FIELD TRIP NO. 2
ROAD-LOG

BRADY'S HOT SPRINGS, DESERT PEAK and RYE PATCH (Humboldt House)

September 26, 2002

Geothermal Resources Council
2002 Annual Meeting
September 22 - 25, 2002
Reno Hilton Hotel & Casino
Reno, Nevada

2002 GRC Field Trip No. 2
Reno – Brady's – Desert Peak – Rye Patch (Humboldt House)

MILE DESCRIPTION

0 Leave Hilton Hotel proceed to 395 north to I-80 East

6.5 Vista Exit. This is the eastern-most part of the Truckee Meadows. The U. S. Corps of Engineers deepened the river channel in this area to lessen flood damage and to lower the watertable. It apparently didn't work as planned as evidenced by the flood of January 1997.

Ahead is the canyon that the Truckee River has cut through the Virginia and the Pah Rah Ranges. The Pah Rah Range is north of the river and the Virginia Range is to the south. In a very general way, this range is a large syncline. At both ends of the canyon, metamorphosed volcanic and sedimentary rocks of the Triassic and/or Jurassic Peavine Sequence are exposed. Progressively younger volcanic rocks are found towards the central portions of the Virginia Range near the freeway. The volcanic rocks range in composition from basalt to rhyolite and their origin varies from intrusive plugs to ash-flow tuffs and extensive lava flows. The age of the volcanic rocks ranges from Oligocene (27 m.y., million years) to Pleistocene (3 m.y.).

The Truckee River existed before warping and faulting uplifted the Virginia Range. As uplifting took place, the river apparently downcut at the same rate, and no deep lake was formed in the Truckee Meadows area where Reno and Sparks are located. The Truckee River has its origin above Lake Tahoe and empties into Pyramid Lake. The river is about 100 miles (160 km) in length.

The Truckee River Canyon has been used since the days of the 49ers as one of the main transportation routes to and from California. The first transcontinental railroad, the Central Pacific (formerly the Southern Pacific and now the Union Pacific Railroad) follows the canyon.

11 Mustang Exit. Nevada's premier pleasure palace, the Mustang Ranch used to be across the river in Storey County. Pleistocene basalt and andesite flows in this area cover Miocene volcanic and sedimentary rocks.

15.5 Large industrial building across river, to the south, is the Kal Kan dog and cat food plant.

16 On the south side of the freeway is Sierra Pacific Power Company's Tracy Power station. The original plant came on-line in 1963 and had an initial capacity of 250 mega watts from conventional gas fired steam turbines. Today, this facility contains eight generating units ranging from 108 to 11 megawatts, totaling 534 megawatts. The larger units are standard natural gas steam turbines and the Pinon Power plant is a coal gasification unit. The smaller, 11-megawatt units are combustion turbines. The large geodesic dome on the westside of the facility is to store coal. Six gas combustion turbines have been added for peaking power. These units are very inefficient and were used for only 200 hours last year.

17.8 The two, high voltage power lines crossing the highway are 345,000 volt each and intertie with the North Valmy coal-fired generating facility near Battle Mountain, Nevada, some 150 miles (245 km) to the northeast. This line is also an intertie with Idaho Power, which is a partner with Sierra Pacific Power in the North Valmy facility.

19.6 On you right is Eagle-Pitcher Industries diatomite plant. The open-pit mine is located about 6 mile (10 km) to the east and will be visible later. Diatomite (diatomaceous earth) is the white, glassy skeletal remains of microscopic organisms that lived in shallow Tertiary age fresh water lakes. When the organism dies the test (shell) falls to the bottom of the lake and under favorable conditions form economic deposits. It is used extensively as an absorbent, filter material, insulation and as an inert filler in many consumer products. The crushing, drying and air-classification sections of the plant produce mostly absorbents and fillers for domestic and foreign consumption.

23 Thisbee-Derby Dam. Derby Dam was constructed in 1913 to divert a portion of the Truckee River flow into the Newlands Project, which carries the water to Lahontan Reservoir for storage and subsequent use as irrigation water in the Fallon area. This was the first Bureau of Reclamation project to convert desert into viable agricultural land. It has had its environmental impacts. The dam and spillway are currently undergoing moderization.

24.6 High up at 2:00 are waste dumps at the Celatom mine which supplies the raw diatomite which is processed in the Eagle-Pitcher Plant at Clark station. The white band on the canyon will to the south is volcanic ash and tuff, not the diatomite bed.

26.6 Painted Rocks. The rocks exposed in the road cuts are Early to Middle Miocene ash-flow tuffs which uncomformably overlie Mesozoic rocks. Note the thinly laminated lake sediments partially filling the gullies

30 The remains of a stamp mill can be seen on your left along the base of the low hills. The mill was economically unsuccessful due to inadequate ore reserves in the near-by Olinghouse district and only operated for three months in 1907 and 1908.

31.5 Truckee River Bridge. For the pioneers on the California Trail the Truckee river marked the end of the terrible Forty Mile Desert. From this point, the river flows 19 miles (32 km) north where it empties into Pyramid Lake.

32.8 Fernley Exit. On your left is Nevada Cement Company. The limestone used in the plant is mined from late-Tertiary-age fresh water limestone deposits located south of Fernley.

35.2 Ahead lies the famous Forty Mile Desert. For forty miles there is no potable water. The freeway closely follows the Truckee River route of the California Trail. The Donner party passed this way in 1846 on their way to an historic encounter with the Sierra Nevada. This was truly rough country to travel in the mid 1800's. When Mark Twain passed this way, he reported there were 3000 abandoned wagons with $3,000,000 of abandoned property and one could walk almost the entire 40 miles on the carcasses of oxen.

To the left of the freeway lies the Truckee Range. The visible part of this range is composed of basalts from two or three large shield volcanoes which are five to seven million years old.

To the right of the freeway, the hills across the Alkali Flat are the southern part of the Hot Springs Mountains. These hills are composed of Tertiary basaltic rocks and some interbedded lacustrine sediments. Note the well developed shorelines which represent various stages of Lake Lahontan. Hazen Hot Springs are located near the south end of this range.

38.0 The power line crossing the highway is an 800,000 volt DC line that runs from the Dalles hydroelectric station located on the Columbia River to Sylmar, California, near Los Angeles where the electrical power is converted into AC power for distribution by Los Angeles Department of Water and Power.

46.2 To the right of the freeway lie the old vats of the Eagle Marsh Salt Works. The Eagle Marsh Salt Works probably produced over 500,000 tons of salt for use in treating ores from Virginia City and Humboldt County between 1870 and 1915. It is reported that on a good day one acre of vats could produce ten tons of salt. The brine came from springs located across the valley. These springs have essentially the same chemistry as water from the Desert Peak geothermal wells. The chemistry and temperature data in the area conclusively show that salt was the first commodity to be commercially extracted from the Desert Peak geothermal reservoir.

51.8 Leave the highway at the Hot Springs - Nightingale Exit and proceed east.

52.3 Geothermal Food Processors Plant: Continue east past the plant. This plant, which is the first U.S. vegetable dehydration plant to utilize geothermal energy, was dedicated on November 3, 1978. Water at approximately 270°F is passed through a heat exchanger; the resulting warm air is used to dry vegetables. Onions are the main vegetable processed here.

52.5 STOP 1 - BRADY'S HOT SPRINGS.

Tour Brady's Geothermal Power Plant

Board bus for trip to Desert Peak Geothermal Plant

58.1 The brick building contains support equipment for a transcontinental telephone cable which crosses the area.

60.1 Well 29-1 is located on the left side of the road.

61.6 Well B21-1, the discovery well, is located on the left side of the road.

62.3 STOP 2 - DESERT PEAK CONFIRMATION WELL (B21-2)

Discussion of Desert Peak geology and drilling. Most of this discussion has been published by the Nevada Bureau of Mines and Geology as Bulletin 97, Discovery and Geology of the desert Peak Geothermal field – a case history: W. R. Benoit, J. E. Hiner, and R. T. Forest (1982), 82 p., 14 Plates.

Board bus for return to the Ormat Power Plant at Brady's Hot Springs – STOP 3 LUNCH

BRADY'S HOT SPRINGS TO RYE PATCH (HUMBOLDT HOUSE)

Taken in part from a GRC Field Trip Log by W. L. DESORMIER May, 1983

MILE

0 Start – Brady's Hot Springs to Rye Patch (Humboldt House) - Hot Springs - Nightingale Exit, Interstate 80.

4.3 The building on the right produces cat liter from low-grade diatomite deposits on both sides of the freeway. This diatomite is part of the Truckee Formation of Pliocene age. The mountains to the left of the freeway are the Trinity Mountains. These mountains consist of metamorphosed volcanic and sedimentary rocks of Mesozoic age overlain by Tertiary volcanic rocks.

8.3 The large valley to the right of the freeway contains the Carson Sink. This is the largest valley in northern Nevada. The Carson and Humboldt Rivers drain into this area from the crest of the Sierra Nevada and from north-eastern Nevada. Tufa mounds deposited in and around Pleistocene Lake Lahontan are visible in this area, on both sides of the freeway.

16.1 The West Humboldt Range is located to the right of the freeway. This small but steep range consists predominantly of calcareous siltstone, shale, and argillite of the Auld Lang Syne Group of upper Triassic and lower Jurassic age. The hills at the southwest end of the range are called the Mopung Hills. Mopung is an Indian word for mosquito. The mosquitos must have been fierce here before the water was diverted for irrigation upstream. The brightly colored rocks in the Mopung Hills are rhyolitic ash-flow tuffs, which are equivalent to those overlying the Desert Peak geothermal reservoir and those exposed at Painted Rocks in the Truckee River canyon. The Mopung Hills also contain exposures of gabbroic rocks from the very large Jurassic Humboldt Lopolith.

28.4 Toulon. The large building is the shell of a mill which treated ores from the tungsten mines at Nightingale. The layered units high in the Trinity Range are welded tuffs from the Early Pliocene eruptive center called Ragged Top.

39.0 Lovelock, Nevada: Population 2,880, Elevation 3,980 feet. Lovelock was a rest stop on the Emigrant Trail to California. A large meadow in the vicinity was used as feed for the oxen and fresh water was carried in everything available, since this was the last stop before the dreaded Forty Mile Desert. Lovelock now serves as a supply center for the agriculture and mining industries.

46.5 On the right about one mile up the alluvial fan is a large drill pad. This is where Getty Oil Company drilled a non-commercial geothermal well to a total depth of 7965 feet. The maximum reported temperature is 282°F at a depth of 7064 feet.

47.5 Colado Siding. To the left of the highway is the northern part of the Trinity Range, which consists mainly of granitic intrusives, metasedimentary rocks of the Auld Lang Syne Group and Quaternary-Tertiary volcanics. On the left side of the highway is another Eagle-Picher diatomite plant. Some of the largest diatomite mines in Nevada are located in Pershing County. A warm well is located near the diatomite plant. The Humboldt Range is to the right of the highway and consists mainly of Mesozoic carbonates and clastics, Quaternary -Tertiary volcanics, and some granitic intrusives. The rocks in this area were subjected to large-scale folding, thrust faulting, volcanism, and Basin and Range faulting. Several of the thrust faults are well exposed in this range.

The abundant and diverse mineralization in the Humboldt Range consists of tungsten, copper, gold, silver, mercury, lead, antimony, tin and fluorspar. Approximately $35 million dollars in tungsten ore was produced 1936 to 1956 in Pershing County.

54.7 Oreana. Ahead and to the right is one of the granitic intrusives of the Humboldt Range. The Canyon is aptly named Rocky Canyon. Tungsten, silver, lead and antimony came from Rocky Canyon and Rochester in the Humboldt Range (to the right of the highway) and from Arabia in the Trinity Range (to the left of the highway).

64.2 Rye Patch Interchange. This is the entrance to the Rye Patch State Recreation Area. The dam across the Humboldt River was built by the Bureau of Reclamation to provide irrigation water in the area around Lovelock.

