GL00944 1st Qtr - 92

FORM EIA-459F (10/80)

U.S. DEPARTMENT OF ENERGY
FEDERAL ASSISTANCE PROGRAM/PROJECT STATUS REPORT

FORM APPROVED OMB No. 1900-0127

1. Program/Project Identification No.	2. Program/Project Title	3. Reporting Period
DE-FG07-89ID12834	Inves. Thermal Regime High Cascades, Ore	1-1-92 through 3-31-92

4. Name and Address	
Oregon Department of Geology and Mineral Industries	5. Program/Project Start Date 6/27/89
	6. Completion Date 10/15/92

7. Approach Changes

[X] None

8. Performance Variances, Accomplishments, or Problems

[X] None

9. Open Items

[X] None

10. Status Assessment and Forecast

Final report is finished in draft form and being assembled for initial review by technical reviewers. Once the technical review is complete, a revised draft will be sent to USDOE for final review. Publication will follow receipt of final USDOE review.

[X] No Deviation from Plan is Expected

11. Description of Attachments

See excerpt from final report explaining geothermal model.

[ ] None

12. Signature of Recipient and Date	13. Signature of DOE Reviewing Representative and Date
George R. Priest 5-7-92	

FINANCIAL STATUS REPORT

(Follow instructions on the back)

1. FEDERAL AGENCY AND ORGANIZATIONAL ELEMENT TO WHICH REPORT IS SUBMITTED	U.S Department of Energy
2. FEDERAL GRANT OR OTHER IDENTIFYING NUMBER	DE-FG07-89ID12834
OMB Approved No. 80-R0180	
PAGE 1 OF 1 PAGES	
3. RECIPIENT ORGANIZATION (Name and complete address, including ZIP code)	Oregon Department of Geology and Mineral Industries 1400 SW Fifth Avenue, Suite 910 Portland, OR 97201
4. EMPLOYER IDENTIFICATION NUMBER	93.6001955
5. RECIPIENT ACCOUNT NUMBER OR IDENTIFYING NUMBER	
6. FINAL REPORT	☐ YES ☒ NO
7. BASIS	☒ CASH ☐ ACCRUAL
8. PROJECT/GRANT PERIOD (See instructions)	FROM (Month, day, year) 6/27/89 TO (Month, day, year) 10/15/92
9. PERIOD COVERED BY THIS REPORT	FROM (Month, day, year) 1-1-92 TO (Month, day, year) 3-31-92

10. STATUS OF FUNDS

PROGRAMS/FUNCTIONS/ACTIVITIES ►	(a) USDOE	(b) Private Funds (Oxbow)	(c)	(d)	(e)	(f)	TOTAL (g)
a. Net outlays previously reported	$ 184,353	$ 125,000	$	$	$	$	$
b. Total outlays this report period	3,754	- 0 -					
c. *Less:* Program income credits							
d. Net outlays this report period (*Line b minus line c*)		- 0 -					
e. Net outlays to date (*Line a plus line d*)	188,106	125,000					
f. *Less:* Non-Federal share of outlays							
g. Total Federal share of outlays (*Line e minus line f*)	188,106						
h. Total unliquidated obligations							
i. *Less:* Non-Federal share of unliquidated obligations shown on line h							
j. Federal share of unliquidated obligations							
k. Total Federal share of outlays and unliquidated obligations	188,106						
l. Total cumulative amount of ~~Federal~~ funds authorized	200,000	125,000					
m. Unobligated balance of Federal funds	11,894	- 0 -					

11. INDIRECT EXPENSE

a. TYPE OF RATE (*Place "X" in appropriate box*) ☐ PROVISIONAL ☐ PREDETERMINED ☐ FINAL ☒ FIXED

b. RATE	c. BASE	d. TOTAL AMOUNT	e. FEDERAL SHARE
20.3%	3,120	634	634

12. REMARKS: *Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation.*

13. CERTIFICATION

I certify to the best of my knowledge and belief that this report is correct and complete and that all outlays and unliquidated obligations are for the purposes set forth in the award documents.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL: Angie Karel for

TYPED OR PRINTED NAME AND TITLE: John Nielsen, Business Manager

DATE REPORT SUBMITTED:

TELEPHONE (*Area code, number and extension*): (503)229-5580

269-102

STANDARD FORM 269 (7-76)
Prescribed by Office of Management and Budget

somewhat deeper along the Santiam Pass section, in agreement with the relatively low degree of alteration seen in the drill hole.

GEOTHERMAL MODEL

The effect of alteration on permeability and consequently on heat transport by groundwater flow in the volcanic rocks of the Cascade Range has been previously described by Blackwell et al. (1982, 1990). They concluded from the drilling evidence that the shallow hydrologic properties and shallow thermal conditions were related to the degree of rock alteration, which coincides to some extent with maximum depth of burial (maximum temperature reached) of the rocks. The degree of success of obtaining gradients in 150 m holes in the Cascade Range described by Blackwell et al. (1982) is a testimony to the careful selection of sites based on age and alteration criteria by the DOGAMI geologists in charge of siting the wells. Geothermal exploration studies, which have been more constrained by a need to have data from certain locations, generally higher in elevation, have had significantly lower rates of success in 150 m exploration holes.

The extensive fluid flow at shallow depths has been referred to as the "rain curtain" and discussed in detail for two Newberry Volcano holes by Swanberg and Combs (1986) and Swanberg et al. (1988). Temperatures from all deep holes (over 1 km depth) in the Cascade Range except the Santiam Pass 77-24 (excluding data from the Newberry volcano which show similar characteristics) were shown in Figure 4 of Blackwell et al. (1990, see also Figure 6 in Blackwell et al., 1982). In addition to the EWEB-2 and USGS-PUC wells another example of the temperature-depth behavior in the High Cascade Range is the 1.4 km deep hole CTGH-1 drilled near the Cascade Range crest north of Mount Jefferson. It has a heat flow of 110 mW/m^2. Its thermal characteristics have been discussed in detail by Blackwell and Steele (1987) and Blackwell and Baker (1988a, 1988b). The increase in gradient to regional values occurs between 400 and 500 m is associated with the initial occurrence of alteration that has taken place at temperatures above 50°C (Barger, 1988) and has lowered the electrical resistivity of the volcanic rocks. In all these cases the gradients and heat flow values in the deep holes below the groundwater flow zones are consistent with the predictions based on 150 m holes nearby or on regional considerations.

Blackwell and Steele (1987) described temperature-depth data from a well at the edge of Crater Lake Park (CE-CL-1) in an area of no surface geothermal manifestations. Hole CE-CL-1 has a high gradient (about 250°C/km). The results there illustrate that if the surface rocks are altered, gradients may be obtained even above the depth of 200 to 400 m typical of areas with unaltered volcanic rocks at the surface. Thus in the Cascade Range low electrical resistivity values are associated with alteration of the high temperature minerals to clay and zeolites and may or may not be associated with contemporary high temperature regions.

The interpretation is that in general in the Cascade Range the rocks that have been subjected to alteration due either localized hydrothermal activity or regional diagenitic low grade metamorphism have low resistivity. Thus in general areas of low electrical resistivity correspond to areas of generally low permeability, altered volcanic rocks while areas of high electrical resistivity generally correspond to regions of high permeability, unaltered volcanic rocks. A similar situation has been described in detail at Newberry volcano by Wright et al. (1988).

The deep drilling results show that isothermal sections occur to depths ranging up to 500 m at various sites within the High Cascade Range although typical values are less than 400 m. We also conclude that, on the basis of present data, consistently high geothermal gradients (in excess of 50°C/km) are observed below the zone of rapid groundwater circulation. The only exception at present is the EWEB-1 hole near Santiam Junction. Furthermore, there is often an abrupt depth transition between rocks which have high permeability and rapid fluid through-flow (near isothermal temperature-depth curves) and rocks where the average permeability is quite low and fluid flow is suppressed. The 50-200 m transition zones from low to regional values of geothermal gradient typical of the deep holes is evidence that large scale flow at depth is unlikely to occur generally except along particularly favorable stratigraphic regions or along fractures or fault zones.

However, the geothermal model for the Santiam Pass area must involve significant, general, fluid flow at depth in the Quaternary rocks of the Cascade graben (the eastern half of Figure 1). In some cases the flow is confined to discrete aquifers (as in the top of well EWEB-1) and in other cases there must be general porous media flow. In all probability most of the flow systems terminate against the low-permeability preQuaternary rocks of the Western Cascade Range. Thus warm water is forced to, or close to, the surface along the faults bounding the west side of the Cascade graben. The depth of the widespread diffuse flow cannot be established at the present time because there are no drill data available below 400 m at the west edge of the system and the permeability structure is unknown. The depth of ground water flow that effects the heat flow is as deep as or deeper than the level of the lowest point along the map, the McKenzie River at elevation of 300 to 600 m, and must at some point go as deep as required (at least 1.5 km below the surface) to heat the groundwater to the 76 °C seen in one of the hot springs. Thus there is a net loss of heat along the profile through the groundwater system. Ingebritsen et al. (1989) have emphasized the role of this sort of fluid flow on the heat transfer in the High Cascade Range. This area comes the closest to the characteristics of their ideal model, unlike the area around Breitenbush hot springs where the low permeability rocks predominate the section.

The required loss of heat can be accounted for by leakage of geothermal fluid into the McKenzie River drainage at the hot springs such as Belknap and Foley hot springs (Mariner et al., 1990) and via unexposed shallow systems such as the one encountered in EWEB-1. The inferred reservoir temperatures of the Belknap and Foley systems are only 113 and 99°C respectively (Brook et al., 1979), temperatures that could be reached at depths of less than 2 km in the regional gradient of 65°C/km. So there is no evidence at the present time for very hot fluid flow associated with the systems that cause the high heat flow observed along the fault zones that mark the west side of the Cascade Graben.

The general geothermal model that derives from the results described above is shown in

Figure 7. The general groundwater flow regime in the area is certainly from the Cascade Range crest on the east to the McKenzie River valley on the west more or less parallel to the topographic gradient. The temperature profiles in the shallow and deep wells are consistent with this assessment. The shape of the profiles is also consistent with a permeability that decreases rapidly with depth in the outer 1 km. In the case of the EWEB-2 well the permeability must decrease abruptly at a depth of 200 m to explain the abrupt change from near zero to regional gradients there. The more gradual increase in gradient with depth in the EWEB-1 and SP 77-24 wells is consistent with a more gradual decrease in permeability with depth and/or with vertical groundwater velocities that decrease with depth. Unfortunately, neither of the wells is deep enough to definitively outline the regional thermal gradients and fluid flow conditions in this area of the High Cascade Range.

The type of flow paths expected are shown by the arrows. The length of the arrow indicates in a generalized way the flow velocity expected in the depth range shown. Thus the rate of flow decreases rapidly in the depth range of 500 to 1000 m and most of the flow is confined to depths of less than 2000 m. The flow is complicated by the shallow, warm aquifer in EWEB-1 so that the flow pattern is not completely two-dimensional. The flow is primarily topographically driven.

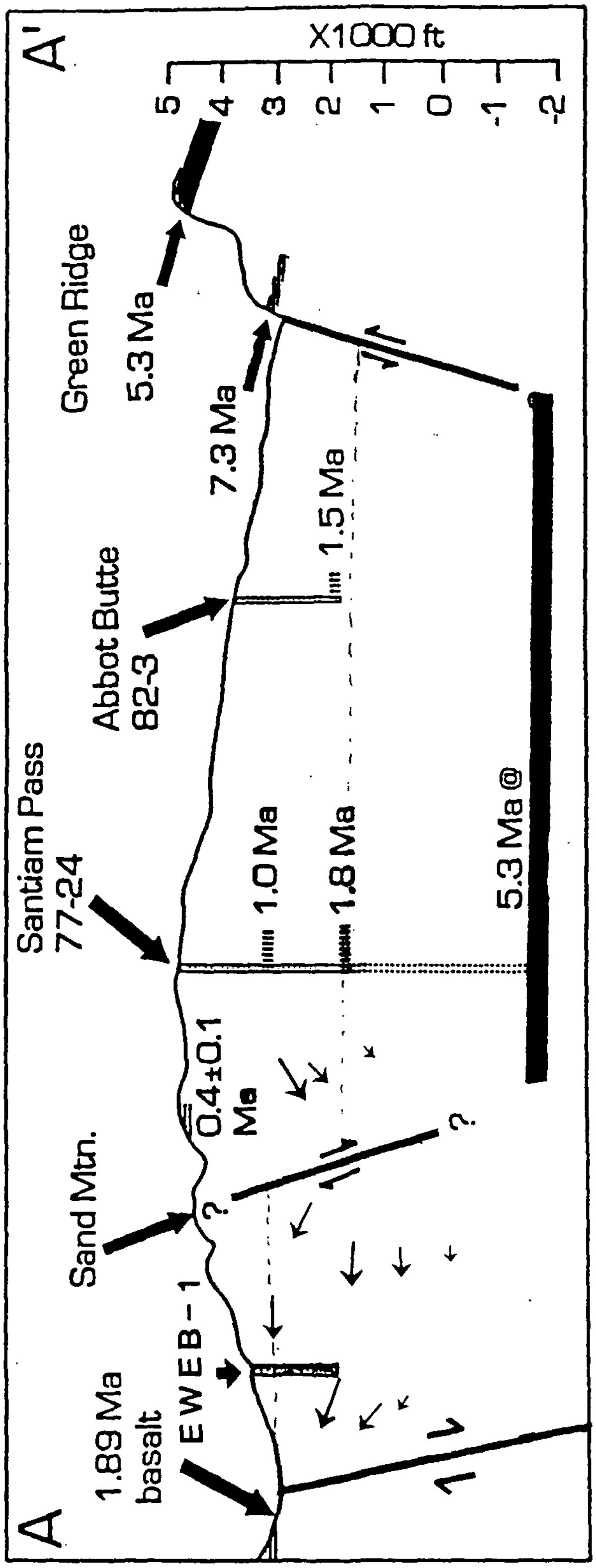


Figure 7. Interpretative cross section of the Santiam Pass area. Geology from Hill et al. (1991b)

4th Qtr '91

ORM EIA-459F
9/80

U.S. DEPARTMENT OF ENERGY

FEDERAL ASSISTANCE PROGRAM/PROJECT STATUS REPORT

FORM APPROVED
OMB No. 1900-0127

1. Program/Project Identification No.	2. Program/Project Title	3. Reporting Period
DE-FG07-89ID12834	Inves. Thermal Regime High Cascades, Ore	10/1/91 through 12/31/91

4. Name and Address	5. Program/Project Start Date
Oregon Department of Geology and Mineral Industries	6/27/89
	6. Completion Date
	10/15/92

7. Approach Changes

[X] None

8. Performance Variances, Accomplishments, or Problems

[X] None

9. Open Items

[X] None

10. Status Assessment and Forecast

Project is on schedule. Final report is in preparation with all essential geophysical and geological data in hand. Report should be completed by the contract deadline for review.

[X] No Deviation from Plan is Expected

11. Description of Attachments

Reports from Dave Blackwell and Brittain Hill.

[ ] None

12. Signature of Recipient and Date	13. Signature of DOE Reviewing Representative and Date
George R. Priest 1-31-92	

FORM EIA-459E
(10/80)

U.S. DEPARTMENT OF ENERGY

FEDERAL ASSISTANCE MANAGEMENT SUMMARY REPORT

FORM APPROVED
OMB No. 1900-0127

Page ____ of ____

1. Program/Project Identification No.	2. Program/Project Title	3. Reporting Period
DE-FG07-89ID12834	Inves. Thermal Regime High Cascades, OR	10-1-91 through 12-31-91

4. Name and Address	5. Program/Project Start Date	6. Completion Date
Oregon Dept. of Geology and Mineral Industries	6/27/89	10/15/92

7. FY 92

8. Months or Quarters: quarters

9. Cost Status — a. Dollars Expressed in: Thousands — b. Dollar Scale

10. Cost Chart

Fund Source		Quarter 1st	2nd	3rd	4th	Cum. to Date	Tot. Plan
USDOE	P	2				181	200
	A	2				184	
Oxbow	P	0				100	100
	A	0				125	
	P						
	A						
	P						
	A						
Total P		2				281	300
Total A		2				309	
Variance		0				-28	

P = Planned A = Actual

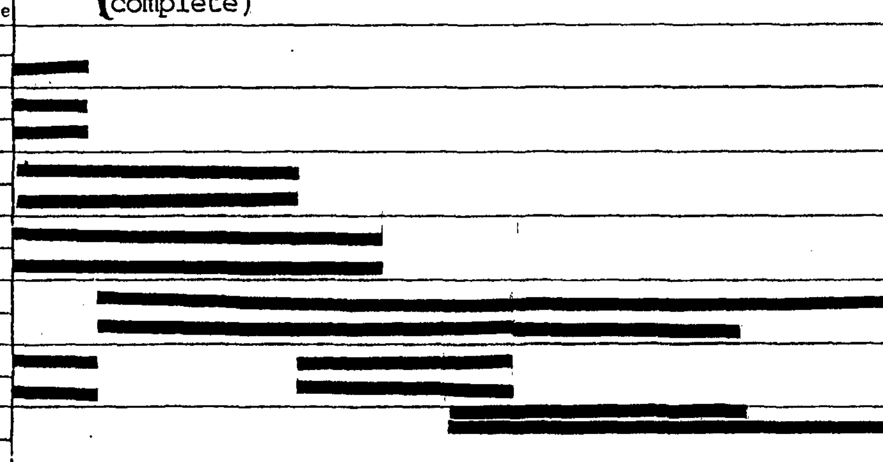
Total Planned Costs for Program/Project: $300,000

c. Cumulative Accrued Costs

	7-9 89	10-12 89	1-3 90	4-6 90	7-9 90	10-12 90	1-3 91	4-6 91	7-9 91	10-12 91	1-3 92	4-6 92
Planned	16	50	52	54	169	273	276	278	279	281	287	290
Actual	5	38	43	48	172	301	304	306	307	309		
Variance	11	12	9	6	-3	-28	-28	-28	-28	-28		

11. Major Milestone Status (Units Planned / Units Complete: P / C)

4.1 Site Selection (complete)
4.2 Permitting
4.3 Phas I Report
4.4 Bid Solicitation
4.5 Drilling
4.6 Data Analysis
4.7 Core Curation
4.8 Final Report



12. Remarks

See attachment and Project Status Report Form

13. Signature of Recipient and Date	14. Signature of DOE Reviewing Representative and Date
George R Priest 1-31-92	

Rec 02/03/92 H.H.R.

FINANCIAL STATUS REPORT

(Follow instructions on the back)

1. FEDERAL AGENCY AND ORGANIZATIONAL ELEMENT TO WHICH REPORT IS SUBMITTED	U.S Department of Energy
2. FEDERAL GRANT OR OTHER IDENTIFYING NUMBER	DE-FG07-89ID12834
OMB Approved No. 80-R0180	
PAGE 1 OF 1 PAGES	
3. RECIPIENT ORGANIZATION (Name and complete address, including ZIP code)	Oregon Department of Geology and Mineral Industries 1400 SW Fifth Avenue, Suite 910 Portland, OR 97201
4. EMPLOYER IDENTIFICATION NUMBER	93.6001955
5. RECIPIENT ACCOUNT NUMBER OR IDENTIFYING NUMBER	
6. FINAL REPORT	☐ YES ☒ NO
7. BASIS	☒ CASH ☐ ACCRUAL
8. PROJECT/GRANT PERIOD (See instructions)	FROM (Month, day, year) 6/27/89 TO (Month, day, year) 10/15/92
9. PERIOD COVERED BY THIS REPORT	FROM (Month, day, year) 10-1-91 TO (Month, day, year) 12-31-91

10. STATUS OF FUNDS

PROGRAMS/FUNCTIONS/ACTIVITIES ►	(a) USDOE	(b) Private Funds (Oxbow)	(c)	(d)	(e)	(f)	TOTAL (g)
a. Net outlays previously reported	$ 182,016	$ 125,000	$	$	$	$	$
b. Total outlays this report period	2,337	- 0 -					
c. *Less:* Program income credits							
d. Net outlays this report period (*Line b minus line c*)	2,337	- 0 -					
e. Net outlays to date (*Line a plus line d*)	184,353	125,000					
f. *Less:* Non-Federal share of outlays							
g. Total Federal share of outlays (*Line e minus line f*)	184,353						
h. Total unliquidated obligations							
i. *Less:* Non-Federal share of unliquidated obligations shown on line h							
j. Federal share of unliquidated obligations							
k. Total Federal share of outlays and unliquidated obligations	184,353						
l. Total cumulative amount of ~~Federal~~ funds authorized	200,000	125,000					
m. Unobligated balance of Federal funds	15,646.41	- 0 -					

11. INDIRECT EXPENSE

a. TYPE OF RATE *(Place "X" in appropriate box)* ☐ PROVISIONAL ☐ PREDETERMINED ☐ FINAL ☒ FIXED

b. RATE	c. BASE	d. TOTAL AMOUNT	e. FEDERAL SHARE
20.3%	1,943	394	394

12. REMARKS: *Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation.*

13. CERTIFICATION

I certify to the best of my knowledge and belief that this report is correct and complete and that all outlays and unliquidated obligations are for the purposes set forth in the award documents.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL: [signature]

DATE REPORT SUBMITTED: 1/31/92

TYPED OR PRINTED NAME AND TITLE: John Nielsen, Business Manager

TELEPHONE *(Area code, number and extension)*: (503)229-5580

January 15, 1992

Dr. George Priest
Department of Geology and Mineral Industries
910 State Office Building
Portland, Oregon 97801

Dear George:

During the last quarter we have completed the activities associated with the Santiam Pass study. We integrated the results of the last logging of the well (in September) into the previous results. We presented a paper describing the results at the 1991 annual meeting of the Geothermal Resources Council in Reno, Nevada in early October. Since that time the activities have been associated with the completion of the final report for the project. That report should be in the mail by the end of next week.

Sincerely yours,

Dave

David D. Blackwell
W. B. Hamilton Professor of Geophysics

INSTITUTE FOR THE STUDY OF EARTH AND MAN
GEOTHERMAL LABORATORY / 214 · 692-2745
SOUTHERN METHODIST UNIVERSITY / DALLAS, TEXAS 75275

Quarterly progress report

Santiam Pass 77-24 Geothermal Drilling Program

Brittain Hill, DOGAMI, October-December 1991.

Research conducted under D.O.E. grant DE-FG07-89ID12834 for the period 1 October 1991 through 30 December 1991 focused on the petrology of core from the Santiam Pass 77-24 hole. Samples of the Santiam Pass core have been analyzed by a variety of techniques over the past year. These data were compiled, and preliminary geochemical models were developed during this quarter. In summary, a total of 42 whole-rock samples were analyzed for major and select trace element abundances through X-ray fluorescence (XRF) techniques at Washington State University, Pullman. A subset of 20 whole-rock samples were also analyzed for major and trace element abundances through Inductively-coupled plasmaspectrometry (ICP) at the University of Utah Research Institute. In addition, 12 samples were analyzed for trace element abundances through Instrumental Neutron Activation Analysis (INAA) at the Oregon State University Radiation Center.

In general, the ICP analyses gave more precise values for only MnO, K_2O, P_2O_5, and a few trace elements; XRF data are more precise and more accurate for other major elements. However, the ICP technique provides some of the first analyses of unaltered Oregon Cascade volcanic rocks for Li, Be, B, As, Mo, Cd, Sn and Pb. The INAA analyses for transition metals and rare earth elements are very precise and accurate, and will be extremely useful in constraining and developing petrochemical models in the next quarter. The ultimate goal of the geochemical modeling is to contrast and compare the petrologic evolution of mafic rocks in the Santiam Pass core with the petrogenesis of other mafic rocks in adjacent areas of the central High Cascades (e.g., Hughes, 1990; Conrey, 1991). This comparison will be used to further constrain geothermal models for the Santiam Pass area.

Next quarter's activity will focus on the interpretation of geochemical and geothermal data, and the preparation of an open file report. A preliminary outline for this report consists of chapters on the general geology of the Santiam Pass area (G. Priest and B. Hill), drilling operations (D. Benoit), core petrology (B. Hill), and geophysical data (D. Blackwell, B. Hill, G. Priest).

