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THE CRAIG MOUNTAIN GEOTHERMAL PROSPECT

UNION COUNTY, OREGON

by: Lon D. Cartwright
Richard G. Bowen

February 1975

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This prospect and report has been put together by the combined efforts of Lon Cartwright and myself. Prior to January 1975 my part was pointing out the area as a good prospect to Lon and philosophical discussions of the conditions that make it a good prospect. After resigning from the Oregon Department of Geology and Mineral Industries in 1974, I have taken a financial interest in the prospect.

Magma Energy drilled this prospect to a depth of 2729' in the fall of 1974 but abandoned it after encountering difficult drilling conditions and because drilling mud return temperatures never increased appreciably. Subsequently, it was released back to Lon. Utilizing the data from the well along with my general knowledge of the geology of the region and of geothermal systems I have modified Lon's original report giving my interpretation of the well results and on why higher temperatures were not found by the Magma test. This report details the well conditions and how the authors believe this relates to the subsurface. After studying the logs and comparing them with other geothermal tests I have tried to show that the manner of drilling and of testing the well was the reason for low temperatures at the mud return line and a low temperature when the well was logged prior to abandonment.

I believe this prospect offers an excellent opportunity for a steam discovery that is well located geographically and has an adequate acreage position. Particularly attractive is the availibility of taking a look at the subsurface conditions of the prospective reservoir without the need to drill a well. I propose the hole be re-entered by drilling out the plugs and taking a true temperature gradient and on that basis decide to either proceed to deepen or abandon the prospect.

The acreage position is sufficient that if a successful steam field were found many wells could be drilled within the bounds of the lease. I believe this lease block is the most attractive in the area and Lon's leasing activities in 1972 and 1973 triggered others to follow him into the area. Adjoining lease tracts are held by Amax Mining Company and by Gulf Oil Company.

The portions of this report detailing the Reservoir, Well History, Reasoning why the test well was unsatisfactory and Recommended action to evaluate the Prospect were prepared by myself. Locations and Accessability, Geologic Setting, Hot Springs description and most of the maps were prepared by Lon.

Respectively submitted,

Richard G. Bowen

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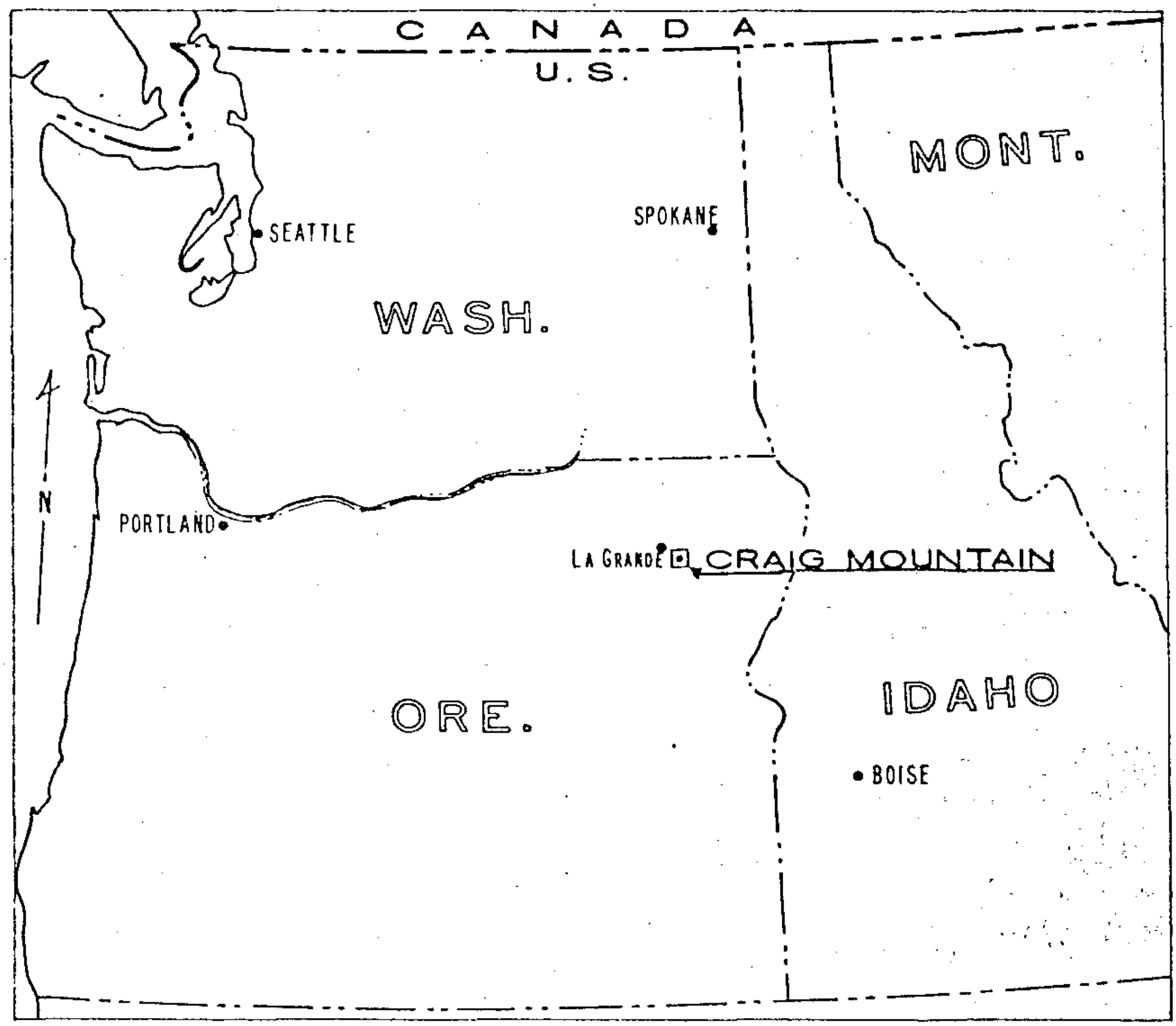


INDEX MAP
OF
PACIFIC NORTHWEST

SHOWING LOCATION OF

CRAIG MOUNTAIN
GEOTHERMAL PROSPECT

LON D. CARTWRIGHT
RICHARD G. BOWEN

THE CRAIG MOUNTAIN GEOTHERMAL PROSPECT
UNION COUNTY, OREGON

LOCATION AND ACCESSIBILITY

The Craig Mountain Geothermal Prospect is in northeastern Oregon, some 230 miles east of Portland and 145 miles northwest of Boise, Idaho. (See Index Map, Figure 1) It is five miles southeast of LaGrand, a thriving town of 10,000 people. The prospect is crossed by State Highway No. 203 and by a branch of the Union Pacific Railway. Interstate Highway 80N - U.S.30 - is 2 miles west of the prospect. A trunk power transmission line of the Idaho Power Co. passes 2 miles west of the prospect. A Bonneville Power Administration substation is located about 4 miles northwest.

The full extent of the prospective area isn't known at this time, but the 4500 acre block as outlined on accompanying maps is considered to be the heart of it. Part of the block lies in Grande Ronde Valley, altitude 2700 feet, and part of it on Craig Mountain which rises to 4700 feet. The hot springs flow from a fault zone at the contact between valley and upland and feed a thirty acre lake which sends a cloud of steam to the air; known locally as Hot Lake.

The Grande Ronde Valley, a northwest-southeast trending valley 25 miles long, and a maximum of 15 miles wide, is a flat-surfaced former lake bed extensively cultivated in farms of from forty to three hundred twenty acres. The adjoining uplands are a part of the Columbia Lava Plateau, lava-capped, grassy pasture land. A topographic map of the local Craig Mountain Area is enclosed showing the extent of the leased area.

GEOLOGIC SETTING

The Grande Ronde Valley occupies a down-faulted depression in the upland of the Columbia River Plateau. USGS Water Supply Paper 1597, Geology and Ground Water Resources of the Upper Grande Ronde River Basin, published in 1964, maps and describes the geology of the general area. Figure 2 shows a portion of the map from Water Supply Paper 1597 that includes the prospect area. Reference is here made to the paper for a more detailed account of the regional geology.

