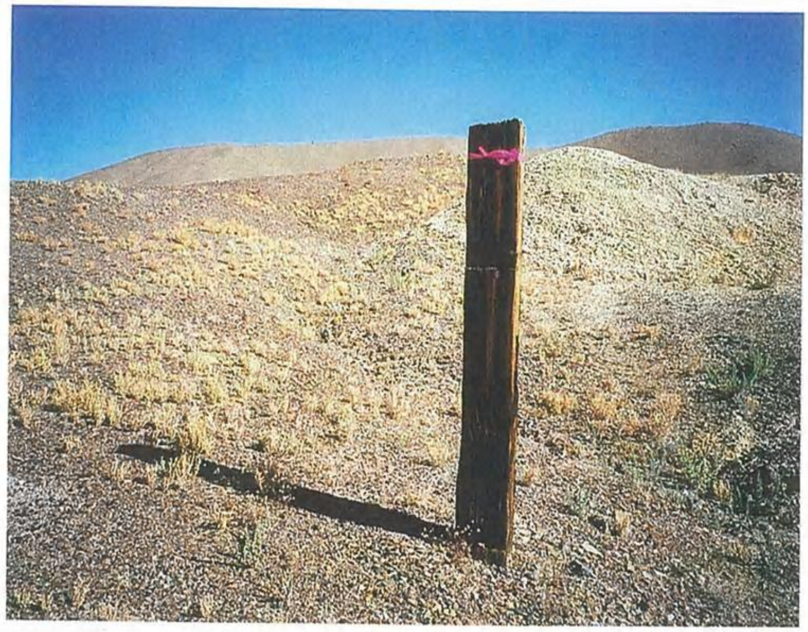

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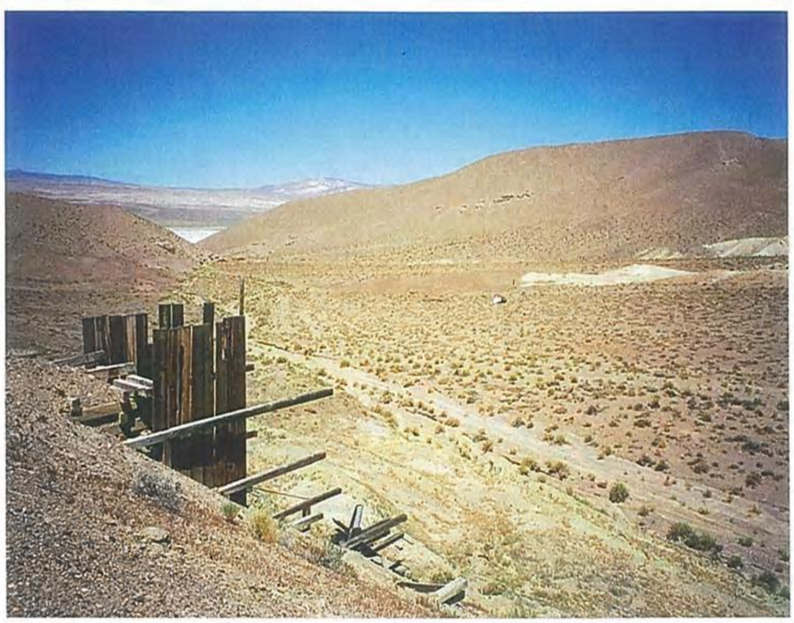
Site CrNV 61-11408, Photo 21, Feature 10, BLM Report 6-2701 (P).



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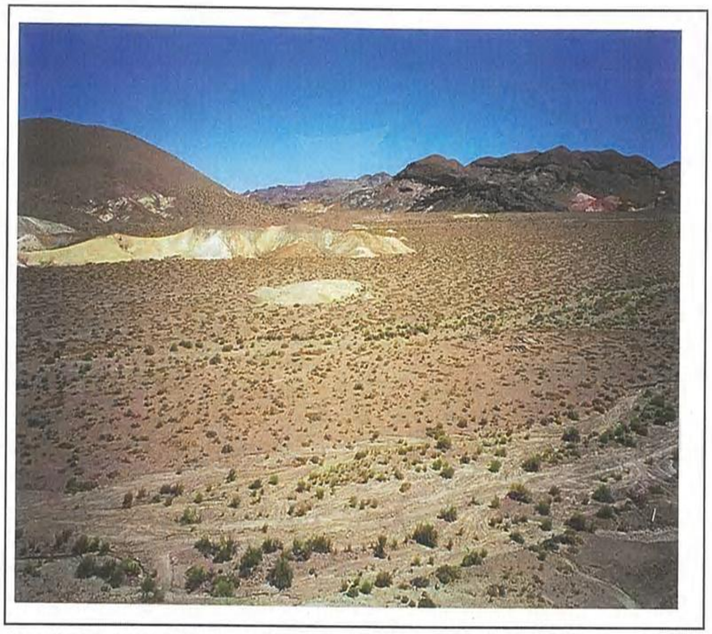

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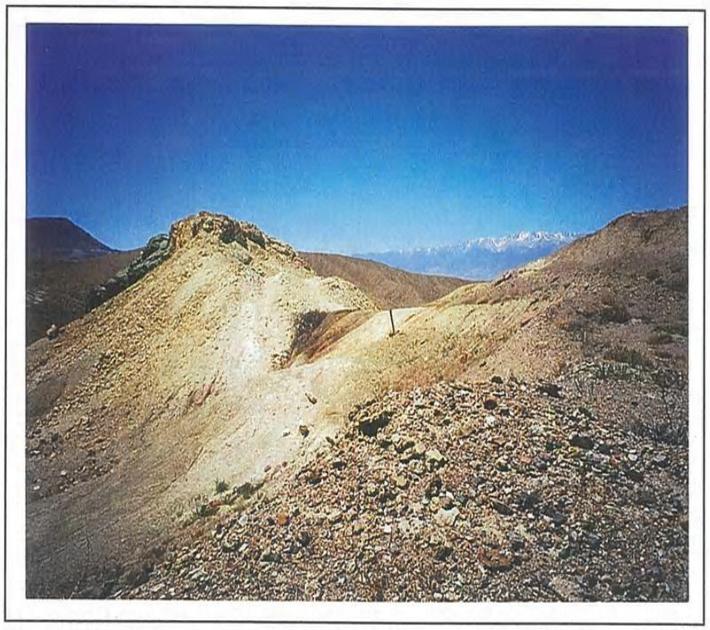

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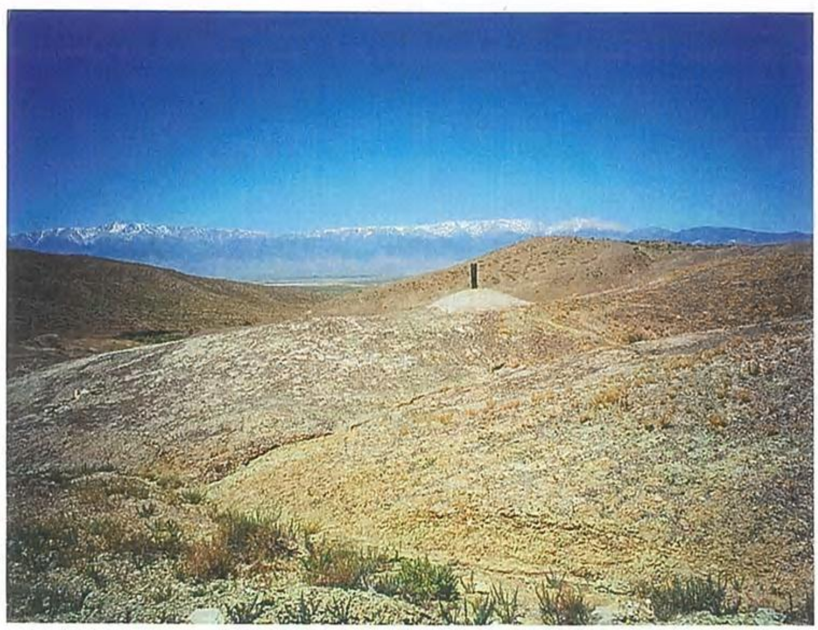

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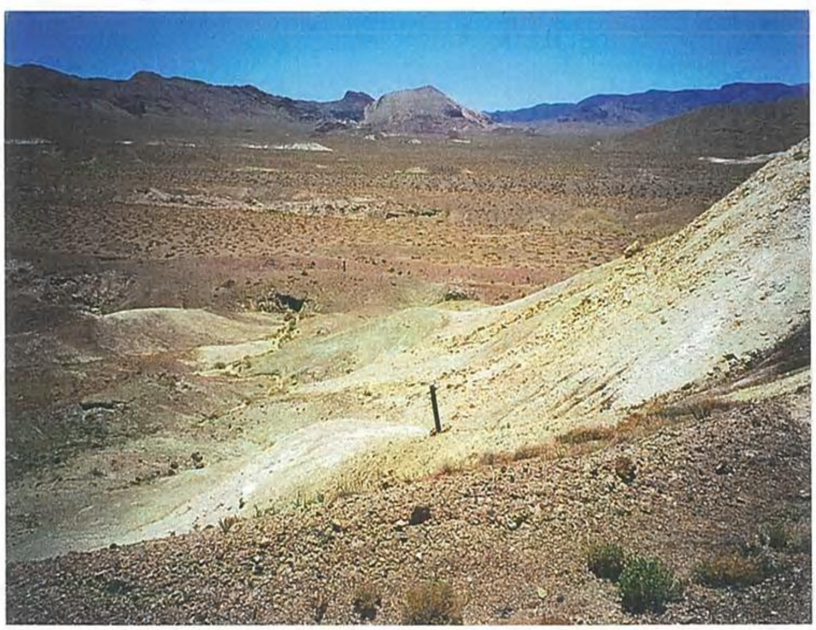

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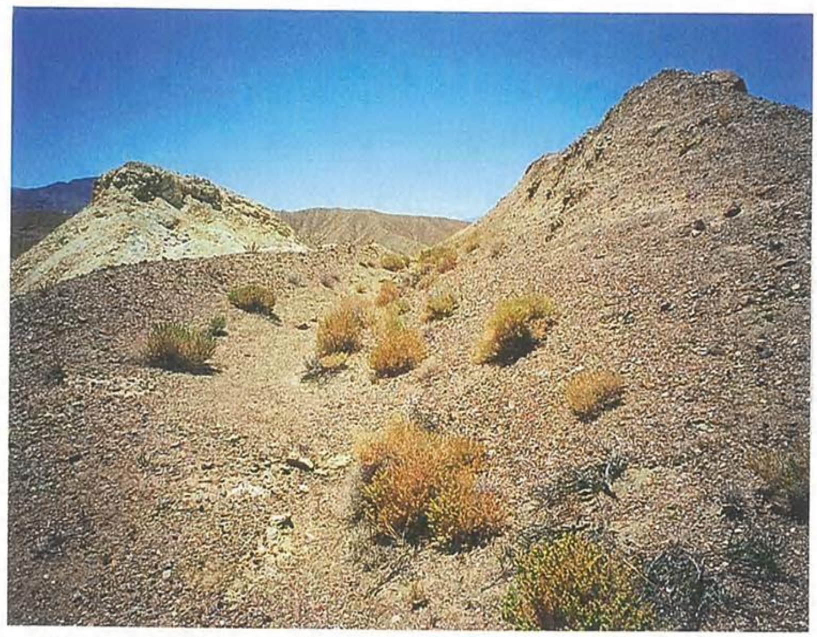

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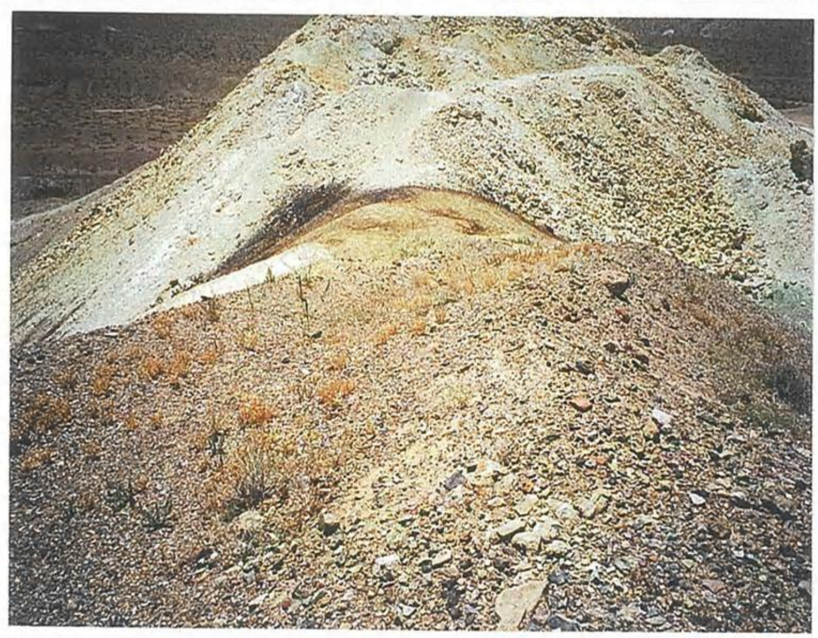

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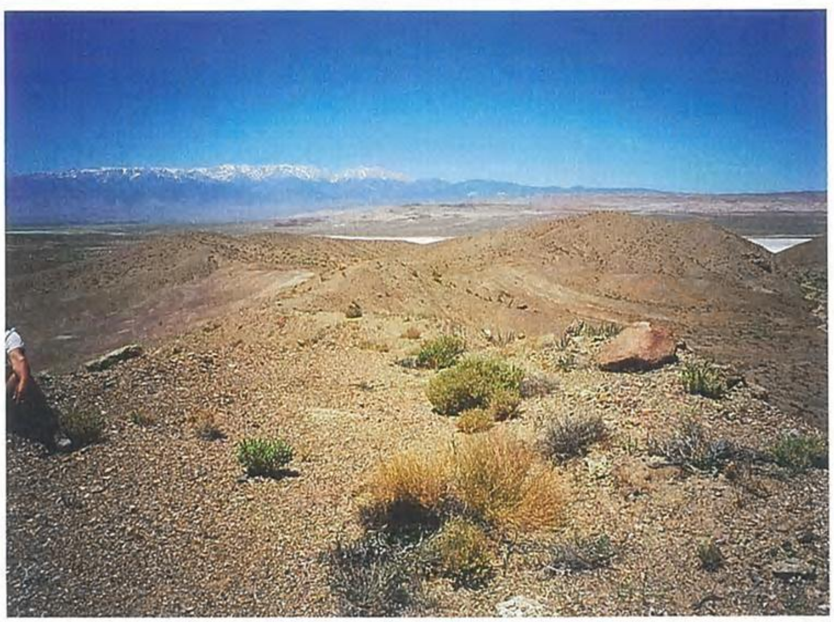

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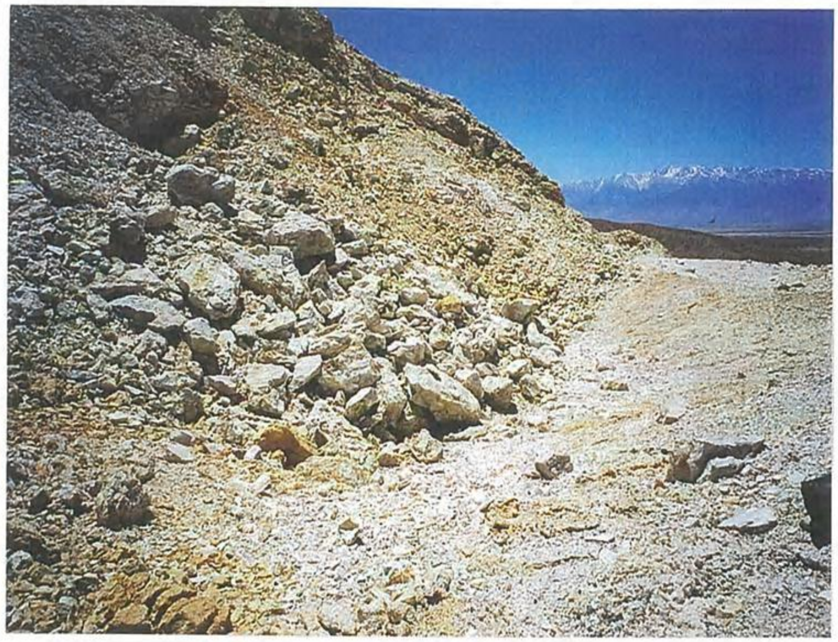

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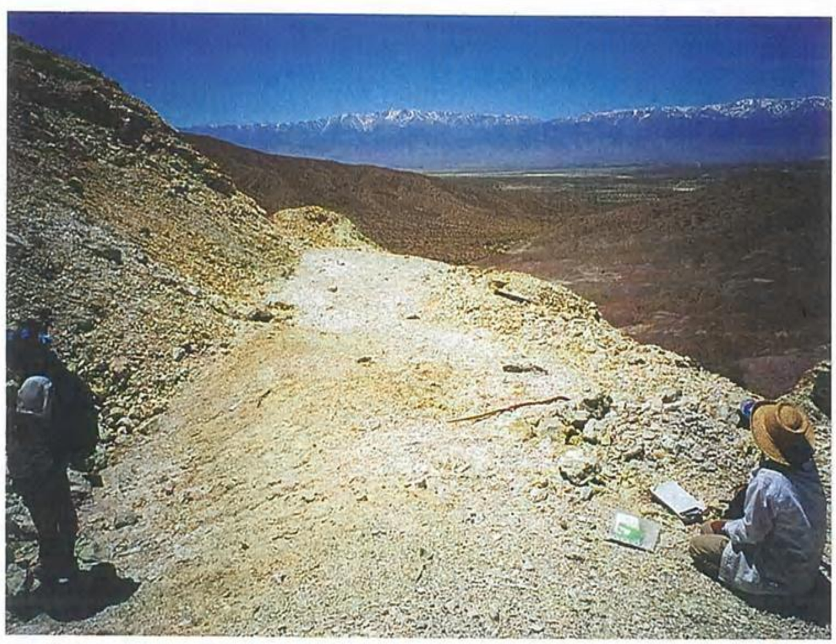

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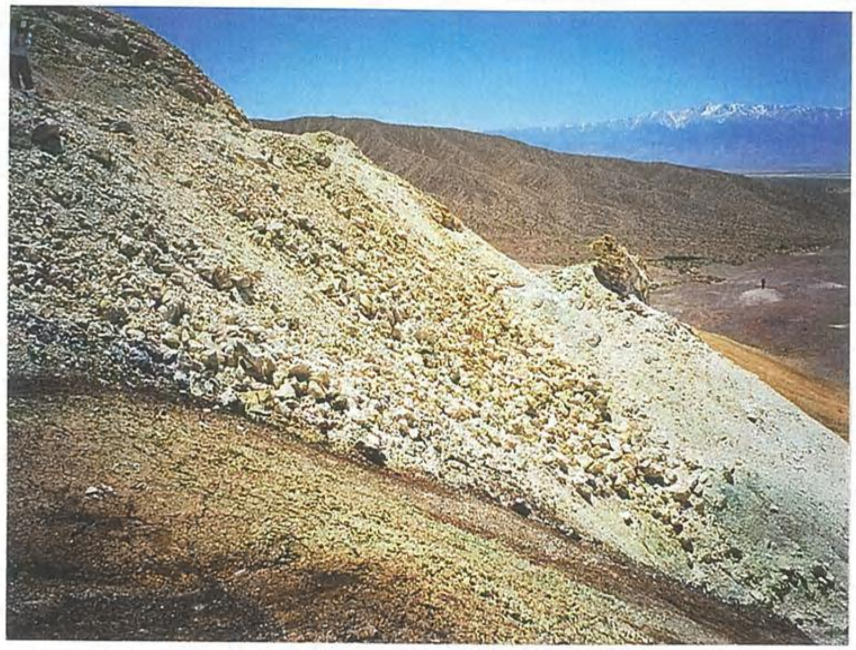

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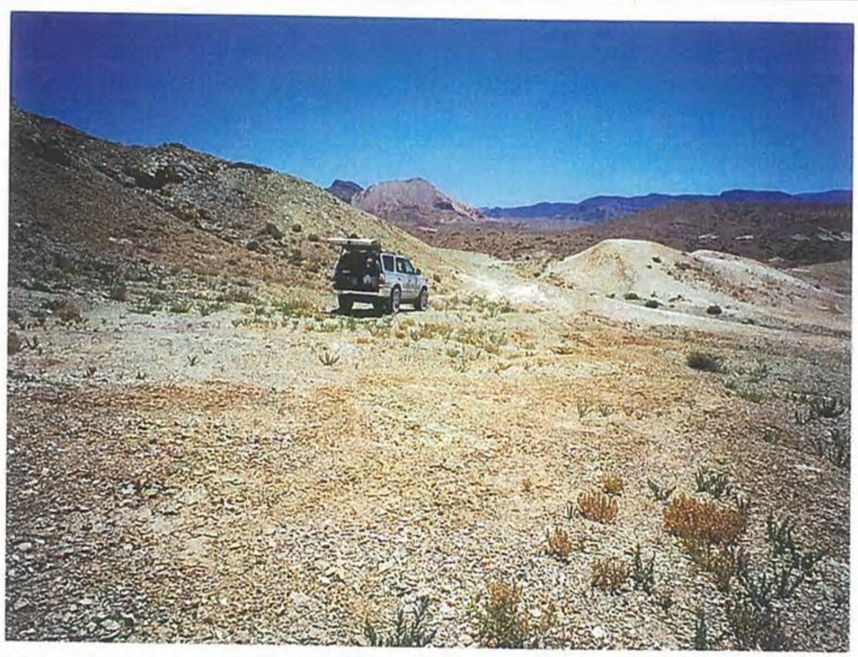

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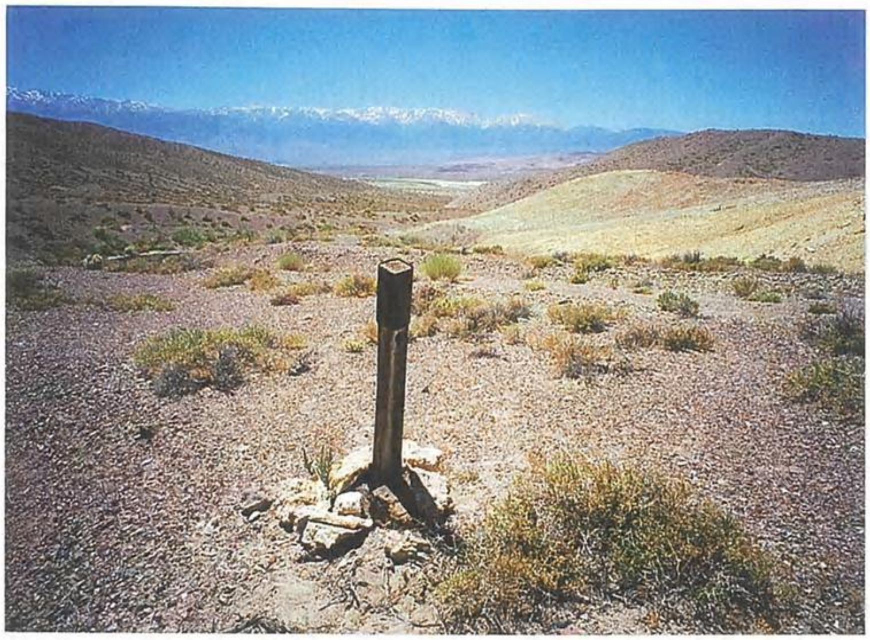

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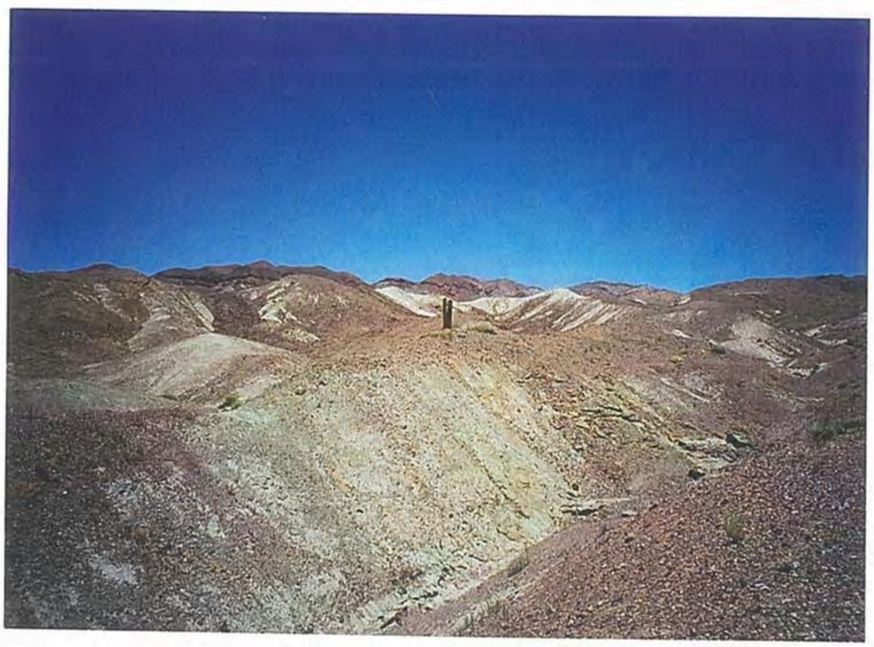

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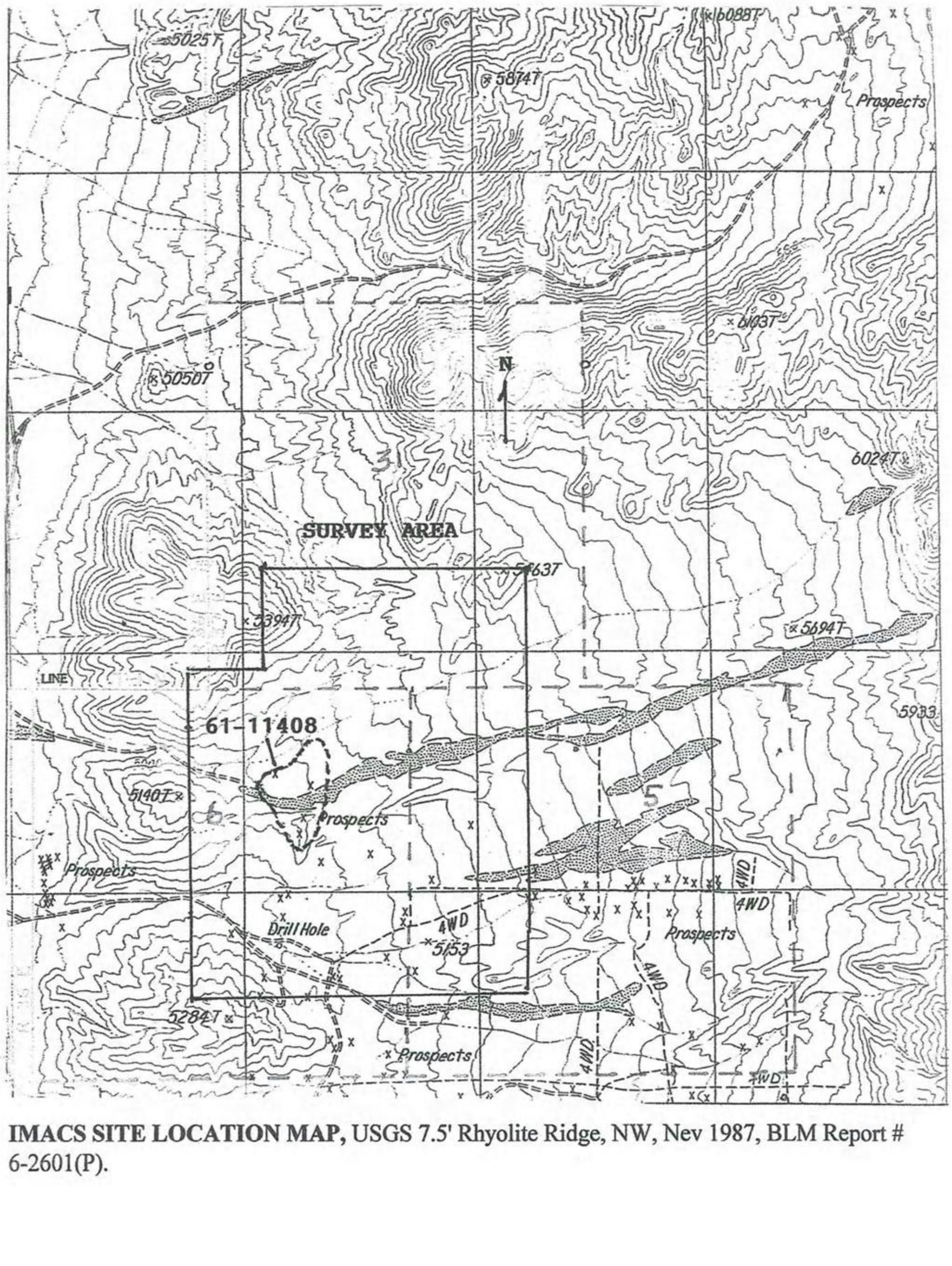

IMACS SITE LOCATION MAP, USGS 7.5' Rhyolite Ridge, NW, Nev 1987, BLM Report # 6-2601(P).

R.K. Vierra and Associates, Inc.

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A CULTURAL RESOURCES INVENTORY OF 640 ACRES PROPOSED GEOTHERMAL EXPLORATION PROJECT FOR THE FISH LAKE GREEN POWER COMPANY, ESMERALDA COUNTY, NEVADA

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And
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Submitted to
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Battle Mountain District
Tonopah Resource Area
1553 South Main Street
Tonopah, Nevada 89049-0911

BLM Cultural Resource Permit Number N-54136
BLM Report Number 6-2601(P)

REVISED FEBRUARY 2006

MANAGEMENT SUMMARY

Between June 29, 2005 and July 4, 2005, a crew from R. K. Vierra & Associates performed a Class III archaeological inventory of approximately 640 acres in Esmeralda County, Nevada, for Fish Lake Green Power Company.

A total of one site and 32 isolated historic artifacts were recorded during the inventory. The site consists of historic mining features. The isolated artifacts consist of 15 rock cairns (some with claim posts) 13 claim posts (with no cairn), two prospect pits, one bladed road segment, and one two-track road segment. Site CrNV-61-11408 is recommended as unevaluated for inclusion to the National Register of Historic Places (NRHP) pending further historical archival research. It is recommended that this site be avoided which will result in no adverse effect.

TABLE OF CONTENTS

MANAGEMENT SUMMARY ii

1.0 INTRODUCTION AND PROJECT AREA DESCRIPTION 1

2.0 ENVIRONMENTAL SETTING 5

3.0 CULTURAL RESOURCES SUMMARY 6
3.1 PREHISTORIC OVERVIEW 6
3.2 ETHNOGRAPHIC BACKGROUND 7
3.3 HISTORIC OVERVIEW OF THE REGION 8

4.0 LITERATURE REVIEW AND EXPECTATIONS 11
4.1 NATIONAL REGISTER REVIEW 13

5.0 FIELD METHODS 10

6.0 RESEARCH QUESTIONS 15
HISTORIC CONTEXT 15
REGISTRATION REQUIREMENTS FOR HISTORIC SITES 16
MINING RESEARCH DOMAIN QUESTIONS 16

7.0 INVENTORY RESULTS AND DISCUSSION 17
7.1 SITE CrNV 61-11408 17
7.2 ISOLATED ARTIFACTS 18
7.3 SUMMARY 22

8.0 SUMMARY AND AVOIDANCE RECOMMENDATIONS 24

9.0 LITERATURE CITED 25

LIST OF FIGURES

Figure 1: Project Location 2
Figure 2: Project Area and Site Location 3
Figure 3: Isolate Location Map 18

LIST OF TABLES

Table 1: Isolated Artifacts 16

APPENDICES

Appendix A: IMACS Form and Photos

1.0 INTRODUCTION AND PROJECT DESCRIPTION

Between June 29, 2005 and July 4, 2005, a crew from R. K. Vierra & Associates performed a Class III archaeological inventory of approximately 640 acres in Esmeralda County, Nevada, for Fish Lake Green Power Company at the request of John Deymonaz. R. K. Vierra served as Principal Investigator, Jana Trudell served as Field Supervisor. The field crew consisted of Lila Lindsay and Lee Duryee. The report was prepared by Bob Vierra and Jana Trudell. Site documentation and data compilation was completed by Jana Trudell. The site map was prepared by Lila Lindsay.

The project location is shown in Figure 1. The survey area is shown in Figure 2. The Isolated artifacts are described in Table 1 and an Isolate location map is shown in Figure 3. The block survey will allow Fish Lake Green Power Company to drill at specific locations and adjusted accordingly after preliminary results within the survey area.

This report discusses the location of the project area, provides background information on the environment and cultural resources reported close to the project area, reviews field methods, summarizes the survey results, and provides recommendations pertaining to cultural resources identified within the survey area. The Intermountain Antiquities Computer System (IMACS) forms and photographs are presented in Appendix A.

Legal Description For The Proposed Geothermal Exploration Survey Area:

Section 31:	NE Corner:	SW 1/4 SE 1/4 NE 1/4 T1N/R37E	
Section 31:	NW Corner:	SE 1/4 SW 1/4 NW 1/4 T1N/R37E	
Section 36:		SE 1/4 SE 1/4 SE 1/4 T1N/R36E	
Section 6:	SW Corner:	NE 1/4 SE 1/4 SW 1/4 T1S/R37E	Use SE corner of template.
Section 5:	SE Corner:	NW 1/4 SE 1/4 SW 1/4 T1S/R37E	" " " "

2.0 ENVIRONMENTAL SETTING

The survey area is located in Fish Lake Valley, Esmeralda County, Nevada, about 23 miles northeast of the community of Dyer on the lower west facing flank of the Silver Peak Range. As reported by Clay and Young (1994:5), "The valley is enclosed by mountains except at The Gap. The White Mountains on the west side of Fish Lake Valley form a bold range extending south-southeast from Boundary Peak near the Nevada-California border in the northwest part of the valley. At an altitude of 13,150 ft, Boundary Peak is the highest point in Nevada, and slightly south of Boundary is White Mountain Peak, the third highest peak in California at an elevation of 14,246 ft. North and east from Boundary Peak, the terrain declines rapidly into Fish Lake Valley. On the east side of the valley is the irregular crest of the Silver Peak Range, which does not exceed 10,000 ft; to the southeast are the Palmetto Mountains. An alluvial divide connects the Sylvania Mountains with the southeast extension of the White Mountains to close the valley at the south end. The area included within the drainage boundary of Fish Lake Valley is about 965 sq mi. Precipitation on the floor of the valley is generally less than 5 inches per year. Melted snow supplies, by far, a greater amount of water than rain (Eakin 1950:8-9; Rush and Katzer 1973:5,16)."

The proposed Geothermal Exploration is located within an alluvial drainage at the lower west facing flank of the Silver Peak Range. The elevation ranges in between 5140-5394 feet. No Pluvial Lakes have been identified in Fish Lake Valley (Mifflin and Wheat 1979). Also, no springs were noted within the project area.

Vegetation in the project area that was noted includes greasewood, rabbitbrush, shadscale, hopsage, russian thistle, swollen stalk buckwheat, ephedra, pencil choya, feathered finger grass, wild aster, prince's plume, halogeton glomeratus, globe mallow, astragalus, and other forbes and grasses.

Fauna directly observed during the study include black-tailed jackrabbit, wild horses, and numerous lizards. Indirect evidence of fauna observed include scats of coyote. A good synthesis of prehistoric Great Basin environments has been prepared by Mehringer (1986) and a review of historic environmental change has been summarized by Harper (1986).

3.0 CULTURAL RESOURCES SUMMARY

3.1 PREHISTORIC OVERVIEW OF THE REGION

Archaeological investigations in the Great Basin have been summarized elsewhere (Busby et al. 1979; Davis 1964; Elston 1982; McGonagle and Waski 1978; Pendleton et al. 1982; and Thomas 1982.) A brief chronological overview and regional synthesis is presented below:

Pre-Archaic (9000 B.C. - 6000 B. C.)

The Pre-Archaic period represents the earliest well documented evidence of man's presence in the Great Basin. Most Great Basin Pre-Archaic sites are surface lithic scatters located on pluvial lakeshore features and gravel bars or on ancient river terraces (only a few have buried components); there was apparently a heavy reliance on lacustrine resources. These sites lacked structural remains or other archaeological features. Lithic technology of this period is highly distinctive, reflecting an emphasis on the hunting of big game; it resembles that of the megafauna-hunting Paleo-Indians of the Great Plains much more that it does the later Archaic cultures of the Great Basin. Assemblages typically contain large stemmed, and concave base projectile points (Touhy and Layton 1977), large bifacial knives, crescents, gravers, punches, scraper/planes and choppers; seed processing implements (manos and metates) are very rare or absent.

Early Archaic (5000 B.C. - 1500 B. C.)

The origins of the Early Archaic in the Great Basin are obscure; sites are rare and generally poorly dated. Diagnostic artifacts include Pinto and Gypsum projectile points (both subsumed in the Gatecliff Series), atlatl dart points and Humboldt Series projectile points. Sites typically are located in valley bottoms near permanent water sources or, less frequently, near springs in upland settings. Although hunting is emphasized, there is an increased reliance on plant and seed food resources processed with manos and metates.

Middle Archaic (2000 B.C. - A.D. 500)

The transition between the Early Archaic and the Middle Archaic periods is gradual and not marked by large technological changes. The Middle Archaic is distinguished by major shifts in settlement and subsistence strategies and stylistic elaboration. Population density appears to have increased significantly and a much greater diversity of resources were exploited during this period. While there was a continued reliance on hunting, seed processing tools are much more abundant. Both winter residential sites and seasonal field camps in target resource areas were utilized and consistently re-occupied. Diagnostic projectile points of this period are Elko Series and Martis Series; medium to large-sized bifacial tools (knives) are common. Trade in exotic materials such as marine shell and obsidian becomes important.

Late Archaic (A.D. 500 to White Contact)

The Late Archaic is marked by shifts in technology and further changes in settlement/subsistence patterns. Plant food resources (especially pine nuts) were emphasized. Small game, such as rabbits, rodents, and birds, were hunted instead of big game; the atlatl (spear thrower) and dart were replaced by the bow and arrow. Diagnostics of this period are Rose Spring and Eastgate (Rosegate) points and Desert Series points (Desert Corner-notched, Cottonwood Triangular, and Cottonwood Leaf-shaped). After A.D. 1100, brownware pottery appears (Western Shoshone made pottery but is was rare with the Paiute). Plant and seed processing equipment became more elaborate and there was an increased emphasis on the production of simple, expedient flake tools. These technological changes accompanied the adoption of a subsistence strategy that entailed an increase in both the diversity of resources used and in the number of ecozones exploited. Sedentism increased as reflected by the construction of sequential houses and the occurrence of large village sites. Present understanding of the archaeological record in the transition from the Middle to the Late Archaic are those that eventually culminated in the patterns observed for the ethnographic Numic speakers (Western Area in the Handbook of North America Indians (D'Azevedo 1986:135-148)); a detailed prehistoric overview is presented by Jennings, Elston, Thomas, and others in the above cited reference.

3.2 ETHNOGRAPHIC BACKGROUND

As reported by Hause and Clay (1993:7-8) "At the time of Euro-American contact the native inhabitants of the valley were the Fish Lake Valley Paiute, a group of Numic speakers. Much of what is known about them was compiled by Steward in his classic study of Basin-Plateau groups (Steward 1938).

Much like their neighbors to the west, the Owens Valley Paiute, a varied, relatively rich resource patch allowed the Fish Lake Valley Paiute to develop a hunting and gathering subsistence practice, seasonally directed from a centrally-based semi-permanent site. These residential base camps were probably occupied most regularly in the winter, but Steward (1938:62) states they were more or less permanent, except during the summer and fall. In Fish Lake Valley, eight such sites were well situated near a variety of resources along the valley edge, especially the western (White Mountain) edge. These settlements were clusters of one to four families with a total valley population comprising approximately 100 individuals (1870 estimate) camped along streams or around springs. Economic pursuits emphasized gathering a number of greens, roots, seeds, berries, and nuts, especially pine nuts. Hunting was of secondary importance.

Bettinger (1991:484) contends that aboriginal occupation of the higher elevations of the White Mountains was a "pressure gauge" for the burgeoning population of adjacent Owens Valley. This pattern started about 4500 B.P. and continuing until contact with Europeans in the 1850s. At that time, population reduction by disease and the disruption of the aboriginal economy occurred. By 1870 the aboriginal population density in Owens Valley was about 0.5 persons per square mile (Steward 1938:48). Liljeblad and Fowler (1986:415) calculate that the precontact population density was close to 1.0 person per square mile. Hence, European contact caused a population reduction of about 50 percent by some means.

Fish Lake Valley is much less fertile than Owens Valley (Steward 1938:61) and had an 1870 population density of 0.1 persons per square mile, one-fifth that of Owens Valley (Steward 1938:48). It is likely that the natural environment of Fish Lake Valley limited the population to a greater extent than the effects of European contact, and that decimation due to disease and conflict was less of an influence than in Owens Valley. This assumes that the frequency of aboriginal/European and aboriginal/aboriginal contact was less, diminishing the communication of disease and the likelihood for conflict. If so, precontact population in the valley may have been close to the 100 population figure related by Steward (1938:62).

Steward reports greater mobility and less permanent village associations among the Fish Lake Valley group than among their Owens Valley neighbors; moreover, they did not share the same distinct territorial ownership whereby bands owned seed areas, pine nut territories and irrigated plots of land. Additionally, the Fish Lake Valley groups had no band names or communal sweat house. These groups did gather to conduct drives for antelope, deer and rabbit, and held dances, especially in the fall. In contrast, mourning observances were held strictly on the village level (Steward 1938:62)."

3.3 HISTORIC OVERVIEW OF THE REGION

This overview is a brief description of the historic themes pertinent to Fish Lake Valley, namely, Exploration, Mining, and Ranching.

Exploration Theme:

As reported by Palmer in Hause and Clay (1993:A2) "The first white people to enter Fish Lake Valley and the project areas were surveyors on their way to Death Valley in the fall of 1853 looking for a railroad route across the continent (Lingenfelter 1986:80-81). These men were transients who left no permanent settlements (Mordy and McCaughey 1968:78). The party of seventeen explorers was led by "Major" John Ebbetts who had come to California originally in 1849 as leader of the Knickerbocker Exploring Company. Ebbetts Pass in the Sierra Nevada is named for him. Funded by a group of San Franciscans, the Ebbetts railroad route expedition was fitted out in little over a month, and they set out from Stockton, California on October 7. They headed for the Vegas de Santa Clara on the Old Spanish Trail at Meadow Valley Creek, but took a wandering course and never reached their goal (Lingenfelter 1986:80-81).

Crossing the Sierra Nevada over the Sonora Trail, they turned north along the Walker River to Walker Lake before heading southeast toward their intended destination. The quest for water, however, brought them much farther south to the base of the White Mountains in Fish Lake Valley. From there they continued down into the basin of Eureka Valley, just missing numerous springs in the Sylvania Mountains. On November 7, 1853, after two waterless days, they crossed eastward in desperation over the Last Chance Range and into Death Valley where they found water at Last Chance Spring (Lingenfelter 1986:80-81)."

Mining Theme:

The history of mining in the vicinity of the project area is very extensive as reported by Palmer in 1993. For the purposes of this report, a brief discussion of mining only for Fish Lake Valley is provided here. The following excerpts are taken directly from Palmer (1993).

"South of the project area, the Dyer Mining District was first prospected for silver and lead in 1863 and 1864. It was located east-northeast of Dyer's Ranch in the foothills of the west flank of the Silver Peak Range. The community of Dyer which subsequently grew up around Dyer's Ranch, as well as the mining district, was named for a pioneer of Esmeralda County, Alex P. Dyer, the community's first postmaster (Carlson 1974:102; Leigh 1964:83).

The Fish Lake Valley Mining District, also known as the White Mountain District, came into existence to the northwest of the project area in 1916 to develop some mercury (also known as quicksilver or cinnabar) mines (Bailey and Phoenix 1944:66; Albers and Stewart 1972:66). Workings began during World War I and peaked in 1927 with only small scale operations conducted after 1932."

Ranching Theme:

The following is taken directly from Palmer (1993). "The first ranch in First lake Valley was established by Chester and Ira Hale in 1860. Their homestead later became known as the Lower McNett Ranch. The McNetts freighted hay and produce to Candelaria, Blair, Silver Peak and the borax works.

The McAfee Ranch was first established by Samuel, Daniel and Dudley McAfee, Scottish immigrants, who later bequeathed it to Angus and Sara McAfee.. Angus raised alfalfa, timothy, wheat, barley and corn instead of the wild hay that his neighbors sold. In 1940, E.L. Cord, developer of the Cord automobile, purchased this ranch and renamed it to the Circle L (Hanson and Hanson 1972:13,26).

Francis Marion "Borax" Smith, who cornered the international borax market for a period of time, also established a ranch in Fish Lake Valley. In 1878, this operation was managed by Frank and Camilla Stewart (Hanson and Hanson 1972:27).

John Chiatovich, another Fish Lake Valley rancher, heard rumors of wealth to be made in the salt marshes to the south and traveled to the Fish Lake Valley area. He established his ranch on what became known as Chiatovich Creek in 1865 (Hanson and Hanson 1972:29; Zeier 1992:9). The

Chiatoviches also constructed a sawmill in the White Mountains above Indian Creek. The mill produced lumber of a rough grade suitable for corrals and barns in Fish Lake Valley. The Chiatovich ranch later become known as Arlemont and was the site of a post office in 1910 (Hanson and Hanson 1972:29,31).

Another ranch previously mentioned was established at the site of a natural spring on the eastern side of the valley by Alex P. "Papa" Dyer (Hanson and Hanson 1972:11). This ranch was located in Sec. 18, T.2S, R.36E, and the modern community of Dyer is to the west of the ranch site. He married a Fish Lake Valley Paiute woman who subsequently abandoned him (Hanson and Hanson 1972:11). By 1908, the community of Dyer claimed a population of sixty with nine residents listed as farmers and livestock producers. A semi-weekly stagecoach made the trip to Coaldale for $5.00 (Polk 1908:338).

A school was established in Fish Lake Valley for the ranchers' children, but like the post office, it migrated. First established at the Chiatovich Ranch, it later moved to the McNett Ranch until a school building was constructed between the two ranches. This building was subsequently moved to the Dyer Ranch and then the Smith Ranch (Hanson and Hanson 1972:20). Today, the Dyer School building is along State Route 264 in Sec. 4 T.3S, R.33E, outside of the project area."

4.0 LITERATURE REVIEW AND EXPECTATIONS

A total of 14 cultural resource surveys were conducted within a mile radius of the current project area in Fish Lake Valley between 1975-2001. These are briefly described below.

CRR 5-133(N) 1975, H.A. Wirtz surveyed a number of proposed wells for Magma Power Company covering an area of about 1200 acres. No cultural resources were noted.

CRR 5-997(P) 1982, Alvin McLane of the Desert Research Institute conducted a survey of six geothermal test wells for GeothermEx covering an area of about 10 acres. Four sites were found: CrNV 05-4236 is a multi-component site consisting of a small lithic scatter and fragments of purple, green, brown, and aqua glass. The site was not evaluated for the NRHP. CrNV 05-4237 was noted as a chert flake and biface. CrNV 05-4238 is an isolated white chert flake. CrNV 05-4239 is a chert uniface and two chert flakes.

CRR 6-581(P) 1984, J. Jackson (DRI) surveyed three proposed geothermal test wells for AMAX Exploration covering an area of about 9 acres. Two sites were found: CrNV 64-3486 is an isolated Elko Corner-notched point base and CrNV 64-3487 is an isolated obsidian Gypsum point base.

CRR 6-593(N) 1984, D. Eddy (Tonopah BLM Geologist) surveyed about 1.4 acres for the Bob Jamison Gravel sale for a geothermal well pad. No sites were found.

CRR 6-652(N) 1985, Kurt Wallof of Archaeological Research Services (ARS) conducted a survey of five drill pads covering an area of about 38 acres for the Steam Reserve Corporation. No sites were found.

CRR 6-1004(N) 1986, Vickie Clay (ARS) surveyed two drill pad sites covering 4.5 acres for the Steam Reserve Corporation. No sites were found.

CRR 6-1288(N) 1990, M. Waski and D. Ross (Tonopah BLM Archaeologists) surveyed 10 acres for an Esmeralda County R&PP lease on a hot water artesian well. No sites were found.

CRR 6-1438(P) 1992, J. Carter and R. Werner (Archaeological Services, Inc.) carried out a survey of a proposed 26-mile long Fish Lake Valley to Silver Peak geothermal power transmission line for Geo-Energy Partners. Twenty-one previously unrecorded sites, two previously recorded sites, and 30 isolated artifacts were found. Those sites located within a mile radius of the current project area are described below. CrNV 64-6235 consists of 33 discreet flake concentrations and 13 cores. The site was regarded as a quarry and considered eligible for the NRHP. CrNV 64-6236 is a dense lithic scatter with 500+ flakes, three concentrations, one Desert Side-notched point and one metate fragment. Buried deposits are likely and the site is deemed eligible for the NRHP. CrNV 64-6237 is a lithic scatter with 150+ primary flakes considered to be a chipping station/workshop. The site is eligible for the NRHP. CrNV 64-6238 is a small diffuse lithic scatter with two biface fragments. The site is not eligible for the NRHP. CrNV 64-6239 is a diffuse lithic scatter with 100+ flakes, one Rosegate point, and one biface. The presence of rhyolite flakes and rhyolite raw material suggest a chipping station/workshop or small quarry. The site is deemed eligible for the NRHP. CrNV 64-6240 is a lithic scatter with four flake concentrations and one Rosegate point. Buried deposits are possible and the site is eligible for the NRHP. CrNV 64-6241 is a lithic scatter with 800+ biface reduction flakes and possible buried deposits. The site is deemed eligible for the NRHP. CrNV 64-6242 is a diffuse lithic scatter with 150+ flakes, one biface fragment, and one core. The site is not eligible for the NRHP. CrNV 64-6243 is a diffuse lithic scatter with 35+ flakes and one core. The site is not eligible for the NRHP. CrNV 64-6244 is a diffuse lithic scatter with 1000+ flakes, one Rosegate point, and three cores. The site is deemed eligible for the NRHP. All of the above sites deemed eligible for the NRHP were concurred by the BLM and the SHPO.

CRR 6-1451(P) 1992, Pat Hicks and G. Pine (BLM Archaeologists) conducted a survey of six geothermal well pads covering about 20 acres for Magma Power. Eight sites were located several miles north of the current project area; none in the vicinity of this project.

CRR 6-1478(P) 1993, Vickie Clay (ARS) conducted a survey of a proposed plant site and access road for Fish Lake Valley Power. Only three Isolates were found; an obsidian point fragment, an obsidian core, and an obsidian biface fragment. No sites were found.

CRR 6-1482(P) 1993, L. Hause and V. Clay (ARS) conducted a survey of 10 geothermal drill sites and access roads covering about 75 acres for Magma Power Company. Two sites and two Isolates were found. CrNV 64-7355 is a sparse lithic scatter with seven lithic reduction loci, cores, one biface, one perforator, and one metate. Also present are fire-cracked rock partially buried, and a possible hearth feature. The site is deemed eligible for the NRHP. CrNV 64-7356 is a lithic scatter with two lithic concentrations, four bifaces, one core, and one modified flake. Lacking definite boundaries, the site remains unevaluated. The two Isolates consist of a flake and a bottle.

CRR 6-1483(P) 1993, R. Reno, V. Clay, and L. Hause (ARS) surveyed 9.2 miles of pipeline and access roads covering an area of 119 acres for Magma Power Company. Two sites and two Isolates were found. CrNV 64-7359 is a small core reduction site with one core and two primary flakes. The site is not eligible for the NRHP. CrNV 64-7360 is a habitation site with possible buried deposits. Spatial patterning consists of five separate loci: Locus 1 with two hearths, Locus 2 has a possible hearth, a metate, and a biface, Locus 3 is a possible hearth, Locus 4 is a possible hearth with flakes, and Locus 5 consists of two possible hearths eroding out of a small dune. The site is deemed eligible for the NRHP. The two Isolates are one flake and one core.

CRR 6-1485(P) 1994, Vickie Clay and B. Young (ARS) conducted a survey of four proposed transmission corridors and two proposed power plant locations for Magma Power Company. A total of 31 sites were recorded during the survey; however, none of these sites were located within a mile radius of the current project area.

CRR 6-2223(N) 2001, R. K. Vierra and Assoc., Inc conducted a survey of 14 proposed geothermal well pads covering an area 3.21 acres for the Fish Lake Green Power Company. No sites were found.

CRR 6-2236(P) 2002, R. K. Vierra and Assoc., Inc conducted a survey of 8 mile proposed powerline for the Fish Lake Green Power Company. Five sites and five isolates were found. CrNV 64-10804 is a diffuse lithic scatter consisting of one metate and about 300+ flakes. The site is not eligible for the NRHP. CrNV 64-10805 is a small lithic scatter consisting of eight flakes. The site is not eligible for the NRHP. CrNV 64-10806 is a small lithic scatter consisting of a Stage III biface and about 100+ flakes. The site is not eligible for the NRHP. CrNV 64-10807 is a small lithic scatter consisting of one metate and four flakes. The site is not eligible for the NRHP. CrNV 64-10808 is a secondary deposit of historic trash consisting of mostly a glass debris concentration. The site dates between 1900-1954. The site is not eligible for the NRHP. The five isolates consists of a chert secondary flake, three prospect pits, and done claim post.

Expectations: Based on the literature review discussed above, the following kinds of sites are expected to be found within the project area. Prehistoric sites should consist of mostly small to moderate lithic scatters and Isolates. In areas where toolstone is available, lithic reduction sites such as chipping stations and workshops may be encountered. Habitation sites with fire-cracked rock concentrations, buried deposits, and hearth features are unlikely to be found. These kinds of sites were reported south of the proposed geothermal exploration, closer to the playa edge in sand dune deposits. Historic sites that can be expected include prospect pits, and trash scatters associated with mining in the area. Since most of the current project area is located along the valley floor, historic sites will most likely relate to borax mining activities or possibly ranching. Sites associated with mining activities for quicksilver and other precious minerals at the higher elevations are unlikely to be encountered.

4.1 NATIONAL REGISTER REVIEW

The Goldfield Historic District is the closest NRHP listed property in Esmeralda County. Several sites within the vicinity of the project have been determined to be eligible for the NRHP these are CrNV 6235, 6236, 6237, 6239, 6240, 6241, and 6244 as described above.

5.0 FIELD METHODS

The field methods were designed toward the identification, recordation, and evaluation of all cultural resources located within the surveyed area. Data were collected so as to make these goals possible and to provide information which could be applied toward research topics pertinent to the region and the immediate area. Particular attention was given to eligibility potential for the NRHP. In addition, eligibility determinations are made in a regional context addressing significant research questions. Significant research questions addressed have been outlined in An Archaeological Element for the Nevada Historic Preservation Plan (Lyneis 1982), and the Nevada Comprehensive Preservation Plan (Bernstein and James 1991).

On June 29, 2005, a project authorization was filed with the Tonopah Resource Area of the BLM. A literature review of the previous archaeological surveys conducted within the vicinity of the study area was carried out at that time.

The survey of the 640 acres of proposed geothermal exploration was performed by Robert K. Vierra (PI), Jana Trudell (FS), Lila Lindsay, and Lee Duryee. John Deymonaz of Fish Lake Green Power Company met us in the field on June 29, 2005, to show us the location of the project area. The survey started at the southeastern end of the project area. Each person walked a 30 meter transect interval to ensure full coverage of the survey area. When cultural materials were encountered, the surrounding area was intensively examined for associated materials. When a site was identified, it was plotted on a USGS 7.5' topographic map using a Garmin 60CS GPS unit with accuracy no less than four meters. NAD 27 was used as the coordinate system.

The first step in recordation was to determine the extent and nature of the site. Cultural materials were pin flagged so that the boundaries could be determined and concentrations or internal features could be identified. The site was mapped, using compass and pace, and artifacts were identified and recorded. The data were recorded on IMACS recording forms to Battle Mountain District/Tonopah Resource Area standards. Any evidence of potential buried deposits was noted. Site overview photographs were taken for all sites to aid in the futures relocation of the site.

In the case of isolated artifacts, they were recorded, described, and plotted on a USGS 7'5 topographic map.

6.0 RESEARCH QUESTIONS

HISTORIC CONTEXT:

The historic context presented below is relevant to only the historic site found within the project area. Only one major theme, Mining, is relevant to the project area under the research domain of Industry and Commerce as described in the Nevada Comprehensive Preservation Plan (Bernstein and James 1991). Specifically, since the project area is mostly confined to the lower flank of the Silver Peak Range, the history of hard rock mining in the Silver Peak mining district is most relevant here.

SILVER PEAK MINING DISTRICT:

As reported by Albers and Stewart "The Silver Peak district has also been called the Red Mountain district and the Mineral Ridge district. Preferably the district should be divided into a Red Mountain district and a Mineral Ridge district as the geology and mineral deposits in two parts are markedly different. The deposits in the Mineral Ridge part are gold-bearing quartz veins, whereas the deposits in the Red Mountain part are silver-bearing veins. Total recorded production of the Silver Peak district is $16,312,849, making it second to Goldfield in total dollar value." (1972:71).

According to Lincoln "The Red Mountain section was discovered in 1863 and a 3-stamp mill was erected there in 1864." (1982:81). The Mineral Ridge district was discovered in 1864, and a 10-stamp mill was erected in 1865. These two mills were acquired in 1867 by the Great Salt Basin M. & M. Company when a 30-stamp mill was constructed and operated for two years. Subsequent to the 1870s, little mining was conducted in the district. In 1906, the Pittsburgh Silver Peak Gold M. Company acquired several mines and erected a 100-stamp mill in 1907. This was the largest stamp mill in Nevada and was the largest producer of low-grade ores in the state.

The Mineral Ridge district was worked in the 1860s and 1870s but most of the activity was conducted between 1933-1942. Mines in the Red Mountain district are located approximately 6-10 miles southeast of the current survey area. Mineral deposits in this district trend toward the northwest toward the survey area. These include numerous prospect areas. As shown in Albers and Stewart (1972, Plate 2), mines that are closest to the survey area include Black Rock (61), Silver Queen (62), Gold No. 1 (63), Sanger (64) dating to the 1920s, Mohawk (65) dating to the 1920s, Sixteen-to-One (66) dating to the 1920s, and the Nivlock dating to 1907, and between 1937-1943.