Rye Patch Reservoir has a capacity of approximately 180,000 acre-feet. The water is used almost exclusively to irrigate about 44,000 acres of land in the Lovelock area. Irrigation wastewater and any other Humboldt River flow below the dam ultimately discharge into the Carson Sink.

The range to the east is the Humboldt Range. The highest point in the range is Star Peak at 9834 feet. The Humboldt Range consists primarily of Mesozoic sedimentary and volcanic rocks. These rocks have been highly deformed by normal faulting, thrust faulting and folding and have undergone low--grade regional metamorphism.

66.6 To the right of the highway is the Standard Gold Mine. Leaching on a small scale was conducted here a few years ago.

68.5 To the right of the highway is Phillips Petroleum Company's Campbell E-l drill pad and reserve pit.

69.6 To the immediate right of the highway is a road going up the alluvial fan. This is the access road to Phillips Petroleum Company's Campbell E- 2. The drill pad and reserve pit are about 1-1/2 miles up the alluvial fan but are not easily visible from the highway.

72.3 To the right of the highway in the lowermost hills is a large area of argillic alteration. This altered area has been explored by numerous drill holes and was the site of a small leaching operation several years ago. Just below the altered rocks is Union Oil Company's Campbell Number 1 drill pad and reserve pit.

77.7 STOP 4. RYE PATCH (HUMBOLDT HOUSE) GEOTHERMAL SYSTEM

Geothermal
Resources Council

Field Trip #2
Post-Meeting
September 26, 2002

An Introduction to

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Marrakech, Morocco
November 2001

Thomas Becker, Chair
Climate Technology Initiative

Historic Brady Hot Springs

Weary Pioneers Loved

Pop's springs

The Nevadan
4/14/1974

by Katherine Gehm

If you're in the right place at the right time, with something somebody wants, you've got it made. That's what "Pop" Haver learned back in pioneer days when he stopped to rest a spell at the Hot Springs in western Nevada Territory. But the incredible thing about it is, he didn't have it planned. It just happened.

Now, the most dreaded part of anyone's journey from the Mississippi River to the broad Pacific, during gold rush days, was through the Nevada strip known as the Forty-Mile Desert. This trail, over barren sandy wasteland, stretched southwest from where Lovelock is today to the Truckee and Carson Rivers — the golden army's last stop before the long climb over the rugged Sierra Nevada.

The Hot Springs, about midway through this alkali sink land, proved many times to be a curse instead of a blessing when exhausted oxen, scenting moisture in the air, rushed frantically to them. Thirst-crazed animals, not heeding the warning clouds of steam, would plunge into the boiling water and often die from a horrible scalding.

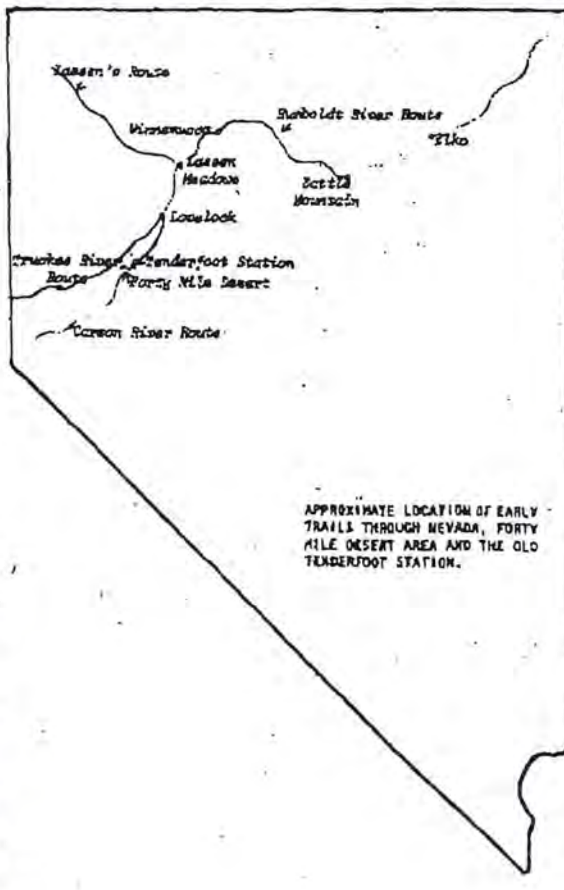
However, in the fall of 1850 when Pop Haver and his oxen barely made it to the Springs, enroute to the gold fields of California, things changed.

Pop decided to rest awhile and let his animals regain strength in the scattered patches of swamp grass and stunted sagebrush growing there. He dug ditches, which formed canals, to cool the boiling water for his livestock. He kept barrels filled not only for himself but for anyone passing through. And with the irrigation system he soon had more forage for the oxen.

One day while Pop was sitting on a bank of a ditch soaking his feet in the refreshing water he got an idea. He immediately got up and went to work. He widened a place in the streamlet. Then, with rocks he formed a sort of natural contour bathtub, even to a headrest.

This proved very satisfactory and here he lazed away many an hour for he had lots of time and the water temperature was ideal. With the swift, soft current flowing over him he lay, cool and comfortable. He could watch the blazing sun cast its weird mirages across the desert flats to nearby Hot Springs Mountains and to distant peaks on farther west. It looked as if trees were suspended from the sky and fabulous rivers were there flowing up instead of down.

Haver built a portable shelter around the contour bathtub for privacy and it proved to a dream come true for travel-weary pioneers. It was quite a celebration when a wagon train pulled in and its members found such luxurious surroundings. Not only could they take a bath, but women even cooked in the hot springs by setting pans of dried fruit and vegetables to float on the boiling water.



APPROXIMATE LOCATION OF EARLY TRAILS THROUGH NEVADA, FORTY MILE DESERT AREA AND THE OLD TENDERFOOT STATION.

But no one stayed very long. Everybody was anxious to get past the bleak expanse of soft sand to untold riches in California. And about the time Pop Haver's oxen were rested and he was preparing to move on, too, another party of gold seekers arrived at the Springs. They told him they were in the greatest rush ever to get over the Sierra before all the mines were exhausted. In their anxiety they offered to swap 70 head of sore-footed oxen, five wagons and their spare goods for Pop's 22 head of trail-ready fresh stock.

Well, Pop simply couldn't resist an offer like that, so he made the deal. After they left he went back to his cool bathtub and relaxed.

But soon another wagon train pulled in, and another and then another. Within a month he'd made several more transactions, and decided the only sensible thing to do was to stay through the winter.

Pop's camp became well known along the Emigrant Trail, and was called "The Tenderfoot Station." Maybe because tender-footed animals were traded for fresh oxen. Or maybe the name applied to inexperienced travelers in the Frontier West.

Anyway, by the spring of 1851, Pop had over 200 head of stock, 20 wagons and more property than he ever dreamed of owning. In fact, he had so many animals he had to start hauling in feed.

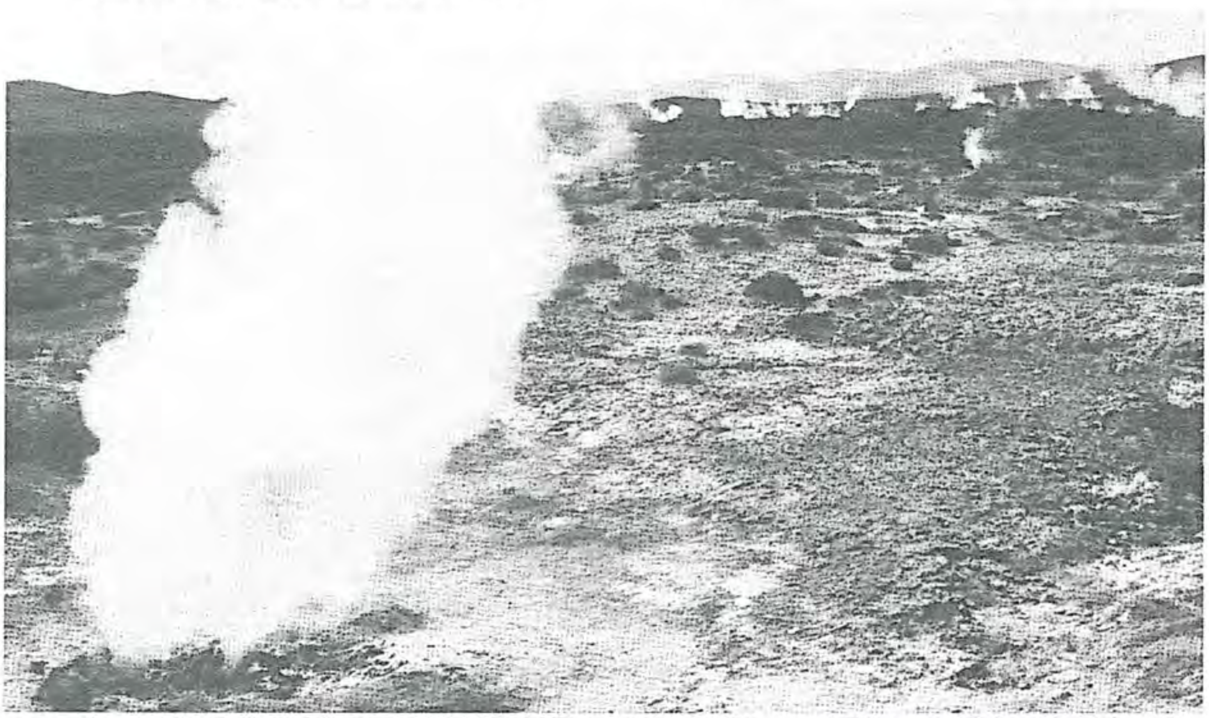
"It just doesn't make sense," Pop said. "I've struck it rich right here on the dreaded Forty-Mile Desert and all the diggin' it took was for ditches. I was sure in the right place at the right time."

Today, the old Tenderfoot Station along the Forty-Mile Strip is known as Brady's Hot Springs. U.S. Highway 40 has replaced the Humboldt Wagon Trail.

Brady Fumaroles 1959

Above: Steam escaping from a fault zone which crossed U. S. Highway 40 approximately 1 mile north of Brady's Hot Springs, Churchill County. This unusual geothermal activity resulted from a well blow-out following drilling in 1959 (photo courtesy Nevada State Highway Department).

Below: Close-up of a steam vent which formed after the well blow-out at Brady's Hot Springs. Other new vents can be seen in the background (photo courtesy Nevada State Highway Department).



From: 1979. Garside, Larry and Schilling, John H. Thermal Waters of Nevada. Nevada Bureau of Mines and Geology, Bulletin 91. University of Nevada, Reno. pp.10.

Brady Hot Springs
Geothermal Facility Information

BRADY HOT SPRINGS GEOTHERMAL FACILITY DESCRIPTION

The Brady Geothermal Project is a 21 MW (rated) double flash geothermal power plant, well field, and related facilities located at Brady's Hot Springs near Fernley in Churchill County, Nevada. Geothermal fluid is produced from the project's geothermal production wells using electrically powered line-shaft well pumps and piped under pressure to the power plant site. The geothermal production well field is currently comprised of the following seven geothermal production wells that are generally located north and west of the power plant site: 27-1, 46-1, 46A-1, 47A-1, 47C-1, 48A-1, and 82A-11.