Grande Ronde Valley was the site of a large Pleistocene lake, and the formations underlying the valley floor are beds of clay, silt,

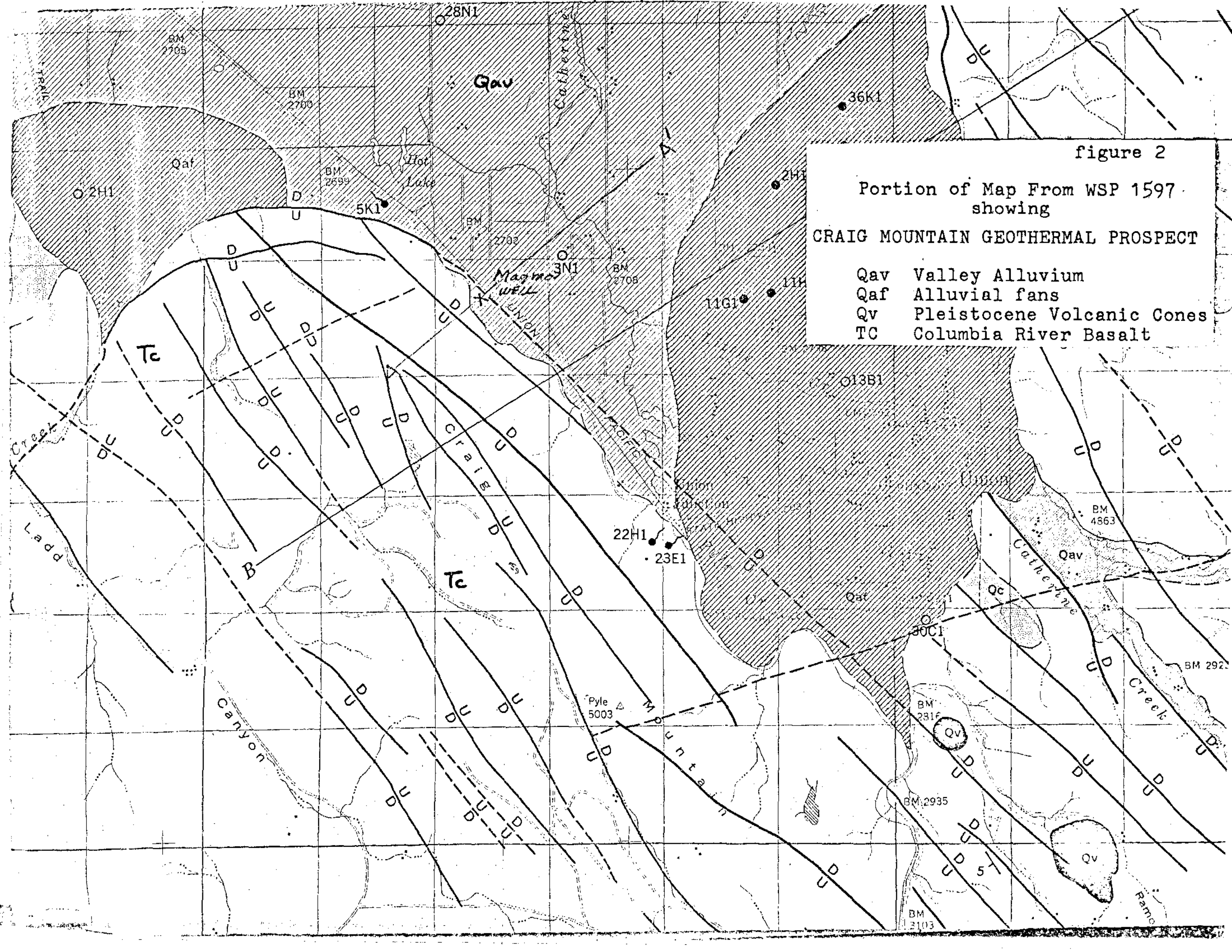


figure 2
Portion of Map From WSP 1597
showing
CRAIG MOUNTAIN GEOTHERMAL PROSPECT
Qav Valley Alluvium
Qaf Alluvial fans
Qv Pleistocene Volcanic Cones
TC Columbia River Basalt
Qav
Qaf
Tc
Qc
Qv
28N1
36K1
2H1
5K1
3N1
11G1
13B1
22H1
23E1
30C1
Hot Lake
Magma well
Catherine
Craig
Mountain
Canyon
Ladd
Creek
Pyle 5003
BM 2705
BM 2700
BM 2699
BM 2702
BM 2708
BM 4863
BM 2816
BM 2935
BM 3103
A'
B

sand, and gravel lenses aggregating as much as 2000 feet in thickness in places and resting on a floor of lava.

The uplands adjoining the Grande Ronde Valley are rugged, formed on Columbia River Lavas of Pliocene and Miocene age. Andesite and basalt interbedded with volcanic tuffs and gravel in the region attain a maximum thickness of between 2500 and 3000 feet. The thickness at Craig Mountain is not readily apparent.

The lavas thin southward from this area and rest unconformably on Mesozoic rocks within 12 miles of Hot Lake. These rocks (described in USGS Bull. 879, Geology of Baker Quadrangle, 1937) are highly deformed and fractures quartzites, schists, greenstones, and argillites, and probably aggregate 12,000 feet or more in thickness. These formations are not greatly dissimilar from the Fransciscan formation which is the reservoir for the steam chamber at The Geysers geothermal field in California.

There are three small volcanic cinder cones of Quaternary age cutting the Columbia River Lavas, as is shown. These may be significant with respect to a heat source for the hot springs.

The Pleistocene lake beds of the valley are essentially undisturbed except that the major faults bounding the Grande Ronde Valley appear to cut them. The lava uplands are extensively faulted with displacements ranging up to 1500 feet. The lave beds are commonly gently dipping except that adjacent to some of the faults they are steeply tilted.

The geologic map taken from USGS Water Supply Paper 1597 shows a pattern of extensive faulting which is especially prominent on Craig Mountain. The large fault between the mountain and the valley is of especial interest because it is the channel for the rising hot waters of the springs. This fault extends southeastward for some 9 miles from Hot Lake. Near its southeastern extremity are two Quaternary volcanic cones of red cinders. They are 1000 and 2500 feet in diameter respectively, and immediately adjoin the fault. At Hot Lake the fault swings at right angles to the southwest suggesting a bend around a structural salient created by a buried mass in the subsurface, here interpretted as a Quaternary intrusive that may be a magma chamber, and the source of the heat for the hot spring.

THE HOT SPRINGS

The several hot springs are best shown on the topographic map assembled from four USGS quadrangle maps. Two springs, rising in spring houses, are located on the south bank of Hot Lake in Sec. 5, Tsp 4S, Rge 39E. Two thousand feet east, in Sec. 4, a four inch pipe rises three feet above the ground and yields a strong flow of hot water and a few feet away in a small pool there is a strong bubbling hot spring. The surrounding ground is marshy and traversed with ditches and at half a dozen places active steam plumes indicate other hot water vents.

The USGS reports a yield at 170 gallons per minute from the springs in Sec. 5. This is 6100 barrels per day and with the springs in Sec. 4, this yield probably increases to 7500 barrels or more. Temperature of 180°F is reported by the USGS and the writers have made several readings of 178° to 180°F.

The chemical analysis of the water is as follows:

	Hot Lake by USGS	Well in Sec. 4 by Ore. D.E.Q.
SiO_2	81. ppm	74
Fe	0	0.03
Ca	3.6	6.
Mg	.3	.4
Na	128.	126.
K	2.7	2.5
HCO_3	0	
CO_3	31.	
Hydroxide	4.	
SO_4	56.	47.5
Cl	129.	131.
F	1.6	1.4
NO_3	0	
Residue at 180°C	461.	480.
Ph	9.5	8.7

In addition to the hot springs there is a flowing springs of cool water near the west line of Sec. 5, 4S, 39E, which drains into Hot Lake. And there are cool springs southeast of Hot Lake several miles distant. (See topographic map) These springs also appear to rise from the same fault zone and probably represent meteoric waters falling on Craig Mountain which descended through the lava and drained from the fault channel without having penetrated to the heated area below.

A subtle point that is often overlooked in the discussions of hot spring geochemistry and how it might relate to subsurface conditions is that fact that when the geothermal fluid migrates in the form of steam nearly all the normal chemical components remain behind at the point of the phase change. In general only the most volatile elements along with those normally in a vapor state migrate with the steam. Consequently, if waters are heated by steam leaking into shallow aquifers, rather than by deep circulation, the steam-heated waters should have a lower content of dissolved solids.

The thermal waters from Hot Lake and the well in Sec. 4 show total dissolved solids of less than 500ppm - much less than normal in most hot springs of this temperature. This may be significant in indicating that there is a steam reservoir at depth.

RESERVOIR

The data from Magma-LaGrande #1 indicates that the geologic section was about as anticipated with the Clover Creek Greenstone being intersected at 1860' after passing through the bounding fault at 1760'. The well was abandoned at 2729' because drilling was more difficult than Magma anticipated and mud flow line temperatures failed to show significant increases. In the following pages of this report the writer shows that the mud temperature did not increase because of the methods used in drilling the well, not because there is a lack of heat in the rock.