REVISED Santiam Pass Budget As Of: 13-Jan-92
Incorporates changes to indirect% & charges; G. Priest, 10/90

	Original DOE Contract Phase I	Phase II	Total
Personnel	7100.00	8520.00	15620.00
Fringe (OPE)	3333.00	4000.00	7333.00
Travel	790.00	4561.00	5351.00
Supplies	50.00	4390.00	4440.00
Contractual	2100.00	31000.00	33100.00
Drilling	0.00	96790.00	96790.00
Publication	0.00	6000.00	6000.00
TOTALS**	13373.00	155261.00	168634.00
w/ 18.6% Indirect	15860	184140	200000

DETAILED CHARGES

Date	Expense	Ind %	Total	Balance from 200000.00
6/30/89	4155.64	0.186	4928.59	195071.41
9/30/89	334.80	0.190	398.41	194673.00
10/30/89	7.00	0.190	8.33	194664.67
11/30/89	1960.57	0.190	2333.08	192331.59
12/30/89	897.14	0.190	1067.60	191263.99
1/30/90	185.78	0.190	221.08	191042.92
2/30/90	841.95	0.190	1001.92	190041.00
3/30/90	3135.10	0.190	3730.77	186310.23
4/30/90	2531.12	0.190	3012.03	183298.19
6/30/90	1964.50	0.190	2337.76	180960.44
7/30/90	6708.22	0.161	7788.24	173172.20
8/30/90	18045.97	0.161	20951.37	152220.82
9/30/90	20816.07	0.161	24167.46	128053.37
10/30/90	79397.32	0.161	92180.29	35873.08
11/30/90	7420.05	0.161	8614.68	27258.40
12/30/90	2684.17	0.161	3116.32	24142.08
1/30/91	1731.89	0.161	2010.72	22131.35
2/30/91	670.70	0.161	778.68	21352.67
3/30/91	283.92	0.161	329.63	21023.04
4/30/91	754.38	0.161	875.84	20147.21
5/30/91	689.19	0.161	800.15	19347.06
6/30/91	347.05	0.161	402.93	18944.13
7/30/91	256.12	0.203	308.11	18636.02
8/30/91	294.74	0.203	354.57	18281.45
9/30/91	222.35	0.203	267.49	18013.96
10/30/91	1709.05	0.203	2055.99	15957.97
11/30/91	101.57	0.203	122.19	15835.78
12/30/91		0.203	0.00	15835.78

Projected costs	
Logging: w/ $3300 holdback	3841.63
Hill:12/91 Salary	150.00
Hill:1/92 Salary	400.00
Publications	6000.00

Blackwell/SMU	
To 8/90	14372.00
9/90	4489.99
10/90	3669.98
11/90	6626.40
12/90	0.00
Total	29158.37
Holdback	3300.00
To Pay	541.63

Projected Total: 10391.63
w/ 20.3% Indirect: 12501.13

As of 13-Jan-92 , TOTAL AVAILABLE:: 3334.65

U.S. DEPARTMENT OF ENERGY

FEDERAL ASSISTANCE PROGRAM/PROJECT STATUS REPORT

2nd Qtr '91

FORM APPROVED
OMB No. 1900-0127

1. Program/Project Identification No.	2. Program/Project Title	3. Reporting Period
DE-FG07-89ID12834	Inves. Thermal Regime High Cascades, Ore	4-1-91 through 6-30-91

4. Name and Address

Oregon Department of Geology and Mineral Industries

5. Program/Project Start Date: 6/27/89

6. Completion Date: 10/15/92

7. Approach Changes

2nd Qtr '91

[X] None

8. Performance Variances, Accomplishments, or Problems

[X] None

9. Open Items

[X] None

10. Status Assessment and Forecast

- Project is on schedule.
- Still awaiting some isotopic age data and final temperature readings on the drill hole. Hole will be logged in August or early September.
- Article summarizing current data submitted to Geothermal Resources Council for inclusion in 1991 transactions.

[X] No Deviation from Plan is Expected

11. Description of Attachments

Article submitted to GRC.

[ ] None

12. Signature of Recipient and Date	13. Signature of DOE Reviewing Representative and Date
[signature] 7-29-91	

FORM EIA-459E
(10/80)

U.S. DEPARTMENT OF ENERGY

FEDERAL ASSISTANCE MANAGEMENT SUMMARY REPORT

FORM APPROVED
OMB No. 1900-0127

Page ____ of ____

1. Program/Project Identification No. DE-FG07-89ID12834	2. Program/Project Title Inves. Thermal Regime High Cascades, OR	3. Reporting Period 4-1-91 through 6-30-91
4. Name and Address Oregon Dept. of Geology and Mineral Industries		5. Program/Project Start Date 6/27/89
		6. Completion Date 10/15/92

7. FY: 90-91

8. Months or Quarters: quarters

7-9 89	10-12 89	1-3 90	4-6 90	7-9 90	10-12 90	1-3 91	4-6 91	7-9 91	10-12 91	1-3 92	4-6 92

9. Cost Status a. Dollars Expressed in: Thousands

b. Dollar Scale

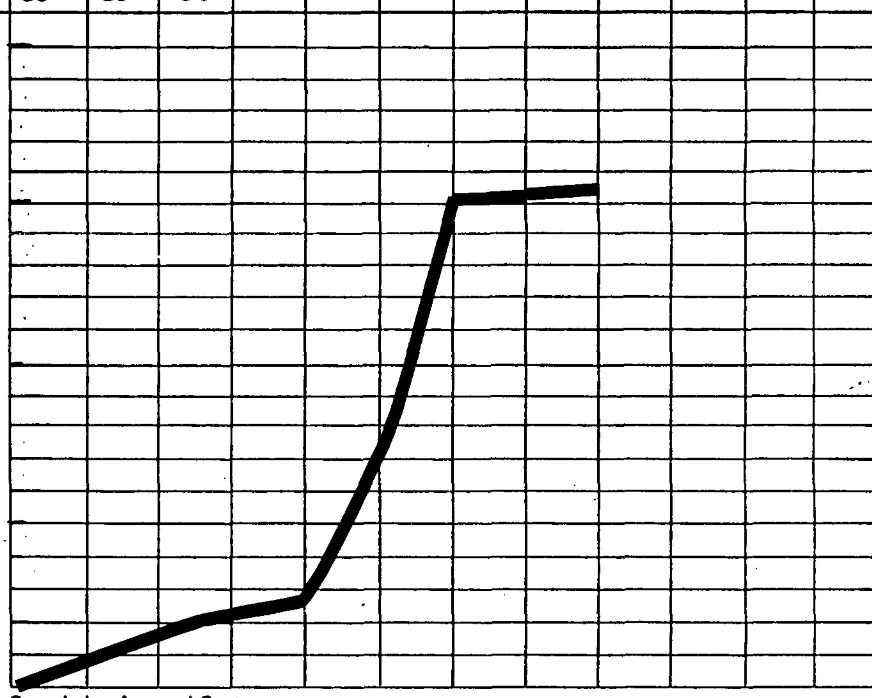
10. Cost Chart

Fund Source		Quarter 1st	2nd	3rd	4th	Cum. to Date	Tot. Plan
USDOE	P	104	3	3		110	
	A	104	3	2		109	
Oxbow	P	0	0	0		0	
	A	25	0	0		25	
	P						
	A						
	P						
	A						
Total P		104	3	3		110	
Total A		129	3	2		134	
Variance		-25	0	1		-24	

P = Planned A = Actual

Total Planned Costs for Program/Project

$300,000

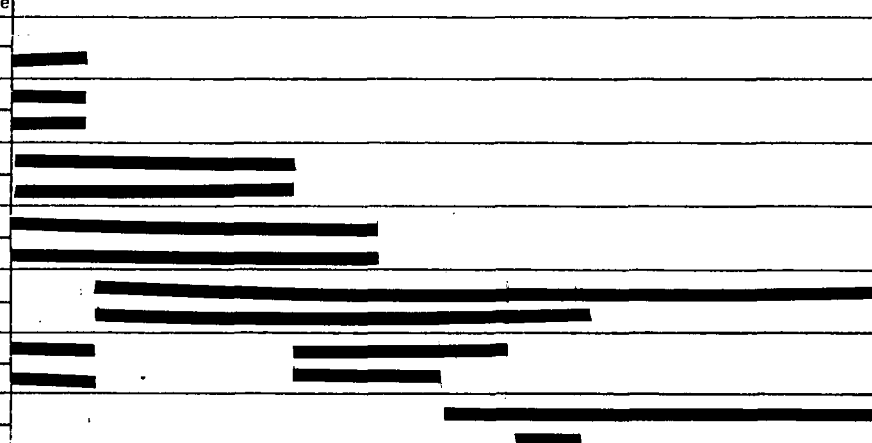


C Cumulative Accrued Costs

	7-9 89	10-12 89	1-3 90	4-6 90	7-9 90	10-12 90	1-3 91	4-6 91	7-9 91	10-12 91	1-3 92	4-6 92
Planned	16	50	52	54	169	273	276	280	290	293	297	300
Actual	5	38	43	48	172	301	304	134				
Variance	11	12	9	6	-3	-28	-28	-24				

11. Major Milestone Status

Milestone	Units Planned / Units Complete
4.1 Site Selection	P / C
4.2 Permitting	P / C
4.3 Phas I Report	P / C
4.4 Bid Solicitation	P / C
4.5 Drilling	P / C
4.6 Data Analysis	P / C
4.7 Core Curation	P / C
4.8 Final Report	P / C



12. Remarks

See attachment and Project Status Report Form

13. Signature of Recipient and Date: George R. Priest 7/29/91

14. Signature of DOE Reviewing Representative and Date

4/16/91 HPR

FINANCIAL STATUS REPORT

(Follow instructions on the back)

1. FEDERAL AGENCY AND ORGANIZATIONAL ELEMENT TO WHICH REPORT IS SUBMITTED	2. FEDERAL GRANT OR OTHER IDENTIFYING NUMBER	OMB Approved No. 80-RO180	PAGE 1 OF 1 PAGES
U.S. Department of Energy	DE-FG07-89ID2834		

3. RECIPIENT ORGANIZATION (*Name and complete address, including ZIP code*)	4. EMPLOYER IDENTIFICATION NUMBER	5. RECIPIENT ACCOUNT NUMBER OR IDENTIFYING NUMBER	6. FINAL REPORT	7. BASIS
	93.6001955		☐ YES ☒ NO	☒ CASH ☐ ACCRUAL

8. PROJECT/GRANT PERIOD (*See instructions*) FROM (*Month, day, year*)	TO (*Month, day, year*)	9. PERIOD COVERED BY THIS REPORT FROM (*Month, day, year*)	TO (*Month, day, year*)
6-27-89	10-15-92	4-1-90	6-30-90

10. STATUS OF FUNDS

PROGRAMS/FUNCTIONS/ACTIVITIES ►	(a)	(b)	(c)	(d)	(e)	(f)	TOTAL (g)
a. Net outlays previously reported	$ 178,977	$	$	$	$	$	$
b. Total outlays this report period	2,080						
c. *Less:* Program income credits							
d. Net outlays this report period (*Line b minus line c*)							
e. Net outlays to date (*Line a plus line d*)	181,057						
f. *Less:* Non-Federal share of outlays							
g. Total Federal share of outlays (*Line e minus line f*)	181,057						
h. Total unliquidated obligations							
i. *Less:* Non-Federal share of unliquidated obligations shown on line h							
j. Federal share of unliquidated obligations							
k. Total Federal share of outlays and unliquidated obligations	181,057						
l. Total cumulative amount of Federal funds authorized	200,000						
m. Unobligated balance of Federal funds	18,943						

11. INDIRECT EXPENSE

a. TYPE OF RATE (*Place "X" in appropriate box*) ☐ PROVISIONAL ☐ PREDETERMINED ☐ FINAL ☒ FIXED

b. RATE	c. BASE	d. TOTAL AMOUNT	e. FEDERAL SHARE
16.1	16,316	2,627	2,627

12. REMARKS: *Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation.*

13. CERTIFICATION

I certify to the best of my knowledge and belief that this report is correct and complete and that all outlays and unliquidated obligations are for the purposes set forth in the award documents.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL: John Nielsen

DATE REPORT SUBMITTED:

TYPED OR PRINTED NAME AND TITLE: John Nielsen, Business Manager

TELEPHONE (*Area code, number and extension*): 503-22905580

269-102

1st Qtr '91

Quarterly progress report
Santiam Pass 77-24 Geothermal Drilling Program
Brittain Hill, DOGAMI, January-March, 1991.

Research conducted under D.O.E. grant DE-FG07-89ID12834 for the period 1 January 1991 through 30 March 1991 focused on the petrology and petrography of Santiam Pass 77-24 core. Other activities included development of regional structural models using constraints from the Santiam Pass hole, and presentation of scientific results of this project at a Oregon Department of Geology and Mineral Industries open house and the annual meeting of the Canadian Geothermal Energy Association, and preparation of an article for the Geothermal Resource Council Transactions (Blackwell, Hill, and Priest).

Detailed petrographic analysis has been accomplished on the upper 1200' of core. These data will be combined with geochemical data to model the chemical evolution of the Santiam Pass volcanic system, and to further constrain low temperature alteration relationships. Units examined to date show abundant textural evidence of magma mixing, indicating that the Santiam Pass volcanic system may have been open to relatively large amounts of recharge. Core petrography and geochemical modeling will continue into the next quarter.

K-Ar ages and sample depths from the Santiam Pass core have been combined with other dated volcanic units in the surrounding area to produce a structural model for the Santiam Pass area of the Oregon Cascades (figure 1). Mafic flows of about 1.8 Ma are exposed 16 km west of the drill site (Black et al, 1987), at elevations of ≈3200' (figure 1). If these flows are correlative with the ≈1.8 Ma mafic flows in the Santiam Pass core, then there is a minimum vertical displacement of 440 meters between these units. This displacement may be associated with the north-striking structure that controlled emplacement of the Sand Mountain cinder cones (figure 1), or some other buried tectonic feature.

Mafic flows of about 5.2 Ma are exposed 19 km east of the drill site at the top of Green Ridge (≈1550 m), which represents the eastern margin of the High Cascade Graben (Smith et al., 1987). Offset between the top of Green Ridge and the base of

ELEMENT TO WHICH REPORT IS SUBMITTED | 2. FEDERAL GRANT OR OTHER IDENTIFYING NUMBER | OMB Approved No. 80-RO180 | PAGE 1 OF 1 PAGES

9V | DE-FG07-89ID12834

5. RECIPIENT ACCOUNT NUMBER OR IDENTIFYING NUMBER | 6. FINAL REPORT ☐ YES ☒ NO | 7. BASIS ☒ CASH ☐ ACCRUAL

RIOD (See instructions) | 9. PERIOD COVERED BY THIS REPORT

TO (Month, day, year) 10/15/91 | FROM (Month, day, year) 1/1/91 | TO (Month, day, year) 3/31/91

OF FUNDS	(d)	(e)	(f)	TOTAL (g)
	$	$	$	$

TIFICATION
ify to the best of my knowledge and belief that this report is correct and complete and all outlays and unliquidated obligations are for the purposes set forth in the award documents.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL | DATE REPORT SUBMITTED

TYPED OR PRINTED NAME AND TITLE | TELEPHONE (Area code, number and extension)

John O. Nielsen, Business Manager

STANDARD FORM 269 (7-76)
Prescribed by Office of Management and Budget
Cir. No. A-110

FORM EIA-459E
(10/80)

U.S. DEPARTMENT OF ENERGY

FEDERAL ASSISTANCE MANAGEMENT SUMMARY REPORT

FORM APPROVED
OMB No. 1900-0127

Page ___ of ___

1. Program/Project Identification No. DE-FG07-89ID12834	2. Program/Project Title Inves. Thermal Regime High Cascades,OR	3. Reporting Period 1-1-91 through 3-31-91
4. Name and Address Oregon Dept. of Geology and Mineral Industries		5. Program/Project Start Date 6/27/89
		6. Completion Date 10/15/92

7. FY 90-91
8. Months or Quarters: quarters

7-9 89	10-12 89	1-3 90	4-6 90	7-9 90	10-12 90	1-3 91	4-6 91	7-9 91	10-12 91	1-3 92	4-6 92

9. Cost Status a. Dollars Expressed in Thousands

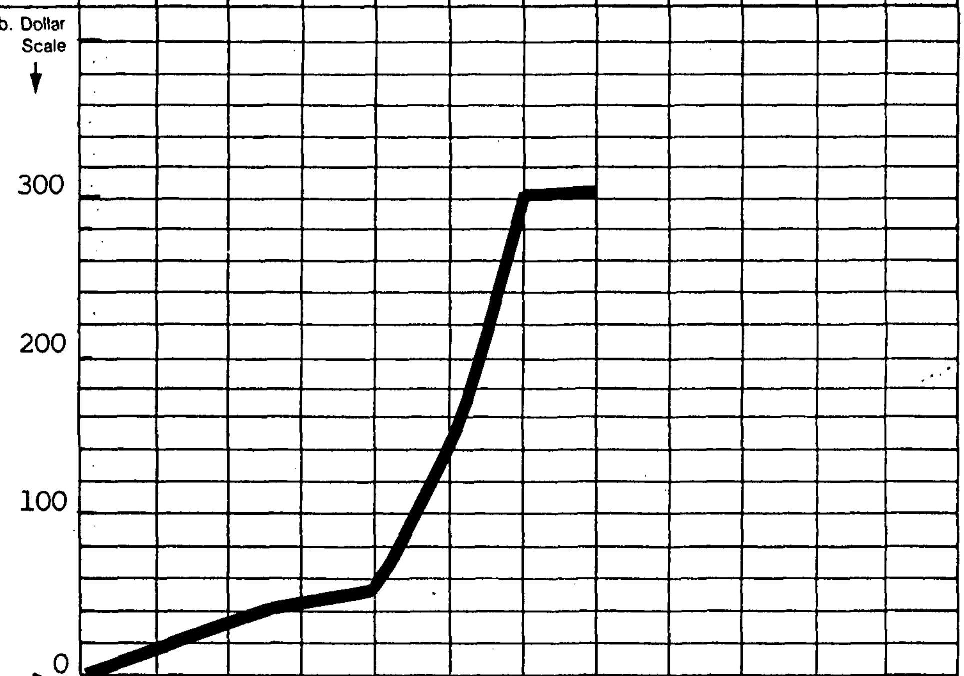
b. Dollar Scale

10. Cost Chart

Fund Source		Quarter 1st	2nd	3rd	4th	Cum. to Date	Tot. Plan
USDOE	P	104	3			176	
	A	104	3			179	
Oxbow	P	0	0			100	
	A	25	0			125	
	P						
	A						
	P						
	A						
Total P		104	3			276	
Total A		129	3			304	
Variance		-25	0			-28	

P = Planned A = Actual

Total Planned Costs for Program/Project
$300,000

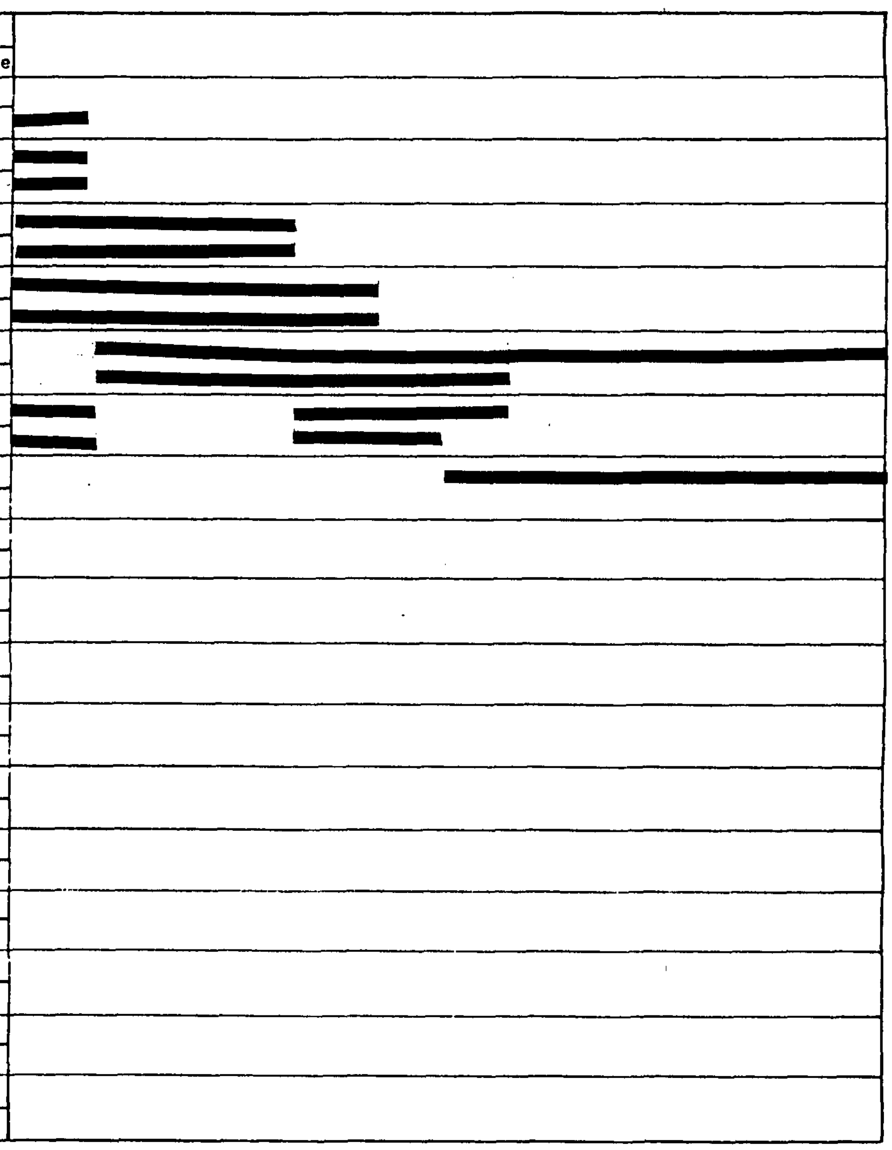


C Cumulative Accrued Costs

	7-9 89	10-12 89	1-3 90	4-6 90	7-9 90	10-12 90	1-3 91	4-6 91	7-9 91	10-12 91	1-3 92	4-6 92
Planned	16	50	52	54	169	273	276	280	290	293	297	300
Actual	5	38	43	48	172	301	304					
Variance	11	12	9	6	-3	-28	-28					

11. Major Milestone Status (Units Planned / Units Complete)

4.1 Site Selection
4.2 Permitting
4.3 Phas I Report
4.4 Bid Solicitation
4.5 Drilling
4.6 Data Analysis
4.7 Core Curation
4.8 Final Report



12. Remarks

See attachment and Project Status Report Form

13. Signature of Recipient and Date: George R. Priest 5-6-91

14. Signature of DOE Reviewing Representative and Date

FORM EIA-459F

U.S. DEPARTMENT OF ENERGY

FEDERAL ASSISTANCE PROGRAM/PROJECT STATUS REPORT

1ST Qtr '91

FORM APPROVED OMB No. 1900-0127

1. Program/Project Identification No.	2. Program/Project Title	3. Reporting Period
DE-FG07-89ID12834	Inves. Thermal Regime High Cascades, Ore	1-1-91 through 3-31-91

4. Name and Address

Oregon Department of Geology and Mineral Industries

5. Program/Project Start Date: 6/27/89

6. Completion Date: 10/15/92

7. Approach Changes

[X] None

8. Performance Variances, Accomplishments, or Problems

[X] None

9. Open Items

[X] None

10. Status Assessment and Forecast

1. Drilling is complete
2. Lithology analysis is proceeding on schedule
3. Geophysical analysis by S.M.U. is on schedule
4. Project activity and expenditures are low while samples are being processed in laboratories

[X] No Deviation from Plan is Expected

11. Description of Attachments

Quarterly reports by Britt Hill and Dave Blackwell

[ ] None

12. Signature of Recipient and Date

George R. Priest 5-6-91

13. Signature of DOE Reviewing Representative and Date

FORM EIA-459E
(10/80)

U.S. DEPARTMENT OF ENERGY

FEDERAL ASSISTANCE MANAGEMENT SUMMARY REPORT

Rec 2/19/91 4th Qtr 90

FORM APPROVED
OMB No. 1900-0127

Page ___ of ___

1. Program/Project Identification No.	2. Program/Project Title	3. Reporting Period
DE-FG07-89ID12834	Inves. Thermal Regime High Cascades,OR	10-1-90 through 12-31-90

4. Name and Address	5. Program/Project Start Date	6. Completion Date
Oregon Dept. of Geology and Mineral Industries	6/27/89	10/15/92

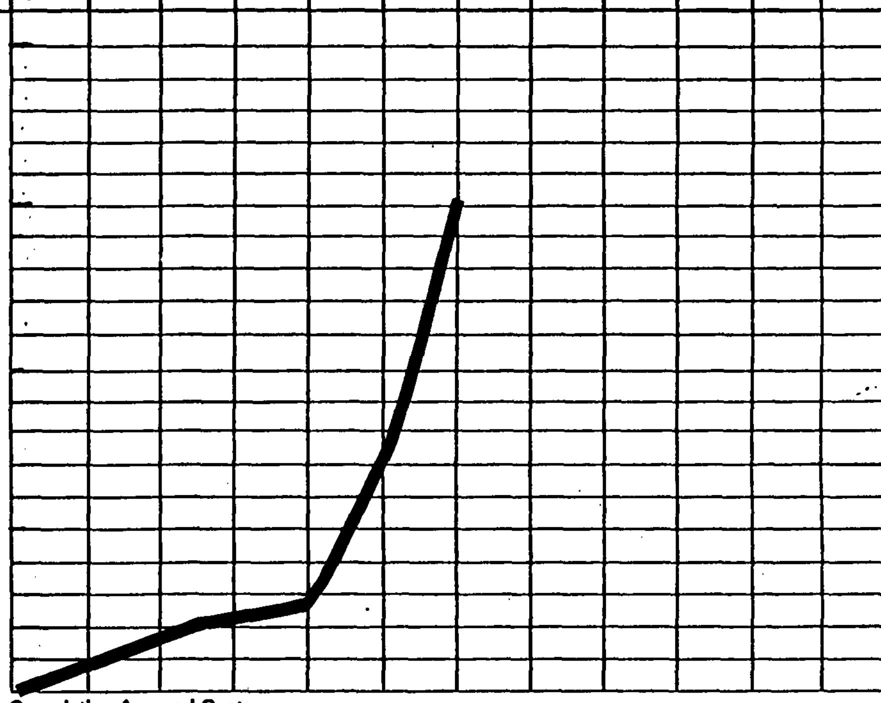
7. FY: 90-91

8. Months or Quarters: quarters

7-9 89	10-12 89	1-3 90	4-6 90	7-9 90	10-12 90	1-3 91	4-6 91	7-9 91	10-12 91	1-3 92	4-6 92

