GL01901

MZI-11A

WELL HISTORY/DRILLER'S LOG SUMMARY

MAŻAMA I-11A
Crater Lake, Oregon

9/12/86	Move in and rig up Buckner Drilling rotary rig. Drill 8" hole to 24' with air foam.
9/13/86	Drilling 8" hole from 24' to 370' with air and foam.
9/14/86	Drill 8" hole from 370' to 575' with air and foam.
9/15/86	Mix mud and condition hole.
9/16/86	Circulate and condition mud for casing job.
9/17/86 to 9/28/86	Run in hole to 575' and circulate--pull out of hole. Rig up and run 18 joints (575') 4-1/2" - 11.6# N-80 casing with 8 round LF & C threads. Land casing at 575' and circulated with mud. Cemented with Halliburton, ran 3 bbls. of H_2O ahead of 272 cubic feet Class G cement with 1:1 Perlite, 3% gel. Displaced top plug to 545' with 8 bbls. of H_2O. Plug in place at 1500 hours 9/17/86. Good returns (100+ cubic feet). Job witnessed by Steve Henderson and Dennis Simontacchi.
9/29/86 to 10/7/86	Weld 6" - 900 series slip on casing head to 4-1/2" casing. Install hydraulic operated annular and blind rams BOP's with dual controls. Install Hydrogen Sulfide detectors and alarm system. Rig up Longyear core rig and work on BOP's.
10/8/86	Tested BOP's 1/2 hr. each at 700 psi, test ok. Witnessed by Dennis Simontacchi.
10/9/86	Drilled cement from 545' to 575'.
10/10/86 to 10/24/86	Coring HQ size (3.50" OD) hole F/575' to 1354'. Fighting lost circulation.
10/25/86	Run temperature survey.
10/26/86 to 10/29/86	Rig down and move off Longyear.

GG:sr:20
Z6132:A5

POSSIBLE LOST CIRCULATION ZONES AND/OR WATER ENTRIES

MZI-11a

It is very difficult to determine exact locations of fluid loss or water entries in the hole during drilling operations. There was no fluid loss reported during the drilling of the surface (0'-575'); however, this was drilled with an air hammer using water and foam mix. There were no water entries in the surface hole which was dry to bottom prior to running casing. There was no observable loss of cement to formation during cementing of the surface casing.

During core drilling (575'-1354') with light mud, a lost circulation zone was reported by the driller at approximately 640'. Upon review of the core, it appears more likely that the fluid loss was between 690' and 693' depth and the standing fluid level while drilling was about 640'.

The attached temperature gradient profile shows a linear gradient in the top 550' of the hole and the bottom 100' or so of the surveyed hole. The thermally perturbed portion of the profile (approximately 550' to 1230') does not suggest cold water entries because the temperature reversals are too minor. These minor reversals probably are reflective of zones where cold drilling fluid was lost to the formation. Since this temperature profile was recorded after only about 20 hours of stabilization, the minor reversals may be the best means of trying to determine where fluid loss actually occurred. Inspection of the core suggests fluid loss zones may occur at the following intervals: significant 690'-693'; major 966'-971'; diffuse 966'-971'; minor 1149'-1152'; minor 1160'-1162'; minor 1263'-1266'; minor 1308'-1314'. These observations on the core do not correspond well to the minor reversals on the temperature log.

There is no evidence to suggest that there were any water entries at all in the hole. The regional water table was not encountered but lies within 200' below the bottom of the hole. The bottom hole elevation is approximately 4700' above sea level and Klamath Marsh is about 4500' above sea level. A cold regional groundwater table, as normally conceptualized, may not be present beneath the site as evidenced by the high heat flow observed in the lower portion of the hole.

Attachment

JLF:sm:42:12:19:86:6138

March 14, 1987

Director, NPS
Attn: Energy, Mining and Minerals Division
(WASO 480, Room 3223
Main Interior Building)
National Park Service
P. O. Box 37127
Washington, DC 20013-7127

RE: Comment on Criteria in Support of Listing of Crater Lake National Park as a Significant Thermal Feature and Request to Delete From List Public Law 99-591, Sec. 115 ("The Act")

Dear Sir:

We submit that the "thermal features" of Crater Lake National Park are not of a nature requiring additional protection under this Act and therefore should be deleted from the Final List. The analyses of the significant thermal features of the Park, as prepared by the National Park Service and summarized in the 2-13-87 Federal Register, is erroneous and misleading.