In 1919, 5 shipper claims were submitted to an assay office in the Tonopah Mining Company from Mineral Ridge deposits. The samples submitted indicate that the mining prospects may have ore deposits that have value. While not being able to tie these mines directly to the one found within the survey area, artifacts noted within site CrNV 61-11408 fall within the range of dates of operations for the mines in the Red Mountain district.

REGISTRATION REQUIREMENTS FOR HISTORIC SITES

CRITERION A: The site is associated with an important series of events that have made a significant contribution to the broad patterns of our history.

CRITERION B: The site is associated with the lives of persons significant in the history of Nevada.

CRITERION C: The site has distinctive characteristics of a type, period, or method of construction.

CRITERION D: The site can provide important information about the history of the area as outlined in the research questions described below for the following relevant research domain.

MINING RESEARCH DOMAIN

Research questions pertaining to mining in Nevada were derived from An Archaeological Element for the Nevada Historic Preservation Plan (Lyneis 1982) and the Nevada Comprehensive Preservation Plan (Bernstein and James 1991). Under criterion (d), the following research questions were proposed:

QUESTIONS

Research Question 1: Is the property associated with a specific event important to the history of mining in Nevada or the history of mining in general?

Research Question 2: Does the resource have significant interpretive value or potential because of a variety of surviving elements?

Research Question 3: Does the property contain several elements which are illustrative of a specific type of operation or function performed by miners in Nevada?

Research Question 4: Does the site have the potential to provide information about changes in the technology of mining and industrial activities in the area through time?

7.0 INVENTORY RESULTS AND DISCUSSION

The Cultural Resource Inventory of 640 acres of proposed geothermal exploration on land administered by the Tonopah Resource Area of the Battle Mountain District of the BLM resulted in the identification and recordation of one cultural resource. The results include one historic site, and 32 Isolated artifacts. A table listing the Isolated artifacts including the agency number, a description of the artifact, legal description and UTMs is presented in Table 1. Isolate location maps are shown in Figure 3. A brief summary of the archaeological site is presented below. A more detailed description is presented in the IMACS site record.

7.1 SITE CrNV 61-11408

The site is located on a highly erosional alluvial drainage on the western side of the lower flank of the Silver Peak Range. The site is a mining/mineral exploration complex measuring 440 m north-south x 260 m east-west. Vegetation within the site area is a shadscale community with lesser amounts of greasewood, cacti and other forbes and grasses The deposition consists of a sandy silt alluvium intermixed with gravels and pebbles. The site has 31 mining features which include one ore chute, one open cut mine pit, five loading/staging platforms, six road cuts, four prospect pits, one collapsed structure, one structural debris scatter, one modified water tank, one dugout, five wooden claim posts, three rock cairns with claim post, one possible tent platform, and two wooden slat alignments. This site is related to hard rock mining. After examination of the open cut pit, it has evidence of sulfur layering the waste rock and sulfur emits from the outcrop. Sulphide deposits are known to be associated with gold and silver ores. The open cut pit is small and possibly the mining was short term. After encountering the sulfur deposit the miners may have ceased operation of the exploration. The site contains a variety of debris which include diagnostic can technology (1903-1922), milled lumber, galvanized sheet metal, nails, hardware, glass fragments (1917), ceramics (1890, 1913), and domestic items. The site is recommend as unevaluated for the NRHP pending further archival research.

Site CrNV 61-11408 is a historic mineral extraction site containing 31 mining features. The site is not associated with an important series of events that have made a significant contribution to the broad patterns of our history, hence, the site is not eligible for the NRHP under criterion (a). There is no evidence that the site is associated with the lives of persons significant in the history of Nevada, hence, the site is not eligible for the NRHP under criterion (b). The site shown no distinctive characteristics of a type, period, or method of construction, hence, the site is not eligible for the NRHP under criterion (c). The mining complex appears as it was during the time the area was in operation for mineral exploration. The transportation and movement of materials from the open cut mine to the ore chute are clearly visible and remain intact where they were originally constructed. This particular mining area may have been short term. The open cut pit has evidence of sulfur layering the waste rock and sulfur emits from the outcrop. After encountering the sulfur deposit the miners may have ceased operation of the mineral extraction. The collapsed structure and variety of associated historic debris including the can technology ranges in dates from 1903-1922. The mining features have not been altered by newer or additional reconstruction. Thus, all of this combined contains data pertinent to the archaeological record. However in terms of the research questions proposed above, a more detailed archival research and a relevant historic context must be conducted to evaluate the site for the NRHP. The integrity of setting, location, design, materials, workmanship, feeling, and association have not been compromised. The site is recommend as unevaluated for the NRHP pending further research.

7.2 ISOLATED ARTIFACTS

A total of 32 historic isolates were recorded. The UTM's and legals are presented below in Table 1. Isolate location maps are shown in Figure 3. A brief description of the isolates is discussed below.

61-11409A: Prospect trench measuring 49' x 19' x 4' deep, with an associated push pile at the west end of the trench that measures 72' x 19' x 6' tall.

61-11409B: Rock cairn consisting of seven boulders stacked one course high measuring 3' x 1', with a fallen 4" x 4" claim post.

61-11409C: Circular prospect pit 19' diameter and 6' deep, with a 3' berm encircling the pit.

61-11409D: Rock cairn consisting of 18 boulders stacked one course high measuring 3' x 1', with a 4" x 4" claim post.

61-11409E: Rock cairn consisting of 14 boulders stacked two courses high measuring 1' x 1', without a claim post.

61-11409F: Claim post made from a split rail road tie measuring 6' long, with a 6" x 6" post. The post is not upright, however the placement hole is still visible.

61-11409G: Claim post 4" x 4" x 3' long, it is fallen but two large boulders remain at it's original placement.

61-11409H: Claim post 4" x 4", which stands 3' above the ground. The upper portion of the post is wrapped with 10" wide cut, rusted sheet metal.

61-11409I: Rock cairn consisting of seven boulders stacked one course high measuring 3' x 3', with a 4" x 4" fallen claim post in two pieces and approximately 3' in length. The cairn is infested with a pack rat midden.

61-11409J: Rock cairn consisting of 17 boulders stacked one course high measuring 3' in diameter, with a 4" x 4" x 3' tall claim post. The upper portion of the post is wrapped with 10" wide cut, rusted sheet metal.

61-11409K: Bladed road approximately 13' wide, trending east/west, with a slight berm (~ 6") on either side.

61-11409L: Claim post 4" x 4" x 2.5' long and is sharpened at the end. The upper portion of the post is wrapped with 10" wide cut, rusted sheet metal. The claim post is fallen and has no associated boulders.

61-11409M: Rock cairn consisting of seven boulders intermixed with small cobbles stacked one course high measuring 3' in diameter, with a 2" x 4" claim post that has a large wire nail at the top.

61-11409N: Claim post 4" x 4" x 3' high, with 12 small dispersed cobbles.

61-11409O: Claim post 4" x 4" x 3' high, with 10 small dispersed cobbles.

61-11409P: Circular rock cairn with three boulders, one course high. Fallen claim post measuring 4" x 6" x 5' long.

61-11409Q: Rock cairn consisting of 24 boulders stacked one course high measuring 3' x 1', with a 4" x 4" x 3' fallen claim post. The upper portion of the post is wrapped with 10" wide cut, rusted sheet metal attached with wire nails.

61-11409R: Fallen claim post measuring 2' long consisting of two 2" x 4" nailed together, with a sharpened ends.

61-11409S: Rock cairn consisting of nine boulders stacked two courses high measuring 1' x 1', with no claim post. Approximately nine feet southwest of the cairn is a 1" x 12" plank cut 1.5' long, a painted sheet metal sign attached with wire nails, reads " Big Hill // W. . . T"

61-11409T: Rock cairn consisting of six boulders stacked one course high measuring 1' x 1', with a 4" x 4" x 3' claim post. The upper portion of the post is wrapped with 10" wide cut, rusted sheet metal.

61-11409U: Two-track road measuring 9' wide, that trends northeast-southwest for approximately 656' and then washes out in alluvial drainage.

61-11409V: Fallen 4" x 4" x 5' long claim post with a rusted rectangular Band-Aid tin with a hinge lid, attached to the top with a wire nail.

61-11409W: Rock cairn consisting of five boulders stacked one course high measuring 1' x 1', with a 4" x 4" x 4' long fallen claim post.

61-11409X: Claim post 6" x 8" x 5' tall, located on the edge of a finger ridge on the northwest side of the project area.

61-11409Y: Rock cairn consisting of seven boulders stacked one course high measuring 1' x 3' with a 4" x 4" x 2' long fallen claim post.

61-11409Z: Rock cairn consisting of five boulders stacked one course high measuring 1' x 1' with a 4" x 4" x 4' long fallen claim post.

61-11409AA: Claim post measuring 4" x 4" x 4' tall.

61-11409BB: Rock cairn consisting of 16 boulders stacked one course high measuring 3' x 1', with a 4" x 4" x 4' long fallen claim post. The post has two side strip coffee can lids (1lb) nailed to the top with wire nails; at the bottom of the cairn is an upright pocket tobacco tin with a hinged lid, inside the tin is a location claim. The paper is too deteriorated to read, but the claim ticket was produced in Tonopah.

61-11409CC: Two claim posts measuring 4" x 4" x 4' tall, standing side by side.

61-11409DD: Claim post 4" x 4" x 3' tall. The upper portion of the post is wrapped with 10" wide cut, rusted sheet metal

61-11409EE: Two claim posts that are 1' apart. One post is an 8" x 8" railroad tie standing 4' tall, the other is a 4" x 4" x 4' tall post with a rusted metal hinged lid, Band-aid tin nailed to the top.

61-11409FF: Rock cairn consisting of six boulders stacked one course high measuring 1' x 1', with a 4" x 4" x 2' tall claim post.

TABLE 1: ISOLATED ARTIFACTS (LEGALS USING SE CORNER OF TEMPLATE)

ISOLATE #	LEGALS	UTM'S
61-11409A	NE NW SW Sec. 5 T1S, R37E	420949 mE, 4192888 mN
61-11409B	SE SE NE Sec. 6 T1S, R37E	420516 mE, 4192894 mN
61-11409C	NE SE NE Sec. 6 T1S, R37E	420562 mE, 4193233 mN
61-11409D	SE SW NE Sec. 6 T1S, R37E	420228 mE, 4192996 mN
61-11409E	NW NE SE Sec. 6 T1S, R37E	420461 mE, 4192865 mN
61-11409F	NE NW SE Sec. 6 T1S, R37E	420168 mE, 4192753 mN
61-11409G	NW NE SE Sec. 6 T1S, R37E	420364 mE, 4192846 mN
61-11409H	NE NW SE Sec. 6 T1S, R37E	420300 mE, 4192867 mN

61-11409I	NW NW SE Sec. 6 T1S, R37E	420062 mE, 4192867 mN
61-11409J	SE SW SE Sec. 31 T1S, R37E	421037 mE, 4193841 mN
61-11409K	begin: SE NW SE Sec.31 T1S,R37E end: SW NE SE Sec. 31 T1S, R37E	begin: 421187 mE, 4193825 mN end: 420948 mE, 4193827 mN
61-11409L	NW SW SE Sec. 31 T1S, R37E	420733 mE, 4193715 mN
61-11409M	SE SW NE Sec. 31 T1N, R37E	420877 mE, 4194171 mN
61-11409N	NW NE SW Sec. 31 T1N, R37E	420334 mE, 4194047 mN
61-11409O	NW NW SE Sec. 31 T1N, R37E	420648 mE, 4194090 mN
61-11409P	SW SW SW Sec. 31 T1S, R37E	420471 mE, 4193363 mN
61-11409Q	NE SE SW Sec. 31 T1S, R37E	420606 mE, 4193570 mN
61-11409R	SE NE SW Sec. 31 T1S, R37E	420449 mE, 4193665 mN
61-11409S	SE SW SW Sec. 31 T1S, R37E	420060 mE, 4193352 mN
61-11409T	SW SW SW Sec. 31 T1S, R37E	419985 mE, 4193398 mN
61-11409U	SE NE SW Sec. 31 T1S, R37E	begin: 420620 mE, 4193807 mN end: 420501 mE, 4193712 mN
61-11409V	NW SE SW Sec. 31 T1S, R37E	420268 mE, 4193677 mN
61-11409W	SE NW SW Sec. 31 T1S, R37E	420204 mE, 4193792mN
61-11409X	NE SW SW Sec. 31 T1S, R37E	420067 mE, 4193690 mN
61-11409Y	SW SW SW Sec. 31 T1S, R37E	420008 mE, 4193538 mN
61-11409Z	SW SW SW Sec. 31 T1S, R37E	419990 mE, 4193534 mN
61-11409AA	SW SW SW Sec. 31 T1S, R37E	419886 mE, 4193425 mN
61-11409BB	SE SW SW Sec. 31 T1S, R37E	420064 mE, 4193360 mN
61-11409CC	SW SW NE Sec. 6 T1S, R37E	419957mE, 4193225mN
61-11409DD	SW SW NE Sec. 6 T1S, R37E	420055mE, 4193182mN
61-11409EE	SW SW NE Sec. 6 T1S, R37E	420056mE, 4193235mN
61-11409FF	SW SW NE Sec. 6 T1S, R37E	420001mE, 4193185mN

7.3 SUMMARY

Expectations were advanced earlier pertaining to historic sites to be found within the project area. As expected, the one historic site recorded appears to be related to hard rock mining within the Silver Peak mining district. In general, our expectations were well met. However, the site remains as unevaluated for the NRHP until further archival research can be conducted.

Figure 3: Isolate Location Map. Isolates 61-11409A to 61-11409FF: USGS 7.5' Rhyolite Ridge NW, Nevada 1987, BLM Report #6-2601 (P).

8.0 SUMMARY AND AVOIDANCE RECOMMENDATIONS

One historic site, and 32 Isolates were recorded during the course of this survey. Site CrNV 61-11408 is a short term mineral exploration site. The site is recommended unevaluated for the NRHP pending further archival research and a more detailed and specific historical context to evaluate whether the site has the potential to answer several research questions proposed under the Mining Research Domain given a variety of surviving cultural elements. It is recommended that the site area be avoided. Fish Lake Green Power Company will not be conducting any exploration activities in this area.

It should be noted that the methods and procedures used throughout the survey were such that all cultural resources located within the project area should have been found and recorded. If, however, cultural resources are subsequently discovered that could be adversely affected by project-related activities, the latter should immediately cease operations and the Tonopah Resource Area of the Bureau of Land Management should be immediately notified.

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Shamberger, Hugh A.
1978 *Candelaria and Its Neighbors*, in Historic Mining Camps of Nevada No.9. Nevada Historical Press, Carson City, Nevada.

University of Utah
1990 Intermountain Antiquites Computer System (IMACS); Users Guide. Salt Lake City.

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Valley, Esmeralda County, Nevada. BLM Report #6-1458(P)

APPENDIX A

IMACS

SITE DESCRIPTIONS

AND PHOTOS

1990

IMACS ENCODING FORM

To be completed for each site form.
For instructions and codes, see IMACS Users Guide.

Encoder's Name J. TRUDELL

A

1 __-__-______ State Site Number

2 61-11408 Agency Site Number

6 CRR62601 Agency Report Number

10 05153 Elevation

11 Zone: 11 | Easting: 420244 | Northing: 4193339

12

1/4	1/4	1/4	Sec.	T.	R.
SE	SW	SW	31	1 S	37 E

13 7 Merid.

14 RHYOLITE RIDGE NW USGS Map

17 LM Owner

18 Forest: __ Dist./Park: BD

19 Loc. Curated Materials: __

21 D Cond.

22 ER MN RD Impacts

23 Z N.R.

26 RH Organ.

28 06-29-05 Survey Date

29 98 Slope 000 Aspect

30 029 A Water: distance/type

31 BPH Geog. Unit

32 G 1st I 2nd Topographic Location

33 H Dep.

34 E 000 Vegetation 1 2 3

35 Misc. Text, Site Name

B

2 Culture/Dating Method

3 Area

4 Collect

5 Depth

6 Excav. Status

7 Prehistoric Artifacts

8 Lithic Tools: # / type

9 # Flaking Stages

11 Ceramics: # / type

13 Features: # / type

14 Architecture: # / material / type

C

2 MN Historic Themes

3 EAF Cultures / Dating Method

4 1890 1929 Dates

5 89849 Area

6 A Collect.

7 A Depth

8 C Excav. Status

9 TH ME CS TC GL CM WD TO NC Artifacts

14 6TR 4PH 3AI Features: # / type

15 1CBE 1CAR 1IAK 1WDA Architecture: # / material / type

LETTERING GUIDE A B C D E F G H I J K L M N O P Q R S T U V W X Y Z 1 2 3 4 5 6 7 8 9 Ø

IMACS SITE FORM

Part A - Administrative Data

INTERMOUNTAIN ANTIQUITIES COMPUTER SYSTEM

1. State No.

2. Agency No. CRNV-61-11408

3. Temp. No. J1

4. State: Nevada County: Esmerelda

5. Project: Fish Lake Green Power Co.

6. Report No: BLM 6-2601 (P)

7. Site Name: none

8. Class: Historic

9. Site Type: Mining/Mineral Extraction (MN)

10. Elevation (ft): 5,153'

11. UTM Grid: Zone 11 420244 mE, 4193339 mN Datum NAD 27

12. Legal Description:
    SE 1/4 of SW 1/4 of SW 1/4 of Sec. 31 T1S/R37E

13. Meridian: Mt Diablo (7)

14. Map Reference: USGS 7.5:

15. Aerial Photo: None Used

16. Location and Access: The site is located on a highly erosional alluvial drainage on the western side of the lower flank of the Silver Peak Range. Access is from Hwy 264 in Fish Lake Valley turn east onto Hot Ditch Road fo 7.9 miles to fork in the road, take right fork for 0.3 mile, go left for 3.6 miles turn right trending south for 0.5 mile take left fork for 0.8 mile trending east into the site area.

17. Land Owner: Administered by the Bureau of Land Management (LM)

18. Federal Administrative Units: Bureau of Land Management (BD)

19. Location of Curated Materials: N/A

20. Site Description: The site is located on a highly erosional alluvial drainage on the western side of the lower flank of the Silver Peak Range. The site is a mining/mineral exploration complex measuring 440 m north-south x 260 m east-west. Vegetation within the site area is a shadscale community with lesser amounts of greasewood, cacti and other forbes and grasses The deposition consists of a sandy silt alluvium intermixed with gravels and pebbles. The site has 31 mining features which include one ore chute, one open cut mine pit, five loading/staging platforms, six road cuts, four prospect pits, one collapsed structure, one structural debris scatter, one modified water tank, one dugout, five wooden claim posts, three rock cairns with claim post, one possible tent platform, and two wooden slat alignments. Examination of the open cut pit shows evidence of sulfur layering the waste rock and sulfur emits from the outcrop. The open cut pit is small and possibly the mining was short term. After encountering the sulfur deposit the miners may have ceased operation of the exploration. The site contains a variety of debris which include diagnostic can technology (1903-1922), milled lumber, galvanized sheet metal, nails, hardware, glass fragments (1917), ceramics (1890, 1913), and domestic items. The site is recommended as unevaluated for the NRHP pending further archival research.

21. Site Condition: Poor (D)

22. Impacting Agent(s): Erosion (ER), Mining (MN), Road (RD), Structural Decay (SD)

23. National Register Status: (Z)

Justify: This is a historic mineral extraction site containing 31 mining features. The site is not associated with an important series of events that have made a significant contribution to the broad patterns of our history, hence, the site is not eligible for the NRHP under criterion (a). There is no evidence that the site is associated with the lives of persons significant in the history of Nevada, hence, the site is not eligible for the NRHP under criterion (b). The site shown no distinctive characteristics of a type, period, or method of construction, hence, the site is not eligible for the NRHP under criterion (c). The mining complex appears as it was during the time the area was in operation for mineral exploration. The transportation and movement of materials from the open cut mine to the ore chute are clearly visible and remain intact where they were originally constructed. This particular mining area may have been short term. The open cut pit has evidence of sulfur layering the waste rock and sulfur emits from the outcrop. After encountering the sulfur deposit the miners may have ceased operation of the mineral extraction. The collapsed structure and variety of associated historic debris including the can technology ranges in dates from 1903-1922. The mining features have not been altered by newer or additional reconstruction. Thus, all of this combined contains data pertinent to the archaeological record. However in terms of the research questions proposed above, a more detailed archival research and a relevant historic context must be conducted to evaluate the site for the NRHP. The integrity of setting, location, design, materials, workmanship, feeling, and association have not been compromised. The site is recommended as unevaluated for the NRHP pending further research.

24. Photos: 1-38

25. Recorded by: Jana Trudell

26. Survey Organization: R. K. Vierra and Associates (RH)

27. Assisting Crew Members: Lila Lindsay, Lee Duryee

28. Survey Date: June 29th 2005

List of Attachments: __Part B _X_Topo Map _X_ Site Sketch __Feature Sketch(s)
_X_Part C _X_Photos _X_ Artifact Sketch(s)

Part A - Environmental Data

29. Slope (degrees): 98 Aspect (degrees): 0
Distance to Permanent Water (29 x 100 meters): 2,900m
Type of Water Source: Spring/Seep (A)
Name of Water Source: Unknown

31. Geographic Unit: Fish Lake Valley (BPH)

32. Topographic Location: Primary Landform: Canyon (G)
Secondary Landform: Multiple Secondary Landforms (I)

Describe: The site is situated on a highly erosional alluvial drainage, slopes, and finger ridges on the western side of the lower flank of the Silver Peak Range.

33. On-site Depositional Context: Alluvial Plain (H)

Description of Soil: The soil is a sandy silt alluvium intermixed with gravels and pebbles.

34. Vegetation: a. Life Zone: Upper Sonoran (E)
b. Community: Primary On-Site: Shadscale (O)
Secondary On-Site: Shadscale (O)
Surrounding Site: Shadscale (O)

Describe: Vegetation is a shadscale/greasewood community intermixed with, rabbitbrush, hopsage, russian thistle, swollen stalk buckwheat, ephedra, pencil choya, feathered finger grass, wild aster, prince's plume, halogeton glomeratus, globe mallow, astragalus, and other forbes and grasses.

35. Miscellaneous Text: N/A

36. Comments/Continuations: N/A

Part C - Historic Sites

1. Site Type: Mining

2. Historic Theme(s): Mineral Extraction (MN)

3. Culture:	AFFILIATION	DATING
	Euro-American (EA)	Artifactual Cross-Dating (F)
		Can Technology

4. Oldest Date: 1890   Recent Date: 1929
   How determined: Ceramic and Can Technology (striker-plate tobacco tins, milk cans)

5. Site Dimensions: 260 m. EW X 440 m. NS   89,849Area (sq. m.): approximately

6. Surface Collection Method: None (A)
   Sampling Method: N/A

7. Estimated Depth of Fill: Surface (A)
   How estimated: The site is confined to the surface with no evidence of buried deposits. Possible alluvial deposits from flooding, but would be out of context.

8. Excavation Status: Unexcavated (C)
   Testing Method: N/A

9. Summary of Artifacts and Debris: Historic artifacts and debris include: ceramics, porcelain, glass fragments, bottle glass fragments, window glass fragments, tin cans, a teaspoon, various sizes of milled lumber, tar paper fragments, concrete slab fragments, various galvanized and corrugated sheet metal, scrap iron, metal strapping, metal springs, cable, wire mesh bands, an iron leaf spring, galvanized banding, cut nails, wire nails, spikes, metal rods, hardware, bailing wire, barrel hoops, window frame fragments, a hand-made aluminum picture frame (drawn), a set of bed box springs, arm chair fragments, battery end caps, and a rubber shoe.

10. Ceramic Artifacts:

#	Paste	Glaze/slip	Decoration	Pattern	Vessel form
4	WIE				plate fragments
1	WIE				plate bottom
1	WIE				saucer

1	WIE	saucer
20±	WIE	fragments
1	Porcelain	bowl

Describe: The ceramic assemblage consists of four white improved earthenware plate fragments, a white improved earthenware plate bottom trademark "RONSTONE CHINA/J & G MEAKIN/MANLEK/ENGLAND" dates to circa 1890, a white improved earthenware saucer with black print "ROYAL IRO.../JOHNSON BROS/ENGLAND" dates to circa 1913 with sheild and crown, lion "L", a white improved earthenware saucer with green print "KROKUS/...INA", 20+ white improved earthenware fragments, and a white porcelain bowl fragment embossed on bottom "CHINA//LEAKA...".

11. Glass:

#	Manufacture	Color	Function	Trademarks	Decoration
1		clear			
10±		clear		yes	yes
15±		amethyst			yes
100±		aqua			
1		amethyst		yes	
15±		amethyst			
5±		aqua			
10±		amber			
1	automatic	aqua		yes	
3		olive			

Describe: a clear glass gallon size jug with aluminum screw cap finish and circular handle, 10+ clear glass fragments some are embossed with alternating arrowhead and chevron pattern with "...LON UNAUTHORIZED USE PRO..." UNDER PATTERN, large body fragment of jug has logo ".../AND//...RITA//...RS. INC", ANOTHER FRAGMENT HAS "OHIBITED", 15+ amethyst panel bottle glass fragments (dates to 1917), one fragment embossed with two circles and an anchor with the circle, 100+ window glass fragments with aqua tint, a small amethyst bottle base embossed with "REDCROSS" (a "B" above the S), 15+ amethyst glass fragments, 5+ aqua bottle glass fragments, 10+ amber glass fragments, an aqua automatic bottle maker mark ("AB") base, three olive green glass fragments.

12. Maximum Density-#/sq. m. (Glass and Ceramic):15±

13. Tin Cans:

#	Type	Opening	Size	Modified	Label/Mark	Function
1	TH	KC	4 9/16 x 3 3/8"			
1			5 3/16" x 3 2/8"			External friction
1	TO		4 1/2"			tobacco
6	TH	KW	3 ½" X 3" X 2		yes	meat

1	TH	KS	4 5/16" x 2 15/16"				meat
15	TC	KC	2 ½" x 2 ½"				milk
1		KC	2" x 3 3/4"				meat
1	TC	KC	4 3/8" x 2 15/16"				milk
1	TC	KC	4" x 2 3/4"				
1	cap					yes	syrup
2	TO					yes	tobacco
3	TO						tobacco
1	CE				yes	yes	coffee
1		CK					beer
1	TC		5" x 6 ½"				
3	TC	RO					
1	TH	PH	3 3/4"x 9"				
1	square		10" x 10"				
2	TO		4 1/2"				
1	lid		4 5/8"				Internal friction
10±	TC	KC	4" x 2 11/16"				
2		KC	6 ½" x 4 ½" x 1 ½"			yes	fish
3	TO		4 1/2"				tobacco
1		KW				yes	fish
1				yes			flashing
1	CU		22" diameter	yes			unknown
4	TO		4 1/2"				tobacco
20±	TC	KC	4 5/8" x 4"				
25±	TH	KC	4 ½" x 3 3/8"				
12±	TC		4 3/8" x 2 15/16"				milk
2			5" x 2 3/4"				External friction
1	TC	KC	2" x 3 7/16"				
2		KS					meat
1	square		5 1/4" x 4 3/8" x 3 3/16"			yes	
1	TC	KC	4 ½" x 3 3/8"				
1		pull-tab					beer
1	CE	KS					
							Lid

KEY: Tin Can Type---- TH Hole-in-Cap; TO Tobacco; TC Sanitary; CU Utility Can; CE Coffee. Opening----- KC knife cut; KS key strip; KW key wind; CK church key; RO rotary wind; PH punched hole.

Describe: hole-in-cap can KC opened 4 9/16" x 3 3/8" diameter, an external friction lid can 5 3/16" x 3 2/8" diameter, three kidney tobacco tins with striker plate on bottom, six hole-in-cap meat tins key wind opened with embossed "ESTAB 32A" 3 ½" x 3" x 2", hole-in-cap meat tin lid with key wind attached 4 5/16" x 2 15/16", 15 solder dot milk cans KC 2 ½" x 2 ½", KC opened meat tin 2" x 3 3/4", milk KC opened 4 3/8" x 2 15/16", sanitary KC opened 4" x 2 3/4", a tin cap with three sided tabs embossed "...SYRUP CO," two "Prince Albert" upright hinge tobacco tins, a 1-lb side strip coffee can, a steel beer can church key opened, a lapped seam sanitary can with friction lid 5" diameter 6 ½" tall, three sanitary can lids rotary opened, a cylindrical hole-in cap 9" tall x 3 3/4" diameter with a 2" cap punched can, a 10" x 10" square can with a 1 ½" pour cap (1" inside), two upright tobacco tins with hinge lid (one crushed), an internal friction lid 4 5/8", 10± sanitary cans 4" x 2 11/16" knife cut, two fish tins 6 ½" x 4 ½" x 1 ½" KC and folded opened with indented circle at bottom, three tobacco tins flat hinge with striker plate on bottom, a key wind top fish tin with "NOVEGE" embossed on bottom, a flattened tin can with circle cut out for stove pipe flashing, a 22" diameter circular tin in waffle pattern, 6" hole cut in center, four flattened hinge tobacco tins, 20+ sanitary cans 4 5/8" x 4" knife cut, 25+ hole-in-cap cans 4 ½" x 3 3/8" knife cut, 12+ solder dot milk cans 4 3/8" x 2 15/16", two external friction top cans 5" x 2 3/4", a sanitary can 2" x 3 7/16" knife cut, two meat tins key strip opened, a square can 5 1/4" x 4 3/8" x 3 3/16", a knife cut sanitary can 4 ½" x 3 3/8" diameter embossed on the bottom "OJD56//5216A," a steel top beer can with a pull tab, and a coffee can lid.

TIN CAN DATES: Kidney-shaped Tuxedo Tobacco tins date to 1919; Prince Albert tobacco tins date to 1909; Hole-in-Cap cans 4 9/16" h x 3 3/"d date to 1917 and 1922; Sanitary cans 4"h x 2 3/4d date to 1917, 1919, and 1922; Sanitary cans 4"h x 2 11/16"d date to 1917; Milk cans 2 ½"h x 2 1/2"d date between 1903-1914; Solder dot milk cans 4 6/16"h x 2 15/16"d date between 1915-1929; pull tabs date to 1962.

14. Landscape and Constructed Features: Road Cut/Bladed-Graded Road (TR), Prospect hole (PH), Rock Cairn (AI), Claim Post/Staging Platform (OT)

Describe:

Feature 3 road cut trending east-west approximately 216' long x 10' to 19' wide. Located between Features 2 and 4. A 1' x 10" plank 1 ½' long is nailed to an upright 2" x 4" protruding from the ground on the east end of the road cut along with another upright 2" x 4" in front of it. No writing visible on the plank.

Feature 4 is a road cut located below the chute. It is trending east-west then northeast-southwest at the eastern end. It measures 557' long x 16' wide with a small segment of twisted cable lying within it. Associated debris include a clear glass gallon size jug with aluminum screw cap finish and circular handle, 10+ clear glass fragments some are embossed with alternating arrowhead and chevron pattern with "...LON UNAUTHORIZED USE PRO..." UNDER PATTERN, large body fragment of jug has logo ".../AND//...RITA//...RS. INC", ANOTHER FRAGMENT HAS "OHIBITED".

Feature 5 rock cairn with six boulders, one course high, 3' x 3'. It has a 4" x 4" wooden claim post standing 4' tall with 10" wide cut, rusted sheet metal wrapped around the upper portion.

Feature 7 small circular pit 10' north-south x 13' east-west x 6" deep, bermed on the east and west sides. Located at the southwest portion of the pit is a pile of slabbed brown/yellow layered stone stacked one course high 3' x 2' with an upright 2" x 4" that is 6" tall, sharpened at bottom. The layered stone may have come from Feature 8 (pit). Associated debris include hole-in-cap can knife cut opened 4 ½" x 3 3/8" diameter, an external friction lid can 5 3/16" x 3 2/8" diameter, a kidney tobacco tin with striker plate on bottom, six hole-in-cap meat tins key wind opened with embossed

"ESTAB 32A" 3 ½" x 3" x 2", hole-in-cap meat tin lid with key wind attached 4 5/16" x 2 15/16", lengths of bailing wire, metal strapping 3/4" wide, heavy galvanized banding 4" wide approximately 20' in length, a fish tin with key strip across the top 4" x 3" x 3/4" deep, 15 solder dot milk cans knife cut 2 ½" x 2 ½", knife cut opened meat tin 2" x 3 3/4", milk can knife opened 4 3/8" x 2 15/16", sanitary can knife opened 4" x 2 3/4", a hand made picture frame approximately 5" x 7" aluminum with twisted aluminum on outer edge raised into two loops for hanging, 15 + amethyst panel bottle glass fragments, one fragment embossed with two circles and an anchor with the circle, a teaspoon, and a tin cap with three sided tabs embossed "...SYRUP CO."

Feature 8 small pit located on the south facing slope on a small finger ridge. The pit is dug into a brown/yellow layered stone outcrop measuring 3' x 3' x 1' deep.

Feature 12 standing wooden claim post 8" x 8" x 5" tall.

Feature 15 wooden 8" x 8" claim post 5' long, fallen with a "Prince Albert" upright hinge tobacco tin.

Feature 16 circular prospect pit 16" x16" x 6" deep surrounded with a 3' berm.

Feature 17 oblong prospect pit 36' north-south x 22' east-west a 5' deep with a 5' berm on the east and west sides. Associated debris include a kidney upright tobacco tin with striker plate on bottom, located 22' south of the pit.

Feature 19 two 8" x 6" wooden claim post standing side by side, one is 4' tall the other 5' tall. Four small cut nails are embedded in the 4' post.

Feature 20 rock cairn with 10 boulders, one course high 1' x 1'. It has a 4" x 4" wooden claim post standing 4' tall with 10" wide cut, rusted sheet metal wrapped around the upper portion attached with wire nails.

Feature 21 staging platform located above Feature 1 (chute). It is triangular in shape with the west end 19' wide and the east end 3' wide and 55' in length trending east-west.

Feature 22 rock cairn with six boulders, one course high 1' x 1'. It has a 4" x 4" wooden claim post standing 4' tall with a 1-lb side strip coffee can lid nailed to the top.

Feature 23 narrow bladed road cut located between Feature 21 (platform) and Feature 28 (platform). It is 6' wide and 196' long cut into the northwest slope with a 1' to 2' berm on the east side. The road trends northeast-southwest.

Feature 24 bladed road cut located above Feature 23 (road cut) and south of Feature 25 (platform). It is 6' wide and 65' in length with a 1' to 2' berm on each side and trends north-south.

Feature 25 triangular platform/turnaround located above Feature 24 (road cut) and directly east of Feature 26 (road cut). It is 16' wide at the west end and 3' wide at the east end and 42' in length. It trends east-west.

Feature 26 bladed road cut that trends east-west across the top of a ridge line west of feature 25 (platform). The road is 6' wide and extends to the west for 295' then drops downslope 196' to the main access road at the north side of the site area.

Feature 28 platform staging area 16' wide x 62' long trending northeast-south-west. Located in front of Feature 27 (open cut). The waste rock fans 98' downslope of the platform to the northwest. Associated debris include a 4" x 4" wooden claim post 4" long lying on the waste rock.

Feature 29 two wooden 8" x 8" claim post standing 5 ½' tall side by side.

Feature 30 wooden 8" x 8" claim post standing 5" tall with 11 large wire nails embedded in the post. Remnants of a rock cairn 22 boulders has been dispersed to the northwest.

Feature 31 graded road with turn around located at the base of femoral 49' x 98'. The southwest side is eroding into several sharp runoff drainage. The road trends north-south 246' until it is washed out in drainage. Associated debris include 20+ milled lumber fragments of 2" x 4", 1" to 2" in length, 1" x 12" boards fragments with finishing nails and 5" wire nails, two 9' in length 1" 12" all located on both sides of the road.

15. Buildings and Structures: Ore Chute (BE), Collapsed Structure (AR), Collapsed Dugout (AK), Tent Platform (DA), Open Cut Mining/Loading Platform/Modified Water Tank/Wood Alignments

Describe:

Feature 1 ore chute constructed on a steep north facing slope on a east-west trending, highly erosional finger ridge. The chute is built with 6" x 6" beams cut into the slope at right angles and supported by a stair stepped series of descending recycled rail road tie cribbing and upright 6" x 6" beams. The upper portion of the chute is sided with close fitting vertical 1" x 12" planks. Metal ½" diameter metal rods extend out from center of chute on either side of support beams. Large nails and spikes were used in the construction of the chute. The 1" x 12" planks are missing at the lower elevation of chute structure sides and sheets of corrugated metal roofing are scattered along the sides and bottom of the chute. The chute measures approximately 49.8' long x 8' wide. Associated with Features 2-4, and Features 21-28.

Feature 2 loading platform is constructed of 7' long horizontal 8" x 8" beams and vertical 3' tall 8" x 8" beams trending east-west with horizontal 8" x 8" beams trending north-south protruding from overlaid fill dirt. The east-west ends have one horizontal beam with a vertical beam on either side and three north-south horizontal beams spaced 3' apart between the vertical beams. Then two stacked horizontal beams with vertical beams on either side and three north-south horizontal beams spaced 3' apart. The center of the platform has three stacked beams with vertical beams on either side and three north-south horizontal beams spaced 3' apart. The top of the beams are covered with 135' long x 16' wide dirt and built up from the surface 6' up to the bottom of the beams. Associated debris located approximately 100' west of the chute includes scrap dimensional wood a 1" x 12", two 2" x 4", four 6" x 8", scrap iron 1' long, and concrete slabs broken into pieces.

Feature 6 remnants of three structure floor sections placed here from another location. The floors are constructed of 1 ½" x 8" frames with1 ½" x 6" joist spaced 2" apart with ½" x 6" tongue and groove over the joist. All of the floors measure 10' long x 8" wide and laid in a 42" diameter area. They are located directly north of the main access road on the east side of the site. Associated debris a steel beer can church key opened, a lapped seam sanitary can with friction lid 5" diameter 6 ½" tall, and three sanitary can lids rotary opened.

Feature 9 circular modified water tank is crushed on top center. Constructed of 5 ½' long x 2 ½' wide lengths of galvanized sheet metal attached together by welding and 3/4" bolts that run horizontally and vertically on the edges of the sheet metal. The tank is approximately 9 ½' diameter x 5' tall. A 3" diameter pipe extends 1' from the upper portion of tank on the west side. Bailing wire is attached and twisted through portions of the top edges of the tank and the pipe. The bailing wiring appears to be for repairs to hold the top to the siding together. A door located on the northwest side of the tank is lying dorsal side down on the ground. The door is constructed of 1" x 6" milled lumber form the frame and galvanized sheet metal for the dorsal side of the door. The galvanized sheet metal is attached with bailing wire and square nails. A 2" x 4" is attached to the door with a large hinge and cut nails. Next to the door is a 13' diameter shallow depression surrounded by a 1' berm. It appears that the tank once stood where the depression is located. Associated debris consists of ±10 segments of deteriorated milled lumber including a 4" x 4", a 2" x 4", and a 1" x 6", ±6 various size galvanized sheet metal sections, four white improved earthenware plate fragments, a cylindrical 9" tall x 3 3/4" diameter with a 2" cap punched can, a 10" x 10" square can with a 1 ½" pour cap (1" inside), two upright tobacco tins with hinge lid (one crushed), and a 12" diameter circular cut galvanized smoke stack section with rectangular holes throughout.

Feature 10 collapsed structure constructed of a built up dirt mound 39' north-south x 19' east-west surrounded by a s1' berm. The walls and floor are scattered to the north of the structure with milled lumber within the mounded area. Three boulders are aligned on the northwest berm and one large boulder remains on the east berm. A small floor section is intact. The dimensional lumber for the floor is 1" x 12" planks and 5' in length. The planks are attached to 1' x 6' with wire nails. A small wall 5' x 5' section is also intact constructed of ½" x 8" planks attached to 2" x 4" and 4" x 4" with wire nails. Associated debris consists of a 6' x 4 ½' bed box spring framed with 2" x 4" and dimensional wood attached together at corners with 4" long carriage bolts. Metal coiled springs are overlaid with wire mesh. The cross slates (5) are 1" wooden dowels. A wooden two vertical pane window frame 32" tall x 32" wide with ½" x ½" framing, 100+ window glass fragments with aqua tint, a white porcelain bowl fragment embossed on bottom "CHINA//LEAKA...", a white improved earthenware plate bottom embossed "RONSTONE CHINA/J & G MEAKIN/MANLEK/ENGLAND" around center shield with crown on top, lion on "L" unicorn on "R", wooden arm chair fragments with twisted brace wire on dowel legs, 20+ white improved earthenware fragments, an internal friction lid 4 5/8", a grey rubber shoe sole, an iron leaf spring fragment embossed "FORD", 10± sanitary cans 4" x 2 11/16" knife cut, two fish tins 6 ½" x 4 ½" x 1 ½" knife cut and folded opened with indented circle at bottom, three tobacco tins flat hinge with striker plate on bottom, tar paper fragments, barrel hoops, a key wind top fish tin with "NOVEGE" embossed on bottom, a flattened tin can with circle cut out for stove pipe flashing, a 22" diameter circular tin in waffle pattern, 6" hole cut in center, four flattened hinge tobacco tins, a white improved earthenware saucer with black print "ROYAL IRO.../JOHNSON BROS/ENGLAND" with sheild and crown, lion "L", a white improved earthenware saucer with green print "KROKUS/...INA", a small amethyst bottle base embossed with "REDCROSS" (a "B" above the S), four 1" wide x 2-3" long wire mesh bands, 15+ amethyst glass fragments, 5+ aqua glass fragments, 10+ amber glass fragments, an aqua automatic bottle maker mark ("AB") base. Tin frying pan handle, 20+ sanitary cans 4 5/8" x 4" knife cut, 25+ hole-in-cap cans 4 ½" x 3 3/8" knife cut, 12+ solder dot milk cans 4 3/8" x 2 15/16", two external friction top cans 5" x 2 3/4", a sanitary can 2" x 3 7/16" knife cut, two meat tins key strip opened, three olive green glass fragments, 5 aluminum battery end caps, and a square can 5 1/4" x 4 3/8" x 3 3/16".

Feature 11 collapsed dugout located on the northwest slope of a small hill 98' from Feature 10 (structure). The feature is dug into the slope with a 7' x 7' milled lumber frame built up from the surface 1 ½'. It is constructed with 2" x 4" for outside frame with 1" x 6", 1" x 12", 1" x 3" milled lumber and 1/8" x 8" slats nailed across the top north-south with wire nails. The lumber is splintered and deteriorating. Tar paper is visible on one 2" x 4". It is difficult to determine depth due to cave in.

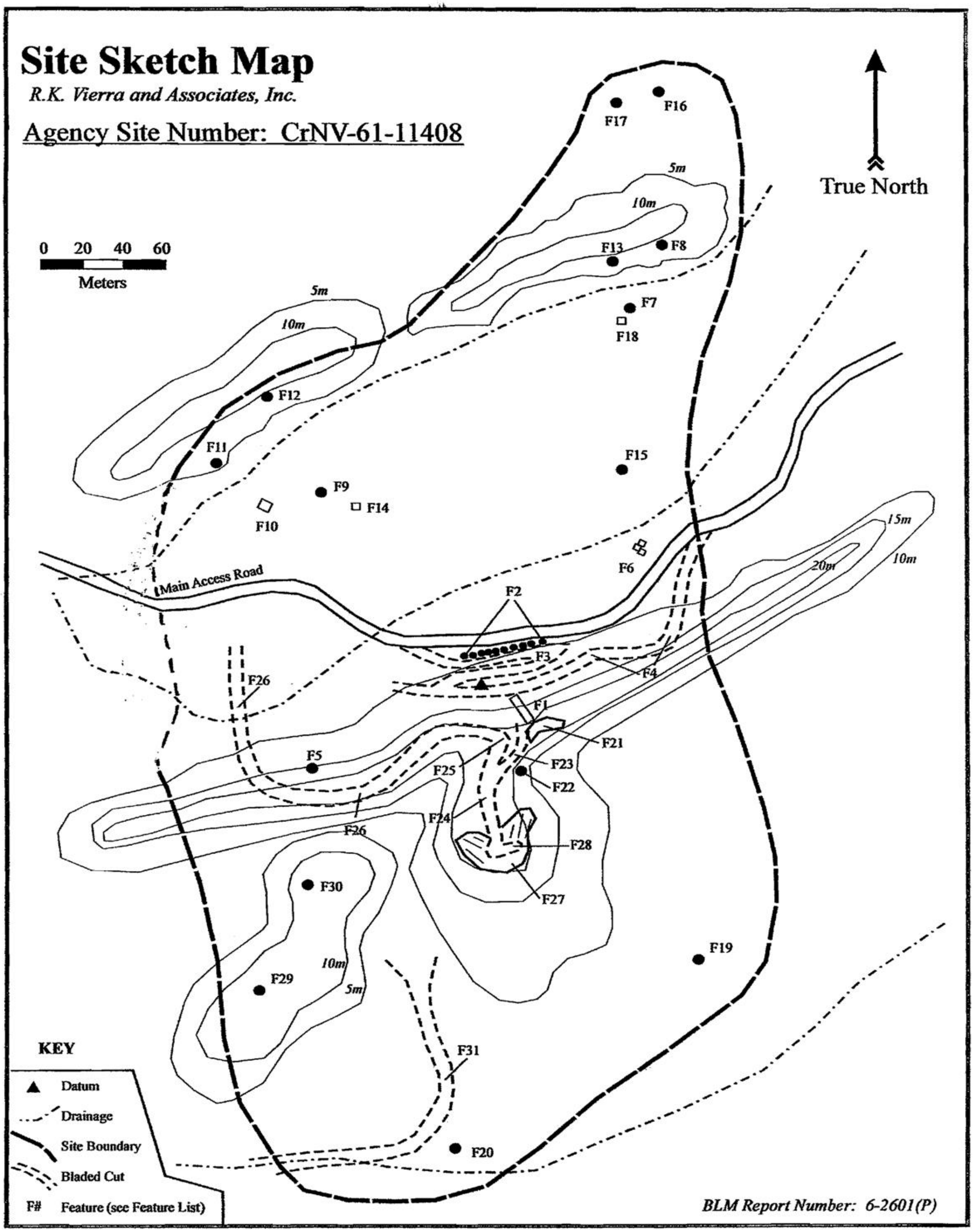
Feature 13 wood alignment built into the lower south facing slope of a small finger ridge near Features 7-8. The alignment consists of two rows of six 1" x 4" vertical slats pounded into the ground with two slats in the middle 16' north-south x 13' east-west. Possibly start of dugout. Associated debris a 1" x 10" board.

Feature 14 wood alignment located 49' east of Feature 9 (water tank). The alignment consists of six rows of small ½" x 2" wooden slats pounded into the ground 16' north-south x 13' east-west on a relatively flat surface. Possibly the start of a tent platform. Associated debris include a knife cut sanitary can 4 ½" x 3 3/8" diameter embossed on the bottom "OJD56//5216A" and a steel top beer can with a pull tab.

Feature 18 remnants of a possible tent platform 9' north-south x 9' east-west with small wooden pegs at four corners. Located in a relatively flat area 16' from Feature 7 (pit).

Feature 27 open cut mining pit located at the top and south facing slope of a mineral outcrop. The pit is 29' wide x 10' tall. The outcrop is white/grey with green/yellow sulfur layered on the rock. Sulfur emits from the outcrop.

16. Comments/Continuations: References: Jim Rock A Brief Commentary on Cans, 1987
Siminos Milk Can Guide 1997
Kovels New dictionary of marks Pottery & Porcelain 1850 to the present, 1986


Site Sketch Map
R.K. Vierra and Associates, Inc.
Agency Site Number: CrNV-61-11408
True North
0 20 40 60
Meters
5m
10m
15m
20m
Main Access Road
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F11
F12
F13
F14
F15
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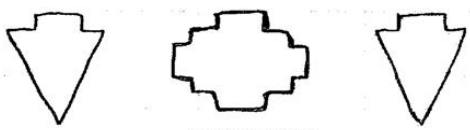
F21
F22
F23
F24
F25
F26
F27
F28
F29
F30
F31
KEY
Datum
Drainage
Site Boundary
Bladed Cut
F# Feature (see Feature List)
BLM Report Number: 6-2601(P)

CrNV-61-11408
FEATURE 4
Loren Huddleson



Not to scale

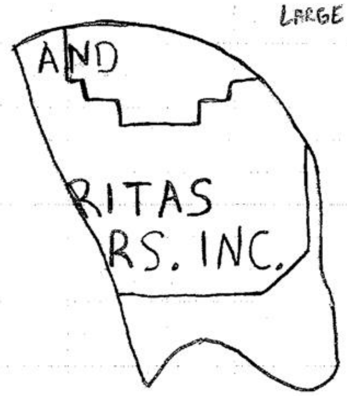
ALTERNATING
ARROWHEAD + CHEVRON EMBOSSED PATTERNS
AROUND BOTTLE BASE FRAGMENTS

"... LON UNAUTHORIZED USE PRO..."

ANOTHER FRAGMENT HAS ARROW PATTERN

"...HIBITED"

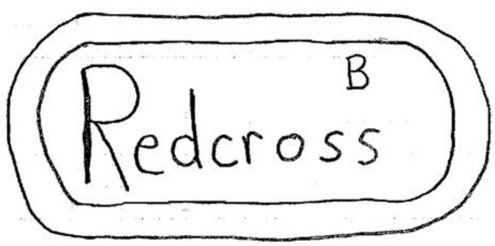
LARGE MIDSECTION FRAGMENT
WITH LOGO



CrNV-61-11408
FEATURE 10
Loren Huddleson

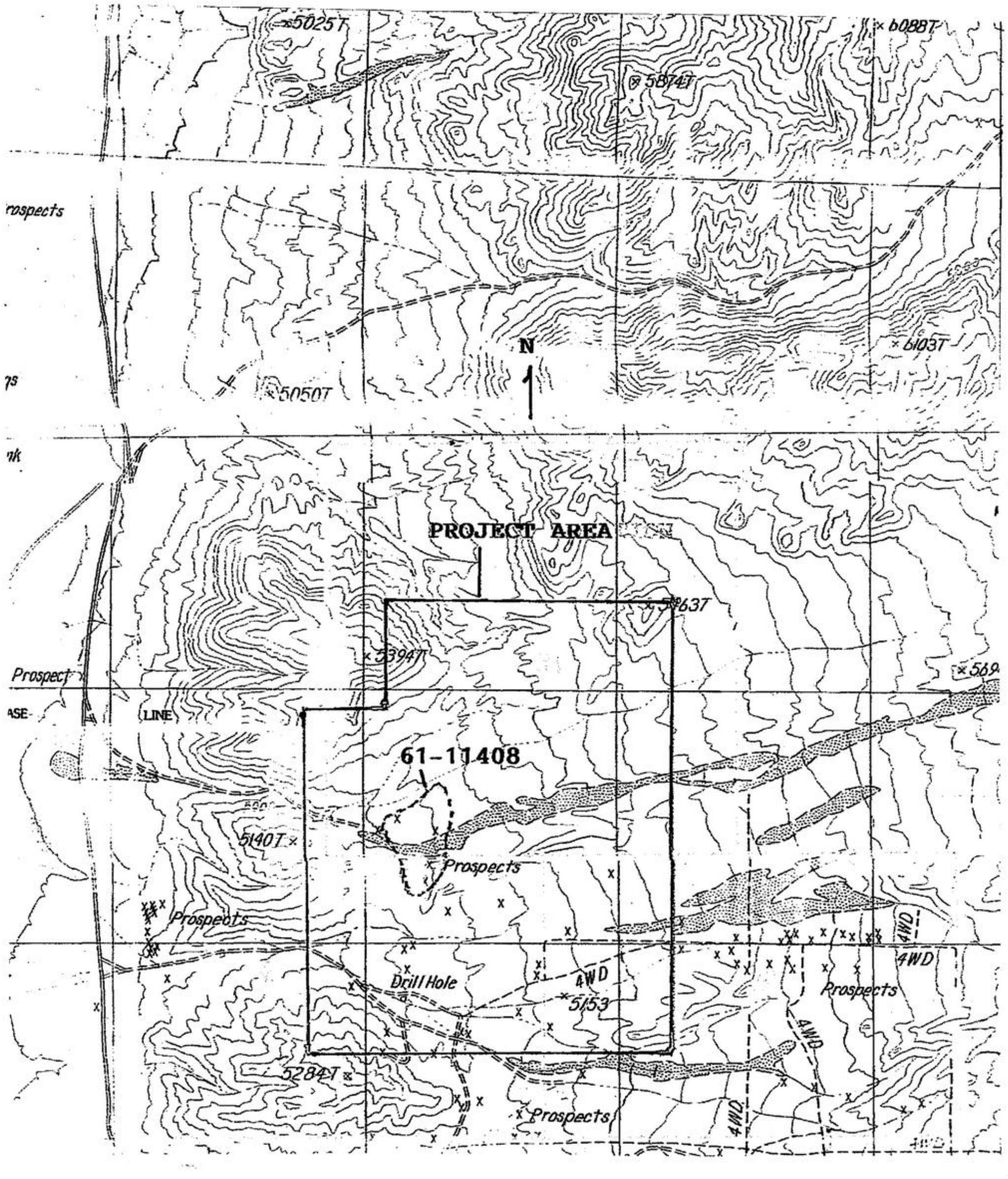
FADED GREEN LOGO
ON WHITE GLAZE
CERAMIC BOWL

Not to Scale



SMALL AMETHYST
BOTTLE BASE

Not to Scale



IMACS SITE LOCATION MAP, USGS 7.5' Rhyolite Ridge, NW, Nev 1987, BLM Report # 6-2601(P).

United States Department of the Interior

Bureau of Land Management

Battle Mountain Field Office September 14, 2006

Tonopah Field Station
Bureau of Land Management
1553 S. Main Street
P.O. Box 911
Tonopah, NV 89049

Environmental Assessment
NV065-EA06-177

Emigrant #17-31Geothermal Drilling Permit
Esmeralda Energy Company

File Number
NVN-74099

INTRODUCTION

Parcels of Federal land are leased for geothermal resources under the Geothermal Steam Act of 1970, as amended and Part 3200 of Ch. 43 Code of Federal Regulations.

Exploration must be in conformance with all State and Federal requirements including, but not limited to, those of the BLM, State of Nevada Division of Minerals, State of Nevada Department of Environmental Protection, Nevada State Engineer, and the Federal Environmental Protection Agency. Esmeralda Energy Company (Esmeralda) has filed a Geothermal Drilling permit with the Bureau of Land Management (BLM) Nevada State Office for a geothermal exploration hole located on the eastern side of Fish Lake Valley, NV.

On April 10, 2006, Esmeralda filed a Geothermal Drilling Permit with the BLM Nevada State Office. Esmeralda proposes to drill a geothermal exploration hole on the east side of Fish Lake Valley, NV. The environmental effects of drilling this geothermal exploration hole and construction of the associated well pad will be analyzed in this environmental assessment pursuant to the National Environmental Policy Act (NEPA) of 1969.

1.0 PURPOSE AND NEED

The purpose of this project is to allow Esmeralda to drill a geothermal exploration hole on the east side of Fish Lake Valley, NV. Exploration and subsequent development of geothermal resources is consistent with the current Federal energy policy (Energy Policy Act of 2005). Continued exploration for additional geothermal reserves would help the United States become less dependent on foreign energy sources.

1.1. Land Use Plan Conformance

The proposed action is in conformance with the Tonopah Resource Management Plan and Record of Decision approved on October 2, 1997, for the Tonopah Planning Area.

The Fluid Minerals Objective in the Tonopah RMP (page 22) is, “To provide opportunity for exploration and development of fluid minerals such as oil, gas, and geothermal resources, using appropriate stipulations to allow for the preservation and enhancement of fragile and unique resources.”

The proposal is within an area that is designated as “open to fluid minerals leasing subject to standard lease terms and conditions” (page 22).

1.2 Relationship to Statutes, Regulations, Policy, Plans or Other EAs

The Geothermal Steam Act of 1970 (30 USC 1001-1025) gives the Secretary of the Interior the responsibility and authority to manage geothermal operations on lands leased for geothermal resource development by the United States of America, and the Secretary has delegated this authority to the BLM.

The Geothermal Energy Research, Development, Demonstration Act of 1974 promotes the development and utilization of geothermal resources.

Regulations found at 43 CFR 3200.4 state that the operator must comply with "(a) the Geothermal Steam Act of 1970, as amended; (b) geothermal resource operational orders; (c) Notices To Lessees; (d) lease terms and conditions; (e) approved plans and permits; (f) conditions of approval; (g) verbal orders from BLM which will be confirmed in writing; (h) other instructions from BLM; and (i) any other applicable laws and regulations."

Regulations found at 43 CFR 3260.11 state that "drilling operations must (a) meet all environmental and operational standards; (b) prevent unnecessary impacts to surface and subsurface resources; …(d) protect public health, safety and property…"

1.3 Other Associated Decisions and Related Environmental Analyses:

The proposed action is in conformance with the Programmatic Geothermal Environmental Assessment for the Tonopah Planning Area (January 28, 2002).

2.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

2.1 <u>Proposed Action</u>

Esmeralda has filed a Geothermal Drilling Permit to drill a geothermal exploration hole in Fish Lake Valley, Nevada. Once the well is drilled, Esmeralda proposes to inject approximately 85,000 gallons of water into the geothermal reservoir in order to test the permeability and porosity of the host rock.

The well would be located at Township 1 North, Range 37 East, section 31, SW¼SW¼ and would be designated as the Emigrant #17-31 (Figure 1, page 6). The affected geothermal lease is NVN-74099.

The nearest inhabited town is Dyer, NV which lies approximately 14 miles southwest of the project area.

The proposed wellhead would be located on a gravel pad roughly 0.33 acre in size (100'X140') and would have a mud pit 0.003 acre in size (20'X 8') located on the pad. The proponent indicated that additional acreage would be disturbed during construction of the pad. Total surface disturbance associated with well pad construction would be 0.65 acre. The well will be drilled to a depth of 4,000 feet. The drill rig components will be trucked to the site and then reassembled on the well pad. When constructed, the drill rig will occupy approximately 1,980 square feet (0.045 acre) and the drill rig mast will be approximately 90 feet tall. The purpose of the mud pit is to hold the drilling mud and drill cuttings. The drilling mud helps keep the drill bit cool and provides a media into which the drill cuttings move out of the hole.

Access to the project area would be by pre-existing, improved gravel roads, Esmeralda county Road #15 Emigrant Pass Road (N-54394), Road #43, and Road #47 (N-55402). Esmeralda County Road Department personnel have indicated that they will maintain the access roads prior to, and after, the proposed exploration hole is drilled.