9. Cost Status a. Dollars Expressed in: Thousands

b. Dollar Scale



10. Cost Chart

Fund Source		Quarter 1st	2nd	3rd	4th	Cum. to Date	Tot. Plan
USDOE	P	104				173	
	A	104				176	
Oxbow	P	0				100	
	A	25				125	
	P						
	A						
	P						
	A						
Total P		104				273	
Total A		129				301	
Variance		-25				28	

P = Planned A = Actual

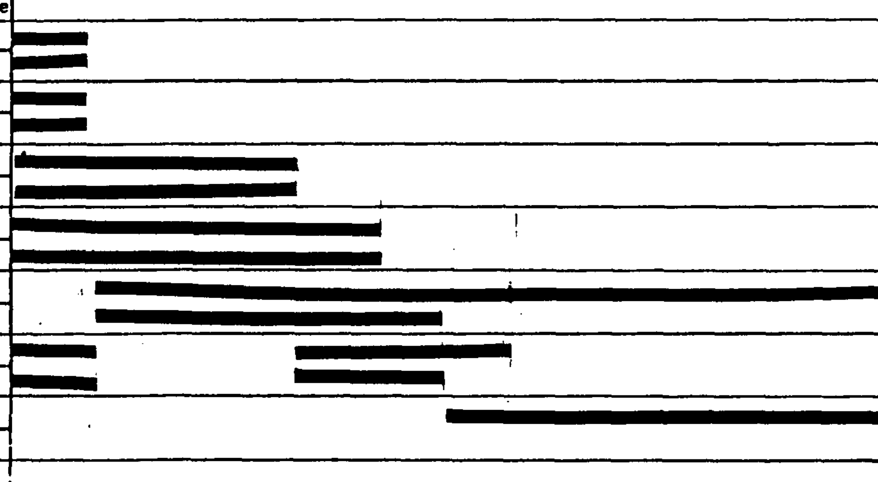
Total Planned Costs for Program/Project: $300,000

c. Cumulative Accrued Costs

	7-9 89	10-12 89	1-3 90	4-6 90	7-9 90	10-12 90	1-3 91	4-6 91	7-9 91	10-12 91	1-3 92	4-6 92
Planned	16	50	52	54	169	273						
Actual	5	38	43	48	172	301						
Variance	11	12	9	6	-3	-28						

11. Major Milestone Status (Units Planned / Units Complete)

- 4.1 Site Selection
- 4.2 Permitting
- 4.3 Phase I Report
- 4.4 Bid Solicitation
- 4.5 Drilling
- 4.6 Data Analysis
- 4.7 Core Curation
- 4.8 Final Report



12. Remarks

See attachment and Project Status Report Form

13. Signature of Recipient and Date: George R. Priest 2-14-91

14. Signature of DOE Reviewing Representative and Date:

FORM EIA-459F
(10/80)

U.S. DEPARTMENT OF ENERGY

FEDERAL ASSISTANCE PROGRAM/PROJECT STATUS REPORT

FORM APPROVED
OMB No. 1900-0127

1. Program/Project Identification No.	2. Program/Project Title	3. Reporting Period
DE-FG07-89ID12834	Inves. Thermal Regime High Cascades, Ore	10-1-90 through 12-31-90

4. Name and Address	
Oregon Department of Geology and Mineral Industries	5. Program/Project Start Date: 6/27/89
	6. Completion Date: 10/15/92

7. Approach Changes

☒ None

8. Performance Variances, Accomplishments, or Problems

☒ None

9. Open Items

☒ None

10. Status Assessment and Forecast

Drilling and logging is complete.

Data analysis is proceeding.

Preliminary data was presented at the December AGU meeting in San Francisco

☒ No Deviation from Plan is Expected

11. Description of Attachments

Detailed report

☐ None

12. Signature of Recipient and Date	13. Signature of DOE Reviewing Representative and Date
Gregg R. Priest 2-14-91	

Quarterly progress report

Santiam Pass 77-24 Geothermal Drilling Program

Brittain Hill, DOGAMI, February, 1991

A 929 meter (3046') geothermal observation hole has been completed near Santiam Pass on the axis of the High Cascades of Oregon. Partial funding for this project was obtained through a U.S. Department of Energy Geothermal Research Grant (DE-FG07-89ID12834) to the Oregon Department of Geology and Mineral Industries (DOGAMI), and a one-third cost share from Oxbow Geothermal Corporation. Progress from September through December, 1990, was as follows:

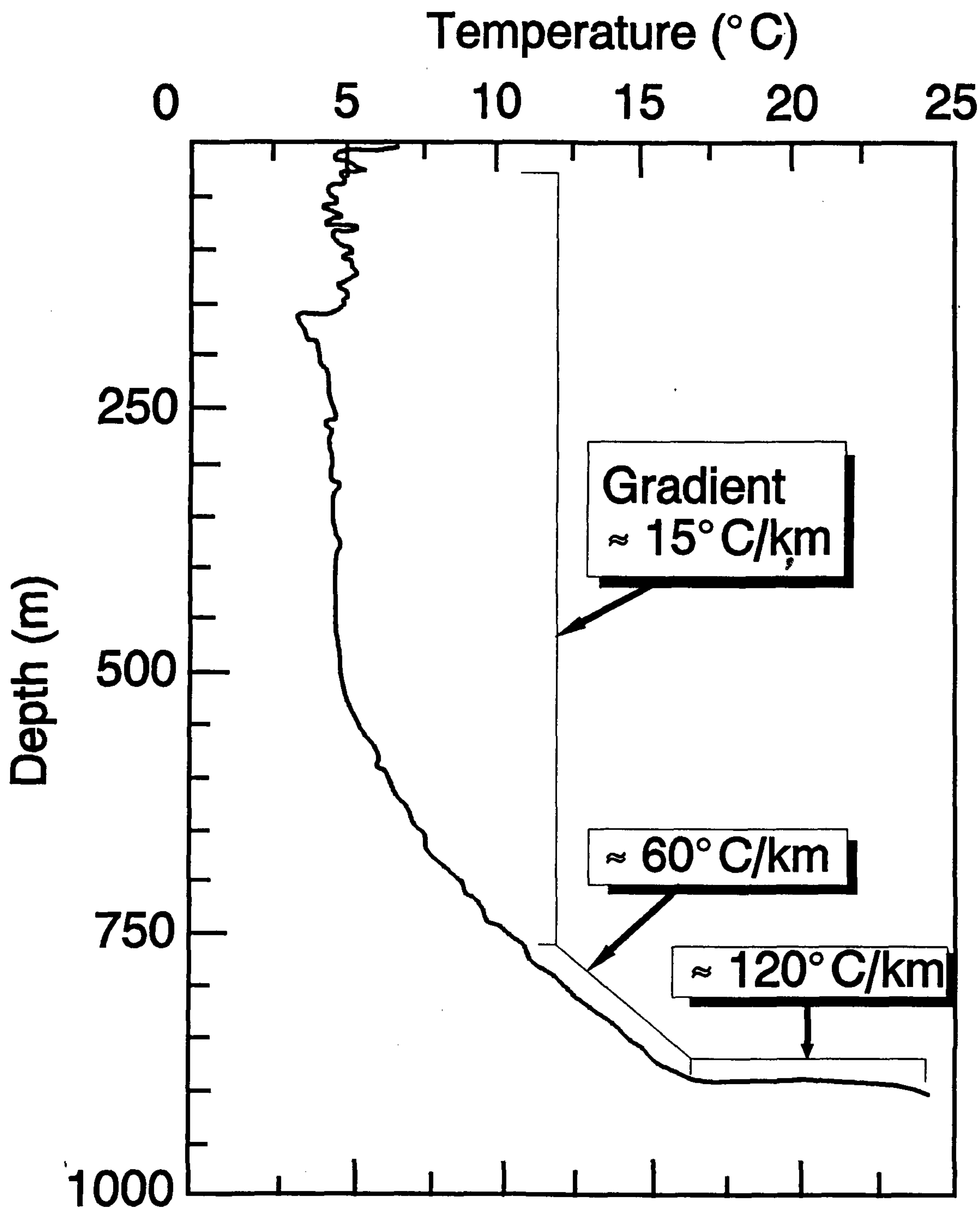
Diamond core drilling was done by Tonto Drilling Services, Salt Lake City, under the direction of Oxbow Geothermal and DOGAMI. The hole was drilled from 140 meters to TD using HQ (4" o.d.) diamond core rods, with >99.5% core recovery. Drilling operations commenced on August 10, 1990, and proceeded at an average daily rate of 91 ft/day with no significant delays. Total drilling costs, including rotary drilling of the upper 140 meters, were approximately $224,000; core drilling costs averaged ≈$75/ft, and rotary costs were ≈$65/ft. The hole was conditioned with heavy drilling mud and completed on 9/14/90 with 1.9" I.D. water-filled black pipe to TD.

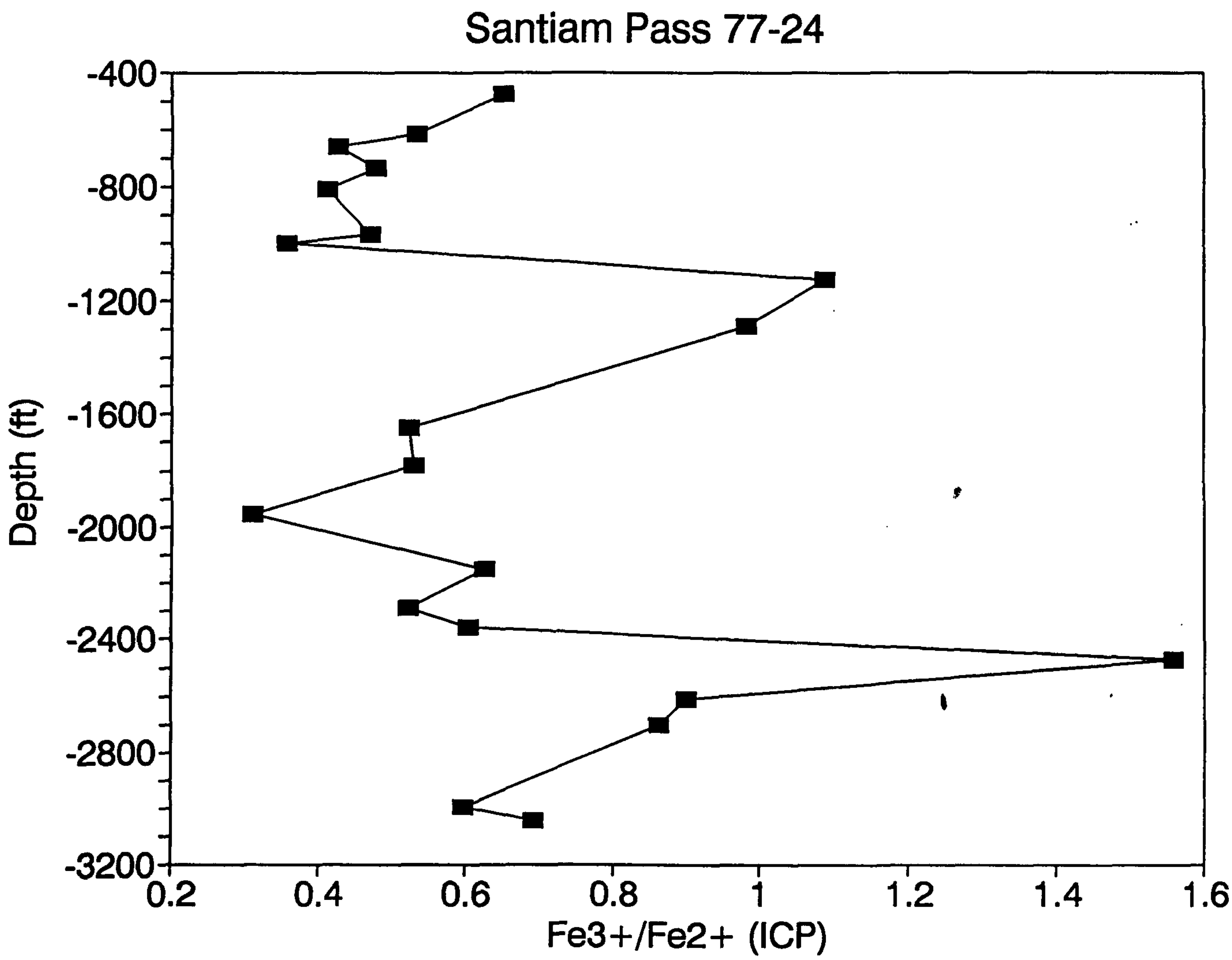
Caliper and sonic logs were run prior to completion by Dr. David Blackwell, Southern Methodist University. Natural gamma-ray and temperature logs were run on 9/19/90, and an additional temperature log was run on 9/27/90. A preliminary, non-equilibrated bottom hole temperature is 24°C, with apparent temperature gradients of ≈60°C/km from 700-900 meters and ≈120°C/km from 905-920 meters. The temperature profile of SP 77-24 is shown in figure 1. Data from sonic and natural gamma-ray logs is being correlated with lithologic logs. The hole will be logged at least once more before September, 1991.

The hole lithologies consist of ≈95% basalt to basaltic andesite flows and dikes, with ≈5% volcanic sediments; most of the units in the upper 670 meters are basaltic andesite ($SiO_2 \approx 54\%$). Disseminated, low grade zeolitic(?) alteration is present in the lower ≈100 meters of the core. Large variations in Fe^{3+}/Fe^{2+} (figure 2) indicate that

Santiam Pass 77-24

logged 9/27/90




Santiam Pass 77-24
Depth (ft)
-400
-800
-1200
-1600
-2000
-2400
-2800
-3200
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
Fe3+/Fe2+ (ICP)

most of the mafic flows below ≈300 meters have undergone post-emplacement oxidation, which was likely produced through interaction with groundwater. Preliminary K-Ar age determinations indicate that the age of bottom of the hole (928 m) is 1.81 ± 0.05 m.y., and that the section above ≈500 meters is younger than 1 m.y. Detailed core studies, including petrographic analysis, measurement of thermal conductivity, and major and trace element analyses, are currently in progress.

The Santiam Pass hole is scheduled remain open for research through September, 1991. Interested researchers should contact Brittain Hill at the Department of Geoscience, Oregon State University, Corvallis, OR 97331-5506 (503-737-1201, FAX 503-737-1200) to coordinate studies. Opportunities for core studies also exist for the Santiam Pass hole, and for several other 200-550 meter High Cascade cores and drill cuttings. The results of this project are scheduled for publication as a DOGAMI Open-file Report in early 1992, and preliminary results have been presented in an informal session at the Fall Meeting of the American Geophysical Union in San Francisco, California.

FINANCIAL STATUS REPORT

(Follow instructions on the back)

1. FEDERAL AGENCY AND ORGANIZATIONAL ELEMENT TO WHICH REP

U.S. Department of Energy

3. RECIPIENT ORGANIZATION *(Name and complete address, including ZIP code)*

Oregon Department of Geology
Mineral Industries
1400 SW Fifth Ave., Room 910
Portland, OR 97201

4. EMPLOYER IDENTIFICATION NUMBER

93.6001955

5. RECIPI

8. PROJECT/GRANT PERIOD *(See instructions)*

FROM *(Month, day, year)* 6/27/91

TO *(Month, day, year)* 10/15/91

10. STATUS OF FUNDS

PROGRAMS/FUNCTIONS/ACTIVITIES ►	*(a)* USDOE	*(b)* PrivateFunds (Oxbow)	*(c)*	*(d)*
a. Net outlays previously reported	$ 71,947	$ 100,00	$	$
b. Total outlays this report period	103,911	25,858		
c. *Less:* Program income credits				
d. Net outlays this report period *(Line b minus line c)*	103,911	25,858		
e. Net outlays to date *(Line a plus line d)*	175,858	125,858		
f. *Less:* Non-Federal share of outlays				
g. Total Federal share of outlays *(Line e minus line f)*	175,858			
h. Total unliquidated obligations				
i. *Less:* Non-Federal share of unliquidated obligations shown on line h				
j. Federal share of unliquidated obligations				
k. Total Federal share of outlays and unliquidated obligations	175,858			
l. Total cumulative amount of Federal funds authorized	200,000	125,858		
m. Unobligated balance of Federal funds	24,142	- 0 -		

11. INDIRECT EXPENSE

a. TYPE OF RATE *(Place "X" in appropriate box)* ☐ PROVISIONAL ☐ PREDETERMINED ☐ FINAL ☒ FIXED

b. RATE	c. BASE	d. TOTAL AMOUNT	e. FEDERAL SHARE
16.1%	151,471	24,387	24,387

12. REMARKS: *Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation.*

13. CERTIFICATION

I certify to the best of my know
lief that this report is correct anc
that all outlays and unliquidat
are for the purposes set forth
documents.

269-102

NEIL GOLDSCHMIDT
GOVERNOR

Department of Geology and Mineral Industries
ADMINISTRATIVE OFFICE
910 STATE OFFICE BLDG., 1400 SW 5th AVE., PORTLAND, OR 97201-5528
PHONE (503) 229-5580 FAX (503) 229-5639

June 29, 1990

To: Interested Persons, Program for Scientific Drilling in the Cascades

From: Brittain Hill, DOGAMI BH

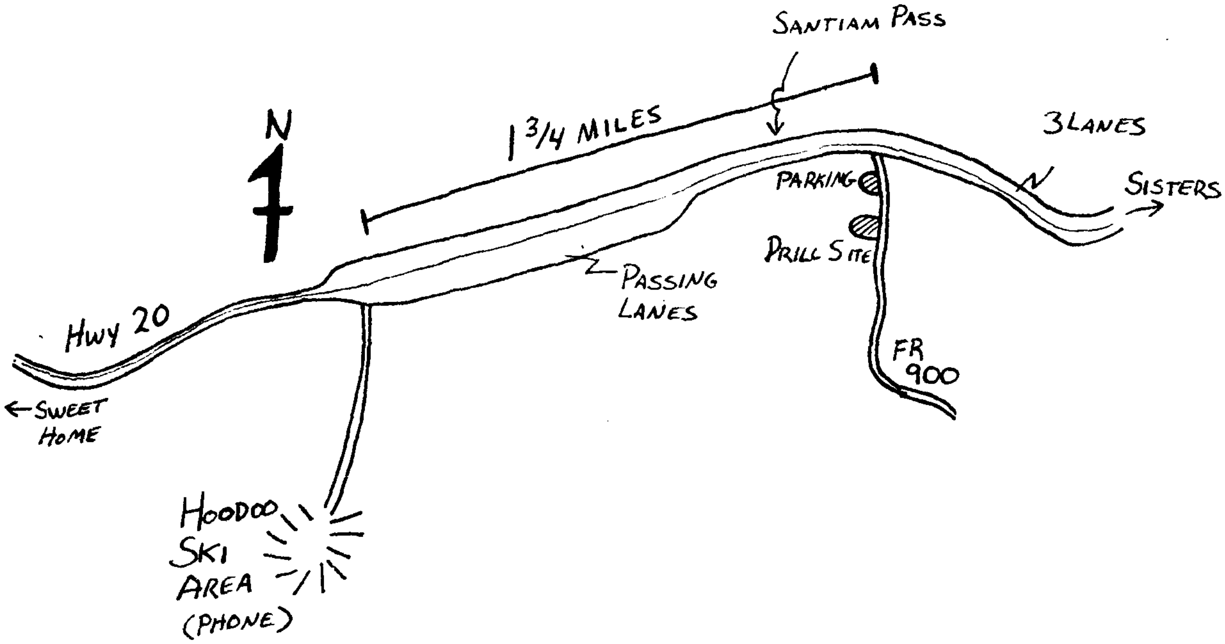
Subject: Update on Santiam Pass Drilling Project

Drilling at the Santiam Pass has been delayed due to mechanical problems with the drill rig. It is not certain when the rig will arrive at the site, but the best estimate is August 6, 1990 ± a week. Drilling operations may have to be modified due to fire hazard conditions, but it is unlikely that a full suspension of operations will occur. On a more positive note, the mosquitos will be gone by August.

The attached map will be useful for those of you who are still planning to visit the site. There should also be some orange flagging at the intersection of Hwy 20 with the turnoff. I will be camping at Blue Lake Resort, which is about 8 miles east of the site. There are also numerous Forest Service campgrounds around Blue Lake & adjacent Suttle Lake. The nearest motels are located in Camp Sherman (15 miles from the site) and Sisters (25 miles).

Once again, please contact me as soon as possible if you are interested in studies involving the Santiam Pass core. I can be reached until August at: Department of Geosciences, Wilkinson Hall 102, Oregon State University, Corvallis, OR 97331-5506, (503) 737-1201.

1st Qtr '90
Tech Prog. Rept.



SANTIAM PASS
N
1 3/4 MILES
3 LANES
PARKING
SISTERS
DRILL SITE
PASSING LANES
HWY 20
FR 900
← SWEET HOME
HOODOO SKI AREA (PHONE)

July, 16, 1990

Dr. George Priest
Department of Geology and Mineral Industries
910 State Office Building
Portland, Oregon 97801

Dear George:

Enclosed in this package are a copy of the revised JGR ms that has gone in to the journal, some figures with resistivity information for the Santiam Pass area (and a quarterly report which is part of this letter), and copies of the temperature-depth logs for the two Occidental holes at Newberry.

Since the last quarterly report we have been working on the compilation of the exploration data in the Santiam Pass area. That compilation is now complete. We have digitized the results of the various electrical exploration studies and plotted them on the same scale map as the geothermal gradient data discussed previously. Working copies of the maps are enclosed. These maps are on the same base as Figure 5 of the manuscript for the JGR volume. The discussion of the thermal characteristics of the Santiam pass area in the paper is part of this report and represents the state of knowledge before the drilling of the Santiam Pass well.

None of the electrial resistivity data impinge directly on the drill site, but the results are fairly extensive in the area to the west, especially along the McKenzie River. The low resistivity area that was the target of the Fish Lake EWEB hole is clearly shown on the maps. However, the thermal gradients in that hole, after passing through the shallow, warm aquifer, were below regional values. Apparently the low values are related to alteration rather than directly to temperature.

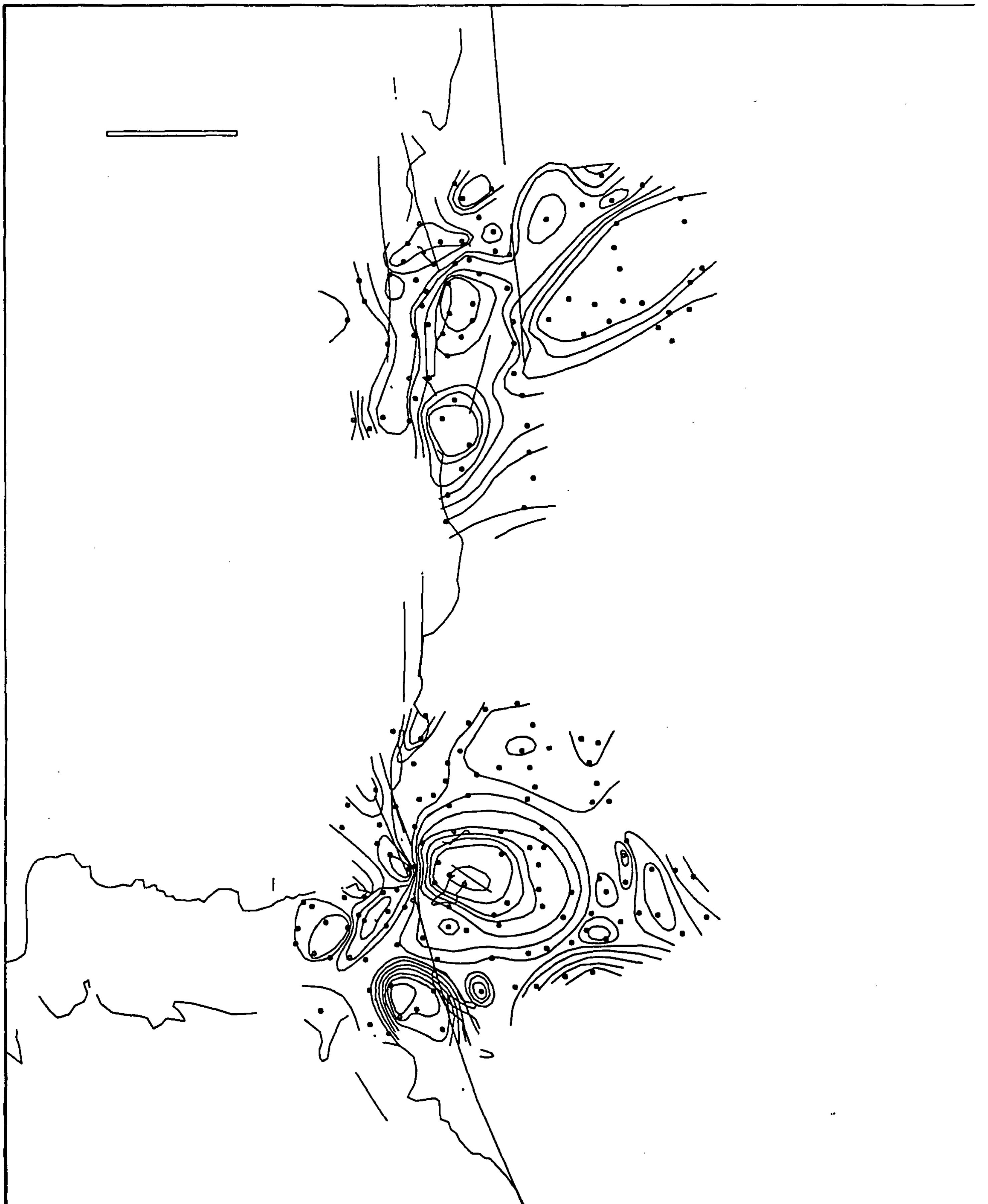
Figure 5 represents an updated geothermal gradient and heat flow map of the area. Although the data are scattered, I believe that there is quite general upflow of warm water along the fault zone that controls the north-south streach of the McKenzie River. There is evidence for such flow from the vicinity of Santiam Junction at two holes, possibly at 14S/6E-15AD to the south, and in the south end of the map at Foley, Belknap, and Bigelow hot springs. The volume of the flow(total heat loss) can not be to significant, however, because Mariner and others (JGR paper) were not able to document any major leakage of hot fluid into that section of the McKenzie River on the basis of their geochemical studies.