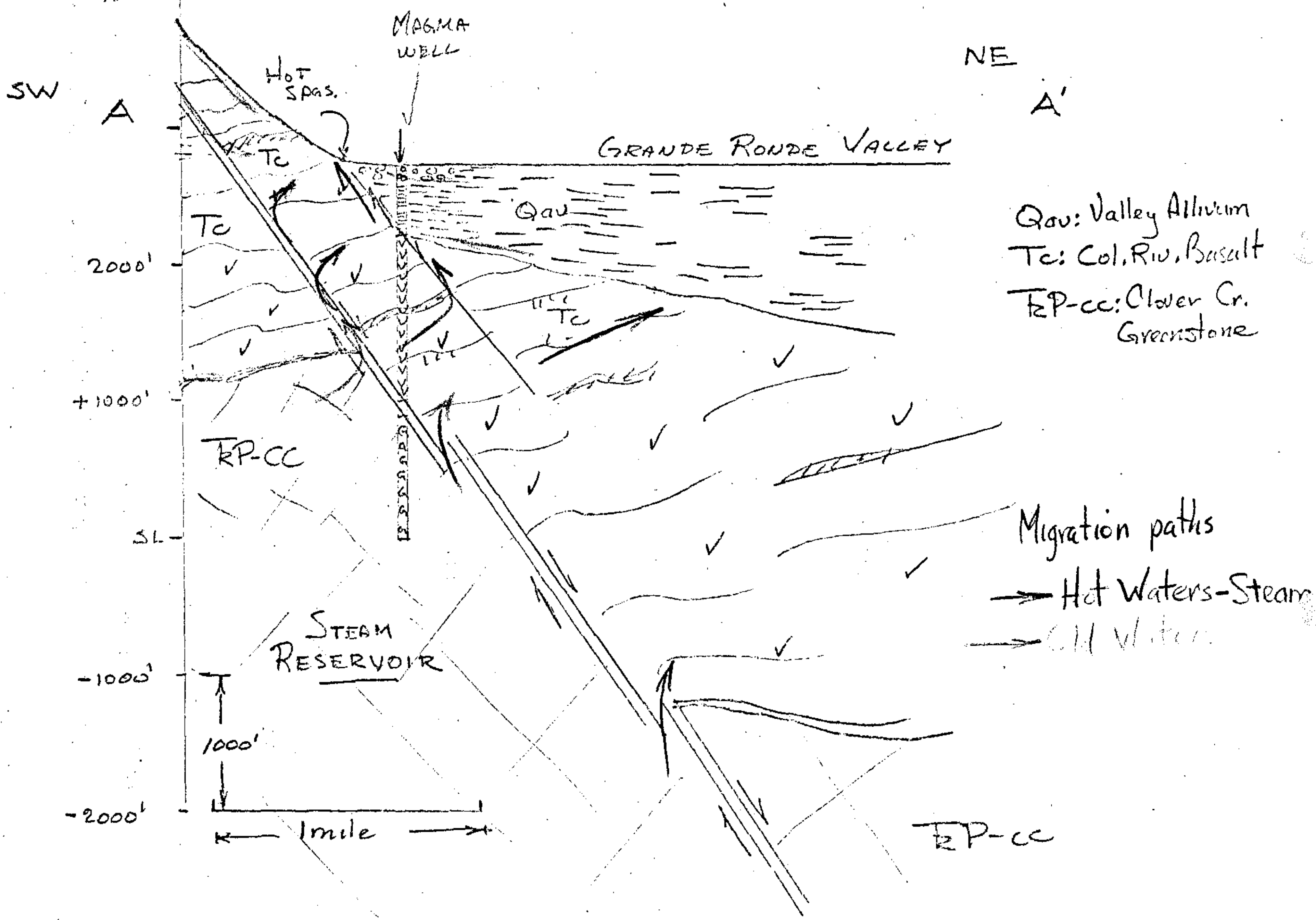
Several indications point to this prospect as being a good chance for a steam reservoir rather than for hot water. One is the rock type. The other well-known steam reservoirs are similar in that they produce from fracture zones in hard impermeable rock. Lithologies at The Geysers are nearly identical to the Clover Creek Greenstone. The steam reservoir at Matsukawa, Japan, consists of brittle fractured andesite. In Larderello, Italy, a fractured limestone is the reservoir. Competent rock is necessary to hold the open-space permeability to allow space for pressure reduction and flashing. A steam reservoir must also be isolated from outside water inflow for if the system is not isolated then ground water flow would convert it into a hot water system. The fact that these conditions of isolation ~~and permeability are~~ met in dry steam reservoirs is shown by the extreme low pressures of steam at great depth in the steam fields. The thickness, competency, existing fracture permeability and structural position of the Clover Creek Greenstone give it the right combination of features necessary for a steam reservoir.

Another contributing factor mentioned earlier that adds to the attractiveness of this prospect is that chemical analysis of Thermal waters at Hot Lake and the nearby well show waters quite low in dissolved solids. This may indicate they have not gained their heat because of deep circulation but are meteoric waters heated by steam leaking into the shallow aquifers.

Also the fact that the Clover Creek Greenstone is structurally higher here at the Craig Mountain prospect increases the chances that a steam reservoir exists. This is because steam being lighter and having very low viscosity migrates similar to natural gas and accumulates in the higher portions of reservoirs. Figure 3,

Figure 3

CROSS SECTION THROUGH MAGMA-LAGRANDE #1



a cross section through the area where the well was drilled, shows what I believe the relations may be. The sealing of the reservoir could be from the unconformable nature of the contact of the Clover Creek and the overlying Columbia River basalts and by self-sealing along the bounding fault to the east.

WELL HISTORY

A generalized geologic section and temperature log is shown in Figure 4. This shows the geologic units to be about as anticipated. Laucstrine sediments were penetrated to 512' to the top of the Columbia River Basalt. From there to 1770' was a monotonous sequence of basalt with occasional interbeds of volcanic ash. A minor lost circulation zone was encountered at 1670'.

From 1770' to 1860' a major lost circulation zone was encountered and eight plugs using 425 sacks of cement were required to get through the zone. This lost circulation zone was obviously the major fault zone that has been mapped at the base of Craig Mountain.

After passing through the lost circulation zone the cuttings returned were still basalt, but this time showing silicification, chloritization and destruction of the mafic minerals. There was also a drop in the penetration rate from around 50' an hour to 10' an hour. All indications are that this was the Clover Creek Greenstone of Permo-Triassic age. From 1860' to T.D. at 2729' the section remained the same. There were, however, occasional lost circulation zones. These showed up on the electric log and caliper logs as fracture zones.

All drilling on this well was done using mud as the drilling fluid. I believe if air had been used, at least after getting into the Clover Creek Greenstone,penetration rates would have been much better and much more information would have been gained from the hole.

It is common practice however to use drilling mud in wildcat wells because under most conditions it is cheaper and simpler. On wildcat geothermal wells this is a mistake, particularly when penetrating potential reservoir rocks as the mud effects the rocks it is penetrating to the extent that much of the information you want is masked. First it cools the rock it is passing through; secondly, it plugs any fractures or fissures in the rock; thirdly, the weight of the mud column keeps other fluids from entering the bore hole.

The cooling effect is most significant as mud returns can be from 200° to 275°F cooler than the formation the bit is penetrating. Figures 5, 6, and 7 showing the relationship of flow line temperature to formation temperatures in three geothermal wells in Japan, illustrates this cooling effect. The flow line temperatures

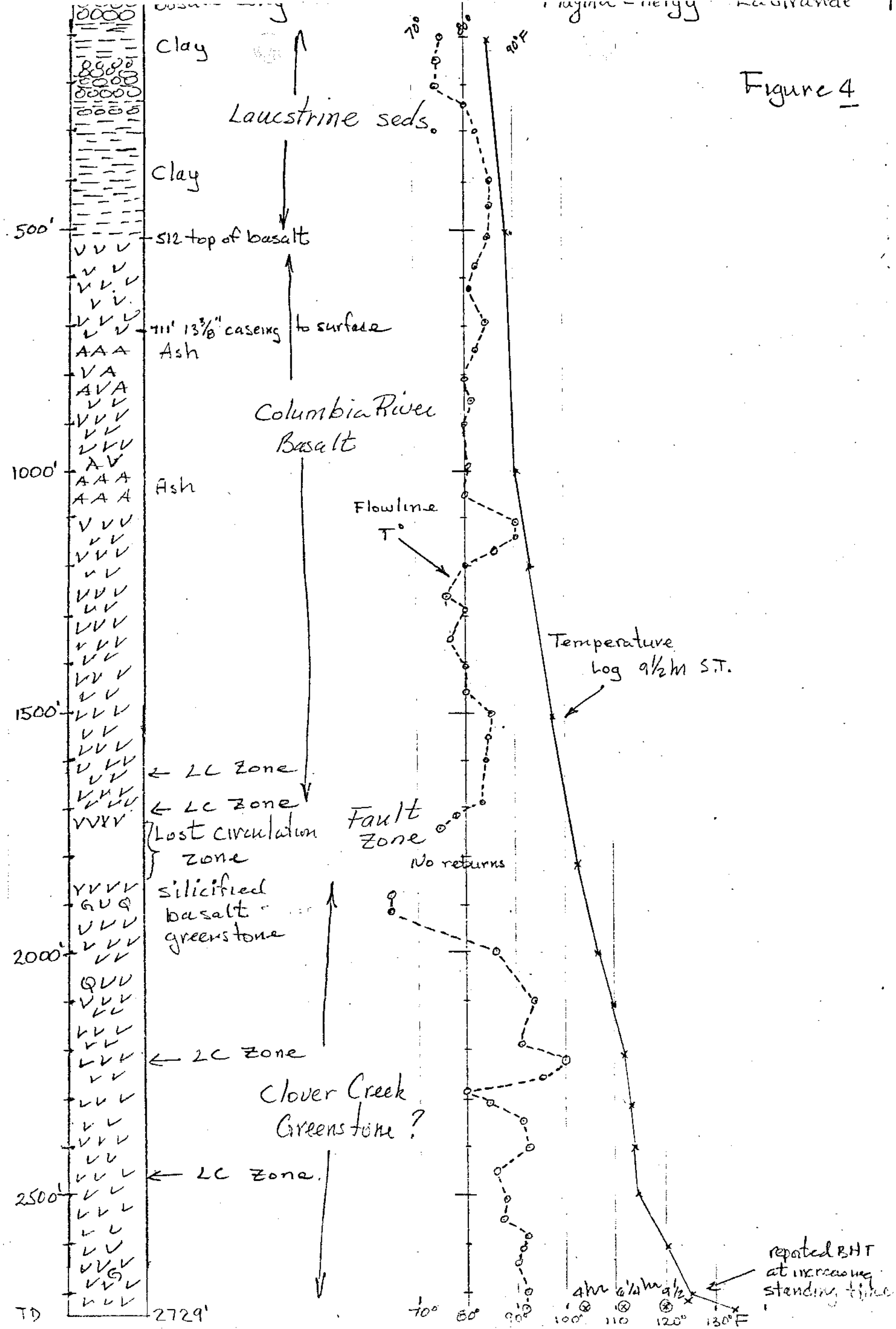

Clay
Laucstrine seds.
Clay
500'
512 top of basalt
711' 13 3/8" caseing to surface
Ash
Columbia River Basalt
1000'
Ash
Flowline T°
Temperature Log 9½ hr S.T.
1500'
LC Zone
LC Zone
Lost circulation zone
Fault Zone
No returns
silicified basalt greenstone
2000'
LC Zone
Clover Creek Greenstone?
LC Zone.
2500'
TD
2729'
70°
80°
90°F
70°
80°
90°
100°
110
120°
130°F
4hr 6¼hr 9½
reported BHT at increasing standing time