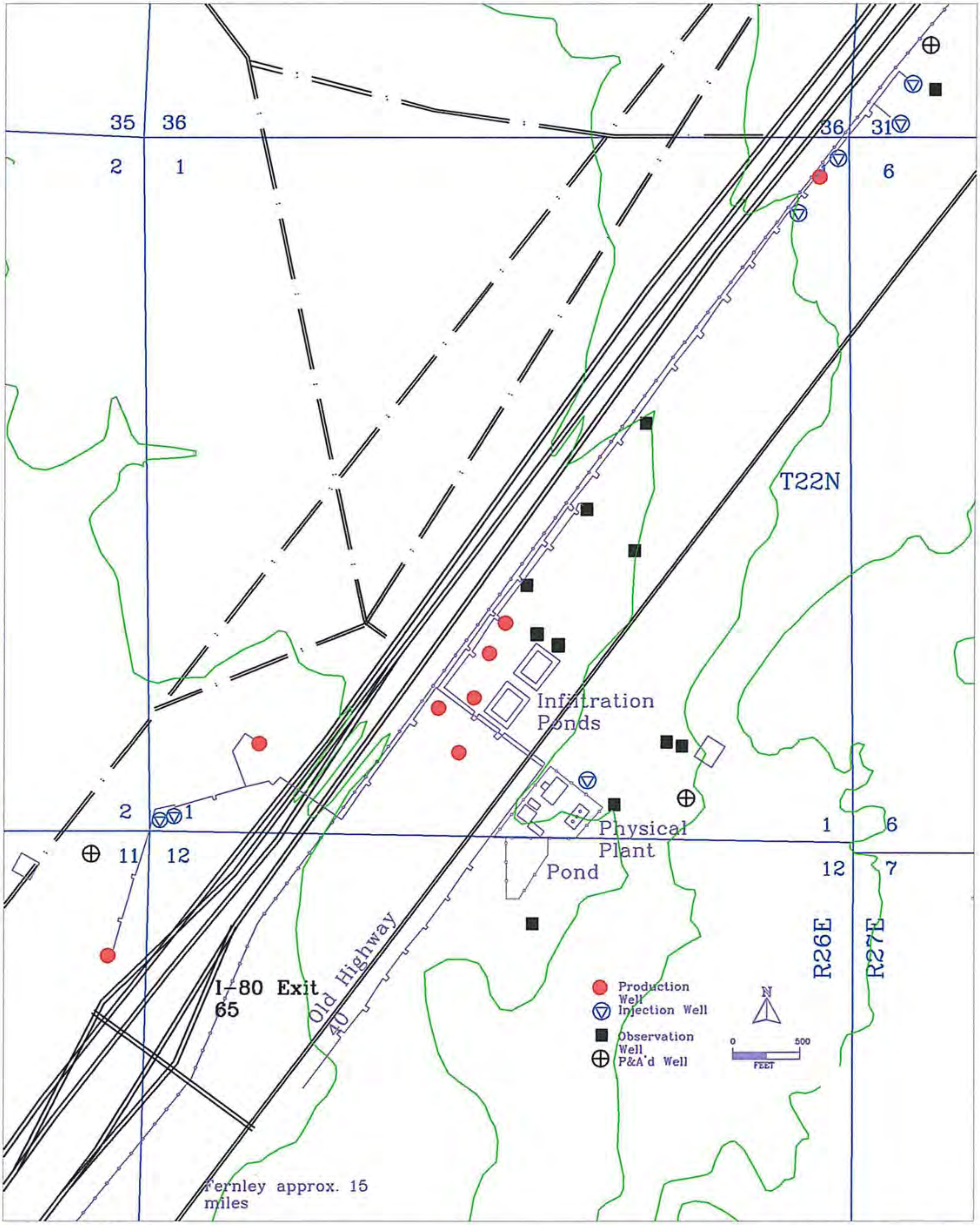
The hot geothermal fluid pumped from the production wells is piped to the power plant where a portion is flashed to steam in two high-pressure flash tanks. The remaining geothermal fluid is piped to a low-pressure flash tank where it is flashed into low pressure steam. Small quantities of chemical anti-scalants may be added to the geothermal fluid to prevent the formation of scale resulting from the changes in temperature and pressure. The high- and low-pressure steam is directed through three steam turbines, each of which is connected to a generator. The fluid from the low pressure separator is pressurized by two injection pumps and is directed to a bottoming binary unit, Ormat Energy Converter (OEC) where heat is exchanged and the fluid is cooled to 180 degrees F. Spent fluid from the binary unit is returned to the injection wellfield via two reinjection pumps.

The geothermal fluid which is not flashed to steam and exiting the OEC in the plant is pumped under pressure through a surface piping system to two spatially separated injection well fields for injection into the geothermal reservoir. The northern injection well field is located generally north of the production well field and is comprised of the following five injection wells: 81A-1, 81B-1, 18B-31, 18D-31, and MGI-2 (located east of the power plant site). The southern injection well field is located approximately four miles south of the power plant site and currently consists of the following four injection wells: 61-25, 73-25, 74-25, and 81-25.

The geothermal steam exiting each of the three turbines is condensed into liquid in separate direct-contact condensers (that is, the cooling water and steam are mixed together in the condenser). The condensate-cooling water mixture is routed to a three-cell forced air cooling tower which cools the circulating water principally through evaporation. Excess cooling water (cooling tower blowdown) resulting from the addition of the steam condensate is injected with the unflashed geothermal fluid into the injection wells. Small quantities of chemical biocides and anti-scalants may be added to the circulating cooling water to prevent the buildup of algae or bacteria or chemical scales which could reduce cooling efficiency.

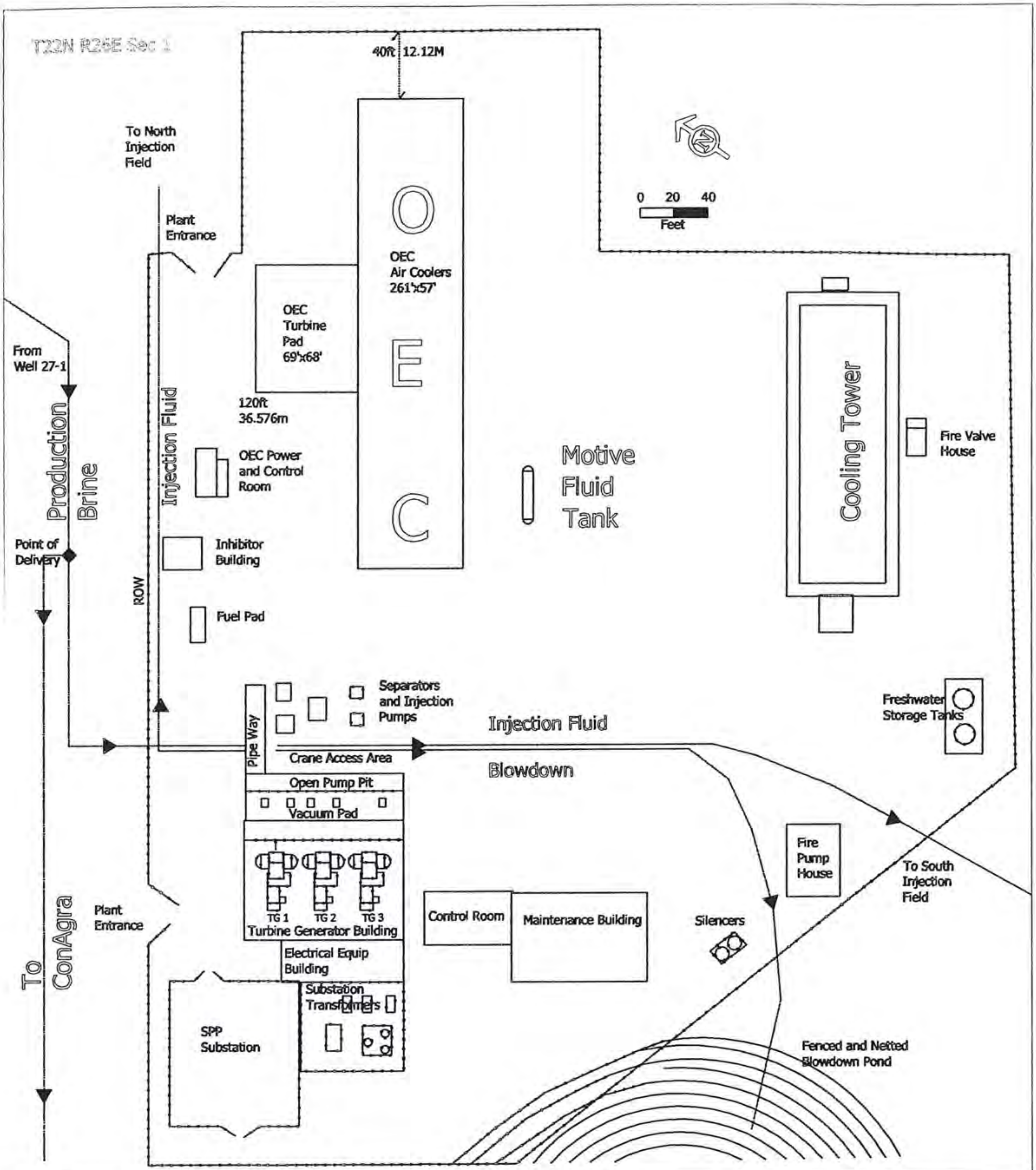
Both the geothermal production and injection wells are periodically or intermittently shut in for various operational purposes. When the production wells are first restarted they are briefly flowed into Pond 1A, which is located immediately south of the power plant site, to clean out any sediment or debris that may have accumulated in the shut in well(s). In addition, any turbine oil which may have accumulated in the well is also discharged with the clean out flow of geothermal fluid into Pond 1A. A drainage line near the bottom of Pond 1A is used to remove excess fluid from Pond 1A to four infiltration ponds located north and west of the power plant site between the Highway 40 and Interstate Highway 80. A commercial oil skimmer is used to remove accumulated oil from the surface of Pond 1A.

Approximately 33 other wells have been drilled for the project within the Brady Power Project area which are being maintained as observation wells. Electricity generated from the plant generators is sold to Sierra Pacific Power Company (Sierra Pacific) and distributed into the local power grid through a short 120 kV electric transmission line which crosses Interstate Highway 80 to tie into Sierra Pacific's 120 kV transmission line.



Brady Plan Map.dwg
Contours 40 ft.
7/02 CLM

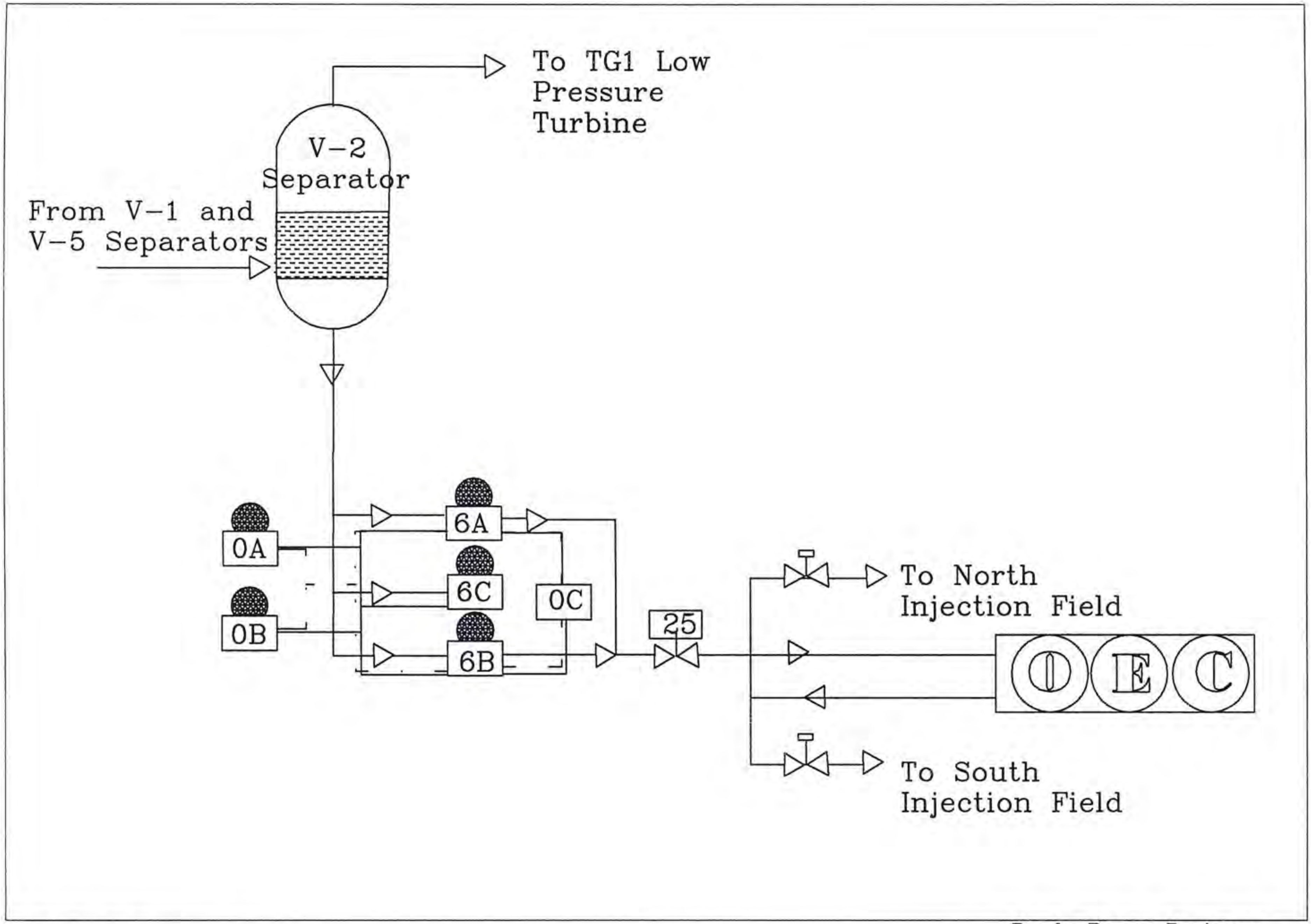
Brady Hot Springs Power Plant
Churchill County, Nevada