Sincerely yours,

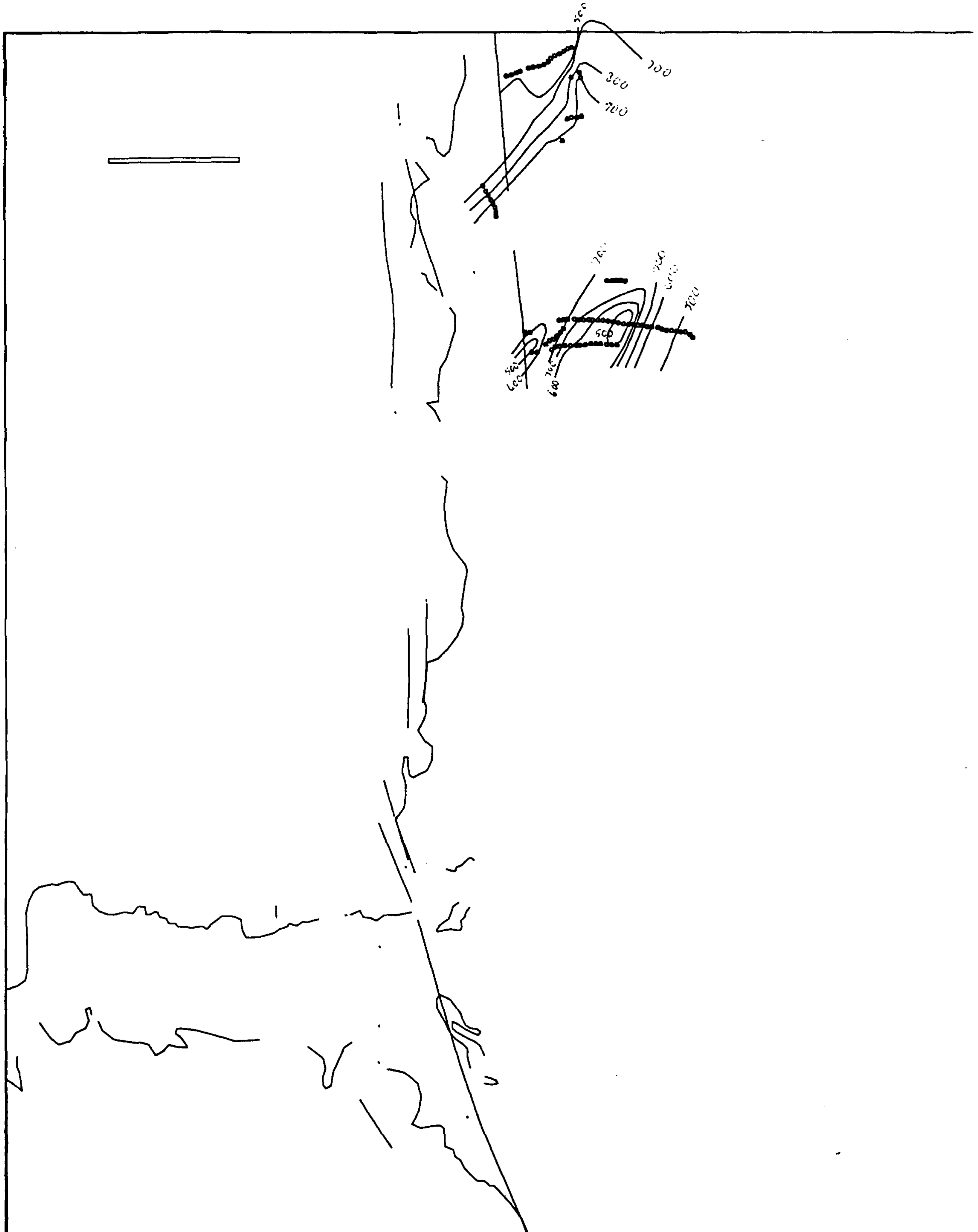
David Blackwell
Hamilton Professor of Geophysics

cc: Doug Wilde, Grants and Contracts

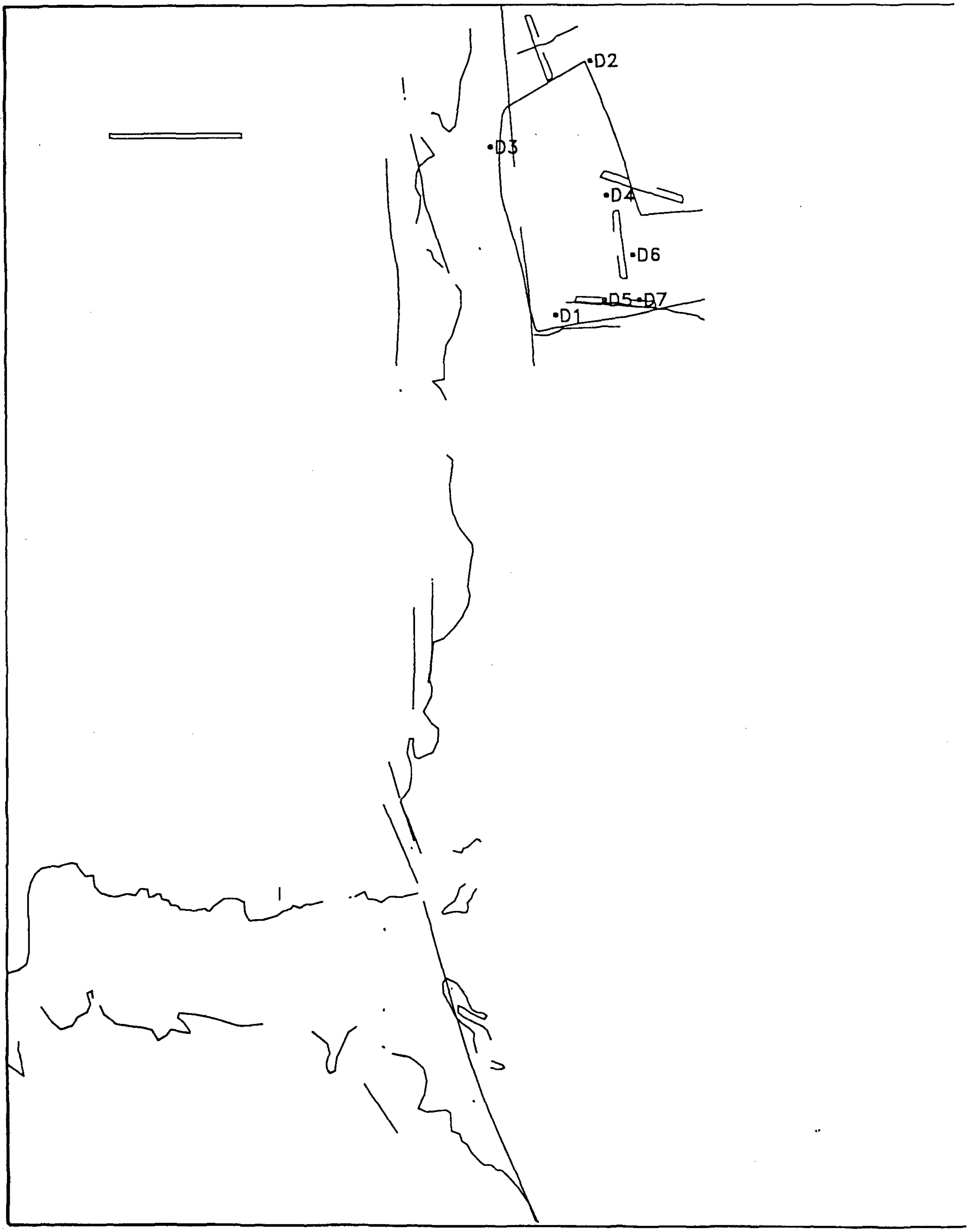
DEPARTMENT OF GEOLOGICAL SCIENCES / 214 • 692-2750 / FAX 214 • 692-4289
SOUTHERN METHODIST UNIVERSITY / DALLAS, TEXAS 75275-0395



Combined 1st, 2nd, and 3rd layers



INTERPRETATION AND RECOMMENDATION



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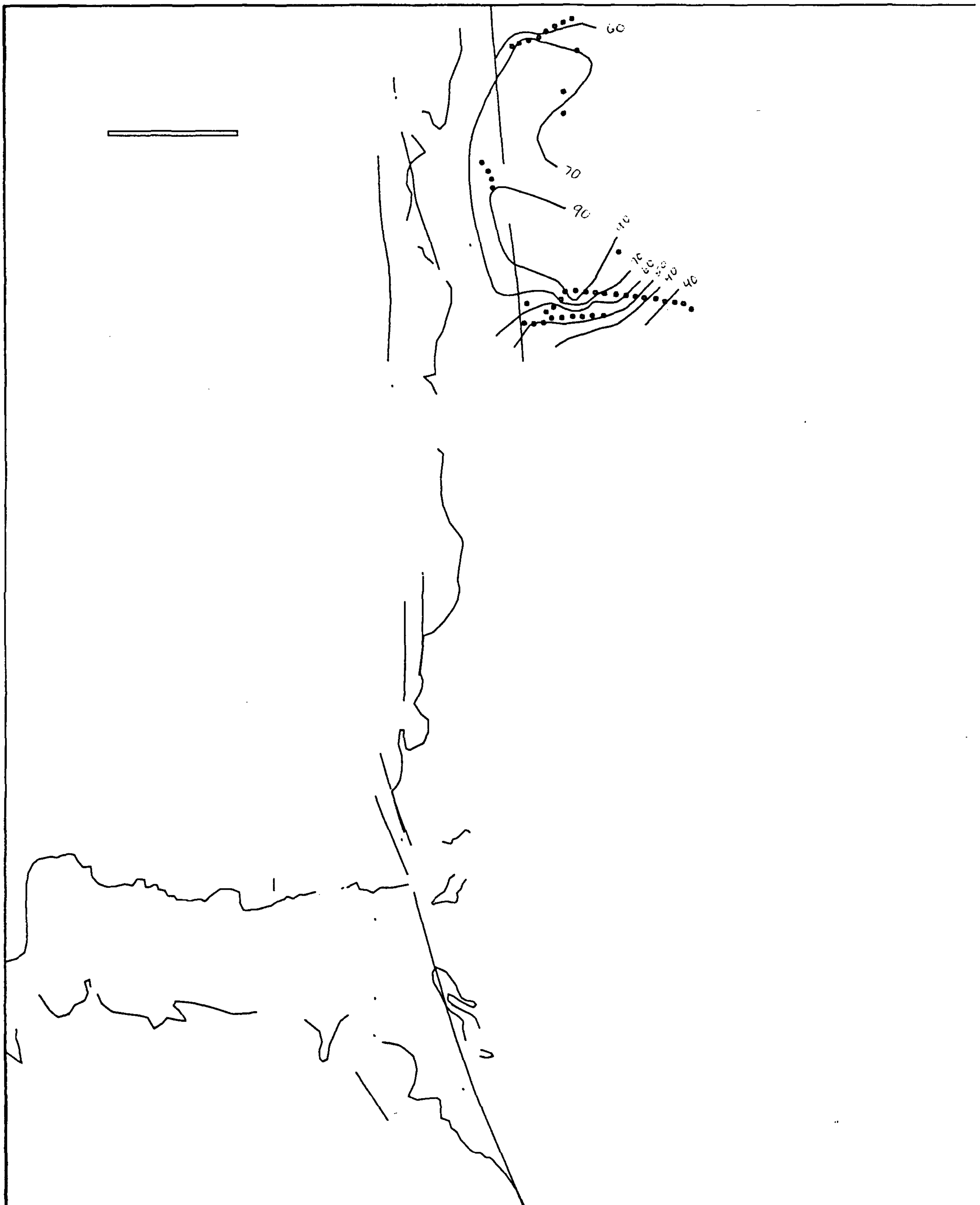

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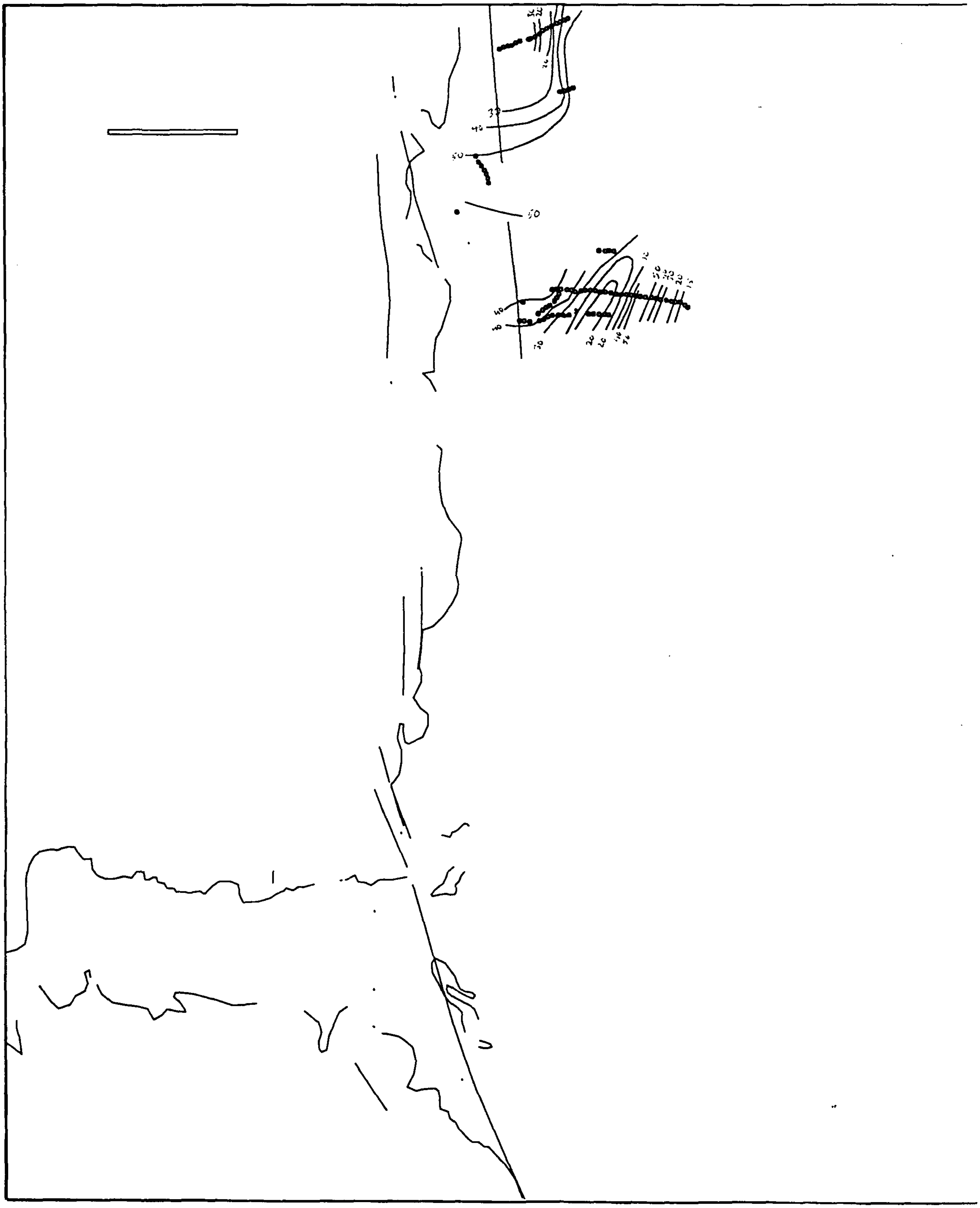
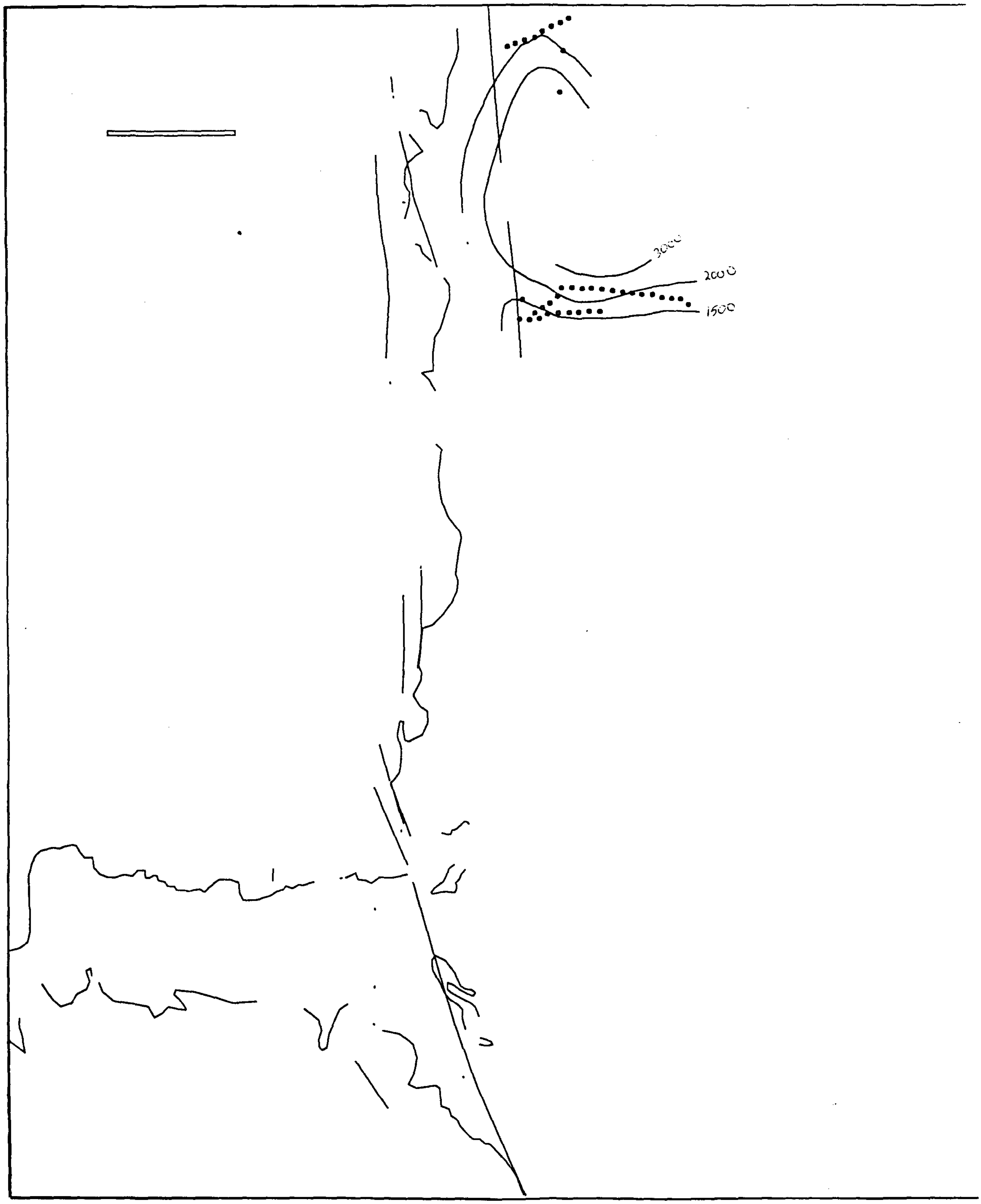
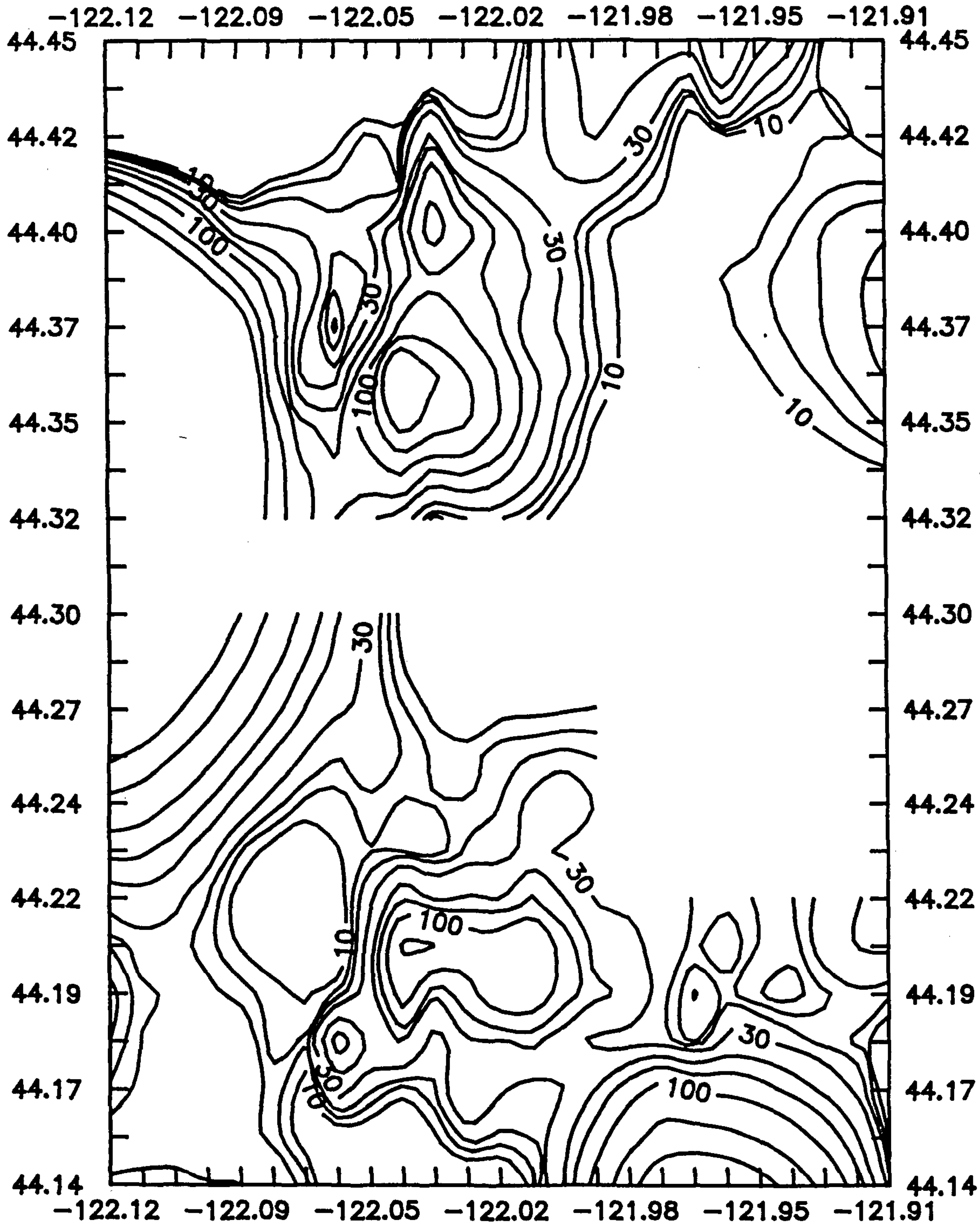