Figure 4

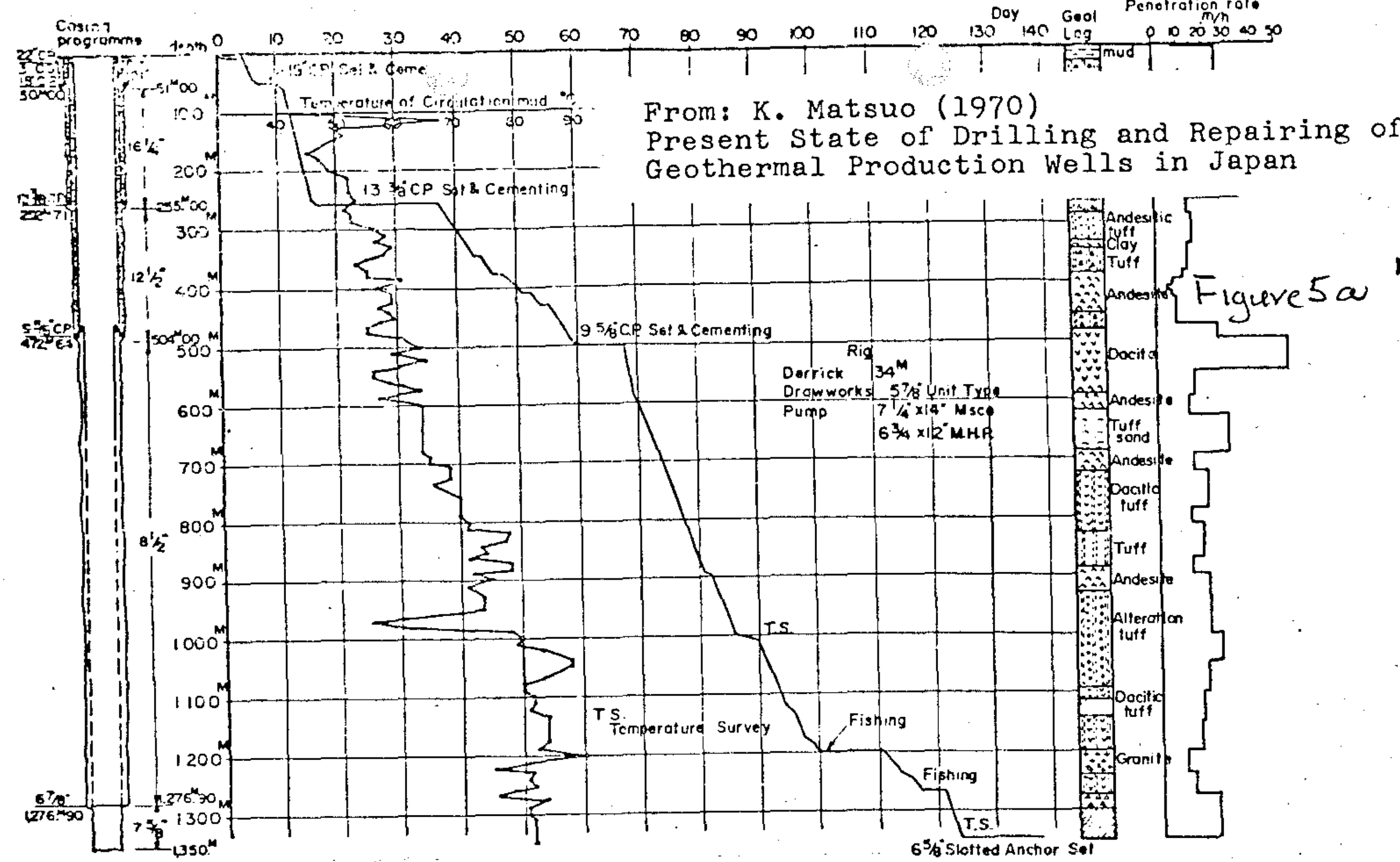


FIG. 5 a — *Drilling Chart of Onikobe GO-10*

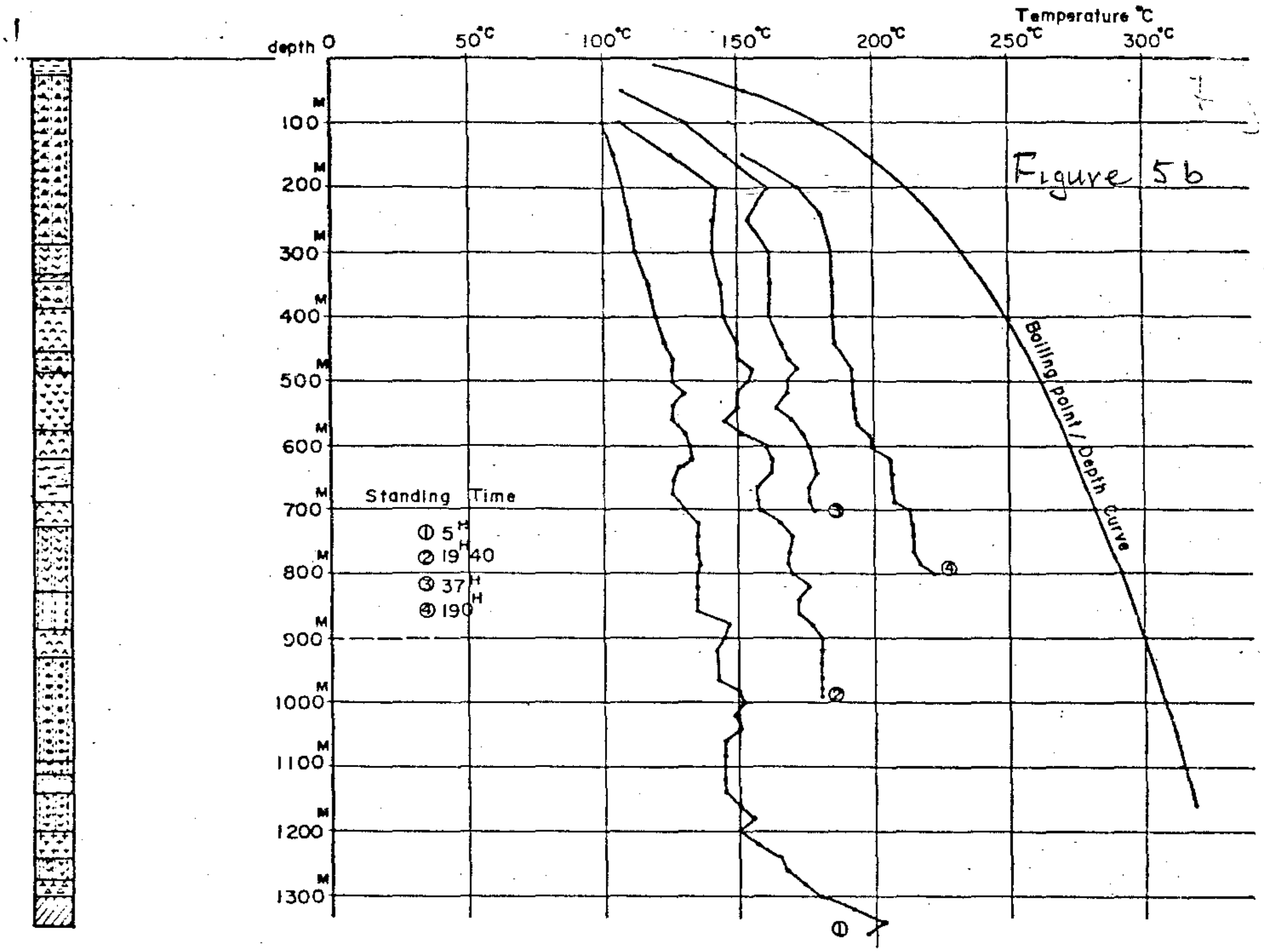


FIG. 5 b — *Temperature Survey of Onikobe GO-10* also show the cooling effect of the lost circulation zones where large quantities of cool mud was pumped into the formations. When exploring for steam at a depth where the mud pressure exceeds expected formation pressures, mud return temperatures don't give useful information - in fact they tend to give a false picture showing the potential production fissures as cool areas when in fact they are cool because their susceptibility to mud penetration has cooled them.

Another purpose of the drilling mud is to seal permeable zones so fluids don't enter the bore hole. If the fluids are at low pressure, mud is particularly effective. It should be pointed out in this well the potential reservoir rock, the Clover Creek Greenstone, was first intersected at 1860'. At that depth the bottom hole pressures produced by the overlying column of mud would be at least 1000psi ranging to 1500psi at the T.D. The maximum pressure that could be expected from steam in the reservoir is 400 - 500psi. With such low reservoir pressure the mud column would seal off any steam so there would be no indication of its presence. If there was hot water at depth its pressures would be somewhere near hydrostatic or 900 to 1500psi so the water might wash away the mud cake and enter the bore hole, but this apparently did not happen - possibly another clue indicating the presence of steam in the reservoir.