BPP Plot Plan.dwg
08-02

Brady Power Partners
Brady Geothermal Power Plant
Churchill County, Nevada

Facility Plot Plan



Not to Scale
OEC Flow Diagram.dwg
08-02

Brady Power Partners
Brady Geothermal Power Plant
Churchill County, Nevada

OEC Flow Diagram

Brady Hot Springs
Geothermal Resource Information

Brady's (Springer's, Fernley) Hot Springs [10]

The hot springs along U. S. Highway I–80 about 20 miles northeast of Fernley have been referred to as Hot Springs, or Brady's, Springer's or Fernley Hot Springs, and are the Emigrant Springs of the Forty-Mile Desert. Some early travelers called it the Spring of False Hope. Coming across the desert, the oxen of the wagon trains could smell the moisture before reaching the springs. However, when they rushed forward to drink, they found the water scalding. The emigrants collected water in casks to cool, but pushed on to the Truckee River, as there was no forage at the springs (Work Projects Administration, 1940).

In the 1880's Russell (1885) reported that hot boiling water issued from a number of orifices, and when these became obstructed, the steam escaped with a hissing and roaring sound. During this same period there was an unsuccessful attempt to separate boric acid from the waters. In later years the hot water was used in a bathhouse and swimming pool which were located at a service station along U. S. Highway 40. The concrete pool, built in 1929, is all that remains today. The pool was apparently supplied by hot water directly from the springs. The hot springs do not flow at the surface today.

Brady's Hot Springs are located in NE/4 NE/4 SW/4 S12,T22N,R26E. Thermal ground water is found within an area of 6 to 8 square miles centered on this location (fig. 4). The elongate thermal area is parallel to the "Thermal Fault" mapped by Anctil and others (1960). Areas of hydrothermal alteration are aligned along this fault, and its trace has also been outlined by areas of observed snowmelt, indicating warm ground (Olmsted and others, 1975, fig. 37). This fault has had recent movement, as it cuts spring sinter and the alluvial fan deposits in the spring area and to the north. The fault is normal and dips steeply to the west, with the downthrown side to the west; the amount of displacement is unknown (Olmsted and others, 1975). All successful steam wells were collared in the hanging wall of the Brady Thermal Fault (Anctil and others, 1960).

The rocks exposed in the vicinity of Brady's consist of Tertiary basalt and andesite, Tertiary sedimentary rocks, Pleistocene lake sediments, and Quaternary alluvial deposits and siliceous sinter (figs. 5, 6). None of the wells drilled at Brady's (up to 7,275 ft. deep) penetrated the pre-Tertiary rocks, although they are exposed in the northern Hot Springs Mountains and were found in steam wells near Desert Peak (see the following section).

Bailey and Phoenix (1944, p. 51) report the presence of cinnabar and sulfur in S6(?),T22N,R27E about one-quarter mile southeast of U. S. Highway 40 and one-half mile east of the hot springs. The best showings of cinnabar are reported from around an active hot-spring vent. The occurrence is in hydrothermally altered tuff. Soil gas in the vicinity of the main Thermal Fault and around active steam vents at Brady's is anomalous in mercury (John Robbins, Scintrex Limited, written communication, 1973).

The spring sinter at Brady's is predominantly opal, and is quite extensive. It is concentrated along the main Thermal Fault and a small subsidiary fault to the east (Oesterling and Anctil, 1962).

The ground water in Fireball Valley (Hot Springs Flat) to the north probably moves as underflow to Brady's Hot

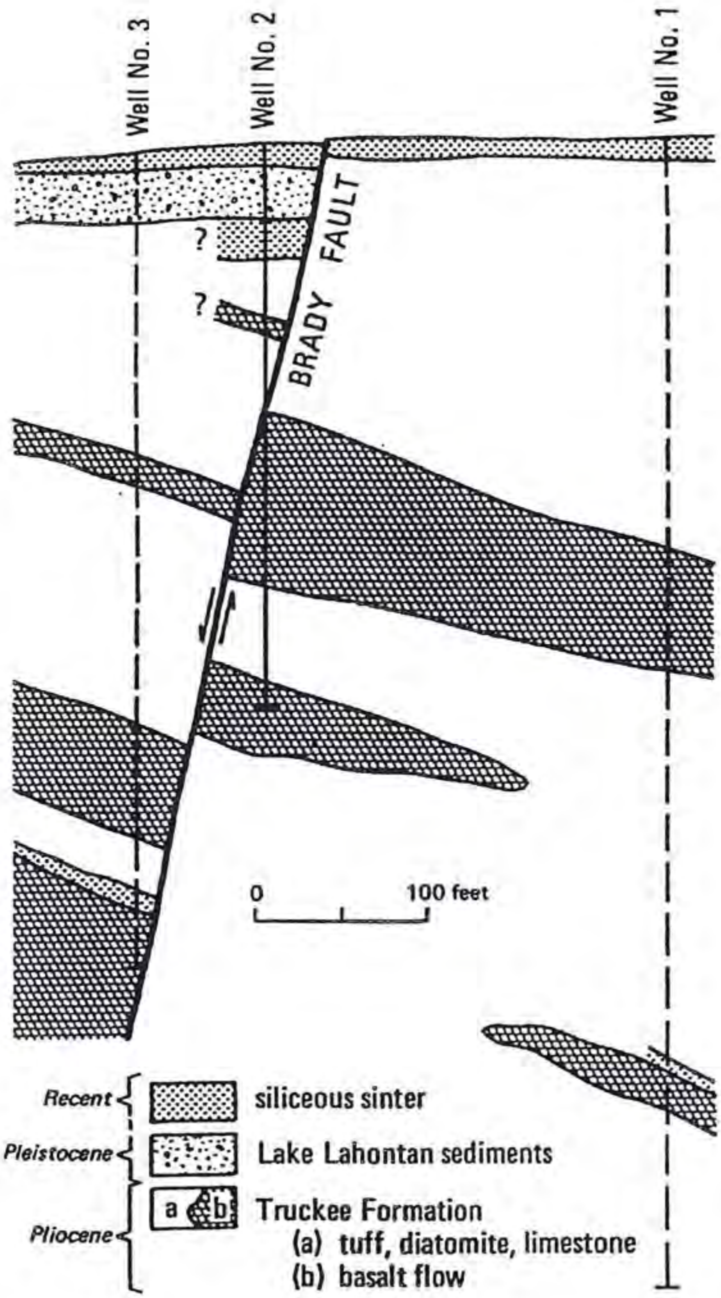


FIGURE 6. Cross section (based on driller's logs), looking north-northeast, at Brady's Hot Springs, Churchill County (after Oesterling and Anctil, 1962).

From
Garside. Larry and Schilling. John H. 1979.
Thermal Waters of Nevada. Bulletin 91
Nevada Bureau of Mines and Geology. Mackey
School of Mines. University of Nevada. Reno. pp 6-8.

Springs, and other ground water may move as underflow from the Fernley area (Harrill, 1970). Olmsted and others (1975) suggest that the recharge of the thermal area could be outside the local drainage area.

Ground-water discharge from the thermal area is in part by evapotranspiration and in part by lateral subsurface outflow toward the south. Prior to the drilling of geothermal wells in the late 1950's and early 1960's (but after diversion of the flow to a swimming pool) White (written communication, 1974 *in* Olmsted and others, 1975) estimated a spring flow of about 20.6 gpm. Waring (1965) reported a larger flow (50 gpm), but White believes that this may be too large. The withdrawal of water during drilling may have caused the springs to cease flowing (Harrill, 1970) and at present all discharge is in the subsurface. The original spring was 180°F (Oesterling, 1962). Boiling water reportedly stands at 20 feet below the surface in one well (Willden and Speed, 1974, p. 55).

Twelve major geothermal wells have been drilled at Brady's Hot Springs over the past 20 years, ranging in depth from 341 to 7,275 feet (see Appendix 2 for details). The temperatures encountered during drilling were up to 418°F, (Koenig, 1971). Following the drilling of Magma Power Co. Brady No. 2 well in 1959 thermal activity spread along the 3-mile portion of the main fault. This activity was probably due to steam escaping through the encased portions of the wells and into the fault zone. Olmsted and others (1975) describe this activity in more detail from data in a 1960 unpublished report by Allen. Tests on several wells shortly after drilling indicated 170,000 to 700,000 lbs/hr of fluid. The well head pressure was 9.5 to 18.0 lbs/in^2 gage (psig) (Middleton, undated report). The steam flashover is reported to be 5% (Koenig, 1971). Calcite is reported to form rapidly in the well bores during flow, requiring reaming of the wells after a short period of time. However, the amount of scaling is reported to decrease after the wells have been produced for some time (Oesterling, 1962). The thermal water at Brady's is of the sodium chloride type, with total dissolved solids from some steam wells reported to be over 2,400 ppm. The silica concentration from a steam well near C S12,T22N,R26E (Harrill, 1970) indicates a reservoir temperature of about 360°F (Olmsted and others, 1975). This seems somewhat low in view of the 400°F + temperatures reported during drilling. Geothermal Food Processors, Inc. of Reno, Nevada have received a $2,836,800 Federally guaranteed loan to construct a geothermal food dehydration plant at Brady's. The Federal guarantee will cover 74 percent of the $3.8 million total cost of the project (Nevada State Journal, October 29, 1977).