Combined 1st, 2nd, 3rd, and 4th Layer



SANTIAM PASS - CONDUCTANCE VALUES



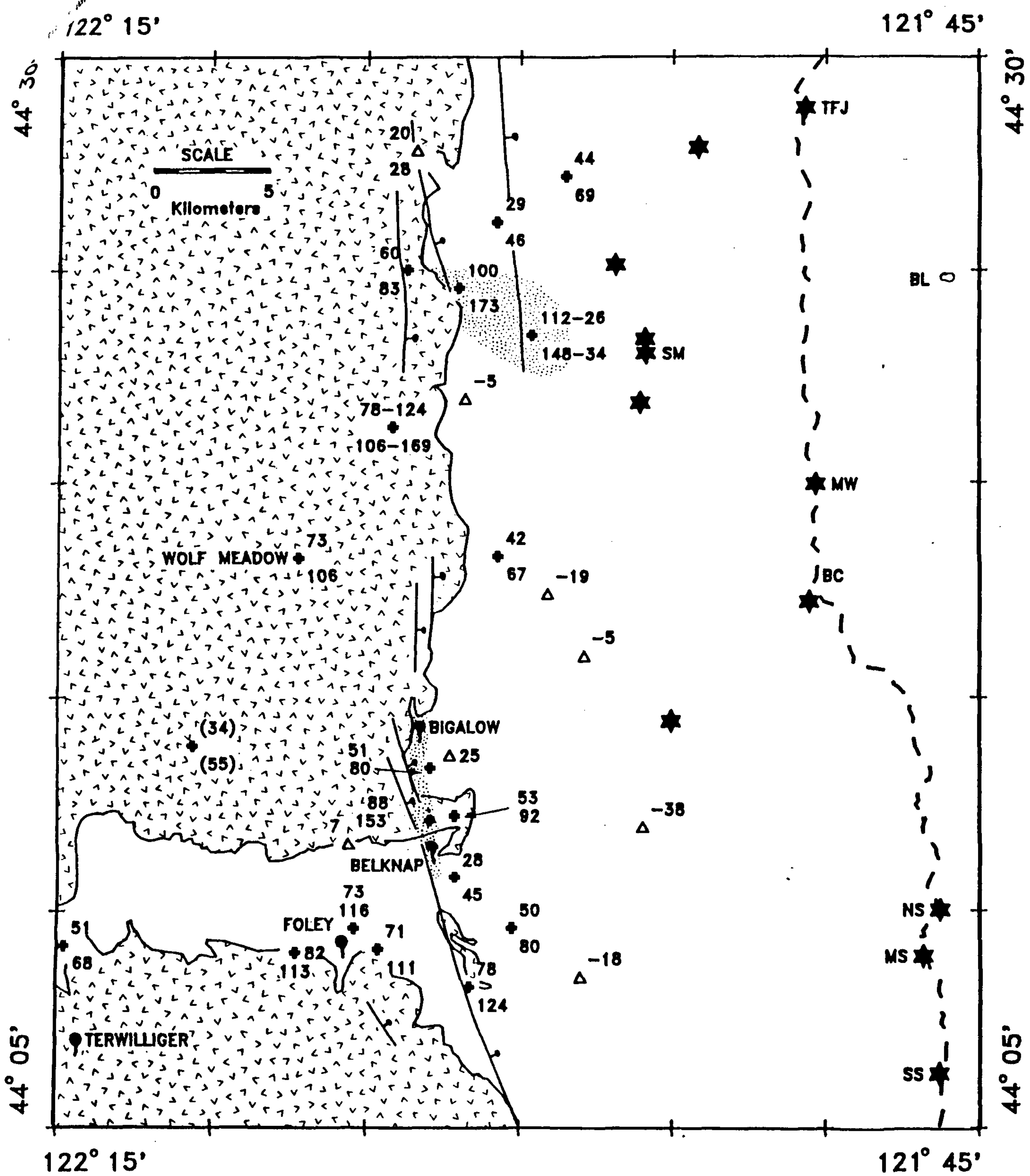

122° 15'
121° 45'
44° 30'
44° 05'
SCALE
0
5
Kilometers
TFJ
BL
SM
MW
BC
NS
MS
SS
20
28
44
69
29
46
60
83
100
173
112-26
148-34
-5
78-124
106-169
WOLF MEADOW
73
106
42
67
-19
-5
(34)
(55)
BIGALOW
25
51
80
88
153
53
92
7
-38
BELKNAP
28
45
73
116
FOLEY
50
80
51
68
82
113
71
111
78
124
-18
TERWILLIGER

Figure 5

Figure 5. Geothermal gradient (°C/km, upper value) and heat flow values (mWm^{-2}, lower value) for sites in Santiam Junction-Belknap/Foley area. Holes in Holocene rocks are marked by open triangles. Major volcanic centers are shown as stars; Cascade Range crest is the dashed line. Major west-edge bounding faults of Cascade graben are shown. Rocks older than Quaternary shown by the caret pattern (from Black et al., 1987; Priest et al., 1988). Stippled pattern marks larger areas of fluid flow and heat flow anomalies. Abbreviations are TFJ, Three Finger Jack; BL, Blue Lake; MW, Mt. Washington; BC, Belknap Crater; NS, MS, SS; North, Middle and South Sister; SM, Sand Mountain.

Rev 02/12/90

FINANCIAL STATUS REPORT

(Follow instructions on the back)

1. FEDERAL AGENCY AND ORGANIZATIONAL ELEMENT TO WHICH REPORT IS SUBMITTED	U.S. Department of Energy
2. FEDERAL GRANT OR OTHER IDENTIFYING NUMBER	DE-FG07-89ID12834
OMB Approved No. 80-RO180	
PAGE 1 OF 1 PAGES	
3. RECIPIENT ORGANIZATION (Name and complete address, including ZIP code)	Oregon Department of geology and Mineral Industries 1400 SW Fifth Avenue, Suite 910 Portland, Oregon 97201
4. EMPLOYER IDENTIFICATION NUMBER	93.6001955
5. RECIPIENT ACCOUNT NUMBER OR IDENTIFYING NUMBER	
6. FINAL REPORT	☐ YES ☒ NO
7. BASIS	☒ CASH ☐ ACCRUAL
8. PROJECT/GRANT PERIOD (See instructions)	FROM (Month, day, year) 6-27-89 TO (Month, day, year) 12-31-89
9. PERIOD COVERED BY THIS REPORT	FROM (Month, day, year) 6-27-89 TO (Month, day, year) 12-31-89

10. STATUS OF FUNDS

PROGRAMS/FUNCTIONS/ACTIVITIES ►	(a) USDOE	(b) Private Funds (Oxbow)	(c)	(d)	(e)	(f)	TOTAL (g)
a. Net outlays previously reported	$ 0	$ 0	$	$	$	$	$
b. Total outlays this report period	8,736	29,460					
c. *Less:* Program income credits							
d. Net outlays this report period (*Line b minus line c*)	8,736	29,460					
e. Net outlays to date (*Line a plus line d*)	8,736	29,460					
f. *Less:* Non-Federal share of outlays							
g. Total Federal share of outlays (*Line e minus line f*)	8,736						
h. Total unliquidated obligations							
i. *Less:* Non-Federal share of unliquidated obligations shown on line h							
j. Federal share of unliquidated obligations							
k. Total Federal share of outlays and unliquidated obligations	8,736						
l. Total cumulative amount of ~~Federal~~ funds authorized	200,000	100,000					
m. Unobligated balance of ~~Federal~~ funds	191,264	70,540					

11. INDIRECT EXPENSE

a. TYPE OF RATE (Place "X" in appropriate box)	☐ PROVISIONAL	☐ PREDETERMINED	☐ FINAL	☒ FIXED
b. RATE	c. BASE	d. TOTAL AMOUNT	e. FEDERAL SHARE	
19%	7,342	1,394	1,394	

12. REMARKS: *Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation.*

13. CERTIFICATION

I certify to the best of my knowledge and belief that this report is correct and complete and that all outlays and unliquidated obligations are for the purposes set forth in the award documents.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL: [signature]

TYPED OR PRINTED NAME AND TITLE: John Nielson

DATE REPORT SUBMITTED: 2/8/90

TELEPHONE (*Area code, number and extension*): (503) 229-5580

K-Ar @ 1647, 2290, 3044
Sent 10-22-90
Bob Duncan

Santiam Pass 77-24

Preliminary summary lithology log

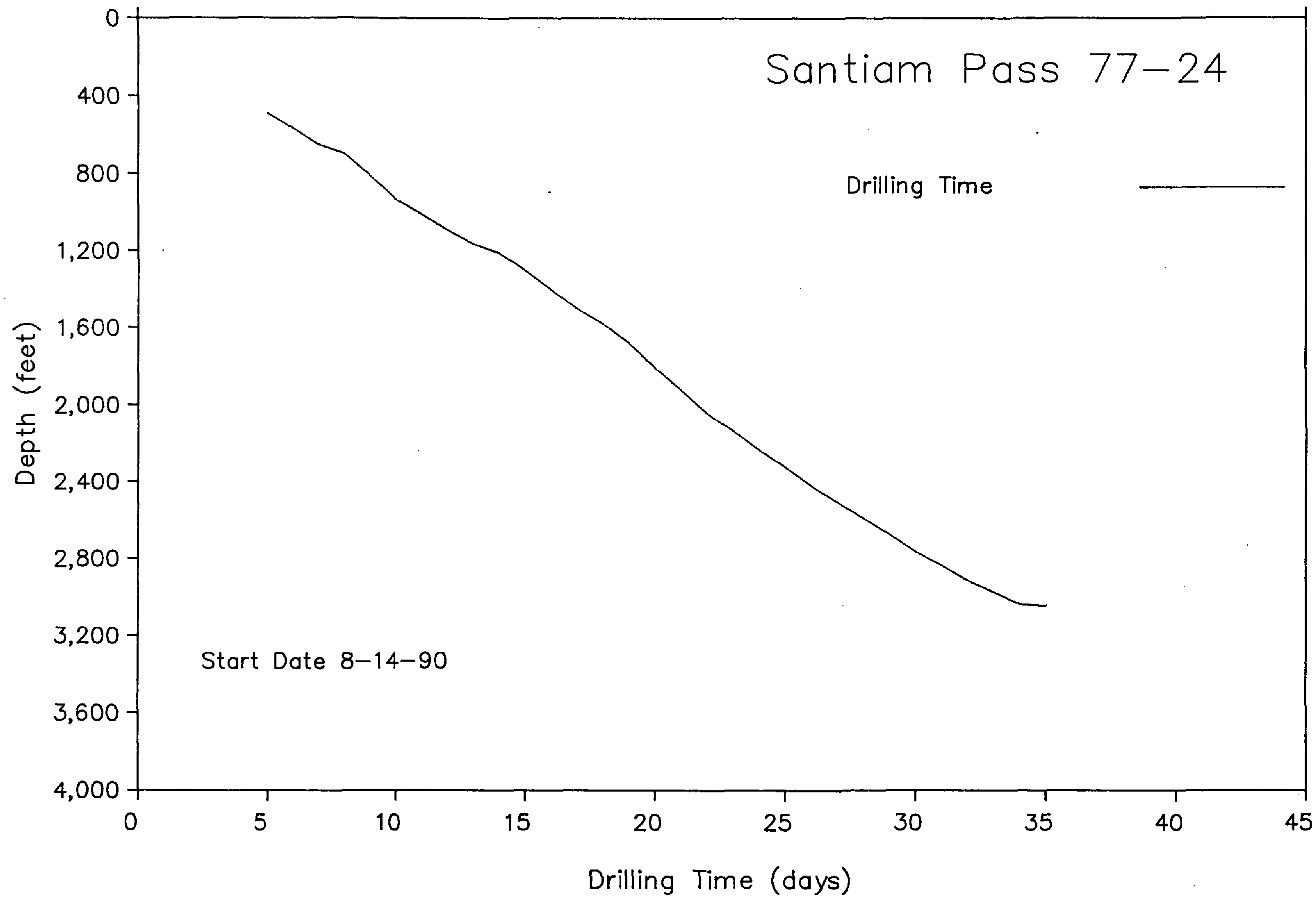
Brittain Hill
Oregon Department of Geology & Mineral Industries
1990

Legend

- Basalt flow
- Basalt dike
- Mafic flow breccia
- Debris flow deposit
- Mafic near-vent agglutinate
- Volcanic sediments
- Basaltic andesite flow
- Andesite flow

All lithologies based on hand-sample identification.

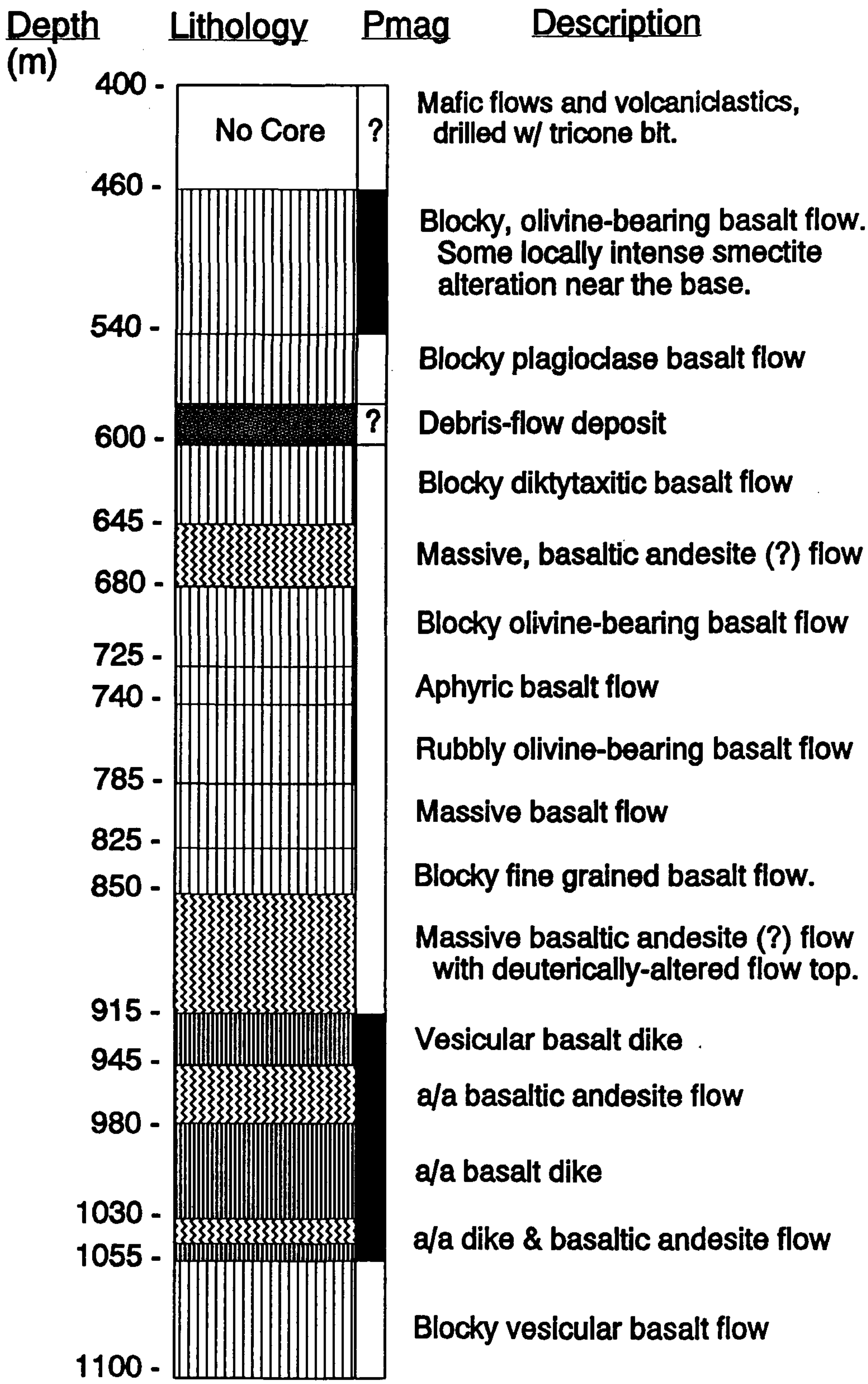
Scale : 1" = 100'



Santiam Pass 77-24
Drilling Time
Start Date 8-14-90
Depth (feet)
0
400
800
1,200
1,600
2,000
2,400
2,800
3,200
3,600
4,000
0
5
10
15
20
25
30
35
40
45
Drilling Time (days)

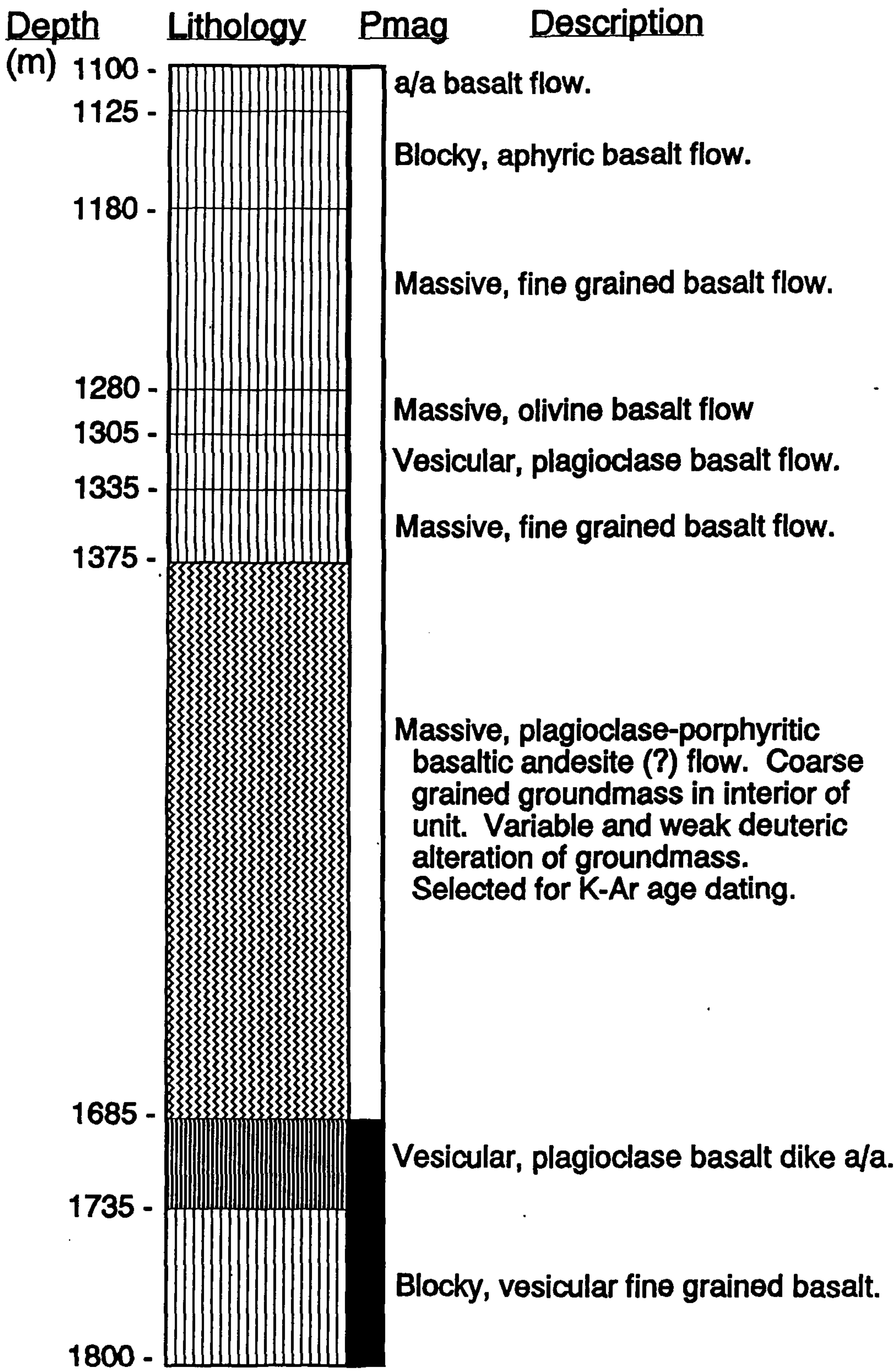
Santiam Pass 77-24

Preliminary summary lithology log



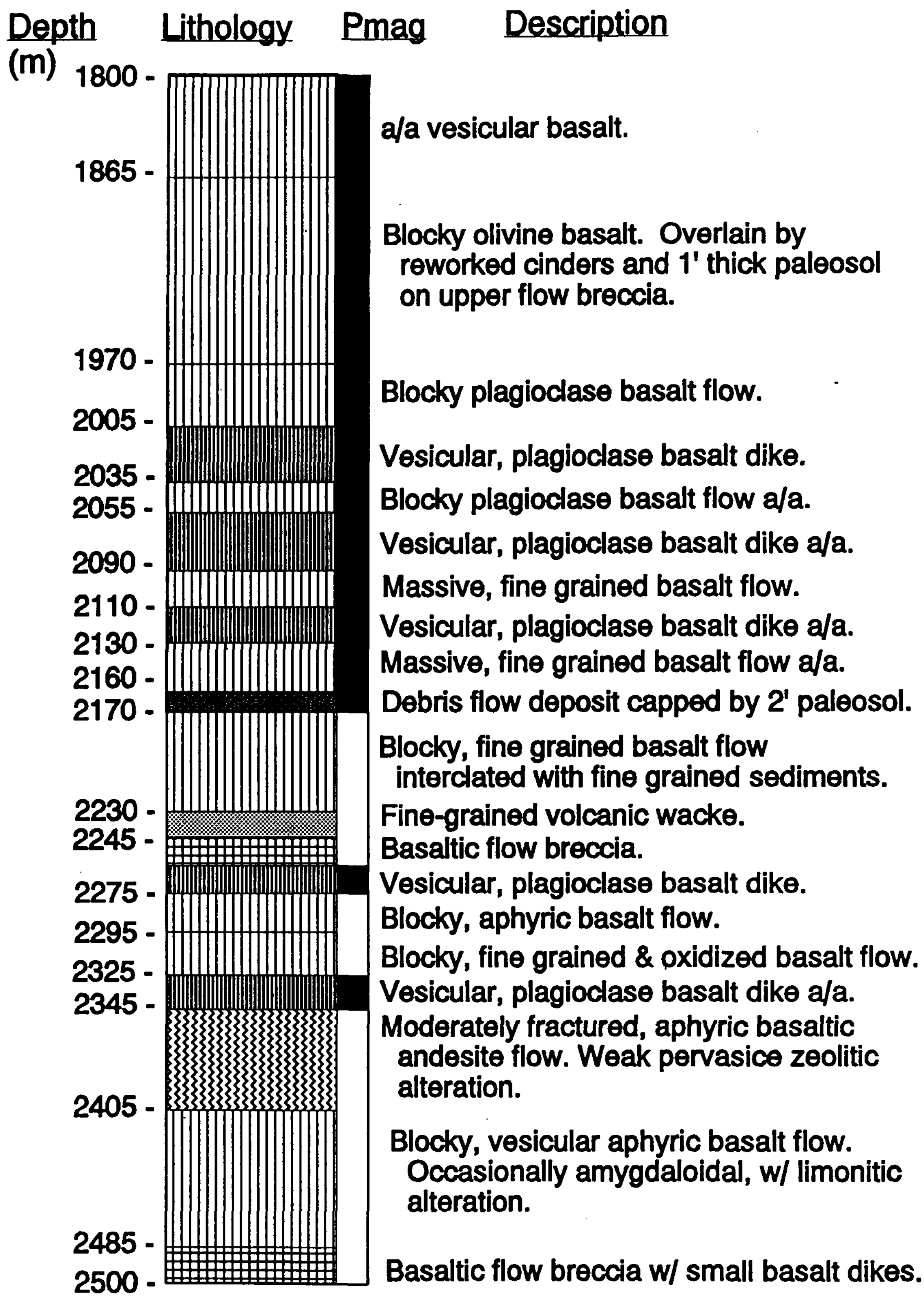
Santiam Pass 77-24

Preliminary summary lithology log



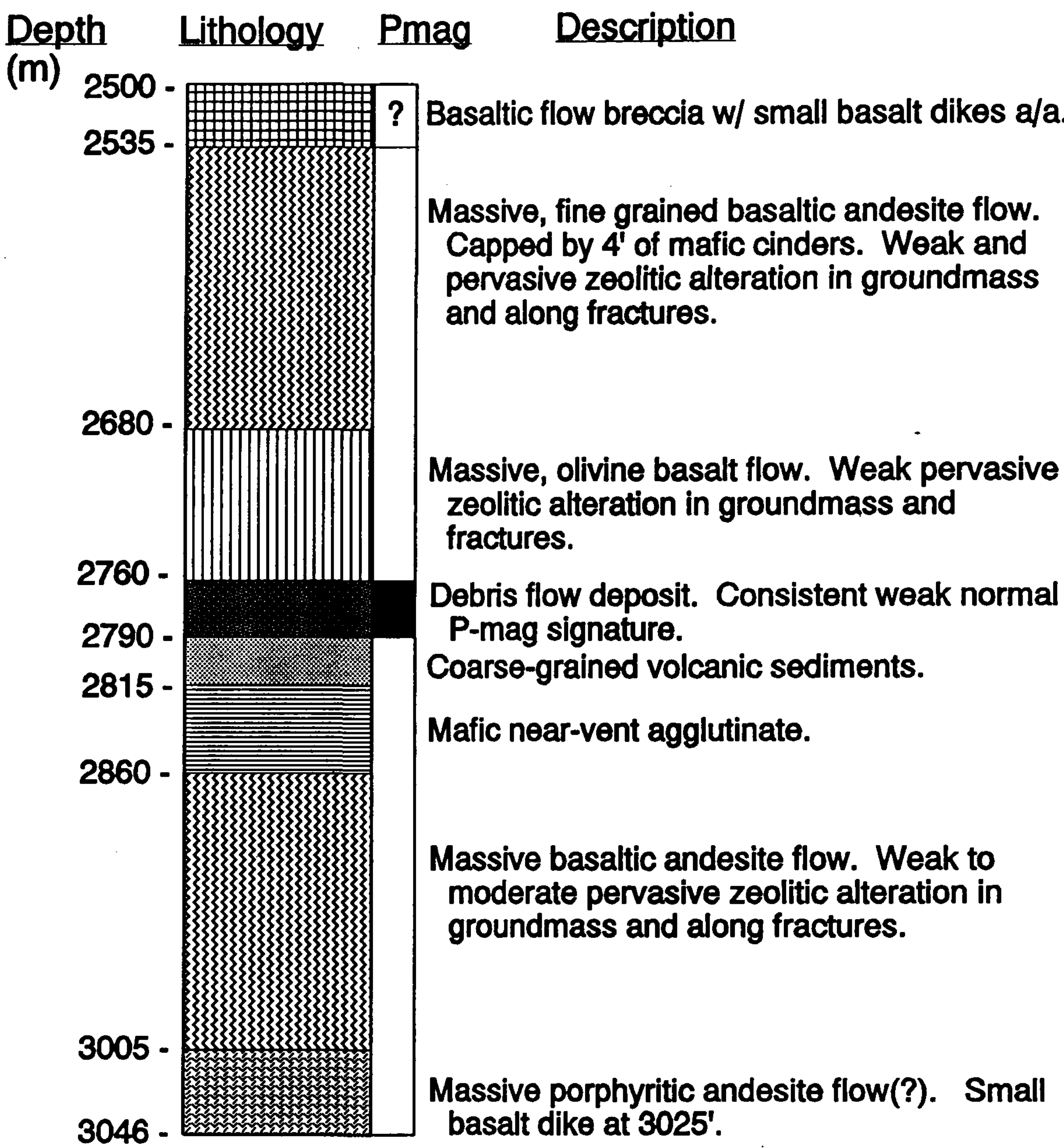
Santiam Pass 77-24

Preliminary summary lithology log



Santiam Pass 77-24

Preliminary summary lithology log



October 12,1990

Dr. George Priest
Dept. of Geology and Mineral Industries
910 State Office Building
Portland, Oregon 97201

Dear George:

Enclosed are copies of the logs for the Santiam Pass well. I have enclosed a floppy disk with the results included as well for your use. We ran a caliper log over a depth range of 105 to 230 m and about 400 to 929 m. The segment between 400 and 840 m seems to have disappeared, however. There were no enlargements of the hole over 3.95 inches within the missing interval so no really useful data was lost. We ran a natural gamma ray log in the tubing after the hole was complete from the surface to 921 m. There is some character to the log and I suspect that there will be a correlation with the geology when Britt gets a summary log done. We ran temperature logs from the surface to 920 m (9/19/90) and to 929 m (9/27/90). The bottom stands of pipe must have leaked mud as we had great difficulty getting the tools to go below 920 meters and on the 9/27/90 log the temperature equilibration of the tool in the bottom of the hole was anomalously slow. We ran a sonic log in the hole between 400 and 929 m, but as you know we had trouble getting the tool to pick the velocities properly. We recorded the waveforms on videotape and will work with the tape to try to pick some typical velocities for the hole using the videotape.