Flow line temperatures diagramed in Figure 4 show relatively subtle changes that have in general masked most of the information that was hoped to be gained from this source. It does show, however, a general increase in temperature after passing from the Tertiary section into the Greenstone section. This would indicate the source of the heat is in the horst block rather than in the graben and illustrates to me that the exploration concept of looking at the horst for a potential reservoir is correct.

The temperature log measured in the well after completion of drilling shows only that the circulating mud has been effective in cooling the rock adjacent to the bore hole. The significant data coming from this temperature measurement is the rapid rise in bottom hole temperature shown by Schlumberger in the three soundings made when logging the well. This showed a BHT rise of 16°F in the 5½ hours that elapsed from the first to the last soundings. Also the very high temperature gradient in the bottom 100' of the hole of about 92°F/1000' compared to 25°F/1000' for most of the rest of the hole illustrates the drilling mud has not cooled the bottom of the hole as much as the upper portion because it has not been circulating in that part of the hole for as long a time as in the upper parts of the hole. A more detailed discussion of the temperature characteristics of this well and comparisons with geothermal wells are made in the next section of this report.

REASONING WHY TEST RESULTS ARE UNSATISFACTORY

In a geothermal well, particularly where steam is filling the reservoir, lost circulation is the key to locating permeable zones and production. That is why at The Geysers and at Larderello all drilling in potential productive horizons is done with either air or foam as the drilling medium. When drilling with mud these permeable zones allow the mud to displace whatever fluid was previously in them and if the primary fluid was hot the area is now cooled because of the deeper penetration of cooler mud into the formation. And areas that are tight appear hotter because they are impermeable.

Recognizing that dry steam reservoirs have very low pressures is of critical importance when drilling exploration wells. The fact that the maximum steam pressures expected, about 500psi, are easily overcome and "swamped out" by mud if the depth of the well is much greater than 1000' must always be considered on a testing program.

My contention is that if the steam zone lies at a depth greater than 1000' it will not be found if mud is used for the drilling fluid. I believe that could be the case with this well.

Rather than fill and seal the lost circulation zones in the potentially productive formations they should be kept open and tested to determine the nature of their fluids. Then if of no interest, cemented off before drilling deeper. This testing adds to the cost of drilling the well so it is often not done. But it is a mistake not to test these zones for they contain the reason for drilling the well.

None of the lost circulation zones were tested in this well.

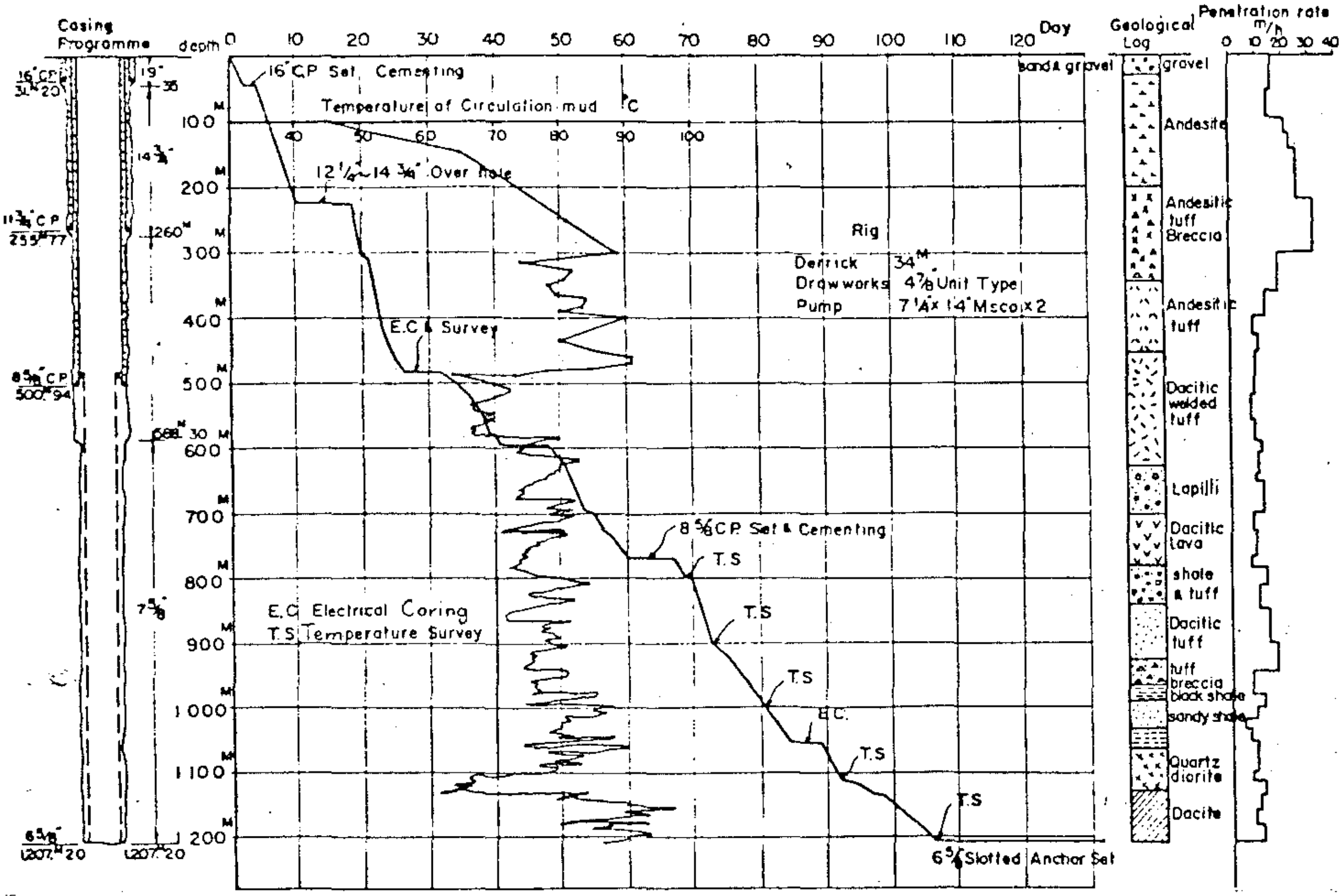
One of the main reasons for using mud as the circulating fluid is to cool the bit to make it last longer as it does an excellent job in transferring the heat from the cutting edge bit to the surface. An example of the cooling effect of the mud is shown in Figure 5 from K. Matsuo (1970). This figure shows mud return temperatures (Figure 5a) at the 300 to 400 meter interval around 55°C (131°F) while true formation temperatures at that interval (Figure 5b, from line 4, after 190 hours of standing time) is around 180°C (356°F) or a cooling effect of around 220°F - enough to make the difference between a failure and a successful well.

Further illustrations of the efficiency of mud on cooling from original formation temperatures are shown in Figures 6 and 7, also from Matsuo (1970).

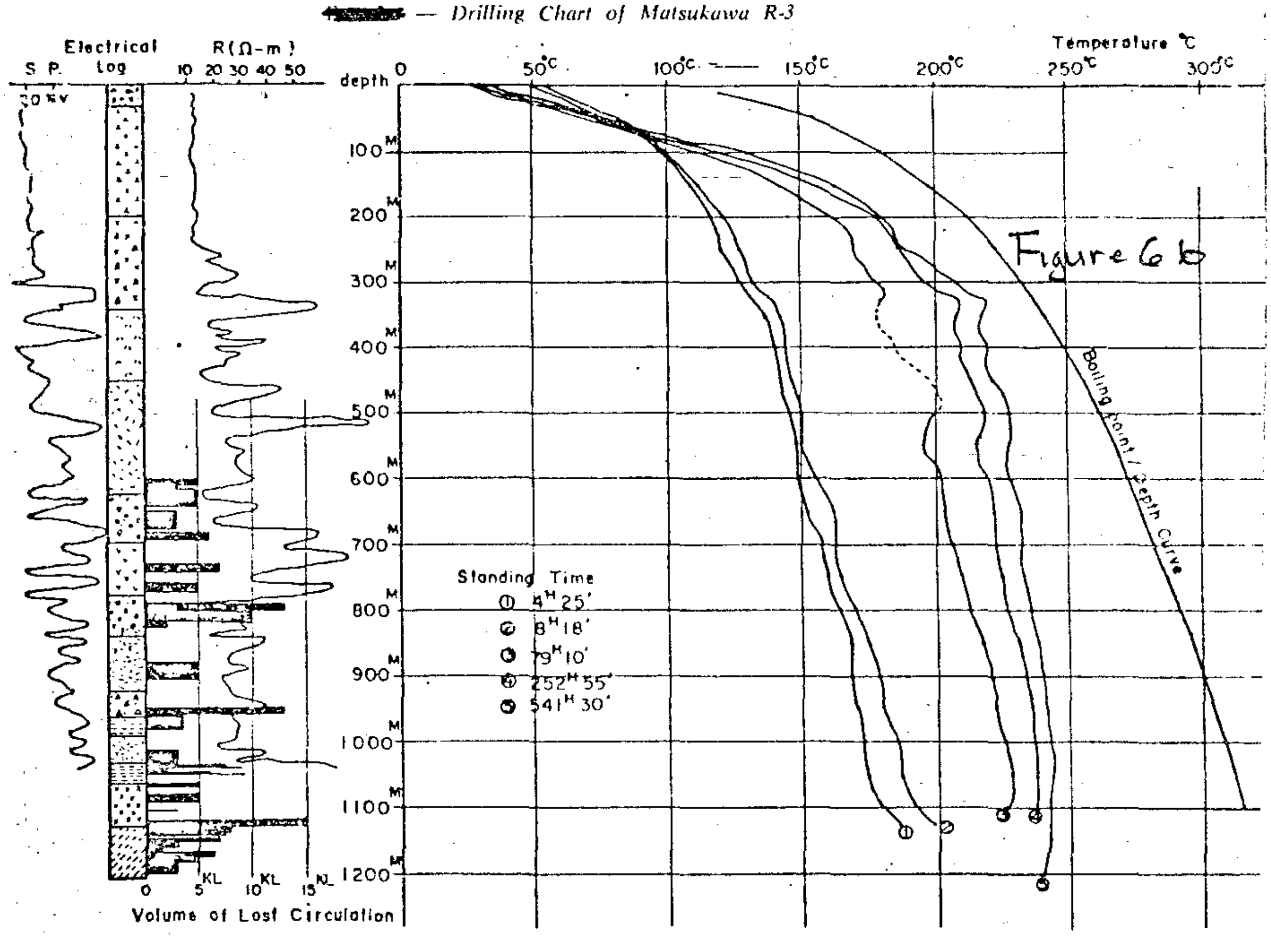
The temperature log on this well taken after 9½ hours of standing time show lower bottom hole temperatures than what is found at