There is no evidence for "hot spring" activity existing on the floor of Crater Lake. The identified thermal features on the lake floor are two areas of moderately anomalous heat flow. These areas of slightly warmer rock (albeit still quite cold at 39°F) cannot be affected by the activities of man.

The identified temperature anomalies are five miles distant from the nearest possible geothermal development.

Crater Lake and Crater Lake National Park in its entirety, is protected from adverse affects under a myriad of existing laws, including the Geothermal Steam Act, the National Environmental Policy Act, and legislation specific to the Park.

Attached for your consideration are the following:

Exhibit 1: Critical review and Response to criteria data relied on by the National Park Service in support of listing Crater Lake as a significant thermal feature. By Joseph LaFleur, Senior Exploration Geologist, California Energy Company, Inc.

Exhibit 2: Notice of Conference and tapes of proceedings of a scientific conference on the geochemistry and hydrology of Crater Lake, held on February 24-25, 1987 in Portland, Oregon to "provide a forum for evaluation and discussion of relevant research and its implications." Representatives of the U.S. Geological Survey, Army Corp of Engineers, Oregon State University, other researchers and industry reviewed the data.

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A conclusion of the conference was that there was insufficient evidence to conclude that thermal springs exist on the bottom of Crater Lake . A major conclusion of the conference was that any thermal features which may exist would be unaffected by geothermal development outside of the Park on National Forest lands.

We would appreciate notice of any opportunities to participate further in any congressional hearings or other opportunities to comment.

Respectfully submitted,

James L. Moore
Senior Vice President Exploration

California Registered Geologist
#980

JLF/PE/AKC:42

Enclosures

EXHIBIT 1

Feature: Crater Lake

Significance Criteria: 1.

"Size--48 square kilometers"

Response--This is the approximate surface area of the lake and is not the size of the thermal features. The thermal features identified were two areas of slightly warmer lake floor. (Williams, D.L. and Von Herzen, 1983 P. 1097). These two areas of warmer rock have a combined area of approximately 2.5 sq. kilometers (See Attachment 1). The anomalous heat emanating from these slightly warmer areas would not be discernible to the touch. These heat flow anomalies are over five miles from the nearest possible geothermal development.

"Extent--Hydrothermal vents are located on the south central floor of the basin of Crater Lake at approximately 1500 feet depth - 30-150 liters per second inflow of thermal water is estimated to enter Crater Lake."

Response--This statement is misleading. Hydrothermal vents were never identified or "located." The highest temperature measured in 62 soundings was 3.64°C (38.6°F), which is less than 0.15°C (0.27°F) above normal lake floor temperatures (Williams, D.L. and Von Herzen, 1983). (Note that water freezes at 0°C). The basis for the 30-150 L/sec "estimate" was never published but it is based on the erroneous assumptions that all the chloride in the lake comes from currently active hot springs and that the chloride level remains constant at this time. There is no data to support these contentions. In fact, the scant available data suggests the contrary. The published literature suggests a declining chloride concentration. Phillips and Van Denburgh, 1968 reported chloride concentrations of 11 ppm in 1912, 10 ppm in 1961 and 9.5 in 1964 (Phillips, K.N. and Van Denburgh 1968, Table 13, Page E57). The average of 14 samples taken in 1984 was about 9.1 mg/L (approximately 9.1 ppm). (Salinas, White, and Thompson, 1984). This apparent decline rate is in good agreement with what the decline rate would be if no chloride were entering the lake (see attached Calculation Sheet 1). Therefore, the 30-150 L/sec rate is not a valid estimate but an unfounded guess. This guess also ignores the highly probable and logical conclusion that other sources of chloride would also contribute to the chloride concentration of the lake. Salts deposited on the original caldera floor may well contribute to the current lake chemistry. Salts left from evaporation would also contribute. Crater Lake evaporates about 2 ft. per year (Phillips & Van Denburgh, 1968). A continuing source of chloride may be hydrogen chloride gas. Hydrogen chloride (HCl) gas is a volatile common to degassing volcanic edifices such as Mount Mazama. Stoiber and Williams recorded 830 tons per day of HCl emanating from a volcanic crater in Nicaragua (Stoiber, R.E. and Williams, S.N., 1984). To ignore this highly probable source of chloride is highly inappropriate, especially since other noncondensable gases such as helium and radon have been recorded in the lake. Isotopes of helium and radon are common to degassing volcanic edifices and provide no evidence for a hydrothermal system.