——20——

line of equal temperature (°C) at a depth of 30 meters

● 30.2

test hole, number is temperature (°C) at a depth of 30 meters

———— —— ——?——

fault, dashed where concealed, queried where indefinite

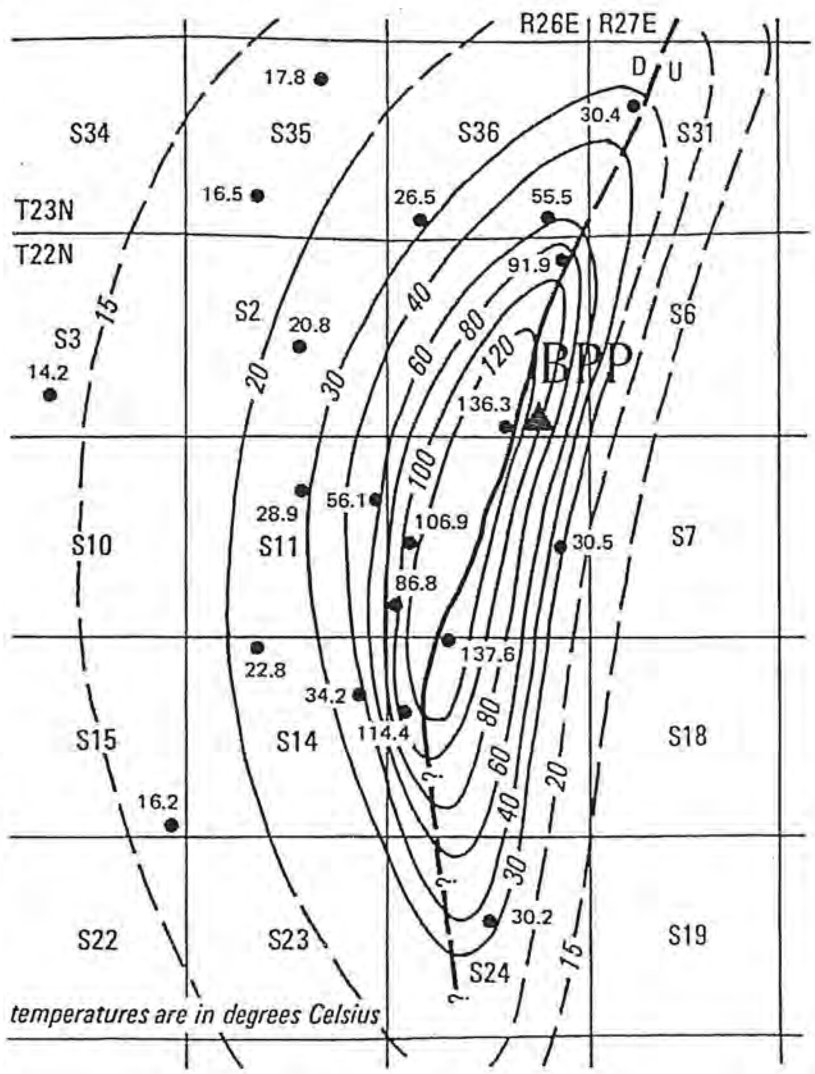


FIGURE 4. Map of Brady's Hot Springs thermal area, Churchill County, showing temperature at depth of 30 meters, 1973 (modified from Olmsted and others, 1975).

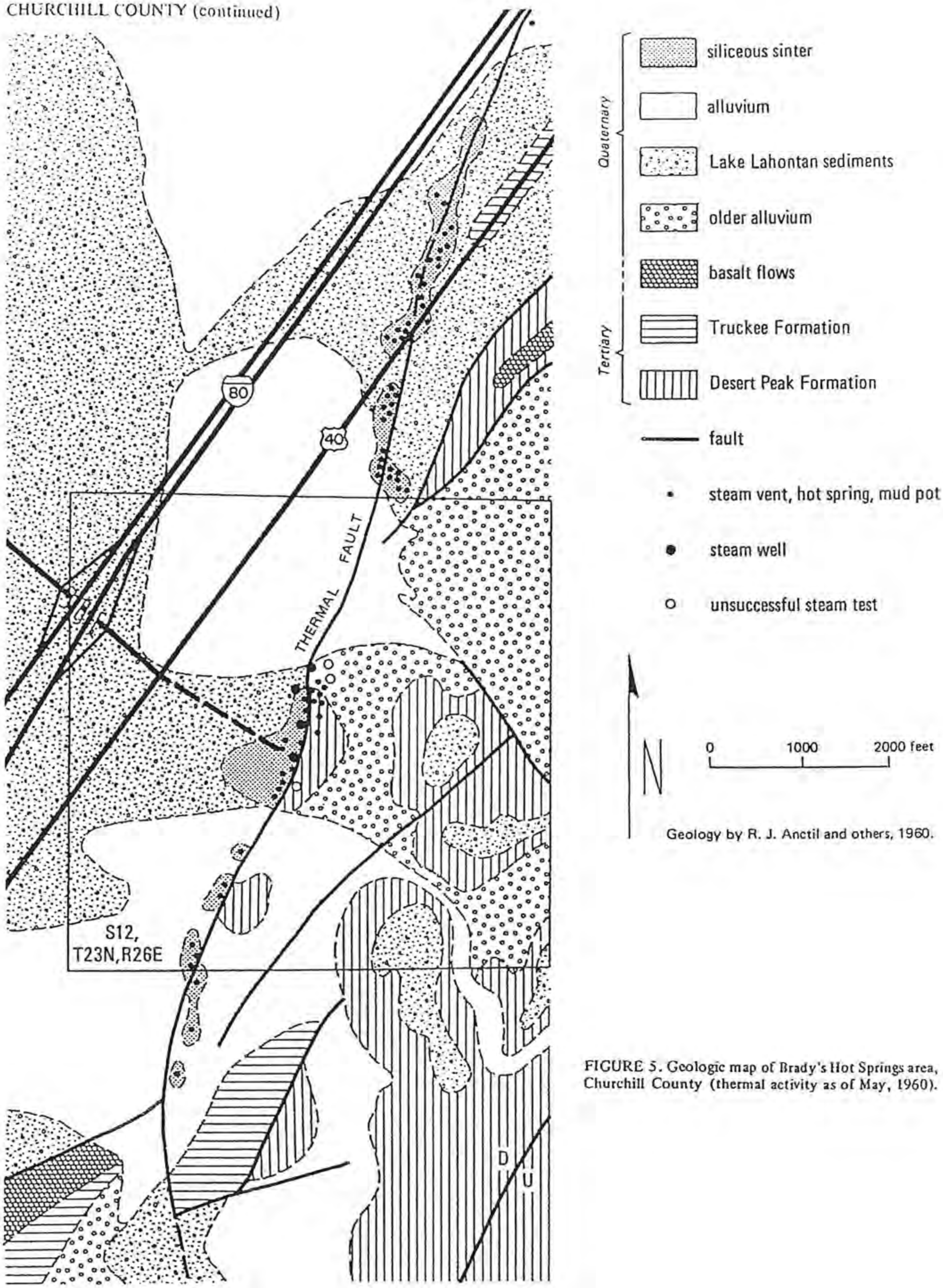


FIGURE 5. Geologic map of Brady's Hot Springs area, Churchill County (thermal activity as of May, 1960).

Desert Peak
Geothermal Facility Information

DESERT PEAK GEOTHERMAL FACILITY DISCRIPTION

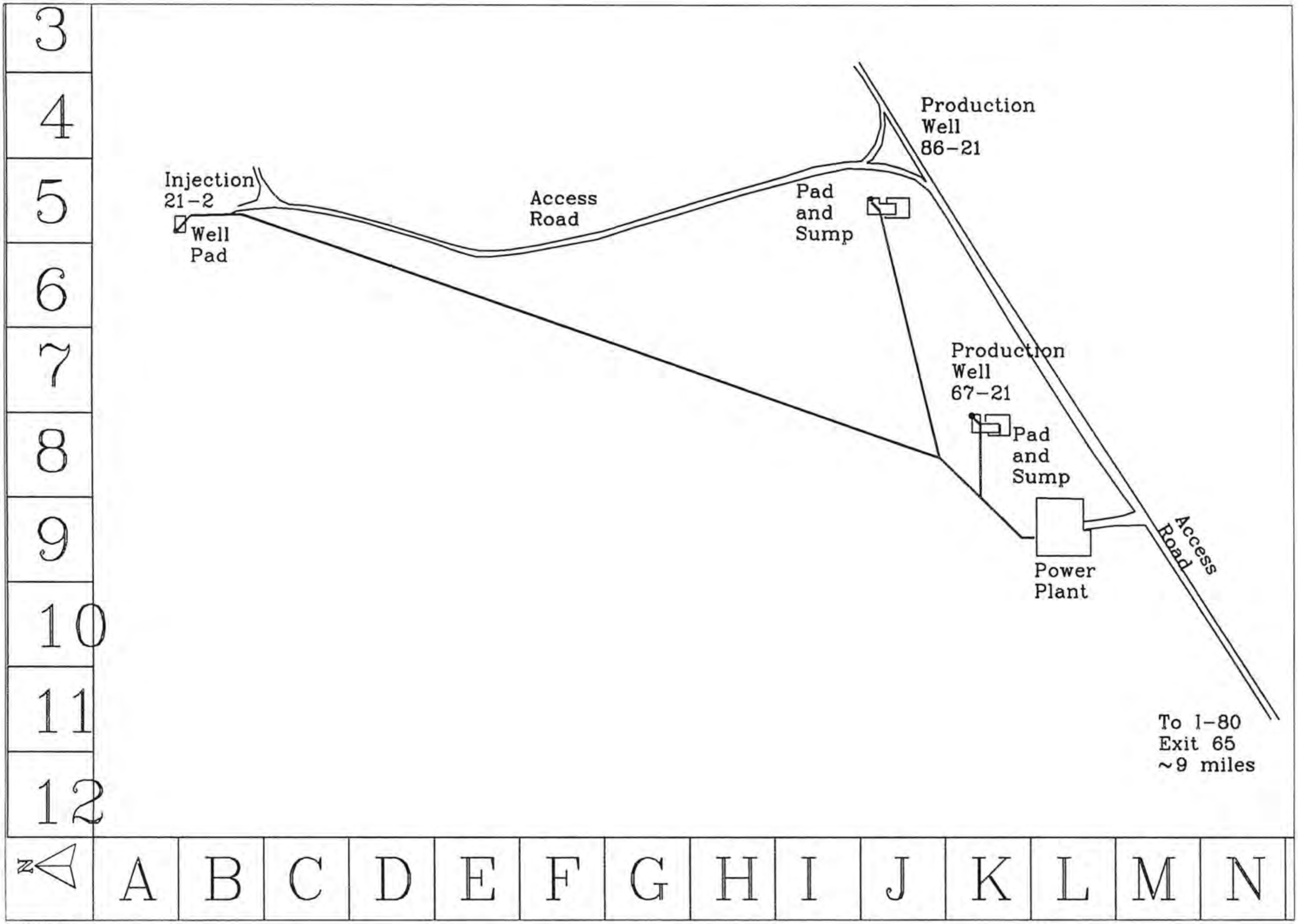
The Desert Peak Geothermal Project is a 12.5 MW (rated) double flash geothermal power plant, well field, and related facilities located approximately four miles east of Brady Hot Springs near Fernley in Churchill County, Nevada. Geothermal fluid is produced from the project's geothermal production wells under natural (artesian) flow to the power plant site. The geothermal production well field is currently comprised of the following two geothermal production wells that are located east-northeast of the power plant site: 67-21 and 86-21. Small quantities of a commercial scale inhibitor are introduced into each of the production wells through a capillary tube to reduce the formation of mineral scale which would otherwise form from the reduction in temperature and pressure as some of the geothermal fluid flashes to steam in the well bore.

The hot, two phase geothermal fluid produced from the production wells is piped to the power plant where a portion is first flashed to steam in a high-pressure flash tank. The remaining geothermal fluid is piped to a low-pressure flash tank where an additional portion is flashed into low pressure steam. The high- and low-pressure steam is directed through the single steam turbine, which is connected to a generator. Electricity generated is directed to the Brady Power Plant over a 13.8 kV distribution line and is either used for internal power needs of the Brady facility and/or sold to Sierra Pacific Power Company and distributed into the local power grid through a short 120 kV transmission line which crosses Interstate Highway 80 to tie into Sierra Pacific's 120 kV transmission line. Historically, electricity generated was sold directly to Sierra Pacific through a second 120 kV electric transmission line.

The remaining geothermal fluid which is not flashed to steam in the plant is pumped under pressure through a surface piping system to an injection well for re-injection into the geothermal reservoir. The injection well field is located approximately one-half mile north of the production wells and currently consists of a single injection well, 21-2. A fourth completed well, 22-22 is currently idle.

The geothermal steam exiting the turbine is condensed into liquid in a direct-contact condenser (that is, the cooling water and steam are mixed together in the condenser). The condensate-cooling water mixture is routed to a two cell forced air cooling tower which cools the circulating water principally through evaporation. Small quantities of chemical biocides and anti-sealants may be added to the circulating cooling water to prevent the buildup of algae or bacteria or chemical scales which could reduce cooling efficiency. Excess cooling water (cooling tower blowdown) results from the addition of the steam condensate is directed to a concrete lined condensate pit located on the south side of the power plant where it cools and is subsequently discharged to the surface in an area about 50 feet south of the access road to the power plant site.