From K. Matsuo, (1970)

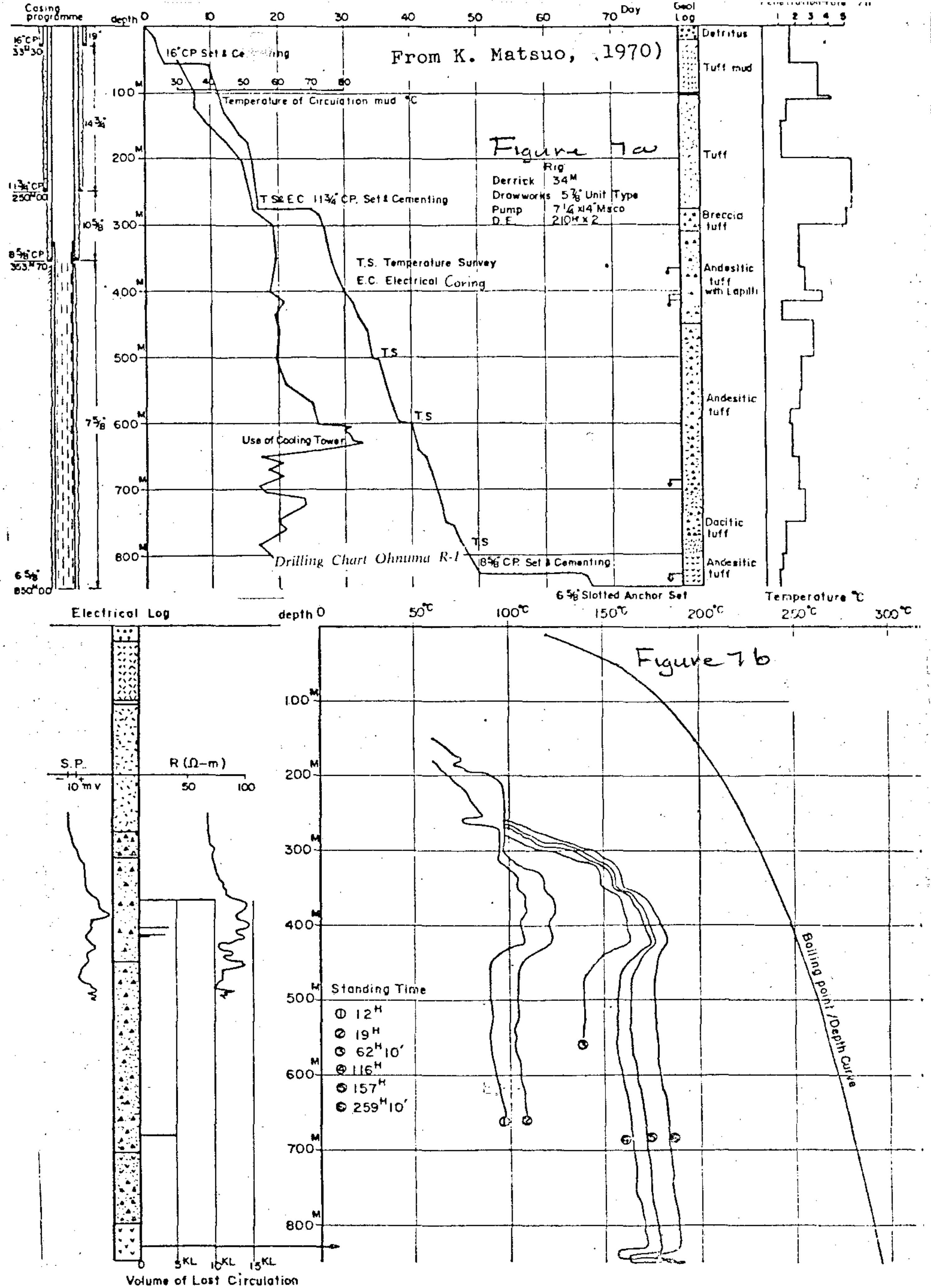
Figure 6a



[redacted] — *Drilling Chart of Matsukawa R-3*



[redacted] — *Electrical logging and temperature survey of Matsukawa R-3*



Electrical log and temperature survey of Ohnuma R-1 the surface in nearby wells and springs; another indication of the efficiency of mud for cooling the drill hole. The most significant information derived from the temperature log is the high gradient of about 92°F/1000' found at the bottom of the hole. This does not indicate true gradient but shows the temperatures have been disturbed for as the drilling mud has been circulating in the upper part of the hole for a longer period of time it has cooled that part more than the bottom of the hole. The temperature logs shown in Figures 5, 6, 7, and 8, all show this same effect on the measurements made shortly after drilling the wells.

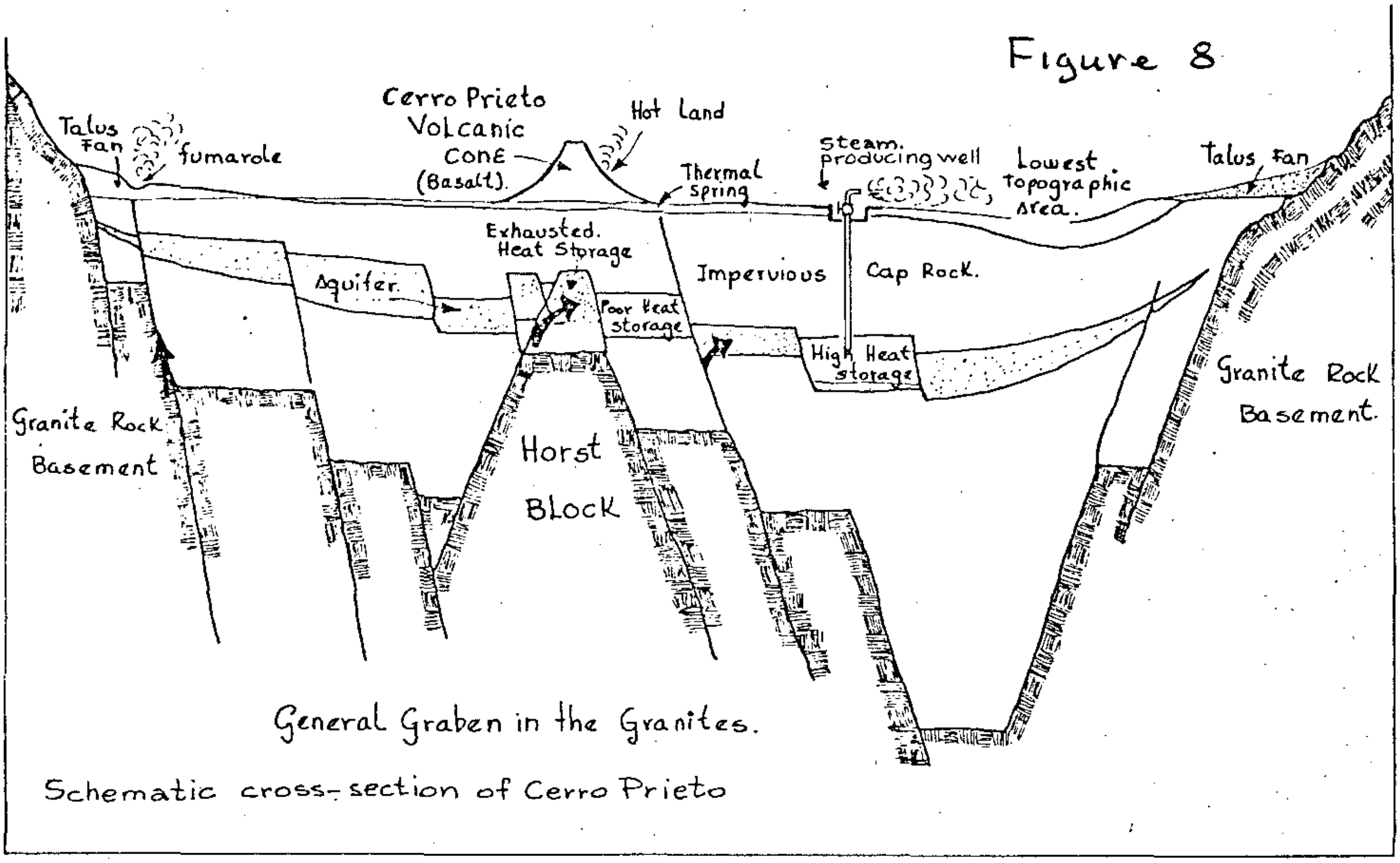
To get an idea of the true formation temperatures it is necessary to make several loggings over an extended period of time. Magma-LaGrande was only logged once, after 9½ hours standing time so it can be reasoned that logged temperatures in this well are significantly lower than true formation temperatures.