The "estimate" of 30-150 L/sec was obtained by comparing the chloride content of a lake situated above a degassing major volcanic edifice (6,800 years old), with hot springs issuing from convection cells in 5-40 million year old volcanic rocks of the western Cascades. There is no reasonable geological basis for this comparison. If the author of the "estimate" had compared the chloride content of the lake with the chloride content of cold mineral springs, common throughout the Cascades, similar flow rates would probably have been "estimated." Chloride is not an element necessarily indicative of heat and is not unique to hot spring activity.

Even if one were to accept the totally unfounded and illogical guess that all the chloride in the lake comes from currently active "hot springs," the resulting "guesstimated" flowrate of 30-150 L/sec would be infinitesimal compared to the total lake volume. Annually, the flow rate 30-150 L/sec would constitute a volume equivalent to 0.000055 to 0.00027 of the total lake volume (see attached Calculation Sheet 2). Compared to the volume of the lake, the midpoint of this 30-150 L/sec is equivalent to putting one and a half drops per day of thermal water into a 44 gallon bath tub of ice water (see attached Calculation Sheet 3). Although there is no evidence that this 1-1/2 drops per day is being added, it would have undetectable affect on the physical properties of the total volume. The two areas of slightly warmer rock identified by Williams and Von Herzen could generate local convection cells that could facilitiate vertical mixing to the mid depth range. These two areas of warmer rock are the significant thermal features on the lake floor and cannot be affected by the activites of man. Therefore, additional legislation to protect them is unnecessary.

> **"Uniqueness--Crater Lake is among the highest, largest and deepest caldera lakes in the world. It is known for its blue color nearly pure optical properties and extreme water clarity."**

Response--These statements address the lake not the thermal features. The deep blue color is a result of the clarity. The apparent 25-30% loss of clarity in a 15 year period reported by Dr. Larson (Larson, Douglas W., 1984) will cause a change in color if allowed to continue. Any thermal vents, if they were present, would add to that loss of clarity by providing nutrients to the lake.

Significance Criteria: 2.

> **"Scientific and geologic significance--Studies indicate that thermal springs feed the lake from the vents located on the floor of the basin. Bathymetric and temperature surveys are needed to characterize the contribution of these vents to the lake's water quality. Crater Lake resembles the primitive ocean. It is ideal for limnological studies and is a prime example of a caldera lake. It is an isolated system which approximates a closed system and provides a laboratory to investigate environmental disturbances from outside influences such as atmospheric fallout."**

Response--The statement that thermal springs feed the lake is misleading. The only data that may suggest the ascension of thermal waters is the 0.15°C above ambient lake floor temperatures that Dr. Williams recorded. This slightly thermal (3.64°C) water was interpreted to be lake water convecting downward and back upward within the lake subfloor (Williams, D.L., 1983). Therefore, the term "feed the lake" is incorrect, since no extraneous water source was suggested by Dr. Williams. That is why Dr. Williams has repeatedly stated that activity outside of the lake cannot effect the thermal features in the lake. The less than 0.15°C anomalous temperature could have been just as reasonably interpreted to be conductive heating of lake water from warmer rocks below the lake floor, without convection of lake water in the subfloor.

Crater Lake bears no resemblance to a primitive ocean. The lake had initially higher salinity due to fumarolic activity at the time of caldera collapse and has become fresher with time. The lake is now fresher than any primitive ocean could have been. The oceans became saltier with time and, therefore, the comparison is unfounded and illogical.

Thermal vents occur on the ocean floors where the oceanic crust is being rifted away from the spreading centers at about 10cm/yr and active faulting is commonplace. The floor of Crater Lake Caldera is tectonically quiescent. Hot springs are relatively short-lived features due to self sealing by mineral precipitation. The cold lake temperatures and tectonic quiescence of Crater Lake make it an unlikely place for hot springs to persist.

Although Crater Lake is definitely not appropriate for comparison to oceanic settings, it does lend itself to interesting limnological studies. However, the purpose of the Crater Lake National Park unit was not to provide a laboratory for research, it was intended to protect the quality of the lake water. Research vessels with outboard motors and water cooled engines do not enhance the lake's water quality.

Significance Criteria: 3.

> **"The extent to which the feature remains in a natural, undisturbed condition - The feature is in a natural, undisturbed condition."**

Response--The thermal features, two areas of warmer rock on the lake floor are in natural undisturbed condition. This legislation, however, contends that the whole lake is a thermal feature. The lake is not in a natural undisturbed condition. Fish have been planted in the lake and there are current research results that strongly suggest sewage infiltration from Rim Village may be affecting the apparent loss of clarity. (Dahm, Dr. Clifford, 1986).