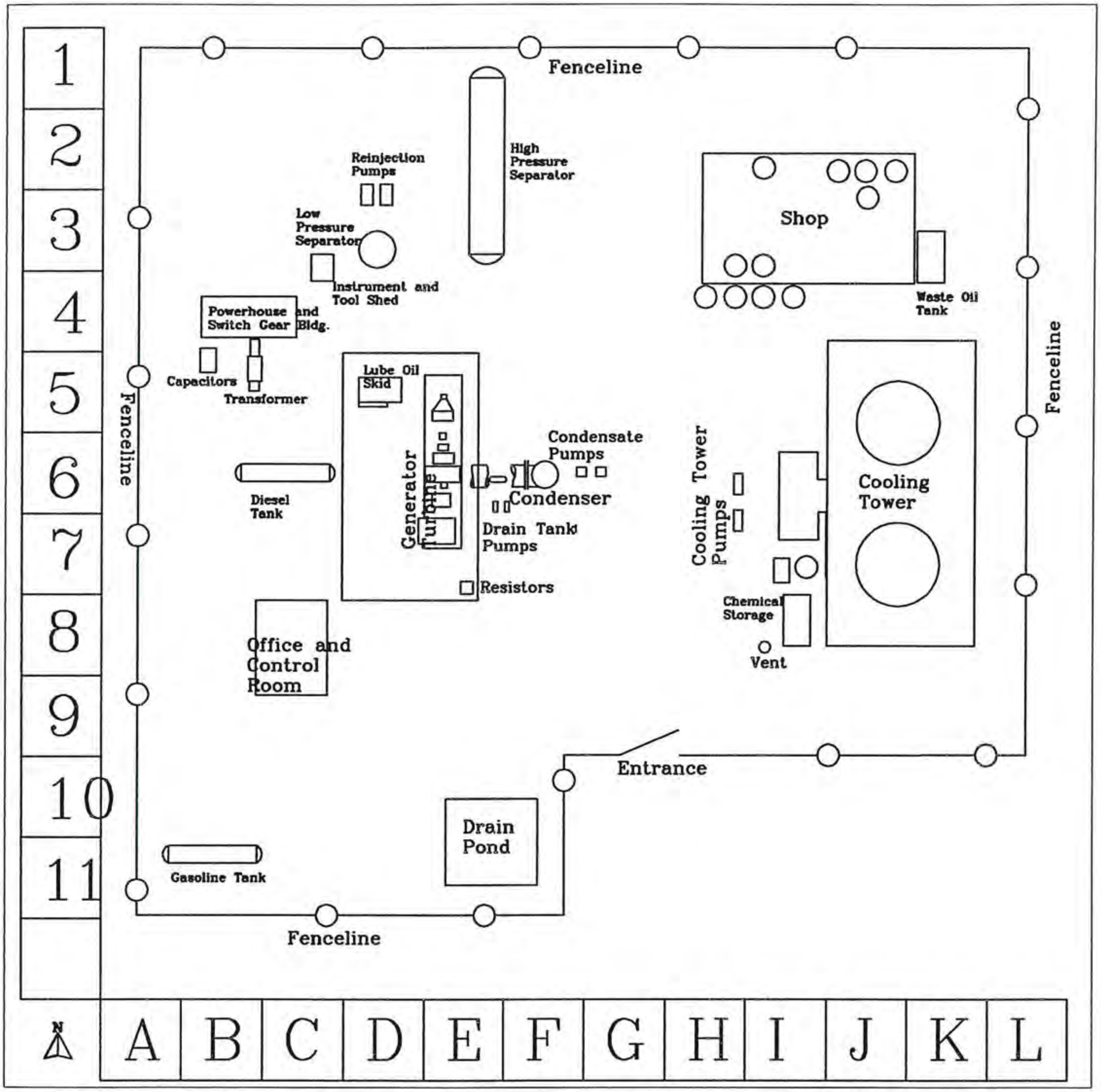
Approximately three other geothermal wells and 14 temperature gradient or stratigraphic test holes have been drilled for the project within the historic Desert Peak Geothermal project area.



CLM 8/02
DP Well Field Site Map.dwg
Located 9 miles East of I-80 Exit 65
via unpaved road

100' Grid

Western States Geothermal
Desert Peak Geothermal Power Plant
Churchill County, Nevada



CLM 8/02
DP Site Map.dwg

Located 9 miles East of I-80 Exit 65 via unpaved road

25' Grid

Western States Geothermal
Desert Peak Geothermal Power Plant

Churchill County, Nevada

Desert Peak
Geothermal Resource Information

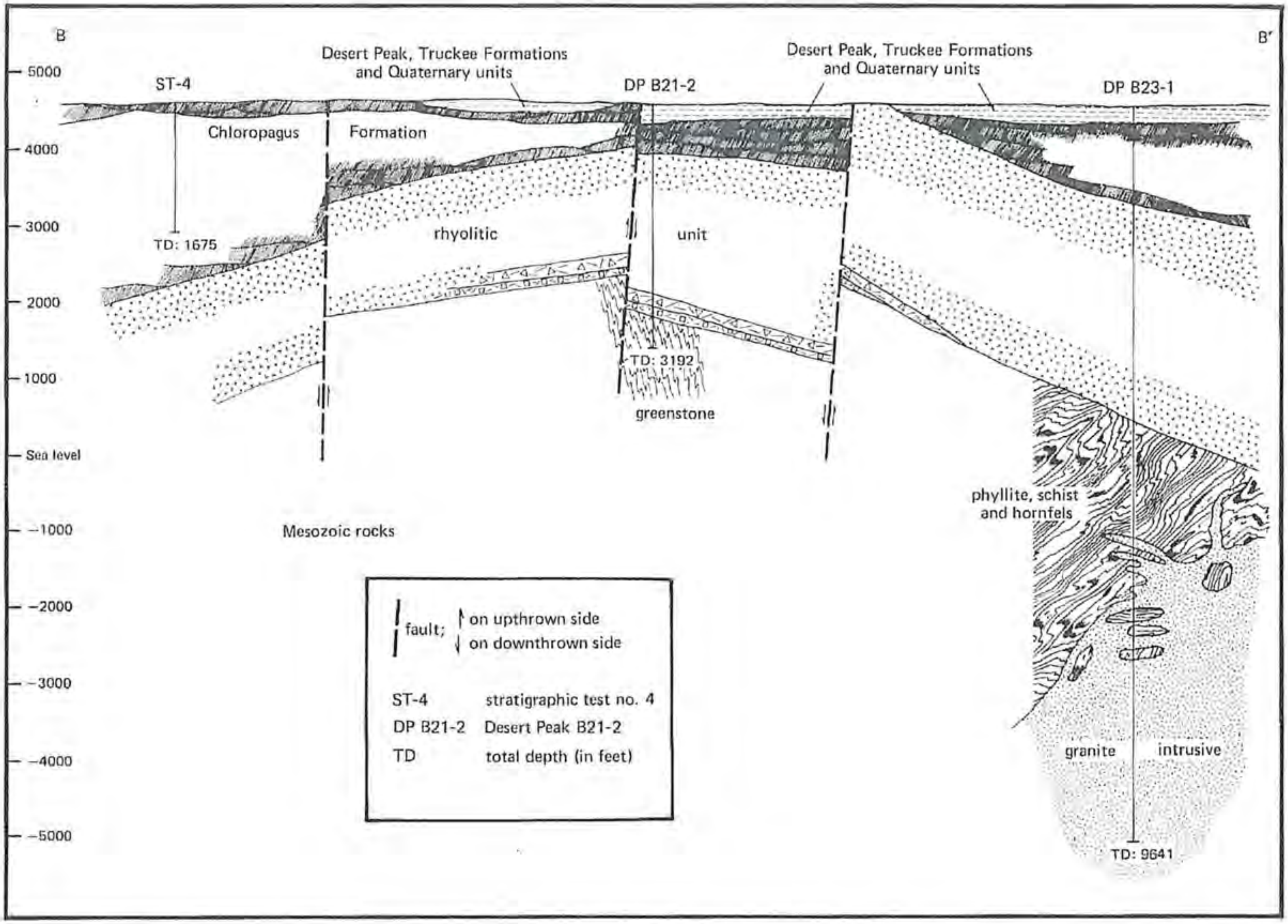
Desert Peak area [12]

The Desert Peak geothermal prospect is located in the northern part of the Hot Springs Mountains about 4 miles southeast of Brady's Hot Springs, and is named for a prominent peak 2 to 3 miles northwest of the area of the steam wells. The thermal area is apparently centered on S21,29,T22N,R27E (fig. 7). It was discovered by Phillips Petroleum Co. after drilling approximately 50 temperature-gradient holes up to 500 feet in depth. Much of the following information is summarized from data released by Phillips.

There are no surface thermal indications at the area, other than a few small occurrences of siliceous sinter and travertine, probably from springs which are now inactive. The geology of the rocks exposed at the surface has not been helpful in predicting the subsurface geology. The three geothermal wells drilled in the 1974–1976 period encountered Mesozoic metavolcanic and metasedimentary rocks at depths of 3,000 to 4,500 feet, below a sequence of Miocene volcanic rocks (fig. 8). Wells 21–1 and 21–2 produce a mixture of steam and water from fractured meta-andesite. It has been suggested that the Tertiary volcanic rocks may act as a seal for the reservoir.

The reservoir is believed to have a temperature of 406°F, and the fluid produced is a sodium chloride type containing about 7,500 ppm total dissolved solids.

From:
Garside, Larry and Schilling, John H. 1979.
Thermal Waters of Nevada, Bulletin 91
Nevada Bureau of Mines and Geology,
Mackey School of Mines,
University of Nevada, Reno. p.9.



From: Benoit, W.R., J.E. Hiner, and R.T. Forest. 1982. Discovery and Geology of the Desert Peak Geothermal Field: A Case History. University of Nevada, Reno. Figure 36, p.66.

Rye Patch Geothermal Field
Pershing County, Nevada
GRC Fieldtrip; September 2002

Wm. J. Ehni; Ehni Enterprises, Inc.
Richard K. Ellis; Presco Energy, LLC

The Rye Patch Geothermal anomaly is located in Pershing County, Nevada, T31N R33E. The area of exploration is roughly 1.5 square miles, centered principally in section 28 and the south half of section 21. Down-hole flowing temperatures from wells in the Rye Patch field have been recorded as high as 400°F (44-28 well), while the highest static bottom hole temperatures have been recorded in the E1 well (353.8°F at 1,835 feet). Most of the wells have significantly lower down-hole flowing temperatures than the 44-28 well, and the geochemistry of these fluids indicates that they are derived from mixed origins, cold water and hot (470°F+) water. Geochemistry of fluids produced from existing wells indicates that the resource temperature is at least 470°F. The average concentration of SiO2 for the 44-28 well is 461ppm (12 samples).

Geothermal and geophysical anomalies define structures which parallel the range-front fault; and the geologic model of this resource, developed using an extensive data base, identifies faults within this system as the primary conduits for the upward migration of hot geothermal fluids from depth. Outflow zones from these faults into permeable intervals have been identified, and they produce large convective, nearly isothermal, intervals in several of the existing wells.

The Humboldt Range, east of the Rye Patch geothermal field, is composed primarily of Mesozoic volcanic, carbonate and clastic rocks. The range is structurally controlled by high-angle normal faults associated with the crustal extension that produced the present day Nevada block-faulted basins and ranges. The area is seismically active, with Holocene age faults offsetting recent fanglomerates on the northwest flank of the range. The amount of structural relief in the area due to faulting is difficult to ascertain; however, considering the depth to Mesozoic rocks west of the range and the presence of Mesozoic rocks at Star Peak, east of Rye Patch, there is probably over 10,000 feet of vertical offset attributable to Cenozoic faulting. The estimated depth to Mesozoic bedrock west of the Rye Patch geothermal field is about 7,000 feet, approximately 3,000 feet below sea level. The elevation of Star Peak east of the Rye Patch geothermal field is 9,834 feet.