Figures 5, 6, 7, and 8 show temperature logs from three geothermal wells in Japan and one at Cerro Prieto, Mexico. The Japanese wells show the relationship of flow line temperatures (part "a" of the figures) to formation temperatures (part "b" of the figures) as mentioned above when discussing the cooling effect of mud. Figures 5b, 6b, and 7b, show how much the mud had cooled the bore hole and the recovery by allowing the well to stand and temperature to stabilize. The significance of this is to compare the first measurement to true formation temperatures. Figure 5b shows an average increase of about 75°C (135°F) in 190 hours (8days). Figure 7b shows a well in which at 500 meter depth the temperature increased from about 80°C (176°F) to 175°C (347°F) for an increase of 171°F in 259 hours (10½ days). Similar effects are shown in figures 6 and 8.

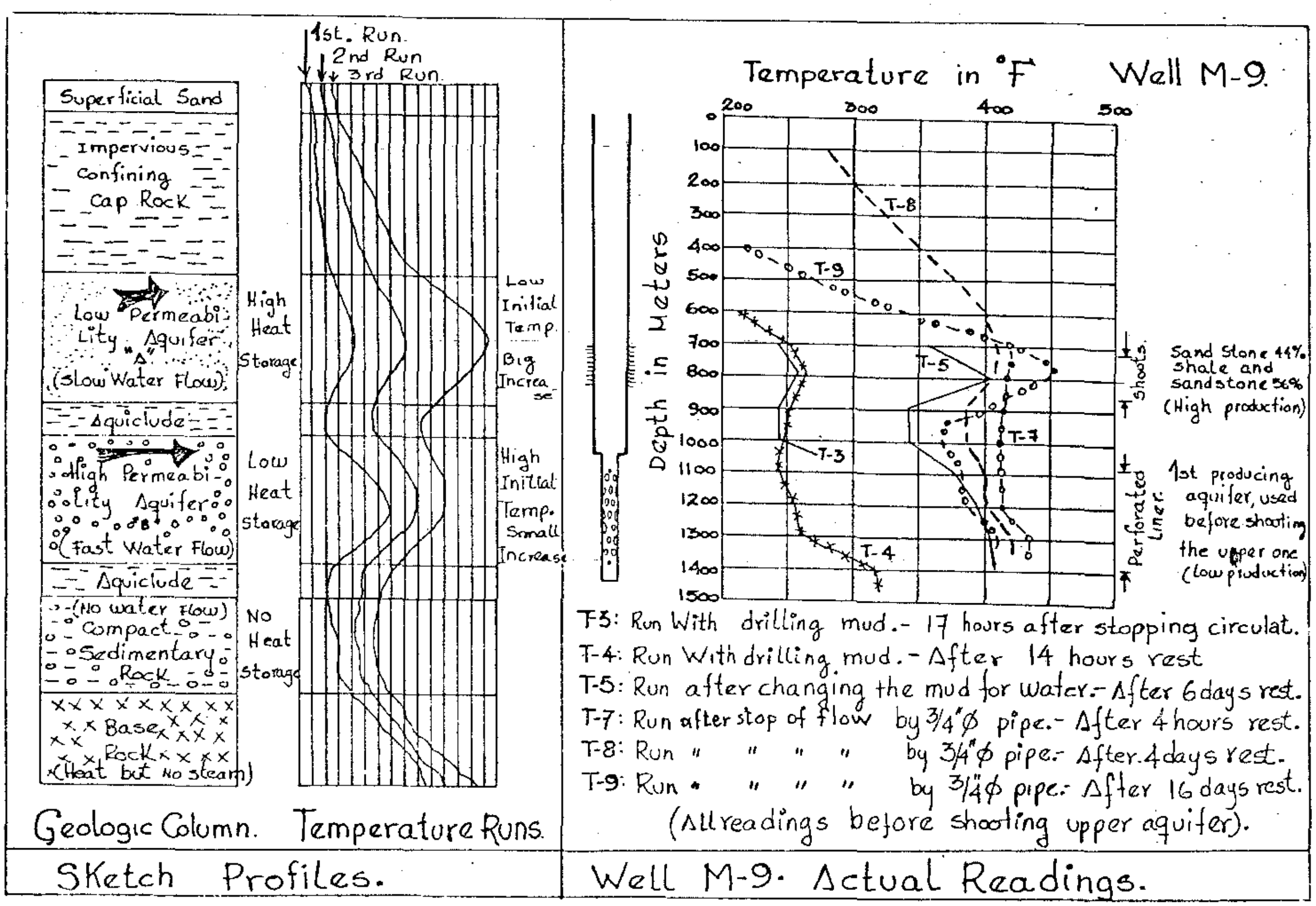
Another indication of true temperature conditions in the hole comes from the bottom hole temperature reported by the Schlumberger engineer as he made the three different runs for the Electric-induction, Neutron-density and Temperature logs. These were made respectively at 4 hours, 6½ hours and 9½ hours standing time (after stopping mud circulation). Bottom hole temperature at these three intervals was 104°, 112° and 120°F for a rise of 16° in 5½ hours or about 3°/hour. Comparing this temperature rise with the three Japanese wells shown in Figure 5b, 6b, and 7b, the first two loggings show a rise of between 2.6° and 4.5°F per hour, or about the same rate as the Magma well.

This compilation points out that the method of drilling, monitoring of temperatures and logging of the well do not give a true picture of the subsurface conditions intersected in the area.

rom J. Isita y Septien (1970)
ow Permeability of a Thick Geothermal Aquirfer in a Highly Fractured
rea As a Necessary Requsit r High Steam Production



[redacted] — *Heat storage in an aquifer.*



[redacted] — *Temperature behaviour with permeability.*

RECOMMENDED ACTION TO EVALUATE THIS PROSPECT

The logical course to evaluate this prospect is to re-enter the Magma well and take advantage of the 2700' they have already drilled. First it would be necessary to get a permit from the Oregon Dept. of Geology and Mineral Industries to re-enter, but this is only a formality. There are four plugs in the well - 20' at the surface and 3 - 100' at depth. The first 100' plug is at 678' to 778'. Two other 100' plugs were set at that point but slipped, probably to the lost circulation zone near 1750'.

These plugs could be drilled out using a local water well driller with a small rig. The first two plugs would be quite simple to drill but the two that slipped may be more difficult. However, because the cement plugs are set in basalt the bit would tend to stay in the cement and not go into the harder rock.

After drilling through the plugs, 1½" to 2" iron pipe plugged on the bottom should be set and filled with water. This water after 2 or 3 days would stabilize to formation temperatures and the true gradient could be measured.

The cost of re-entering the well, putting in casing and measuring the gradient should be no more than $30,000, a very reasonable price for the information on whether to proceed or abandon the project.

I would estimate the bottom hole temperature when the well is re-entered will be in the range of 230° - 250°F. To be successful, 450° temperatures should be found by 6000' to 7000'. For those temperatures to exist it is necessary to have a gradient of about 60°F/1000' or 110°C/km in the Clover Creek Greenstone. If these gradients are present then the well should be re-entered and deepened to 6000'-7000' or wherever commercial production is found.

I would strongly recommend that air be used as the circulating medium rather than mud when the hole is re-entered. As the lost circulation zone at 1760' to 1860' may still be leaking, more effort should be made to seal it off before proceeding deeper. Possibly the well should be cased to the top of the Clover Creek Greenstone.

After the hole is cleaned and drilling resumes every effort should be made to determine the nature of the fluids in the lost circulation zones for these are the potential productive horizons.

OTHER ACTIVITY IN THE AREA

Amax has a major acreage position to the north and east of this leasehold and Gulf has acreage to the south. Both would probably be interested in the results of any tests made on the well and may contribute both for cleaning and measuring the existing well and bottom hole money for deepening.

GEOTHERMAL LEASES

A landownership "take-off" of the Craig Mountain prospect area was prepared by the Abstract and Title Company of LaGrande. Mr. Stuart Wylde, vice-president of the abstract company also assisted Lon in securing the leases. The enclosed topographic map shows the outline of the leases presently held. Landowners are listed below.