Between the two temperature logs the temperatures in the upper part of the hole cooled about 1 to 1.5 °C with the exception of the depth range 160 to 180 m and below 910 m. This is the response of the well the drilling disturbance. The shallow zone that shows little drilling effect must be a zone of active groundwater flow and the flow of the water past the hole has caused the hole to recover more rapidly than the areas of the hole not so effected. When the recovery is complete the temperatures in the groundwater zone will probably be about the 3°C now characteristic of the 170 m zone. The volume and rapidity of the flow is emphasized by the fact that we presumably lost most of the drilling fluid into this zone with virtually no temperature effect.

The results are disappointing because the temperatures are so low. The worst thing though is the downflow that effects most of the interesting part of the hole. As best I can tell the flow enters the hole at above 350 m (perhaps as shallow as 160 m) and exits the hole between 900 and 905 m. The best evidence of the undisturbed temperatures in the well are the BHT's measured during the drilling. These are shown on one of the plots. These imply that the gradient in the hole might be on the order of 15°C/km between 160 and 750 m, about 60°C/km between 750 and 850 m, and about 100 to 120°C/km at the bottom of the hole. The 50°C/km gradient is slightly below regional for the area while the gradient of 120°C/km is about 50 to 100% high. We will rework these BHT's to get the most accurate numbers possible during the next few weeks.

INSTITUTE FOR THE STUDY OF EARTH AND MAN
GEOTHERMAL LABORATORY / 214 • 692-2745
SOUTHERN METHODIST UNIVERSITY / DALLAS, TEXAS 75275

The average gradient in the depth range 900 to 920 m is 120°C/km. The minimum gradient in the bottom third of the hole is 50°C/km. The high gradient in the bottom zone may or may not be the best to use in further extrapolation to depth. Two examples to illustrate possible interpretations are shown in a separate figure based on two other holes on the Cascades. On hole is from the Mt Hood area (USGS-PUC) and one hole is about 25 km northwest of the Santiam Pass hole (EWEB-2). In the EWEB-2 hole (elevation 3920 ft) the regional gradient of 65°C/km starts immediately below the groundwater effect at 250 m. In the USGS-PUC hole the regional gradient is reached at about 400 m, below about 200 m of higher-than-regional gradient.

The nearest hole to the Santiam Pass well is about 12 km to the west at the EWEB-CL site near Fish Lake (elevation 3200 ft, the Santiam pass hole is at 4800 ft so the difference is about 600 m, see the enclosed map). The temperature-depth data are plotted with the Santiam Pass data for comparison. Both wells appear to be in areas of recharge as the temperatures are below normal and the gradients are mostly below normal (unless the bottom part of the Santiam Pass well is a measure of the true geothermal gradient there. The high temperatures at 200 m in EWEB-CL (28°C) are evidence of some flow of warm water from as yet unlocated direction.

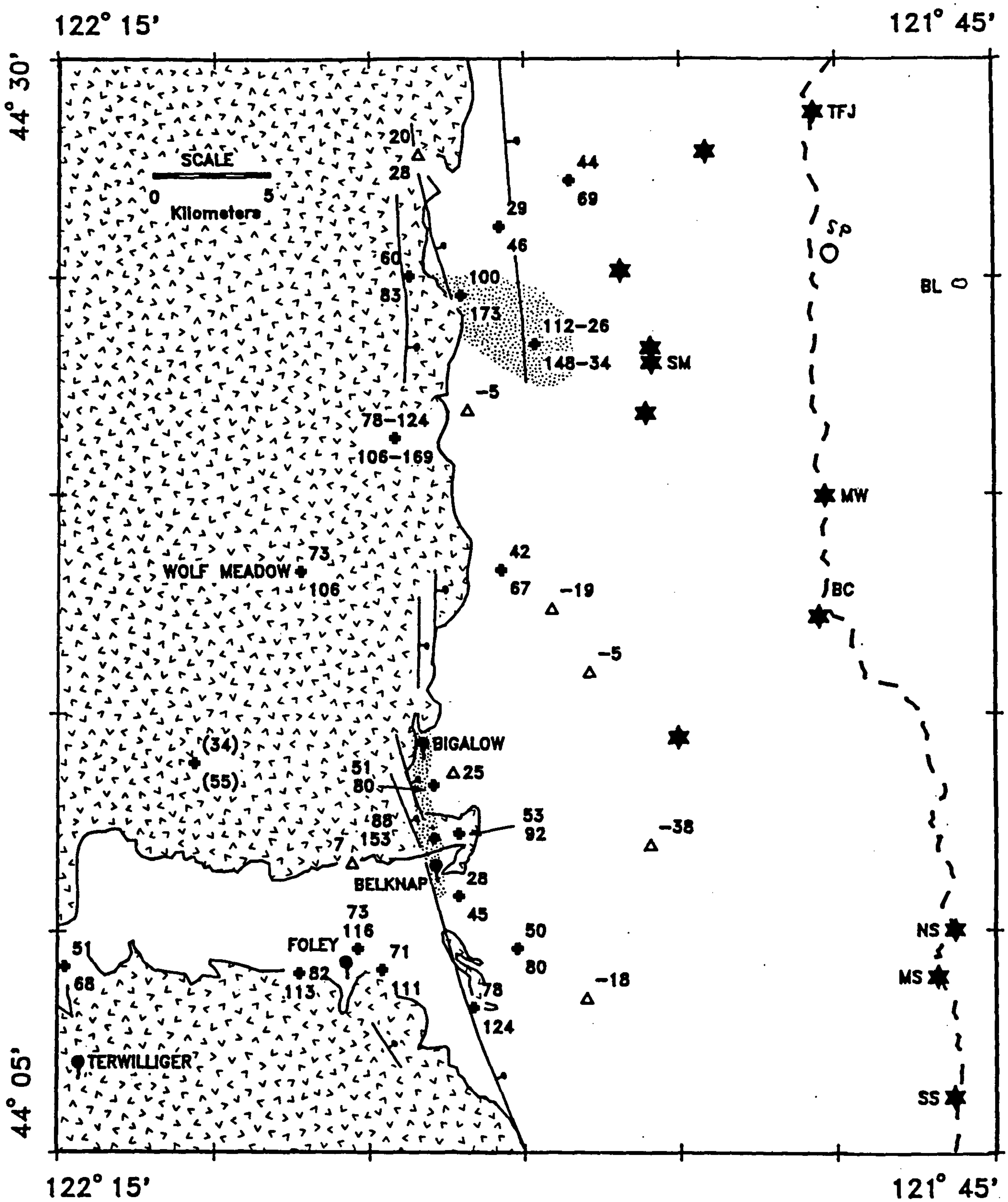
If you want additional plots, data, or have questions let me know. Interpretation is our goal in the next couple of months as we continue to work on the data sets, measure thermal conductivity, etc. We'll keep you informed of the results.

Sincerely yours,

Dave

David D. Blackwell
Hamilton Professor of Geophysics

cc: Britt Hill


122° 15'
121° 45'
44° 30'
44° 05'
SCALE
0
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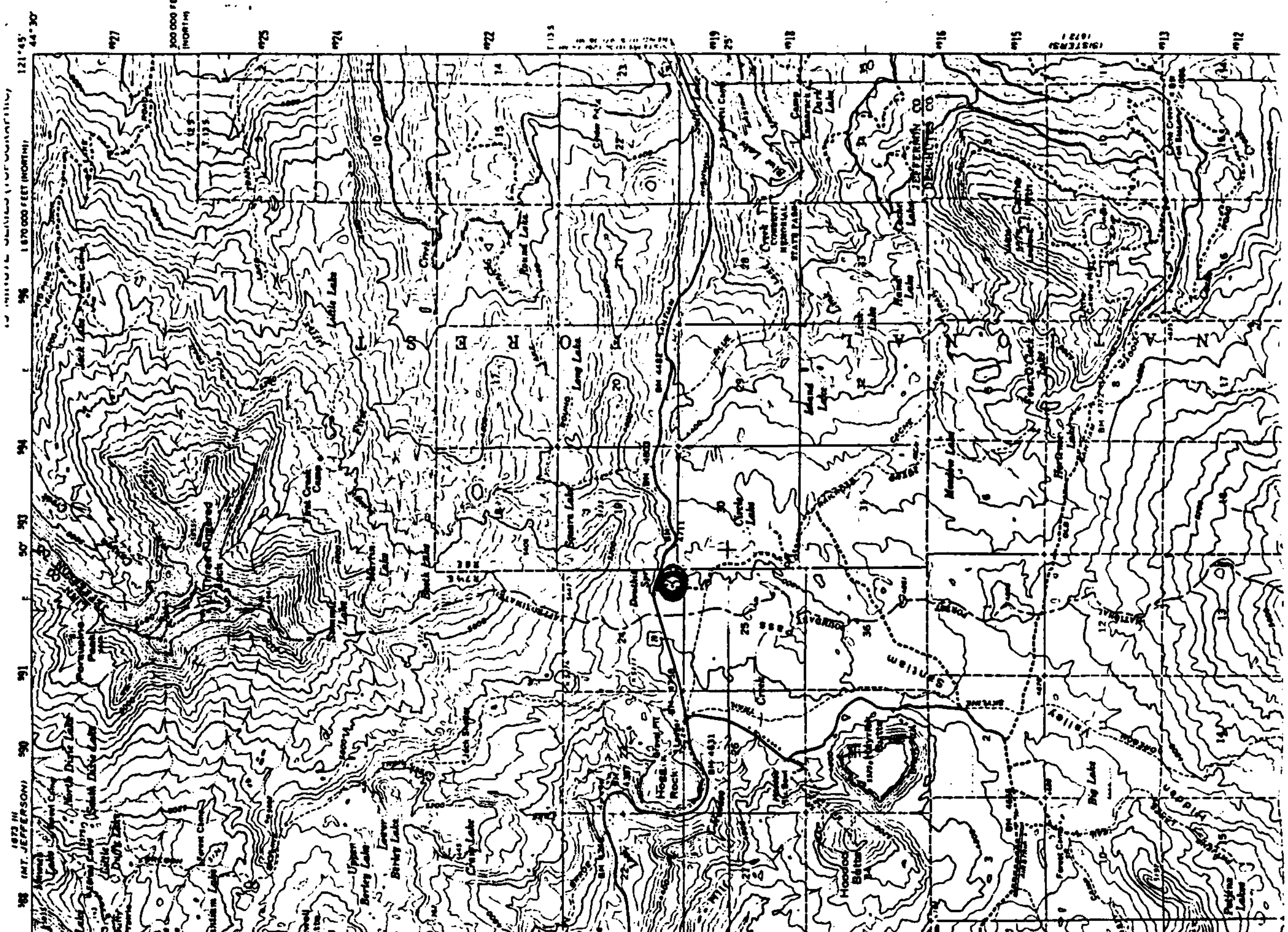
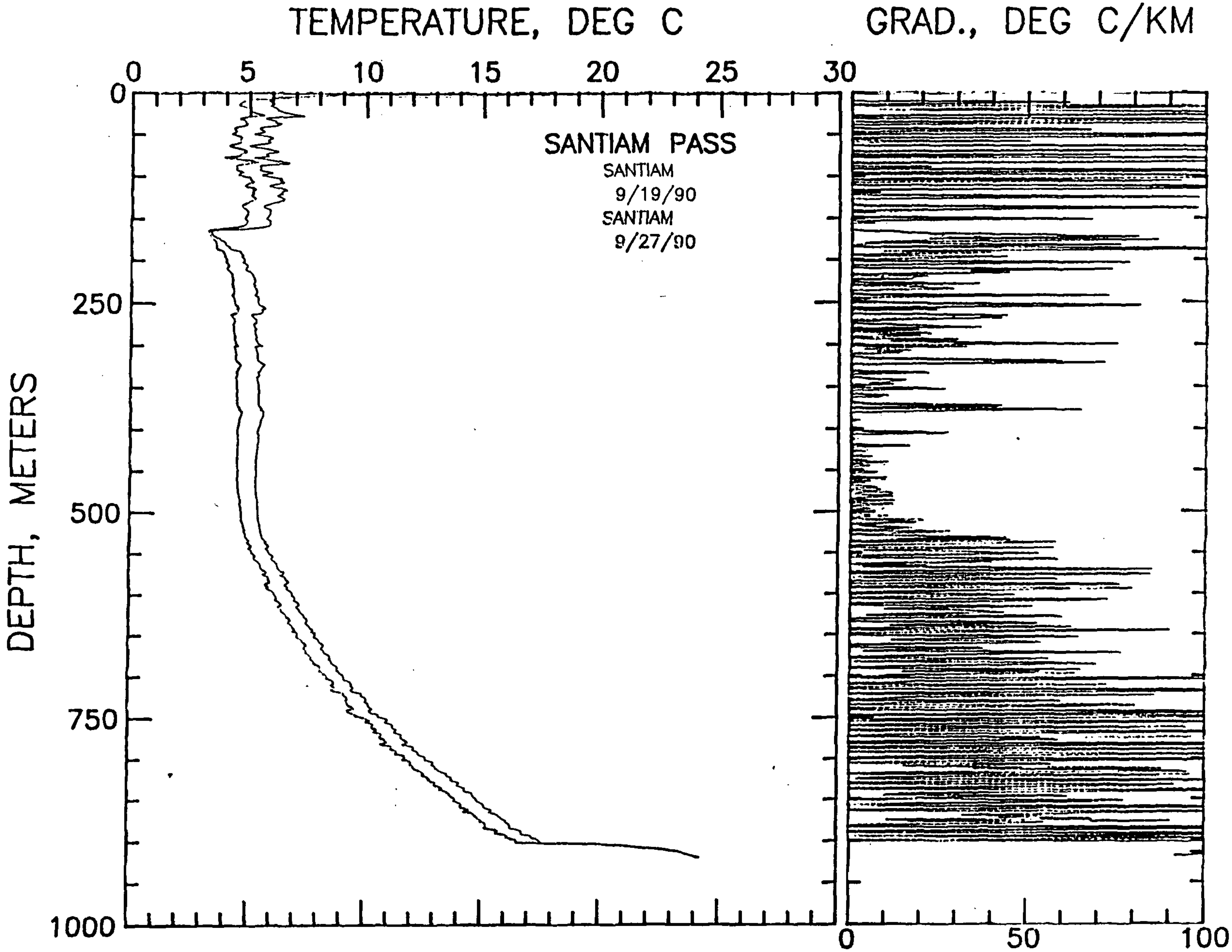
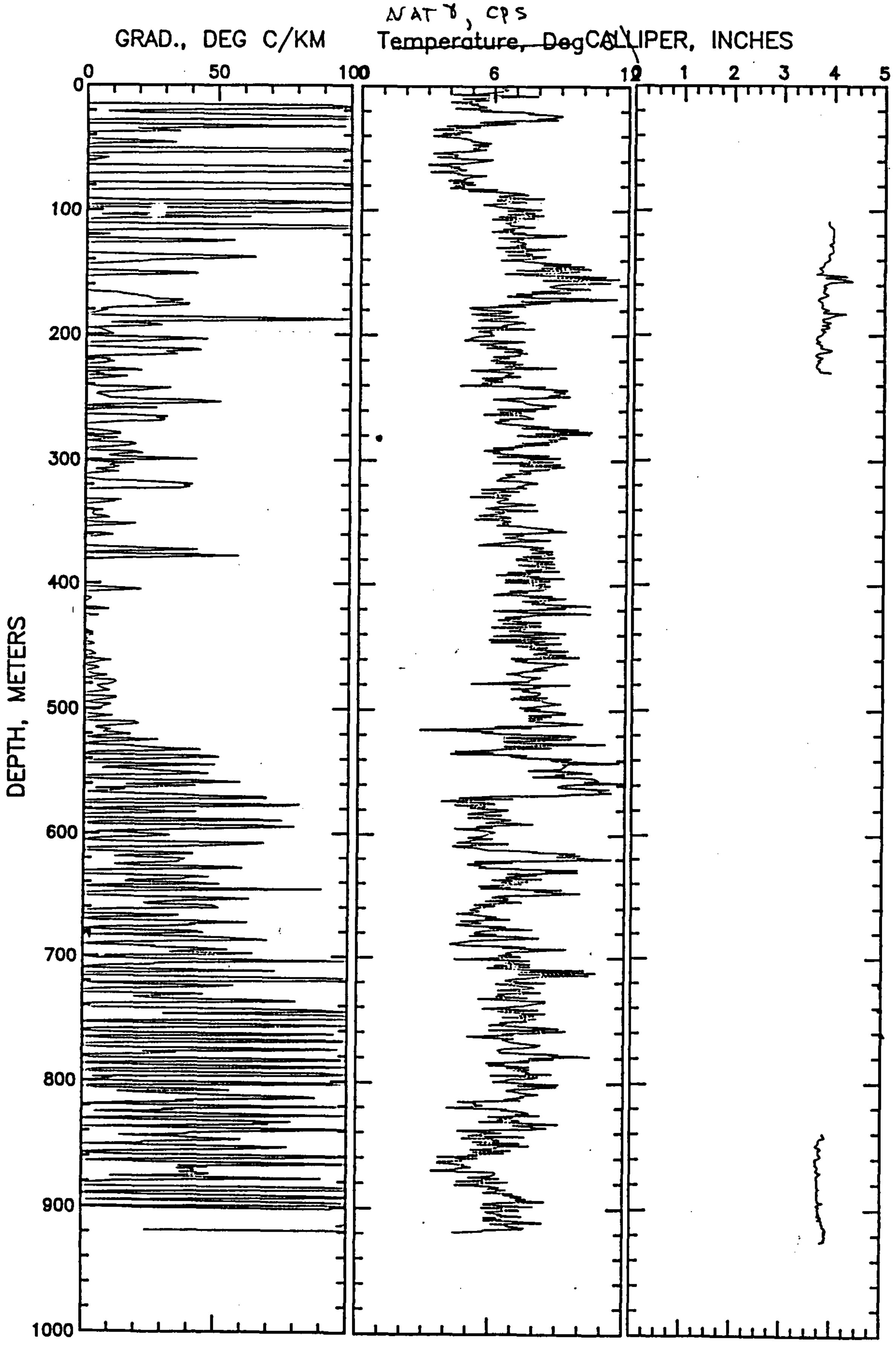
Kilometers
TFJ
SP
BL
SM
MW
BC
NS
MS
SS
WOLF MEADOW
BIGALOW
BELKNAP
FOLEY
TERWILLIGER
20
28
44
69
29
46
60
100
83
173
112–26
148–34
–5
78–124
106–169
42
67
73
106
–19
–5
(34)
(55)
51
80
25
88
153
53
92
–38
7
28
45
73
116
50
80
71
82
113
111
78
124
–18
51
68