Significance Criteria: 4.

> **"Significance of the feature to the authorized purposes for which the unit was created - Crater Lake National Park was established in 1902 to preserve the caldera lake and to assure the retention of the lake's superb water quality (16 U.S.C. 121)."**

Response--Any thermal vents in the lake would have to be deleterious to the quality of the pure lake water. Why is legislation being proposed to protect hypothetical thermal vents which, if present, would have effects on water quality contrary to the purpose for which the park was established?

NOTE: Shading added by LaFleur.

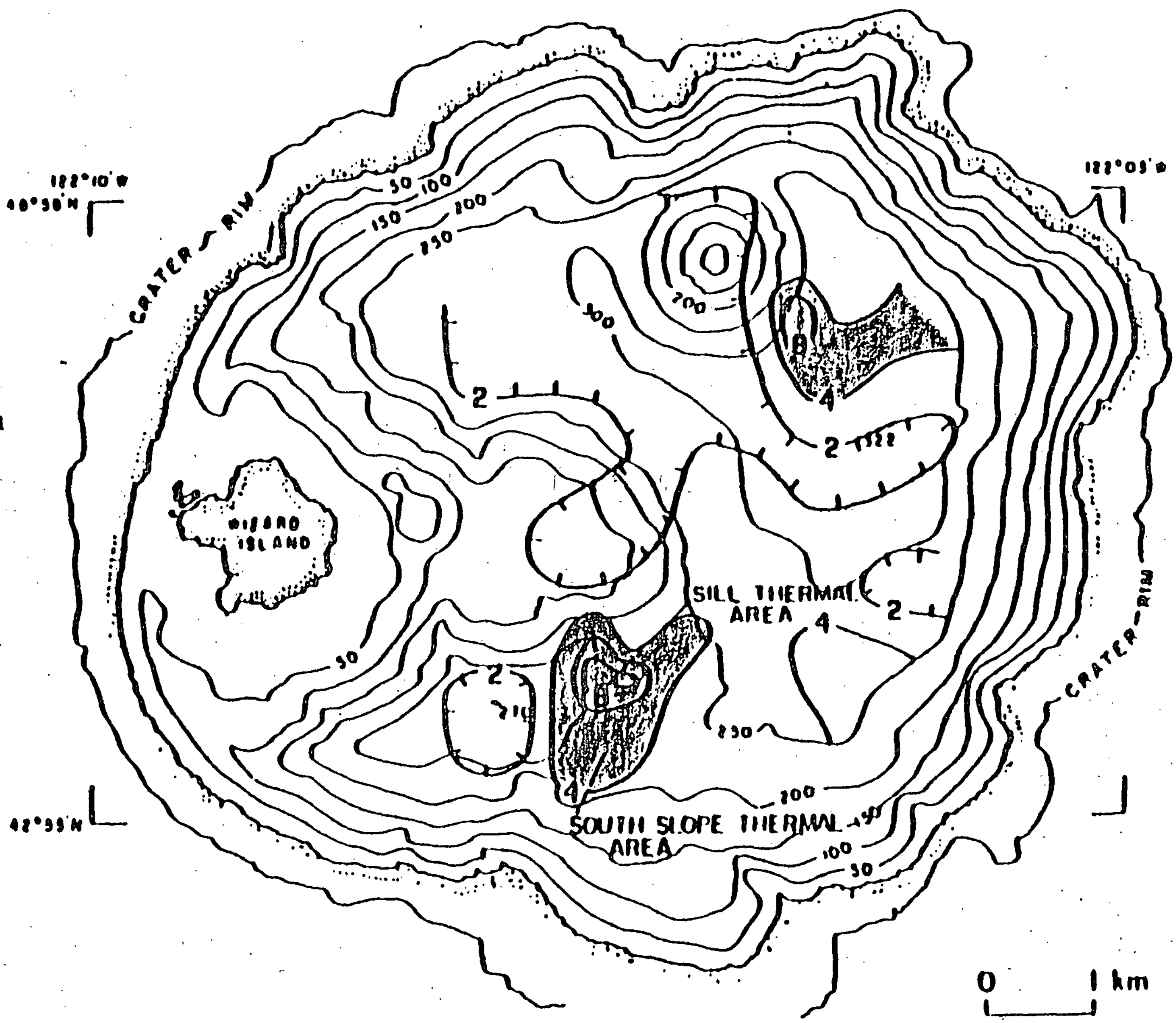

Fig. 3. Heat flow contours at a 2 HFU (84 mW/m²) contour interval. Contours above 8 HFU (334 mW/m²) are omitted for clarity.