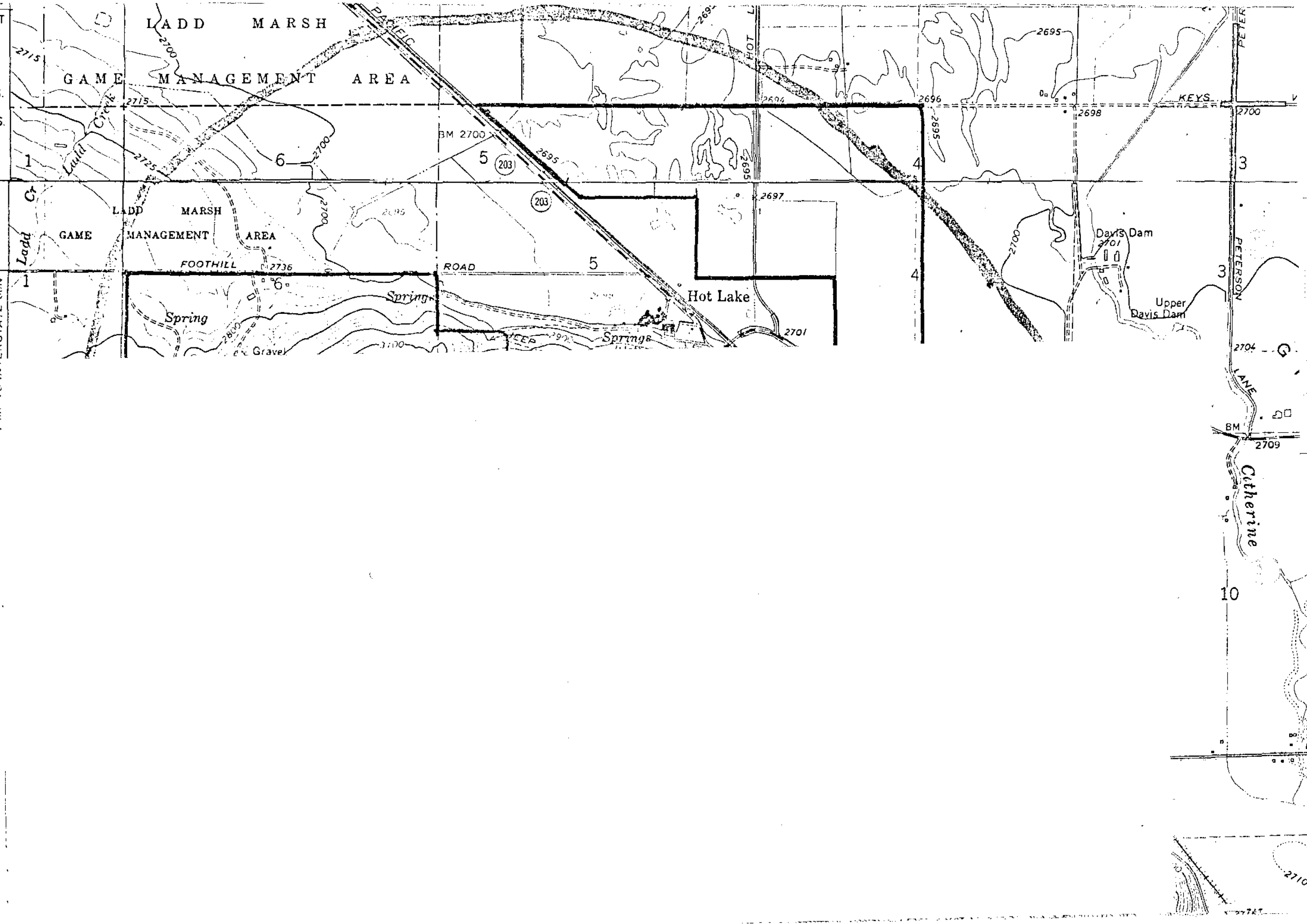
CRAIG MTN. GEOTHERMAL PROSPECT

LA GRANDE, OREGON

LIST OF LEASES AND RENTALS

DATE OF LSE.	LANDOWNERS	ACRES	RENTALS
Jan 18, 1971	Henry J. Simons & Ruby Simons	374.55	$ 374.55
Jan 18, 1971	Lucille M. Bingham & Mr. & Mrs. Wilfred Barstead	99	99.00
Jan 22, 1974	Rodney E. Miller	585	585.00
Jan 24, 1974	Clarice Kohler	25	25.00
Mar 27, 1971	Odin E. Miller & Fonda W. Miller	167.62	167.62
Apr. 2, 1971	Rodney E. Miller	105	105.00
May 31, 1974	William B. Hawkins & Camille Pl Hawkins	95	95.00
June 13, 1973	John William Boothman & Josephine E. Boothman	3,047	3,047.00
	Totals	4498.17	$4498.17

The geothermal leases are on a form prepared by Mr. Joe Aidlin of Los Angeles, or slightly modified from Mr. Aidlin's form with his approval. The primary term of all the leases is 10 years, and the first lease taken was in January of 1971. Royalty to the landowner is 10%. Annual rentals is set at $1.00 per acre except that the large Boothman lease at the end of 5 years is increased to $1.50 per acre and after the first production is $2.00 per acre.


LADD MARSH
GAME MANAGEMENT AREA
LADD MARSH
GAME MANAGEMENT AREA
Ladd Creek
Ladd Cr
PACIFIC
BM 2700
203
203
Hot Lake
Springs
Spring
Spring
Gravel
FOOTHILL
ROAD
KEYS
PETERSON
PETERSON LANE
Davis Dam
Upper Davis Dam
Catherine
BM
2709
2715
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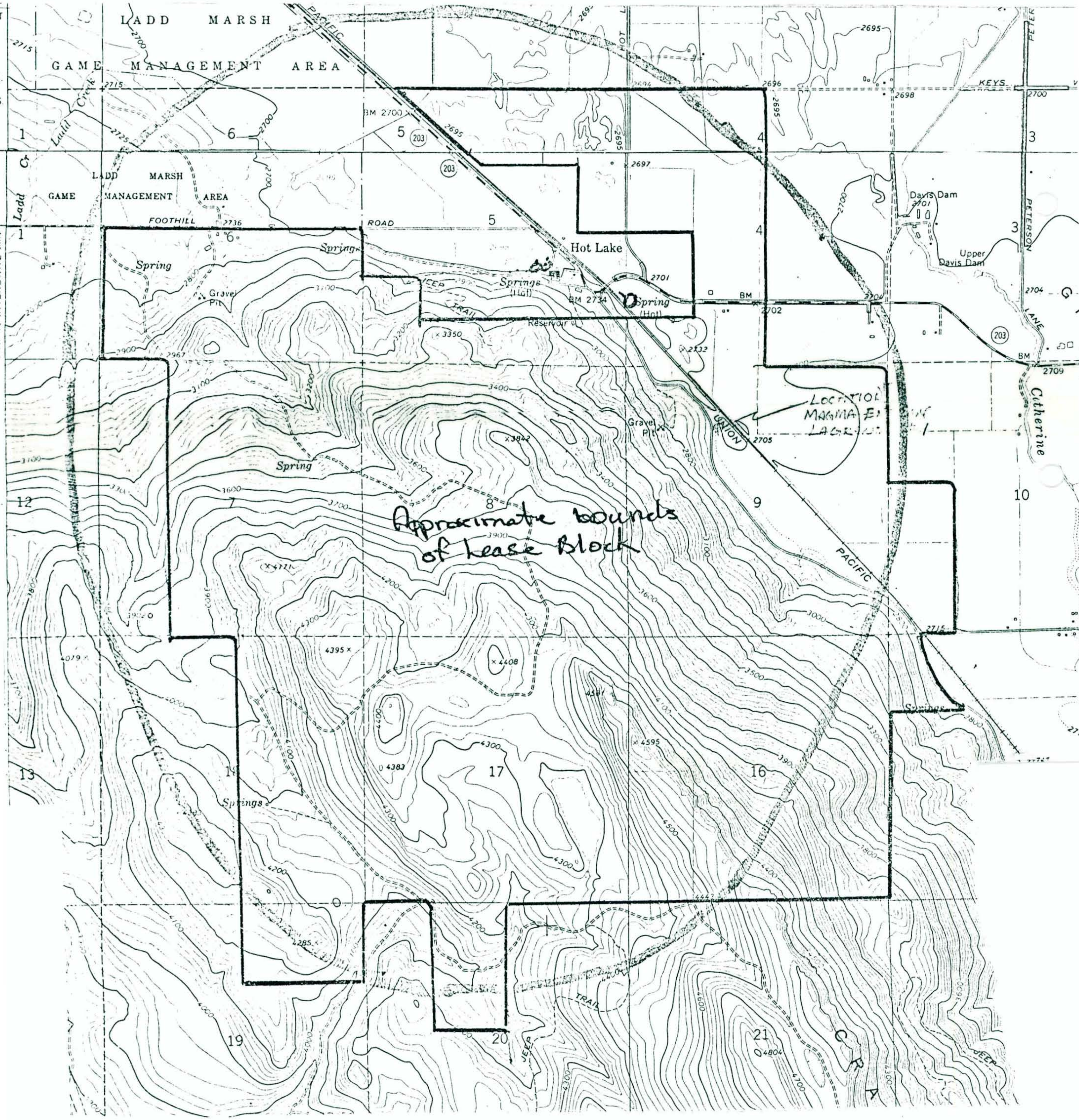
LADD MARSH
GAME MANAGEMENT AREA
LADD MARSH
GAME MANAGEMENT AREA
FOOTHILL ROAD
PACIFIC
UNION
KEYS
PETERSON LANE
Hot Lake
Springs (Hot)
Spring (Hot)
Spring
Springs
Gravel Pit
Reservoir
Davis Dam
Upper Davis Dam
Catherine
JEEP TRAIL
203
Approximate bounds of Lease Block