Water to be used for the drilling of the proposed geothermal well would be obtained from the Hot Box Park, a Recreation and Public Purposes lease (N-50991 and access road N-52827) site held and leased by Esmeralda County. The Hot Box is located approximately 3 miles west of the proposed action and is an improperly plugged and abandoned oil well that is leaking thermal waters under artesian flow. The Tonopah Field Station (TFS) received a letter from the Esmeralda County Commissioners granting Esmeralda permission to use the excess water at the Hot Box Park for the purposes of drilling the hole and testing the geothermal reservoir. The water needed for the drilling mud and injection test will be pumped from the abandoned oil well head and would be hauled to the proposed well site via water trucks on existing roads. It is unknown how much water will be needed to drill the well however, 85,000 gallons of water would be needed for the injection test.

The project area is located on an approximate 6 percent slope. Esmeralda proposes to construct the pad for the proposed exploration hole using the “cut and fill” technique. The upper eastern portion of the proposed drill hole pad will be excavated and moved to the lower western end of the pad in order to make a flat pad. The proponent would use bulldozers to build the well pad. Esmeralda plans to drill the proposed exploration hole in September or October of 2006.

2.2 Standard Operating Procedures

The operator shall obtain and maintain all necessary State of Nevada and local permits applicable to drilling this exploration drill hole.

The operator shall stockpile all topsoil from the pad and reserve pit for use in reclamation.

The mud pit shall be fenced on three sides during drilling. Upon completion of the well when the site is not occupied, the fourth side of the pit shall be fenced. The pit shall remain fenced until reclaimed.

Trash shall be contained on-site and hauled to an approved landfill. Burial of trash on-site is not permitted.

Portable chemical toilets shall be used for human waste. The latter may not be chemically treated or buried on site.

Upon abandonment, the operator shall:

Remove all trash and debris from the site and disposed of it properly.

Recontour the mud pit to as near original grade as possible, and spread topsoil saved from digging the pit over the covered pit and pad.

All reclamation of the disturbed areas shall be completed within one (1) year from the date of the proper plugging and abandonment of the well. The Authorized Officer of the Bureau of Land Management shall be notified in writing when reclamation operations commence and when reclamation is completed and shall accept the reclamation in writing.

2.3 Lease Stipulations

As noted in section 2.1, the proposed well would be located on lease number NVN-74099. Relevant stipulations from the standardized lease stipulations signed by the proponent are listed below.

Air Quality

The Bureau of Land Management (BLM) may require the drilling company to water drill pads and newly constructed dirt roads for dust abatement.

Native American Religious Concerns

As exploration wells are drilled, the Authorized Officer will require the operator, for any local hot springs which have potential to be affected by the operation, to measure the water temperature and water level or discharge prior to initiating operations, and to monitor the water temperature and discharge or level during operations. The specific types of information and results of this monitoring will be reported to BLM as specified in Conditions of Approval for specific permit applications. The operator will be required to take corrective action as directed by the Authorized Officer if the Authorized Officer determines that changes in water temperature, discharge or level have occurred and have a negative impact on listed threatened or endangered species or their habitat, or to Traditional Cultural Properties. Required corrective action may include amending, relocating or discontinuing operations.

Threatened and Endangered and Special Status Species

Mitigation measures will need to be developed on an individual project basis. Land disturbed by the proposed action would be inventoried for Threatened and Endangered or Special Status Species if they are known to occur in the area. All threatened and endangered and special status plant species will be avoided.

Noxious Weeds

Exploration on public land has the potential to spread noxious weeds. The following mitigating measures will be implemented to avoid spreading noxious weeds.

Mitigating Measures:

Areas to be developed must be inventoried for the presence of noxious weeds before disturbance. When sites are abandoned, they will be inventoried for the presence of noxious weeds and treated if noxious weeds are present. Seed and mulch used to reclaim disturbed areas must be weed free. The underside of all heavy equipment must be cleaned by water before entering public lands to do work. During operations, personnel would avoid driving through or parking on weed infestations.

Soils

All topsoil from all disturbances will be stockpiled for use in reclamation.

Vegetation

Mitigating Measures:

All topsoil from all disturbances will be stockpiled for use in reclamation.

1. Avoid developing on or within 100 feet of riparian areas.
2. Disturbed areas will be reseeded with pure live seed with the following mixes:

Salt Desert Shrub Species	Seed rate (*pounds per acre*)
Indian ricegrass (*Oryzopsis hymenoides*)	3.0
Bottlebrush squirreltail (*Sitanion hystrix*)	2.0
Fourwing saltbrush (*Atriplex canescens*)	3.0
Shadscale (*Atriplex confertifolia*)	2.0
Small Burnett (*Sanguisorba minor*)	1.0
Blue Flax (*Linum lewisii*)	1.0

Wildlife

Mitigating Measures: The project proponent would avoid ground disturbance activities during the migratory bird-nesting season to avoid potential violation of the Migratory Bird Treaty Act.

2.4 Alternatives to the Proposed Action

No Action Alternative – Under the No Action Alternative, the BLM would not permit Esmeralda to drill the proposed exploration hole.

Alternatives considered but rejected included directionally drilling the target from an adjacent lease parcel or not allowing Esmeralda to drill on the site they have specified. These alternatives were rejected as they are not consistent with the proposed action, BLM policy, and regulation, and law. The No Action Alternative and the Proposed Action provide a sufficient range of impacts to inform the decision maker of the effects of the Proposed Action.

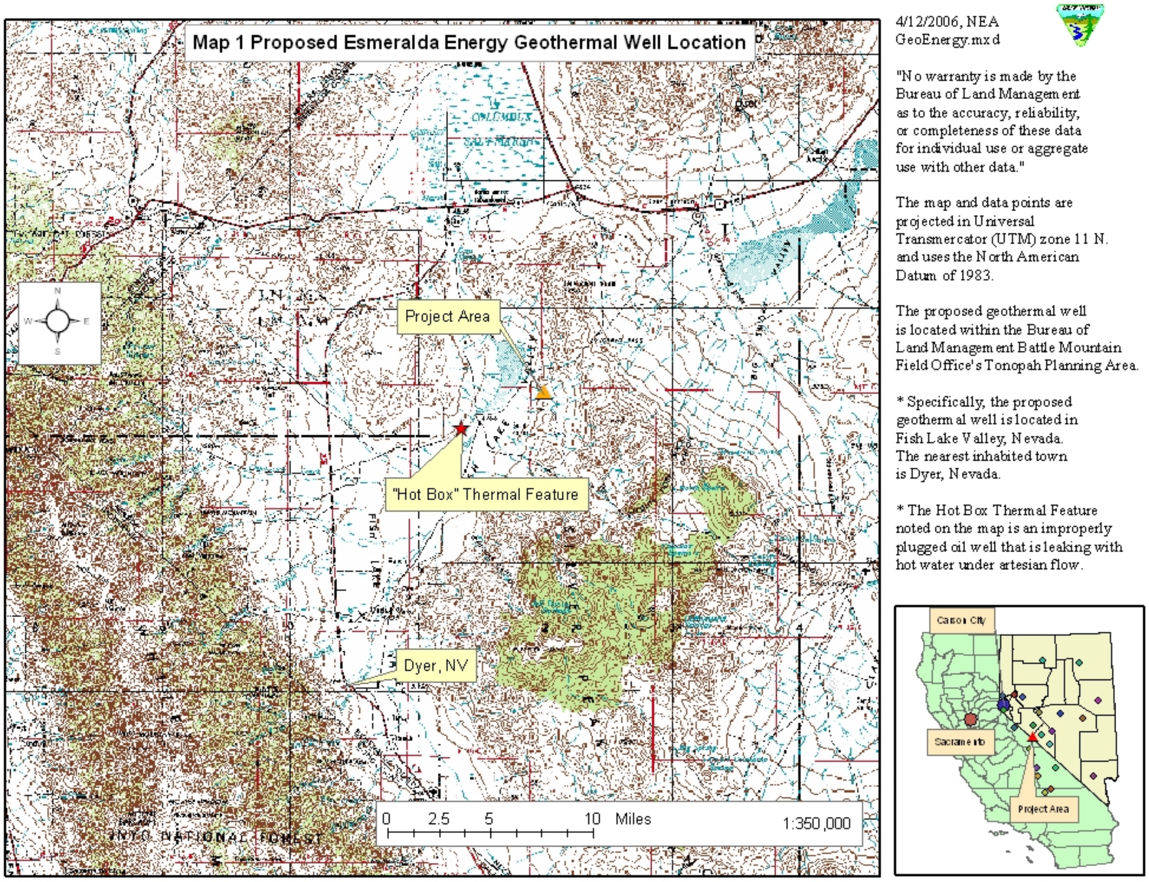


Figure 1. The map shows the location of the Hot Box Recreation and Public Purposes lease site (labeled on the map as "Hot Box Thermal Feature") and the proposed exploration hole (Emigrant #17-31).

3.0 IMPACT ASSESSMENT

3.1 Critical Elements

To comply with the National Environmental Policy Act (NEPA), the Bureau of Land Management is required to address specific elements of the environment that are subject to requirements specified in statute, regulation or by executive order (BLM 1988, BLM 1997).

Critical Element	**Present Yes/No**	**Affected Yes/No**	**Rationale**
Air Quality	Yes	Yes	See discussion below.
ACECs	No	No	There are no ACECs within the vicinity of the Proposed Action or Alternative.
Cultural-Paleontological Resources	No	No	A cultural survey was completed and no cultural resources were found.
Environmental Justice	No	No	Environmental justice would not be affected by the Proposed Action or Alternative because there are no minority populations affected by the Proposed Action area or alternative.
Flood Plains	No	No	There are no Flood Plains within the vicinity of the Proposed Action or Alternative.
Invasive, Non Native Species	No	No	The proposed action or alternative would not affect invasive, non-native species because they do not exist in the project area. Lease stipulations will prevent introducing noxious weeds.
Migratory Birds	No	No	Migratory birds are known to occur in Fish Lake Valley. However, migratory bird nest sites are not known to occur in, within or in close proximity of the proposed drill hole. Therefore, additional analyses of affects to Migratory Birds will not be discussed further except for the Burrowing Owl.
Native American Religious Concerns	Yes	No	Due to project location, methods to be used during project implementation, and identified mitigation/prevention measures, adverse impacts to known and unknown Tribal resources, sites, and activities are not anticipated to occur. See discussion below.
Prime or Unique Farmlands	No	No	Not present within the vicinity of the Proposed Action or Alternative.
Threatened and/or Endangered Species (Plants)	No	No	Threatened and/or endangered species (plants) would not be affected by the Proposed Action or Alternative because none are known to exist in the project area.

Threatened and/or Endangered (Animals)	No	No	Not present within the vicinity of the proposed action or alternative
Wastes, Hazardous or Solids	No	No	Not present within the vicinity of the Proposed Action or Alternative.
Water Quality	Yes	Yes	The Proposed Action and Alternative would have indirect affects to water quality issues. See discussion below.
Wetlands and Riparian Zones	Yes	No	Not present within the vicinity of the proposed drill hole. However, the Hot Box is within a riparian area. The proponent will access the ponds at the Hot Box via the unvegetated sandy area of the ponds. No riparian vegetation or habitat will be disturbed when the proponent extracts the water from the ponds.
Wild and Scenic Rivers	No	No	Not present within the vicinity of the Proposed Action or Alternative.
Wilderness	No	No	Wilderness areas are not present within the vicinity of the Proposed Action or Alternative.

As outlined above, the following critical elements of the human environment are not affected by the proposed action or alternative and will not be brought forward for further analysis in this EA: Areas of Critical Environmental Concern, cultural and historical resources, Environmental Justice, Prime and Unique Farmlands, Floodplains, Native American Religious Concerns, Wastes (Hazardous or solid), Threatened or Endangered Species, Wetlands/Riparian, Wild and Scenic Rivers, and Wilderness.

3.2 Other Resources

Other Resources	Present Yes/No	Affected Yes/No	Rationale
Forestry	No	No	Forestry resources will not be affected by the Proposed Action or the Alternative because none exist in the project area.
Grazing Management	Yes	No	The Silver Peak Allotment has been allocated 50 acres/AUM. The Proposed Action would occupy only 0.33 acre and represents 0.0066 AUM. In comparison with the total size of the allotment (283,907 acres), the proposed action represents a disturbance of 0.00012% of the allotment.
Land Use	Yes	Yes	See discussion below

Authorization			
Minerals	Yes	Yes	See discussion below
Recreation	Yes	Yes	See discussion below
Socio-Economic Values	Yes	Yes	See discussion below
Soils	Yes	Yes	See discussion below
Special Status Species (plants and animals)	No	No	Special status plant species will not be affected by the Proposed Action or the Alternative because none exist in the project area.
Vegetation	Yes	No	Vegetation at the project site is sparse. A combination of low precipitation and poor soils has resulted in minimal vegetation within the assessment area. In comparison with the total size of the assessment area (6 mile radius), the proposed disturbance represents a neglible affect on the resource and will not be brought forward for further analysis.
Visual Resources	Yes	Yes	See discussion below.
Wild Horses & burros	Yes	Yes	See discussion below.
Wildlife	Yes	Yes	See discussion below.

3.3 Impacts requiring further analysis

As outlined above, the following resources have been determined, through internal scoping, to be present and affected by the Proposed Action: Air Quality, Land Use Authorizations, Minerals, Recreation, Socioeconomics, Soils, Visual Resource Management, Water Quality, and Wild Horses and Burros, Wildlife. These resources will be brought forth for further analysis in this Environmental Assessment.

3.3.1. Air Quality

Affected Environment

Weather in central Nevada is characterized by low humidity often with large diurnal variations in temperature. Prevailing wind patterns are generally from the west but locally follow the north-south orientations of the mountain ranges. Occasional intense winds can cause localized dust storms, dust devils, and decreased visibility.

Environmental Consequences of the Proposed Action on Air Quality

The fine-grained nature of the existing soil associations occurring within the assessment area would likely contribute to increased dust particulates when disturbed by the Proposed Action (i.e., access road and well pad building and mineral materials mining). The effect on air quality of the area would be mainly in the form of an increase in fugitive dust related to the freshly exposed surfaces and exhaust fumes of motorized equipment related to drilling activities. This impact would be minor and would occur during the construction phase of the proposed action. All operations would comply with applicable air quality standards. Travel on roads would create dust; however, all of this would still be in the short term (i.e., during the drilling the exploratory hole and performing the injection test).

Environmental Consequences of the No Action Alternative on Air Quality

There would be no changes to the air quality in Fish Lake Valley under the No Action Alternative.

3.3.2 Land Use Authorizations

Affected Environment

Three RS 2477 roads have been identified for use in the proposed project. These roads are identified as Esmeralda County Road #15 Emigrant Pass Road (N-54394), Road 43 and Road #47 (N-55402).

Water to be used for the drilling of the proposed oil well would be obtained from the Hot Box Park, a Recreation and Public Purposes lease (N-50991 and access road N-52827) site held and leased by Esmeralda County. The Hot Box is an improperly plugged and abandoned oil well that is leaking thermal waters under artesian flow. TFS received a letter from the Esmeralda County Commissioners granting Esmeralda permission to use the excess water at the Hot Box Park for the purposes of drilling the hole and testing the geothermal reservoir. The water needed for the drilling mud and injection test will be pumped from the abandoned oil well head. The water would be hauled to the proposed well site via water trucks on existing roads.

Environmental Consequences of the Proposed Action on Land Use Authorizations

The Esmeralda County Road Department has provided the Tonopah Field Station with a letter indicating they will maintain utilized access roads prior to, and after, the proposed exploration hole is drilled.

Esmeralda County Commissioners support the development of geothermal energy resources in Esmeralda County. A unanimous decision was given to provide excess water from the artesian well known as VRS-1 at the Hot Box recreation area. Esmeralda Energy was authorized to take water from the wellhead at no charge as needed to complete the project in either August or September 2006.

Environmental Consequences of the No Action Alternative on Land Use Authorizations

There would be no change to local land use authorizations under the No Action Alternative.

3.3.3 Minerals and Geology

Affected Environment

There are no active or pending mineral material contracts or free use permits issued to operators within a six mile radius of the proposed action. There are no pending sodium prospecting permits and potassium prospecting permits located within 6 miles of the proposed action. The closest hard rock mining notice, operated by Vanderbilt Minerals Corporation (NVN-73451), is located approximately 1 mile west of the proposed action. The closest mining plan of operations, operated by Golden Phoenix Minerals (NVN-73109), is located approximately 12.5 miles southeast of the proposed action. Authorized noncompetitive geothermal leases bound the project area on all sides except the east side. The holder of these leases is the proponent.

Environmental Consequences of the Proposed Action on Mineral Resources

A better understanding of the physical properties of the underlying geothermal reservoir will be gained as a result of the proposed action. A well pad would be constructed in order to facilitate this endeavor. No other mineral resources would be affected by the proposed action as there are no other known mineral resources in the vicinity of the proposed action.

Environmental Consequences of the No Action Alternative on Mineral Resources

There would be no change to the mineral resources under the No Action Alternative.

3.3.6 Socioeconomics

Affected Environment

Esmeralda County is located in the southwestern portion of Nevada and is bordered by California to the west. The county also borders and contains a small part of Death Valley National Monument and is 3,588 square miles in size. Goldfield is the county seat. About 98 percent of the county's total area is managed by the federal government. Of these federally-managed lands, approximately 2.2 million acres are managed by the Bureau of Land Management.

The total population of Esmeralda County in 2000 was 971, a decrease of 28 percent since 1990. Projections show the county to grow to 1,611 persons by 2006. Since 1970, the population in Esmeralda County has grown slower rate than the state.

In terms of employment opportunities in Esmeralda County, the majority of jobs are in the agriculture and mining industries. Of those, most are employed in construction and extraction occupations. Over the past 30 years, job growth in the county has been slower than both the state and the nation and the unemployment rate is estimated at 8.2 percent.

Most residents (63 percent) earn less than $30,000 annually, with about 3 percent earning more than $100,000, with a per capita annual income of about $19,000. However, average earnings per job in the county are lower than the state and the nation.

Environmental Consequences of the Proposed Action on Socioeconomics

Approximately four people could be employed on-site as the Emigrant #17-1 exploratory drill hole is drilled.

Environmental Consequences of the No Action Alternative on Socioeconomics

There would be no change to local socioeconomics under the No Action Alternative.

3.3.5 Soils

Affected Environment

The predominant soil association in the vicinity of the proposed action is the Wardenot-Stonell-Roic soil association. It is described by the Natural Resources Conservation Service as being composed of very gravelly sandy loam to a very gravelly fine sandy loam. This soil association is typically found on various parts of an alluvial fan.

Environmental Consequences of the Proposed Action on Soils

The upper sections of the soil association would be disturbed where new drill pad construction would occur. Additionally, soils would be disturbed by increased vehicular traffic to the drill site. However, the soil profile would be restored to as near natural conditions as possible when the drill pad is reclaimed.

Environmental Consequences of the No Action on Soils

There would be no changes to the soils under the No Action Alternative.

3.3.6 Visual Resources Management

Affected Environment

The assessment area consists of a Class IV Visual Resource Management (VRM) area. The Class IV objective is to provide for management objectives that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high.

Environmental Consequences of the Proposed Action on Visual Resources

The drill rig would be visible in a very limited area, within approximately 500 feet of the disturbance. The drill site would be visible from higher peaks and ridge tops surrounding the site.

These intrusions are within the allowable limits of the class IV Visual Resource Management Area determination in the Tonopah Resource Management Plan and Record of Decision.

Environmental Consequences of the No Action Alternative on Visual Resources

There would be no change to the visual resources under the No Action Alternative.

3.3.7 Water Quality

Affected Environment

The following paragraph is a brief summarization of the groundwater regime of Fish Lake Valley as described by Rush and Katzer in 1973.

The principle source of water in Fish Lake Valley is the alluvium that composes the valley-fill aquifer. Groundwater migrates through alluvium from the alluvial fan and mountain fronts toward the axis of the valley and then migrates northward along the axis toward the playas. Under unusually wet conditions, some water may flow northward beyond the playa and discharge through The Gap into Columbus Salt Marsh Valley. Water quality appears to vary with respect to proximity to the playas (i.e., water quality generally degrades as it migrates toward the playa). As precipitation enters and flows through the hydrologic systems, contact of the water with vegetation, soil, and rock increases the dissolved solids content of the water.

Water analysis taken at the Hot Box, the water source for the drilling mud and injection test, which was submitted by the proponent to the Tonopah Field Station, documented good quality water with total dissolved solids (TDS) concentrations of 913.3 mg/l and a pH of 8.1 (standard units). This is less than the primary drinking water standards of 1000 mg/l and a pH of 8.5, respectively. In contrast, water samples taken from several sources near the proposed drill site show TDS and pH values exceeding the primary drinking water standards. The sample locations are shallow wells within the basin fill deposits whose chemistry could vary considerably to the deeper geothermal waters. By their very nature, however, most constituents have a greater saturation index in geothermal waters resulting in greater dissolved solids and lower water quality so injection into the geothermal unit would not adversely affect the water quality.

Water associated with geothermal reservoirs is often described as a brine because the fluid contain large amounts of dissolved silica, precious and base metals, alkali earth metals, and arsenic. These brines can contain high enough concentration of a given commodity to make it economical to extract it from the brine before re-injecting the fluid into the geothermal reservoir. CalEnergy is producing high-grade zinc from geothermal brines in Salton Sea, California while Lawrence Livermore National Laboratory is researching methods to extract silica from brines at the geothermal power plant in Mammoth Lakes, California.

Environmental Consequences of the Proposed Action

The proponent is working with the Nevada Division of Environmental Protection-Underground Injection Control (NDEP-UIC) program to permit the injection test. In a conversation with Birgit Widegren, an environmental scientist with the NDEP-UIC indicated the proposed drill hole would be classified as a Class V injection well. According to the U.S. Environmental Protection Agency, wells with a Class V designation typically inject non-hazardous fluids into or above an aquifer and are typically shallow, on-site disposal systems.

When asked about the possible affect of injecting 85,000 gallons of ambient temperature water into a thermal reservoir, Christi Morris, petroleum engineer for the Nevada Division Of Minerals (NDOM), indicated that the proposed action could impact (i.e., localized cooling of the geothermal reservoir) the thermal reservoir in close proximity of the drill hole for a period of a few days to a few weeks. It is likely that the drill hole may intersect geothermal brines at the bottom of the drill hole and the ensuing injection test would add water of better quality to the aquifer. Water quality or temperature of the geothermal reservoir are unknown and can only be determined after the well has been drilled. Water analyses will be conducted wherever the proponent encounters water in the drill hole. The Proposed Action is not expected to impact the temperature of the water in the Hot Box Springs because the Hot Box is located approximately 5 miles southwest of the proposed drill hole and the Hot Box is recharged with artesian flow.

Environmental Consequences of the No Action Alternative on Water Quality

There would be no change to the water quality under the No Action Alternative.

3.3.8 Recreation

Affected Environment

The recreational uses of the assessment area consist primarily of visitors interested in soaking in the nearby Hot Box Hot Springs. Many visitors to the area come from Las Vegas, Reno, California and local communities. Though the local citizens are primarily day visitors, those from further away often camp nearby for several days. In addition to hot spring bathing, visitors to the area engage in a variety of recreational activities including camping, viewing wildlife, riding off-highway vehicles, hunting, hiking, riding mountain bikes and driving for pleasure.

The assessment area also contains several sections of past authorized off-road motorized race course. There is one race planned for an adjacent area on August 26, 2006 from the Silver Peak area to Coaldale Junction, west of State Highway 265, east of the Silver Peak Range. Typically, there are 1-2 off-road racing events a year that utilize the past authorized race routes in the general area.

Environmental Consequences of the Proposed Action

Due to the short term nature (approximately 2 weeks) of the proposed action and the fact that there are no proposals to limit access other than possibly to the immediate work site, the impact to current recreation uses in the area are expected to be minimal because the Hot Box is located 5 miles southwest of the proposed drill hole. There would be minimal interruption to users at the Hot Box Springs since the project will only last two weeks. The intermittent extraction of water is not anticipated to affect the water temperature or volume of water in the ponds. Individual episodes of water extraction would be on the order of an hour or so.

Environmental Consequences of the No Action Alternative on Recreation

There would be no impact to recreation under the No Action Alternative.

3.3.9 Wild Horses & Burros

Affected Environment

The Silver Peak Herd Management Area (HMA) is approximately 240,000 acres in size and encompasses the Silver Peak Mountain Range and a portion of Fish Lake Valley. According to a 2005 aerial census, there are approximately 61 horses distributed in small bands along the north half of the HMA and 15 burros located mostly on the southeast portion.

The Silver Peak HMA has a history of emergency horse gathers because horses were starving due to poor quality forage. Therefore, in 2005, the Fish Lake Valley Complex Evaluation (EA # NV065-2005-037) set the Appropriate Management Level for horses on the HMA at 0. For more details regarding the Silver Peak area, vegetation and water availability, and wild horse and burro management decisions, refer to the Fish Lake Valley Complex Evaluation. A wild horse and burro gather is scheduled for September 2006 in which all the horses on the HMA will be removed to prevent further starvation issues.

Environmental Consequences of the Proposed Action

The water extraction portion of the proposed action is located within the western boundary of the Silver Peak HMA. In addition to the Hot Box Well from which the water will be extracted, there are several ponds in the vicinity which provide supplemental water for wild horses in the area. The injection test site, however, will not occur within the boundaries of the HMA. The Hot Box recharges under artesian flow and the horses do not use it.

Environmental Consequences of the No Action Alternative on Wild Horses & Burros

There would be no impact to wild horses or burros under the No Action Alternative.

3.3.10 Native American Concerns

Affected Environment

Recognized tribes with known interests within the BLM Battle Mountain Field Office administrative boundary are the Te-Moak Tribe of Western Shoshone (Elko, South Fork, Wells, and Battle Mountain Bands), Duck Valley Sho-Pai Tribes of Idaho and Nevada, Duckwater Shoshone Tribe, Ely Shoshone Tribe, Yomba Shoshone Tribe, Timbisha Shoshone Tribe, and various other community members and individuals. Specifically, Fish Lake Valley lies within the traditional territory of the Timbisha Shoshone Tribe, and is part of the BLM Tonopah Field Station administrative boundary, which is known to contain spiritual/traditional/cultural resources, sites, and social practices that aid in maintaining and strengthening social, cultural, and spiritual integrity.

Resources, sites and social practices of importance include, but are not limited to: Existing antelope traps; certain mountain tops used for prayer; medicinal and edible plant gathering locations; prehistoric and historic village sites and gravesites; sites associated with creation stories; hot and cold springs; material used for basketry and cradle board making; locations of stone tools such as points and grinding stones (mono and matate); chert and obsidian quarries; hunting sites; sweat lodge locations; locations of pine nut ceremonies, traditional gathering, and camping; boulders used for offerings and medicine gathering; tribally identified Traditional Cultural Properties (TCP's); TCP's found eligible to the National Register of Historic Places; rock shelters; "rock art" locations; lands that are near, within, or bordering current reservation boundaries; water sources (hot and cold springs, etc) in general that appear to be considered the "life blood of the Earth and all who dwell upon it."

Specifically, Fish Lake Valley, before the arrival of non-native ranchers and pioneers, once contained many Shoshone people who participated in the lifeways discussed above. It has been reported that the valley contains many sites of past traditional, cultural, and spiritual use, during a time when water was more abundant, before the advent of historic and contemporary farming and ranching use. Currently, few Timbisha Shoshone live in Fish Lake Valley, although tribal and family associations with Fish Lake Valley and the surrounding area are quite strong.

Environmental Consequences of the Proposed Action on Native American Concerns and proposed Mitigation

In accordance with the National Historic Preservation Act (P.L. 89-665), the National Environmental Policy Act (P.L. 91-190), the Federal Land Policy and Management Act (P. L.94-579), the American Indian Religious Freedom Act (P.L. 95-341), the Native American Graves Protection and Repatriation Act (P.L. 101-601) and Executive Order 13007, the BLM must also provide affected tribes an opportunity to comment and consult on the proposed project. BLM must attempt to identify locations having traditional, cultural, or spiritual importance and limit, reduce, or possibly eliminate any negative impacts to identified traditional, cultural, spiritual sites, activities, and resources.

On May 1, 2006, BLM mailed a "consultation initiation letter to the Timbisha Shoshone Tribe. Communication with Timbisha Tribal representatives produced a field tour, which took place on Tuesday, June 13, 2006.

During the June, 2006, field tour and subsequent phone discussions, with Timbisha Shoshone representatives, the following concerns were identified: 1. Timbisha requests information demonstrating a no adverse impact to Big Horn Sheep (which frequent the area) migration routes and mating/birthing locations. 2. Although surface artifacts were not found during cultural survey, subsurface or buried artifacts may exist. Therefore, Timbisha requests one or two tribal monitors to be present during access route and drill pad construction.

The affects of this activity to be conducted under the Proposed Action is expected to be minimal and relatively short-term due to the nature and limited complexity of the specific exploration activities (one geothermal exploration drilling site) and identified mitigation/prevention measures. Access to the area would be maintained and use throughout the area would continue. However, any subsequent plan leading to production facilities (or continued/expanded exploration activities) may increase the level and type of impacts in the Fish Lake Valley area and therefore, should be presented to the affected tribal entities for further analysis when or if such a plan (or a new or expanded exploration plan) is submitted to BLM.

Also, during project implementation, if any cultural properties, items, or artifacts (stone tools, projectile points, etc…) are encountered, it must be stressed to those involved in the proposed project activities that such items are not to be collected. Cultural and Archaeological resources are protected under the Archaeological Resources Protection Act (16 U.S.C 470ii) and the Federal Land Management Policy Act (43 U.S.C. 1701).

Though the possibility of disturbing Native American gravesites within most project areas is extremely low, inadvertent discovery procedures must be noted. Under the Native American Graves Protection and Repatriation Act, section (3)(d)(1), it states that the discovering individual must notify the land manager in writing of such a discovery. If the discovery occurs in connection with an authorized use, the activity, which caused the discovery, is to cease and the materials are to be protected until the land manager can respond to the situation.

Environmental Consequences of the No Action Alternative on Native American Concerns

Under the No Action Alternative, potential impacts to any Native American traditional/cultural/spiritual resources, sites, and activities would not exist. However, opportunities for limited tribal employment, coordination and collaboration, proactive and productive working relationship development, and cross cultural education opportunities would not present themselves.

3.3.11 Wildlife (Including Big Game, Small Game, and BLM Sensitive Status Species)

Affected Environment

As stated in section 3.2, the proposed action, drilling an exploratory geothermal well and performing an injection test on the geothermal reservoir, will occur in the Silver Peak Allotment. Specifically, the proposed drill hole is located at the easternmost margin of the allotment however, the Hot Box, the source of water for the drilling mud and injection test, is located in the southeastern portion of the Red Spring Allotment.

The following discussion has been excerpted from the Fish Lake Valley Complex Evaluation environmental Assessment (NV065-2005-037) Appendix A Rangeland Health Assessment. For more specific information regarding wildlife species in the Silver Peak or Red Spring Allotment, the reader is encouraged to contact the Tonopah Field Station for a copy.

The Silver Peak and Red Spring allotments provide habitat for a host of wildlife species including Mule deer *(Odocoileus hemionus)*, Desert bighorn sheep (*Ovis canadensis nelsoni)*, coyote *(Canis latrans)*, chukar *(Alectoris chukar)*, Greater sage grouse *(Centrocercus urophasianus)*, burrowing owl, waterfowl species, raptor species, and many others.

Mule deer

Suitable deer habitat on the allotment is found within the sagebrush and pinyon-juniper zone at elevations above 4500 ft with annual precipitation of more than 8”. Mule deer use in lower elevations would be incidental. Optimal summer habitat for mule deer is considered to be 8000 ft and above in elevation, with slopes greater than 30%, and plant communities rich in forbs.

Desert bighorn sheep

Optimal habitat for bighorns consists of rugged, steep, canyon country with greater than 80% slopes, and 4 to 8 inches or more of annual precipitation. Optimal habitat will also have available water sources less than 4 miles apart, generally 2 miles is considered a maximum.

Chukar

Optimal year-round chukar habitat can be described as areas in proximity to slopes greater than 25% with a good rock outcrop component. Areas with shrub (like sagebrush) cover of 30-80% with a good understory of annual grass (like cheatgrass) and forbs. One of the primary components of good chukar habitat is a reliable source of perennial water. By most accounts chukar are rarely, if ever, more than 2 miles from perennial water source.

Greater Sage Grouse

Due to the marginal Sage grouse habitat found in the area of the Silver Peak Allotment and the general lack of information, there are no current population estimates for the area. It is thought that there are no yearlong residents of the area and any use by sage grouse is transient.

Burrowing Owl

There are no records of Burrowing owls on the Silver Peak Allotment. However suitable habitat does exist on the Silver Peak allotment and burrowing owls have been found in adjacent allotments. Therefore it is likely that small numbers of burrowing owls nest on the allotment. Burrowing owls can be found in a variety of habitats from salt desert shrub to montane parklands. However one necessary component of burrowing owl habitat is another burrowing animal such as prairie dogs, ground squirrels, kit foxes, or badgers. This is because the owls don't dig their own burrows but rather utilize existing burrows as their nest and shelter sites.

Nevada BLM Sensitive Species

The Nevada BLM Sensitive Species that is known to occur in the vicinity of the proposed action is the Desert big horn sheep.

Sensitive Species are taxa that are not already included as BLM Special Status Species under (1) Federally listed, proposed, or candidate species; or (2) State of Nevada listed species. BLM policy is to provide these species with the same level of protection as is provided for candidate species in BLM Manual 6840.06 C, that is to "ensure that actions authorized, funded, or carried out do not contribute to the need for the species to become listed". The Sensitive Species designation is normally used for species that occur on Bureau administered lands for which BLM has the capability to affect the conservation status of the species through management. The BLM Manual 6840.06 E provides factors by which a native species may be listed as "sensitive" if it:

1. Could become endangered or extirpated from a State or within a significant portion of its range in the near future;
2. Is under status review by the USFWS and/or National Marine Fisheries Service;
3. Is undergoing significant current or predicted downward trends in: (1) habitat capability that would reduce a species' existing distribution; and/or (2) population or density such that federally listed, proposed, candidate, or State listed status may become necessary;
4. Typically consists of small and widely dispersed populations;
5. Inhabits ecological refugia, or specialized or unique habitats; or
6. Is State-listed, but which may be better conserved through application of BLM sensitive species status.

Environmental Consequences: Proposed Action: As noted in the affected environment section, optimal habitat for mule deer, Desert big horn sheep, and Greater sage grouse does not occur within the vicinity of the proposed drill hole. Examination of range studies of the area suggest that a population of these animals within the project area would be transient as they would be migrating through the area to a more suitable location. Given the size of disturbance associated with the proposed action (0.33 acre), these animals can readily avoid the area. Construction activities have the potential to affect sensitive species that may occur in the project area.

Environmental Consequences: No Action Alternative: The project area would be unchanged.

Mitigation: None identified.

Residual Impacts: None identified.

4.0 CUMULATIVE IMPACTS ANALYSIS

The proposed action has been examined for cumulative effects to the project area (6 mile radius around the drill hole) surroundings. Cumulative impacts are those effects on resources within an area or region caused by a combination of past, present, and reasonable foreseeable future actions (RFFA's). These impacts may be individually minor but added together over time may become significant (40 CFR 1508.7).

4.1. Past and Present Actions

The past and present actions include several separate hard rock-related drilling programs that have been completely reclaimed. Within the same township as the Proposed Action, approximately thirty-one miles of road rights-of-way have been granted to Esmeralda County under the auspices of the Revised Statute 2477. The proposed drill hole would be located in the Silver Peak allotment which has an animal unit month (AUM) rate of 50 acres per AUM. The dominant activities in the proposed project area include occasional off highway vehicle races, dispersed recreational activities (i.e., mineral collecting, hunting or riding off-highway vehicles) and limited amounts of cattle ranching and mineral exploration. These activities are expected to continue.

4.2. Reasonable Foreseeable Future Actions (RFFA's)

Reasonable Foreseeable Future Actions associated with the proposed action include drilling additional exploration holes or production wells and building associated well pads and access roads for these wells and drill holes on the east side of Fish Lake Valley. Due to the speculative nature of geothermal exploration and development further discussion of geothermal production and development would be premature. Any future actions associated with geothermal exploration, development, or production will have site-specific analyses.

Off highway vehicle races in the area of the proposed action would continue to be held at irregular intervals.

4.3 Cumulative impacts from past and present actions

The activities noted above exist throughout the project area and surrounding areas identified in section 4.0. Cattle grazing is widely scattered throughout Fish Lake Valley with local vegetation being grazed year-round on the Silver Peak allotment (refer to section 3.2).

4.4 Cumulative impacts from RFFA's

Air Quality – Continued exploration drilling activities and associated construction activities in the area would create short term (i.e., during the timeframe of respective projects) air quality impacts. Particulates/fugitive dust would be caused by disturbing the soil cover by additional travel on dirt roads, new access road and well pad construction, and additional drilling activities. However, all operations would comply with applicable air quality standards. Air quality impacts would be short term and localized. Future potential development project would be subject to site specific environmental analysis. Therefore, the cumulative impacts of the proposed action, when combined with past, present, and RFFA's and incorporating mitigating measures, would be insignificant.

Land Use Authorizations – Roads could be needed for continued exploration drilling and associated construction activities in the area. The playa area would become the main ingress and egress for these activities. Roads currently utilized for access would need to be in compliance with the BLM regulations and road specifications, 9113 BLM Roads Manual. Future potential project development would be subject to site specific environmental analysis and the valid and existing of existing rights-of-way holders.

Mineral Resources and Geology – Additional drilling would further refine the characteristics of the geothermal resources located below the project area. Any further exploration activities would require site specific environmental analyses. Site specific mitigation measures would be developed which would keep cumulative impacts of these projects at a minimum.

Socioeconomics – Additional exploration activities (i.e., drilling thermal gradient wells, exploration wells or production wells) would provide employment for local residents and would improve the local economy for the duration of their employment. The socioeconomic impact of the proposed project, when compared to the overall economy within the vicinity of the area, is expected to be temporary and minimal.

Soils – Additional drilling would create short term effects (i.e., during the timeframes of the respective projects) to the local occurrences of the soil association as the soil would be less likely to support vegetation growth. By implementing best management practices (i.e., building exploration or production well drill pads as small as practicable) and reclaiming these disturbances, the impacts to soils would be minimal.

Visual Resources Management – Additional drilling would create short term effects (during the timeframe of respective projects) to the visual resources by creating more drill pads and exploration roads in varying states of reclamation. By building exploration or production well drill pads as small as practicable, the impacts to local visual resources would be reduced. It is expected that the Proposed Action would contribute minimal cumulative impacts to visual resources when analyzed with other past, present, and reasonably foreseeable actions within the cumulative impact study area. There will be no surface expression of the drill hole as the casing will be cut off below ground and covered when the drill pad is recontoured.

Water Quality – Exploration and development of the geothermal resource would entail the drilling and completion of additional geothermal well(s) very similar to the current project. The geothermal development production phase, during which the geothermal fluid would be produced and injected, may also begin during the "foreseeable future." These additional activities would not be expected to create any direct cumulative impacts to water quality. The chemical composition of the water will remain unchanged therefore the incremental impact of the proposed action or future actions will not impact water quality. Any future exploration and development will require site specific environmental analyses.

Wild Horses and Burros— Direct impacts to wild horses or burros would not occur due to the proposed action unless the action occurs simultaneous to the proposed wild horse and burro gather for Silver Peak Herd Management Area (HMA). This gather is planned for September, 2006, at the same time as the proposed action is estimated to take place. This may cause atypical movement of horses and heightened herd vigilance due to increased human activity, which may be problematic for the gather itself.

However, this wild horse gather will remove all horses within the Silver Peak HMA, eliminating the risk of any long or short term impacts to horses. Burros are located on the southeast side of the Silver Peak HMA and will not be impacted by the proposed action.

Cumulative impacts to wild horses are expected to be negligible because a) the amount of disturbance is less than 1 acre, and b) all horses will be gathered and removed from the Silver Peak HMA, reducing the impacts from wild horse and burros of any past, present, and reasonably foreseeable future actions.

Recreation – Exploration activities are generally short-term in nature that is, these activities can take one month or less per action. Access, aesthetics, and relative solitude are reasons OHV enthusiasts, campers, and other recreationists spend their free time in the desert. Additional exploration or production activities would have little impact on these activities as these activities have a short duration and do not occupy large areas. The intermittent extraction of water is not anticipated to affect the water temperature or volume of water in the ponds. Opportunities for recreational use of the Hot Box springs will not be affected because the water temperature and volume will remain unchanged. Therefore, the incremental impacts from the proposed action when compared to the overall assessment area, combined with past, present, and RFFA's, and incorporating mitigation measures, are expected to be minimal.

Native American Religious Concerns -- As stated above, the affects of this activity to be conducted under the Proposed Action is expected to be minimal and relatively short-term due to the nature and limited complexity of the specific exploration activities (one geothermal exploration drilling site) and identified mitigation/prevention measures. Access to the area would be maintained and use throughout the area would continue. However, any subsequent plan leading to production facilities (or continued/expanded exploration activities) may increase the level and type of impacts in the Fish Lake Valley area and therefore, should be presented to the affected tribal entities for further analysis when or if such a plan (or a new or expanded exploration plan) is submitted to BLM.

Wildlife -- Additional drilling (and associated well pad and access road construction) activities would temporarily reduce the amount of habitat for small animals that may occur in the assessment area. As individual access roads and well pads are revegetated, the habitat for these animals would return. Therefore, the incremental impacts from the proposed action when compared to the overall assessment area, combined with past, present, and RFFA's, and incorporating mitigation measures, are expected to be minimal.

5.0 Mitigation Measures and Residual Impacts

The mitigation measures listed below would be undertaken in addition to the standard operating procedures indicated in section 2.2 and the lease stipulations noted in section 2.3.

Upon the proper plugging and abandonment of the well, the proponent would scarify and recontour the site.

Coordination between the BLM and the Esmeralda Energy Company would need to occur to ensure the Proposed Action and the wild horse and burro gather on the Silver Peak HMA do not overlap. Specifically, Esmeralda Energy Company will call the wild horse and burro specialist at the BLM Tonopah Field Station in order to ensure that coordination between the BLM, the horse gather crew, and the current proponent occur.

If reclamation activities occur during the migratory bird breeding season (mid-March to August) the proponent would survey the project area for migratory bird nests including the Burrowing Owl.

6.0 Persons or Agencies Consulted

Nancy E. Army, Tonopah Planning Area Reclamation & Compliance Specialist, Lead Preparer

Andrea Felton, Tonopah Planning Area Wild Horse and Burro Specialist

William S. Fisher, Assistant Field Manager, Tonopah Field Station

Valerie Metscher, Tonopah Planning Area Rangeland Management Specialist

Robert Perrin, Tonopah Planning Area Outdoor Recreation Specialist

Angelica Ordaz, Battle Mountain Field Office Planning and Environmental Coordinator

Susan Rigby, Tonopah Planning Area Archaeologist

Wendy Seley, Tonopah Planning Area Realty Specialist

Christopher Worthington, Battle Mountain Field Office Planning and Environmental Coordinator

Barbara Durham, Timbisha Shoshone Tribe

Joe Kennedy, Timbisha Shoshone Tribe

Brad Hardenbrook, Nevada Department of Wildlife

7.0 References Cited

U.S. Bureau of Land Management, 1997, Tonopah Resource Management Plan and Record of Decision, on file at the Bureau of Land Management Tonopah Field Station, 146 pgs.

U.S. Bureau of Land Management, 2005, Fish Lake Valley Complex Evaluation, on file at the BLM Tonopah Field Station.

8.0 List of Appendices

Appendix A, VRM Worksheet

APPENDIX A. VRM WORKSHEET

EMIGRANT 17-31 CORE HOLE
GRED III PROJECT DE-FC36-04GO14339
US. DEPARTMANT OF ENERGY / ESMERALDA ENERGY COMPANY

SUMMARY

John Deymonaz – Esmeralda Energy Company

The Emigrant 17-31 core hole (officially known as the Emigrant Slimhole Drilling Project) is a joint endeavor between the U.S. Department of Energy ("DOE") and Esmeralda Energy Company ("EEC") under DOE's Geothermal Resources Exploration and Definition III ("GRED III") program. Under the program DOE awarded EEC a $740,000 grant (80% DOE funds and 20% EEC funds) to conduct a detailed geologic mapping program, construct a Geologic Information System database, review existing data from the area, select a drill site and drill a core hole to a maximum depth of 4,000 feet.

Drilling on 17-31 commenced on October 13 and continued until November 6, 2006 to a depth of 2,938 feet. Upon completion, temperature measurements were made in the hole and an injection test to evaluate formation permeability was conducted. The upper 400 feet of the hole was rotary drilled to 8-3/4 inches and casing was set and cemented in place.

From 400 – 2,938 feet the hole was core drilled with HQ sized drilling equipment (2.50 inch core and a 3.78 inch hole). The technique involves "continuous wire line coring" in which core drilling advances until 10 feet of core is collected inside the drilling rods in a "core barrel" (core barrels vary in length from 5 – 20 feet). When the barrel is full, an "overshot" is run down inside the drilling rods on a steel cable referred to as a "wire line" and latches onto the core barrel when they make contact. The core barrel is then pulled back up the inside of the drilling rods and the core is retrieved. As soon as the full core barrel is at the surface, an empty core barrel is run back down the drilling rods and drilling resumes. This may continue for up to a week before the core bit requires replacement. At this time all of the drilling rods are pulled from the hole and the bit is replaced.

Core drilling a geothermal exploration hole such as 17-31 has several distinct advantages. The core retrieved is a continuous column of rock which shows not only rock type, but alteration and fractures, bedding, secondary mineralization and its relationship to fractures, multigenerational fracture events and their relationship to each other, fault orientations and much more.

By contrast, rotary drilling, which is much more common, (as used to drill water wells and production sized geothermal wells) generates sand sized cuttings which are collected from the drilling fluids as they return to the surface. Study of the cuttings, while valuable, is more abstract and requires much more interpretation and many important structural, mineral and alteration relationships are impossible to establish.

The negative aspect to core drilling is that the holes are small diameter, generally ranging from 5.28 inches down to 2.98 inches in diameter. The small size limits the holes to being used for testing and research purposes and they cannot be used to produce geothermal fluids in commercial quantities. Commercial geothermal wells have diameters of 8.5 to 13 inches in diameter, or larger.

The 17-31 drill hole has been successful in several areas. Primarily, it has encountered commercial geothermal temperatures (323 F) and the temperatures were still increasing at the bottom of the hole. This opens up a new geothermal field with commercial potential in Fish Lake Valley which will provide the necessary resource to justify the required infrastructure cost to develop the resource when tied to the existing geothermal field located approximately 8 miles to the west of the Emigrant Project.

The formation encountered in the bottom of the hole appears to be an excellent reservoir rock in that it is very silicic, brittle and will maintain open fractures, the drilling was completed under budget and the core recovered will provide information for continued research. The 17-31 core hole was completed in a manner which will enable the hole to be deepened with very little effort to a depth of 5 – 6,000 feet which will provide a tremendous amount of information on the deeper geothermal reservoir and the commercial potential of the resource.

FINDING OF NO SIGNIFICANT IMPACT AND
DECISION RECORD
FOR

Emigrant #17-31Geothermal Drilling Permit
Project Number: NV065-EA06-177

I have reviewed Environmental Assessment **NV065-EA06-177** (EA), dated September 14, 2006. After consideration of the environmental effects of the Bureau of Land Management's (BLM's) preferred alternative (Proposed Action) described in the EA and supporting documentation, I have determined that the Proposed Action with the project design specifications identified in the EA is not a major federal action and will not significantly affect the quality of the human environment, individually or cumulatively with other actions in the general area. No environmental effects meet the definition of significance in context or intensity as described in 40 CFR 1508.27. Therefore, preparation of an Environmental Impact Statement is not required as per section 102(2)(C) of the National Environmental Policy Act.

I have determined the Proposed Action is in conformance with the approved Tonopah Resource Management Plan and is consistent with the plans and policies of neighboring federal agencies, local, county, state, and tribal agencies and governments. This finding and conclusion is based on my consideration of the Council on Environmental Quality's (CEQ's) criteria for significance (40 CFR 1508.27), both with regard to the context and the intensity of impacts described in the EA.

Context:

Esmeralda Energy Company (Esmeralda) has filed a Geothermal Drilling Permit to drill a geothermal exploration hole in Fish Lake Valley, Nevada. The proposed hole would be drilled on lease NVN-74099, which is held by the proponent. Once the well is drilled, Esmeralda proposes to inject approximately 85,000 gallons of water into the geothermal reservoir in order to test the permeability and porosity of the host rock.

The well would be located at Township 1 North, Range 37 East, section 31, SW¼SW¼ and would be designated as the Emigrant #17-31 (Figure 1). The affected geothermal lease is NVN-74099.

The nearest inhabited town is Dyer, NV which lies approximately 14 miles southwest of the project area.

The proposed wellhead would be located on a gravel pad roughly 0.33 acre in size (100'X140') and would have a mud pit 0.003 acre in size (20'X 8') located on the pad. The proponent indicated that additional acreage would be disturbed during construction of the pad. Total surface disturbance associated with well pad construction would be 0.65 acre. The well will be drilled to a depth of 4,000 feet. The drill rig components will be trucked to the site and then reassembled on the well pad. When constructed, the drill rig will occupy approximately 1,980 square feet (0.045 acre) and the drill rig mast will be approximately 90 feet tall. The purpose of the mud pit is to hold the drilling mud and drill cuttings. The drilling mud helps keep the drill bit cool and provides a media into which the drill cuttings move out of the hole.

Access to the project area would be by pre-existing, improved gravel roads, Esmeralda County Road #15 Emigrant Pass Road (N-54394), Road #43, and Road #47 (N-55402). Esmeralda County Road Department personnel have indicated that they will maintain the access roads prior to, and after, the proposed exploration hole is drilled.

Water to be used for the drilling of the proposed geothermal well would be obtained from the Hot Box Park, a Recreation and Public Purposes lease (N-50991 and access road N-52827) site held and leased by Esmeralda County. The Hot Box is located approximately 3 miles west of the proposed action and is an improperly plugged and abandoned oil well that is leaking thermal waters under artesian flow. The Tonopah Field Station (TFS) received a letter from the Esmeralda County Commissioners granting Esmeralda permission to use the excess water at the Hot Box Park for the purposes of drilling the hole and testing the geothermal reservoir. The water needed for the drilling mud and injection test will be pumped from the abandoned oil well head and would be hauled to the proposed well site via water trucks on existing roads. It is unknown how much water would be needed to drill the well however, 85,000 gallons of water would be needed for the injection test.

The project area is located on an approximate 6 percent slope. Esmeralda proposes to construct the pad for the proposed exploration hole using the "cut and fill" technique. The upper eastern portion of the proposed drill hole pad will be excavated and moved to the lower western end of the pad in order to make a flat pad. The proponent would use bulldozers to build the well pad. Esmeralda plans to drill the proposed exploration hole in September or October of 2006.

Intensity:

1) *Impacts that may be both beneficial and adverse.*

The EA considered both beneficial and adverse impacts of the Proposed Action.

Impacts of the Proposed Action include the following: fugitive dust from the disturbance of the local soil profile, impacts on land use authorization, impacts on minerals, water quality, recreation, wildlife Native American religious concerns, wild horses, migratory birds, socioeconomic impacts, and a temporary impact to visual resources. These impacts, which are described in detail in Chapter 3 of the EA, would be minimized by the lease stipulations and standard operating procedures presented in Chapter 2 and mitigated by measures outlined in Chapter 5.

None of the environmental impacts disclosed above and discussed in detail in Chapter 3 of the EA are considered significant.

2) *The degree to which the proposed action affects public health or safety.*

The Proposed Action will not affect public health or safety. Personnel working on the drill rig will bar the public from the drill site. Trash will be contained on-site and hauled to an approved landfill as burial of trash on-site is not permitted. Portable chemical toilets will be used for human waste and will not be chemically treated or buried on site.

3) *Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.*

The nearest inhabited town is Dyer, NV which lies approximately 14 miles southwest of the project area. There are no ecologically critical areas, prime farmlands, wetlands, or wild and scenic rivers within a mile of the project area. Site type diversity is limited; no National Register eligible properties have been identified. In addition, the EA did not identify any significant impacts to unique species or their habitats.

4) *The degree to which the effects on the quality of the human environment are likely to be highly controversial.*

The Proposed Action is not expected to be controversial. The BLM has been coordinating with the Nevada Division of Wildlife (NDOW). Coordination was done by informal phone calls and follow-up e-mails describing the Proposed Action and asking for their concerns.

During the June 13, 2006, field tour and subsequent phone discussions, with Timbisha Shoshone tribal representatives, the following concerns were identified: 1. Timbisha requests information demonstrating a no adverse impact to Big Horn Sheep (which frequent the area) migration routes and mating/birthing locations. 2. Although surface artifacts were not found during cultural survey, subsurface or buried artifacts may exist. Therefore, Timbisha requests one or two tribal monitors to be present during access route and drill pad construction. The tribe did not comment on copies of the EA that were given to them.

5) *The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.*

There are no known effects of the Proposed Action identified in the EA that are considered uncertain or involve unique or unknown risks. This is demonstrated through the effects analysis in the EA.

6) *The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.*

The proposed action will not establish a precedent for future actions with significant effects or represent a decision about future consideration. Completion of the EA does not establish a precedent for other geothermal exploration drilling projects of similar size or scope. Any future projects within the project area or in surrounding areas will be analyzed on their own merits and implemented, or not, independent of the actions currently selected.

7) *Whether the action is related to other actions with individually insignificant but cumulatively significant impacts.*

Past, present and reasonably foreseeable future actions have been considered in the cumulative impacts analysis within Chapter 4 of the EA. The cumulative impacts analysis examined all of the other appropriate actions and determined that the proposed action would not incrementally contribute to significant impacts. In addition, for any actions that might be proposed in the future, further environmental analysis, including assessment of cumulative impacts, would be required prior to surface disturbing activities.

8) *The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the NRHP or may cause loss or destruction of significant scientific, cultural, or historical resources.*

The BLM has completed a Class III cultural survey for the Project Area and found no sites within the project area that are eligible to the National Register of Historic Places.

9) *The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act (ESA), as amended, of 1973.*

Endangered or threatened animal or plant species are not known to occur in the project area or areas adjacent to the Proposed Action.

10) *Whether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment.*

The Proposed Action will not violate or threaten to violate any federal, state, or local law or requirement imposed for the protection of the environment.

DECISION:

As a result of the analysis presented in the Environmental Assessment (EA), it is my decision to approve of the Proposed Action for the Esmeralda Energy Company Emigrant #17-31Geothermal Drilling Permit. This decision for the Esmeralda Energy Company Emigrant #17-31Geothermal Drilling Permit is issued under the Federal Land Management Policy Act of 1976, the Geothermal Steam Act of 1970, as amended, Part 3200 of Ch. 43 Code of Federal Regulations (CFR) and 43 §CFR 3250, and is effective immediately upon signing of this Decision Record (DR).

The preceding rationale for the Finding of No Significant Impact (FONSI) supports this decision. The Proposed Action coupled with design features, mitigation measures and environmental protection detailed in the EA and FONSI have led to my decision that all practicable means to avoid or minimize environmental harm have been adopted and that unnecessary or undue degradation of the public lands will not result. This decision is consistent with the Tonopah Resource Management Plan, Record of Decision (1997).

All resource values impacted by the proposed action have been evaluated for cumulative impacts. It has been determined that cumulative impacts would be negligible for all resources.

BOART LONGYEAR

Boart Longyear Company
2745 W. California Ave.
Salt Lake City, UT 84104

February 8, 2006

Esmeralda Energy Company
P.O. Box 258
MM 8, Hwy 264
Dyer, NV 89010
Attn: Mr. John Deymonaz

SUBJECT: 2006 Proposal for Geothermal Well Located in North East Fish Lake Valley, Near Dyer, NV

Dear John,

Thank you for this opportunity to bid your upcoming core drilling program located near Dyer, NV. Boart Longyear Company is dedicated to providing the best service, equipment and personnel to meet all of your drilling needs. If awarded this project, Client will be responsible for all applicable taxes and permits. This proposal is based on the specifications outlined below and as discussed earlier. The prices offered below may be subject to change based on a site visit or any changes made to the specifications at a later stage.

Tri-cone 12 ¼" to 20' and install and cement in place 9 5/8", 32lb, .312 wall casing
Tri-cone 8 ½" to 400' and install and cement in place 4", 11lb, .25 wall casing
Install 4 1/2" full closing valve and 1000 PSI Annular BOP, test BOPE
Core HQ to 4000' TD

It is understood that to facilitate this project, the client will provide the following services at no charge to Boart Longyear Co.

A water source suitable for haulage by water truck
Construction and maintenance of suitable drill sites including mud pits
Construction and maintenance of all access routes to and from the drill sites
Reclamation of sites and access routes
Sanitary Facilities
Disposal of all solid and liquid wastes generated at project

Boart Longyear Company is pleased to offer the following equipment and services for the completion of the core-drilling program:

HD 602 Truck Mounted Drill Rig
HQ Wire-line Drilling System

Experienced 2-man Drill Crews with a Non-drilling Supervisor with CBM and Geothermal drilling experience with MSHA Certification
Light Plant for 24hr operation
Supply truck complete with welder, torches, hose crimping machine, supplies, etc.
Crane Truck
4000-gallon tandem-axle water truck
4 X 4 F350 Support Vehicles for Each Crew

Mobilization:	$10,510.00
De-mobilization:	$10,510.00

This is a lump sum fee to be paid per Drill Rig. Costs associated with loading and unloading of equipment will be at $50.00/hour/man plus any ancillary equipment needed at cost plus 15%. Equipment will be mobilized from our Salt Lake City, UT and Elko, NV facilities. Rates are to the nearest offloading/loading point to project for transport vehicles and do not include initial rigging up or final rigging down. This rate includes mobilization of drill, crane truck, supply truck, water truck, light plant, HQ rod, mud pump, pickups and drill crews. Mobilization charges for optional equipment are addressed elsewhere in this proposal.

Footage Pricing:

HQ Core 0 – 4000 feet	$8.00/ft
10 ¾" Tri-cone	$8.00/ft
8 ½" Tri-cone	$8.00/ft
Reaming	$8.00/ft

Hourly Operating Rate: $295.00/hour
It shall include but will not limited to the following activities; drilling, rod tripping, tube tripping, reaming, re-entry, mud mixing, hole conditioning, lost circulation control, casing installation/pulling, cementing operations, surveying, BOP Installation, BOP testing, hole abandonment, well control measures, rigging up/down, moving between hole, pre-shift inspection, flow test, etc. and any time that requires drill to be operating.

Hourly Non-Operating Rate: $265.00/hour
Stand-by time requested by the client, water delays.

Drill Supervisor: (Provided) Included in rates

Drill Crew Per Diem: $50.00/day per man
This per diem is a per man charge.