CALCULATION SHEET 1

Reported Chloride Concentrations, Crater Lake, Oregon

Data Points:	Date	Concentration	Source
	1912	11 ppm	Phillips & Van Denburgh, 1968
	1961	10 ppm	" " " " " "
	1964	9.5 ppm	" " " " " " "
	1984	9.13 ppm	Salinas, White, & Thompson, 1984 (Average of 14 determinations)

Matrix for Comparison of Apparent Decline Rates

	1912 11 ppm	1961 10 ppm	1964 9.5 ppm
1961 10 ppm	1 ppm/ 49 Yrs.	X	X
1964 9.5 ppm	1.5 ppm/ 52 Yrs.	.5 ppm/ 3 Yrs.	X
1984 9.13 ppm	1.87 ppm/ 72 Yrs.	.87 ppm/ 23 Yrs.	.37 ppm/ 20 Yrs.

The Average Rate of Apparent Decline between any Two Data Points

	1912	1961	1964
1961	.020 ppm/Yr.	X	X
1964	.029 ppm/Yr.	.167 ppm/Yr.	X
1984	.026 ppm/Yr.	.038 ppm/Yr.	.0185 ppm/Yr.

The average of these six calculated rates of apparent decline is <u>.04975 ppm/Yr.</u>

If no additional chloride were entering the lake, the chloride decline rate could be estimated by determining what the rate of change would be (assuming the lake to be thoroughly mixed annually).

Annual Seepage Loss: 64,400 Acre Ft.

Phillips & Van Denburgh, 1968

Total Lake Volume: 14,000,000 Acre Ft.

$$\frac{6.44 \times 10^4 \text{ Acre Ft.}}{14 \times 10^6 \text{ Acre Ft.}} = .0046$$

This ratio would be the rate of decline for any given year if no chloride were being added.

$$.0046/\text{Yr.} \times 9.13 \text{ ppm*} = .042 \text{ ppm/Yr.}$$

*Averaged 1984 chloride concentration (Salinas, White & Thompson, 1984)

This would be the rate at which the chloride content would currently be declining if no chloride were being added. This agrees well with the .04975 ppm/Yr. calculated for the apparent decline rate from data reported in the published literature.

NOTE:	Because the accuracy of analysis for chloride determinations is about plus or minus 1 ppm, it is actually impossible to say whether the chloride content of the lake is or is not really changing. The apparent decline since 1912 is just that - apparent. However, it is illogical to ignore this apparent decline and assume no decline.

CALCULATION SHEET NO. 2

The "estimated" flow rate of 30-150 L/sec:

1 L/sec = 15.85 gal/min. = 8.33×10^6 gal/Yr.

30 L/sec = $.25 \times 10^9$ gal/Yr.

150 L/sec = 1.25×10^9 gal/Yr.

Total lake volume = 14,000,000 Acre Ft. (Phillips & Van Denburgh, 1968)

1 Acre Ft. = 325851.40764 gallon liquid U.S.

14,000,000 Acre Ft. = 4.57×10^{12} gallons = Total Lake Volume

The "estimated" annual flow rate compared to the total lake volume would be:

$$\frac{.25 \times 10^9 \text{ gal.}}{4.57 \times 10^{12} \text{ gal.}} = 0.000055$$

$$\frac{1.25 \times 10^9 \text{ gal.}}{4.57 \times 10^{12} \text{ gal.}} = 0.00027$$

Thus the "estimated" annual flow rates would amount to .0055 to .027 percent of the total lake volume.

CALCULATION SHEET NO. 3

From Calculation Sheet No. 2: the "estimated" flow rate of 30-150 L/sec can be expressed as an annual flow rate of $.25 \times 10^9$ to 1.25×10^9 gallons per year, the midpoint of this range is $.75 \times 10^9$ gal/Yr.