Figure 5

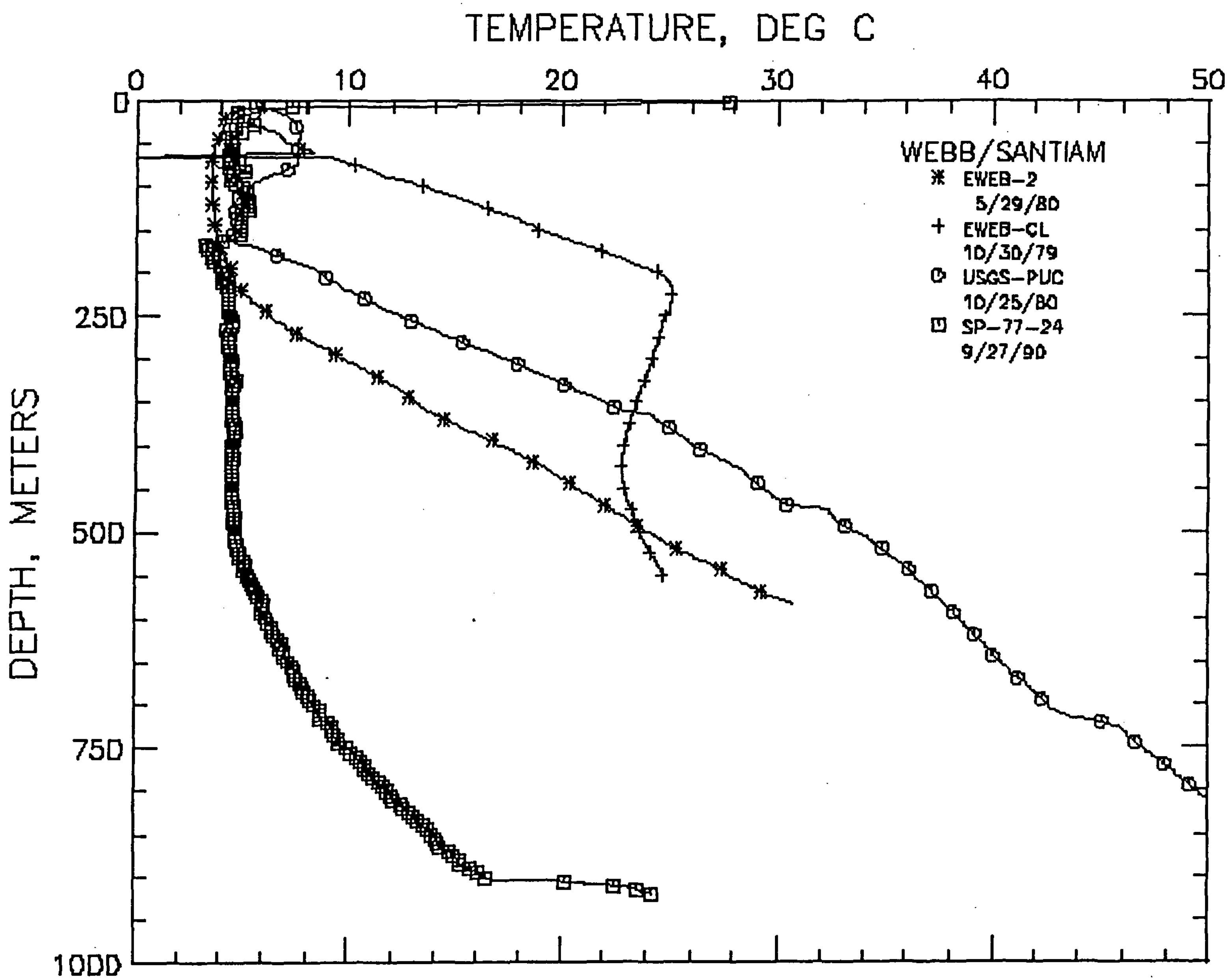


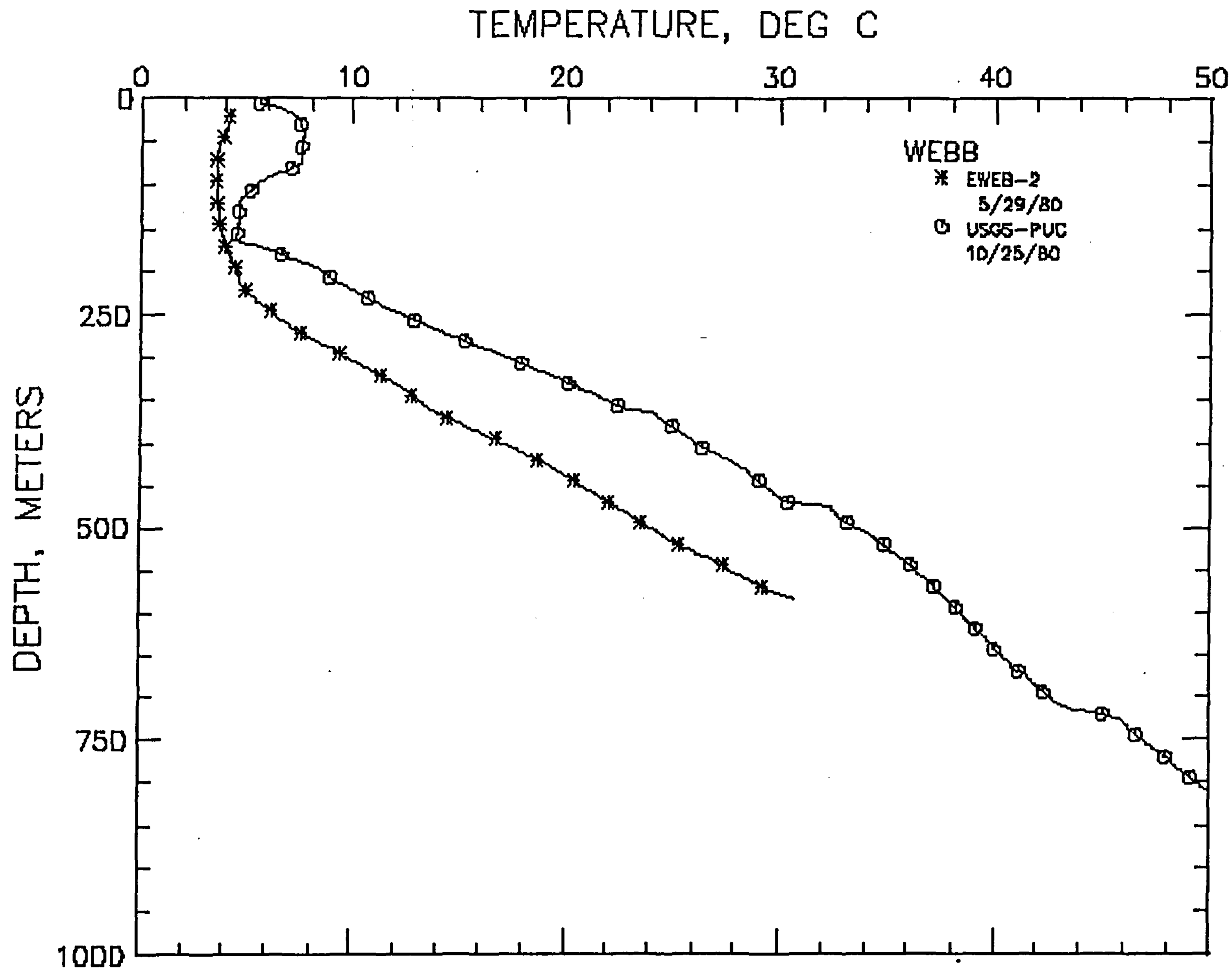


TEMPERATURE, DEG C
GRAD., DEG C/KM
0
5
10
15
20
25
30
0
250
500
750
1000
DEPTH, METERS
SANTIAM PASS
SANTIAM
9/19/90
SANTIAM
9/27/90
0
50
100

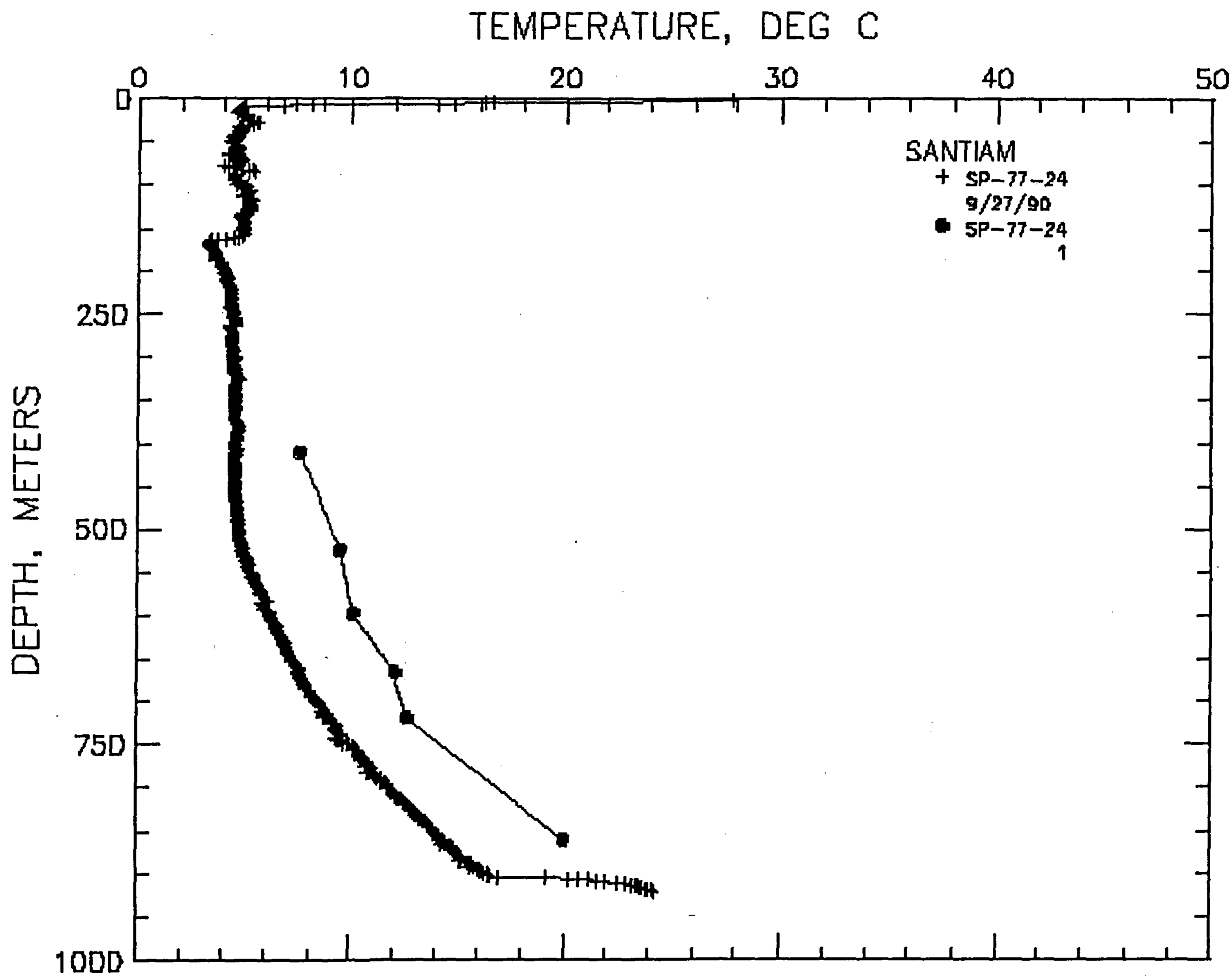


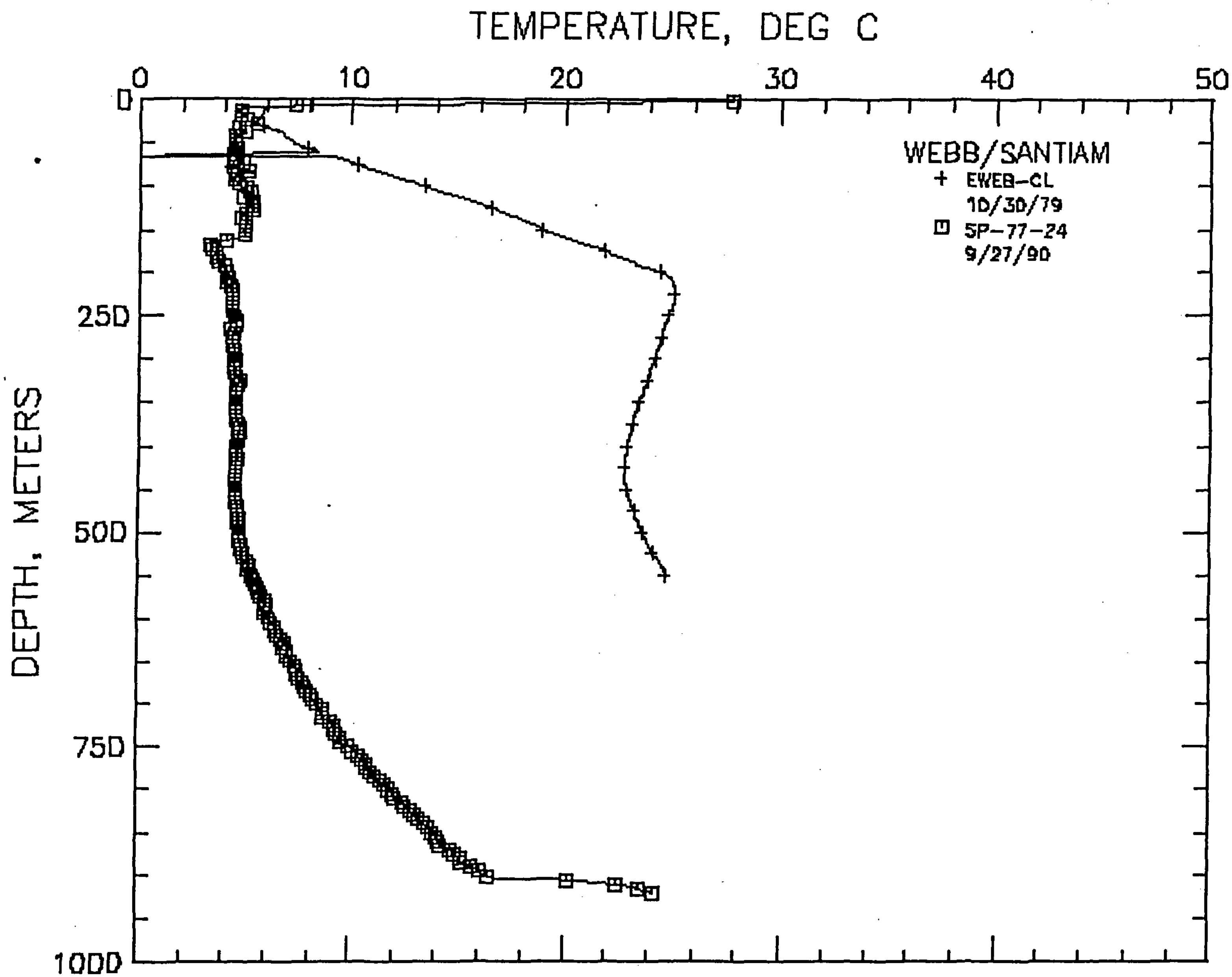
NAT γ, CPS
GRAD., DEG C/KM
Temperature, Deg
CALIPER, INCHES
0
50
100
6
12
1
2
3
4
5
DEPTH, METERS
100
200
300
400
500
600
700
800
900
1000


TEMPERATURE, DEG C
0
10
20
30
40
50
DEPTH, METERS
0
250
500
750
1000
WEBB/SANTIAM
EWEB-2
5/29/80
EWEB-CL
10/30/79
USGS-PUC
10/25/80
SP-77-24
9/27/90



TEMPERATURE, DEG C
0
10
20
30
40
50
0
250
500
750
1000
DEPTH, METERS
WEBB
EWEB-2
5/29/80
USGS-PVC
10/25/80


TEMPERATURE, DEG C
0
10
20
30
40
50
0
250
500
750
1000
DEPTH, METERS
SANTIAM
+ SP-77-24
9/27/90
SP-77-24
1


TEMPERATURE, DEG C
0
10
20
30
40
50
DEPTH, METERS
0
250
500
750
1000
WEBB/SANTIAM
+ EWEB-CL
10/30/79
SP-77-24
9/27/90

Rec'd 11/02/90

FINANCIAL STATUS REPORT

(Follow instructions on the back)

1. FEDERAL AGENCY AND ORGANIZATIONAL ELEMENT TO WHICH REPORT IS SUBMITTED	U.S Department of Energy
2. FEDERAL GRANT OR OTHER IDENTIFYING NUMBER	DE-FG07-89ID12834
OMB Approved	No. 80-R0180
PAGE 1 OF 1 PAGES	
3. RECIPIENT ORGANIZATION (Name and complete address, including ZIP code)	Oregon Department of Geology and Mineral Industries 1400 SW Fifth Ave., Room 910 Portland, OR 97201
4. EMPLOYER IDENTIFICATION NUMBER	93.6001955
5. RECIPIENT ACCOUNT NUMBER OR IDENTIFYING NUMBER	
6. FINAL REPORT	☐ YES ☒ NO
7. BASIS	☒ CASH ☐ ACCRUAL
8. PROJECT/GRANT PERIOD (See instructions)	FROM (Month, day, year) 6/27/89 — TO (Month, day, year) 10/15/92
9. PERIOD COVERED BY THIS REPORT	FROM (Month, day, year) 7/1/90 — TO (Month, day, year) 9/30/90

10. STATUS OF FUNDS

PROGRAMS/FUNCTIONS/ACTIVITIES ▶	(a) USDOE	(b) Private Funds (Oxbow)	(c)	(d)	(e)	(f)	TOTAL (g)
a. Net outlays previously reported	$ 19,040	$ 24,460	$	$	$	$	$
b. Total outlays this report period	52,907	70,540					
c. *Less:* Program income credits							
d. Net outlays this report period (*Line b minus line c*)	52,907	70,540					
e. Net outlays to date (*Line a plus line d*)	71,947	100,000					
f. *Less:* Non-Federal share of outlays							
g. Total Federal share of outlays (*Line e minus line f*)	71,947						
h. Total unliquidated obligations							
i. *Less:* Non-Federal share of unliquidated obligations shown on line h							
j. Federal share of unliquidated obligations							
k. Total Federal share of outlays and unliquidated obligations	71,947						
l. Total cumulative amount of ~~Federal~~ funds authorized	200,000	100,000					
m. Unobligated balance of ~~Federal~~ funds	128,053	- 0 -					

11. INDIRECT EXPENSE

a. TYPE OF RATE (Place "X" in appropriate box)	☐ PROVISIONAL	☐ PREDETERMINED	☐ FINAL	☒ FIXED
b. RATE 16.1%	c. BASE $61,970	d. TOTAL AMOUNT $11,573	e. FEDERAL SHARE $11,573	

12. REMARKS: *Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation.*

13. CERTIFICATION

I certify to the best of my knowledge and belief that this report is correct and complete and that all outlays and unliquidated obligations are for the purposes set forth in the award documents.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL: [signature]

DATE REPORT SUBMITTED: 10-29-90

TYPED OR PRINTED NAME AND TITLE: John Nielsen, Business Mgr.

TELEPHONE (Area code, number and extension): 503-229-5580

3rd Qtr '90

U.S. DEPARTMENT OF ENERGY

FEDERAL ASSISTANCE PROGRAM/PROJECT STATUS REPORT

FORM EIA-459F (10/80)

FORM APPROVED OMB No. 1900-0127

1. Program/Project Identification No.	2. Program/Project Title	3. Reporting Period
DE-FG07-89ID12834	Inves. Thermal Regime High Cascades, Ore	7/1/90 through 9/30/90

4. Name and Address

Oregon Department of Geology and Mineral Industries

5. Program/Project Start Date: 6/27/89

6. Completion Date: 10/15/92

7. Approach Changes

☒ None

8. Performance Variances, Accomplishments, or Problems

☒ None

9. Open Items

☒ None

10. Status Assessment and Forecast

- Diamond coring was completed to a depth of 3046 ft. on September 17, 1990 Drilling rates averaged 90.7 ft/day during the 28.5 days of coring. The attached graph shows time vs. depth for the coring. The hole was cased with water-filled, capped 2-inch tubing.
- Field logging of core and the hole is complete. Summaries of the findings are attached.
- The project is on schedule and met most objectives, although additional depth on the hole would be highly desirable to facilitate gradient interpretation.

☒ No Deviation from Plan is Expected

11. Description of Attachments

Logs and preliminary interpretations.

☐ None

12. Signature of Recipient and Date: George R. Priest 10-29-90

13. Signature of DOE Reviewing Representative and Date

FORM EIA-459E (10/88)

U.S. DEPARTMENT OF ENERGY

FEDERAL ASSISTANCE MANAGEMENT SUMMARY REPORT

FORM APPROVED OMB No. 1900-0127

Page ____ of ____

1. Program/Project Identification No.	2. Program/Project Title	3. Reporting Period
DE-FG07-89ID12834	Inves. Thermal Regime High Cascades, Oregon	7/1/90 through 9/30/90

4. Name and Address

Oregon Dept. of Geology and Mineral Industries

5. Program/Project Start Date: 6/27/89

6. Completion Date: 10/15/92

7. FY: 89-90

8. Months or Quarters: Quarters

7-9 89	10-12 89	1-3 90	4-6 90	7-9 90	10-12 90	1-3 91	4-6 91	7-9 91	10-12 91	1-3 92	4-6 92

9. Cost Status a. Dollars Expressed in: Thousands

b. Dollar Scale

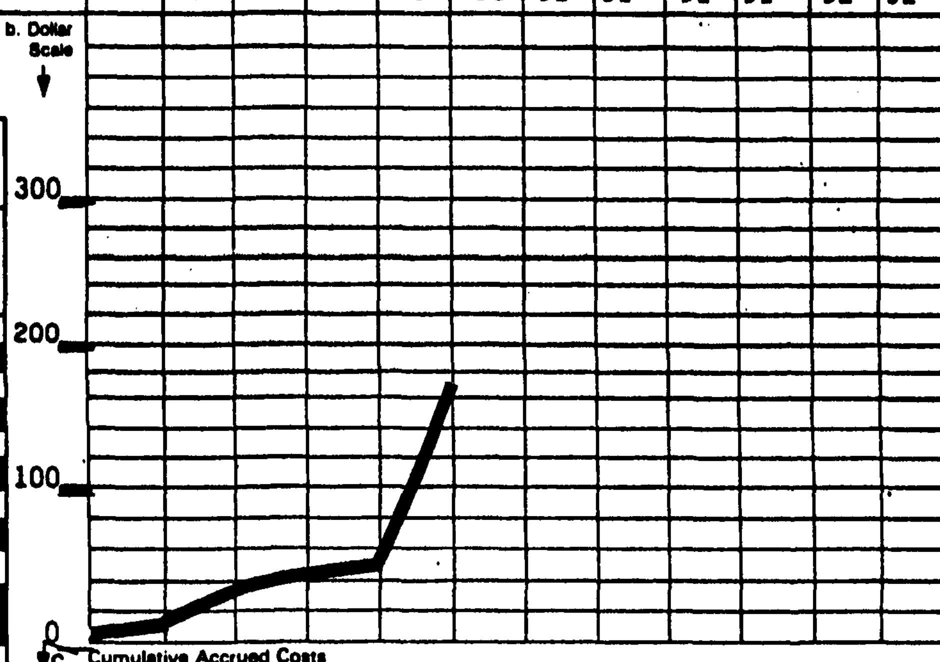
10. Cost Chart

Fund Source		Quarter 1st	2nd	3rd	4th	Cum. to Date	Tot. Plan
USDOE	P	5	2	2	53	69	
	A	4	5	5	53	72	
Oxbow	P	29	0	0	71	100	
	A	29	0	0	71	100	
	P						
	A						
	P						
	A						
Total P		34	2	2	124	169	
Total A		33	5	5	124	172	
Variance		1	-3	-3	0	-3	

P = Planned A = Actual

Total Planned Costs for Program/Project

$300,000

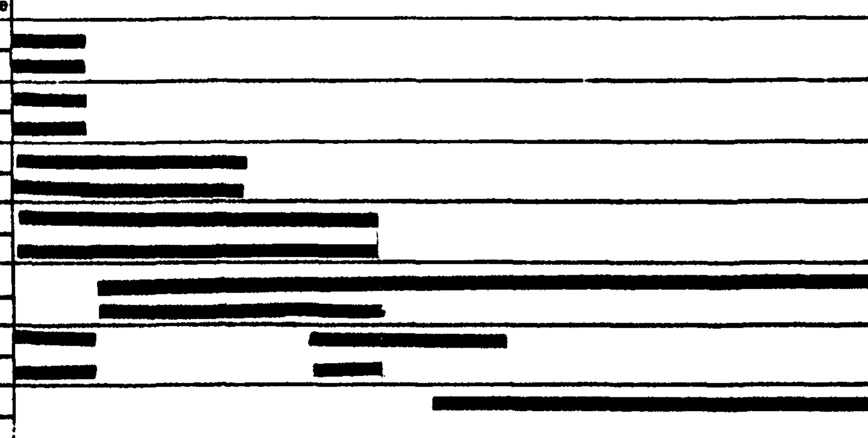


c. Cumulative Accrued Costs

	7-9 89	10-12 89	1-3 90	4-6 90	7-9 90	10-12 90	1-3 91	4-6 91	7-9 91	10-12 91	1-3 92	4-6 92
Planned	16	50	52	54	169							
Actual	5	38	43	48	172							
Variance	11	12	9	6	-3							

11. Major Milestone Status (TASKS)

Task	Units Planned / Units Complete
4.1 Site Selection	P / C
4.2 Permitting	P / C
4.3 Phase I Report	P / C
4.4 Bid Solicitation	P / C
4.5 Drilling	P / C
4.6 Data Analysis	P / C
4.7 Core Curation	P / C
4.8 Final Report	P / C



12. Remarks

See attachment and Project Status Report Form

13. Signature of Recipient and Date

George R. Priest 10-29-90

14. Signature of DOE Reviewing Representative and Date

Phase I final report — needs maps at larger scale.

FINAL REPORT TO THE UNITED STATES DEPARTMENT OF ENERGY

PHASE I

INVESTIGATION OF THE THERMAL REGIME OF THE HIGH CASCADES, OREGON

Report by: George R. Priest and Gerald L. Black
Oregon Department of Geology and Mineral Industries

Reference: Grant No. DE-FG07-89ID12834

Date: July 10, 1989

INTRODUCTION

This report summarizes site selection and permitting for a hole to be drilled in the Santiam Pass area of Oregon (Figure 1). The drill hole is aimed at measuring regional heat flow at the volcanic axis of the High Cascades. Secondary goals are to explore the types of volcanic rock and structures that occur at depth beneath the young volcanic arc. Scientific, logistic, and environmental considerations were carefully weighed during the site selection process.

SITE CONSTRAINTS OFFERED BY SCIENTIFIC DATA

Available Data

The attached folded map summarizes gravity and geologic data from the study area. Other data was not, in general, very useful for site selection owing to the regional scale of the data sets. For example, the study of Connard (1980) shows that the entire study area is characterized by a shallower Curie Point isotherm than surrounding areas but offers no further detail for site selection. Likewise, the study of Stanley (1982) shows that the entire study area is characterized by an electrical conductor somewhat shallower than surrounding areas, but his station spacings were too wide to offer further constraints on drill sites. Regional heat flow studies suggest that the entire area has higher heat flow than adjacent areas (Blackwell and others, 1982; Black and others, 1983), but there is no heat flow data in 90% of the study area (Table 1; locations on attached geologic map).