Water Truck Rental: (4000-gallon tandem-axle) $185.00/day plus fuel @ cost + 15%

Water Truck Driver Rate: (If required) $50.00/per hour
If required, either to keep up with loss circulation or if the water haul is an excessive distance from the drill site, a third hand can be supplied based on mutual agreement at the quoted price. In addition, Per Diem of $50.00 per man per day will be added as well as a mobilization charge of $1000.00 per man.

Travel Trailers: $1000.00/month each

If necessary, trailers will be provided for crew at quoted rate.

Drill Crew Drive Time:	$50.00/hour per man

Drive time in excess of one hour per day will be billed at the stated rate.

Drill Bits Consumed:	BLY List Price

Boart Longyear will supply all drill bits including button style rock bits and impregnated diamond core bits. The costs will be charged to client based on Boart Longyear list price.

Blow Out Prevention Equipment:	Cost Plus 15%

The Client has the option to self source all BOP equipment; including casing heads valves and ancillary connection items. However, if required Boart Longyear can provide all such necessary BOPE equipment and miscellaneous wellhead parts. This shall include freight and applicable taxes.

1000 PSI Triple M Annular:	$85.00/day

Replacement costs for damage or repair of floor valve, BOPE, element or manifold will be invoiced to Client at Cost Plus 15%.

Drilling Fluid Products:
The Client has the option to self-source all the Drilling Fluid Products required for the Drilling Program. However, if required Boart Longyear Company can provide all the required drilling fluid products. This will be charged based on the Suppliers List Price plus 15%. This shall include freight and applicable taxes.

Crane Truck Rental: (Required)	$185.00/day plus fuel @ cost + 15%
Gardner Denver Mud Pump: (Required)	$185.00/day plus fuel @ cost + 15%

This pump will be billed for those days when used.

Drilling Fluid Mixing and Cleaning System: (Required)	$185.00/day plus fuel @ cost + 15%
Mobilization/De-mobilization	$1900.00 each way
Frac Tank:	Cost Plus 15%
9 5/8" Casing:	Cost plus 20%
4" Casing:	Cost plus 20%
Delivery:	Cost Plus 15%
Core Boxes: HQ/NQ	$5.75 each plus freight

Boart Longyear Co. will supply HQ/NQ waxed cardboard core boxes.

Trash Disposal:
Trash disposal will be billed at the hourly operating rate. Charges incurred from Refuse Transfer Stations will be invoiced at cost.

Heaters: (If required)	$15.00/day each plus fuel @ cost + 15%

Damage or Loss of Tools:
Boart Longyear Company shall bear no responsibility for damage to or loss of tools in any hole, unless such loss is a direct result of negligence on the part of Boart Longyear Company. Any and all loss or

damage of tools shall be assessed a charge to the client based on Boart Longyear Company's List Price, pro-rated for wear.

The prices detailed above may be subject to change based on any new information received after this point. In any event these prices are good for a period of 60 days from the time of writing. A fuel surcharge will be instated should fuel prices exceed $2.75/gallon. Pricing is dependent upon crew and equipment availability.

If I have failed to address any issues in this document or if there are any questions, please do not hesitate to contact me.

NV Office: 800-327-7049 #222 Cell: 775-720-1307 E-Mail: sbarnwell@boartlongyear.com
NV Fax: 775-246-3208

Yours Sincerely,

Steve Barnwell
Manager Coring Division
Boart Longyear Co.

****TERMS AND CONDITIONS****

INSURANCE:
Boart Longyear Company will carry Comprehensive General Liability and Automobile Insurance covering personal injury and property damage and also statutory Workmen's Compensation Insurance. Certificates showing these coverage's will be furnished upon request.

LICENSING:
Boart Longyear Co. certifies that it is licensed to do business in the state of this site location. All other licenses, land and water use permits, environmental reports, state reports relating to hole plugging, etc, shall be the responsibility of Client. Boart Longyear Co. shall cooperate with and give technical assistance for Client's compliance with these regulations.

INVOICES
Invoices covering the work performed will be prepared on a regular basis throughout the duration of the project. Payment Terms shall be Net Due Upon Receipt of Invoice. Amounts not paid within 30 days of Invoice Date will begin accruing interest at the rate of 1 ½ percent per month.

DAILY DRILL REPORTS
In order to facilitate prompt notification to the Client of drilling progress or problems, Boart Longyear Co. agrees to provide our Daily Drill Reports to the Client based upon one or more of the following options:
( ) Presented daily to the Client's on-site representative for sign off.
( ) Faxed daily to the Client's Fax No.
( ) Faxed weekly to the Clients Fax No.
( ) Attached to the Invoices

TAXES
Invoices arising from this project will be subject to all applicable Federal State and Local Taxes (Sales, Use, Gross Receipts, Privilege, etc.)

FORCE MAJEURE

Except for the duty of Client to make payments hereunder when due, neither party shall be liable for delays in performance or for damage occasioned by or caused by Force Majeure, which shall include, but not be limited to, acts of God, actions of the elements, war, strikes, or differences with workmen, acts of the public enemy, rules or regulations of any governmental authority having jurisdiction or control in the premises, compliance with which makes continuance of operations impossible or any other cause beyond the reasonable control of either party. Inability of either party to secure funds, arrange bank loans or other financing, or to obtain credit shall not be regarded as Force Majeure.

EXPIRATION

Prices quoted herein are firm only if this proposal is accepted within 60 days of above date and if work is commenced within a reasonable period of time.

CREDIT APPROVAL

This agreement is subject to continuing credit approval by Boart Longyear Co. of Client's financial condition, or to other financial arrangements satisfactory to Boart Longyear Co. If at any time Boart Longyear Co., in its sole judgment, deems Client's financial condition unsatisfactory, notice shall be made to client, and if action is not taken satisfactory to Boart Longyear Co., then work under this agreement shall cease. Nothing contained herein shall excuse Client's obligation to pay for work already performed in its behalf pursuant to this agreement.

INDEMNIFICATION

Nothing herein shall be construed or deemed to create any relationship between Client and Boart Longyear Co. other than Boart Longyear Co. acting as either a Contractor or a Sub-Contractor to Client. Each party shall be solely responsible for the acts of its employees or agents, and each shall hold harmless and fully indemnify the other party, its officers, employees, agents, and affiliated companies from any liability for injury to or death of any person, or for damage to or destruction of any property, and from any claims, actions, proceedings and costs in connection therewith, including reasonable attorney fees, arising out of or resulting from the performance of the work hereunder.

LIABILITY

Boart Longyear Company shall drill at the locations and to the depths specified by the representative of Client and shall be held harmless for all liability related to pollution of ground water or surrounding land from discharge of drill water and wastes. Boart Longyear Company will accept responsibility for any spills which are a result of Boart Longyear Company's negligence. Boart Longyear Company agrees to accept liability for the negligent acts of its employees.

The client shall assume liability for any environmental losses associated with a well out of control and any below grade fluid losses. Client shall be liable for any cost of regaining control of any wild well, as well as the cost of removal of any debris, and shall release Boart Longyear Company from any liability for any such cost.

Client shall share liability at all time for damage to or destruction of Boart Longyear Company's in-hole equipment. Client shall reimburse Boart Longyear Company for the value of any such loss or damage as agreed by both parties.

ENTIRE AGREEMENT

This proposal together with its covering letter and all attachments will constitute the terms and conditions of this working agreement. Your authorized signature in the space provided below will acknowledge your acceptance and will validate this agreement.

Boart Longyear Co. Client:

BK-1

BOART LONGYEAR HD-600 CRANE CARRIER

RIG SPECIFICATIONS

1. DEPTH CAPACITY (Vertical):

NRQHP	9,725 ft.	(2964 m) Dry Hole
NRQHP	15,413 ft	(4698 m) Wet Hole
HRQHP	9750 ft	(2972 m) Dry Hole
HRQHP	16752 ft	(5106 m) Wet Hole
HWT/PQ	4,900 ft.	(1500 m) Dry Hole

2. POWER UNIT: Cummins 325 HP @ 2100 RPM

3. TOP DRIVE: Two-Speed Rotary Spindle

Manufacturer:	Lang
Hydraulic Pump:	Denison P14P
Hydraulic Motors (2):	Denison M7H

	Coring	Rotary
RPM Low Range:	0 – 562	0 - 140
RPM High Range :	0 – 1007	0 - 252
Torque Low Range:	0 – 3,270 Ft/Lbs	0 – 13,080 Ft/Lbs
Torque High Range:	0 – 1,827 Ft/Lbs	0 - 7,308 Ft/Lbs

4. FEED SYSTEM:

Feed Length:	22.5 Feet
Cylinder Size:	5” Bore X 2-3/4” Piston Rod
Lift Capacity:	120,000 Lbs @ 4000 PSI
Hydraulic Pump:	P6W Denison

5. MAIN HOIST: Hydraulic

Drum Diameter:	35.375” Grooved
Drum Length:	38”
Flange Diameter:	41.375”
Drum Capacity:	2076’ of ¾” 6X26 IWRC Cable
Standard Cable Length	600 Ft.
Required Working Length	400 Ft.

Powered by:	P14P Denison Pump & 2 M7H Motors (7.25 cu.in./rev.)
Block Speed (with 6-Part Line):	

1st Layer	65 Ft/Min
2nd Layer	68 Ft/Min
3rd Layer	71 Ft/Min
4th Layer	74 Ft/Min

Hoisting Capacity:

1st Layer	116,367 Lbs.
2nd Layer	111,818 Lbs.
3rd Layer	107,612 Lbs.
4th Layer	103,711 Lbs.

Note: Line pull is based on manufacturer's hydrostatic motor performance curves at 4,000 PSI and include efficiency in the main hoist gear train of 85%.

6. WIRELINE HOIST: Hydraulic

Drum Diameter	8"
Drum Length	29-3/8"
Flange Diameter	26"
Drum Capacity	9000' X 1/4" Cable at 75% of full drop capacity
Bare Drum Speed	0 – 600 Ft/Min
Control	Power up and down through hydraulics

7. MAST:

Crown Block Rating:	120,000 Lbs.
Hook Load Rating:	100,000 Lbs. (with 6-Part Line) *
Method of Raising:	Two Hydraulic Cylinders
Rod Stacking Length:	40 Ft. Stands
Guy Lines Required:	4
Mast Length:	58 Ft. 4 Ins.
Weight Indicator Gauge:	150,000 Lbs (with 6-Part Line:)
Angle Range:	Vertical

* Hook Load Rating is based on a single line pull of 20,780 lbs. and a 6-part line, using ¾" 6X26 hoist cable of 58,800 lbs. providing a safety factor of 2.83:1.

8. MOUNTING: 4-Axle Crane Carrier

Rig Height (Mast Down)	13 Ft. 1-1/4 Ins.
Rig Height (Mast Up)	60 Ft. 6 Ins.
Rig Width:	8 Ft. 5-1/2” Ins. (with Jack Pads Removed)
Rig Length:	59 Ft. 6 Ins.

9. MUD PUMPS: FMC Model: L1622BCD (2 Each)

Displacement:	Positive, Inside Packed
Cylinders:	3 with Reciprocating Pistons
Gallons per Minute:	58.725 @ 985 RPM (Motor Speed)
Maximum Discharge Pressure:	1325 PSI

10. RIG WEIGHT: 77,400 pounds

MAJOR
Drilling America Inc.

January 31, 2006

Esmeralda Energy Company
PO Box 258
N.M 8 Hwy 264
Dyer, NV 89010

ATTENTION: Mr. John Deymonaz:

Via Email: greenpower@gbis.com

Q06-108C
CORE DRILLING PROJECT

COST ESTIMATE

We are pleased to submit our proposal number Q06-108C for your drilling project in the northeast of Fish Lake Valley, Esmeralda County, Nevada.

1. **SCOPE OF THE PROGRAM.**

The work entails the drilling of one vertical core holes to a maximum of 4000 feet.

The approximate footage of the project is 4000 feet of HQ wireline core drilling.

C. The work would commence approximately September 2006 pending on rig and crews availability.

The work would be carried out with truck UDR1500 type drill operating two 12-hr shifts per day. The work schedule is to be determined.

2. **CLIENT'S RESPONSIBILITES.**

A. Drill roads and drill sites are to be constructed and maintained accessible to track and difficult terrain drill rigs free of cost to Major. Any environmental responsibility relating to the construction, use, or reclamation of same shall be the responsibility of the Client. Major will, however, remove all trash and loose materials, leaving drill sites in a clean and orderly condition.

B. All licenses, land and water use permits, environmental reports, reports relating to hole plugging, etc. shall be the responsibility of the Client. Major shall cooperate with and give technical assistance, if requested, for compliance with these regulations.

C. The Client will hold Major harmless for any liability claims which may arise from normal activity related to this contract, including pollution of ground water or surrounding land from discharge of drill water and wastes, save if Major's employees act in an irresponsible manner.

D. The Client will provide suitable equipment at no cost to the Contractor for the purposes of:

1. Moving the drilling equipment from the staging area, including loading and off-loading.

Moving the drilling equipment from site to site.
Crane available to load and unload.
Forklift on site at all time
Backhoe
Water storage tank on site

E. The Client will provide or be responsible for the following items; alternatively, the Contractor will provide and charge back to Client at Major's list price plus fifteen percent (15%). Any items not covered by Major's list price will be charged at supplier's list price plus fifteen percent (15%).

1. Drilling mud, rod grease and in-hole additives.
2. Cementing service
3. Core boxes and lids, sample bags, and marker blocks.
4. Special tools or drilling accessories required for testing purposes or which may be left in the hole upon Client request.

Casing and casing shoes consumed or unrecovered from the hole.
All tricones and diamond bits
BOP

Note: Cost for above items will be F.O.B. source.

3. **<u>CONTRACTOR'S RESPONSIBILITIES.</u>**

A. <u>Equipment and Supplies.</u>

Contractor will provide the following equipment to carry out the work.

1. One (1) truck UDR1500 with substructure
2. One (1) water truck
3. Three (3) 4 x 4 pickup.
4. One (1) mud mixing unit and circulation tank
5. 4000 feet of HMCQ size core rod and 4000 feet of NCQ rods
6. Sufficient spares for the job.

B. <u>Crew Transportation and Travel Time.</u>

The Contractor will provide means of crew transportation from accommodation to sites and return.

C. Water Supply.

If water must be hauled, Contractor can supply water truck at specified rates (see Bid Prices, Section 5). Cost of water that must be purchased will be the responsibility of the Client.

D. Personnel.

Contractor will provide crew consisting of one driller and one helper per shift and one non drilling forman.

E. Accommodation.

Major shall provide room and board for the crews at no cost to the Client.

F. Equipment Down Time.

Standby due to equipment repair is to the Contractor's account.

4. **GENERAL PROVISIONS.**

A. Lost Materials.

In the event that drill rods, casing, or other equipment become lost, broken or stuck in the hole while drilling at the footages rates, the Client agrees to reimburse the Contractor at field cost rates, for time and materials expended in recovery attempts. If materials are unrecoverable, the Contractor shall be reimbursed for same at replacement cost.

B. Unsatisfactory Progress In Hole and Hole Abandonment.

In the event that excessive water flows, cavities, loose, swelling, or caving materials or hole stability problems are encountered of a nature as to prevent the completion or satisfactory progress of a hole, then the Contractor does not guarantee to drill to a predetermined depth. If it becomes necessary to abandon said hole, the Contractor shall charge the Client for those holes abandoned, at the depth of abandonment, and at the rates specified. If the Client wishes the Contractor to proceed in the hole, the Contractor has the option to revert to the operating field cost rate, plus all materials, supplies, and equipment required at replacement cost plus ten percent (10%), subject to Client's approval.

C. Field Cost Definitions.

1. Operating.

It is agreed that the operating rates shall include the labor of the regular two-man crew per shift, and shall include drill and support equipment rental. The cost of rods, casing, below-the-head consumables, and other materials and supplies consumed in the work shall be charged to the Client at cost plus ten percent (10%).
In the event that extra labor over and above the regular two-man crew per shift is utilized, the Contractor agrees to supply such additional labor at the rates specified in Bid Prices, Section 5.

2. Non-Operating (Standby).

It is agreed that the non-operating rates shall prevail when work is interrupted due to delays not caused by the Contractor, or delays beyond his control.

5. **BID PRICES.**

A. Mobilization.
Move-in charge for all equipment and personnel to the staging area with 2 men. — $ 24,500.00

B. Demobilization.
Move-out charge for all equipment and personnel from the staging area with 2 men. — $ 24,500.00

C. Moving.

Moving charge from staging area to the first drill site and from the last drill site back to the staging area.

Moving from site to site, setting up and tearing down.

$430.00 Rig/Hour

Note: Staging area is defined as the highway transport off loading area.

D. Rotary Drilling.	**Operating Hourly Rate Plus**
0 – 400 Feet	$10.00/Ft

E. Core Drilling. **Operating Hourly Rate Plus PRICE PER FOOT**

	HQ/NQ
0 – 4000 Feet	$ 15.00

F. Field Cost – Operating.

Includes all hourly functions such as, but not limited to:

1. Testing, hole surveying.
2. Regaining circulation.
3. Hole stabilization/conditioning.
4. Down-hole equipment recovery.
5. Hole reduction.
6. Drilling sand or cave or entry to precased hole
7. Cementing.
8. Setting or pulling casing.
9. Mud mixing when drilling, unduly interrupted.
10. Abandonment procedures.
11. Client directed operations.
12. All drilling functions.

OPERATING RATE: $ 450.00 Rig/Hour

G. Field Cost – Non-Operating.

Includes times when rig is not operating, such as, but not limited to:

1. Awaiting instruction.
2. Cement setting time.
3. Waiting for Client provided services.
4. Hole logging by others.
5. Site or access delays.
6. Water delays if haulage cycle time is excessive or not arising from Contractor's equipment.

NON-OPERATING RATE: $ 430.00 Rig/Hour

H. Extra Labor Rate.

If additional to the drill crew and
Client approved. $ 52.00/Man Hour

I. <u>Rental Of-</u>

Well Nav or other hole
orientation devices. $ 2,200.00/Month

J. <u>Water Truck Rental:</u> $150.00/day

K. <u>Travel Time.</u>

After 1 hr per man per shift $52.00/Man Hour

We wish to thank you for considering this proposal, and we look forward to working with you again on this project.

Sincerely,
MAJOR DRILLING AMERICA INC.

Nguyen T. Do

COST ESTIMATE

Description	**Unit Price**	**Quantity**	**Total**
Mobilization	$24,500	1	24500
Demobilization	$24,500	1	24500
Operating - Day Rate	$10,800		
Non Operating - Day Rate	$10,320		
Setting up - Est. 1. day	$10,320	1	10320
Rotary 10 3/4" to 20 ft & Set and cement 7" casing - Est. 1 day	$10,320	1	10320
Rotary 6 1/4" to 400 ft	$10,800	1	10800
Rotary footage at $10.00/ft	$10	400	4000
Cementing and setting	$10,800	1	10800
Install BOP and pressure test - Est. 1 day	$10,800	1	10800

HQ core from 400 - 4000 ft			
400 - 2000 ft - Est. 160 ft/day	$10,800	10	108000
2000 - 4000 ft - Est. 120 ft/day	$10,800	17	183600
Logging - Est. 2 days	$10,800	2	21600
Tear down - Est. 1 day	$10,320	1	10320
Coring Price @ $15.00/FT	$15	3600	54000
Tricones	$3,000	1	3000
Diamond Bits - Est. $3.0/FT	$3.00	3600	10800
Core Box @ $6.25/Box	$6.25	400	2500
Drilling Mud - Est. $5.00/FT	$5.00	4000	20000
Water truck rental @ $150/day	$150	40	6000
		Total:	**525860**

Major Drilling Rig Specs

UDR 1500

Mounting	Truck or Trailer	Removable from a 5 axle carrier
	Length	52' 6"
	Width	8' 2"
	Height	1 1' 6"
	Weight	42,900 lbs.
Power	Drill Engine	Detroit 671 230 HP
	Generator	8 Kw Hydraulic
Derrick	Rod Capacity	40 ' Rod Stands
	Angle Capability	-45 to -90 degrees
	Max. Casing Diameter	16 inch
	Max. Casing Length	Range 3 (35' to 44')
Hoist	Single Line Pull	36,000 lbs.
	Pulling Speed	0 to 300 FPM
Rotation	Type	Hydraulic Top Drive
	Feed Length	24'
	Maximum Torque	5630 lb./ ft.
	Speed Range	0 to 1500 RPM
	Pull Back	32,000 lbs.
	Pull Down	15,700 lbs.
Pump	Type	Hydraulically Driven
	Model	FMC Bean L1122B
	Max. Flow Rate	40 GPM
	Maximum Pressure	1,000 PSI
Wireline	Type	Hydraulic c/w spooler
	Line Pull	4,200 lbs.
	Cable Size	5/16"
	Capacity	6,560 feet

Ancillary Equipment

12' 6" Clearance Sub-Structure for BOP Equipment
Self erecting up to sub-structure
Hydraulic Footclamp and break-out tool

Depth Capacity	NCQ	7,100 Feet
	CHD 76	5,640 Feet
	HMQ	5,400 Feet
	CHD 101	3,670 Feet

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Date: February 26, 2007

Subjects:

1—New geologic sections through Esmeralda Energy Company (EEC) corehole EM 17-31

2—Location and significance of the Green Monster fault zone

3—Implications of the core from 17-31 for density/gravity modeling

4—Reconnaissance X-ray diffraction and fluid-inclusion microthermometry

5—Recommendations for future exploration and development drilling

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Contents

	Page
Introduction	1
New geologic sections through EM 17-31	1
Reconnaissance XRD investigation	4
Reconnaissance fluid-inclusion microthermometry	6
Revised conceptual model	8
Conclusions—and recommendations for future drilling	10
References	13

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Illustrations

After Page

Figure 1. East-west geologic section through EEC corehole EM 17-31—Alternative I: Green Monster fault zone (GMFZ) dips 60-65° west....1

Figure 2. East-west geologic section through EEC corehole EM 17-31—Alternative II: GMFZ dips 80-85° west....1

Figure 3. East-west geologic section through EEC corehole EM 17-31—alternative III: (1) Section consistent with the density/gravity model of Lide (2006); (2) GMFZ dips 65-70° west; (3) hidden fault west of and proximally parallel to the GMFZ has >2000 ft. of down-to-the-west displacement....1

Figure 4. Comparison, along section of Figures 1 to 3, of measured equilibrium temperatures for corehole EM 17-31 with subsurface temperature distribution predicted from contoured, shallow thermal-gradient data....8

Figure 5. Revised conceptual model of the Emigrant geothermal system, along an east-west section through corehole EM 17-31....8

Appendices

Page

Appendix 1. Geologic map of the Emigrant geothermal prospect (fr. Hulen et al., 2005)....A1

Appendix 2. Pre-drilling interpretive east-west geologic section A-A', through the Green Monster mine (fr. Hulen et al., 2005)....A2

Appendix 3. Bulk X-ray diffraction results for nine samples from corehole EM 17-31 (Hulen, 2007)....A3

Appendix 4. A fluid-inclusion investigation of quartz and calcite (Moore, 2007)....A8

Introduction

At the request of Esmeralda Energy Company, the writer has utilized results from his detailed geologic logging of GRED III corehole EM 17-31 (Hulen, 2006) to construct alternative, coincident, east-west-oriented geologic sections through the heart of the Emigrant geothermal prospect. The sections, supporting geological and geophysical data, and supplementary reconnaissance X-ray diffraction (XRD) analysis and fluid-inclusion microthermometry (FIM) of the core mandate modification of the Emigrant geothermal-system conceptual model presented by Hulen et al. (2005). The modified model can be used to help guide future exploration and development drilling of the Emigrant system in this central sector of the prospect.

New Geologic Sections through EM 17-31

EM 17-31 was sited about 660 ft (201 m) west of the exposed surface trace of the western strand of the northerly-trending Green Monster fault zone (GMFZ; ***Figures 1-3; Appendix 1***). The fault zone itself at the latitude of the corehole is about 920 ft (280 m) wide. The sinuous surface trace of the fault zone suggests that it dips moderately to steeply westward; measured dips on rare exposed fault planes range from 50° to 75° west. However, it is well not to make too much of these isolated measurements, as dip-slip faults, like "rippling curtains," tend to vary considerably in attitude both along strike and down dip.

The *overall* dip of the GMFZ will govern where the structure intersects EM 17-31: Plausible end-member cases are presented on the sections of ***Figures 1*** and ***2***. The first figure has the GMFZ dipping 60-65° westward, with the western strand meeting a mapped, east-dipping, antithetic fault where both structures cut the corehole at a depth of about 1200 ft (366 m; in the middle of a zone of very poor core recovery spanning the depth interval 1155-1252 ft, or 352-382 m; Hulen, 2006). Accordingly, the middle strand of the GMFZ intersects the hole in a "no-core" zone at about 2050 ft (624 m), and the eastern strand passes beneath the bottom of the hole. ***Figure 2*** differs from Figure 1 only

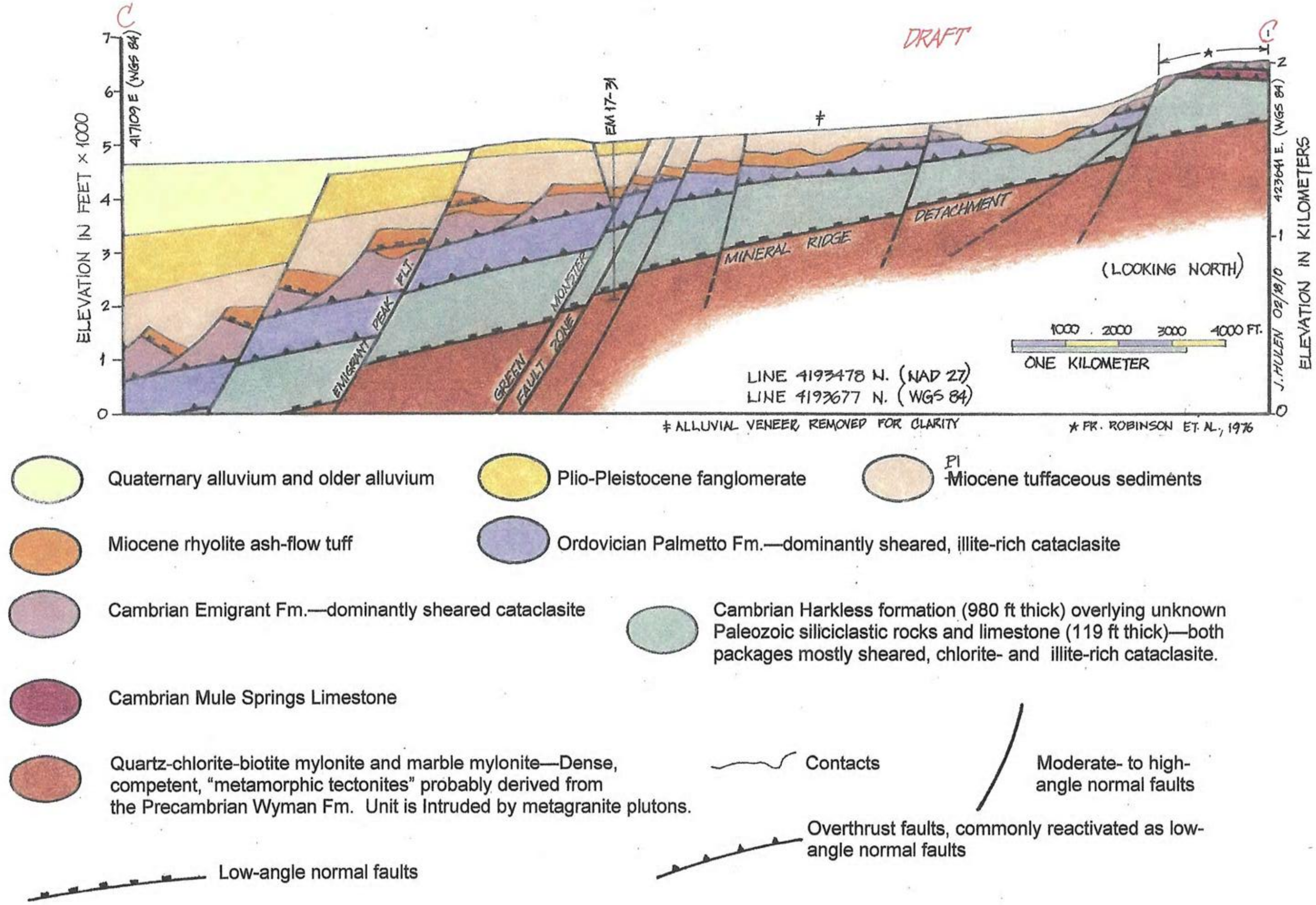

Figure 1. East-west geologic section through EEC corehole EM 17-31—**Alternative I:** Green Monster fault zone dips 60-65° west.

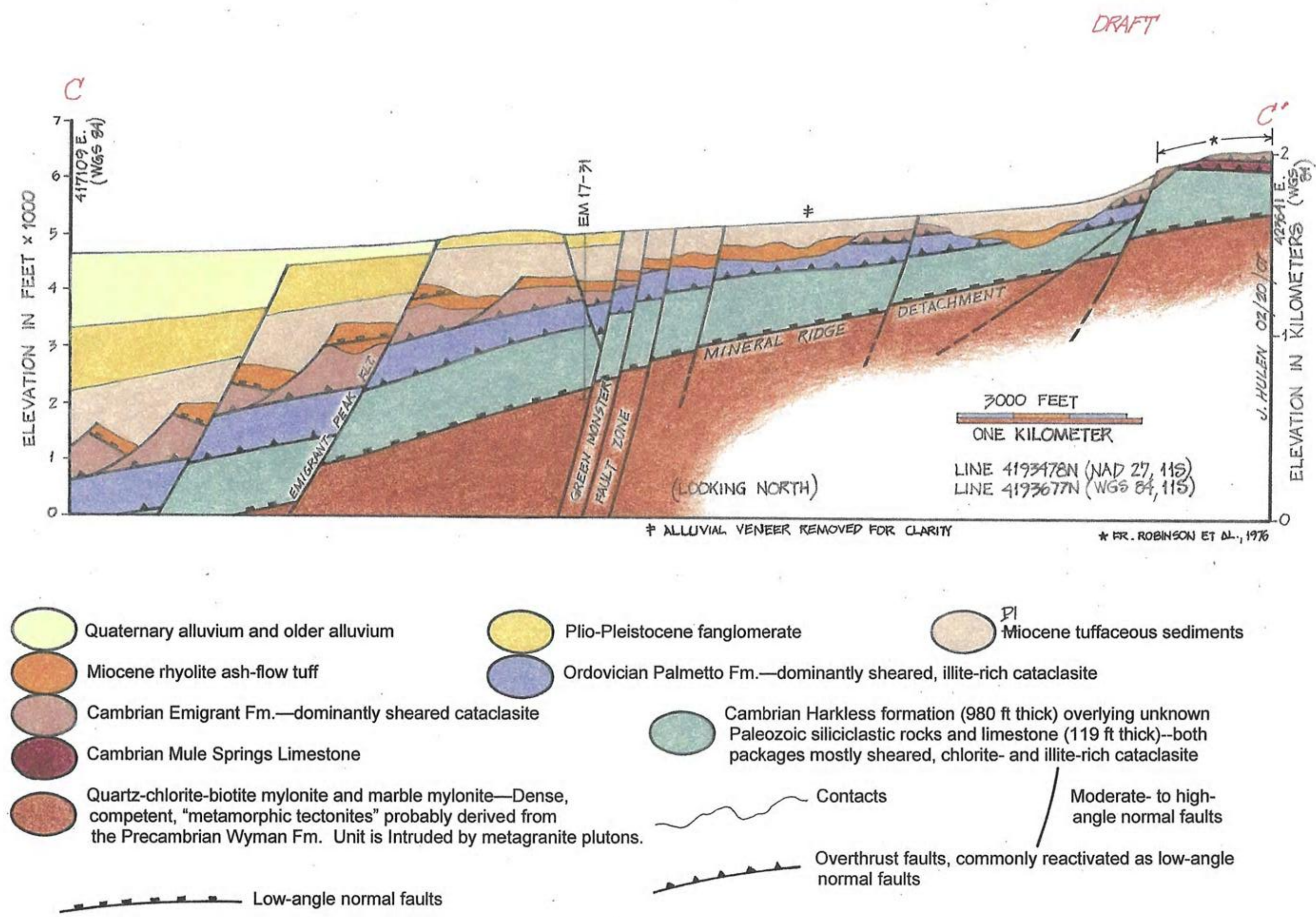

Figure 2. East-west geologic section through EEC corehole EM 17-31—**Alternative II:** Green Monster fault zone dips 75-80° west.

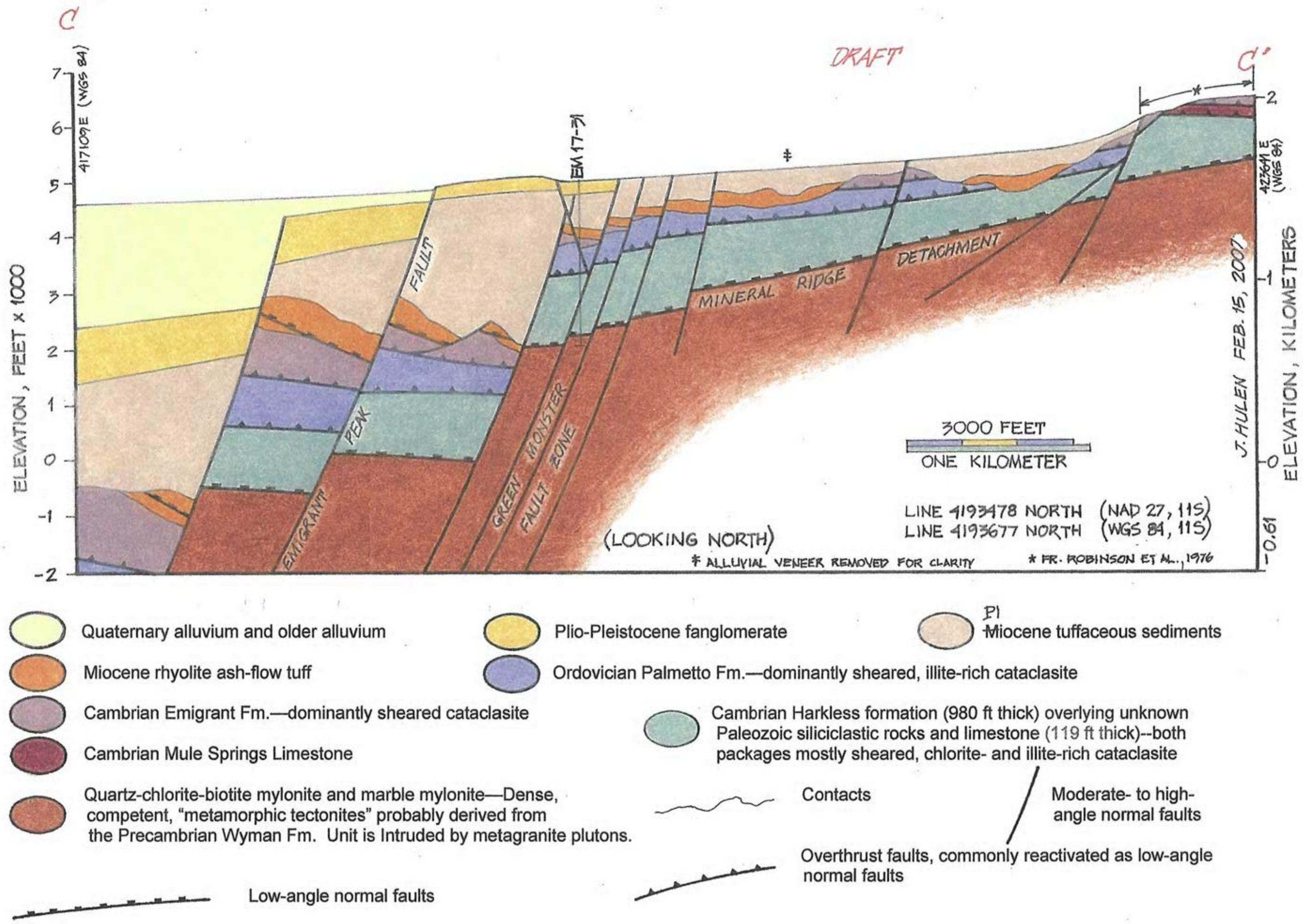

Figure 3. East-west geologic section through EEC corehole EM 17-31—**Alternative III:** (1) Section consistent with the density/gravity model of Lide (2006); (2) Green Monster fault zone (GMFZ) dips 65-70° west; (2) hidden fault west of and proximally parallel to the GMFZ has >2000 ft of down-to-the-west displacement

in having the GMFZ dip 75-80° westward. With this configuration, the westernmost strand of the fault is just beneath the bottom of EM 17-31, and only the aforementioned antithetic fault intersects the corehole at about 1200 ft (366 m).

Figure 3 has the GMFZ dipping at an intermediate 65-70° west, with the westernmost strand intersecting EM 17-31 in the "no-core" zone at about 2050 ft (624 m); and with the antithetic east-dipping fault again piercing the hole at about 1200 ft (366 m). However, this section differs most significantly from the foregoing two alternatives in honoring a detailed, east-west-oriented, gravity/density profile calculated by Lide (2006; cited in Schriener, 2006; see also ***Appendix 2***) for line 4193200N (NAD 27), situated 284 m south of section C-C'.

Lide's (2006) observed gravity values along line 4193200N were modeled and matched using two assigned rock densities—Quaternary alluvium, older alluvium, Pliocene tuffaceous sediments, and Miocene ignimbrite were assigned an aggregate density of 2.1 gm/cm^3; and all other lithologies ("pre-Tertiary") were given a collective density of 2.67 gm/cm^3. On this basis, a density profile matching the observed gravity measurements has two major, steeply-inclined breaks—one a mile (1.6 km) west of EM 17-31; the other about 2130 ft (650) west of the corehole. The profile shows no break corresponding to the mapped Emigrant Peak fault (which is marked at the surface by a scarp in young alluvium); and none matching the mapped Green Monster fault zone.

The major density break closest to EM 17-31 corresponds to ~2210 ft (674 m) of down-to-the-west dip-slip displacement. Given the stratigraphic constraints placed by EM 17-31 (e.g., the top of the Paleozoic section at 1034 ft, or 315 m; Hulen, 2006), this displacement cannot have taken place on any of the outcropping strands of the GMFZ (***Figure 3***). If the density break approximates geologic reality, the displacement must have occurred along a wholly concealed fault just west of and parallel to the GMFZ .

If the writer understands correctly, gravity-matching density profiles are non-unique. In other words, multiple combinations of geologically feasible densities and density configurations can yield similarly impressive matches with observed gravity values. If this is the case, then three critical geologic phenomena noted during detailed mapping and core logging at Emigrant may deserve consideration:

- Virtually the entire Paleozoic section penetrated by EM 17-31 has undergone extreme extensional attenuation in the upper plate of the Silver Peak metamorphic core complex (Oldow et al., 2003). Having thus been profoundly "pulled apart," the initially intact Paleozoic formations as a result are now loose, highly sheared cataclasites—in many cases little more than rubble (Hulen, 2006). It seems likely that these cataclasites could have an aggregate density less than the assigned value of 2.67 gm/cm^3.

- North and northeast of the Green Monster mine in the Silver Peak Range, a significant thickness—locally up to at least 1000 ft (305 m)—of the Tertiary ignimbrite section is not only densely welded but silicified (Hulen, 2005). Only weakly welded ignimbrite was encountered in 17-31, but the silicified and densely welded variety readily could occur along section either to the east or (especially) the west, displaced above the weakly welded tuff along low-angle extensional faults. The altered and densely welded tuffs could be denser than the assigned 2.1 gm/cm^3.

- The metamorphic tectonites in the lower plate of the core complex are densely recrystallized aggregates of either (1) quartz, feldspar, chlorite, and biotite $\pm$ sericite; or (2) calcite (marble) with minor amounts of the foregoing minerals. The tectonites (mylonites) are highly competent and texturally much different than the sheared and brecciated Paleozoic rocks in the upper plate. They (the tectonites) could be denser than the aggregate value assigned to the pre-Tertiary section.

These points notwithstanding, it seems unlikely that any credible combination of assigned densities and density distributions could eliminate entirely the modeled lateral density break just west of the Green Monster fault zone. The most likely explanation for such a break is a moderate- to high-angle, west-dipping normal fault, and this fault (or fault zone) requires consideration in future Emigrant drilling decisions.

Reconnaissance XRD Investigation

Nine samples of core from EM 17-31 have been investigated mineralogically by bulk XRD (Hulen, 2007). For a borehole of this length (2937 ft, or 895 m), results from sample coverage this sparse (less than one sample per 300 ft/91m) must be considered only tentatively representative. Nonetheless, the XRD results provide new insights into the nature and structural evolution of the Emigrant geothermal system.

The XRD results are presented and discussed in ***Appendix 3***, to which the reader is referred for details of individual analyses. Highlights of the work are as follows:

- One sample (489 ft/149 m [depth]) from the "punky" Pliocene sedimentary sequence contains none of the abundant nontronite (a swelling, smectite-family clay) indicated by hand-lens and binocular microscopic investigation. The material believed initially to be nontronite may be just dust-sized volcanic ash, possibly with poorly-crystalline clay minerals like allophone or imogolite. The source of the sample's distinctive "Green Monster green" coloration remains to be determined. If this sample is representative, the lack of an identifiable, *bona fide* clay mineral would indicate that the Miocene tuffaceous sequence may not be as effective a caprock for the geothermal system as initially conceptualized. On the other hand, the argillized-caprock hypothesis cannot be abandoned on the basis of one analysis for the entire tuffaceous sedimentary sequence. A sample from the underlying, similarly greenish, weakly welded ignimbrite (845 ft/258 m) was shown by XRD to contain at least 10% smectite, presumably the previously anticipated nontronite.

- The sheared and brecciated Paleozoic section penetrated by 17-31 is extremely rich in the clay minerals chlorite and illite—particularly the Cambrian Harkless Formation cataclasites between 1622.5 ft and 2602 ft (495-793 m). Although the Emigrant-prospect Paleozoic section was conceptually modeled to include geothermal-reservoir rocks, its enrichment in these layer silicates, its extreme shearing and brecciation, and its distinctly conductive thermal-gradient profile indicate, on the contrary, that the section in this location functions as an impermeable cap.

- Bolstering the idea of the Paleozoic section as a cap is the lack, throughout the section, of hydrothermal alteration or mineralization unambiguously attributable to a modern or recent geothermal system. The secondary phases that *are* present in the Paleozoic rocks are common in the host formations on a regional basis (e.g., Albers and Stewart, 1968). Calcite and quartz veins in the Paleozoic rocks pre-date shearing and brecciation, and the broken veins generally lack diagnostic epithermal textures such as delicate banding, euhedral crystals, and drusy-crystal coatings on open spaces.

- On the other hand, such epithermal secondary minerals and textures are common in the metamorphic tectonites encountered below 2735.6 ft (834 m). The tectonites are extensively disrupted by veins and hydrothermal-breccia cements consisting (as determined by XRD and binocular microscopic examination) of quartz, calcite, chlorite, pyrite, and marcasite. These veins and breccia cements are commonly vuggy, and the vugs are lined with euhedral quartz, calcite, and marcasite crystals. Locally present with the major minerals, but below XRD detection limits (typically 1-3 wt.%), are trace to minor amounts of a bronzy brownish metallic phase that could be a base-metal sulfosalt like enargite or tennantite. The veins and breccia cements have alteration halos wherein the initially dark brownish and biotite-rich host rocks have been converted to pale greenish-gray chlorite-quartz aggregates with disseminated sulfides (and sulfosalts?).

- The presence of hydrothermal marcasite in the veins and breccia cements cutting the metamorphic tectonites is compatible with the modern measured temperature in this depth range—about 160°C, or 320°F. Marcasite under all but extraordinary natural conditions is a relatively low-temperature mineral—precipitated and stable between about 120°C and 200°C (248°F and 392°F). Reconnaissance fluid-inclusion studies discussed immediately below demonstrate that quartz and calcite in the marcasite-bearing veins also were precipitated at very close to modern measured temperatures. The strong implication of these findings is that the veins and breccia cements are features of the contemporary hydrothermal system.

Reconnaissance Fluid-Inclusion Microthermometry

At the writer's request, Moore (2007) has analyzed, using FIM, one sample each of hydrothermal quartz and calcite from open veins cutting the metamorphic tectonites at depths of 2794.5 ft (852 m; calcite) and 2811.8 ft (857 m; quartz). The second sample is from a thick quartz vein coinciding with the sole lost-circulation zone encountered in EM 17-31 (Hulen, 2006). The reader is referred to ***Appendix 4*** for details of the methods and procedures applied for FIM, and for tabulated microthermometric measurements. Basically, FIM can be used effectively to determine (**1**) the temperature either of crystal growth or of fluid transgressing a crystal along post-mineral fractures; and (**2**) the apparent salinities of the causative hydrothermal fluids.

"Dogtooth" calcite crystals from 2794.5 ft (852 m) contained no analyzable primary fluid inclusions, only secondary ones trapped along healed fractures (Moore, 2007; ***Appendix 4***). Analysis of these secondary inclusions thus provided information only about fluids moving through the host vein sometime after the calcite crystals were precipitated. The secondary inclusions yielded *homogenization temperatures* ranging from 178°C to 203°C (352°F to 397°F) and averaging 193°C (379°F)

As a fluid inclusion is heated under controlled conditions, its homogenization temperature is the value at which the liquid and vapor initially present (at room temperature) homogenize to a single phase—liquid in the case of the EM 17-31 inclusions. This value is the minimum trapping temperature of the fluid. The true trapping temperature can be obtained only if the depth and/or pressure of entrapment are known, and a corresponding *pressure correction* (actually, an increment of temperature) is added to the homogenization temperature. However, for the depths and pressures associated with most geothermal (or epithermal) systems, pressure corrections only amount to a few degrees Celsius. Therefore, for the EM 17-31 inclusions, homogenization temperatures closely approximate true trapping temperatures.

The modern measured temperature at 2794.5 ft (852 m) in the corehole is slightly less than 160°C (320°F). Therefore, the temperature at this depth appears to have diminished by about 59°C (106°F) since the calcite-hosted secondary inclusions were trapped.

The calcite crystals in the vein at 2794.5 ft (852 m) were precipitated on a substrate of hydrothermal quartz, which was not analyzed microthermometrically. However, the quartz is texturally identical to that forming the analyzed quartz vein at 2811.8 ft (857 m). Quartz crystals from this vein contain primary inclusions that homogenized (and thus were trapped) at an average temperature of ~164°C (~327°F), just slightly higher than the modern measured temperature at this depth.

An approximation to the salinity of the fluid trapped in an inclusion can be obtained by freezing the fluid, then heating it while observing at what temperature the last of the resulting ice melts. Using this procedure, Moore (2007; ***Appendix 4***) has determined that the calcite-hosted secondary inclusions at 2794.5 ft (852 m) contain fluid with an average apparent salinity of 0.7 wt.% NaCl equivalent (not an uncommon value for producing geothermal systems). The quartz-hosted primary inclusions (at least those that could be analyzed for this parameter) have nil apparent salinity—they appear to be essentially fresh water, which, even so, must have carried at least enough silica to precipitate the inclusion-hosting quartz.

If we assume that the quartz at 2794.5 ft (352 m) is of the same generation as its counterpart at 2811.8 ft (357 m), then the fluid-inclusion data in combination with modern measured temperatures suggest the following scenario: The geothermal system in this depth range increased in temperature from about 164°C (327°F) to about 193°C (379°F), then cooled back to the modern temperature of about 160°C (320°F). The higher temperature could record a transient influx of more energetic thermal fluid from below—an influx triggered, for example, by natural hydraulic fracturing. The latter phenomenon is amply recorded in the metamorphic-tectonite core by vuggy, hydrothermal-explosion breccia (Hulen, 2006).

Revised Conceptual Model

Results from the drilling of corehole EM 17-31, reconnaissance XRD/FIM analysis of the core, and detailed density/gravity modeling require refinement of the pre-drilling conceptual model of the Emigrant geothermal system presented by Hulen et al. (2005; see also ***Figure 4***, this report). The revised model is superimposed on geologic section C-C' (Alternative III; Figure 3) as ***Figure 5***.

Two fundamental features of the pre-drilling conceptual model are retained for the new revision: (**1**) The geothermal system—almost certainly of the "deep-circulation" variety—is supported primarily by focused thermal-fluid upflow along northerly- to northwesterly-trending, moderate- to high-angle, down-to-the-west normal faults, including those of the Emigrant Peak and Green Monster fault zones; (**2**) Beneath an impermeable cap, the thermal fluids are diverted laterally away from the upflow plumes along subhorizontal fracture networks developed or reactivated as part of the regionally prevalent, domally uplifted, Silver Peak metamorphic core complex (Oldow et al., 2003).

The pre-drilling model had this lateral thermal-fluid advection occurring in the upper plate of the core complex along favorable horizons or lenses of the Paleozoic section, for example, in the Cambrian Emigrant Formation (Hulen, 2005). The drilling of EM 17-31

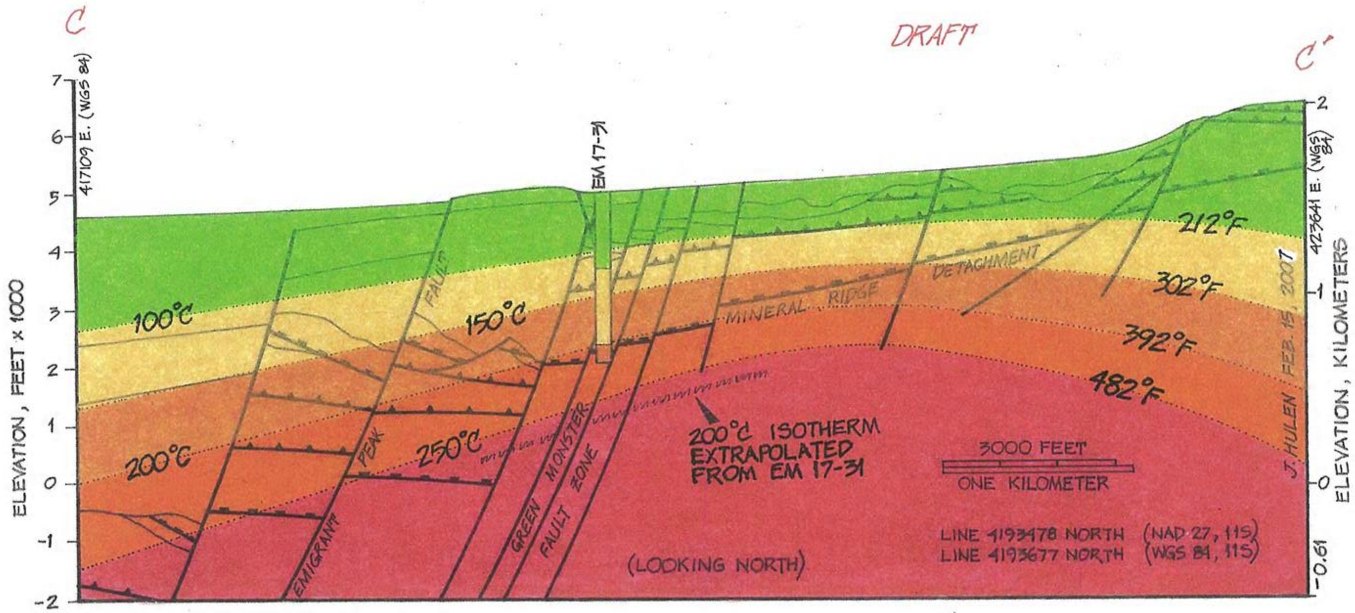

Figure 4. Comparison, along section of Figures 1 to 3, of measured equilibrium temperatures for corehole EM 17-31 with subsurface temperature distribution predicted from contoured, shallow (<~~250~~ 60 m deep) thermal-gradient data. Gradients from AMAX Geothermal (Deymonaz, 1984) and the Southern Methodist University geothermal database (2005). Fully conductive gradients are assumed for this section, but unless the Emigrant geothermal system is driven by a cooling Quaternary pluton (for which there is no evidence; and which the writer believes is highly unlikely here), the prospect's shallow, high, conductive thermal gradients *must* be supported at depth by convectively ascending or laterally advecting high-temperature thermal plumes heated by "deep circulation" in a region of higher-than-typical crustal heat flow.

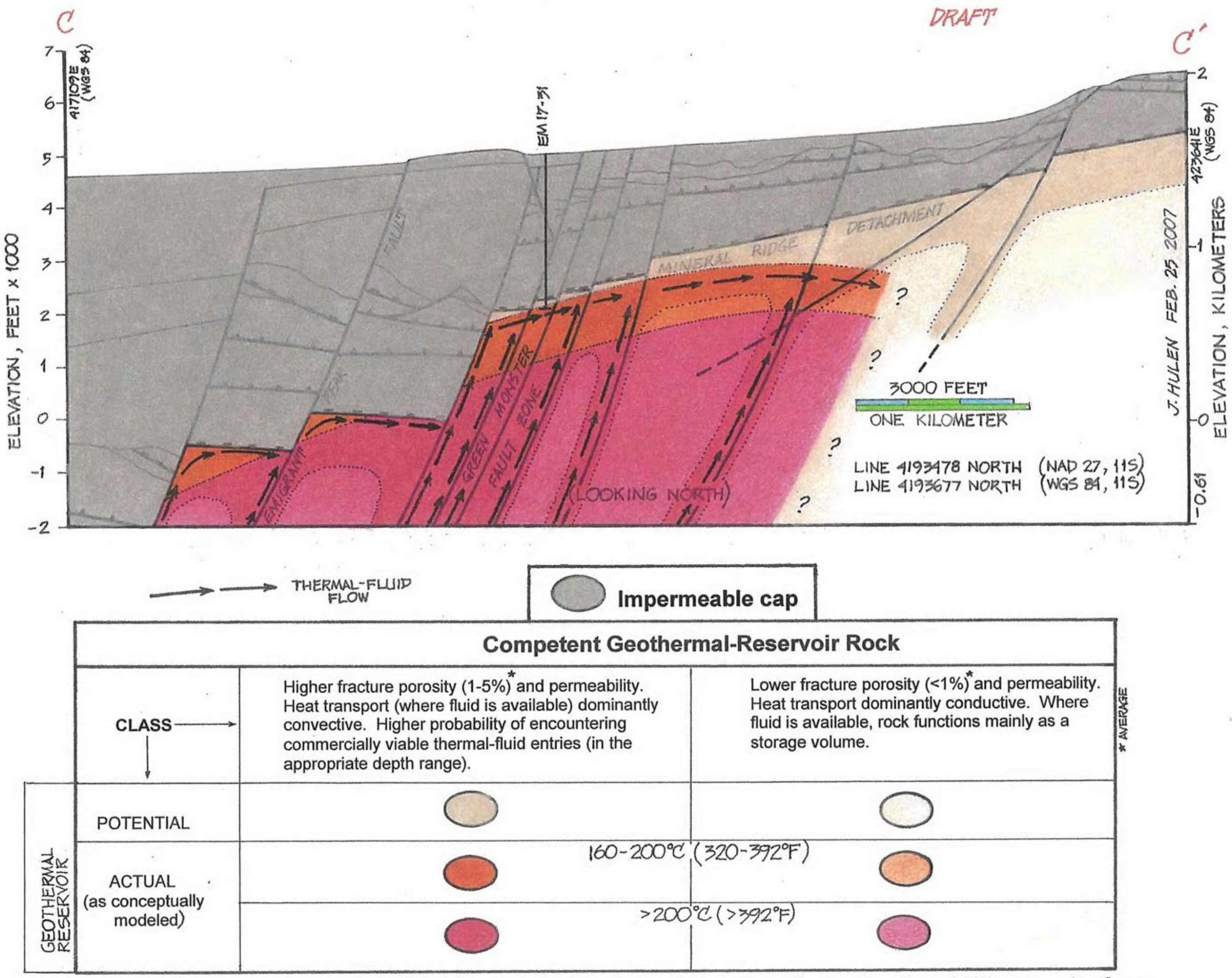

Figure 5. Revised conceptual model for the Emigrant geothermal system, incorporating drilling results from corehole EM-17-31. Please refer to text for discussion.

demonstrated instead that the Paleozoic rocks have been intensely sheared and brecciated to form an impermeable cataclasite sequence (Hulen, 2006). At least in the vicinity of the corehole, the Paleozoic section is far from a favorable reservoir interval. On the contrary, the section appears to function as a hydrologic top-seal, or cap.

The metamorphic tectonites of the lower plate of the core complex were given little consideration as reservoir-rock candidates in the pre-drilling model. The reason? The tectonites were estimated (guessed, really, from outcrops more than 10 km to the southeast) to be at least 6100 ft (about 1.9 km) beneath what would become the drilling site for 17-31 (***Appendix 2***; Hulen et al., 2005). In reality, the tectonites were encountered in the corehole about 3360 ft (more than a kilometer) closer to the surface, at a depth of only 2735.6 ft (834 m).

As a counterpoint to the disappointingly tight Paleozoic strata, the tectonites penetrated by EM 17-31 are dense, hard, brittle, and competent—chlorite-biotite-feldspar-quartz mylonites, marble mylonites, and metagranites that by any measure should be ideal geothermal-reservoir rocks. The hole penetrated only about 200 ft (61 m) into the lower plate of the core complex, but even in this short interval the lower-plate tectonites are extensively fractured and brecciated; hydrothermally altered and mineralized. The weight of the evidence gathered to date and presented earlier in this report indicates that this alteration and mineralization—notable for preservation of abundant fracture porosity—very likely formed in a still-active geothermal system at temperatures comparable to those prevailing today at these depths.

A near-bottom-hole (2900 ft, or 884 m) temperature of 323°F (162°C) in 17-31 provides an indication of the *minimum* temperature of a commercially viable Emigrant geothermal system. The conductive thermal gradient between ~1100 ft (91 m) and 2900 ft is ~130°C/ km (~7.1°F/100 ft). Extrapolating this gradient downward yields a temperature of 200°C (392°F) at ~3900 ft (~1190 m; ***Figure 5***). This temperature is compatible with various Emigrant water-geothermometer temperatures (mostly >160°C/320°F; up to 231°C/448°F) reported by Deymonaz (1984). Short of deeper drilling, we have no way of knowing how far down the conductive gradient of EM 17-31 will prevail—eventually it must give way to a convective regime (except, again, in the unlikely event that a cooling pluton is the heat source). However, given the foregoing facts and relationships, the odds are favorable for a geothermal-reservoir temperature of at least 180°C (356°F), and probably >200°C (>392°F).