The total lake volume of 14,000,000 Acre Ft. can be expressed as 4.57×10^{12} gallons

The ratio of the midpoint "estimated" annual flow rate to the total lake volume is:

$$\frac{.75 \times 10^9 \text{ gal.}}{4.57 \times 10^{12} \text{ gal.}} = .000164$$

---

1 gallon = 256 tablespoons
1 tablespoon $\simeq$ .50 Oz. $\simeq$ 14.8 mililiters
1 mililiter $\simeq$ 20 drops

The ratio of .000164 is the same as 2 tablespoons per year in a 47.64 gallon bath tub

$$\frac{2 \text{ Tablespoons}}{256 \text{ Tbl/gal} \times 47.64 \text{ gal.}} = .000164$$

2 Tablespoons per year $\simeq$ 592 drops per year = 1.62 drops per day

1.62 drops per day into a 47.64 gallon bath tub is equivalent to = 1.5 drops per day in a 44.1 gallon bath tub.

NOTE: You guys sure have me doing some goofy things!

March 20, 1987

Director, NPS
Attn: Energy, Mining and Minerals Division
(WASO 480, Room 3223
Main Interior Building)
National Park Service
P.O. Box 37127
Washington, DC 20013-7127

Attn: Pamela A. Matthes
Environmental Protection Specialist
Land Resources Division

Dear Sirs:

The statements California Energy Company submitted to the National Park Service on March 14, 1987 in response to the February 13, 1987 Federal Register listing of "thermal features" focused exclusively on Crater Lake. We would like now to provide further comment on the broader issue of what the Section 115 bill addresses. We regret that this letter was not forwarded during the brief two week response period designated by the National Park Service, but we hope its content will be evaluated in the final decision making process.

In point-of-fact all features within the National Parks are already protected by a myriad of legislation. The intent of Section 115 was to identify significant thermal features which are "likely" to be affected by geothermal development outside of the parks. It is unfortunate that the objective of Section 115 is lost in the ambiguous and expansive National Park Service definition of "thermal feature." The NPS listing of "thermal features" includes a variety of volcanic landforms such as craters, calderas, ash deposits and volcanoes. To suggest that these landforms could benefit from additional bureaucracy boarders strongly on the absurd. It appears equally unnecessary for the NPS to list parks in places that are of no geothermal interest or development potential. To suggest that remote springs in Gates of the Arctic National Park or huge volcanoes in the Wrangell Range of Alaska require added legislative "protection" is grossly incorrect.

If Section 115 is to have any relevant credibility, it should focus on hydrothermal surface manifestations that are viewed by the tourists and that are "likely" to be affected by geothermal development. Surface manifestations including geysers, hot springs, mud pots and fumaroles are of public interest and could be affected if tapped directly. Few, if any, of these types of features in the Parks could be affected by any "worst case" development scenario. The hydrothermal features of Yellowstone and Mt. Lassen are the only ones that may be applicable to such worst case consideration. Under the consideration of "likely" to be affected, there are no such features in the National Parks that are being threatened by geothermal development. The geothermal lease applications in Island Park Caldera, southwest of Yellowstone, are highly unlikely to be in hydraulic communication with the Yellowstone features.

C A L I F O R N I A E N E R G Y C O M P A N Y
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If the USGS interpretation of the Lassen system is correct, geothermal development outside the southern park boundary would have to rely on limited outflow from the park. This would make commercial exploitation for power development impractical and, therefore, unlikely to transpire. The data from the Walker "0" well, 8 miles south of Lassen Peak, supports the proposed USGS model.

The objectives of Section 115 can best be administered through existing BLM leasing and permitting procedures.

Very truly yours,

Joseph G. LaFleur

Joseph G. LaFleur
Senior Exploration Geologist

JLF:sr:42

in Dec well was
steaming + missed + gurg
sent drilling manager (w/ dirt mover)
and found truck driver
didn't close valve (who put sump water in)

Signif that there
is so much noncondense
gas pressure at such a
Shallow interval

- good evid. that we are
over the apex of system
of local hydrothermal system

into a contaminated system

- only spring contaminated
w/ nitrates is one underneath
the bar restr. etc
increase in upper levels
decrease in lower level
∴ light is
not getting
as deep

loss of clarity ⇒
phytoplankton
that survives
on nutrients
that are provided
by effluent
∴ change
in

- Dont Think ever grnd water
no water in hole
drilled into Older
East side
surface { dome field
manif { rocks

600-700,000 yrs old
v. altered rock w/ no
water

lost circul while drilling
mud to drill core)
cant say anyth
bout water

no cold entries
no massive cold water
zones / no good aquifer
after finished drilling put
sumpwater in hole which
seems to plug up hole
18psi in hole - water in
hole began to boil
(sump water)

Personal
communication
w/ Joe LaFleur
on Crater Lake