The dip of the main system faults is significant and could explain why earlier wells did not penetrate the main fault-fracture zone. Prior to 1991, interpretations of the dip for the Rye Patch fault were between 62° and 67°, based on projecting the surface trace of the fault into the lost circulation zone encountered in the E1 well at a depth of 1831'. This led to an erroneous estimation for the angle at which the fault dips, and may well have resulted in numerous sub-commercial wells. In reality, the E1 well produces from an intermediate-depth carbonate aquifer fed by the high-angle fault system.

HISTORY OF PROJECT

Prior to 1977, approximately eight temperature gradient holes were drilled by Phillips Petroleum Geothermal Division in the area. Most of these wells were drilled to a depth of 300 feet or shallower. An anomaly identified from these shallow temperature gradient holes in sections 21 and 28 in T31N, R33E, led Phillips to drill Strat Test 5A in March 1977, to a total depth of 1,968 feet in section 21. Based on the encouraging results of this hole, which had a bottom hole temperature (BHT) of 345°F, Phillips proceeded to drill a production-size well to test the resource. In December 1977, Phillips drilled Campbell E-1, as a *twin* to Strat Test 5A, to a total depth of 1,859 feet. The E-1 well was successfully completed as a potential geothermal producer, with an initial production rate reported of 900,000 lbs/hr at 360°F. However, this well showed pressure decline over time on long-term tests, which suggested to Phillips personnel that the well had not penetrated the main reservoir.

In December 1978, Phillips continued their exploration efforts to the south in section 33, and drilled Strat Test #6 to a total depth of 1,960 feet; however, the well had a relatively low BHT (169°F), which discouraged further exploration to the south. Then in March 1979, Phillips drilled a full-scale production-size well, the Campbell E-2, about one mile north-northeast of the E1 well in section 15 to a total depth of 8,060 feet. The E2 well did not encounter adequate permeability for production purposes, although the bottom hole temperature was 378°F.

After Phillips ceased company-wide geothermal operations, the project was basically dormant until OESI acquired the prospect and drilled six temperature gradient holes (RP1 - RP6 holes) in July 1991. An anomaly identified with these additional temperature gradient holes near the center of section 28 was then drilled in late 1991. This well (44-28) spudded in September 1991, and completed in November 1991, was subsequently flowed-tested at an initial rate of 400,000 lbs/hr and 400°F. Interestingly, the static BHT for the 44-28 well is only 316° F suggesting communication with a deeper, higher temperature resource.

Seven additional commercial-size wells were drilled following the successful completion of the 44-28 well. None of these wells performed as well as the 44-28 well. The operator and independent contractors determined that there was insufficient production from these wells to fully supply the 12.5 Megawatts power plant, which was constructed and nearly completed at the time drilling ceased. Funding support was withdrawn and the project operations were suspended. In the aftermath, TIC became the owner of the uncompleted power plant, the geothermal leases and related project assets.

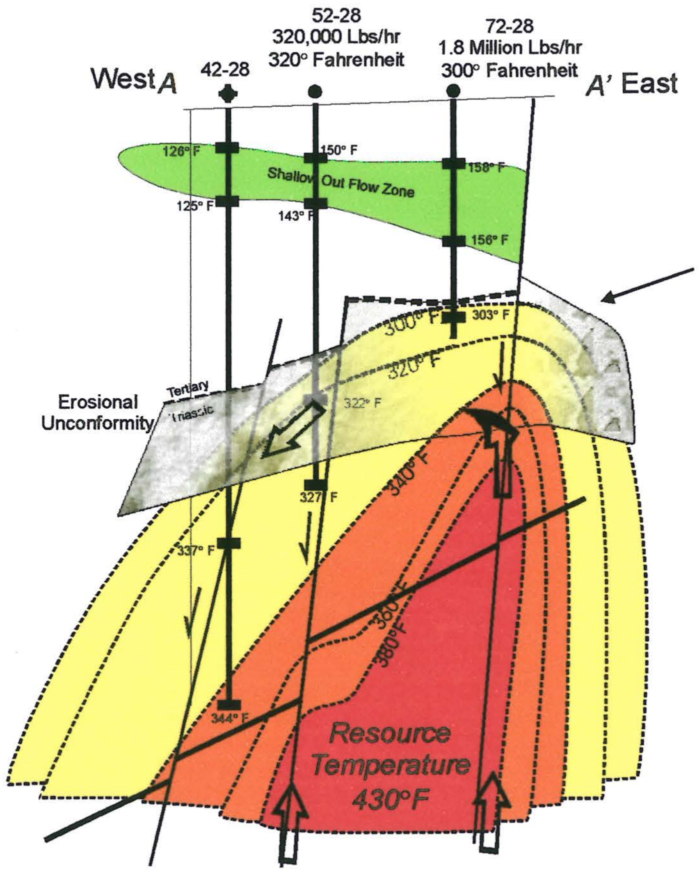
On April 2, 2000, Mt. Wheeler Power began drilling the 72-28 well, with the intent to develop additional production for the mothballed power plant. Two faults were targeted as primary production zones, and a shallower stratigraphic unit of permeable carbonate rocks, fed by these faults, was also mapped as a potential production zone. The E1 fault, mapped with 3D seismic data, and the Rye Patch fault recognized on air photos and temperature gradient data, both intersect the Humboldt City thrust fault at depth (mapped with 3D seismic data). Unfortunately, due to severe drilling problems the well was temporarily abandoned at 977' on April 27, 2000. Drilling resumed on the 72-28 well with additional funding from the DOE on March 31, 2001. Sandia Labs assisted in designing a polyurethane plug for curing the loss of circulation problems and the well was successfully drilled to at total depth of 2088' (GL) into the carbonate production zone. On the 26th of May 2001, the zone was flow tested at 1.8 million pounds per hour with a flowing well-head temperature of 297F and 71 psig well head pressure. The zone was considered commercial and completed in June of 2001.

Presco Energy acquired the plant, wells, leases and related Project assets in July of 2001, and expanded its lease position to cover a substantial portion of the Rye Patch KGRA known to have commercial generation potential. With the early 2002 completion of an extended reservoir test and modeling sequence (72-28 well flowed for 40 days, with injection in the E-1 and pressure/temperature/geochemical monitoring in 68-21, 51-21 and 44-28 wells), the reservoir "certification" process (and final construction design) are complete. What was originally intended to be an early 3rd quarter, 2002 start-up has been pushed back as the PUC completes its rulemaking on the REC, and Sierra Pacific Power resolves its financial dilemma. A number of options exist for the sale of Rye Patch power, however, and these are being explored and pursued aggressively. Presco plans the near-term expansion of the geothermal resource at Rye Patch and the adjoining Humboldt House area to the north, with new geophysical surveys scheduled and at least two new wells to be drilled over the next 12 to 18 months.

Attached Figures:

1. Location Map - Rye Patch Geothermal Field
2. Geologic Well Summary – Well #72-28
3. Geologic Interpretation Along A-A'
4. Photo – Well #72-28 Flowing May 26, 2001

Geologic Interpretation along A-A'

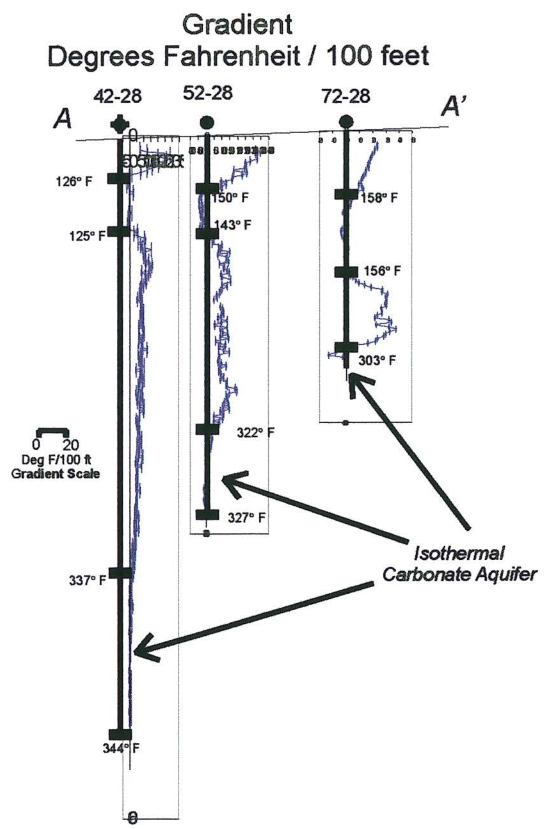


Drilling of the 72-28 well began in April of 2000. After drilling into the intermediate depth aquifer, the zone was tested and determined to be commercial (1.8 million pounds per hour at 300° F) the decision was made to complete the well in this zone, and not risk damaging it by drilling ahead to test the Rye Patch and E1 fault targets..

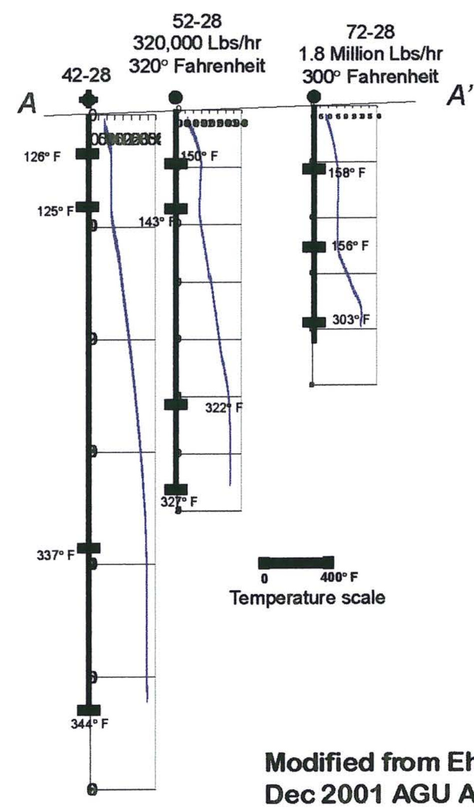
Intermediate depth Carbonate aquifer.
Isothermal temperature profiles.
Permeability decreases with distance from source of geothermal fluids (Rye Patch Fault)

The resource temperature, as calculated using silica geothermometry, is 430°F. These relatively high values are an indication that the "plumbing" system for this resource will be controlled by high angle faults. High angle faults will tend to produce higher temperature fluids than lower angle faults.

Scale (horizontal = vertical)
500 ft
500 ft



Temperature Profiles

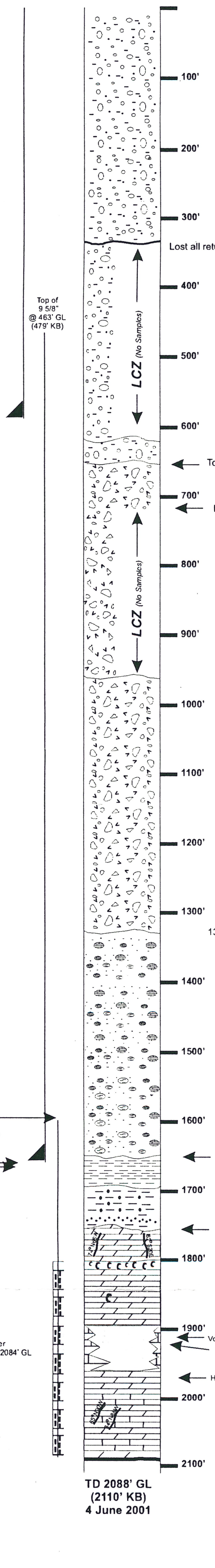


Modified from Ehni
Dec 2001 AGU Abstract and Poster session

Mt. Wheeler Power

Geologic Well Summary
Well #72-28
Rye Patch, Nevada
939' from the east line, 884' from the north line of
Section 28, T31N R33E
Ground Level: 4536' above sea level

All depths relative to Ground Level(GL) unless otherwise noted



TD 2088' GL
(2110' KB)
4 June 2001

20" conductor casing set at 29' GL

Caza Drilling
Spud 2 April 2000
18.6' KB

Top of 9 5/8" @ 463' GL (479' KB)

13 3/8" casing set at 591' (609' KB)

17 1/2" hole drilled to 609' (627' KB)

Lang Drilling
From 959' GL
to 1667' GL (1683' KB)
KB 16'

Equipment 2000' drilled from 1667' GL
to 2088' GL (2110' KB)
KB 22'

Top of 7" Liner @ 1597' GL (1619'KB)

Shoe of 9 5/8" @ 1661' GL (1677'KB)

12 1/4" hole drilled to 1667' GL (1683'KB)

Ran 487.14' of 7" Liner
Slotted from 1801' to 2084' GL

8 3/4" hole drilled from 1667' GL to 2088' GL

Surface to 640' (GL) (656' KB on elog)
Unconsolidated sands and gravels, no returns from 323' to 609' (GL), Lithology from 323'-609' inferred from offset wells

Lost all returns at 323'

Top of Volcanic Rocks (elog) 640' (656' KB)

Video Camera, caliper and spinner logs on April 2-4, 2001, Fluid level in hole at 400' (16' DF). Max recorded temp at 783' (16' DF) was 168.5F.