Conclusions—and Recommendations for Future Drilling—Results from the drilling of EM 17-31 clearly have enhanced the odds for discovery at Emigrant of a producible, high-temperature, low-salinity, liquid-dominated geothermal system. The drilling results and consequent revision of the Emigrant-system conceptual model (***Figure 5***) lead to the following conclusions and recommendations:

1. The Emigrant geothermal reservoir will be hosted principally if not entirely by metamorphic tectonites (mylonites), intruded by metagranite plutons, in the lower plate of the Silver Peak metamorphic core complex. Porosity and permeability for the system in these competent reservoir rocks will be provided mostly by fractures and breccias developed: (**1**) in subhorizontal disruption zones beneath the Mineral Ridge detachment; (**2**) in the damage zones of moderate- to high-angle, down-to-the-west normal faults that dissect the detachment; and (**3**) based on the EM 17-31 core, by natural hydraulic fracturing and hydrothermal brecciation likely induced by the modern geothermal system itself. Hydrothermal dissolution-cavity networks in marble mylonites may provide supplementary porosity and permeability.

2. The entire stratigraphic section (including Paleozoic units) above the Mineral Ridge detachment—at least in the heart of the prospect, and as transected by section C-C' through EM 17-31—acts as an impermeable cap on the underlying geothermal system.

3. The most advantageous drilling targets in the system are the aforementioned high-angle faults and associated damage zones, particularly where these structures are close together or where they may intersect.

4. The Green Monster fault zone (GMFZ), because it is clearly permeable and has multiple strands (and thus potentially coalescing damage zones), still offers the best chance in this sector of the Emigrant prospect for discovery of commercially viable thermal-fluid entries at relatively economical drilling depths.

5. The two-density gravity model of Lide (2006), for an east-west section just south of C-C' (***Appendix 2; Figure 3***) indicates a profound but non-outcropping fault west of and proximally parallel to the GMFZ. If there is merit to the writer's earlier speculations—(**1**) that the modeled density/gravity match, though remarkable, could be non-unique; and (**2**) that based on the coring results, multi-density models might be usefully considered as alternatives—then the location and configuration of this gravity-indicated structure should be further tested and refined. In this position, the hidden fault would likely be a major thermal-fluid upflow zone.

6. If the indicated location/configuration of the hidden fault withstands scrutiny, the structure should be drill-targeted below a depth of ~5000 ft (~1525 m), above which the hanging wall—based on the new conceptual model (***Figure 5***)—would be thick, impermeable caprock. Below ~5000 ft, said hanging wall would consist of brittle, metamorphic-tectonite and metagranite reservoir rock. To maximize the probability of penetrating at least several hundred feet of hanging-wall reservoir rock, a drill hole likely would need to be sited 2500-3000 ft (760-910 m) west of EM 17-31.

7. In the writer's opinion, based on the new drilling results combined with extrapolation from detailed surface geologic mapping, the overall dip of the GMFZ is likely to be somewhere between 65° and 75° to the west (intermediate

between Alternatives II and III). If so, the fault zone permissively could persist downward beneath the bottom of 17-31 for another 2000 ft (610 m) or so (***Figure 5***), offering an incentive for deepening the corehole below its current total depth.

8. The puzzle of overall structural control of the Emigrant geothermal system remains to be satisfactorily solved. Although the new drilling results confirm that the GMFZ is a likely major thermal-fluid upflow channel in the vicinity of EM 17-31, the system's shallow (<60 m), conductive, high-thermal-gradient expression (Deymonaz, 1984; and ***Appendix 1***) is aligned northwest-southeast, distinctly oblique to the GMFZ's generally north-south strike.

The thermal-gradient high is a comparatively superficial feature, and one explanation for its configuration could be a variant of Schriener's (2006) hypothesis wherein hot fluids upwelling exclusively along the GMFZ are diverted subhorizontally upward and eastward as a "rootless" lateral plume beneath the geothermal system's caprock. The surprising impermeability of the Paleozoic section revealed by EM 17-31 rules out stratigraphic control of this lateral flow in the upper plate of the core complex in the vicinity of section C-C'. However, within the constraints of the drilling results and the revised conceptual model (***Figure 5***), the lateral upflow *could* be controlled by subhorizontal fracture-networks in the upper reaches of the lower plate.

Equally plausible in the view of the writer, however, is that the northwest-southeast alignment of the shallow thermal-gradient high (***Appendix 1***) tracks the prospect's northwest-left-stepping, northerly-trending, major fault segments at the western margin of the exposed, Paleozoic-rock *massif* forming this part of the Silver Peak Range (***Appendix 1***). These left-stepping faults, in the parlance of Faulds and Varga (1998), would be linked in the subsurface by southerly-plunging *relay ramps*, which are complexly fractured zones conceptually ideal for focusing high-temperature geothermal-fluid flow and storage.

The implication of the relay-ramp hypothesis for Emigrant is that the high shallow thermal gradients measured in boreholes east of the GMFZ could be supported by other high-angle, ramp-related normal faults, all potentially high-quality geothermal drilling targets.

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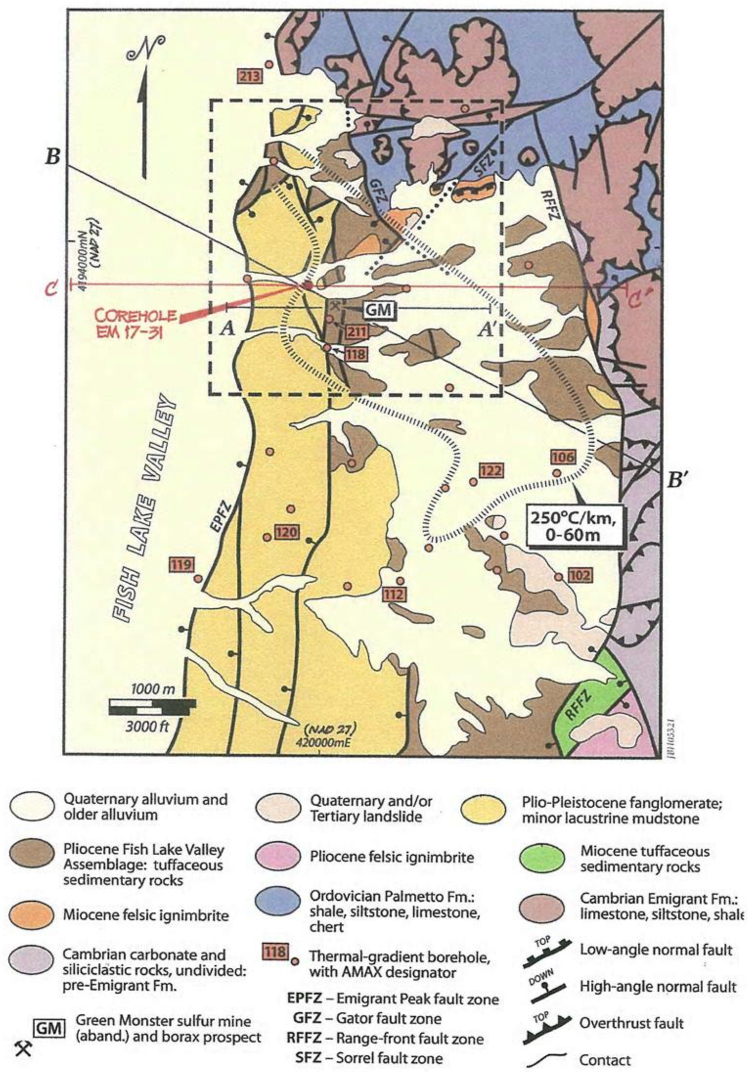
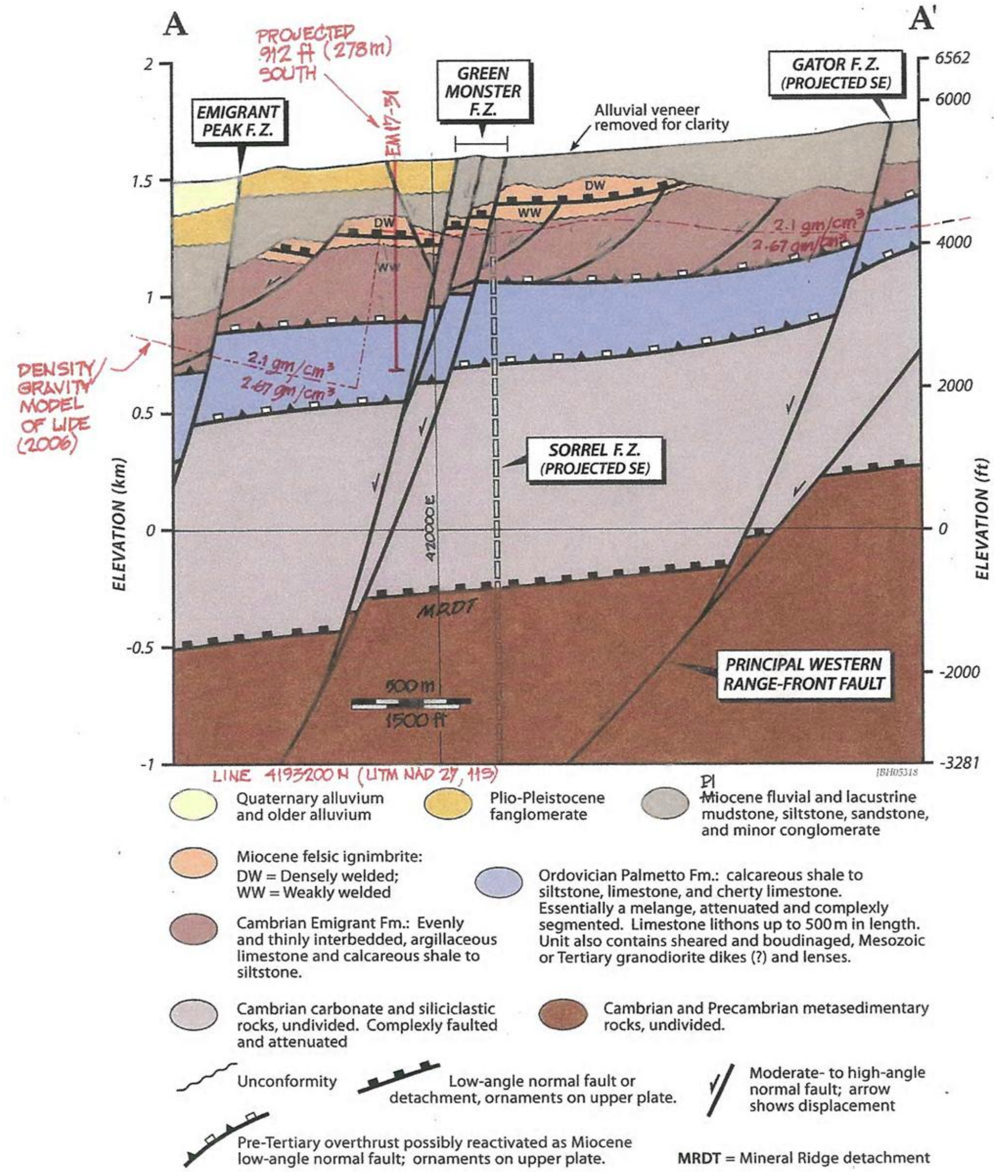


Appendix 1. Geologic map of the Emigrant geothermal prospect (from Hulen et al., 2005).

A1



Appendix 2. Pre-drilling interpretive east-west geologic section A-A', through the Green Monster mine.

A2

Appendix 3

February 11, 2007

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Dyer, NV 89010

re: Bulk X-ray diffraction results for nine samples from EEC corehole EM 17-31

Dear John:

As per your request, I have completed bulk XRD reconnaissance for the core from EM 17-31. I'll finish the new cross section tomorrow. Sorry for the delay, but I owed a big report to another client, and just finished a couple of days ago. The XRD results, with commentary, are as follows:

Sample Depth: 489 ft.

Rock type from field geologic log: Green, tuffaceous, interbedded sandstone and gritstone. From visual examination, the rock appears to be intensely clay-altered, ostensibly to the smectite-family mineral nontronite.

XRD Mineralogy (approximate weight per cent): Quartz—17%; Potassium feldspar—33%; Plagioclase—6%; Calcite—2%; Siderite (?)—2%; Amorphous or below detection limit—40%.

Comments: Although the rock appears strongly argillized, the XRD results show that it is not, as its greenish, "punky" appearance would indicate, altered to the common clay mineral nontronite. The X-ray diffractogram shows a subdued, very broad, poorly-ordered "bulge" between about 10 angstroms and 18 angstroms. This reflection *conceivably* could be poorly crystalline clay such as imogolite. However, much of the "clay-like" fine fraction of this sample more likely is just unaltered, glassy, volcanic dust and ash (hence the sample's large X-ray amorphous component).

This sample was selected, for reconnaissance purposes, to represent the (apparently) clay-altered Pliocene sedimentary sequence. If the XRD results are in fact representative, then the part of the conceptual model calling upon these argillized sediments as a caprock for the underlying geothermal system is in question. On the other hand, it might not be prudent to abandon the concept on the basis of a single sample: Portions of the sequence may yet prove to be clay-rich.

Sample Depth: 616.6 ft.

Rock/sample type from field geologic log: Refractured veinlets of bright white clay cutting interbedded tuffaceous sandstone, gritstone, and conglomerate. Veinlet-filling material hand-picked for XRD.

XRD Mineralogy (approximate weight per cent): Kaolinite—95%; Quartz—5%.

Comments: Kaolinite in a geothermal setting is typically indicative of mineralization by acidic thermal fluids. The "bright white" kaolinite is rare in the Pliocene sediments of 17-31, but its presence is not surprising. The clay-mineralizing fluids are postulated to have been high-level groundwaters acidified through condensation of volatiles like hydrogen sulfide, boiled and vapor-transported from deeper in the contemporaneous hydrothermal system.

Sample Depth: 845 ft.

Rock/sample type from field geologic log: Green clay from cataclasite (biotite rhyolite ignimbrite breccia). Sample hand-picked for XRD, but unavoidably containing considerable matrix material.

XRD Mineralogy (approximate weight per cent): K-feldspar (sanidine)—22%; Quartz—17%; Smectite—10%; Plagioclase—9%; Biotite—5%; Amorphous or below detection limit—37%.

Comments: Like the sample from 485 ft (see above), this one contains: (1) far less clay than the color and texture of the rock suggest; and (2) a significant amount of X-ray amorphous material, in all probability unaltered to partially altered volcanic ash. The smectite permissively could be the nontronite tentatively identified earlier on site.

Sample Depth: 1032 ft.

Rock type from field geologic log: Biotite rhyolite ignimbrite breccia (cataclasite), extensively sheared and slickensided, apparently strongly argillized. Sample is 8 ft above contact with underlying Paleozoic strata.

A4

XRD Mineralogy (approximate weight per cent): Quartz—32%; K-feldspar (sanidine)—21%; Unknown mixed-layer clay—22%; Smectite—20%; Plagioclase—5%.

Comments: This sample appears to be no more argillized than its counterparts at 489 ft and 845 ft, yet unlike them it contains more than 40% clay minerals. The smectite is unambiguous, and is probably nontronite. The mixed-layer clay is characterized by expansion from about 12 angstroms to about 13.5 angstroms upon vapor glycolation. It clearly contains a swelling component, but its identity cannot be determined from bulk XRD alone.

Sample Depth: 1200 ft.

Rock type from field geologic log: Fault breccia and gouge. Protolith is black, carbonaceous, shaly siltstone. Ordovician Palmetto Formation.

XRD Mineralogy (approximate weight per cent): Quartz—40%; Illite—22%; Dolomite—18%; Chlorite—14%; Pyrite—1%; Amorphous or below detection limit—5%.

Comments: Note that this rock is also layer-silicate) rich, containing more than a third by weight of illite plus chlorite. Brecciated and sheared as it is, this "clay"-rich rock almost certainly would make an excellent, impermeable cap for an underlying geothermal system. The amorphous component is almost certainly remobilized organic carbon.

Sample Depth: 1671 ft.

Rock type from field geologic log: Fault breccia and gouge. Greenish shaly siltstone protolith. Cambrian Harkless Formation.

XRD Mineralogy (approximate weight per cent): Quartz—36%; Illite—33%; Chlorite—23%; Dolomite—5%; Rutile (?)—2%; Pyrite—1%

Comments: This rock has a sheared, "soapy" texture in hand sample. The texture is readily explained by the rock being more than half illite plus chlorite. The chlorite accounts for the rock's greenish coloration.

A5

Sample Depth: 2049 ft.

Rock type from field geologic log: Fault breccia and gouge. Harkless Formation siltstone protolith.

XRD Mineralogy (approximate weight per cent): Illite—40%; Quartz—30%; Chlorite—27%; Rutile(?)—2%; Calcite—1%.

Comments: Same as for immediately preceding sample.

Sample Depth: 2811.8 ft.

Rock type from field geologic log: Chlorite-biotite-quartz mylonite ("metamorphic tectonite"). This sample was collected only 0.2 ft above a lost-circulation zone in EM 17-31.

XRD Mineralogy (approximate weight per cent): Quartz—36%; Potassium feldspar—18%; Plagioclase—16%; Illite +/- Biotite—12%; Chlorite—13%; Calcite—2%; Amorphous and below detection limit—3%.

Comments: Illite reflections readily can mask those of biotite.

Sample Depth: 2817.5 ft.

Type of material: "Sand" in core box at end of run. Drillers reported to John Deymonaz that this material "ran into" the hole after curing of the lost-circulation zone.

XRD Mineralogy (approximate weight per cent): Quartz—30%; Illite +/- Biotite—43%; Chlorite—23%; Rutile(?)—2%; Calcite—2%.

Comments: The sample is compositionally reminiscent of the Harkless Formation shaly siltstone breccia (see above). Biotite and illite patterns are very similar, so the amount of one layer silicate vs. the other cannot be determined from bulk XRD alone (some biotite is apparent in the sample when examined with a binocular microscope). If this "sand" is dominantly Harkless-derived, the implication is that what might otherwise be a viable thermal-fluid channel could be plugged by "fines" from higher in the stratigraphic section. The odds of this complication presumably would lessen with increasing depth in the geothermal reservoir.

A6

Thanks for the opportunity to analyze these samples for EEC. I look forward to speaking with you again soon.

Jeff

A7

Appendix 4

A FLUID INCLUSION INVESTIGATION OF QUARTZ AND CALCITE

Prepared for J. Hulen
BY
J. Moore
February 14, 2007

A8

Methodology

Fluid inclusion heating and freezing measurements were conducted on samples of quartz and calcite provided by Jeff Hulen. Doubly polished plates were prepared for study. Reconnaissance petrographic examination of the chips was conducted prior to performing the measurements in order to determine the relationship of the fluid inclusions to mineral growth (e.g. primary or secondary), the number of phases present at room temperature in the inclusions and the relative phase relationships.

The measurements were made on a Linkham THSMG 600 heating and freezing stage calibrated with synthetic fluid inclusions. The precision of the measurements is estimated to be $\pm$ 0.1°C at 0.0°C and $\pm$ 3°C at 374°C. Two measurements were made; the temperature of vapor bubble disappearance, which is referred to as the homogenization temperature and the temperature of ice-melting. In small inclusions less than a few micrometers across, it is generally difficult to monitor the behavior of the vapor bubble near the point of homogenization, even with a high quality 80X objective. The standard practice is to bracket the homogenization temperature by cooling the inclusion back to the temperature at which the bubble was clearly visible after each heating step. In this study the inclusions were heated in increments of 5°C or less near the homogenization temperature. Thus all of the reported values are within 2.5°C of the homogenization temperature. The melting point was determined by heating the inclusions in increments of 0.2°C near the melting temperature. After each heating step, the inclusions were rapidly cooled to confirm that the ice had melted. The salinities of the inclusions were calculated using the equation proposed by Bodnar (1993). No pressure corrections have been applied to the homogenization temperatures, as the pressures during mineral formation are unknown.

The results of the heating and freezing measurements are given in Table 1.

Results

Petrographic Relationships

The sample from a depth of 2811.8 ft consists of fine grained, parallel quartz crystals characterized by complex, plumose extinction patterns (Fig. 1). Variations in the birefringence of the crystals suggest growth zoning. Quartz-hosted fluid inclusions are small (<3 micrometers), irregular in shape, contain liquid and vapor at room temperature and have consistent phase ratios. These characteristics suggest relatively low temperatures of entrapment.

Most of the inclusions trapped in the quartz crystals are interpreted as being primary in origin. In the crystal shown in Figure 2a, the majority of the inclusions are concentrated in the area where the birefringence changes from light to dark green, suggesting these inclusions define a growth zone. Inclusions on either edge of the crystal follow the grain of the extinction pattern. Similarly, the dendritic pattern of the inclusions shown in Figure 2b suggests that their distribution was controlled by growth of the crystal.

In contrast to the fluid inclusions in quartz, many of the inclusions trapped in the calcite crystals have variable liquid to vapor ratios, suggesting the inclusions annealed or "necked" after trapping. Necked populations can be recognized by the presence of elongated "tails", the petrographic pairing of liquid and vapor-rich inclusions displaying variable liquid to vapor ratios, the pairing of 2 phase and single phase inclusions, and by large variations in the homogenization temperatures of the inclusions (Goldstein and Reynolds, 1994). Only populations of inclusions that displayed consistent phase ratios were studied. Individual inclusions from a single assemblage (e.g. a single healed fracture or individual growth zone) will have homogenization temperatures within 15° to 20°C of each other (Goldstein and Reynolds, 1994). The salinities, however, will not be significantly affected by necking.

Only secondary (or pseudosecondary) inclusions were measured in the calcite crystals (Fig. 3). These inclusions define short healed fractures. Although growth zones are present in the calcite crystals, workable fluid inclusions were not observed in them.

No direct evidence of boiling, such as the presence of coexisting liquid- and vapor-rich inclusions, was observed in the either the quartz or calcite.

Fluid Inclusion Measurements

Quartz-Hosted Inclusions

Quartz-hosted inclusions yielded homogenization temperatures ranging from 158° to 168°C. The fluid inclusion temperatures are significantly below the boiling point temperature for a water table that intersects the surface. Because of their small size, it was not possible to measure the ice-melting temperatures in most of the inclusions studied. Those that were measured yielded salinities of 0 weight percent NaCl equivalent.

Calcite Hosted Inclusions

Homogenization temperatures of inclusions in calcite ranged from 183° to 203°C. The salinities of these inclusions ranged form 0.5 to 1.2 weight percent NaCl equivalent, with an average value of 0.7 weight percent. As is the case for the quartz-hosted inclusions, the homogenization temperatures plot considerably below the boiling point for this depth.

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A10

Table 1. Results of fluid inclusion measurements. Abbreviations: AVG = average; Mineral: cal = calcite; qtz = quartz; p/s = primary/secondary; Th = homogenization temperature (°C); Tm-ice = final ice-melting temperature (°C); Wt % NaCl eq; salinity as weight percent NaCl equivalent.

Depth (ft)	Th	Tm-ice	NaCl eq	Mineral	p/s
2794.5	183	-0.5	0.9	cal	s
2794.5	183	-0.5	0.9	cal	s
2794.5	183	-0.5	0.9	cal	s
2794.5	178	-0.5	0.9	cal	s
2794.5	178	-0.5	0.9	cal	s
2794.5	178			cal	s
2794.5	183			cal	s
2794.5	183			cal	s
2794.5		-0.5	0.9	cal	s
2794.5		-0.5	0.9	cal	s
2794.5		-0.5	0.9	cal	s
2794.5		-0.5	0.9	cal	s
2794.5		-0.5	0.9	cal	s
2794.5	203	-0.3	0.5	cal	s
2794.5	198			cal	
2794.5	203	-0.4		cal	
2794.5	203	-0.3		cal	
2794.5	203	-0.3		cal	
2794.5	198	-0.4	0.7	cal	s
2794.5	198			cal	s
2794.5	193	-0.3	0.5	cal	s
2794.5	193	-0.3	0.5	cal	s
2794.5	193	-0.3	0.5	cal	s
2794.5	198			cal	s
2794.5	203	-0.3	0.5	cal	s
2794.5	198	-0.3	0.5	cal	s
2794.5	198	-0.3	0.5	cal	s
2794.5	198	-0.4	0.7	cal	s
2794.5	198	-0.7	1.2	cal	s
2794.5	203	-0.3	0.5	cal	s
AVG	193.2	-0.4	0.7		
2811.8	168	0	0.00	qtz	p
2811.8	168	0	0.00	qtz	p
2811.8	168	0	0.00	qtz	p
2811.8	168	0	0.00	qtz	p
2811.8	168	0	0.00	qtz	p
2811.8	168			qtz	p
2811.8	168			qtz	p
2811.8	168			qtz	p
2811.8	168			qtz	p

A11

Table 1 continued.

Depth (ft)	Th	Tm-ice	NaCl eq	Mineral	p/s
2811.8	168			qtz	p
2811.8	168			qtz	p
2811.8	168			qtz	p
2811.8	168			qtz	p
2811.8	168			qtz	p
2811.8	168			qtz	p
2811.8	163			qtz	p
2811.8	163			qtz	p
2811.8	163			qtz	p
2811.8	163			qtz	p
2811.8	163			qtz	p
2811.8	163			qtz	p
2811.8	163			qtz	p
2811.8	163			qtz	p
2811.8	163			qtz	p
2811.8	163			qtz	p
2811.8	163			qtz	p
2811.8	163			qtz	p
2811.8	163			qtz	p
2811.8	163			qtz	p
2811.8	163			qtz	p
2811.8	163			qtz	p
2811.8	163			qtz	p
2811.8	163			qtz	p
2811.8	163	0		qtz	p
2811.8	168			qtz	p
2811.8	158			qtz	p
2811.8	158			qtz	p
2811.8	158			qtz	p
2811.8	158			qtz	p
2811.8	158			qtz	p
AVG	164.4	0	0		

A12

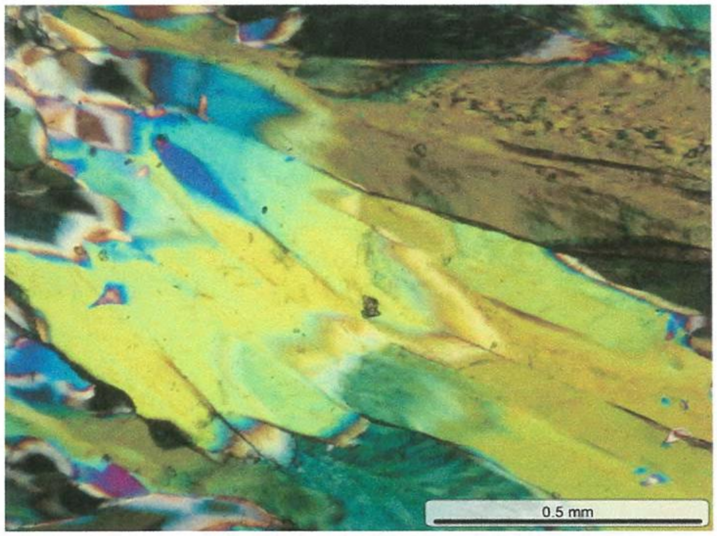

Fig. 1. Photomicrograph of quartz crystals showing complex extinction patterns. Crossed nicols.

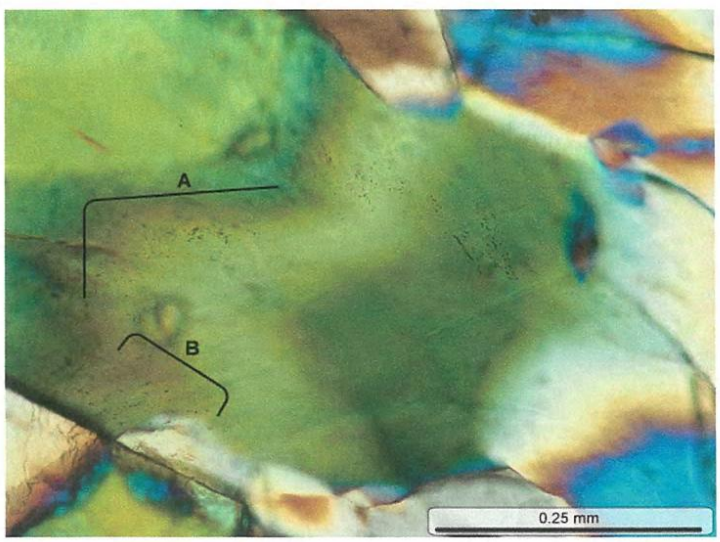

Fig. 2a. Primary fluid inclusions in quartz. The inclusions in the center of the photomicrograph (group A) are concentrated along the boundary where the where the birefringence changes from light to dark green. Inclusions in group B define linear arrays that follow growth patterns defined by variations in birefringence. Crossed nicols.

A13

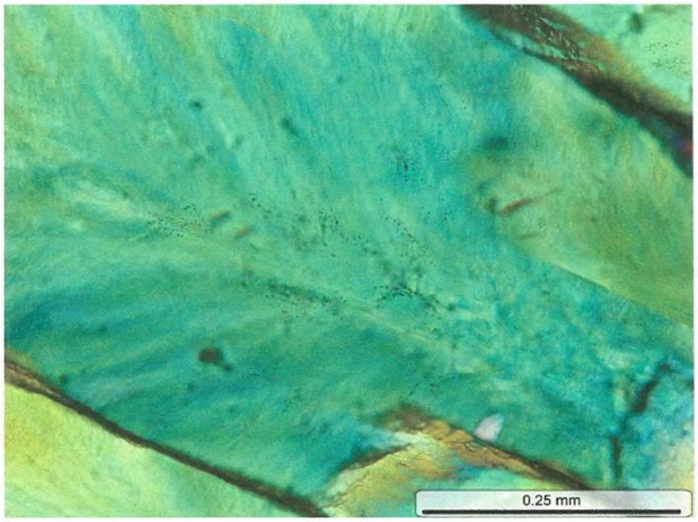

Fig. 2b. Fluid inclusions in quartz. The inclusions are concentrated along the axis of the crystal and in areas where there are subtle changes in birefringence. The inclusions are interpreted as primary in origin. Crossed nicols.

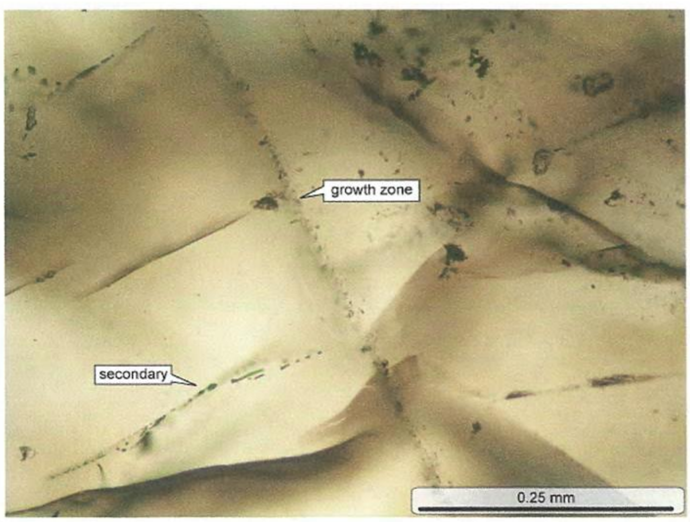

Fig. 3. Fluid inclusions in calcite. The secondary (or pseudosecondary) inclusions define a short healed fracture that does not cut across the growth zone.

A14

Descriptive Geology of Core and Cuttings from Drill Hole EM 17-31, Emigrant Geothermal Prospect, Esmeralda County, Nevada

for

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by

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December 26, 2006

SYNOPSIS

Corehole EM 17-31, with a total depth (TD) of 2938 ft, was sponsored jointly by Esmeralda Energy Company (EEC; Dyer, Nevada) and the U.S. Department of Energy (DOE; Geothermal Technologies Program) as a "GRED III" exploration-drilling project in the Emigrant geothermal prospect, Esmeralda County, Nevada (Hulen et al., 2005a, 2005b). Below ~832 ft of late Cenozoic, siliciclastic sediments, EM 17-31 appears to have been completed entirely in the regionally extensive, 11-6 Ma, Silver Peak metamorphic core complex (SPCC; Oldow et al., 2003).

As penetrated by EM 17-31 in the depth interval 831.8-2735.6 ft, the upper plate of the SPCC comprises the following major tectonostratigraphic units:

- 831.8-1033.6 ft—Weakly welded, probable early Miocene, rhyolitic ignimbrite of the Miocene Icehouse Canyon Assemblage.
- 1033.6-1155 ft—Interstratified limestone and minor siltstone, provisionally assigned to the Cambrian Emigrant Formation.
- 1155-1622.5 ft—Interstratified carbonaceous limestone and siltstone, sheared cataclasite derived from these protoliths, and fault gouge and breccia of similar parentage, all conditionally correlated with the Ordovician Palmetto Formation.
- 1622.5-2602 ft—A three-component sequence consisting of an upper siltstone-limestone unit containing the pisolitic structures known as *Girvanella*; a middle, gray-green shaly siltstone unit; a lower, very fine-grained sandstone unit; and, throughout, thick and gently-dipping cataclasites and fault breccias derived from these protoliths. This entire sequence is strongly reminiscent of exposures and published descriptions of the Cambrian Harkless Formation.
- 2602-2720.6 ft—Numerous tectonically juxtaposed horizons of siltstone, limestone, and sandstone along with gently-dipping cataclasites derived from these rock types. Formational affiliation unknown.
- 2720.6-2735.6: Gently-dipping, granodiorite cataclasite to mylonite, becoming progressively denser and more intricately foliated with depth. This sequence is believed to represent the Mineral Ridge detachment, which separates the SPCC's upper and lower plates.

The likely lower plate (or "core") of the SPCC was breached in EM 17-31 between 2735.6 ft and TD. By contrast with the sheared, brecciated, crumbly, and largely incompetent Paleozoic rocks in the upper plate, the presumed lower plate here consists of dense, hard, and highly competent chlorite-biotite-quartz mylonites, marble mylonites, and metagranite dikes and sills. The mylonites are believed to be the "metamorphic tectonites" characteristic of the lower plate (Oldow et al., 2003); the metagranites are sheared and partially recrystallized plutons of probable Mesozoic age.

Alteration and mineralization of upper-plate SPCC rocks in the corehole are distinctly different from their lower-plate counterparts in composition, texture, and inferred origin. Except for scattered granodiorite intercepts, upper plate alteration and mineralization could be either hydrothermal or diagenetic, or both. Rhyolitic ignimbrite is argillized and commonly altered to probable celadonite. Underlying Paleozoic siliciclastic rocks contain abundant chlorite and sericite (illite), layer silicates that are prevalent as diagenetic phases in corresponding strata on a regional basis; associated limestones are, for the most part, apparently unaltered. The granodiorite intercepts are hydrothermally propylitized, but this alteration pre-dates the extensive shearing and cataclasis affecting these intrusives.

Lower-plate mylonites and metagranites in the corehole are hydrothermally silicified, with the silicification accompanied by chlorite, calcite, and disseminated marcasite ± pyrite. The alteration is clearly associated with open veinlets of the same mineralogy—veinlets that typically contain fine drusy quartz and large, scalenohedral, "dogtooth" calcite crystals. Hydrothermal-dissolution cavities in the mylonites and metagranites are similarly quartz- and calcite-lined. A minor lost-circulation zone at 2812 ft in EM 17-31 corresponds with a vuggy, silicified, "jigsaw-puzzle"-textured dilational breccia almost certainly created by natural hydrothermal rock rupture.

INTRODUCTION

At the request of EEC, the writer has geologically examined and described cuttings and nearly-continuous core representing the depth interval 30-2938 ft (TD) in GRED-III drill hole EM 17-31. Core from 406-2600 ft was logged at a scale of ~1:60. A more detailed account, at a scale of ~1:30, was undertaken for the interval 2600-2938 ft, which arguably approaches the upper regions of a high-temperature Emigrant geothermal system. Multiple copies of the detailed core log (Hulen, 2006a) were shipped to EEC's Dyer offices earlier this month. A similar number of copies of the corresponding cuttings log for 30-406 ft (Hulen, 2006c) are to follow shortly. Abridged, graphic geologic summary logs for the full sampled interval in 17-31 are presented as **Figures 1** and **2**, appended to this document. The geology is further described in Hulen (2006b), and in the following pages of this communication.

From a geothermal perspective, corehole EM 17-31 encountered the following encouraging features: (**1**) high temperature at relatively shallow depth (161°C at TD); (**2**) conductive thermal gradients mostly >160°C/km from top to TD, hinting at even higher temperatures at greater depths; (**3**) highly competent, prospective reservoir rocks about a mile closer to the surface than predicted (~2700 ft vs ~8000 ft; Hulen et al., 2005a, 2005b); and (**4**) in those competent rocks, ample evidence of dilational fracturing and epithermal fluid-rock interaction at temperatures compatible with those prevailing today at drill-tested depths.

The present document is a descriptive summary of the rock sequence penetrated by the inaugural Emigrant corehole. Implications of the corehole geology for exploration, conceptual modeling, and development of the Emigrant geothermal system are to be addressed as a separate phase of EEC's overall investigation of the resource.

METHODS AND PROCEDURES

Prior to examination and description, the core for each 20- or 40-ft interval of EM 17-31 was washed where (typically) necessary to remove dried coatings of drilling polymer and rock dust that variously obscured or obliterated the core surface. The core then was examined and described in detail—routinely with the aid of a 10X hand lens; occasionally with a Zeiss binocular-zoom microscope—and described with emphasis on the following features:

- *Lithology*, with special attention to contemporary competence and potential permeability.
- Types and configurations of *Contacts* between geologic units: For example, sharp vs. gradational; planar vs. undulatory; depositional vs. sheared; unmarked vs. slickensided.
- *Alteration* types and intensities.
- *Fracture* types, attitudes, abundances or intensities, and diagnostic markings. As the core is not oriented, "attitude" in this context is restricted to dip and (where applicable) to rake of slickensides relative to horizontal.
- *Breccia* types, textures, and abundances: For example, tectonic vs. hydrothermal; sheared vs. purely dilational; "jigsaw-puzzle" vs. stockwork.
- *Vug* (megascopically visible pore) types, distributions, and sizes;
- *Vein-, Breccia-cementing, and Vug-filling Secondary Minerals* and their paragenesis (order of precipitation).
- Mineralogy and paragenesis of open-space-filling, euhedral *Hydrothermal Crystals*, additional indicators of contemporary potential permeability.

The lithologic units penetrated by EM 17-31 have been correlated provisionally, for this document, with recognized local or regional formations and other geologic units based on (**1**) prior detailed geologic mapping of the Emigrant prospect and vicinity (Hulen et al., 2005a, 2005b); (**2**) reconnaissance examination and description of other formations and units exposed in the Silver Peak Range, but beyond the boundaries of the prospect (J. Hulen, field notes, 2005); and (**3**) comparison with published descriptions in Albers and Stewart (1972), Robinson et al., (1976), Craig (2003), and Oldow et al. (2003). More rigorous correlation must await detailed paleontological analysis and (for igneous rocks) radiometric geochronology, both approaches beyond the scope of the present investigation.

EM 17-31 GEOLOGIC SUMMARY

DEPTH INTERVAL 30-230 ft (cuttings)

Lithology: Unconsolidated sand, grit, and pebble gravel, with minor mud and silt. >1 mm-fraction clasts are generally subequant, angular to subangular (rarely subrounded) and comprise, in various proportions, shale, siltstone, sandstone, chert, limestone, felsic volcanic rocks (mostly ignimbrite), weakly to moderately-consolidated tuffaceous sandstone, and broken phenocrysts of quartz and feldspar (mostly sanidine, some of which is chatoyant). Mud and silt fractions are light gray to gray-buff. Clast rock types with the exception of tuffaceous sandstone are firmly indurated and clearly derived from Paleozoic and Tertiary formations including those now exposed in the Silver Peak Range to the east and perhaps north.

Alteration/Mineralization: Mud and silt fractions are glutinous when wet, and could be weakly argillized (XRD required for confirmation). Alternatively, the "alteration" could simply be detrital clay or dust-sized volcanic ash. The mud/silt fraction of a few samples is sparsely stained with goethitic to hematitic "limonite."

Fracturing, Brecciation, Veining, Euhedral Crystals: None.

Correlation: Based on comparison with nearby, well-exposed outcrops, this unit is believed to be Pleistocene "older alluvium" (Robinson et al., 1976; Hulen et al., 2005a, 2005b)—mostly debris-flow and hyperconcentrated-flood-flow deposits. In outcrop, the older alluvium is weakly consolidated; its wholly disaggregated condition in cuttings is interpreted to be the result of drilling.

DEPTH INTERVAL 230-831.8 ft (cuttings to 406 ft)

Lithology: Interbedded, gently- to moderately-dipping (mostly $\leq 40^{o}$), weakly consolidated, tuffaceous conglomerate, gritstone, sandstone, and siltstone (in decreasing order of abundance), all a distinctive gray-green in color, and reminiscent of the greenish tuffaceous siliciclastic strata responsible for the name of the nearby Green Monster mine (Hulen et al., 2005a, 2005b). This sequence, unlike the overlying "older alluvium", commonly contains abundant ash- to lapilli-sized detrital pumice. Coarser (>1 mm) clastic grains in this pumiceous unit are similar in lithology to those in the "older alluvium," except that the lower half of the deeper sequence contains conspicuous clasts of intermediate-composition volcanic rock. The cuttings sample from 270-280 ft depth is dominated by a buff-colored, hydrothermally or diagenetically silicified, fine-ash fallout tuff, a horizon which is likely to be a useful marker horizon in future Emigrant drill holes.

The core from 442-442.5 ft is a planar- to contortionally-laminated silica-pyrite rock of possible exhalative origin (i.e., from a long-extinct "black-and-white smoker," or sublacustrine hot spring).

Alteration/Mineralization: Apparent argillic alteration of this unit could be hydrothermal, diagenetic, or a combination of both. The distinctive greenish coloration of the unit, from top to bottom, appears to be due to the presence of secondary, iron-rich clay (**Fig. 1**), possibly nontronite and/or saponite. This tentative identification is based solely on hand-lens and binocular microscopic examination; permissively, the clay could be accompanied by microcrystalline zeolite (a common diagenetic alteration product of alkaline-lake tuffaceous sediments). Alternatively, but believed by the writer far less likely, the "argillization" could be mimicked by dust-sized, felsic volcanic ash.

The presumed nontronitic argillization of this sequence affects mostly the mud- and silt-size fraction along with some of the pumice, and the coarser clasts do not appear to have been altered during or after sedimentation (some of the clasts are derived from formations that were previously altered). Minor amounts of disseminated pyrite/marcasite are also locally present, especially where these sulfides are also found as veinlet minerals.

Fracturing, Faulting, Brecciation: The tuffaceous sediments of this unit are commonly weakly to moderately fractured and minor-faulted. Most of these structures are moderately to steeply-dipping (>50°), and the faults have slickensides indicating oblique dip-slip displacement. However, the lower 2.5 ft of the unit is disrupted by low- to low-moderate-angle (14-37°) shears, and the interval from 829.3-829.7 ft can be characterized as a gently-dipping, moderately-indurated mylonite. The basal contact of the unit at 831.8 ft is a 35°-dipping, discordant shear.

Open-Space Filling: This tuffaceous sedimentary sequence is locally disrupted by thin veinlets comprising quartz, clay, pyrite/marcasite, and local calcite in various combinations. The two sulfides also occur sparsely as local disseminations.

Correlation: Again based on comparison with nearby mapped exposures and with written descriptions of similar units (Hulen et al., 2005a, 2005b; Robinson et al., 1976; Oldow et al., 2003), the tuffaceous clastic sequence penetrated by corehole EM 17-31 is correlated provisionally with tuffaceous sedimentary rocks of the Miocene Fish Lake Valley Assemblage (**Fig. 2**), considered by Albers and Stewart (1972) to be part of the broader regional Esmeralda Formation.

DEPTH INTERVAL 831.8-1033.6 ft

Lithology: Felsic ignimbrite (**Fig. 1**), weakly welded, crystal- and lithic-rich, very light gray to gray buff, commonly mottled dull to bright gray-green. Contains bipyramidal quartz phenocrysts, commonly broken and embayed. Abundant angular clasts of porphyritic, intermediate-composition volcanic rock. The upper and lower portions of this unit (respectively, 831.8-855 ft and 1022.3-1033.6 ft) are so intensely brecciated (though moderately cohesive) that they are technically ignimbrite cataclasites (**Fig. 1**).

Alteration/Mineralization: Like the overlying tuffaceous sedimentary sequence, the ignimbrite appears to be argillized throughout (**Fig. 1**), although the alteration is apparently less intense than in the sediments. The characterization as argillic alteration again is based on hand-lens and binocular-microscopic examination, and the clay could be accompanied by cryptic, microcrystalline zeolite (clinoptilolite is a common alteration product of this this unit on the northeastern side of the Silver Peak Range (J. Hulen field notes, 2005).

Between 831.8 ft and ~950 ft depth, the ignimbrite also appears to be altered in part to medium to dark gray-green celadonite, an iron-rich illite analogue. The celadonite (?) also occurs as veinlets in the argillized ignimbrite, and appears to post-date the argillization. The celadonite persists in traces to at least 1000 ft depth. Finally, the ignimbrite is also weakly silicified below 831.8 ft depth.

Fracturing, Faulting, Brecciation: The upper and lower cataclastic portions of the ignimbrite have been noted above. The entire ignimbrite interval is fractured and minor-faulted to about the same degree as the overlying tuffaceous sedimentary sequence. The lower cataclastic horizon (1022.3-1033.6 ft) is more intensely fractured and minor-faulted, with many of these being low-angle (<30° dip) features. Many of the minor faults in this lower cataclasite are characterized by chaotic (multidirectional) slickensides, possibly recording "jostling" displacements over time.

Open-Space Filling: Hydrothermal veinlets are much more prevalent in the ignimbrite than in the overlying tuffaceous sedimentary sequence (**Fig. 1**). The ignimbrite-hosted veinlets consist mostly of quartz and clay, accompanied by bright gray-green celadonite between 831.8 ft and ~950 ft. Many of these veinlets have been extensively sheared, particularly those occurring in the upper and lower cataclasite intervals. This relationship indicates that the sheared veinlets pre-date the cataclasis.

Correlation: Outcrops of weakly welded rhyolite ash-flow tuff near EM 17-31 (Hulen et al., 2005a, 2005b) are compositionally and texturally very similar to the ignimbrite penetrated in the corehole, (although the exposures lack the deeper celadonite alteration and veining). Based on this proximity and similarity, it is believed that the concealed ignimbrite, like the one exposed, is part of the Miocene Icehouse Canyon Assemblage (Oldow et al., 2003). As reported in Albers and Stewart (1972), two samples of felsic ignimbrite from this sequence have been radiometrically dated at 21.8 Ma and 22.5 Ma.

DEPTH INTERVAL 1033.6-1040 ft.
(included with the interval 1033.6-1155 ft
on **Figure 1** due to constraints of scale)

Lithology: Multi-lithologic hematitic cataclasite between 1033.6 ft and 1037 ft; argillized, hematitic basalt between 1037 ft and 1040 ft. The cataclasite, moderately cohesive, is brick red to maroon, and extensively sheared and slickensided; the rock contains clasts of basalt, sandstone, siltstone, and shale. The basalt below the cataclasite is medium- to dark grayish-maroon, earthy-textured, and also extensively sheared and slickensided. Internal and external contacts of this two-part sequence are shears.

Alteration: The cataclasite and underlying basalt are intensely argillized and hematite-impregnated. Phenocrysts in the basalt are almost entirely altered to chalky-textured, light gray clay. Hematite also occurs as variously sparse to abundant disseminated grains.

Fracturing, Faulting, Brecciation: Cataclasis has been noted. Both the cataclasite and the basalt are intensely fractured, commonly to the point of being rubble. Many of the fractures are re-broken, hematitic shear veinlets, and it is possible that some of the rubblization took place during drilling, or during forceful extraction of core from the tube.

Open-Space Filling: Intense stockwork calcite-clay-hematite veining, with many of the veins, as noted above, rebroken and sheared.

Correlation: Texturally and compositionally similar basalt is exposed at the base of the probable Icehouse Canyon Assemblage ignimbrite a few km north-northeast of EM 17-31 (Hulen et al., 2005a). The outcropping basalt is intrusive. If, as seems likely, the corehole basalt is also intrusive, its age based on this relationship can be constrained loosely as post 21.8-22.5 Ma. The cataclasite post-dates the basalt.

DEPTH INTERVAL 1040-1155 ft

Lithology, Stratigraphy, and Tectonostratigraphy: Interstratified argillaceous limestone and minor calcareous siltstone; and, derived from these sedimentary rocks, (**1**) weakly to moderately cohesive limestone-siltstone cataclasite; and (**2**) incohesive to barely cohesive fault gouge and breccia. The limestone-siltstone intervals are, for this corehole, relatively intact, that is, only moderately fractured, brecciated, and sheared. Some limestone-siltstone intervals are stylolitic; shearing and cataclasis post-date stylolitization. Shearing and foliation are subparallel to bedding (avg. dip of all these features ~25^{o}). Fault breccia and gouge contain clasts that are bounded by slickensided shear fractures, so the brittle-mode disruption appears to post-date the brittle-ductile cataclasis.

Alteration/Mineralization: None apparent

Fracturing, Faulting, Brecciation: Cataclasites are noted above. Fault breccia/gouge post-dates the earlier cataclasis. The fault breccia/gouge is now rubble, consisting of commonly fracture- and shear-bound fragments ranging in maximum dimension from less than one mm to several cm. Stockwork calcite veinlets in some of the more intact intervals are offset by shearing presumably related to the earlier cataclasis. Shearing is concentrated at silty horizons.

Vugs: The more limestone-rich intervals locally host irregular dissolution vugs up to a few mm in diameter. The vugs also occur in clasts, both in cataclasite and fault breccia/gouge, in which the cavities appear to have been inherited from a pre-disruption dissolution event.

Open-space Filling: White, fine- to coarse-crystalline calcite veins and veinlets are common in limestone-rich portions of this sequence. The veinlets pre-date shearing and shear-related cataclasis, and thus also fault breccia and gouge.

Correlation: Even though locally fractured, sheared, and brecciated, this unit is among the more intact of the entire penetrated rock sequence in 17-31. Similarly, limestones and siltstones of the Cambrian Emigrant Formation have undergone the least amount of penetrative shearing among Paleozoic formations exposed within and near the Emigrant prospect (Hulen et al., 2005a). Moreover, the 17-31 sequence closely matches published descriptions of the "limestone-and-siltstone" member of the Emigrant Formation. Finally, the Emigrant is the formation typically occurring immediately beneath the Icehouse Canyon Assemblage ignimbrite throughout and near the prospect. On the basis of the foregoing similarities and relationships, the 1040-1155 ft interval in 17-31 is provisionally assigned to the Emigrant Formation "limestone-and-siltstone member" **(Fig. 2)**.

DEPTH INTERVAL 1155-1622.5 ft. Although generalized as a single sequence on **Figures 1** and **2**, this span can be further separated usefully into four sub-intervals—1155-1236 ft; 1236-1248 ft; 1248-1386.6 ft; and 1386.6-1622.5 ft. the entire sequence is conditionally correlated with the Ordovician Palmetto Formation (**Fig. 2**).

A. 1155-1236 ft

Lithology: Fault breccia and gouge; shaly carbonaceous siltstone protolith; variously calcareous to non-calcareous; An incohesive to barely cohesive, dark gray to black rubble in which individual clasts range from less than one mm to several cm in maximum dimension. Carbonaceous limestone-siltstone cataclasite, marginally more indurated than in the overlying sub-interval, occurs between 1226.3 ft and 1234 ft.

Alteration/Mineralization: None apparent.

Fracturing, Faulting, Brecciation: See above. The rubblized nature of this interval caused drilling difficulties, as indicated, among other clues, by multiple zones of drill-milled, abraded, and rounded rock fragments.

Open-Space Filling: Stockwork calcite veinlets are moderately abundant throughout this interval, but are confined to clasts. No veinlets or cements appear to post-date the brecciation.

Correlation: The carbonaceous, locally calcareous, shaly siltstone that was pulverized, granulated, and sheared to form this breccia/gouge is conditionally assigned to the Palmetto Formation. Little-weathered exposures of this formation, which is a shale-siltstone-matrix mélange where mapped within and near the Emigrant prospect (Hulen et al., 2005a; J. Hulen field notes, 2005), are commonly black and carbonaceous as well as phosphatic and pyritic.

Additional Notes: Uncharacteristically for EM 17-31, the upper contact of the breccia/gouge (with the overlying limestone-siltstone sequence) dips at a relatively steep angle, ~70°. This fact, together with other widely-scattered but higher-angle (60-80°) fractures and breccia seams in the unit—along with the apparent absence of well-developed shear textures—suggests that the interval might represent a relatively young, purely brittle-mode, and presumably extensional major fault.

B. 1236-1248 ft: No core retrieved

C. 1248-1386.6 ft.

Lithology, Stratigraphy, Tectonostratigraphy: Interstratified silty, carbonaceous limestone; calcareous cataclasite derived from that limestone; and fault breccia/gouge with the same protolith. The breccia/gouge is incohesive to weakly cohesive, sheared, and commonly crudely shear-foliated at low angles (5-20° relative to horizontal).

Alteration/Mineralization: Finely crystalline pyrite is common in minor amounts throughout this unit. Some of the sulfide appears to be syngenetic (of exhalative origin), and some appears to be epigenetic, spatially associated with pyrite stringers and blebs, and with stockwork calcite-pyrite veinlets.

Fracturing, Faulting, Brecciation: The cataclasite and breccia/gouge have already been noted. All contacts between these units and rare, associated, relatively intact limestone are shears with dip angles, where measurable, in the range 40-65°.

Vugs: Irregular dissolution cavities, ranging from <1 mm to more than 1 cm in diameter, are common throughout the more cohesive portions of this calcareous sequence, that is, those portions not reduced to rubble.

Open-Space Fillings: The vugs noted above are commonly lined with small, euhedral calcite crystals. White stockwork calcite ± pyrite veins and veinlets disrupt the rocks of the entire sequence. The veinlets are dislocated by cataclasite-related shears; and occur only in clasts in the fault breccia/gouge.

Correlation: Based on its similarity to certain mapped, Paleozoic-rock exposures within and near the Emigrant prospect (Hulen et al., 2005a; J. Hulen, field notes, 2005), this carbonaceous/calcareous rock sequence is also tentatively assigned to the Palmetto Formation.

D. 1386.6-1622.5 ft

Lithology, Stratigraphy, and Tectonostratigraphy: Interstratified shaly siltstone; shaly-siltstone cataclasite; and fault breccia/gouge derived from the same protolith. These rock types are variously calcareous and carbonaceous. The sequence is locally disrupted by thin (< 10 m) intervals of microgranodiorite, porphyritic granodiorite, and mylonitized granodiorite. Contacts of all of the above units with each other are (typically) low- to moderate-angle shears.

Alteration/Mineralization: The siltstone of this sequence, whether intact or occurring as a component of cataclasite or fault breccia/gouge, contains moderately abundant chlorite and sericite (fine-crystalline micaceous clay, probably illite). For the most part, these layer silicates are believed to be diagenetic in origin rather than hydrothermal (chlorite and illite are not uncommon constituents of Paleozoic siliciclastics on a regional basis). On the other hand, concentrations of chlorite around some of the granodiorite bodies could be either hydrothermal or contact-metamorphic in origin. The granodiorite and its ruptured derivatives are low-grade propylitically altered, with chlorite and calcite replacing mafic minerals; and calcite with minor sericite replacing feldspars.

Fracturing, Faulting, Brecciation: Cataclasite and fault breccia/gouge have already been mentioned. It is noteworthy that the cataclasis affects even the granodiorite (more commentary under "Correlation" below).

Open-Space Filling: Rocks throughout the entire sequence are abundantly disrupted by veins and veinlets consisting of chlorite, quartz, calcite, pyrite, and (locally) hematite in various proportions. The veinlets are disrupted and dislocated by shears, and are believed on this basis to be relatively old features, unrelated to the Emigrant geothermal system.

Correlation: The commonly calcareous siltstone and its sheared and broken to rubblized counterparts in this sub-interval are conditionally assigned to the Palmetto Formation. For one reason, in the Emigrant prospect and vicinity, the Palmetto is the only unit that encompasses outcrops of sheared, dismembered granodiorite like that found in the corehole (Hulen et al., 2005a). Additional reasons for the tentative correlation are provided in the previous section of this document.

Based on the regional geologic setting of the Emigrant prospect, the structurally-dismembered granodiorite found in the probable Palmetto in outcrop and in EM 17-31 could be either Mesozoic or Tertiary in age. Whatever its age, the intrusive was emplaced prior to wholesale shearing and brecciation of the host Paleozoic siliciclastic sequence.

DEPTH INTERVAL 1622.5-2602 ft. The distinctive, mostly siltstone-sandstone sequence penetrated in this interval is closely reminiscent of outcrops and published descriptions of the Cambrian Harkless Formation. In the corehole, the likely Harkless consists of three distinct sub-intervals: A. 1622.5-1695 ft; B. 1695.5-2313 ft, accounting for the bulk of the interval; and C. 2313-2602 ft. The rocks of each of these intervals are briefly described below.

A. 1622.5-1695 ft

Lithology, Stratigraphy, and Tectonostratigraphy: Interbedded siltstone and shaly siltstone; silty, fossiliferous limestone; and cataclasite derived from these protoliths (mostly from siltstone). The siltstone is light greenish gray; the limestone is stylolitic and fossiliferous, containing trilobite "hash" and pisolitic, possibly algal structures that are probably *Girvanella* (Albers and Stewart, 1972). The strata are shallow-dipping (5-15^{o}), and less brecciated than the overlying, probable Palmetto Formation.

Alteration/Mineralization: The siltstone contains ubiquitous chlorite and illite, but these phases almost certainly are diagenetic rather than hydrothermal in origin. Associated traces of disseminated pyrite are likewise also probably diagenetic.

Fracturing, Faulting, and Brecciation: Thin seams of cataclasite, as noted above, are locally present in this sequence. The cataclasite was derived by shearing and brecciation of the siltstone in which the fault rock occurs.

Vugs** and **Open-Space Fillings: Fossiliferous-limestone beds in this interval variously contain dissolution cavities (sometimes developed in the fossils themselves) and some of these cavities are lined with euhedral calcite crystals. Stockwork quartz-calcite ± pyrite veinlets throughout the interval pre-date formation of cataclasite.

Correlation: Based on detailed descriptions in Albers and Stewart (1972), this sequence in EM 17-31 is believed to be the upper unit of the Harkless Formation. Not only do the lithologies closely match the published description, but the distinctive *Girvanella* is noted by the authors as occurring only in one other formation, the Cambrian Mule Springs Limestone (which the 17-31 sequence clearly is not).