Analysis of Geologic Data

The area sits astride the High Cascade Range, an active volcanic mountain chain in Oregon and northern California. Quaternary and Holocene volcanic rocks in the area are chiefly basalt and basaltic andesite that form flows and local composite cones. The volcanic axis for Quaternary volcanism is approximated by the drainage divide, which lies about 2 km east of Hogg Rock (see also the attached geologic, topographic, and road maps). Basic geologic data summarized below is from Taylor (1981) unless otherwise indicated.

Volcanism has been more or less continuously active for the last 30-35 m.y (Priest, 1989). The volcanic arc subsided at least 1 km into a graben 5.4-4 m.y. ago (Smith and others, 1987; Smith and others, 1989) during a period of intense volcanic activity that continues at nearly the same rate today (Priest, 1989). The last eruptions were 3800-3000 y. ago, producing the Sand Mountain-Nash Crater line of mafic cinder cones on the west flank of the range. About 3500 y. ago, basaltic andesite interacted with shallow ground water on the east flank of the range, causing a phreatic explosion that formed the Blue Lake crater (see geologic map).

The near contemporaneity of Holocene eruptions on the east and west flank is puzzling. If both vent areas are fed by a single complex mafic magma body at depth, why did no eruptions occur at the volcanic axis? If there were a lower density, more silicic magma body blocking basaltic eruptions, then we should see some evidence of this magma at the surface near the volcanic axis. There are in fact two glassy andesite vents near the axis (Hogg Rock and unit Qa south of Hogg Rock on geologic map), but age of these rocks is Pleistocene not Holocene. Perhaps buoyancy and hydraulic factors were such that basaltic andesite magma rose up to an elevation equal to Blue Lake and the west flank sites but less than the axis. Maybe eruptions only occurred where zones of weakness were present. The alignment of the Sand Mountain line of vents suggests a buried structure.

It is possible that all of the above factors have played a role in controlling the locus of Holocene volcanic activity. Nevertheless, it should be pointed out that concentration of silicic and andesitic vents near the volcanic axis is typical of most of the volcanic arc and suggests a connection between maximum volcanic rate and magma composition. It may be that where heat flux from mafic intrusions is highest, continental crust becomes partially molten, forming mixed magmas of intermediate to silicic composition. The proposed measurement of heat flow in the area may help to resolve the issue. Presumably heat flow at the axis should be higher than flank areas if this model is correct. These interpretations strongly favor initial drilling near the drainage divide.

The hole should also be sited in an area where the maximum amount of geologic data may be gathered. A site on layered volcanic rock would be better than one on intrusive rock, because the hole would intercept lithologies in a layered sequence that could be used for correlation.

Drilling through thick glacial or alluvial deposits would cause appreciable increases in the cost of the hole. The hole should therefore be drilled rocks actually crop out or are covered by only a thin veneer of surficial deposits.

Most of the area of the drainage divide in the study area meets the geologic constraints. With possible the exception of the Hogg Rock volcanic center, most of the drainage divide is underlain by layered volcanic rocks with only a thin veneer of Holocene cinder and ash.

Analysis of Gravity Data

Available gravity data support the hypothesis that the area at and adjacent to the drainage divide has been a focus intrusive activity. The attached map shows that this area is characterized by a gravity high. Couch and others (1982) proposed that this high is most likely caused by closely spaced intrusions. The gravity data may also indicate that fill within the previously mentioned High Cascade graben is denser than surrounding rocks by virtue of the abundance of mafic lava flows. In any case, the peak of the gravity high is very close to the drainage divide, so the data is permissive of a magmatic focus at the axis of Quaternary volcanism. Heat flow measurements at the drainage divide would therefore likely measure the time-averaged heat flow maximum from magmatic intrusion.

Hydrologic Data

There is no detailed data on the configuration of the ground water table, although the elevation of Blue Lake and Suttle Lake (about 3400 ft.) probably approximates the regional ground water table on the east side of the volcanic axis. Advective distortion of conductive temperature gradients probably occurs when vadose-zone aquifers flow rapidly through the volcanic pile. This so called "rain curtain" effect can probably be mitigated to some extent by drilling ~~below a~~ several hundred feet below the regional ground water table. A hole at the drainage divide (4800-5200 ft elevation) would therefore need to be at least 2000 ft. deep, and preferably 3000-4000 ft. deep, to ensure that advective effects are eliminated.

Conclusions

Scientific data in the area offer few constraints on the depth of the drill hole and location of the site. A heat flow measurement in a hole greater than or equal to 2000 ft in depth and drilled at any layered bedrock site at the drainage divide, would test the hypothesis that there is a heat flow maximum at the axis of volcanism.

LOGISTICAL CONSTRAINTS

Access to the drainage divide is good (see attached USFS road map). USFS Road 2690 accesses the west and south sides of the divide. USFS Road 900 accesses the north and east side of the divide.

The intersection of USFS road 900 with Highway 20 lies essentially at the drainage divide (see attached USFS road map). This intersection is also only about 6 miles west of the point that Highway 20 crosses Lake Creek, the permitted source of surface water for the project (see Exhibit D of attached personal service contract). Therefore logistical considerations dictate that a site as close as possible to the Road 900-Highway 20 intersection would be most efficient.

GENERAL ENVIRONMENTAL CONSTRAINTS

Assuming that the general area of the drainage divide is the best target for the drill hole, there are only two major environmental restrictions that would eliminate sites. The site cannot, according to federal regulations, be in designated wilderness or in the scenic corridor 300 feet north and south of Highway 20 (see attached USFS road map). This leaves open all of the roaded area adjacent to the drainage divide.

FINAL SITE SELECTION AND PERMITTING

Scientific considerations argue for a site as close as possible to the drainage divide at Santiam Pass. Logistical constraints argue for a site as close as possible to the intersection of Highway 20 and USFS Road 900. A 300-foot scenic corridor restricts access north and south of Highway 20, so the best site is the area 300-600 feet south of Highway 20 on USFS Road 900.

A field visit to this area with officials of the USFS and USBLM on June 1, 1989 revealed that a previously cleared, relatively level area exists on the west side of USFS Road 900 about 350 feet south of Highway 20 (Site #1 on attached topographic map). Subsequent environmental assessment of this site revealed that the proposed scientific drilling project would have no impacts that would prevent use of this site (see attached federal environmental assessment).

Federal, State, and county permits for the drilling operation at the proposed site ~~are~~ have received preliminary approval but are currently out for public comment. All permits should be finalized by July 20, 1989 (Dennis Davis, U.S. Bureau of Land Management, 1989, personal communication).

OVERVIEW OF THE PLAN OF OPERATIONS

The attached draft personal service contract with the drilling contractor, Oxbow Geothermal Corporation (OGC) gives details of the responsibilities of DOGAMI and OGC, a detailed plan of operations, and drill hole design for a proposed 3000 ft. diamond core hole at Santiam Pass. Management of the project will be handled by the Oregon Department of Geology and Mineral Industries (DOGAMI). OCC has already filed a drilling permit with the U.S. Bureau of Land Management (USBLM). OGC will, in addition to providing $100,000 cost share, manage the drilling operation and subcontract for all services necessary to drill, plug, and abandon the hole. Drilling should begin between August 15 and Sepetember 15, 1989 and continue for approximately 40-45 days. Plugging and abandonment will be complete about one year after drilling begins.

Coordination of scientific work on the hole began with a meeting of all interested participants on June 27, 1989. The following tasks were addressed at the meeting and in subsequent conversations:

> Project coordination and management. The DOGAMI representative will be in charge of the project and will be responsible for coordination between scientific and technical support personnel.

> Public announcements and press releases. DOGAMI will have responsibility and authority for this task.

> Drilling management and engineering. OGC will provide drilling experts who will be responsible for day-to-day drilling decisions and management; however, authority for decisions affecting collection of scientific data from the hole resides with the DOGAMI representative.

> Lithologic logging and scientific decisions. The site geologists will be responsible for lithologic logging and for drilling decisions affecting acquisition of scientific data. One full-time geologist will be available from DOGAMI (funded by the grant). A second full-time geologist will be available at no cost to the grant. A geologist will be available from the University of Utah Research Institute (UURI) for three weeks, and the USGS will provide the services of David Sherrod for the balance of the time that the UURI geologist will not be available, probably about 3 weeks. The hole will be drilled 24 hrs. per day, so the site geologists will be on call or present during 12-hour shifts.

> Petrography. The analytical budget provides for 70 thin sections. DOGAMI personnel will examine the mineralogy in cooperation with other investigators.

> Analysis of hydrothermal alteration. USGS and UURI workers have offered to analyze hydrothermal alteration mineralogy and isotopic composition, including fluid inclusions, at no cost to the grant.

> Analysis of whole rock major- and minor-element chemistry. UURI will provide 20 free ICP analyses. The grant can fund up to 35 additional analyses, if necessary.

> Analysis of trace elements and isotopes relevant to igneous petrology. There is no support in the grant for this task. Scott Hughes of the Montana Bureau of Mines and Geology may provide some trace element analyses at no cost to the grant.

> Isotopic age determination. UURI will provide 2-4 K-Ar ages at no charge to the grant. The grant can directly fund up to 4 age determinations, if necessary.

> Geophysical logging and interpretation. David D. Blackwell (Southern Methodist University) will provide geophysical logging services, including temperature, heat flow, self potential, sonic velocity, gamma ray, and caliper logs. He will also provide a report interpreting the geophysical data. VSP would be highly desirable, but is not supported by the grant. All geophysical logs will be filed with Petroleum Information Service, Denver, Colorado.

> Paleomagnetic measurements. There is no support in the grant for this task.

> Determination of physical properties of core. David Blackwell will determine **thermal conductivity**. UURI will, at no charge to the grant, determine **density, magnetic susceptibility**, and **electrical resistivity**.

> Core storage. Oregon State University will, at no cost to the grant, curate and dispense all core. DOGAMI will also curate a summary core for public use.

> Downhole water sampling. Carter Hull of the University of Oregon has agreed to be present during rotary drilling of the top 500' of the hole. He will take a water sample of the first major aquifer encountered. The water will by blown out of the hole by the air rotary drilling process. Robert Mariner of the USGS will be on call for downhole water sampling in the diamond-cored part of the hole, should sufficient quantities of thermal water be encountered to warrant sampling. He will also provide chemical analysis of water samples. The above services will be at no cost to the grant, although some travel may be reimbursed to Carter Hull.

> In situ rock stress determination. There are no plans to do hydrofracture tests. Borehole breakout analysis may be analyzed from the caliper log, although no one has volunteered to do this as yet.

> Surface geological mapping. Existing map coverage is good. No further work is proposed in the grant.

> Surface geophysical surveys. In 1991 Craig Weaver and Dal Stanley plan to do east-west, regional-scale M-T, refraction, and reflection transects. No other surveys are planned or supported by the grant.

> Preparation of final report and interpretation. The DOGAMI representative will prepare the final report to USDOE. The report will summarize water-rock reactions, lithology, geochemistry, and age relationships in the drill hole, nearby drill holes, and at the surface. An east-west geologic cross section and summary 1:62,500-scale geologic map will be produced as part of the report.

> Publication. The final report will be open-filed through DOGAMI.

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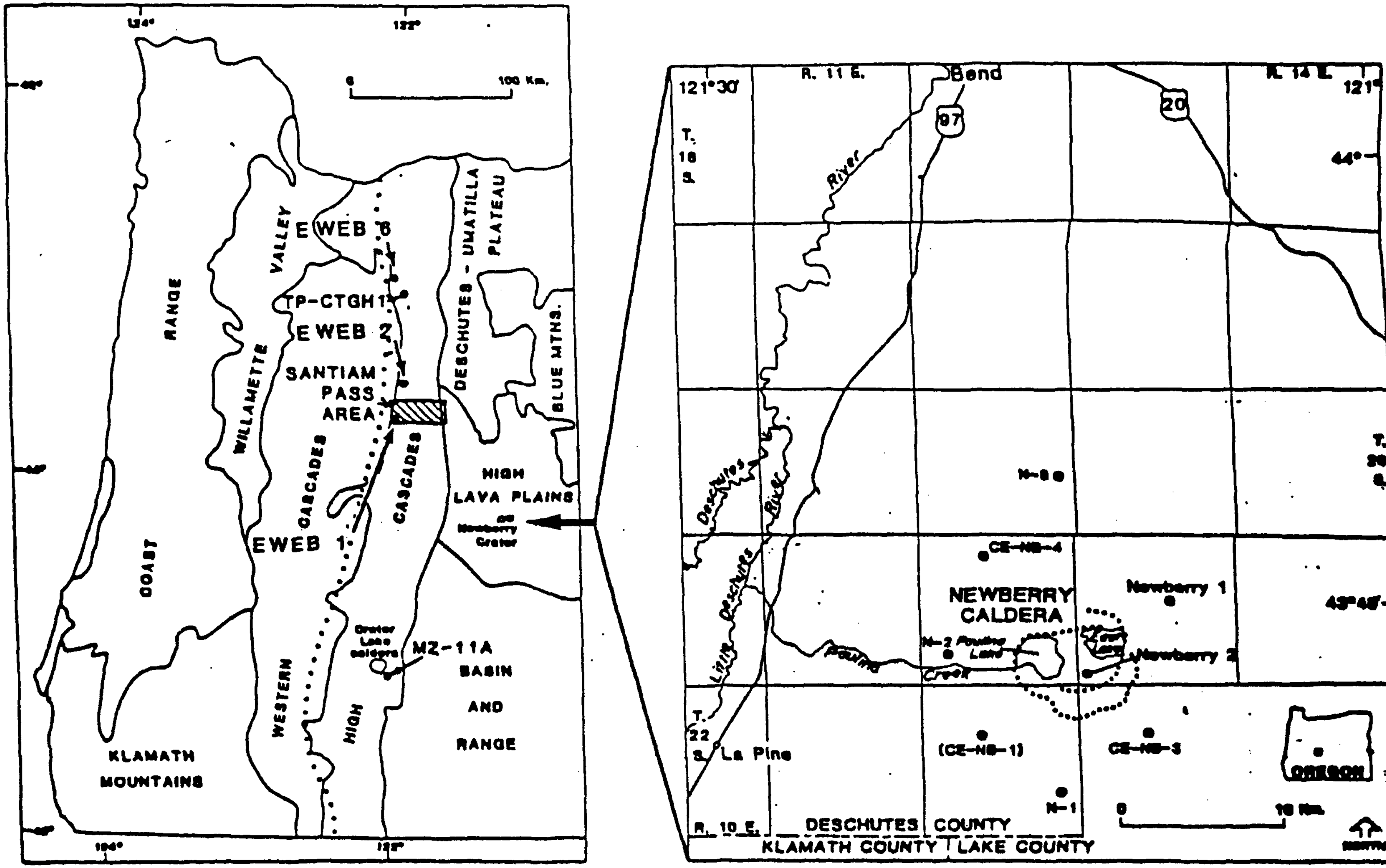
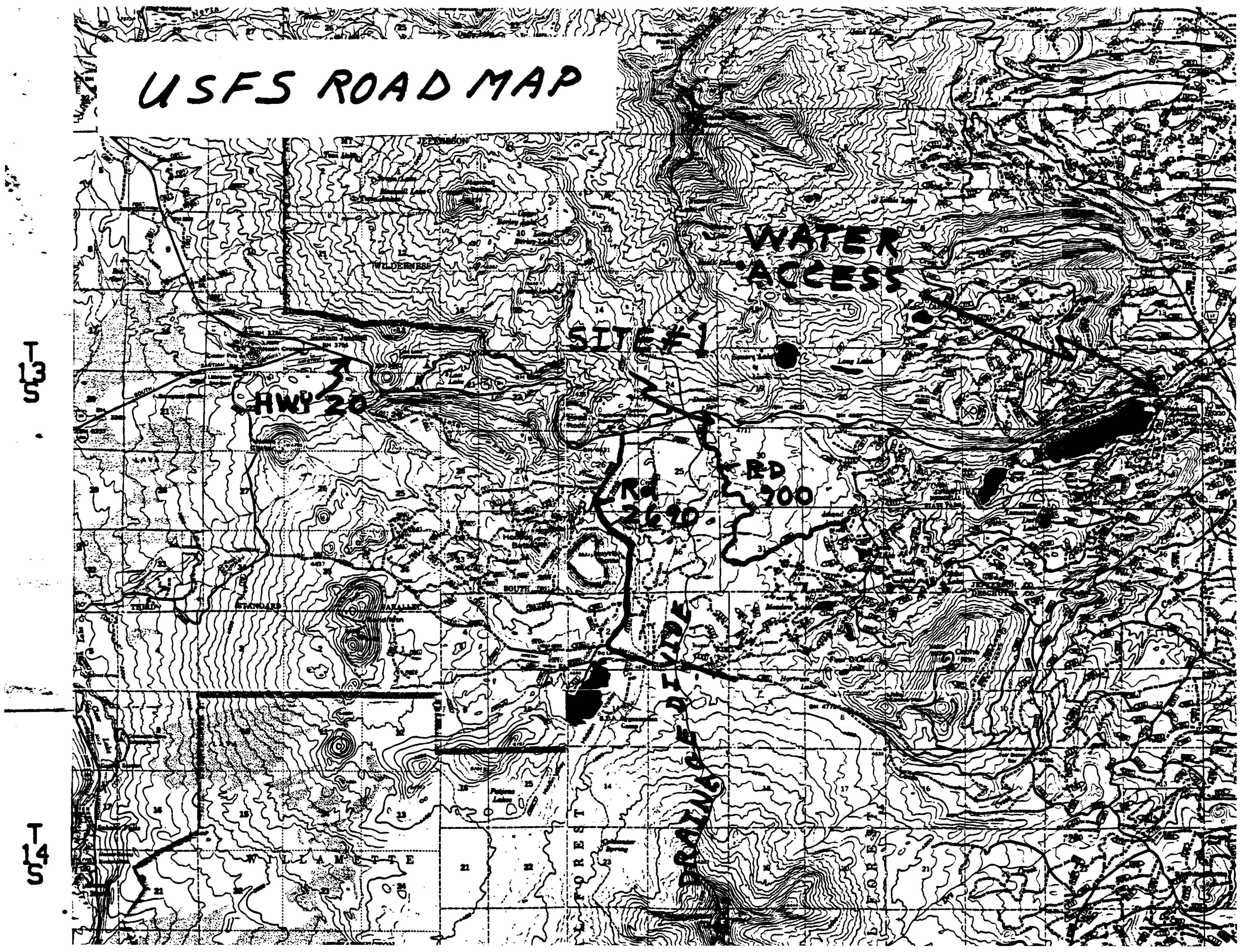


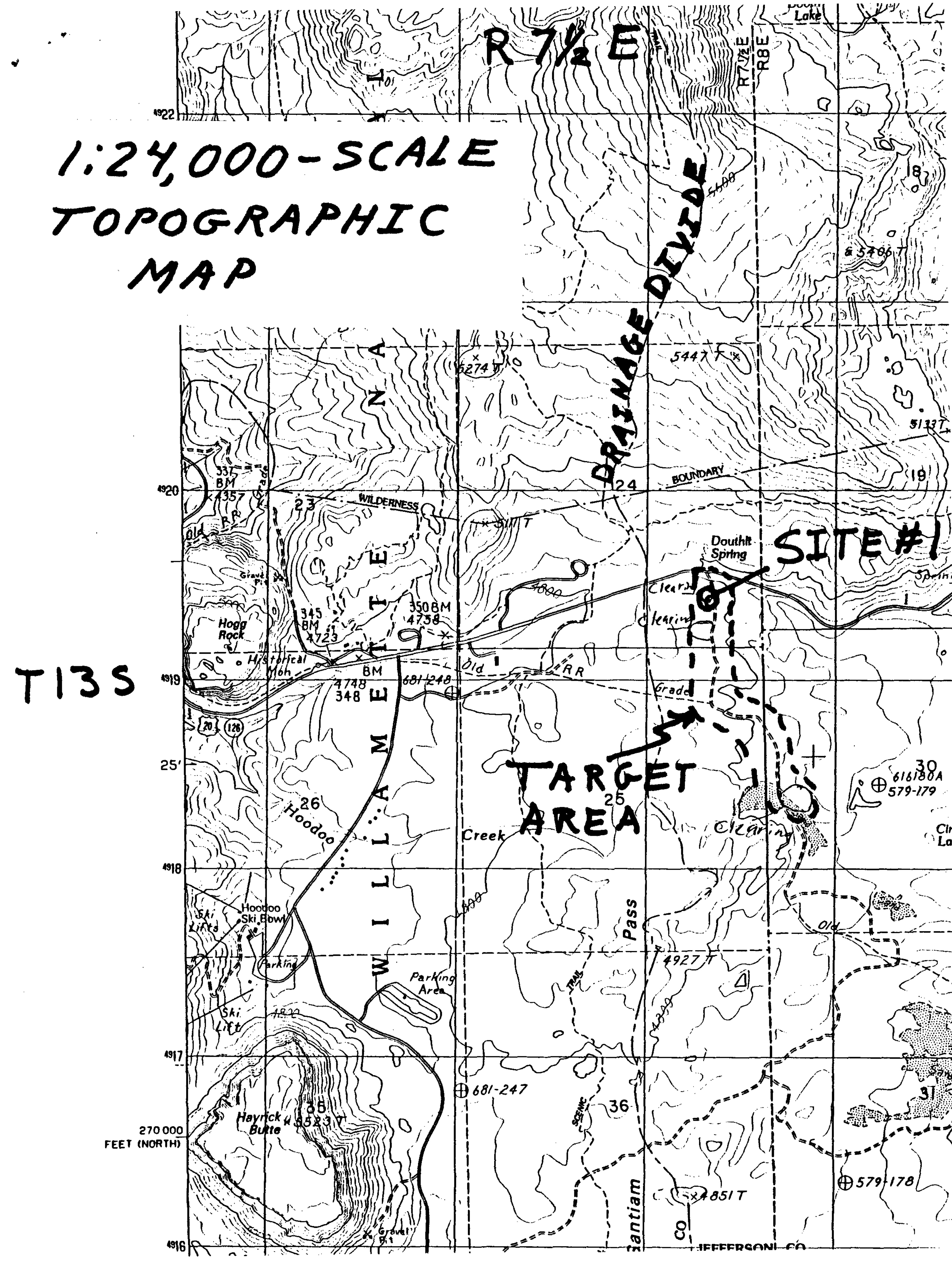
Figure 1. Physiographic provinces of western Oregon (after Dicken, 1950), showing the Santiam Pass study area and locations of recently drilled temperature-gradient holes. Also shown is the edge of the High Cascade heat-flow anomaly from Black and others (1983) as a dotted line.

Table 1. - Heat-flow data from the Cascade Range and adjacent areas in north-central Oregon

Hole	T-R-Sec. 1/4	Longitude (* ' ")	Latitude (* ' ")	Name	Elev. (m)	Depth (m)	Water	Hole	Interval (m)	Cond.	Uncorr. (*C/km)	Corr. (*C/km)	Flow (mW/m2)
1	13S-6E-17b	122 07 17	44 26 30	-	945	46	12	10.2	27-46	1.50e	51.1	38.1	57
2	13S-7E-09a	121 58 30	44 27 42	DETRO-FM	1128	55	15	3.7	-	-	adv.	-	-
3	13S-7E-32c	121 59 40	44 23 24	EWEB-CL	955	557	20-25	24.9	485-555	1.50e (0.25)	20.8 (0.27)	37.5	[56]
									50-205	1.44	112.0	102.8	148
									0-555	1.40	25.6	23.9	33
4	13S-7.5E-23d	121 52 49	44 25 24	-	1453	121	-	3.2	-	-	-	-	-
5	13S-8E-27d	121 45 41	44 24 56	- (by Blue L. airstrip)	1070	46	5.8	5.2	-	-	adv.	-	-
6	13S-10E-05a	121 33 25	44 28 46	FLY CRK	1195	105	73	7.3	-	-	iso.	-	-
7	14S-9E-08c	121 40 41	44 22 37	Kiewit Pacific Company	1030	120	89	5.7	-	-	iso.	-	-
8	14S-10E-07c	121 35 32	44 22 09	-	987	180	77	8.8	-	-	iso.	-	-
9	14S-10E-08b	121 34 17	44 22 19	Gill	984	66	22	8.2	-	-	iso.	-	-



USFS ROAD MAP
WATER ACCESS
SITE #1
HWY 20
RD 2690
RD 700
DRAINAGE DIVIDE
WILDERNESS
WILLAMETTE
FOREST
T 13 S
T 14 S


R 7½ E
1:24,000-SCALE TOPOGRAPHIC MAP
T13S
R7½E
R8E
DRAINAGE DIVIDE
SITE#1
TARGET AREA
Douthit Spring
Clearing
Old RR Grade
WILLAMETTE
WILDERNESS
BOUNDARY
Hogg Rock
Historical Mon
Hoodoo Creek
Hoodoo Ski Bowl
Ski Lifts
Ski Lift
Parking
Parking Area
Hayrick Butte
Santiam Pass
SCENIC TRAIL
JEFFERSON CO
Lake
5447 T
6274 T
5133 T
5406 T
4927 T
4851 T
5523 T
337 BM 4357
345 BM 4723
350 BM 4758
BM 4748 348
681-248
681-247
616180A 579-179
579-178
4922
4920
4919
4918
4917
4916
25'
270 000 FEET (NORTH)
23
24
25
26
35
36
18
19
30
31
20
126