Lost all returns at 711' GL

711' to 959' (GL)
No sample returns. Major Loss Circulation Zone. Lithology inferred from correlation of Elogs between well 52-28 and well 72-28 with 52-28 mud log.

Video Camera Interpretation: At 736' (720 GL) gray, aphanitic rock with white rectangular pheonocrysts, common vertical jointing, probably best described as Lahar, volcanic mud flow. At 739' (723' GL) red cinder?

961'-1328' (GL)
977'-1344' (KB)
Silicified Conglomerate, poorly sorted, very well indurated (silicified) grayish green to olive green very fine-grained matrix, clast size range from 1/10 inch to 1 inch, poorly rounded to angular. Non calcareous, rare vugs lined with botryoidal and/or euhedral quartz, common white quartz veins; common disseminated and microcrystalline fracture filling pyrite. Silicification is Hydrothermal (epithermal). Thin section at 1233'.

1328' (GL) elog top of red conglomeritic gravels

Conglomerate, red brown matrix, poorly indurated, matrix is very fine grained red brown to brick red, sample washes to a gray to med gray overall color. Clasts are poorly sorted, rounded to angular, loose, composed primarily of limestone with non calcareous shale content increasing with depth.

Tertiary Sands, Gravels and Pyroclastic rocks.

1652' (GL) elog top of red brown non-calcareous, poorly indurated, claystone-clay. — 1652' (GL)

Weathered and or Reworked Grass Valley Formation

1698' (GL) elog base of low resistivity, poorly indurated, claystone- clay.

1698' - 1758 (GL) Siltstone

1758'-1802' (GL) Fractured carbonate rocks (10 ohm-m, EMI shows fracturing and compressional shearing from1767'-1782' and 1789' - 1797') — 1758' (GL)

Triassic Star Peak Group Natchez Pass Formation

1802' -1814' (GL) Brownish yellow silicified carbonate (Jasperoid)

@ 1888' GL (1910' KB), common quartz veining and drusy quartz, milky white and clear. Common clear euhedral quartz. Host rock is dark gray silicified carbonate (Jasperoid) and light gray to dark gray, limestone and dolomite.

At 1893' GL (1915' KB) well began flowing(13 bbls in 5 mins)

Void reported by driller at 1913' GL (1935' KB)

Production Zone
Cavernous Porosity from 1890 to 1964' (GL)

Open hole Rig Test 1661' - 1896' (GL)
5.5 hours, average flow rate
1.8 million pounds hour (3600 gpm),
297 F well head temperature,
71 psig flowing well head pressure

High H_2S and CO_2 from 1968'-1978'

Drilling break 1998'-2005'

No sample returns from 1893' GL to 2088' GL (TD)
Elog interpretation indicates low gamma ray and high resistivity, which is indicative of carbonate rocks (limestone and dolomite) from 1893' GL to 2088' GL, except for zones with cavernous porosity where the resistivity is low due to well-bore fluid and not formation.

Legend

- Limestone
- Dolomite
- Sandstone
- Shale
- Chert
- Cavernous porosity
- EMI fracture showing angle and dip direction

22 September 2002

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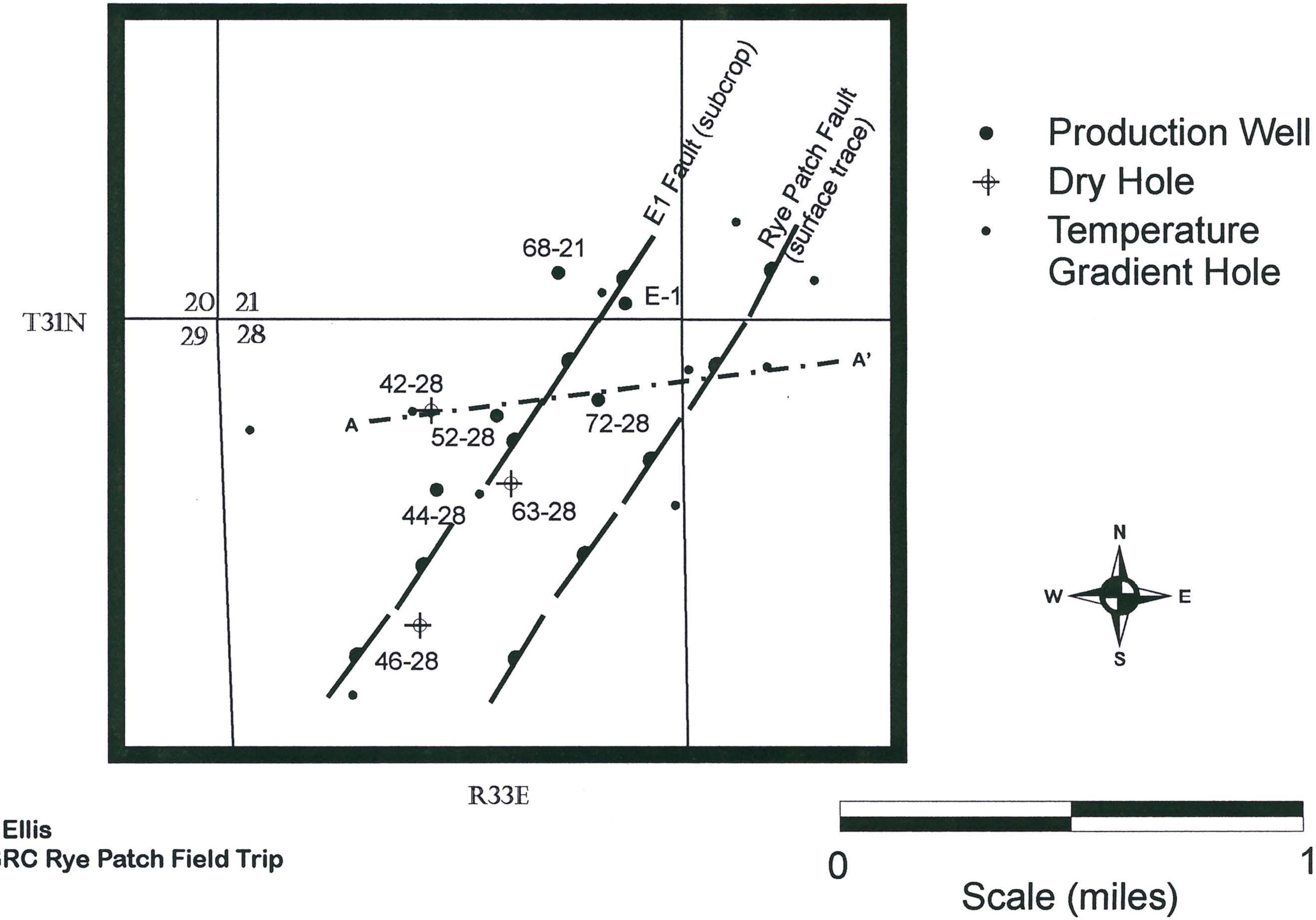
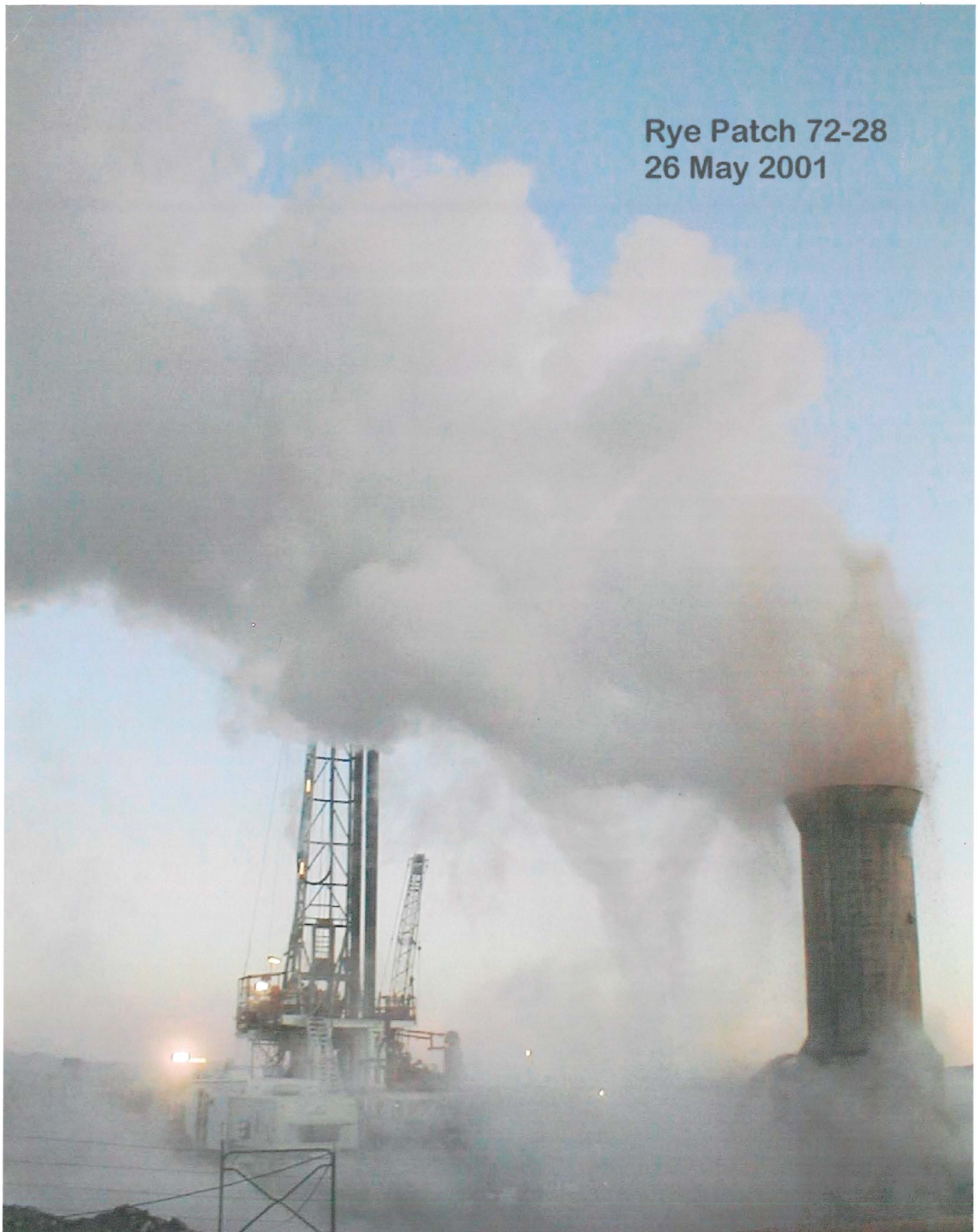
Location Map: Rye Patch Geothermal Field
Pershing County Nevada



Ehni & Ellis
2002 GRC Rye Patch Field Trip


Rye Patch 72-28
26 May 2001