B. 1695.5-2313 ft

Lithology, Stratigraphy, and Tectonostratigraphy: Throughout this entire interval, the penetrated rocks are pearlescent, light grayish-green, shaly siltstones, extensively disrupted to form thick intervals of fault breccia and gouge. Even more intact portions of the sequence are laced with slickensided shear fractures, and much of the rubblization noted in some intervals could readily have been induced by drilling and/or forceful extraction of the core from the tube. In other words, even though lying in pieces in the core boxes, these portions of the siltstone sequence could well be intact and impermeable *in situ*. Clearly also impermeable are the unambiguous fault breccias and gouges derived from the siltstone sequence. This impermeability is believed to be due to shearing and smearing of the abundant layer silicates present in the parent rock, essentially encapsulating more brittle parts of that rock that might otherwise transmit fluids.

Alteration/Mineralization: None that can be confidently identified as hydrothermal. Abundant illite and chlorite in both the intact and fault-disrupted siltstones are likely to be diagenetic in origin, as is associated, disseminated pyrite (in traces only).

Fracturing, Faulting, and Brecciation: The distinctive siltstone of this sequence is pervasively shear-fractured, with the fractures commonly marked with chaotic slickensides. As noted above, the talcose-textured surfaces of the fractures have predisposed the rock to disaggregation, whether in the formation itself, or as result of drilling, retrieval, and extraction of core.

Open-Space Filling: Veinlets are notably sparse in this sequence, attesting even to past impermeability of the layer-silicate-rich siltstone. The veinlets consist of quartz, calcite, and traces of pyrite in various combinations, and they (the veinlets) clearly pre-date cataclasis.

Correlation: Based on published descriptions and reconnaissance examination of representative outcrops, this siltstone sequence matches most closely either portions of the Precambrian to Cambrian Campito Formation or the siltstone member of the Harkless Formation (Albers and Stewart, 1972; J. Hulen, field notes, 2005). The Harkless siltstone can be confused with the shale member of the Emigrant Formation, but the Emigrant shale is distinctly finer-grained (Albers and Stewart, 1972). As the 17-31 siltstone occurs (**1**) beneath a *Girvanella*-bearing siltstone-limestone sequence and (**2**) above a sandstone that could readily be the "quartzitic siltstone" member of the Harkless Formation (see immediately below), the gray-green shaly siltstone is assigned herein to the Harkless with a high level of confidence.

C. 2313-2602 ft

Lithology, Stratigraphy, and Tectonostratigraphy: Interstratified sandstone and sandstone cataclasite. The sandstone is very fine-grained (locally fine-grained) and light to medium gray to gray-buff. The rock is dense and tightly cemented with secondary quartz (additional comments below), and portions of the unit are less fractured overall than the overlying shaly siltstone.

Alteration/Mineralization: Moderate to strong silicification, as noted above. This alteration could be diagenetic, hydrothermal, or a combination of both. The rock is also rich in sericite (illite) and contains minor disseminated pyrite, both of which phases could also be either diagenetic or hydrothermal in origin.

Fracturing, Faulting, and Brecciation: Cataclasite has already been noted. Both the cataclasite and sandstone are commonly cut by myriad shear fractures that, variously, are highly polished or have a slick, talcose texture. This texture has likely fostered disaggregation of the rock, both *in situ* and in response to drilling and core retrieval.

Open-Space Filling: The sandstone and cataclasite are moderately to strongly disrupted by generally thin quartz-sericite-pyrite $\pm$ calcite veinlets.

Correlation: This sandstone is believed by the writer to be the lower, "quartzitic-siltstone" member of the Harkless Formation (Albers and Stewart, 1972). The sandstone is slightly coarser-grained than the formally-described quartzitic siltstone, but Albers and Stewart (1972) note that in representative outcrops, the silt of that member is coarse and approaches very fine sand-size. Moreover, the sandstone, like the quartzitic-siltstone member, is overlain by a thick interval of greenish shaly siltstone that is also capped, like the Harkless in parts of Esmeralda County, by a *Girvanella*-bearing limestone-siltstone sequence.

DEPTH INTERVAL 2602-2720.6 ft

Lithology, Stratigraphy, and Tectonostratigraphy: Complex sequence of siltstones, sandstones, and stylolitic, carbonaceous limestones; as well as sheared cataclasites derived from these lithologies. All contacts between these units are typically low-angle shears.

Alteration/Mineralization: Probably diagenetic: chlorite and illite in the siltstones and sandstones, locally accompanied by weak to moderate silicification and trace to minor amounts of pyrite.

Fracturing, Faulting, and Brecciation: Cataclasites and sheared unit-boundaries noted above. All units more or less sheared, with chaotic slickensides common. Limestones stockwork-fractured and -sheared.

Vugs: Carbonaceous limestones contain conspicuous dissolution vugs that locally account for up to 5 vol.% of the host rock over 2-3 ft intervals.

Open-Space Fillings: The dissolution vugs noted above are typically partially lined with <1 mm euhedral calcite crystals.

Correlation: Unknown. Likely Paleozoic because of a lack of regional metamorphism, even low-grade (Albers and Stewart, 1972). Could readily represent tectonically-juxtaposed portions of several Paleozoic formations.

DEPTH INTERVAL 2720.6-2735.6 ft

Lithology: Granodiorite cataclasite to mylonite, with mylonitization particularly intense over the lower 2.6 ft of the unit. The rock is medium grayish-green, mottled and streaked with brick-red to maroon hematite. It is intensely brecciated (though rehealed) and crudely to very distinctly shear-foliated at low angles (2-20°). Although granodiorite is the main protolith, the unit also contains scattered porphyroclasts of siltstone and sandstone. The granodiorite is altered, but the alteration clearly preceded shearing, cataclasis, and mylonitization.

Alteration/Mineralization: Pre-shearing, low-grade propylitic alteration, similar to that affecting granodiorite intercepts at higher elevations of the corehole.

Fracturing, Faulting, and Brecciation: Cataclasis and mylonitization noted above. Where discernible, contacts of this unit with others are low- to moderate-angle shears.

Open-Space Filling: To a depth of slightly more than 2730 ft, the cataclasite is laced with stringers, veinlets, and breccia cements of earthy, brick-red to maroon hematite together with calcite and chlorite; quartz appears as a vein mineral just below 2733 ft depth.

Correlation: Based on the few relatively undeformed porphyroclasts, the granodiorite protolith for this unit was little if at all different from granodiorite intercepts higher in 17-31. Position of the cataclasite/mylonite directly above hard, competent, "metamorphic tectonites" (see below) makes it likely that this unit represents the Mineral Ridge detachment, a feature regionally separating the upper and lower plates of the 11-6 Ma Silver Peak metamorphic core complex (Oldow et al., 2003).

DEPTH INTERVAL 2735.6-2922 ft

Lithology, Stratigraphy, and Tectonostratigraphy: Interstratified, intricately foliated and minor-folded, chlorite-biotite-quartz mylonite and (lesser) marble mylonite, with intervening intervals of similarly metamorphosed but less deformed and recrystallized metasandstone. All rock types locally invaded by thin sills and dikes of metagranite, locally approaching protomylonite in texture.

By contrast with the disrupted and friable, impermeable Paleozoic lithologies penetrated higher in the corehole, these mylonites (and invading metagranites) are dense, hard, highly competent, and excellent prospective geothermal-reservoir rocks

Alteration/Mineralization: The mylonites and metagranites are locally but commonly intensely silicified and chloritized, with accompanying, disseminated marcasite ± pyrite. This alteration and mineralization are distinct from the older, metamorphic biotitization and chloritization affecting these rocks. The younger alteration and mineralization are invariably associated with vuggy hydrothermal veinlets and breccia cements consistent in texture and mineralogy with an epithermal origin.

Fracturing, Faulting, and Brecciation: Again by contrast with overlying Paleozoic units, these mylonites and metagranites, although clearly sheared, are dense, tight, hard, recrystallized, and resistant to refracturing along the older shear planes. On the other hand, their resulting competency has rendered the rocks susceptible to open fracturing across the old shear planes; and to post-fracturing maintenance of the newly-created open spaces.

A minor lost-circulation zone at 2812 ft depth in these rocks is encompassed by a hydrothermally-cemented dilational breccia zone spanning the interval 2809-2912.5 ft. This breccia and a similar one between 2886.5 ft and 2889.5 ft are characterized by angular "floating clasts" with a "jigsaw-puzzle" texture embedded in a hydrothermally altered and cemented rock-flour matrix. These breccias retain considerable open space (at least at the scale of the core), and their presence enhances the odds for subsequent discovery of commercially permeable, reservoir-scale, high-temperature thermal-fluid conduits.

Vugs: Two types of megascopically visible pores are present in the mylonites and metagranites—incompletely healed extensional cavities in veinlets and hydrothermal-breccia cements; and dissolution cavities, which occur plentifully in marble mylonites, but are also locally present in chlorite-biotite-quartz mylonites and metagranites.

Open-Space Fillings: Both types of open spaces noted above are typically lined with euhedral quartz (earlier) and calcite crystals, locally accompanied by clusters of bladed marcasite crystals up to 15 mm in maximum dimension.

Correlation: As noted above, these deeper mylonites are texturally and mineralogically distinct from any of the overlying Paleozoic lithologies. Position of the mylonites beneath the presumed Mineral Ridge detachment, and similarity of these rocks to published descriptions and key outcrops in the core of the Silver Peak metamorphic core complex, makes it likely that the mylonites are "metamorphic tectonites" derived from the (already regionally metamorphosed) Precambrian Wyman Formation (Craig, 2003; Oldow et al., 2003). Similarly, the metagranites are likely Mesozoic (Cretaceous?) intrusives, sheared and otherwise deformed during core-complex evolution.

DEPTH INTERVAL 2922-2938 ft.

Metagranite, commonly sheared, fractured, brecciated, veined, and hydrothermally altered similarly to intercepts of this rock occurring in the immediately overlying interval. A few intervening "screens" of chlorite-biotite-quartz mylonite, also as above.

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ABBREVIATIONS (for **Figures 1** and **2**, which follow)

bte.—biotite

chl.—chlorite

flt.—fault

ft.--feet

hem.—hematite

ignim.—ignimbrite

LCZ—lost-circulation zone

LS, ls.—limestone

m—meters

M—moderate

Ma—million years before present, or million years ago

mbr.—member

mcst.—marcasite

MRD—Mineral Ridge detachment

Msz.--Mesozoic

py.—pyrite

S--strong

smpl.—sample

slts.—siltstone

ss.—sandstone

T—Tertiary

W--weak

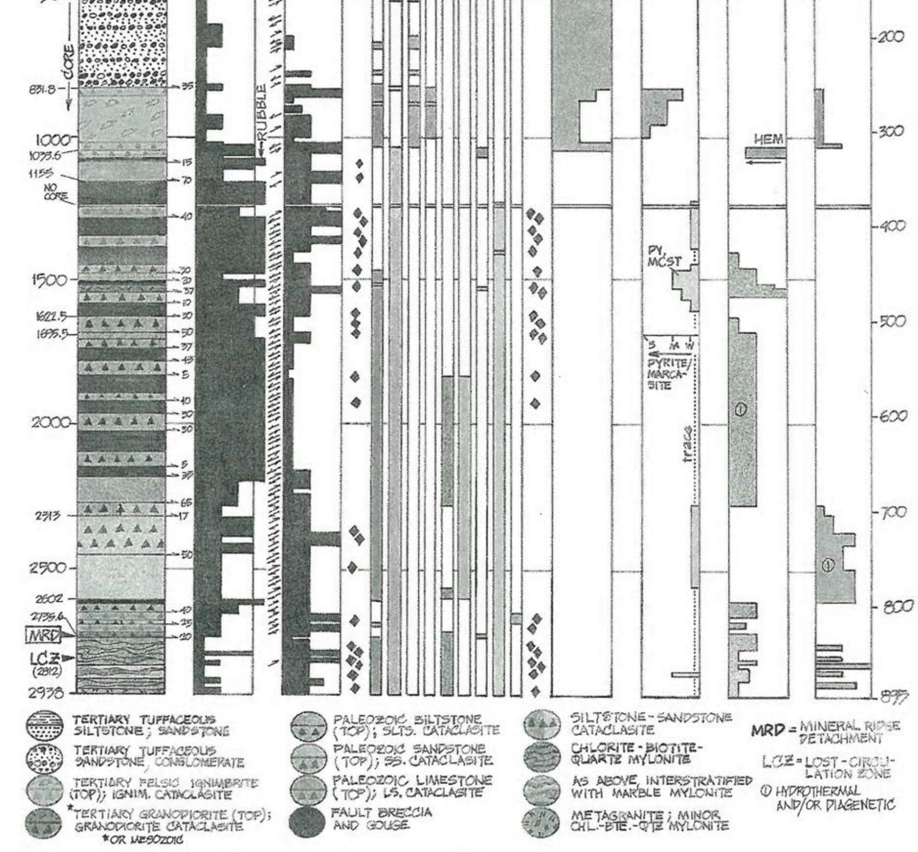


FIGURE 1: SUMMARY GEOLOGIC LOG FOR COREHOLE EM17-31, EMIGRANT GEOTHERMAL PROSPECT, ESMERALDA COUNTY, NEVADA

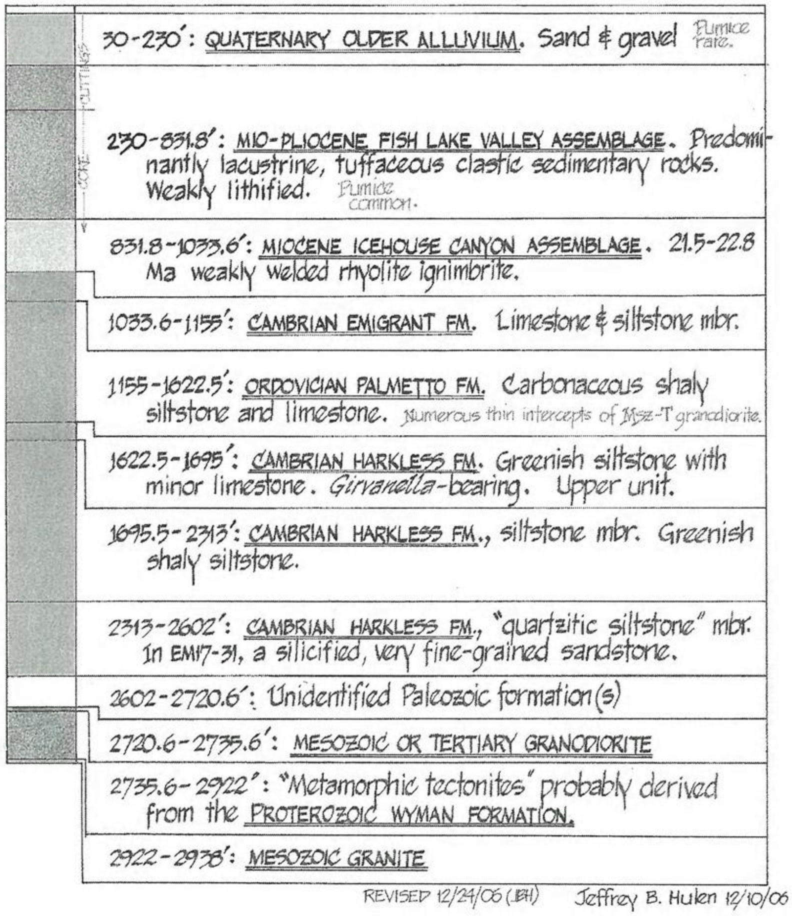


FIGURE 2. COREHOLE 17-31: CORRELATION OF PENETRATED ROCKS WITH ESTABLISHED STRATIGRAPHIC UNITS IN AND NEAR THE SILVER PK. RANGE. Based on descriptions in Albers & Stewart ('72), Oldow et al. (2003), and Hulen et al. (2005), and on reconnaissance examination of formation outcrops near the Emigrant prospect by J. Hulen.

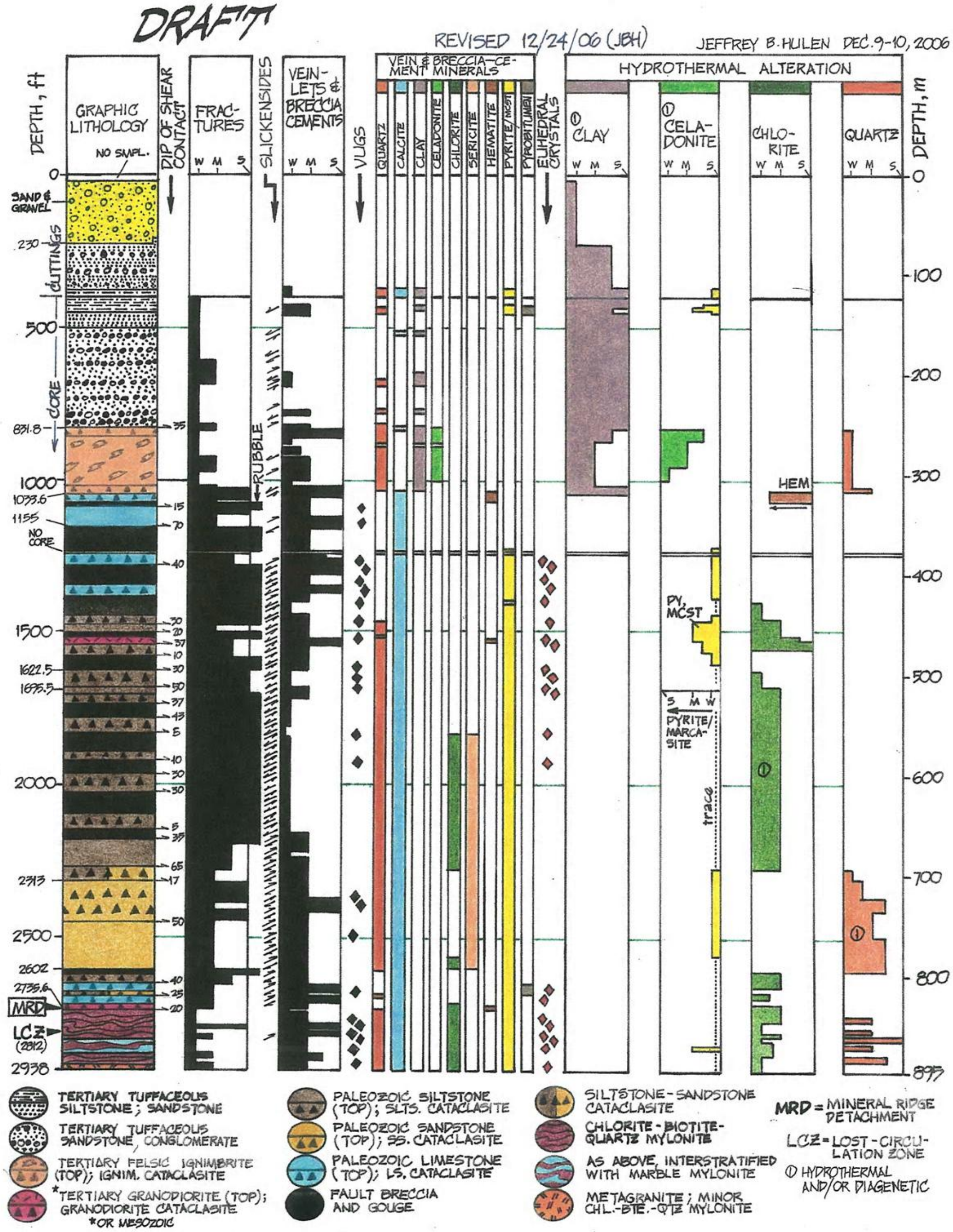
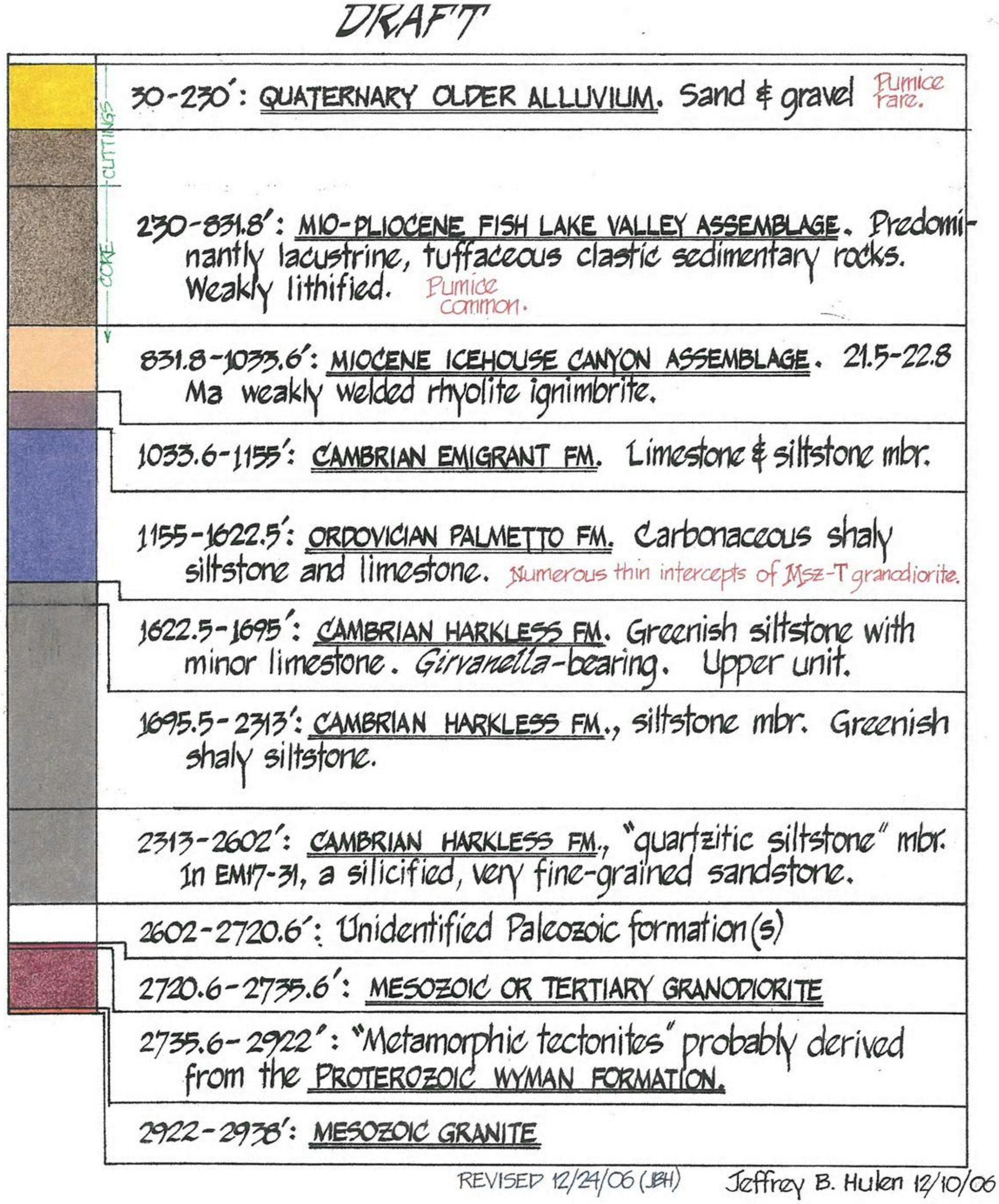


FIGURE 1: SUMMARY GEOLOGIC LOG FOR COREHOLE EM17-31, EMIGRANT GEOTHERMAL PROSPECT, ESMERALDA COUNTY, NEVADA



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EMIGRANT 17-31 CORE HOLE

GRED III PROJECT DE-FC36-04GO14339

US. DEPARTMANT OF ENERGY / ESMERALDA ENERGY COMPANY

SUMMARY

John Deymonaz – Esmeralda Energy Company

The Emigrant 17-31 core hole (officially known as the Emigrant Slimhole Drilling Project) is a joint endeavor between the U.S. Department of Energy ("DOE") and Esmeralda Energy Company ("EEC") under DOE's Geothermal Resources Exploration and Definition III ("GRED III") program. Under the program DOE awarded EEC a $740,000 grant (80% DOE funds and 20% EEC funds) to conduct a detailed geologic mapping program, construct a Geologic Information System database, review existing data from the area, select a drill site and drill a core hole to a maximum depth of 4,000 feet.

Drilling on 17-31 commenced on October 13 and continued until November 6, 2006 to a depth of 2,938 feet. Upon completion, temperature measurements were made in the hole and an injection test to evaluate formation permeability was conducted. The upper 400 feet of the hole was rotary drilled to 8-3/4 inches and casing was set and cemented in place.

From 400 – 2,938 feet the hole was core drilled with HQ sized drilling equipment (2.50 inch core and a 3.78 inch hole). The technique involves "continuous wire line coring" in which core drilling advances until 10 feet of core is collected inside the drilling rods in a "core barrel" (core barrels vary in length from 5 – 20 feet). When the barrel is full, an "overshot" is run down inside the drilling rods on a steel cable referred to as a "wire line" and latches onto the core barrel when they make contact. The core barrel is then pulled back up the inside of the drilling rods and the core is retrieved. As soon as the full core barrel is at the surface, an empty core barrel is run back down the drilling rods and drilling resumes. This may continue for up to a week before the core bit requires replacement. At this time all of the drilling rods are pulled from the hole and the bit is replaced.

Core drilling a geothermal exploration hole such as 17-31 has several distinct advantages. The core retrieved is a continuous column of rock which shows not only rock type, but alteration and fractures, bedding, secondary mineralization and its relationship to fractures, multigenerational fracture events and their relationship to each other, fault orientations and much more.

By contrast, rotary drilling, which is much more common, (as used to drill water wells and production sized geothermal wells) generates sand sized cuttings which are collected from the drilling fluids as they return to the surface. Study of the cuttings, while valuable, is more abstract and requires much more interpretation and many important structural, mineral and alteration relationships are impossible to establish.

The negative aspect to core drilling is that the holes are small diameter, generally ranging from 5.28 inches down to 2.98 inches in diameter. The small size limits the holes to being used for testing and research purposes and they cannot be used to produce geothermal fluids in commercial quantities. Commercial geothermal wells have diameters of 8.5 to 13 inches in diameter, or larger.

The 17-31 drill hole has been successful in several areas. Primarily, it has encountered commercial geothermal temperatures (323 F) and the temperatures were still increasing at the bottom of the hole. This opens up a new geothermal field with commercial potential in Fish Lake Valley which will provide the necessary resource to justify the required infrastructure cost to develop the resource when tied to the existing geothermal field located approximately 8 miles to the west of the Emigrant Project.

The formation encountered in the bottom of the hole appears to be an excellent reservoir rock in that it is very silicic, brittle and will maintain open fractures, the drilling was completed under budget and the core recovered will provide information for continued research. The 17-31 core hole was completed in a manner which will enable the hole to be deepened with very little effort to a depth of 5 – 6,000 feet which will provide a tremendous amount of information on the deeper geothermal reservoir and the commercial potential of the resource.

PHASE II COMPLETION REPORT
ESMERALDA ENERGY COMPANY
EMIGRANT SLIMHOLE DRILLING PROJECT
DOE GRED III (DE-FC36-04GO14339)
By

John Deymonaz
Esmeralda Energy Company
Principal Investigator
January 7, 2007
Revised February 4, 2007

Phase II of the Emigrant Slimhole Drilling Project consisted of securing the necessary permits, selecting a drilling contractor, constructing a drill site, rotary and core drilling to a depth of 2,938 feet. Upon completion an injection test was performed and multiple temperature logs run over a period of several months.

Permitting Process

Permitting efforts for the 17-31 slimhole ("core hole") began in early February, 2006 and the final permit was approved 8-1/2 months later on September 25, 2006, 15 days before the drill rig arrived at the project. Permits for the drilling and injection test were secured from:

U.S. Bureau of Land Management (State, Tonopah, Battle Mountain & Elko offices) – Permit, Environmental Assessment (EA) and Finding of No Significant Impact (FONSI)

Nevada Division of Minerals – Drilling Permit

Nevada Division of Environmental Protection – Injection Test Authorization

Nevada Division of Water Resources – Temporary Water Use Permit

The nearly nine month long permitting process was the result of a variety of reasons. None of the agencies involved share the same forms and apparently share very little information on an interagency basis. Each agency required essentially the same information, but in a slightly different format, different forms, etc. The BLM process was the slowest by far, extending over the entire period and sometimes being put on hold until some other agency issued a permit. Following the preparation of an Environmental Assessment (about 2 months) and frequently being stalled due to a missing "interdisciplinary team member" who was required to address pertinent questions so the process could move to the next step. Finally there was a 30 day "public comment period". This was then followed by the passage of another week for the paperwork to move from the BLM Tonopah Field Station to the Nevada State BLM office in Reno (first class mail takes 2 days)

Drilling Contractor Selection Process

Due to the unique circumstances which may be encountered while core drilling deep geothermal holes, only contractors with extensive geothermal experience were considered. This limited the choices to Boart-Longyear Drilling Company and Major Drilling Company, both based in Salt Lake City, Utah. Both companies submitted bids in February, 2006.

Boart-Longyear proposed using a HD-600 drilling rig and Major proposed using a Universal 1500 drilling rig. Both drilling rigs would have been more than adequate for the proposed 4,000 foot core hole and both companies have a long and proven track record in core drilling geothermal exploration holes.

Bids for drilling are fairly complicated, and each contractor has a different standard company format. When the bids are evaluated various assumptions must be made regarding the number of days involved and cost of consumables which are invoiced at cost plus, hourly rates vs. footage rates, rental equipment provided vs. equipment and materials the client must provide, etc. After laying out a projected 30-day drilling period and comparing the bids, Boart-Longyear appeared to have substantial cost advantage over Major Drilling.

Due to the very limited availability of drilling rigs, it was necessary to choose a contractor seven months before the drilling was to commence. Quotes are good for 60 days and this resulted in two revised quotes from Boart-Longyear prior to drilling.

Drill Site Construction Process

The 17-31 drill site is relatively small, approximately 100 by 150 feet or about 0.33 acres. It is located on a gentle slope on a low rise of alluvial gravels. Due to the slope, about 3 feet of material was excavated on the east side and used to build up about 3 feet of fill on the west side of the drill site. The only locally available equipment was from Arden Salvage Company ("ASC"), which is located approximately 15 miles from the drill site in Fish Lake Valley. A D-4 dozer, grader and backhoe were used to construct the site in less than 2 days at a cost of less than $2,000.

ASC also transported in three 21,000 gallon "Baker" water storage tanks from their facility to the drill site and then transported 63,000 gallons of water to fill the tanks prior to the drilling contractor arriving at the site. Having water available on site served to speed the rigging up time when the contractor arrived. ASC will also be used for the site reclamation when it is time to abandon 17-31.

Drilling Operations of 17-31

The Boart-Longyear crews and equipment arrived on October 10, 2006. The staging area was approximately 15 miles from the drill site and access was over gravel and dirt roads maintained by Esmeralda County. Several days of rain slowed mobilizing to the drill site and required the use of an alternate route, which added approximately one hour to each trip. Moving and rigging up took just over three days.

Drilling commenced on October 13 and a 12-1/4 inch hole was rotary drilled to a depth of 31 feet. 9-5/8 inch casing was set and cemented in place. On October 14 a 8-3/4 inch hole was rotary drilled to a depth of 406 feet and 4-1/2 casing was run in the hole and cemented using neat cement pumped through a tremmie pipe in the annular space. A small "bag type" blow out preventor with pipe and blind rams was then installed on the 4-1/2 inch casing.

On October 17, core drilling commenced using HQ equipment. This produced a 3.782 inch hole and 2.50 inch core was recovered. The tertiary tuffaceous sediments were fractured and sheared and the intense argillic alteration increased the viscosity of the drilling mud to a point that the system had to be dumped in a reserve pit and new mud mixed to continue drilling.

Despite abundant clay, fracturing and many short core recovery runs, core drilling progressed smoothly averaging just over 189 feet per day for 4 days. On October 22 at a depth of 1,236 feet the drill rods became stuck during a core recovery run. While attempting to work the drill rods free, they separated at 660 feet. NQ drill rods were trucked in for the fishing effort and after several attempts, the stuck drill rods were cut about 4 feet above the bit and recovered. The remaining bit and part of the core barrel were cored over with the next bit and core drilling resumed on October 25.

From October 26 through November 5 a total of 1,551 feet was cored. Daily drilling ranged from 95 to 200 feet with an 11-day average of 141 feet/day. At 2,812 feet a small open fracture resulted in a total loss of circulation with a pumping rate of 20 – 25 gpm. Core drilling continued with occasional fluid returns to a total depth of 2,938 feet at 8 AM on November 7. The crew then began breaking down HQ and NQ rods into 10 foot lengths and ran HRQHP (3.5 inch) tubing open ended with core bit to 2,798 feet and a temperature log was run to 2,700 feet. Following the temperature survey an injection test was performed.

During drilling operations, no fluid loss or gain was noted until the loss of circulation at 2,812 feet indicating a lack of water bearing strata from the surface to 2,812 feet. The loss of circulation zone at 2,812 feet appears to have been a small open fracture, less than one inch across and sand filled with minor permeability. Injection rates never exceeded 25 gallons per minute. Future temperature logs may indicate if there is any fluid movement at this small zone.

Upon completion of the injection test, the crew attempted to run the HRQHP tubing to the bottom of the hole, but it could not be lowered below a depth of 2,920 feet, 18 feet off bottom. The H tubing with drill bit was run to facilitate the deepening of 17-31 at a future date. If the hole is to be deepened, a cement plug will be set to secure the bottom of the drill string and then core drilling will resume using NQ core drilling equipment (2.98 inch hole with 1.88 inch core).

Rigging down and moving equipment off location took place from November 8 to November 12. A second temperature log was run on November 10 to only 2,900 feet with a maximum recorded bottom hole temperature of 322 F. Future temperature logs will be run to total depth of 2,938 feet if possible.

Core Logging

Jeff Hulen spent several hundred hours conducting a highly detailed report on the core, mineralogy, alteration and interpretative history. His reports have just been received and are being forwarded on to DOE in Golden in both paper and electronic versions.

Future Plans for 17-31

Current permit stipulations with the Nevada Division of Environmental Protection require the abandonment of 17-31 in May 2007. Given the encouraging positive conductive thermal gradient to total depth and brittle, silicic rock with an excellent potential to hold open permeable fractures encountered in the bottom 200 feet, Esmeralda Energy Company will request an extension on the abandonment date and attempt to secure funding to deepen this very encouraging geothermal exploration hole in 2007.

APPENDIX C – Task 3 Resource Testing and Assessment: Supporting documents and data

Figure 1. 17-31 Temperature Profiles ……………………………………………………………… 292
Initial Testing of Imigrant 17-31 (Geothermex) …………………………………………….. 293 - 301
Ground Water in the Emigrant/Fish Lake Valley Area …………………………………… 302 - 303

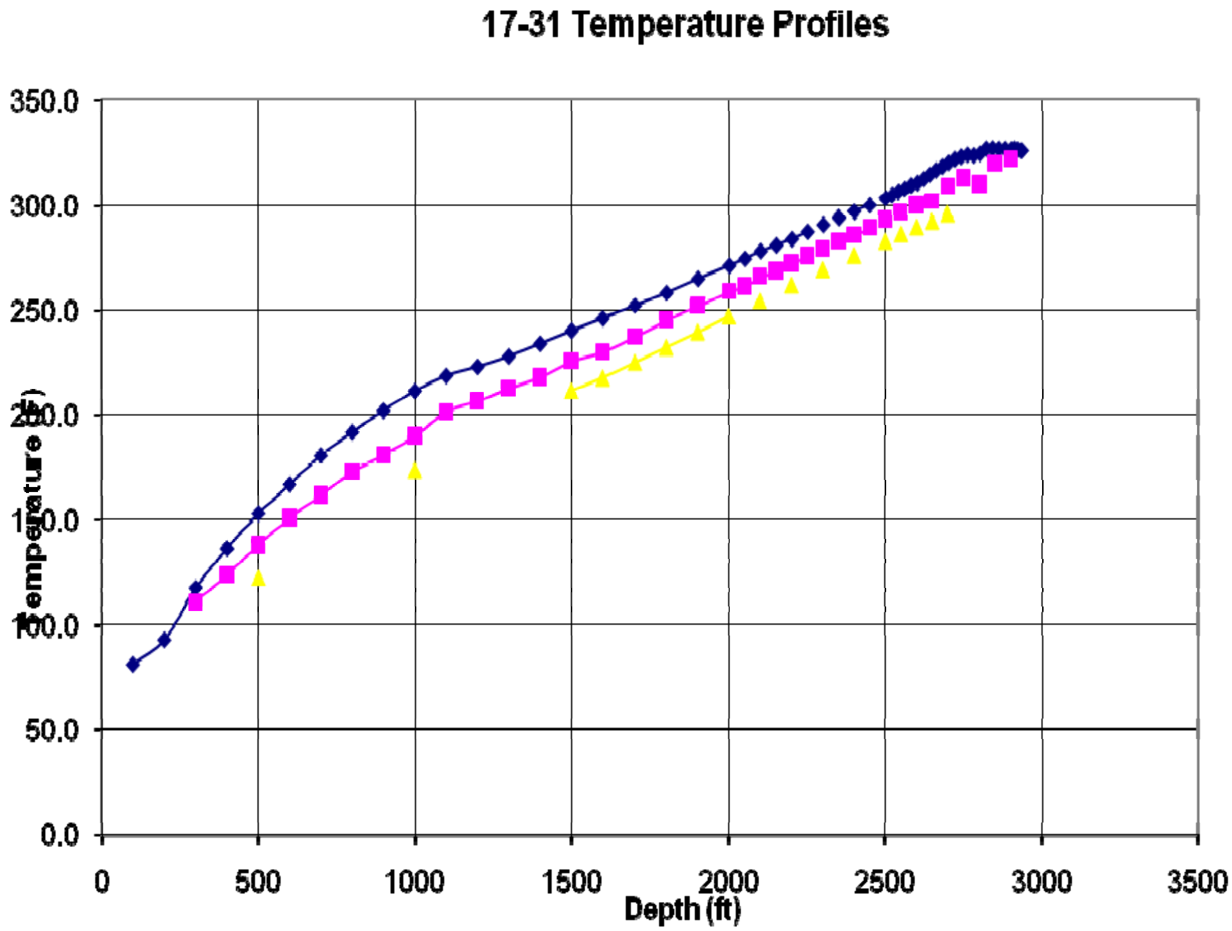

Figure 1. Tempreature profies for 17-31.

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REPORT

To: John Deymonaz
Esmeralda Energy Company
P. O. Box 1380
Agoura Hills, CA 91376
sent via e-mail: greenpower@veawb.coop

Date: 20 December 2006

From: Jim Lovekin

Subject: Initial Testing of Emigrant 17-31

Summary

Initial testing was conducted on the 17-31 slim hole at the Emigrant geothermal project on 8 November 2006. A temperature survey showed a conductive gradient of 7.0°F / 100 feet below a depth of about 1,500 feet, with a maximum recorded temperature of 295.9°F at 2,700 feet. The liquid level at the time of the survey was at 393 feet. An injection test on the same day indicated a low reservoir flow capacity (approximately 300 millidarcy-feet). A second temperature survey on 10 November 2006 confirmed the conductive gradient of 7.0°F / 100 feet and reached a maximum recorded temperature of 322°F at 2,900 feet. The conductive temperature profiles and the low permeability indicate that the well did not penetrate the reservoir, despite the loss of circulation encountered at 2,812 feet during drilling. Nonetheless, the presence of fracturing in the core and temperatures over 320°F are encouraging indicators of a potentially commercial geothermal resource.

Background

The 17-31 slim hole was spudded on 13 October 2006 with a Boart-Longyear HD-600 rig (No. BK-1). A 9-5/8-inch casing was cemented in 12-1/4-inch hole at 40 feet, followed by 4-1/2-inch casing cemented in 8-3/4-inch hole at 401 feet. The upper portions of the hole were rotary drilled. Below 401 feet, the well was cored with HQ rods (hole diameter 3-1/2 inches). The well began losing about 30% of its circulating mud below 2,660 feet, and it lost total circulation at 2,812 feet. The well was drilled to a total depth of 2,938 feet. Used HQ rod was installed in the well to a depth of 2,798 feet, with the intention of having the loss zone at 2,812 feet in the open-hole section at the time of injection testing. After the injection testing, the HQ rod was deepened to 2,920 feet, which allowed the temperature survey on 10 November to be safely run to a greater depth.

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Temperature Surveys

Figure 1 shows the temperature surveys of 8 and 10 November 2006. Both surveys have essentially the same gradient (7.0°F / 100 feet) below 1,500 feet. The first survey was run about 18 hours after circulation. The second survey shows temperatures about 10 to 14°F hotter across the board, reflecting recovery from the cooling effects of drilling. The slight reversal at 2,800 feet probably results from invasion by water during the injection test into the lost circulation zone at 2,812 feet. The linear quality of both surveys above the lost circulation zone indicates minimal invasion by injection water and drilling fluid in most of the well. This is consistent with the interpretation of conductive rather than convective gradients in this part of the formation. Table 1 shows the measured temperatures from both surveys.

After the temperature on 8 November, a 1/8-inch capillary tube was run in the well to a depth of 7,950 feet, and a down-hole pressure of 989.0 psia (976.7 psig) was measured at this depth. Using water density values based on the temperatures in the 8 November survey, a pressure profile has been calculated, and a liquid level of 393 feet has been estimated. The calculated pressure values are included in Table 1.

Injection Testing

An injection test was conducted with the capillary tube remaining at 2,750 feet, in order to measure down-hole pressures as close as practical to the zone of permeability. The capillary tube was kept within the HQ tubing, to ensure that there would not be any difficulty in retrieving the pressure chamber and sinker bar on the bottom of the capillary tube. Figure 2 shows the configuration of the capillary tubing and the injection line at the wellhead. Flow rates were estimated from changes in the liquid levels of water tanks on the location.

Table 2 shows the chronology of the temperature survey and injection testing on 8 November 2006, and Figure 3 shows the rates and pressures measured during the test. Prior to starting injection, the down-hole pressure was monitored for six hours to ensure a stable background. Injection started at about 2:30 PM at a wellhead pressure of about 10 psig. Because the well was taking very little water, the wellhead pressure was increased after less than 15 minutes to about 118 psig. After about an hour of injection, an attempt was made to further increase injection rates, but the maximum wellhead pressure that could be supplied by the centrifugal pump was about 126 psig. Injection with the centrifugal pump lasted about two hours, after which the pressure fall-off was monitored. The test was repeated later in the day using the rig's positive-displacement pumps for a period of about 1 hour. During the second injection period, the wellhead pressure was kept within the maximum value of 150 psig specified in the permits for the well. The pressure fall-off after the second injection period had a very similar character to the first, and down-hole pressures consistently returned to the same value of approximately 975 psig.

Figure 4 shows the result of pressure transient analysis on the second pressure fall-off. The analysis indicates a permeability-thickness product of about 300 millidarcy-feet (md-ft), assuming a thickness of about 100 feet in the vicinity of the zone of lost circulation. The slightly

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negative skin factor is consistent with the interpretation of a fracture at the lost circulation zone, which is also visible in the core recovered from this interval. The low permeability value is typical of what might be expected in a cap rock overlying a geothermal reservoir. The temperature of 322°F measured two days after the injection test and the fracturing evident in the core are both encouraging indicators of a potentially commercial geothermal resource at the Emigrant project.

Table 1: Emigrant 17-31 Temperature Surveys				
Depth with respect to ground level (feet)	Temperature Survey 8 Nov 06, 18 hours after circulation (°F)	Calculated Pressures (psig)	Temperature Survey 10 Nov 06 (°F)	Comments:
0	42.7			Pressures calculated from measured
300			111.1	bottom-hole pressure and liquid density
400			124.1	based on temperature survey of 8 Nov 06.
500	122.6	45.4	138.3	Liquid level estimated at 393 feet below
600			151.1	ground level.
700			162.0	Atmospheric pressure of 12.3 psia was used
800			173.0	to convert from psia to psig.
900			181.0	
1,000	173.7	258.0	190.2	
1,000			190.2	
1,100			201.5	
1,200			206.7	
1,300			213.1	
1,400			218.4	
1,500	211.7	467.6	225.9	
1,600	217.9	509.1	230.4	
1,700	225.2	550.6	237.7	
1,800	232.3	591.9	245.3	
1,900	239.6	633.0	252.3	
2,000	247.1	674.0	259.2	
2,050			261.9	
2,100	254.5	714.9	266.3	
2,150			269.1	
2,200	262.5	755.6	272.7	
2,250			276.1	
2,300	269.5	796.1	279.5	
2,350			282.9	
2,400	276.3	836.5	286.1	
2,450			289.7	
2,500	282.9	876.7	293.4	
2,550	286.3	896.8	296.9	
2,600	289.7	916.8	300.0	
2,650	292.4	936.8	302.0	
2,700	295.9	956.8	309.2	
2,750		976.7	313.1	Measured pressure with cap tube on 8 Nov 06
2,800			310.3	
2,850			320.0	
2,900			322.0	

Table 2: Chronology of Emigrant 17-31 Temperature Survey and Injection Test on 8 November 2006

12:45 AM	**Start running temperature probe** in hole. Last circulation was approximately 6 am on 7 Nov 06.
1:50 AM	Temperature probe at 2,700 feet (last temperature reading). Bottom of HQ tubing at 2,798 feet.
2:18 AM	**Temperature probe out of hole.**
5:15 AM	Started running 1/8" capillary tube in hole. Purged with N_2 every 300 feet going in.
7:10 AM	Capillary tube set with chamber openings at 2,750 feet. Purged with N_2.
7:26 AM	Measured down-hole pressure stabilized at 989.0 psia (976.7 psig).
	Down-hole pressure remained steady for 6 hours.
9:30 AM	Installed pressure transducers on casing annulus and on wellhead pressure (WHP).
1:30 PM	Began seeing down-hole pressure bleed off. Located leak at pressure transducer.
2:15 PM	Completed repair of leak at transducer.
2:17 PM	Purged capillary tube.
2:25 PM	Pressure stabilized at 990.0 psia (977.7 psig)
2:33 PM	**Started injection** with centrifugal pump at about 10 psig WHP. Well not taking much water.
2:47 PM	Increased pumping rate. WHP rose to about 130 psia (118 psig). Estimated 23 gpm injection.
3:30 PM	Attempted further increase in pumping rate. WHP rose to about 138 psia (126 psig).
4:32 PM	**Stopped injection** and recorded fall-off in down-hole pressure. WHP went on vacuum.
4:56 PM	Down-hole pressure stabilized at about 990 psia (977 psig).
5:15 PM	Began installation of ball valve in injection line at wellhead. Well was still on vacuum.
5:28 PM	Completed installation of ball valve and began another N_2 purge
5:42 PM	Completed purge. WHP returned to about 986 psia (974 psig) and stabilized.
5:45 PM	Started injection with positive-displacement pumps. Kept WHP to 163 psia (150 psig).
5:54 PM	Stopped injection due to leak in injection line. Allowed pressure to fall off again. Fixed leak.
6:20 PM	Down-hole pressure re-stabilized at about 986 psia (974 psig).
6:25 PM	**Resumed injection** with positive-displacement pumps. Still kept WHP to 150 psig.
6:40 PM	Transducer on annulus pressure was disconnected, causing leak. Backed off on rate briefly.
6:44 PM	Resumed injection with WHP at 150 psig.
7:32 PM	**Stopped injection** and recorded fall-off in down-hole pressure. WHP went on vacuum.
8:00 PM	Down-hole pressure declined to about 983 psia (970 psig) and stabilized.
8:01 PM	Disconnected transducer on down-hole pressure. End of test.

Figure 1: Emigrant 17-31 Temperature Surveys, 8 and 10 November 2006

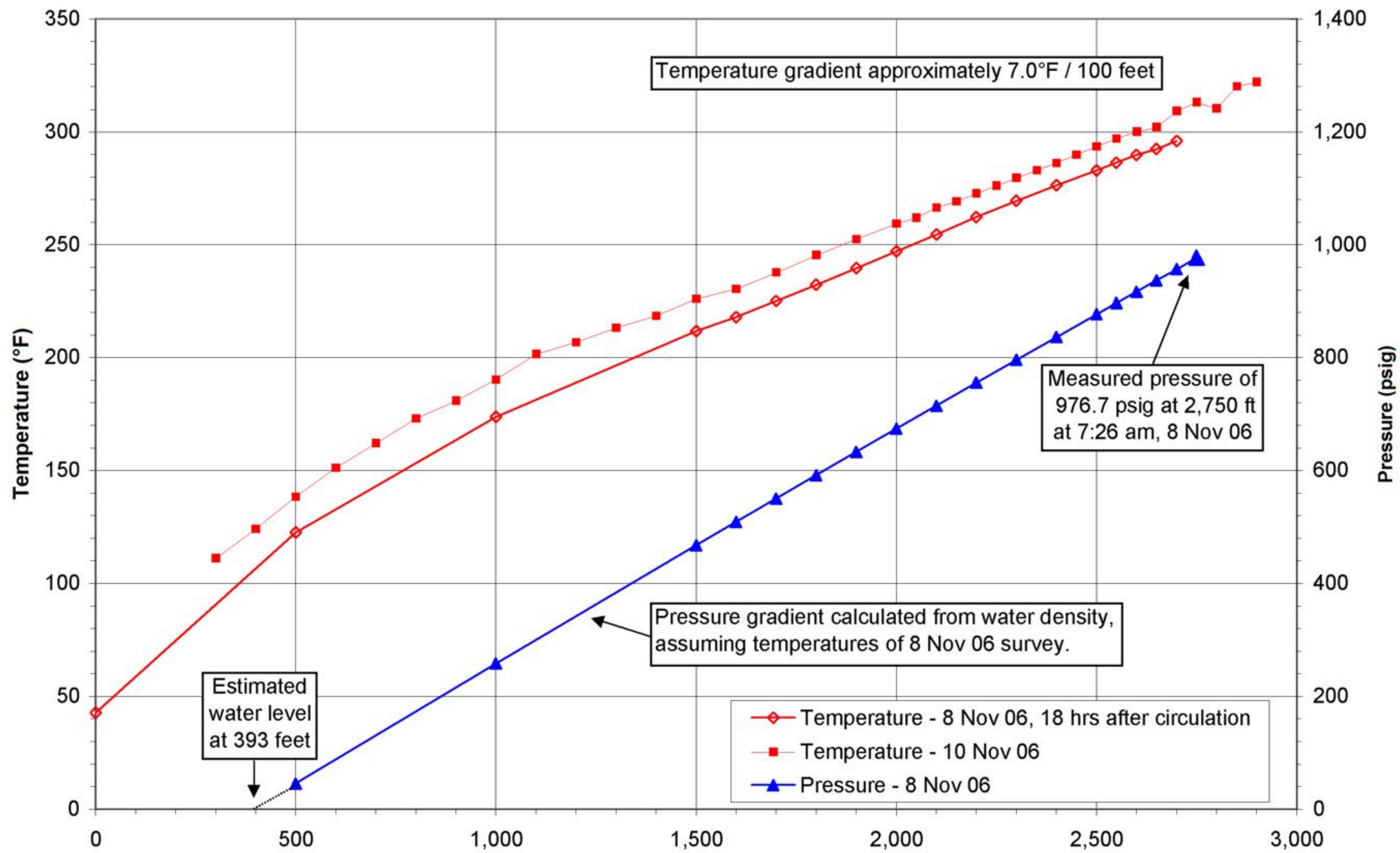

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Figure 2: Emigrant 17-31 Injection Test Equipment Layout

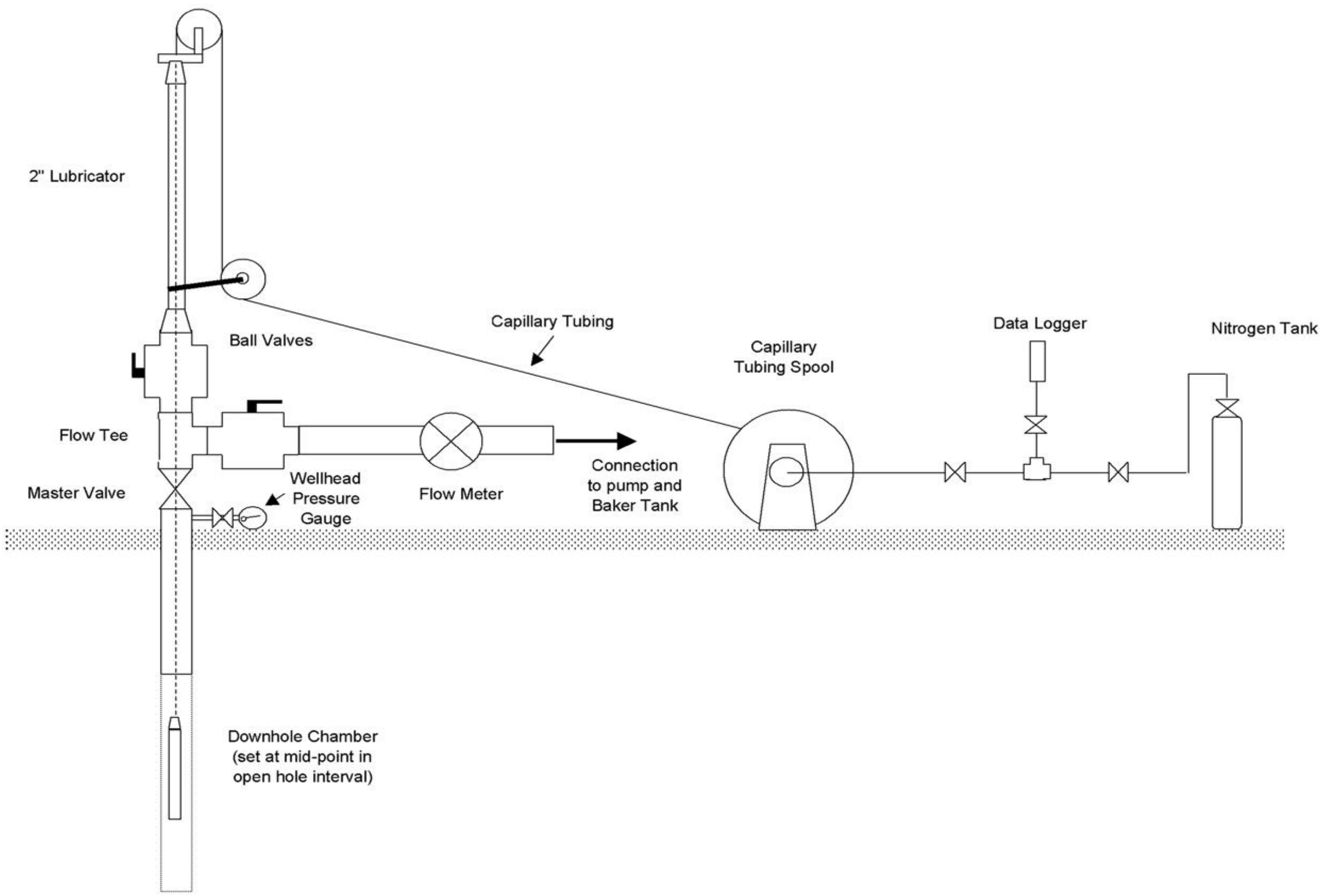

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Figure 3: Emigrant 17-31 Injection Test
8 November 2006

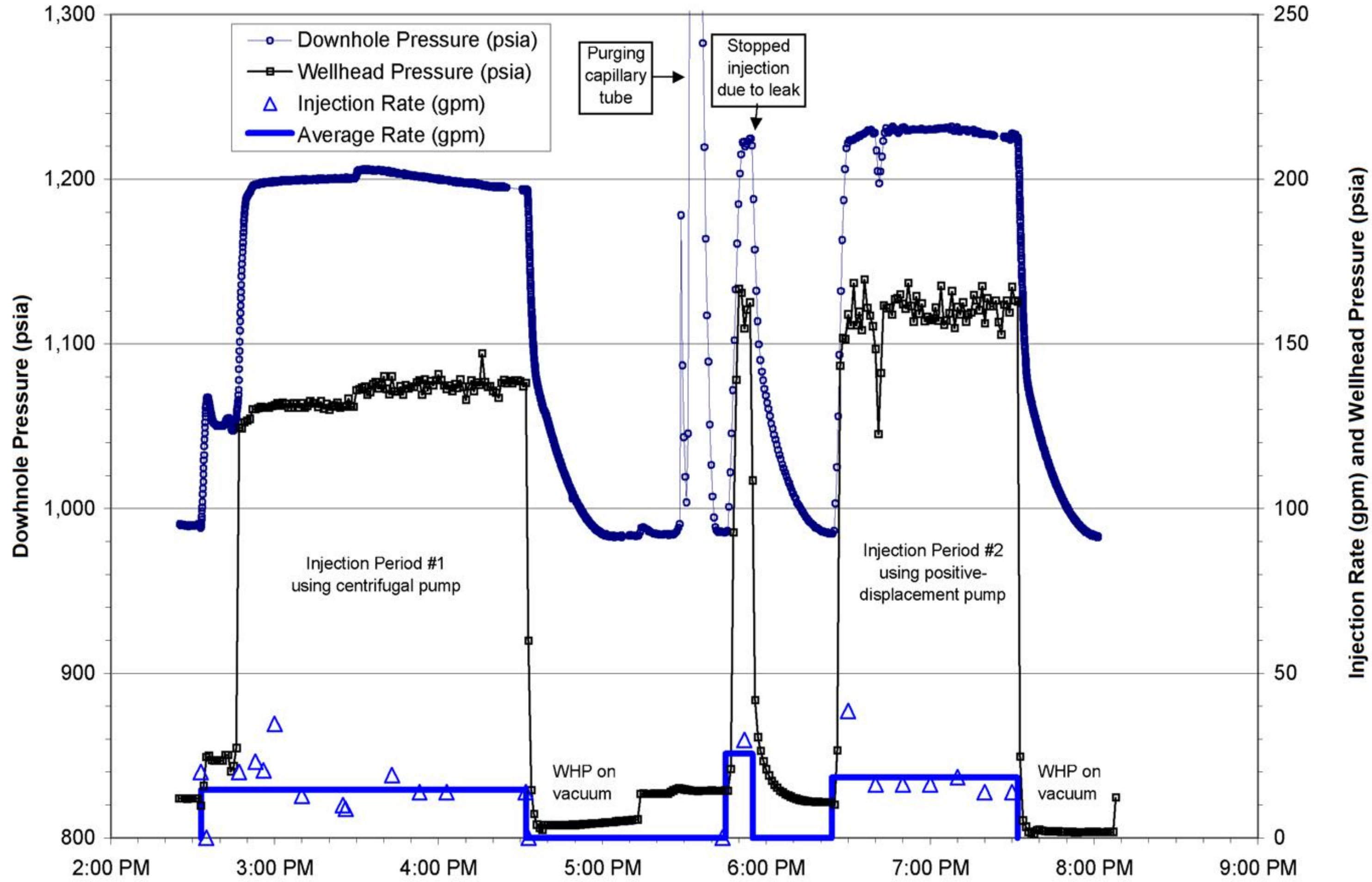
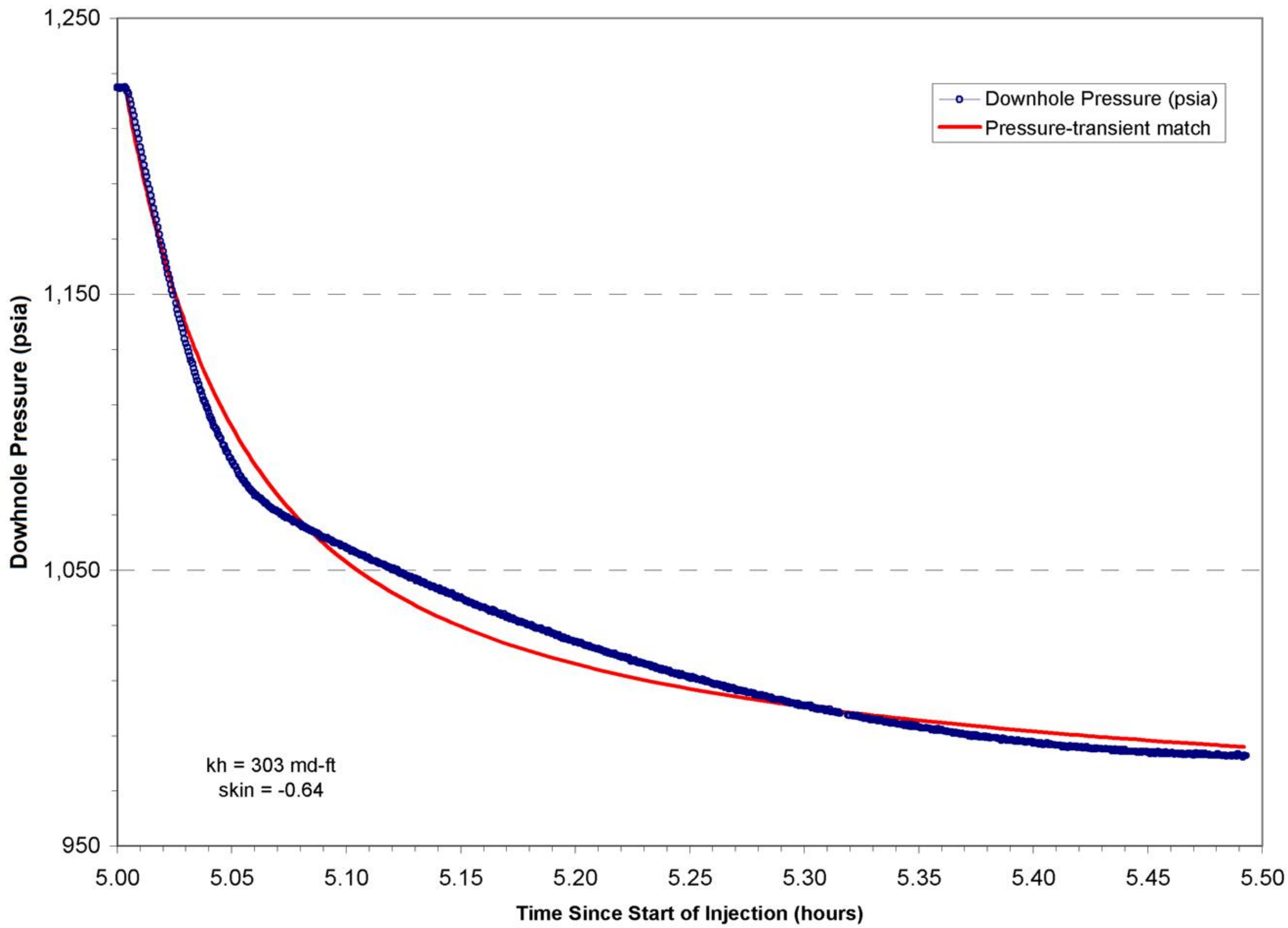


Figure 4: Emigrant 17-31 Pressure Fall-off After Injection
8 November 2006



Emigrant 17-31 Injection Test.xls

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ESMERALDA ENERGY COMPANY

GROUND WATER IN THE EMIGRANT/FISH LAKE VALLEY AREA

John Deymonaz
March 2, 2006

Ground water encountered in the Emigrant geothermal area has occurred within a narrow north-south zone of several closely spaced which dip steeply to the west. Outside of this fault zone and below a thin veneer of alluvial material a thick sequence of Tertiary mudstone and siltstone is encountered. Just to the south, U.S. Borax drilled holes to over 2,000 feet without drilling out of these sediments. The thick sediments are clay rich and nearly impermeable. At the proposed 17-31 core hole site the sediments are believed to thin to about 1,500 – 2,000 feet, which was a consideration in picking the site. At that depth the 17-31 core hole should intercept the westerly dipping fault zone and encounter hot fluids. The clay rich sedimentary formation is competent and virtually impermeable, forming an ideal "cap rock" for the underlying geothermal system and will provide an excellent medium to cement the casing.

Of the 39 holes around the Emigrant project area, in which I made temperature measurements in the 1980's, 17 were dry to TD. The depth of the dry holes ranged from 170 – 900 feet. Nearly all of the temperature measurements were made in open, uncased hole conditions. Fluid was encountered in the remaining 22 holes at depths ranging from 117 to 540 feet. However, it is unknown if the "fluid" was the static water level or drilling mud remaining in the well-bore. Judging by the material these holes were drilled in I believe many of these "fluid" levels were simply trapped drilling mud.

I was the geologist on Amax gradient hole 33028-211 which was drilled to a total depth of 406 feet in 1983 and penetrated silicified fractured intervals and fluid entries at 398 and 403 feet. Hole 211 was located approximately 1,200 feet southeast of the proposed 17-31 site. Two samples (Amax lab numbers W15008 and W15009) were taken as the water was lifted by air injection.

The two water samples have total dissolved solids of over 3,200 ppm with over 1,000 ppm of sodium, over 1,250 ppm of chloride, up to 33 ppm of boron and 7 – 9 ppm of fluoride.

In 1985 U.S. Borax drilled a 971 foot hole (FLH-14B) just to the south in the same fault zone to gather water samples to see if economic brines existed in the Boron rich sediments. The hole is located approximately 3,000 feet south of the proposed 17-31 drill site. Drilling progressed through sediments and fractured, silicified intervals. Fluid samples were collected at depths of 590, 650, 758, 810, 880, 900 and 970 feet (CT Lab numbers BS-1 through BS-7). Total dissolved solids ranged from 1,891 to 4,748 mg/l and decreased with depth.

The only ground water encountered within a one mile radius of the 17-31 site is saline, with 2 – 5 times the TDS as the water proposed to be used for an injection test and falls far short of U.S. EPA Drinking water standards. While with Amax, I drilled 2 additional temperature gradient holes within a one mile radius of the 17-31 site and 9 more gradient holes further south. The 11 holes were drilled to a depth of 200 feet. The holes were rotary drilled and used an air/foam drilling medium. No ground water was encountered in these holes.

Ground water movement in Fish Lake Valley is from south to north, with the valley terminating in the Fish Lake Playa located approximately one mile west of the 17-31 drill site. The vast majority of ground water recharge into Fish Lake Valley is from the White Mountains (Nevada Water Resources – Reconnaissance Series Report 58) which rise to over 14,000 feet along the west side of the valley and supports 6 perennial streams which flow into the valley. The Silver Peak Range, bordering Fish Lake Valley on the east, reaches just over 9,400 feet at its highest point and has no perennial streams. The 17-31 site is located in the western foothills of the Silver Peak Range at an elevation of 5,020 feet. East of the 17-31 site, the Silver Peak Range rises to an elevation of around 7,700 feet.

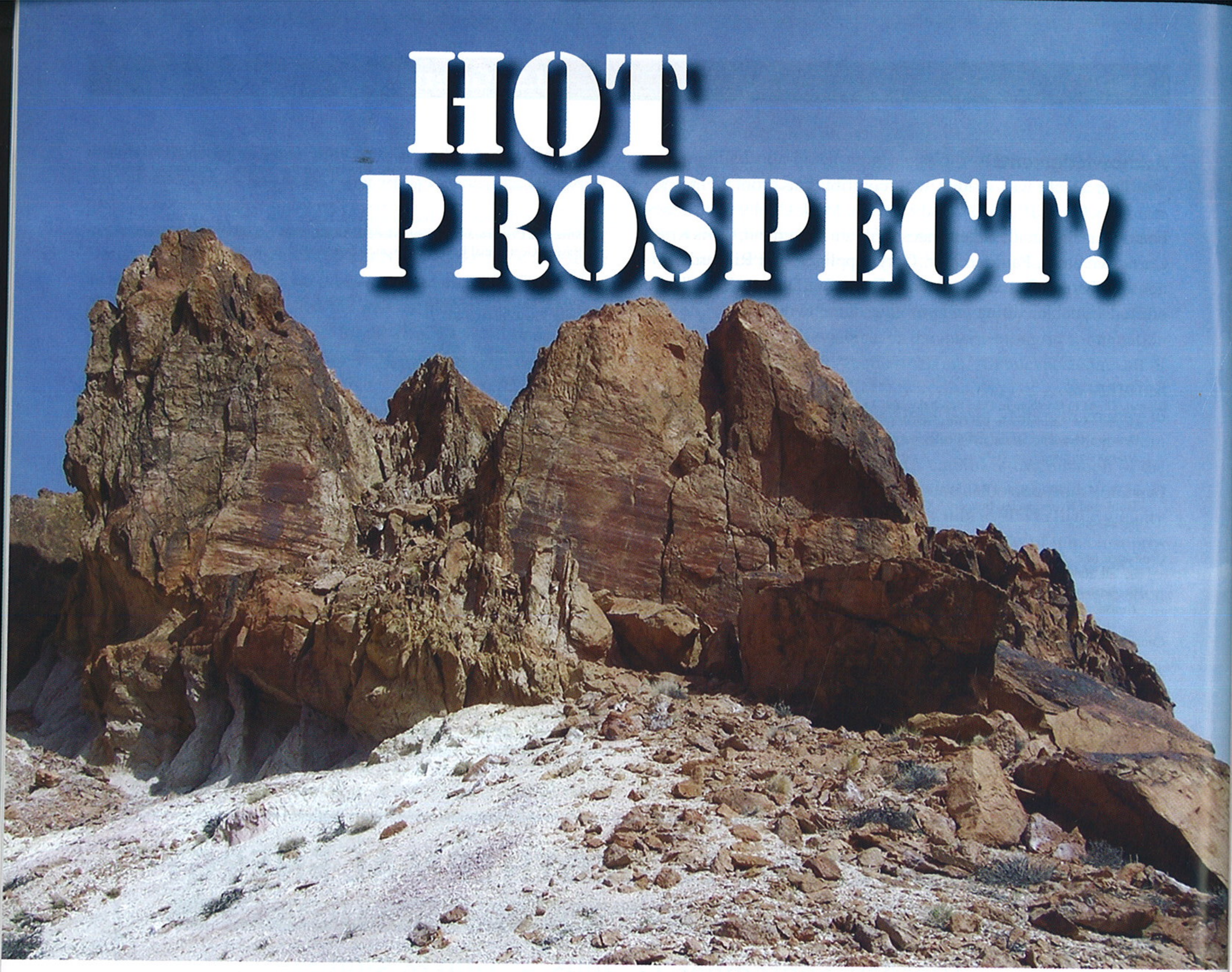
The majority of water wells throughout Fish Lake Valley, south and west of the Fish Lake Playa area, have total dissolved solids generally ranging from 170 to over 350. Domestic wells drilled near the base of the White Mountains tend to be the most pure. Ground water sampled near and north of the playa area have much higher TDS values, as sodium, chloride and carbonate content rapidly increase. At the Lower McNitt Ranch, an artesian water well approximately 5 miles south-west of the 17-31 site has a TDS content of 1,061 ppm (Amax lab numbers W-11149 and W-14393). The VRS-1 well, which will be the water source for the project, is approximately 4 miles west of the 17-31 drill site and has a TDS content of 913 ppm (From GeothermEx 1983 report and Amax lab number W-14164).

Small seeps around the margin of Fish Lake Playa have TDS contents of well over 1,000 ppm. Just north of the playa, where a narrow drainage discharges groundwater, and occasional surface water, into Columbus Salt Marsh to the north, Gap Spring has a TDS content of 3,562 ppm (Amax lab number W-11644) and a sample collected from nearby Gap Well has a TDS content of 7,162 ppm (Amax lab number W-11645).

TDS is certainly not the only item to be considered in the water chemistry, but it does provide a general road map of how the groundwater becomes much more saline as it approaches the Fish Lake Playa area near the 17-31 drill site. Water to be used in the injection test, taken from the VRS-1 well, will have a considerably lower mineral content than that of any ground water near the 17-31 drill hole or "down stream" from the drill hole in the Fish Lake Playa area.

The water analysis information is taken from Amax, U.S. Borax and Magma reports. Amax in particular undertook an extensive survey and sampled water from wells, streams and springs throughout Fish Lake Valley and the White Mountains and Silver Peak Range. I can provide whatever portions of the reports are needed.

ATTACHMENTS
Publications



DOE Enables the Emigrant Geothermal Exploration and Slimhole Drilling Project in Fish Lake Valley, Nevada

By Jeffrey B. Hulen and Gregory D. Nash - EGI, University of Utah;
John Deymonaz – Fish Lake Green Power Co.; and Alex Schriener – Earth Systems Southwest

A key component of the Strategic Plan for the U.S. Department of Energy's (DOE) Geothermal Technologies Program is "...collaborative effort with industry to support exploration for and definition of new hydrothermal resources." To help implement this part of the Strategic Plan, the agency's Geothermal Resources Evaluation & Demonstration (GRED) Program assists industry in ameliorating the risks and costs of "greenfield" prospect evaluation.

Certainly among the most encouraging greenfield prospects yet to be meaningfully drill-tested in the western United States is the Emigrant property, at the northeastern edge of Nevada's famous Fish Lake Valley (Fig. 1). Detailed geologic mapping and data synthesis made possible by a GRED III grant to Esmeralda Energy Co. (EEC) have

Slickensided erosional remnant (klippe) of fractured, welded, Miocene ash-flow tuff (brownish-orange) in low-angle normal-fault contact with underlying, non-welded tuff (pale greenish- to purplish-gray) near the Emigrant geothermal prospect, Esmeralda County, Nevada. The fractured upper plates of these newly-recognized, regionally prevalent low-angle structures would be high-quality aquifers and geothermal-reservoir rocks in a deeply concealed, Emigrant geothermal system. View at the horizon is 60 m wide. Photo: Greg Nash confirmed the prospect's potential, and set the stage for slimhole core drilling into the upper reaches of a moderate- to high-temperature geothermal upflow plume. EEC and Fish Lake Green Power Co. (FL-GPC) are wholly owned subsidiaries of Geo-Energy Partners 1983 Ltd. (GEO-83).

Introduction

The Emigrant region's stellar geothermal potential was first recognized in the early 1980s by AMAX Exploration, Inc. (Deymonaz, 1984), when that company became aware of unusually high temperatures in shallow mineral-exploration boreholes being drilled at the time by U.S. Borax and Chemical Corp. AMAX entered into a cooperative agreement with Magma Power Co. (the leaseholder) and proceeded to drill additional, dedicated temperature holes. Shallow static thermal gradients in the U.S. Borax and AMAX holes locally exceeded 700° C/km to depths in excess of 100 m. Understandably encouraged by these numbers—and by the area's clearly favorable geologic setting—AMAX was poised to implement accelerated exploration and deep drilling of the Emigrant prospect when the company withdrew from all geothermal activities in 1984.

Magma shelved further exploration at Emigrant in favor of deep drilling at the nearby and now proven, commercially-producible Fish Lake geothermal system (Fig. 1). Magma was subsequently acquired by CalEnergy Co., which soon thereafter dropped the primary Emigrant leases. GEO-83 acquired these properties by filing for non-competitive lease applications in December 2000. Based on an evaluation of GEO-83's Emigrant database, Geothermex, Inc. (Richmond, CA - 2004) estimated that the property could be capable of producing 1,380 megawatt-years of electrical energy.

The Emigrant GRED III project has three phases: prospect evaluation and site characterization (Phase 1); slimhole drilling (Phase 2); and well testing (Phase 3). Phase 1, involving existing- data collation, classification, and synthesis as well as detailed geologic mapping, is well underway at this writing (August 2005). Drilling and well testing are to follow in 2006.

Phase 1 geologic mapping has revealed previously undocumented geologic features and relationships critical not only for drill-site selection, but for elaborating the unusual structural history of one of the most tectonically active regions in the United States. This article summarizes Phase 1 findings and

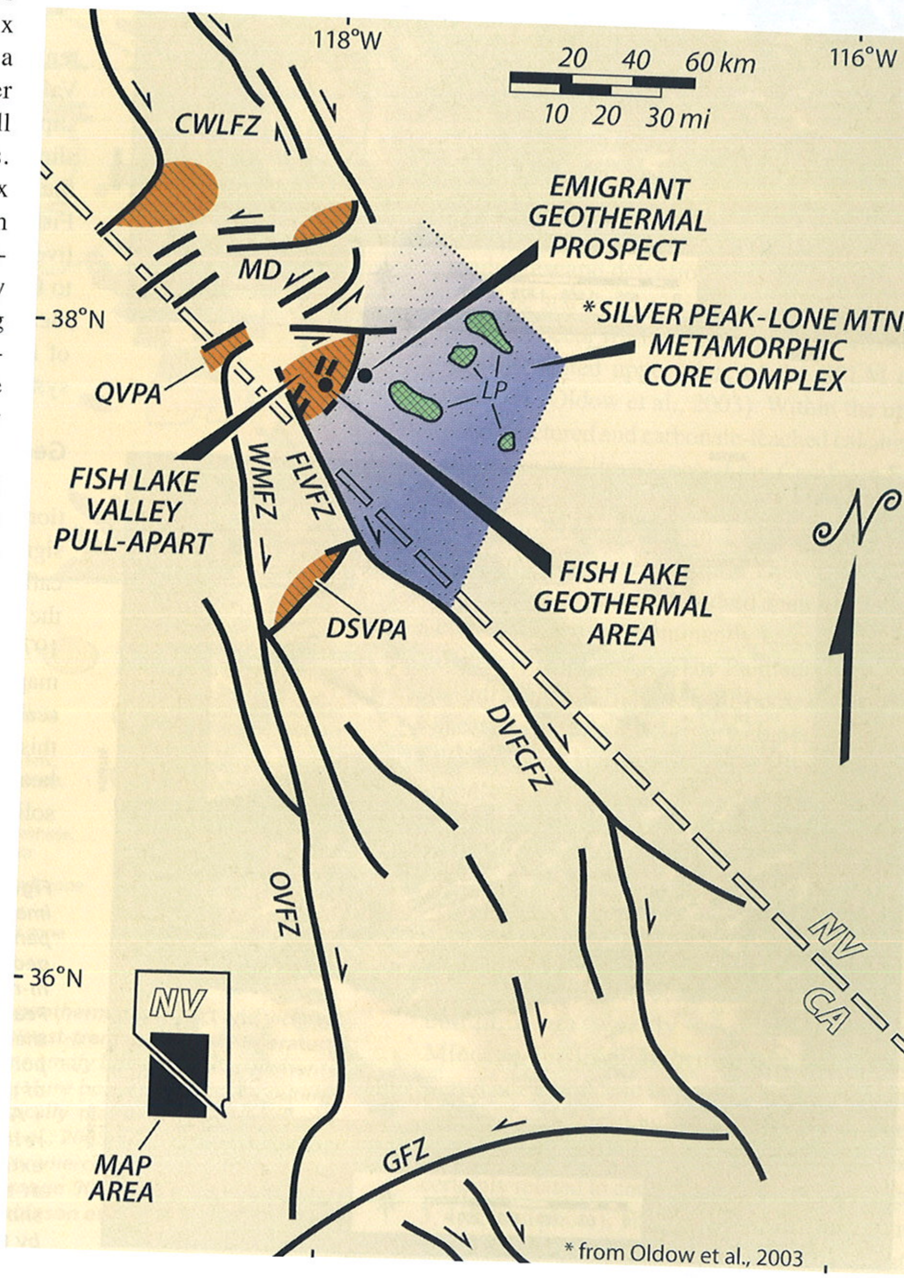
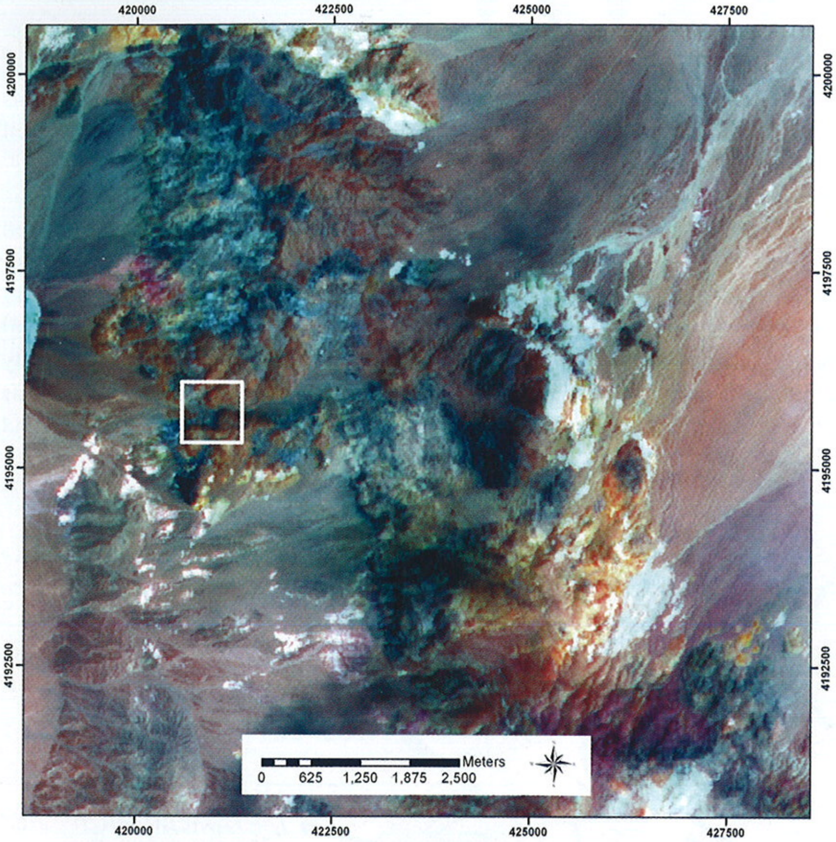
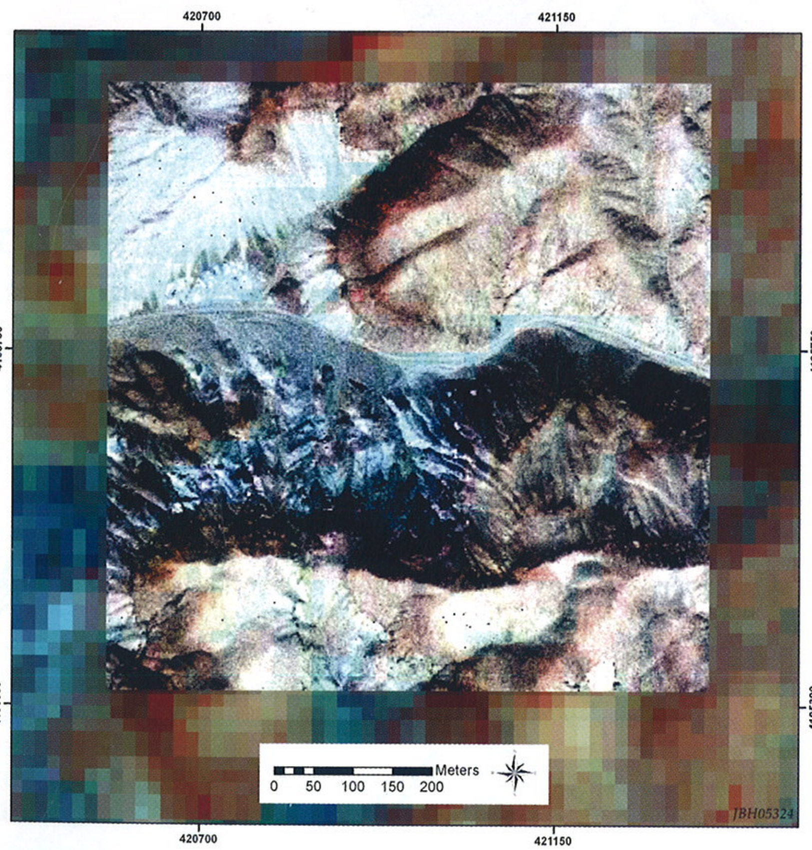


Figure 1 – Location map (generalized from Stockli et al., 2003) showing position of the Emigrant geothermal prospect relative to major structural elements of west-central Nevada and adjacent southeastern California. Bold black lines signify major high-angle fault zones, with arrows showing relative displacements. Lightly hatched, orange-colored areas highlight the Fish Lake Valley and other pull-aparts in the region. Crosshatched and green-colored areas show exposures of lower-plate (LP) tectonites in the middle to late Miocene Silver Peak-Lone Mountain metamorphic core complex (purple and light stipple; from Oldow et al., 2003). Additional abbreviations as follows: CWLFZ – Central Walker Lane fault zone; DSVPA – Deep Springs Valley pull-apart; DVFCFZ – Death Valley-Furnace Creek fault zone; FLVFZ – Fish Lake Valley fault zone; GFZ – Garlock fault zone; MD – Mina Deflection; OVFZ – Owens Valley fault zone; QVPA – Queen Valley pull-apart; WMFZ – White Mountains fault zone.





conclusions to date, and outlines the current drilling plan for penetrating the upper reaches of an Emigrant geothermal system at depth.

Geologic Setting

Fish Lake Valley occupies a classic "pull-apart" between two major dextral transcurrent fault zones: the Fish Lake Valley fault zone (FLVFZ) to the west; and the central Walker Lane to the east (Fig. 1; Reheis and Sawyer, 1997; Petronis et al., 2002; Stockli et al., 2003; Oldow et al., 2003). The pull-apart apparently began to form at about 6 Ma, following ostensible extinction of the southeast- adjoining, middle to late Miocene, Silver Peak-Lone Mountain (SPLM) metamorphic core complex (Oldow et al., 2003).

The FLVFZ, from which displacement is currently transferred eastward through the Fish Lake Valley pull-apart, has an integrated late Cenozoic slip rate of 5 mm/yr (Reheis and Sawyer, 1997). This slip speed makes the FLVFZ the single most active fault in the Great Basin. The kinematically coupled Fish Lake Valley pull-apart is only slightly less active (Reheis and Sawyer, 1997; see also references to the Emigrant Peak fault zone below), offering an ideal scenario for creation and frequent rejuvenation of fracture permeability in an Emigrant geothermal system.

Geology of the Emigrant Prospect

Because of its rapid erosional rate, sparse vegetation, excellent rock exposures, and key plate-tectonic significance, the Emigrant region had been geologically mapped many times in the past (see references in the foregoing section, as well as Albers and Stewart, 1972; and Robinson et al., 1976). However, none of the maps for these classic papers were sufficiently large-scale to permit effective drill-targeting for Phase 2 of this project. Accordingly, we geologically mapped the heart of the prospect at a scale of 1:4,000 (later consolidated to 1:10,000), with the aid of state-of-the-art

Figure 2 – A comparison of low-resolution ASTER imagery and the corresponding, high-resolution, fused panchromatic + ASTER imagery used to facilitate detailed geologic mapping for the Emigrant project. Top – 20-m-resolution ASTER imagery for the northern Silver Peak Range and a part of adjacent Fish Lake Valley to the west. Small, white-outlined square shows the area portrayed at larger scale below. Bottom – Enlargement of the white-bordered area showing fused panchromatic + ASTER imagery. The high-resolution (1-m) fused data retain virtually all of the advantages of the ASTER extravisual imagery. The fused image is surrounded, at the same scale, by adjoining pure-ASTER imagery to show the dramatic reduction in pixel size accomplished by the fusion.

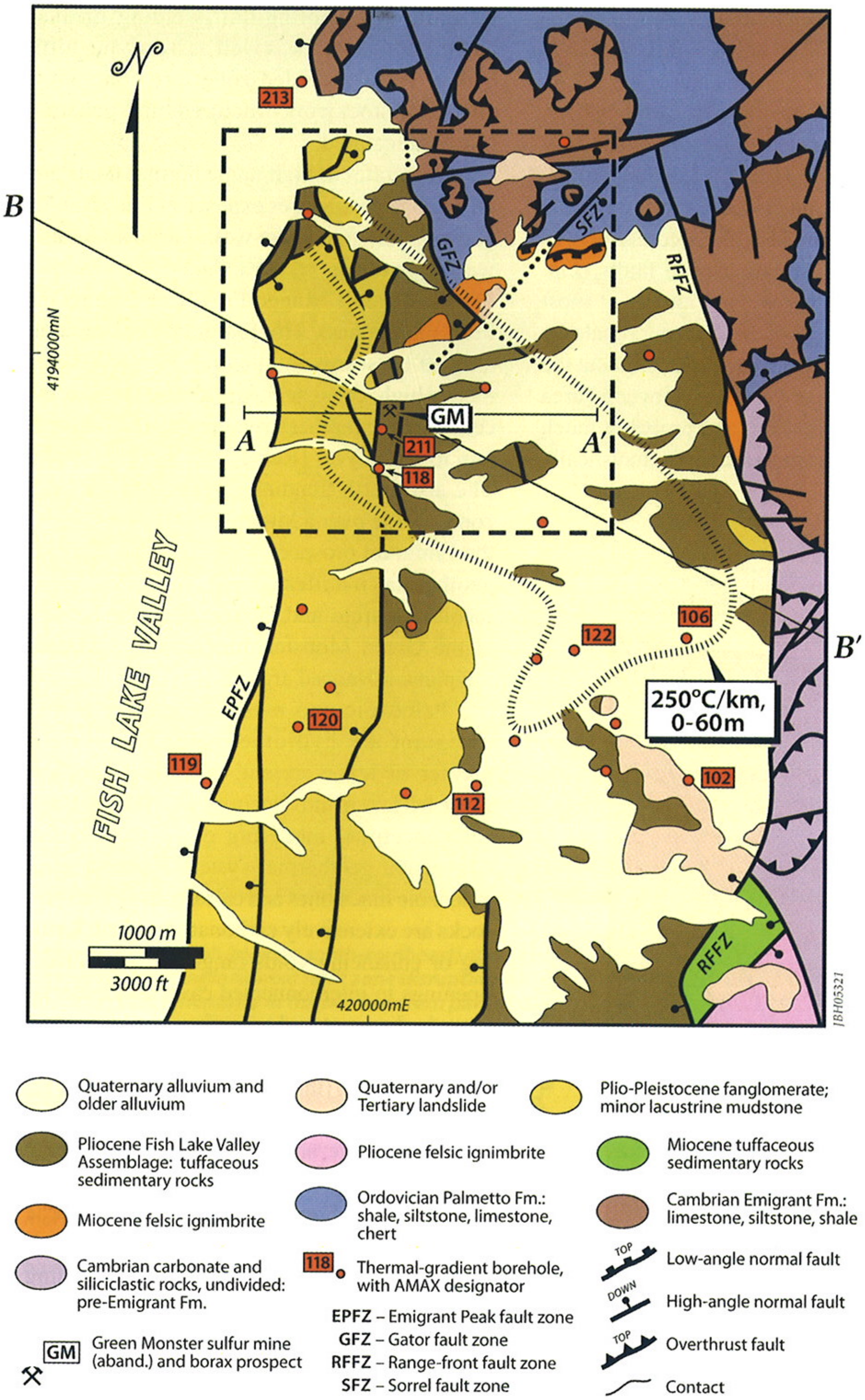


Figure 3 – Generalized geologic map of the Emigrant geothermal prospect and vicinity, illustrating, relative to major mapped faults, the northwest-trending, high-temperature nucleus of a broad, shallow, static thermal-gradient anomaly based on measurements made in 24 borax-exploration and dedicated-temperature boreholes. Dashed outline encloses that portion of the property: (1) geologically mapped by J. Hulen and G. Nash at 1:4000 for this investigation (see Hulen et al., 2005, for the detailed map); and (2) considered most favorable for drilling into a commercially viable, moderate- to high-temperature geothermal plume in the depth range 900-1300 meters. Geology beyond the borders of this area synthesized from Robinson et al. (1976; 1:62,500) and Reheis (1991; 1:24,000).

remote sensing technology, and with a focus on features most relevant to conceptual modeling of a geothermal system at depth. These include faults, fractures, fracture-amenable lithologies, active thermal phenomena, and hydrothermal alteration.

In preparation for the mapping, Greg Nash mathematically fused U.S. Geological Survey (USGS) Digital-Orthophoto-Quadrangle (DOQ) panchromatic imagery (1-m resolution) with selected spectral bands from the 15-30 m-resolution Advanced Spaceborne Thermal-Emission and Reflection Radiometer (ASTER). For details of the data-fusion process, refer to Hulen et al., 2005. Such fusion generates three-band imagery that can be printed as false-color composites with the fine-scale resolution of the panchromatic imagery and the extravisual imaging advantages of ASTER (Fig. 2). At minimal expense, the composites highlight rock types, structural trends, thermal features, and alteration that might otherwise readily escape detection.

The starkly exposed rocks of the Emigrant prospect occur within or rest upon the extensionally-attenuated upper plate of the SPLM core complex (Oldow et al., 2003). Within the upper plate, fractured and carbonate-leached calcareous siltstones and limestones of the Cambrian Emigrant Formation rest in overthrust contact upon the Ordovician Palmetto Formation—mostly a mélange of limestone and cherty limestone blocks, up to several hundred meters in diameter, in a sheared, dominantly calcareous shale matrix (Figs. 3 and 4). The Palmetto Formation is intruded locally by small bodies of equally sheared, Mesozoic or Tertiary granodiorite. Both the Emigrant and Palmetto Formations lie structurally above a thick sequence of thrust-faulted and folded Cambrian carbonate and siliciclastic formations that in turn are separated from lower-plate, Cambrian to Proterozoic tectonites by the regionally prevalent Mineral Ridge detachment (Fig. 4; Oldow et al., 2003).

The youngest rocks of the SPLM core complex are weakly to densely welded Miocene felsic ignimbrites that are locally intruded by Miocene or younger basalt, and are intricately dissected by low-angle faults and associated breccias and stockwork fractures almost certainly related to core-complex evolution (Figs. 3, 4, 5, lead photo). The ignimbrite is unconformably overlain, in succession (in the immediate prospect area) by Pliocene tuffaceous fluvial and lacustrine sedimentary rocks, Plio-Pleistocene fanglomerate, and at least two generations of alluvial fans. Quaternary and/or Tertiary landslides occur locally, and Holocene lacustrine muds occupy much of Fish Lake Valley west of the prospect. Miocene tuffaceous sediments and Pliocene ignimbrite occur just outside the prospect in the southeastern corner of the map area (Fig. 3).

The Emigrant rocks have been folded, fractured, sheared, and brecciated repeatedly during an intensive tectonic history stretching back at least to early Devonian time. Late Mississippian or early Devonian overthrust faults caught up in the upper plate of the SPLM core complex have almost certainly been reactivated as Cenozoic low-angle extensional features (Fig. 4). Low-angle normal faults in the prospect's early Miocene ignimbrites are also likely core-complex features. These remarkable faults (Fig. 5 and lead photo), individually at most just a few km^2 in areal extent, coalesce to form composite nappes throughout the northern Silver Peak Range over an area exceeding 100 km^2, and probably much more. The faults formed opportunistically at ignimbrite cooling-unit welding breaks, and these structures as well as overlying tuffs of the densely welded zones are commonly silicified, stockwork-fractured, and penetratively brecciated.

Moderate- to high-angle normal faults are the youngest structures exposed at Emigrant. In general, they trend east-west, northeast-southwest (e.g., the Sorrel fault; Figure 3) and northerly (the Gator, "Range-Front", and Emigrant Peak fault zones). The Emigrant Peak zone is marked by scarps in alluvium locally several meters high, consistent with a calculated Holocene slip rate for that structure ranging from 2.5 mm to 4 mm/year (Reheis and Sawyer, 1997). The also north-trending Green Monster fault zone, a little over a kilometer to the east, hosts the Emigrant prospect's only obvious surficial geothermal manifestations. These include a feeble fumarole and elemental sulfur deposit at the Green Monster mine, and associated, incipient, advanced argillic alteration.

Paleozoic and most Cenozoic rocks at Emigrant are hydrothermally altered to a greater or lesser extent, and this alteration must be taken into account in various ways for conceptual modeling of an underlying, convective geothermal system. For example, Paleozoic limestones and calcareous siliciclastic rocks are extensively carbonate-leached, forming or enhancing voids ranging from hairline openings to interconnected caverns a meter or more in diameter and tens of meters or more in individual length. The Paleozoic rocks are also locally silicified (thus embrittled) and laced with stockwork fractures and partially open veinlets of quartz, calcite, and other secondary minerals. Silicified low-angle fault zones and upper-plate densely welded zones in Miocene ignimbrite are penetratively fractured and brecciated, with secondary porosities locally exceeding an estimated 20 percent. Pliocene tuffaceous sedimentary rocks are massively argillized, and if sufficiently thick would provide an effective caprock on an underlying geothermal system. Fractured, silicified and pyritized zones disrupting the Pliocene strata in U.S. Borax and

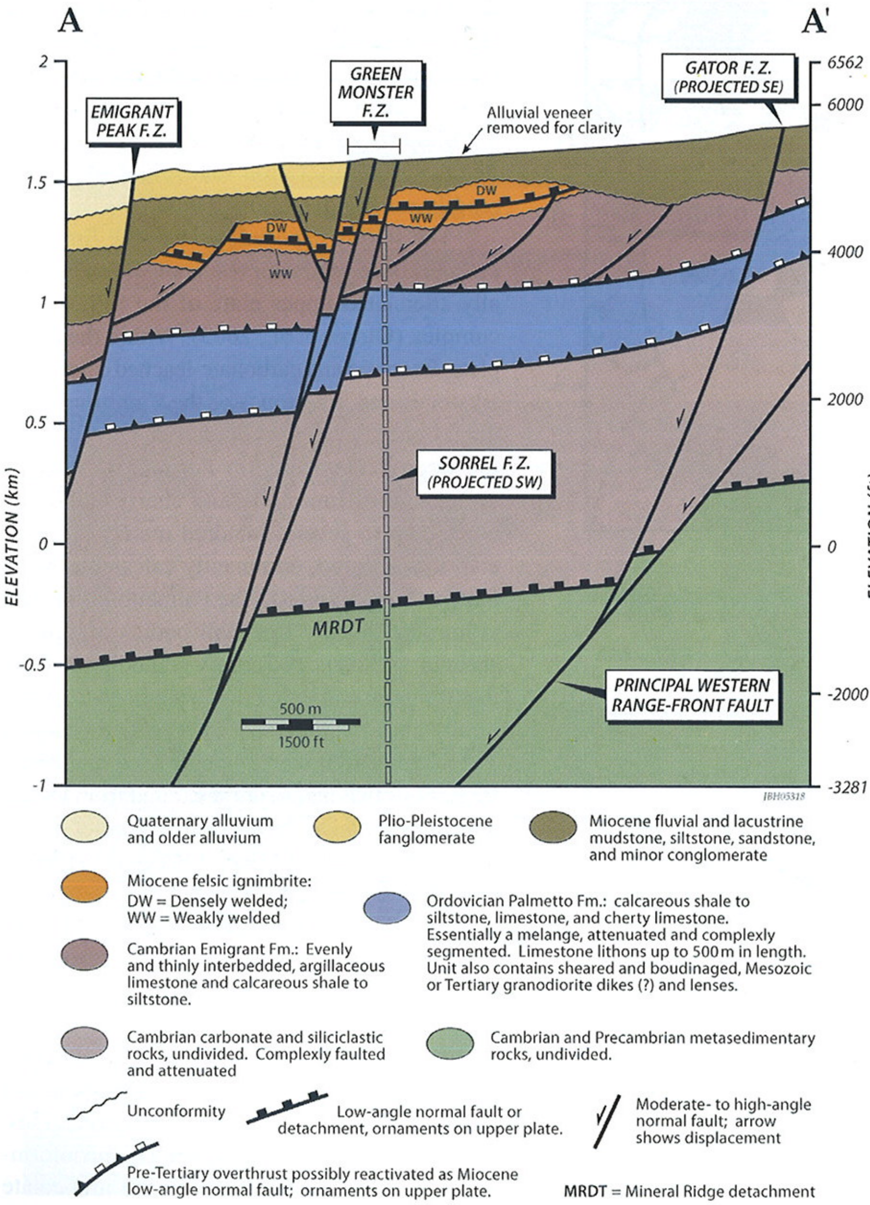


Figure 4 – Detailed, east-west geologic section through the interior of the Emigrant geothermal prospect. Please refer to Figure 3 for section location. Map features the Green Monster fault zone, along which the prospect's modern surficial geothermal manifestations are located.

Figure 5 – Photograph (looking south-southeast) of part of a generally low-angle normal fault zone disrupting early Miocene felsic ignimbrite in the northeastern part of the Emigrant prospect (photo taken just south of the location marked by "SFZ" on Figure 3). Vertical ledge at left of photo is about 5 meters high. A – Undulatory, principal displacement surface (PDS), typically grooved, mullioned, and slickensided. At left, the PDS is subhorizontal; at right, it dips about 50° southward, oblique to and away from the picture plane. B – Subsidiary dip-slip and oblique-slip faults cutting the PDS, but extending no more than a few meters into that feature's upper and lower plates. These areally restricted faults appear to have formed contemporaneously with the PDS itself. C – Intensely fractured, moderately silicified, and hematitic "limonite"-stained damage zone above the PDS. D – Argillized, weakly welded tuff in the lower plate of the PDS. E (in immediate background) – Fractured, locally rubblized, and small normal-fault-segmented, moderately to densely welded tuff in the PDS upper plate. Compaction foliation in these upper-plate tuffs dips steeply into and abruptly terminates at the PDS. Where buried to sufficient depth, both the PDS damage zone and the ruptured upper-plate ignimbrites would constitute high-quality reservoir rocks in an Emigrant geothermal system.

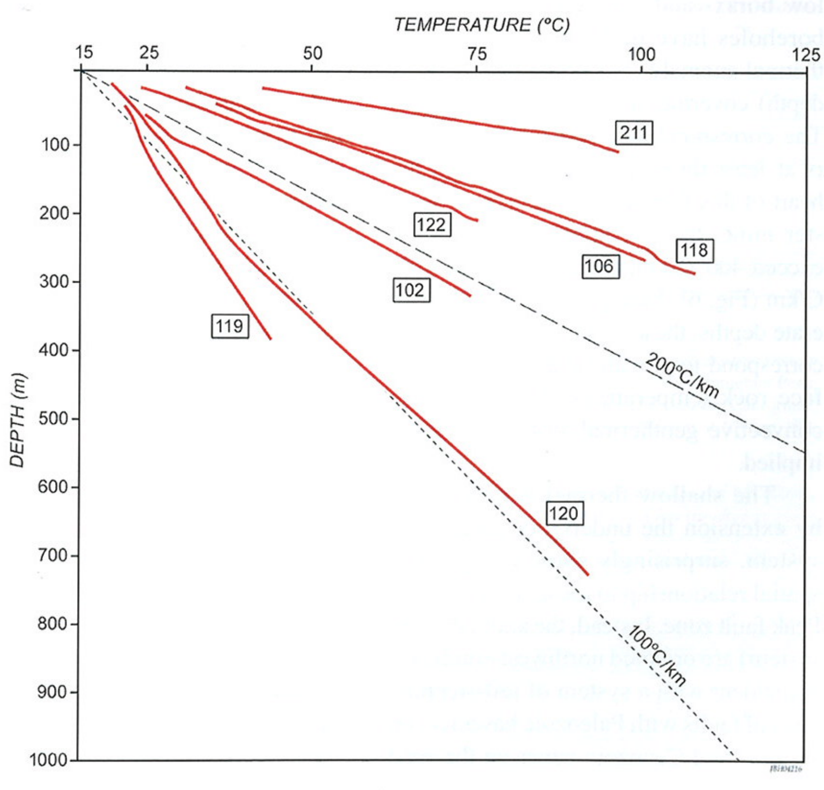
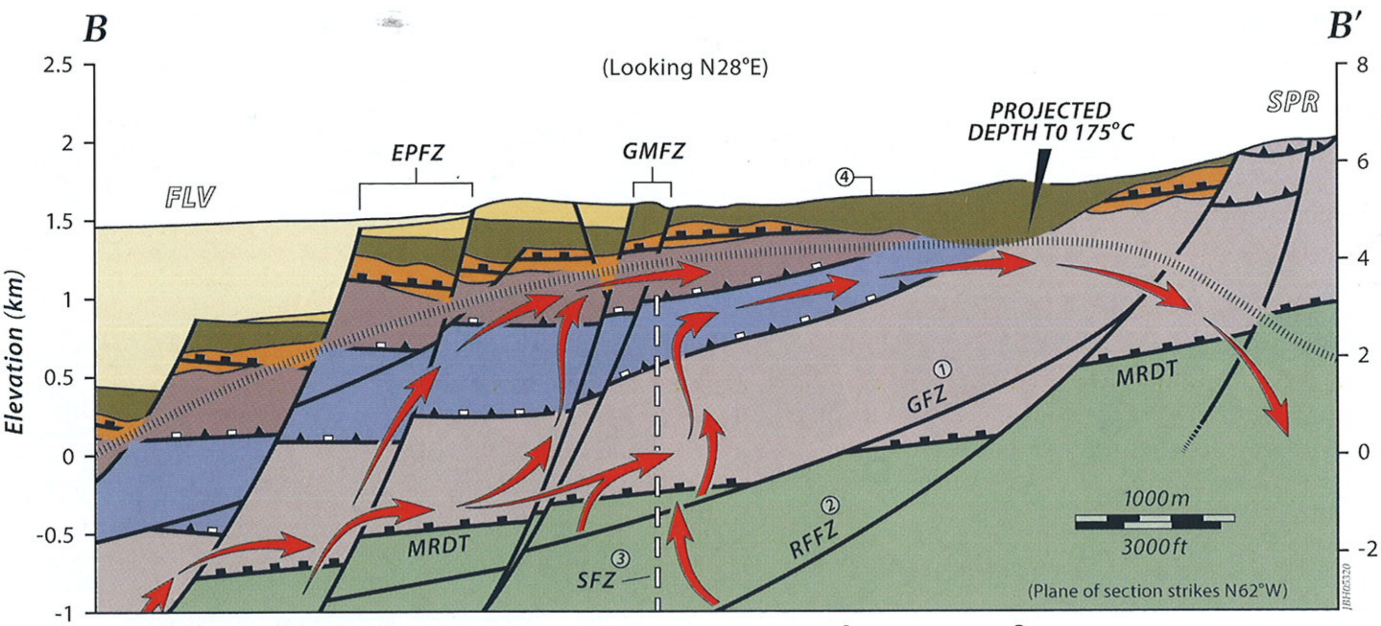


Figure 6 (right) – Static thermal-gradient profiles for selected shallow boreholes in the Emigrant geothermal prospect. Refer to Figure 3 for borehole locations.



AMAX exploration drillholes (e.g., Hambrick, 1985) locally coincide with shallow hot-water entries.

The Emigrant Shallow Thermal Regime

Measurements in two dozen shallow borax- and geothermal-exploration boreholes have outlined a >250° C/km thermal anomaly (ground surface to 60 m depth) covering at least 12 km^2 (Fig. 3). The corresponding >100° C/km anomaly is at least three times that large. In the heart of this feature, near the Green Monster mine, thermal gradients commonly exceed 400° C/km, and locally reach 700° C/km (Fig. 6). Extrapolated even to moderate depths, these higher gradients would correspond to unrealistically high subsurface rock temperatures. An underlying, convective geothermal system is clearly implied.

The shallow thermal anomaly, and by extension the underlying geothermal system, surprisingly show no apparent spatial relationship to the active Emigrant Peak fault zone. Instead, the anomaly (and system) are oriented northwest-southeast, coincident with a system of left-stepping normal faults with Paleozoic basement on the east and Cenozoic cover on the west (Fig. 3). This type of structural control, with fracture complexity and permeability enhanced at the oversteps, has also been documented for several northern Nevada geothermal systems by Faulds et al. (2003).

Unambiguously indigenous hot-water samples were collected by AMAX from two shallow boreholes within the >250° C shallow thermal-gradient anomaly—one hole close to the Green Monster Mine, and the other about 5 km to the south. Geochemical analysis revealed the hot waters to be dilute (~0.3 wt.% total-dissolved-solids) sodium-chloride-bicarbonate-sulfate fluids (Deymonaz, 1984). Multiple chemical geothermometers applied to the two samples yielded estimated deeper equilibration temperatures ranging from 129° to 213° C, with SiO_2 (quartz) geothermometry indicating a range of 158° to 169° C (see Hulen et al., 2005, for greater detail). On the basis of just two samples, we cannot rule out derivation of these thermal fluids along various chemical mixing paths. If so, even higher subsurface temperatures at Emigrant are a distinct possibility. More rigorous assessment of the prospect's subsurface temperature regime must await drilling and well testing planned for project Phases 2 and 3.

***Figure 7** – Conceptual geologic model of a moderate- to high-temperature convective geothermal system circulating beneath the heart of the Emigrant shallow-thermal-gradient anomaly (Fig. 3). At the center of this section is the drilling target currently considered optimum for penetrating, in the depth range 900-1300 m, the upper reaches of an upwelling geothermal plume. The target is centered on major fault intersections involving the Green Monster, Gator, and Sorrel fault zones. Red arrows trace conceptual thermal-fluid pathlines. EPFZ – Emigrant Peak fault zone; FLV – Fish Lake Valley; GFZ – Gator fault zone; GMFZ – Green Monster fault zone; MRDT – Mineral Ridge detachment; SFZ – Sorrel fault zone; SPR – northern Silver Peak Range. Rock units and symbols same as for Figure 4.*

Conceptual Modeling and Drill Targeting

Key stratigraphic, lithologic, and structural features of the Emigrant prospect newly recognized during project Phase 1 have been combined with results of previous investigations to: 1) construct a conceptual model of the sought-after, moderate- to high-temperature geothermal system circulating at depth; and 2) select drilling targets optimum for penetrating the upper reaches of that system within the project's practical and fiscal constraints. Geologic and thermal-gradient data point strongly to one of these targets—immediately north of the Green Monster mine (Fig. 3)—as preeminently favorable. By the time this paper is published, the results of Phase 1 "fuzzy-logic" mathematical modeling (e.g., Zahdeh, 1971) of all the Emigrant geological, geochemical, geophysical, and thermal data will have either supported the provisional No. 1 target as most advantageous, or pointed more convincingly toward one or more alternative sites.

The current conceptual model of the envisioned Emigrant geothermal system is graphically portrayed in Figure 7. According to the model, thermal waters heated by deep circulation (there is no evidence for a magmatic heat source) buoyantly ascend along left-stepping segments of the basement to the east range front fault zone and perhaps to the structurally-dissected Mineral Ridge detachment. The rising fluids focus and accelerate upward at major fault intersections, for example, junctures between the Gator, Sorrel, and Green Monster fault zones. Beneath an impermeable argillized caprock, the fluids advect subhorizontally along subsidiary conduits ranging from carbonate-dissolution channels to flat stockwork-fracture and breccia zones associated with low-angle faults in Miocene ignimbrite. As with other Great Basin geothermal systems, modern recharge is likely to be minimal, and the bulk of the reservoir fluid will probably be fossil water of pre-Holocene age (Flynn and Buchanan, 1992).

Drilling and Well-Testing

Once the initial Emigrant drilling target has been confirmed, a vertical slimhole nominally 900-1300 m deep will be drilled during 2006 to penetrate the upper reaches of the postulated geothermal system. This work will be completed by a drilling company experienced in dealing with hot, hostile, subsurface geothermal environments. The drilling will proceed under close consultation with geologists thoroughly familiar with the site-specific intricacies of the prospect area.

To the extent possible, the slimhole will be completed by diamond coring, because core is far superior to cuttings in providing: 1) a record of the tectonic and hydrothermal history leading to circulation of the contemporary geothermal system; and (2) intact samples of geothermal reservoir rock for the characterization and quantification of porosity and permeability requisite for subsequent drilling and reservoir engineering. Following resistivity, density, and pressure-temperature-spinner (PTS) logging (borehole diameter and condition permitting), slotted tubing will be installed in the well, and an injection test will be performed to determine various reservoir characteristics.

Summary and Conclusions

This GRED III, DOE/industry cooperative project is providing the impetus and the means to test drill an important greenfield geothermal prospect in west-central Nevada. Should the project lead to discovery of an electric power-producing geothermal system at Emigrant, development at the nearby Fish Lake geothermal project (Fig. 1) will also inevitably be bolstered. One of the key deterrents to full commercialization at Fish Lake has been the cost of connecting a geothermal power plant to the electric grid with an approximately 50-km, 60-kilovolt power line. If as now seems quite possible, Emigrant becomes a second viable Fish Lake Valley geothermal field, then the two can share transmission expenditures and significantly reduce each project's total development cost.

Acknowledgments

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Geology of the Emigrant Geothermal Prospect, Esmeralda County, Nevada

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Keywords

Emigrant, geothermal system, geologic mapping, remote sensing, GIS, data fusion, drilling targets, pull-apart, Fish Lake Valley fault zone, displacement transfer, Silver Peak Range, metamorphic core complex, detachment faults, low-angle normal faults, high-angle normal faults, left-stepping, fault reactivation, flower structures, fractures, damage zones, permeability, thermal-fluid flow, fluid-rock interaction, geochemistry, geothermometry, alteration, veins, travertine, sulfur, borax

ABSTRACT

At the western edge of the northern Silver Peak Range and the eastern margin of the active Fish Lake Valley pull-apart in southwestern Nevada, the Emigrant prospect has all the classical surface and shallow-subsurface indications of a deeper convective geothermal system capable of commercial electrical-energy production. Shallow boreholes completed to date at Emigrant have conductive thermal gradients as high as 700°C/km – with bottom-hole temperatures up to 109°C – over an area of at least 12 km^2. Preliminary silica geothermometry of hot waters from two of these boreholes suggests that deeper reservoir temperatures could reach at least 169°C and probably higher. Obvious surface manifestations of the concealed system include a feeble fumarole, warm ground, incipient advanced argillic alteration, and a small elemental sulfur deposit.

The rocks within and around the Emigrant prospect occur in the fractured and attenuated upper plate of the middle to late Miocene Silver Peak-Lone Mountain metamorphic core complex. In the prospect area, folded and brittly-fractured limestones and calcareous siltstones of the Cambrian Emigrant Formation rest in thrust contact on the Ordovician Palmetto Formation, here essentially a sheared mélange with a matrix of calcareous shale and siltstone supporting scattered blocks and lithons of limestone and various other lithologies. Mesozoic or Tertiary granodiorite boudins in the Palmetto provide permissive evidence for post-thrust shearing of the formation during core-complex evolution. The Emigrant and Palmetto are overlain, in succession, by: (1) early Miocene ignimbrite; (2) a tuffaceous and mostly lacustrine Pliocene sedimentary sequence; (3) Plio-Pleistocene fanglomerate; and (4) two ages of Quaternary alluvial fans. Altered, fractured, veined, and carbonate-leached Emigrant Formation and densely welded or silicified Miocene ignimbrite would be excellent geothermal reservoir rocks, as would portions of the Cambrian siliciclastic and carbonate sequence cropping out east of the prospect. Tuffaceous Pliocene sediments at Emigrant are widely and intensely argillized, and would make equally effective caprocks.

Deep thermal-fluid flow in the Emigrant geothermal system appears to be controlled mostly by (1) left-stepping, north- to northwest-trending, “major” range-bounding normal faults (Paleozoic basement on the east, Cenozoic cover on the west); and (2) northeast-trending high-angle faults that may have originated as strike- or oblique-slip structures. Shallower fluid ascent is likely channeled by younger, more valleyward, north-trending, moderate- to high-angle normal faults, including those along which the prospect’s modern surface geothermal manifestations are located. Shallow subhorizontal aquifers may be provided by the core-complex-related, low-angle normal faults and fracture networks that disrupt early Miocene ignimbrites throughout the northern Silver Peak Range. An intermediate-depth (1-1.3 km) drilling target at the intersection of a major northeast-trending fault zone and a younger, north-trending, and sulfur-mineralized fault is believed to be optimum for discovery of the upper reaches of a commercially-producible geothermal upflow plume.

Introduction and Previous Investigations

The Emigrant area, on the west flank of the northern Silver Peak Range and the eastern margin of the Fish Lake Valley pull-apart in southwestern Nevada (Figures 1 and 2, overleaf), is among the most promising geothermal prospects yet to be meaningfully drill-tested in the western United States. Shallow thermal-gradient boreholes completed at Emigrant during the 1980s encountered hot water with temperatures as high as

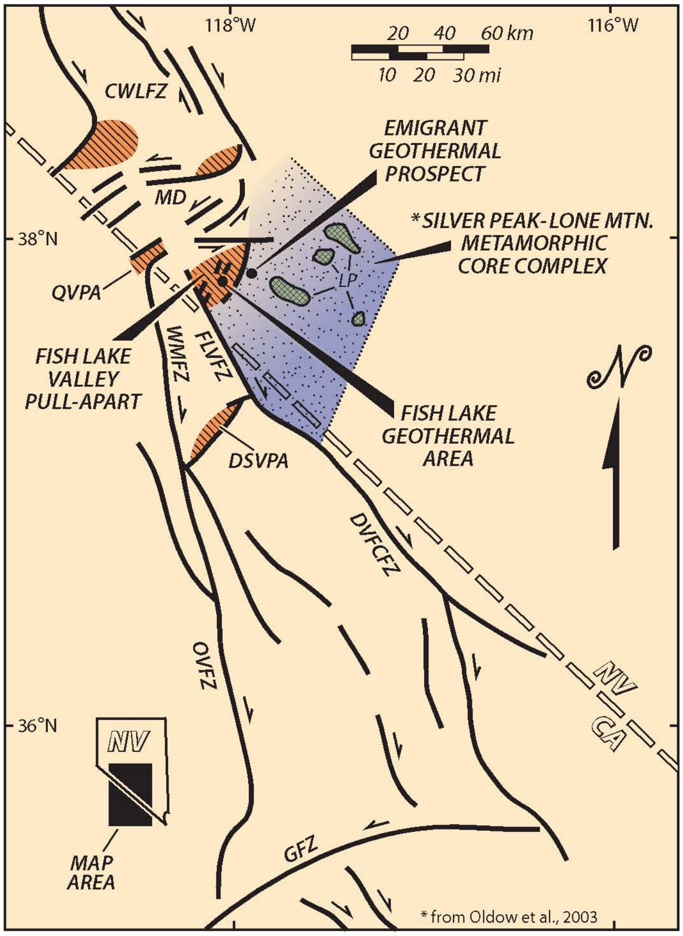

Figure 1. Location and index map showing position of the Emigrant geothermal prospect relative to major structural elements of west-central Nevada and adjacent southeastern California. Bold black lines signify major high-angle fault zones, with arrows showing relative displacements. Lightly hatched areas show selected pull-aparts. Densely stippled areas portray exposures of lower-plate (LP) tectonites in the Silver Peak-Lone Mountain metamorphic core complex (light stipple); Additional abbreviations are as follows: CWLFZ – Central Walker Lane fault zone; DSVPA – Deep Springs Valley pull-apart; DVFCFZ – Death Valley-Furnace Creek fault zone; FLVFZ – Fish Lake Valley fault zone; GFZ – Garlock fault zone; MD – Mina Deflection; OVFZ – Owens Valley fault zone; QVPA – Queen Valley pull-apart; WMFZ – White Mountains fault zone.

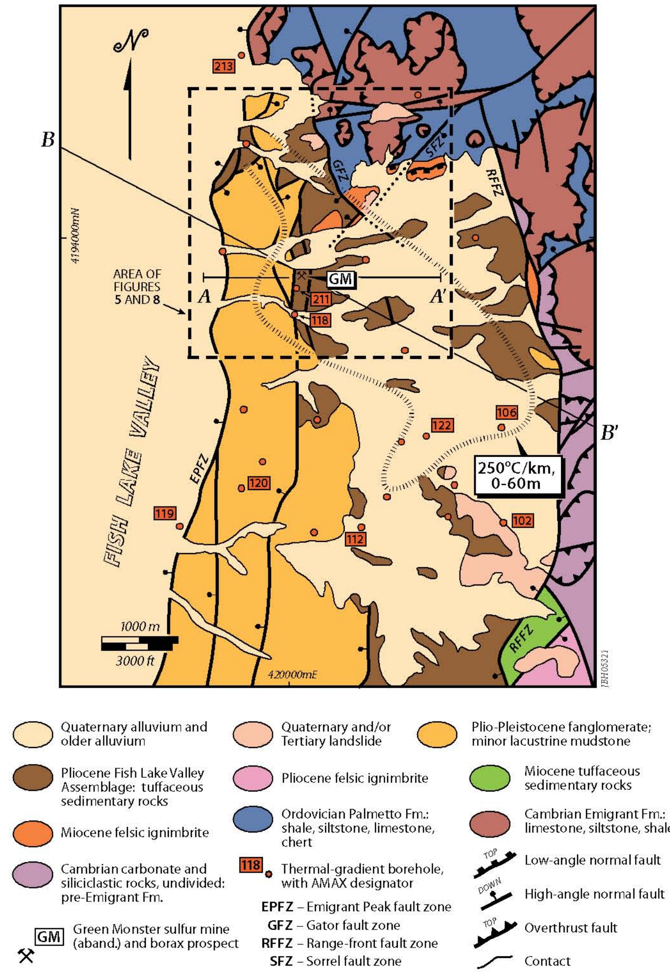

Figure 2. Generalized geologic map of the Emigrant geothermal prospect and vicinity, illustrating, relative to major mapped faults, the northwest-trending, high-temperature nucleus of a broad, shallow, static thermal-gradient anomaly. Dashed outline encloses that part of the prospect (1) considered most favorable for drilling into a commercially viable, moderate- to high-temperature geothermal upflow plume in the depth range 900-1300 meters; and (2) mapped in detail [1:4000] for this investigation. Geology beyond the borders of the detailed-map area synthesized from Robinson et al. (1976; 1:62,500) and Reheis (1991; 1:24,000).

109°C at less than 300 m depth (Figure 3), and static thermal gradients for these holes are as high as 700°C/km. Results of a preliminary evaluation of the property by Geothermex, Inc. (2004), showed that an Emigrant geothermal system likely could support production of at least 1380 megawatt-years of electrical energy.

Based in part on this assessment, the U.S. Department of Energy in 2004 awarded a "GRED III" cost-shared grant to Esmeralda Energey Company ("EEC"), a wholly owned subsidiary of Geo-Energy Partners-1983 Ltd. ("GEO-83"). GEO-83 is th sole leaseholder at Emigrant. The GRED III grant is for (Phase 1), exploration drilling (Phase 2), and well-testing (Phase 3) at the prospect. A key component of Phase 1 is detailed geologic mapping, to help focus the drilling-target selection process on those areas of the property with the best chance for exploration success.

Previous investigations in the Emigrant area have varied widely in emphasis, scope and detail. Robinson et al. (1968) published a map of the entire Silver Peak Range and vicinity at an approximate scale of 1:155,000, noting that widespread Pliocene ignimbrites at the crest of the range might signal the cryptic presence of a large corresponding caldera (the Silver Peak caldera). Albers and Stewart (1972) mapped the area for their 1:250,000-scale geologic and mineral-resource maps of Esmeralda County, and Robinson et al. (1976) later completed 1:62,500-scale mapping of a 15' quadrangle encompassing the Emigrant area. U.S. Borax and Chemical Corporation (unpublished data; 1980s) mapped the region at 1:12,000, concentrating on Pliocene lakebeds hosting borax/lithium mineralization. Reheis (1991) and Reheis and Sawyer (1997) published 1:24,000-scale maps including Emigrant and emphasizing the area's tectonic history and unusually well-exposed

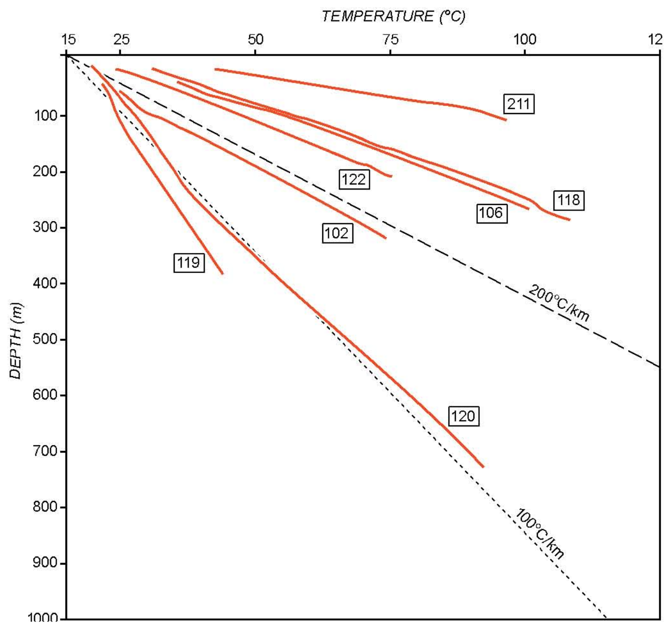

Figure 3. Static thermal-gradient profiles for selected shallow boreholes in the Emigrant geothermal prospect. Please refer to Figure 2 for borehole locations. Data from AMAX Exploration, Inc., temperature-logging reports.

late Cenozoic deposits. Oldow (1992) and Oldow et al. (1994, 2003) incorporated the prospect area into mostly small-scale (≤1:62,500) geologic maps highlighting the regionally important, middle to late Miocene, Silver Peak-Lone Mountain (SPLM) metamorphic core complex (Figure 1). Petronis et al. (2002) used paleomagnetic data to deduce that the entire core complex had been rotated clockwise and had ceased to evolve by about 6 Ma.

The Emigrant area's considerable geothermal potential was first realized by AMAX Exploration, Inc. (Deymonaz, 1984), from the high temperatures encountered in shallow U.S. Borax drill holes. AMAX entered into a cooperative agreement with Magma Power Company ("Magma"). Due to federal acreage limitations facing AMAX, the geothermal leases were held by Magma. AMAX later withdrew from geothermal development activities before a full-scale exploration effort could be implemented. Magma focused its efforts on the now proven geothermal field at nearby Fish Lake (Figure 1; Cascadia Exploration Corporation, 1999) and exploration at Emigrant ceased. Magma was subsequently acquired by Cal Energy Company ("CalEnergy") which redeployed the former company's geoscientific staff to the latter's Salton Sea geothermal field in Calaifornia's Imperial Valley. Magma dropped the primary Emigrant leases on which GEO-83, in December 2000, filed noncompetitive lease applications. BLM issued the leases effective June 1, 2002. GEO-83 and its operating company, Fish Lake Green Power Company ("FLGPC"), have undertaken exploration activities at Emigrant since that time. Under contract to FLGPC, Ciancanelli et al. (2003) combined then-existing geologic maps with the AMAX thermal-gradient data and a new precision gravity survey by FLGPC to formulate the generalized Emigrant conceptual model from which the model presented in this paper deviates only in detail. Geothermex, Inc. (2004), synthesized all contemporaneously available geoscientific data to report that the Emigrant property had a likely minimum electrical-generation capacity of 46 megawatts for 30 years.

The Fish Lake Valley pull-apart occurs within an extensional right overstep between two major dextral transcurrent fault zones – the Fish Lake Valley zone (FLVFZ) to the west, and the central Walker Lane, to the east (Figure 1; Reheis and Dixon, 1996; Reheis and Sawyer, 1997; Oldow et al., 2001, 2003, 2004; Petronis et al., 2002; Stockli et al., 2003). This still-active pull-apart apparently began to form at about 6 Ma (Reheis and Sawyer, 1997), that is, at about the time the SPLM core complex had apparently ceased its active growth phase (Petronis et al., 2002). Prior to that time (but after ~11Ma), displacement transfer at the overstep had been accommodated by regional, northwest-directed detachment faulting attending the rise of the complex itself (Oldow et al., 2001, 2003, 2004; Stockli, 2003).

In a geothermal context, it is important to note here that the FLVFZ, with an integrated lateral displacement rate of 5 mm/yr (Reheis and Sawyer, 1997), is not only the single most active fault zone in the Great Basin, but in the entire United States is surpassed in this regard only by dextral transcurrent faults of the plate-bounding San Andreas system. Kinematically linked to the FLVFZ is the Fish Lake Valley pull-apart, with which the Emigrant geothermal prospect is clearly and closely affiliated (Figure 1).

Methods and Procedures

As noted above, the Emigrant property had been mapped many times prior to the current GRED III project. However, the Phase 1 governing goal of the project was selection of a high-quality, intermediate-depth (900-1300 m), geothermal drilling target. Accomplishing this objective called for detailed (1:4000-scale) geologic mapping focused on those features of the prospect most relevant to conceptual modeling of a geothermal system at depth – faults, fractures, fracture-amenable lithologies, active thermal phenomena, and hydrothermal alteration. This work was greatly facilitated by state-of-the-art remote-sensing and GIS technology.

Remote-Sensing and GIS for Geologic Mapping – Remotely sensed data can be highly effective for increasing the productivity and accuracy (in turn lowering the cost) of geologic mapping. For example, inexpensive multispectral imagery can be used to prepare provisional regional to sub-regional lithologic, alteration, and fault maps to guide subsequent field work. The trade-off in this economical approach is that these data sets – from the LandSat Thematic Mapper and Advanced Spaceborne Thermal-Emission and Reflection Radiometer (ASTER) – have 15-30 m spatial resolutions, less than ideal for large-scale mapping. The problem is not insurmountable. Comparably inexpensive panchromatic (PCR; gray-scale) data, available at spatial resolutions to 1 m, can be mathematically combined (fused) with the multispectral imagery to create new images retaining the distinct advantages of ASTER and the fine-scale PCR resolution.

For this project, fused imagery was created using ASTER data and USGS Digital Orthophoto Quandrangles (DOQs).

The ASTER data have a spatial resolution of 20 m for the visible to infrared and near-infrared bands, and 30 m for shortwave-infrared bands; the cost can range from free to US$60 per 60 x 60 km image. The DOQs utilize a single gray-scale band with a 1-m spatial resolution; the cost per 7.5-minute quadrangle can range from nil to US$20. The foregoing approach is undeniably effective for detailed mapping projects with typically limited budgets. Where cost is of lesser concern, the writers would recommend data fusion using hyperspectral airborne imagery (for example HyMap, with 3-m spatial resolution) and Quickbird PCR data (0.6-m).

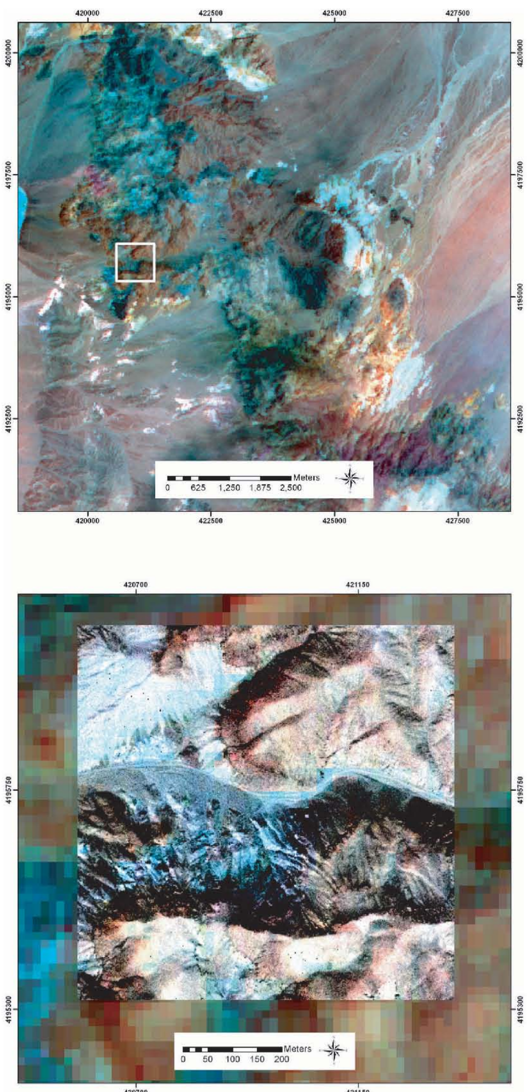

Figure 4. A comparison of low-resolution, ASTER imagery and the corresponding, high-resolution, fused ASTER + panchromatic imagery used to facilitate detailed geologic mapping for this project. **Top** – 20-m-resolution ASTER imagery for the northern Silver Peak Range. Small, white-outlined square shows the area portrayed at larger scale below. **Bottom** – Enlargement of the white-outlined area above showing fused ASTER + panchromatic data at the much-finer-scale resolution of the latter (1 m). The high-resolution fused data retain virtually all the advantages of the ASTER visible, infrared, near-infrared, and shortwave-infrared imagery. For comparison, the fused image is surrounded by adjoining ASTER imagery at the same scale to show the dramatic reduction in pixel size accomplished by the fusion.

Data fusion for this project was accomplished using the Brovey method, a standard procedure found in most image-analysis software packages. For this method, three bands from the multispectral data set are chosen based upon appropriate spectral characteristics. These bands are then merged with the PCR data set as follows:

$$B1_{new} = (B1/[B1+B2+B3]) \times PCR$$

$$B2_{new} = (B2/[B1+B2+B3]) \times PCR$$

$$B3_{new} = (B3/[B1+B2+B3]) \times PCR$$

Where B1, B2, and B3 are the multispectral input bands. This process generates a three-band data set that can be used to produce false-color composites (FCC; Figure 4) readily usable for mapping at scales ranging to 1:4000 and greater. The fused imagery is overlain with a Universal Transverse Mercator (UTM) grid to facilitate field orientation. Color-printed on glossy paper, the imagery provides a distortion-free geologic-mapping base highlighting rock types, structural trends, thermal features, and hydrothermal alteration phenomena that might otherwise escape detection.

Geology of the Emigrant Prospect

Stratigraphy and Lithology

The Emigrant geothermal prospect (Figures 2 and 5) flanks the western part of the northern Silver Peak Range, where that feature has narrowed northward from a high, broad, and rugged range of mountains to a subdued spine of hills only a few km in breadth. Within the prospect proper, Cambrian to Ordovician carbonate and siliciclastic rocks, almost always in fault contact with one another, are overlain, in succession, by Miocene felsic ignimbrite, Pliocene tuffaceous sediments, Plio-Pleistocene fanglomerate, and Pleistocene to Holocene alluvium. Some of the Paleozoic strata, and the more densely welded or silicified portions of the ignimbrite, would make excellent reservoir rocks in a concealed Emigrant geothermal system. The Pliocene sedimentary sequence is extensively argillized, and would provide an equally effective caprock.

Older Cambrian Formations – Several older Cambrian formations exposed at the eastern edge of the Emigrant prospect (Figure 2), but not mapped in detail for this study, are likely to occur nonetheless in the deeper reaches of the envisioned Emigrant geothermal system (Figure 6). The project's Phase 2 intermediate-depth drill hole may barely reach these rocks, but they should be mapped and characterized in detail in advance of deeper production drilling. From oldest to youngest, these units are: (1) The Cambrian Poleta Formation [limestone, siltstone, and quartzite]; (2) Cambrian Harkless Formation [shale, phyllite, siltstone, and quartzite]; and (3) the Cambrian Mule Spring Limestone. The Mule Spring, in particular, might be a particularly effective reservoir rock, as it is riddled with locally extensive carbonate-dissolution networks including caverns up to at least several meters in diameter.

Cambrian Emigrant Formation—The Emigrant Formation crops out widely in the northern and eastern portions of

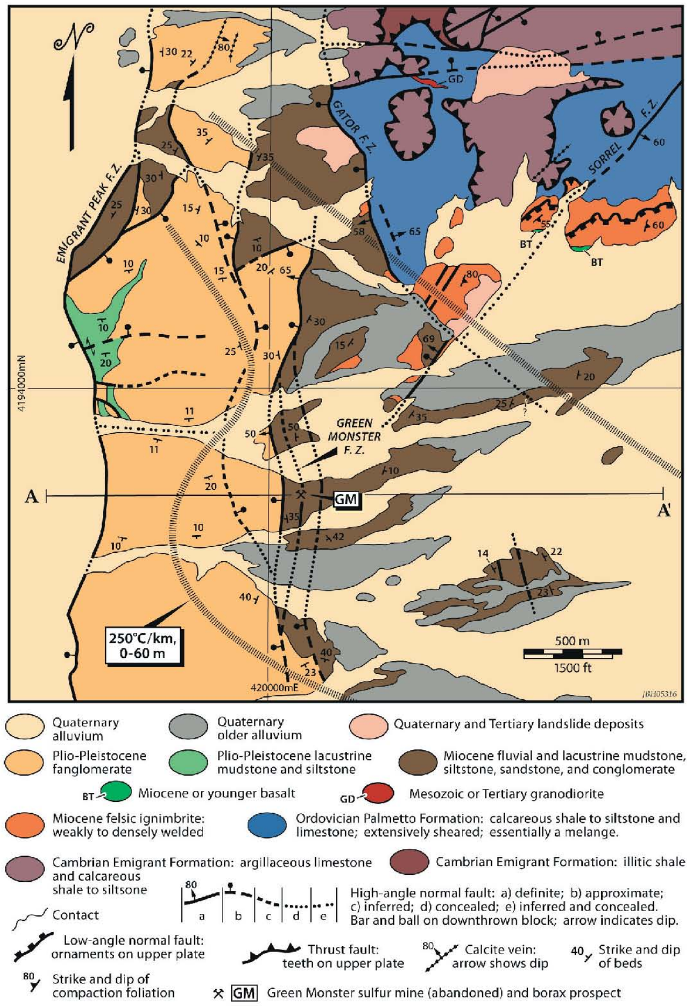

Figure 5. Summary detailed geologic map of the interior of the Emigrant geothermal prospect. Geology distilled from 1:4000-scale mapping. Please refer to Figure 2 for map location.

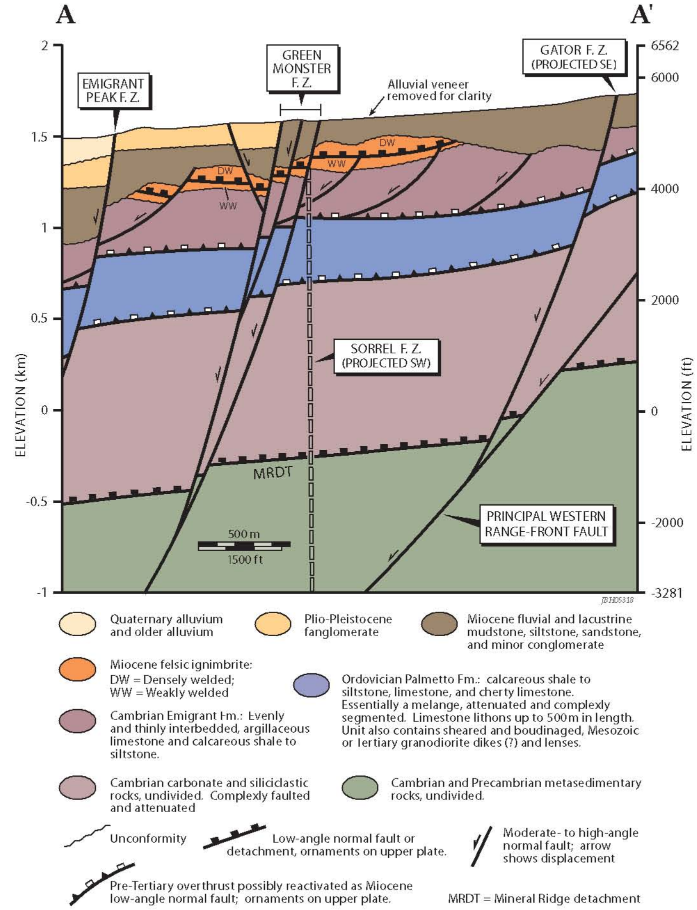

Figure 6. Detailed, east-west geologic section through the interior of the Emigrant geothermal prospect. Map features the Green Monster fault zone, along which the prospect's modern surface geothermal phenomena (e.g., a small native-sulfur deposit and feeble fumarole) are located.

the prospect (Figures 2 and 5). In these areas, the formation has two members: (1) rhythmically interbedded, argillaceous limestone and calcareous shale to siltstone; and (2) papery-weathering shale and phyllite. The first-named member should be an excellent geothermal-reservoir host. Not only has the rock undergone widespread carbonate dissolution (and even small-cavern formation), it is also exensively fractured and veined. The impermeable shale member, fortunately, is of limited local distribution.

Ordovician Palmetto Formation – Underlying the Emigrant Formation in thrust contact on the prospect is the structurally dissected and deformed, Ordovician Palmetto Formation. The Palmetto in west-central Nevada has been described by Oldow (1984) as part of a highly disrupted, imbricate thrust stack emplaced as part of the regionally prevalent, Devonian-Missisippian Roberts Mountains allochthon. In the prospect area, the Palmetto is essentially a mélange, consisting of scattered blocks and lithons of limestone, cherty limestone, chert, and lesser sandstone and siltstone embedded in a variously sheared and chaotically folded matrix of calcareous shale to siltstone. The blocks are penetratively fractured and hydrothermally veined; the matrix appears generally impermeable. Thus, the Palmetto as a whole would not be a particularly favorable geothermal reservoir rock. Even the fractured blocks, if no larger at depth than mapped at the surface, would provide unacceptably small reservoir volumes. Various types of hydrothermal alteration to be discussed would improve the formation's overall reservoir quality, but the presence and extent of such alteration in the subsurface cannot be predicted with confidence from the geologic mapping alone.

Mesozoic or Tertiary Granodiorite—The Palmetto mélange in this part of the Silver Peak Range contains dozens of small granodiorite lithons (only one is large enough to show at the scale of the map; Figure 5). These igneous rock bodies range in form and texture from sheared and offset dikes or sills, to chains of lensoid boudins entirely bounded by shear planes. There are apparently no such plutonic rocks in western Nevada older than Triassic (Stewart, 1980). The presence of these rootless, sheared granodiorite masses in the Palmetto thus indicates that one major shearing episode affecting the formation post-dated emplacement of the Roberts Mountains allochthon. If the granodiorite is younger than mid-Mesozoic, the shearing would also have taken place after the most recent (Jurassic) regional overthrusting (Oldow, 1984). The point to be made here is that the granodiorite permissively could have been sheared during Miocene extension and attenuation of the Palmetto in the upper plate of the SPLM core complex. Radiometric age-dating of the granodiorite currently in progress should rigorously test this hypothesis.

Miocene Felsic Ignimbrite—The Emigrant and Palmetto Formations in the northeastern part of the geothermal prospect area (Figure 5) are overlain, in depositional to structural contact, by early Miocene (21.5-22.8 Ma; Robinson et al., 1976) felsic ash-flow tuffs assigned by Oldow (2003) to the regionally distributed Icehouse Canyon Sequence. These ignimbrites are quartz-, feldspar, and biotite-crystal-rich, and form simple to compound cooling units (Smith, 1960) that are weakly to densely welded and intricately dissected by faulting.

In this area (and apparently throughout the northern Silver Peak Range), the Ice House Canyon ignimbrites occur mostly as structural tongues and slivers above multiple low-angle faults. The upper plates of these faults consist principally of fractured, brecciated, rotated, steeply-dipping and locally silicified blocks of moderately to densely welded tuff. The lower plates are made up of corresponding, commonly argillized, weakly welded tuffs that are also fractured and distended but overall more nearly intact.

The penetratively fractured, welded tuffs in the upper plates of these low-angle fault slivers, along with the fault zones themselves, would clearly be high-quality geothermal-reservoir rocks if buried sufficiently deep. At the crest of the Emigrant thermal anomaly (Figures 2 and 5), these rocks could host the shallowest hot-water entries in the intermediate-depth drill hole planned as Phase 2 of this project. On the other hand, weakly welded tuffs beneath the low-angle faults are commonly argillized, and could function at depth as aquitards.

Pliocene Tuffaceous Sedimentary Rocks—Unconformably overlying the Paleozoic rocks and Miocene ignimbrites in the prospect area are widespread tuffaceous sediments (Figure 5) of the Pliocene Fish Lake Valley Assemblage (Oldow, 2003). These sediments, which accumulated in small structural and erosional basins of limited local extent, comprise basinal-facies, in part turbiditic, ashy lacustrine mudstones, siltstones, and sandstones flanked by pumiceous, basin-margin, fluvial sandstones and conglomerates. Based on radiometrically-determined ages of interstratified tephra, deposition of the Fish Lake Valley Assemblage spanned at least the time interval 4.8-2.6 Ma (Robinson et al., 1968, 1976; Reheis and Sawyer, 1997).

According to U.S. Borax lithologic logs (e.g., in Hambrick, 1985), the Fish Lake Valley Assemblage in the vicinity of the geothermal prospect ranges from a few tens of meters to at least 700 m in thickness. Greenish, tuffaceous, argillized lacustrine mudstones apparently making up the middle part of the assemblage were targeted by U.S. Borax for the sediments' elevated borax and lithium concentrations. These argillized sediments are ideally positioned to provide an impermeable and thermally-insulating cap on an underlying convective geothermal system.

Miocene or Younger Basalt—Porphyritic basalt was found intruding Miocene ignimbrite but no younger rocks in the Emigrant prospect area (Figure 5). The basalt is dark olive-gray where fresh, but is generally argillized and pale greenish-gray. The rock is unlikely to figure prominently in a concealed Emigrant geothermal system.

Plio-Pleistocene Fanglomerates and Lacustrine Sediments—A key marker unit in the Emigrant prospect area is an upper Pliocene to middle Pleistocene sequence dominated by weakly-consolidated pebble to cobble and rarely boulder conglomerate, but also containing distinctive local lacustrine mudstones and siltstones (Figure 5). Tephra are dramatically less abundant in this unit than in underlying Pliocene sediments, but include diagnostic eruptive debris from the Yellowstone caldera complex as well as the nearby, Pleistocene, Long Valley volcanic center (Reheis and Sawyer, 1997). The youngest dated tephra layer in this young fanglomerate/mudstone sequence clearly came from Plinian eruptions precursor to eruption of the voluminous, 0.76 Ma Bishop Tuff ash flows and resulting collapse of the Long Valley caldera.

Quaternary and Tertiary Landslide Deposits—There are three landslides within the detailed map area (Figure 5). The largest and most conspicuous is a 0.1 km^2 mass of Emigrant Formation that collapsed from a high, east-west-trending fault scarp into a deeply eroded adjacent canyon. This landslide ranges in texture from nearly intact glide blocks to incoherent rock rubble. A second slide, just west of the Gator fault zone, is a fractured but mostly coherent glide block consisting of Palmetto Formation with a scab of Miocene ignimbrite. The third slide consists of rubblized but minimally-eastward-transported Miocene ignimbrite just north of the intersection of the Sorrel and Gator fault zones.

Quaternary Surficial Deposits—Older rocks throughout the Emigrant geothermal prospect (Figures 2 and 5) are blanketed extensively by Quaternary alluvial fans of at least two ages; the older deposits overlain and incised by the younger. These fans are of marginal direct interest from a geothermal perspective, and have been removed for clarity from the interpretive geologic sections presented in this report (e.g., Figure 6).

Structure

Overview—The rocks of the Emigrant prospect (and the Silver Peak Range in general) have been folded, fractured, sheared, and brecciated repeatedly during their long and unusually intensive tectonic history. This is an ideal scenario for creating the enhanced permeability and deeply-penetrating thermal-fluid conduits required for a commercial geothermal system. The prospect is still tectonically active, as evidenced by faulted alluvium. Because of this fact, the inevitable "self-sealing" that takes place in all hydrothermal systems (Facca and Tonani, 1967) is likely to be balanced by seismically-induced and frequently recurring fracture rejuvenation.

There are three principal types of faults in the prospect area, from oldest to youngest: (1) Overthrusts, affecting only Paleozoic rocks; (2) low-angle normal faults, in Miocene felsic ignimbrite; and (3) Moderate- to high-angle faults, including those of the current locus of tectonic activity here, the

Emigrant Peak fault zone (Figures 2, 5, and 6). Faults of all three types locally have thick "damage zones" that could focus or distribute thermal-fluid flow in a concealed Emigrant geothermal system.

Overthrust Faults—The Cambrian and Ordovician Formations of the Emigrant prospect are typically in apparent overthrust contact with one another (Figures 2, 5, and 6), although Albers and Stewart (1972) take pains to explain that many of these "overthrusts" could just as readily be low-angle extensional features. The major overthrust separating the Emigrant and Palmetto Formations in the detailed map area (Figure 5), as we have noted (see "Granodiorite" above), shows evidence permissive for low-angle extensional reactivation.

Low-Angle Normal Faults—The dominant structure of the Silver Peak Range (and of the Weepah Hills and Lone Mountain nearby and to the east) is the regional, low-angle detachment surface separating the upper and lower plates of the SPLM core complex (Figure 1; Oldow, 2003). This structure is not exposed in the Emigrant prospect area, but is sure to occur here at depth (Figure 6). The drilling of future deep production wells at Emigrant should be preceded by careful mapping and measurement of the detachment where it crops out nearest to the prospect. Subsidiary low-angle structures in the upper plate of the detachment are locally exposed at Emigrant, and are likely to be penetrated at depth during Phase 2 drilling activities.

A remarkable series of core-complex-related, low-angle normal faults disrupts early Miocene ignimbrite of the Icehouse Canyon sequence not only within the prospect (Figures 2, 5, 6, and 7, but—based on the writers' reconnaissance —throughout the northern Silver Peak Range. These faults, to our knowledge previously undocumented, occur over an area of at least 100 km^2 (and probably more). Rather than being part of a continuous regional break, they appear to cut the ignimbrite into multiple slivers and tongues individually reaching at most a few km^2 in area. The tongues (1) commonly coalesce laterally to form larger, composite nappes; but (2) are locally separated by "islands" and septa of sheared and segmented but overall relatively intact ignimbrite. The faults at the bases of the individual slivers have undulatory, typically slickensided surfaces (e.g., Figure 7). With up to 25 m of structural relief, these surfaces, depending on location in the range, dip gently (<30°) to the east, west, north or (as on the prospect) south, but locally may be near-vertical.

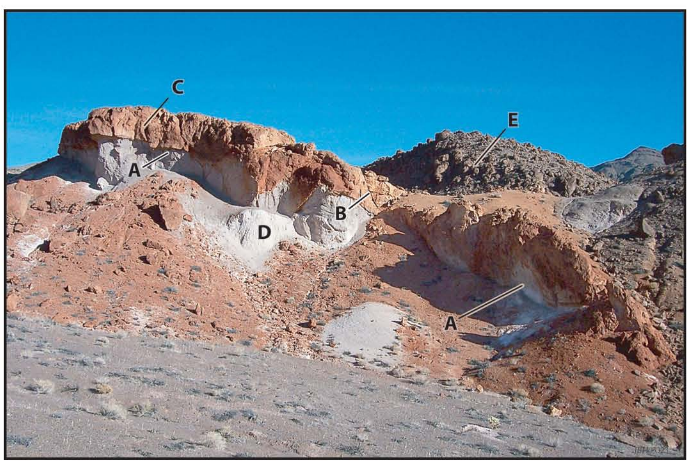

Figure 7. Photograph (looking south-southeast) of low-angle normal fault zone disrupting Miocene felsic ignimbrite in the northeastern part of the detailed geologic-map area (Figure 5). Vertical ledge at left of image is ~5 m high. **A** – Undulatory, principal displacement surface (PDS), typically grooved, mullioned, and slickensided. At left, the PDS is subhorizontal; at right, it dips steeply south, oblique to and away from the picture plane. **B** – Subsidiary dip-slip and oblique-slip faults cutting the PDS, but extending no more than a few meters into that feature's upper and lower plates. These structures appear to have formed near-contemporaneously with the PDS itself. **C** – Intensely fractured, moderately silicified, and hematitic "limonite"-stained damage zone above the PDS. **D** – Argillized, weakly welded tuff in the lower plate of the PDS; **E** (in immediate background) – Fractured, locally rubblized, and small-normal-fault segmented, moderately to densely welded tuff in the upper plate of the PDS. Compaction foliation in this upper plate dips steeply toward the PDS. Photography by G.D. Nash.

These ignimbrite-hosted, low-angle faults appear to have formed opportunistically at cooling-unit welding breaks. Typically, the breaks have occurred between a weakly welded zone below and a moderately to densely welded zone above. Denser tuffs of the upper plates have been displaced over the softer basal tuffs, and locally over Paleozoic rocks. In response to this motion, the upper-plate tuffs have been segmented into multiple local strike-slip- to normal-fault-bounded blocks, many of which have been rotated so that their compaction foliation dips steeply into – and terminates at – the damage zones above the principal subhorizontal displacement surfaces (Figure 7).

The actual slip magnitude along these ignimbrite-hosted low-angle faults has yet to be determined, but, based on field evidence, does not appear to have been appreciable. However limited, the motion was sufficient to break the fault zones and the upper-plate tuffs into penetrative and commonly open fracture networks. The most porous of these networks, found between neighboring, subparallel, oblique-slip faults, are similar in form and texture to the fractured negative flower structures that are a characteristic feature of transtensional strike-slip fault zones (Sylvester, 1988).

Moderate- to High-Angle Faults – Overthrusts and low-angle normal faults at Emigrant are broken extensively by moderately- to steeply-dipping faults, the youngest of which show the most obvious surface expressions of ongoing major extension in the Fish Lake Valley pull-apart (Figure 1). These high-angle structures can be grouped conveniently into three main orientations – northeast, east-west, and northerly (Figures 2 and 5). The northeast-trending faults crop out along what we have designated the Sorrel fault zone. The most recent displacements along this fault zone have been pure normal dip-slip. However, the nearly straight trace of the zone suggests that it may have undergone earlier strike- or oblique-slip motion. East-west faults, confined to the northern part of the prospect (Figures 2 and 5), parallel many of the major left-lateral, Walker Lane transfer faults of the "Mina Deflection" to the north (Figure 1; Stewart, 1985, 1988).

Both the northeast- and east-west-trending faults at Emigrant are truncated by northerly-trending, moderate- to high-angle normal faults. Primarily down-to-the-west, these young faults cut all rock and deposit types on the prospect.

The Emigrant Peak fault zone (Figures 2, 5, and 6) is notable for west-facing scarps up to several meters high in all but the very youngest alluvial deposits. Synthetic to the Emigrant Peak fault zone are the high-angle, north-trending faults of the Green Monster zone (Figures 2, 5, and 6). Occurring along this zone are the only obvious surface manifestations of the concealed geothermal system – warm ground, a feeble fumarole, incipient advanced alteration, and crusts of elemental sulfur.

Alteration

Paleozoic and most Cenozoic rocks at Emigrant are hydrothermally altered and mineralized to a greater or lesser extent (Figure 8). A little of this alteration can be attributed unambiguously to a modern Emigrant hydrothermal system, and all of the alteration is variously useful for conceptually modeling past, recent, and contemporary thermal-fluid circulation deep in the prospect's subsurface.

The Emigrant and Palmetto Formations differ as much in alteration style as they do in structural disruption. The commonly sheared Palmetto hosts scattered patches of alteration and mineralization only locally large enough to show at the scale of the map (Figure 8), but of many varieties and textures including: (1) massive barite; (2) cryptocrystalline silicification [jasperoid]; (3) stockwork quartz ± limonite [-pyrite] veining; (4) decalcification [hydrothermal carbonate-dissolution]; and (5) quartz-sericitization ± limonite [-pyrite]. The chaotic distribution as well as the highly variable composition and texture of this Palmetto-hosted alteration suggests that much of it may be rootless, dismembered from its point of origin and tectonically transported to its present location. Having said this, we note also that some alteration in the Palmetto is obviously and tightly controlled by major throughgoing structures like those of the Sorrel fault zone (Figure 8).

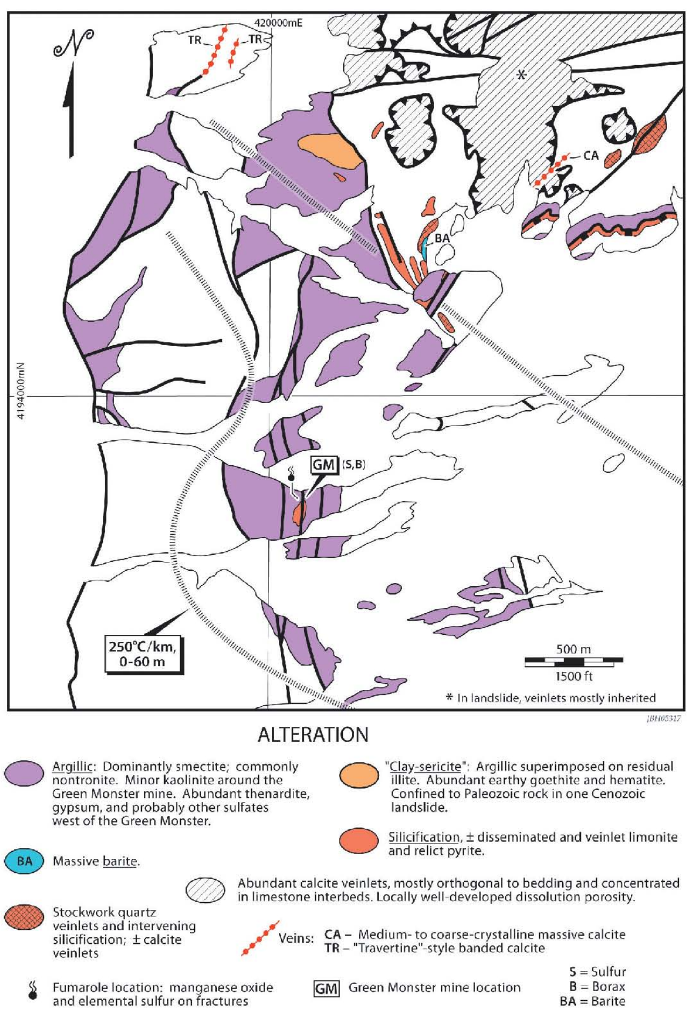

Figure 8. Detailed alteration and mineralization map of the interior of the Emigrant geothermal prospect. Area is the same as Figure 5.

Granodiorite lithons and dissected dikes/sills in the Palmetto Formation are invariably hydrothermally altered. The alteration ranges from propylitic, the most typical, to clay-sericite with limonitic quartz and/or calcite veinlets. The propylitic alteration, which includes minor epidotization of mafics and feldspars, is seemingly out of equilibrium with that prevailing in surrounding rocks (where there is no shortage of calcareous lithologies for the calc-silicate to replace). This disparity could also indicate that the igneous rocks have been tectonically moved from their original sites of emplacement.

In contrast to the Palmetto, the more structurally intact Emigrant Formation as a whole is more pervasively (but less conspicuously) altered and mineralized. The dominant limestone interbeds are typically cut by abundant grayish to brownish calcite veinlets (Figure 8) that are locally only centimeters apart. These veinlets are mostly orthogonal to bedding, and appear to have formed in fractures created as intervening shale/siltstone layers were stretched, and the limestone itself was brittly ruptured. The limestone and the veinlets have been carbonate-leached locally to form networks ranging from hairline openings to small caverns up to a meter or more in diameter. The dissolution is most extensively developed close to major range-bounding normal faults, like those of the Gator fault zone (Figures 2 and 5). At these locations, the formation can be cavernous and mineralized with goethitic to hematitic limonite, rendering the rock a bright reddish-brown.

Also distinctively reddish, at the prospect and regional scales, are the low-angle fault zones disrupting Miocene ignimbrites (Figures 5, 7 and 8). These fault zones are weakly to moderately silicified, and contain abundant introduced limonite along with local veinlets and breccia cements of black manganiferous carbonate. More densely welded tuffs in the upper plates of these low-angle fault zones are erratically silicified and cut by quartz veinlets with or without disseminated hematite. Weakly welded tuffs in the lower plates of the fault zones are commonly altered to smectite. We speculate that some of this argillic alteration may have preceded and facilitated the widespread low-angle faulting.

Tuffaceous sedimentary rocks (particularly lacustrine mudstones) of the Fish Lake Valley Assemblage are also extensively smectite-altered. Much of the smectite is nontronite, which has weathered to a whitish "popcorn" texture but is actually greenish in cast. The Green Monster mine (Figure 7), in fact, was named for the bright greenish knob from which sulfur was briefly extracted many years ago. Much of the nontronite and other smectite- family clays in these Pliocene sediments could be other than hydrothermal in origin. The poorly consolidated rocks are rich in pumice and ash, components which readily alter to smectite in a low-temperature burial-diagenetic environment (e.g., Wohletz and Heiken, 1992). U.S. Borax geologists believed that the nontronite and spatially associated borax mineralization resulted from the action of contemporaneous thermal springs discharging from beneath and into the sediments as they accumulated. In a case like this, the distinction between diagenetic and hydrothermal is blurred.

Just west of the Green Monster, even the Plio-Pleistocene fanglomerates are uncharacteristically but intensely argillized (Figures 5 and 7). In this region, the clay-altered material also contains some kaolinite as well as thenardite, gypsum, and probably other hydrous sulfates. It seems likely that the formation here has been affected by low-temperature acid-sulfate leaching and incipient, advanced argillic alteration (e.g., Schoen and White, 1968; Schoen et al., 1974).

Several thick (i.e., mappable at 1:4000) hydrothermal veins crop out within and just north of the Emigrant prospect (Figures 5 and 8). A calcite vein near and parallel to the Sorrel fault zone is massive, medium- to coarse-crystalline, and probably unrelated to the modern geothermal system. However, delicately-banded, "travertine"-style calcite veins cutting young fanglomerate in the northwest corner of the prospect are of the sort commonly found at shallow depths beneath calcareous spring deposits. Texturally identical veins in the Emigrant Formation just north of the map area are up to 0.5 km long and 5 m or more in thickness. These enormous veins occur in proximity to AMAX borehole 213 (Figure 2), which had the highest temperature at the shallowest depth (51°C at 32 m) yet recorded in the Emigrant area.

Geologic logs for many of the prospect's shallow borax-exploration and thermal-gradient holes record locally intense hydrothermal alteration and mineralization at depth. Of particular interest in this regard is the log for borehole 211 (Hambrick, 1985) near the Green Monster mine (Figures 2 and 3). This hole reportedly encountered intensely silicified and pyritized tuff, tuffaceous siltstone, and sandstone between 195 m and the 296 m total depth (Hambrick, 1985). Pyrite was estimated to account for 5-10 vol.% of this interval, which also featured abundant "black stringer" and "SiO_2" veinlets. The cuttings for this and the other Emigrant boreholes were discarded long ago, but from the written descriptions it seems likely that the alteration and mineralization in borehole 211 could be genetically related to the active Emigrant geothermal system. Bolstering this assertion is the fact that the altered and mineralized interval hosted all three of the borehole's minor thermal-fluid entries. Hot water from these entries was geochemically analyzed to provide what few clues we have to the nature of fluids circulating deeper in the geothermal system.

Thermal-Fluid Geochemistry and Geothermometry

There are no thermal springs within the Emigrant prospect area, but unambiguously indigenous hot-water samples were collected from boreholes 211 (see above) and 112 (Figure 2).

Table 1. Chemistry and geothermometry of hot-water samples from two shallow boreholes in the Emigrant geothermal prospect (from Pilkington, 1984; as reproduced in Deymonaz, 1984).

	Borehole 112	Borehole 211
Temperature (°C)	72	96
Collection depth (m)	238	123
Flow rate (liters/minute)	400	240
pH	8.5	8.7
Constituent and concentration (ppm)		
Cl	680.0	1310.0
F	8.8	9.2
SO_4	391.0	324.0
HCO_3	500.0	161.0
CO_3	3.0	67.0
SiO_2	203.0	168.0
Na	1012.0	1078.0
K	29.0	104.0
Ca	105.0	28.5
Mg	64.0	9.1
Li	6.4	4.3
B	133.0	33.6
TDS (ppm)	3135.2	3296.7
Geothermometry		
T, SiO_2 (quartz), °C	169	158
T, SiO_2 (chalcedony), °C	160	146
T, Na-K, °C	129	214
T, Na-K-Ca, °C	135	211
T, Na-Li, °C	213	169
T, Li, °C	231	213

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These samples were analyzed for major and selected minor chemical components (Table 1; Pilkington, 1984). Hot water at 96°C from borehole 211 was collected by airlifting from a depth of 123 m (water level) at a rate of 240 liters per minute. The corresponding parameters for borehole 112 were: 72°C, 238 meters, and 400 liters per minute.

The two samples, collected from boreholes 5 km apart, were nonetheless similar geochemically. The sample from borehole 211 was a dilute (~0.3 wt.% TDS) sodium-chloride-sulfate-bicarbonate fluid with a pH of 8.7 (Table 1). A wide variety of chemical geothermometers (Truesdell, 1985) indicated subsurface equilibration temperatures for this fluid ranging from 146°C to 214°C; the quartz and chalcedony geothermometers, respectively, suggested reservoir temperatures of 158°C and 146°C. The deeper but cooler sample from borehole 112 was similarly alkaline but contained less chloride and more bicarbonate than the one from 211. Chemical geothermometry for this sample ranged widely from 129°C to 231°C, with the quartz and chalcedony geothermometers indicating, respectively, 169°C and 160°C.

It seems unwarranted to cede too much weight to these two shallow-water analyses in formulating an appropriate conceptual model for the Emigrant geothermal system. The chemistry would seem to point to a moderate-temperature system at depth, but since mixing cannot be discounted, higher subsurface temperatures are also distinctly possible. More and deeper thermal-fluid samples will be required to test these provisional possibilities, and retrieval of those samples must await implementation of Phase 2 drilling. In the meantime, integrated geological, geophysical, and shallow-temperature data collected from the prospect to date suggest strongly that the planned drill hole stands an excellent chance of discovering a viable geothermal resource at depth.

Discussion and Conclusions

Overview

The Emigrant prospect's high shallow conductive thermal gradients must be tied to one or more convectively upwelling hot-water plumes. Otherwise, extrapolated to depth, the gradients would correspond to unrealistically high subsurface rock temperatures. The plumes must exist, so the key question becomes: Are the upflows hot enough, sufficiently transmissive, and supported by a large enough reservoir volume to sustain commercial geothermal power production? The bulk of the evidence gathered to date suggests that the answer is yes.

Reservoir Temperature

Apart from the limited geothermometry, we can gain some perspective on likely deeper reservoir temperatures at Emigrant by projecting the measured shallow conductive thermal gradients through a realistic caprock thickness. As a very rough first approximation, we can assume that the cap consists mostly of argillized Pliocene sediments. The thickness of this relatively low-density sequence should in theory match the "depth-to-dense rock" calculated by geophysicist John Maas (in Ciancanelli et al., 2003) by inverting data from his high-precision gravity survey of the prospect.

Along the axis of the Emigrant thermal anomaly, the estimated depth to dense rock ranges from nil to ~400 m (Figure 9). We assume for this exercise that the thicker portions of the cap will govern the shallowest reservoir temperatures. Projecting the core of the anomaly's "typical" conductive thermal gradient (for borehole 118) down to 400 m depth yields a temperature of ~150°C at the *top* of an upwelling plume. A thermal gradient intermediate between those of boreholes 118 and 211 would increase the plume-top temperature to ~175°C. This temperature range is compatible with that predicted by silica geothermometry. However, we reiterate that a more rigorous assessment of subsurface reservoir temperature at Emigrant can only be accomplished through deeper drilling and fluid sampling.

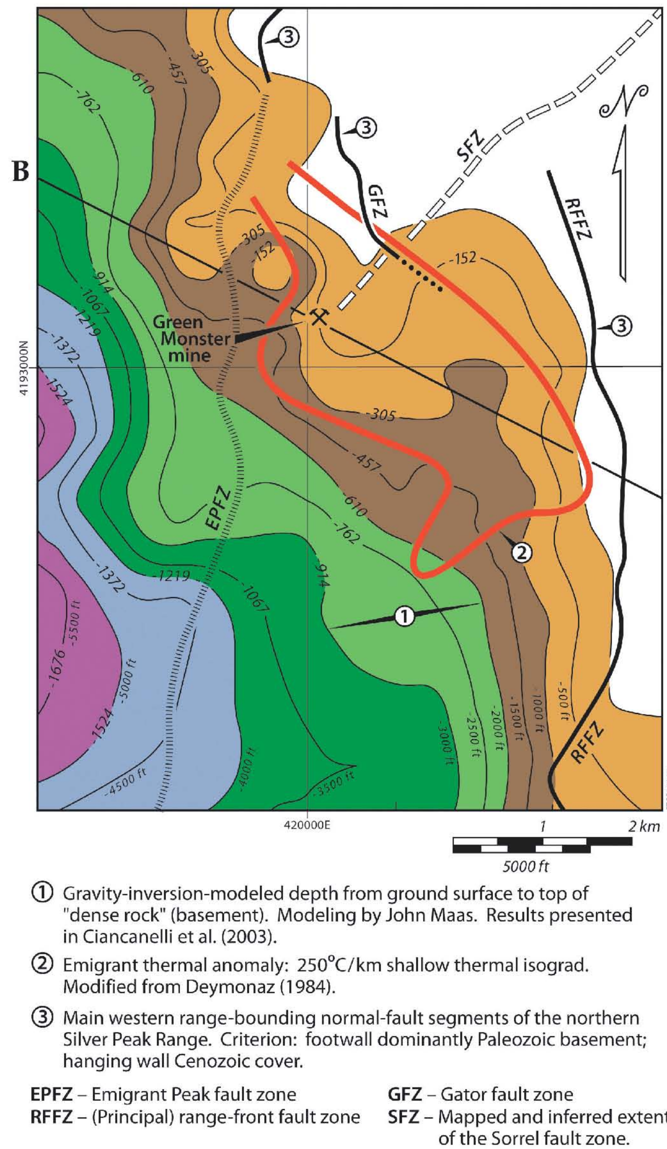

Figure 9. Map of the Emigrant prospect and vicinity, showing the surface traces of major, moderate- to high-angle fault zones relative to (1) the nucleus of the shallow thermal-gradient anomaly and (2) the gravity-modeled depth to "dense rock" [i.e., the basement]. Map area is the same as in Figure 2. Depth modeling by inversion of high-precision gravity data (by John Maas, in Ciancanelli et al., 2003). Note that in general the estimated-depth contours and the trend of the thermal anomaly bear no apparent spatial relationship to the locus of modern tectonic activity, the Emigrant Peak fault zone. The anomaly instead appears to be controlled by the northwest-left-stepping configuration of "major" range-bounding normal faults (Paleozoic basement to the east; Cenozoic cover to the west) at the western margin of the Silver Peak Range. Similar control of "deep-circulation" geothermal systems in northwestern Nevada has been documented by Faulds et al. (2003, 2004).

Permeability Architecture

The elongate shape of the Emigrant thermal anomaly (Figures 2 and 8), in this geologic setting, strongly suggests that the feature is fault-controlled. Somewhat surprisingly, the anomaly bears no obvious relationship to the locus of modern tectonic activity, the Emigrant Peak fault zone. Instead, the anomaly follows a northwest-left-stepping progression of "major" range-bounding fault segments (that is, Paleozoic basement on the east; Cenozoic cover on the west) along the western margin of the northern Silver Peak Range. Of these segments, the axis of the anomaly mimics most closely the trend of the Gator fault zone (Figures 2, 5, and 9). Alignment of the thermal anomaly's minor axes and protuberances suggests that the north-to-northwest-trending major range-bounding fault segments are offset to the left along deeply-penetrating, northeast-trending faults like those of the Sorrel fault zone. This left-stepping fault geometry, though differently oriented, is essentially the same as that documented by Faulds et al. (2003, 2004) as governing the location of numerous "deep-circulation" geothermal systems (for example, Brady's and Desert Peak) in northwestern Nevada.

This is not to say that the prospect's northerly-trending faults have no influence at all on thermal-fluid ascent. Clearly, for example, the north-trending faults of the Green Monster fault zone provide channels for hot fluids like those tapped in borehole 211.

Although deep-seated structural controls at Emigrant may be northwest- and northeast-oriented, the shallower, northerly-trending, ancillary conduits could host the commercial- quality hot-water entries most readily reachable by the depth-limited Phase 2 drill hole.

Still, the best of these shallower entries will clearly be hydrologically tied to the principal conduits at depth. Therefore, we believe that the most favorable initial (intermediate-depth) drilling target at Emigrant should be (1) in the heart of the shallow heat anomaly; and (2) at or near the juncture of a recently altered and mineralized northerly-trending fault zone with one or both of the prospect's two other principal (and deeply-penetrating) fault sets. With these guidelines, a good choice would be the intersection of the Green Monster fault zone with the southwesterly projection of the Sorrel zone (Figures 5 and 9). There are other promising targets, but we believe the one cited is most likely to produce a discovery within the Emigrant project's practical and financial constraints.

A Conceptual Model

A geohydrologic model featuring our favored initial drilling target beneath the Green Monster mine is presented as Figure 10. According to the model, thermal waters heated by deep circulation buoyantly ascend along the Gator fault zone, the lengthier "principal" range-front fault zone that breaches the surface to the east, and the Mineral Ridge detachment, that is, the gently-dipping low-angle fault zone between the upper and lower plates of the SPLM core complex. The rising fluids focus and accelerate upward at the Sorrel-Green Monster, Sorrel-Gator, and other major fault intersections. Beneath an impermeable caprock consisting principally of argillized Pliocene sediments, the fluids advect subhorizontally along subsidiary conduits ranging from carbonate-dissolution channels to flower structures in low-angle fault zones disrupting Miocene ignimbrites. Modern recharge for the system could emanate in part from (1) the Silver Peak range to the east; and (2) the lofty (>4000 m) White Mountains bordering Fish Lake Valley on the west. Over the productive life span of the geothermal system, however, such real-time recharge will surely be minimal. In common with other geothermal systems in the Great Basin, the bulk of the deeper thermal water at Emigrant will likely be "fossil" and older than 10,000 years (Flynn and Buchanan, 1992).

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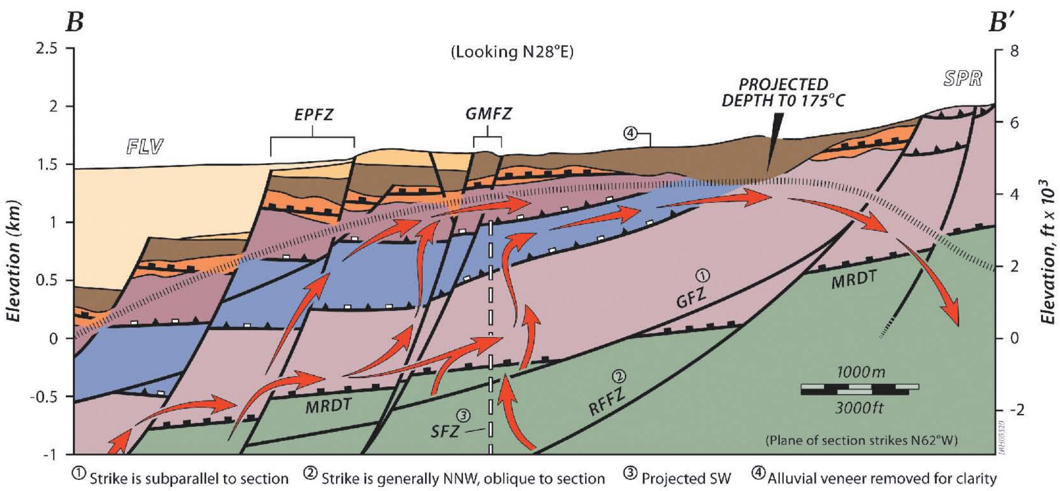

Figure 10. Conceptual geologic model of a moderate- to high-temperature convective geothermal system circulating beneath the heart of the Emigrant shallow thermal-gradient anomaly (Figures 2 and 9). Red arrows schematically portray potential thermal-fluid pathlines. At the center of this section is the drilling target considered by us as optimum for penetrating, in the depth range 900-1300 m, the upper reaches of a commercially producible, moderate- to high-temperature geothermal upflow plume. The target encompasses (1) major fault intersections involving the Green Monster, Gator, and Sorrel fault zones (Figures 2, 5, and 9); (2) the only modern geothermal surface manifestations, including a native sulfur deposit; and (3) the borehole with the second-highest shallow thermal gradient on the prospect (No. 211, at 700°C/km; Figure 3). EPFZ – Emigrant Peak fault zone; FLV – Fish Lake Valley; GFZ – Gator fault zone; GMFZ – Green Monster fault zone; MRDT – Mineral Ridge detachment; SFZ – Sorrel fault zone; SPR – northern Silver Peak Range. Rock units and symbols same as for Figure 5.

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