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May 5, 1980

Dr. Leland L. Mink
Energy and Technology Division
Idaho Operations Office, DOE
550 Second Street
Idaho Falls, Idaho 83401

Dear Dr. Mink:

Subject: Cooperative Agreement No. DE-FC07-79ET-7220; Technical Progress Report No, 1

Submitted herewith is a summary report on the progress to date on the low-temperature resource assessment of the La Grande and Lakeview areas. Upon assimilation of all data, a final report (DOGAMI Open File) will be written for the Lakeview area.

Future technical progress reports will be submitted for the Willamette Pass and Belknap-Foley areas later this year after temperature gradient holes are drilled.

La Grande

Geologic mapping of four 7½' quadrangles (Hilgard, La Grande SE, Glass Hill, and Craig Mountain) has been completed by Geoscience Research Consultants under contract to DOGAMI. The geologic maps and text have been published as Special Paper 6. Six copies of the publication will be sent to you under separate cover.

Because of interest shown by the Grande Ronde Hospital and the local school system, including Eastern Oregon State College, in developing a suitable geothermal resource for space heating and cooling, three heat flow holes were drilled to a maximum depth of 367 feet within the city limits of La Grande on property owned by the hospital and the school system (Federal land was not available). Drilling difficulties were encountered because of caving due to bouldery to blocky debris which comprises the alluvium and/or shallow bed-rock; thus the 6-inch diameter holes could not be drilled to the proposed depth of 500 feet. Casing had to be driven to maintain integrity of the hole with the casing collapsing due to driving.

Waters at a temperature of 62.5°F and at an estimated flow of 100+ gpm were encountered on the hospital and the Central School sites (Fig. 1). The

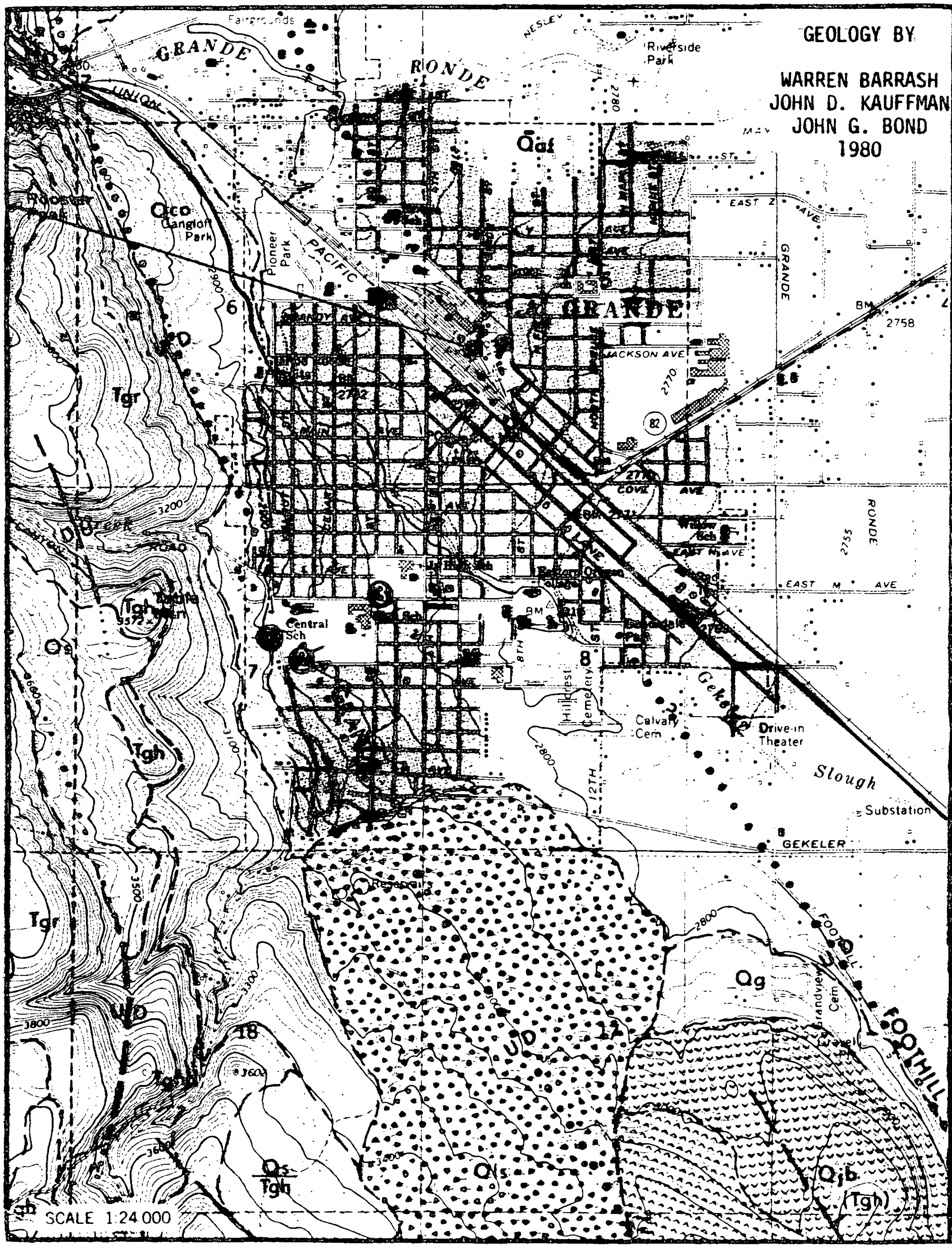


Figure 1. Location of temperature-gradient holes, La Grande area, Oregon.

hospital is aggressively pursuing the use of this resource utilizing water-to-water heat pumps to heat and cool a contemplated major expansion of the existing building. Oregon Institute of Technology (Geo-Heat Utilization Center) has been contacted by the hospital for assistance. DOGAMI will provide OIT with data obtained from our study. According to Oregon Air Reps, Inc., (Templifter heat pump), the 62.5°F water could be boosted to 140°F. It is believed that successful use of this resource will entice other entities such as the school system, college, and local government to follow suit. Warm waters (70°-81°F at 75-500 gpm) also underlie the area of the Union Pacific Railroad yards (Fig. 1).

Water samples from known springs and thermal wells in the Craig Mountain - Cove area, including La Grande, have and are currently being chemically analyzed. Chemical data are being sent periodically to Jim Swanson, USGS, Menlo Park, California, for insertion in the GEOTHERM file.

Whatever "free" holes that were available for temperature/gradient measurements have been completed within the greater La Grande area. However, most "free" holes are not deep enough to overcome the effects of ubiquitous flows of cold ground water.

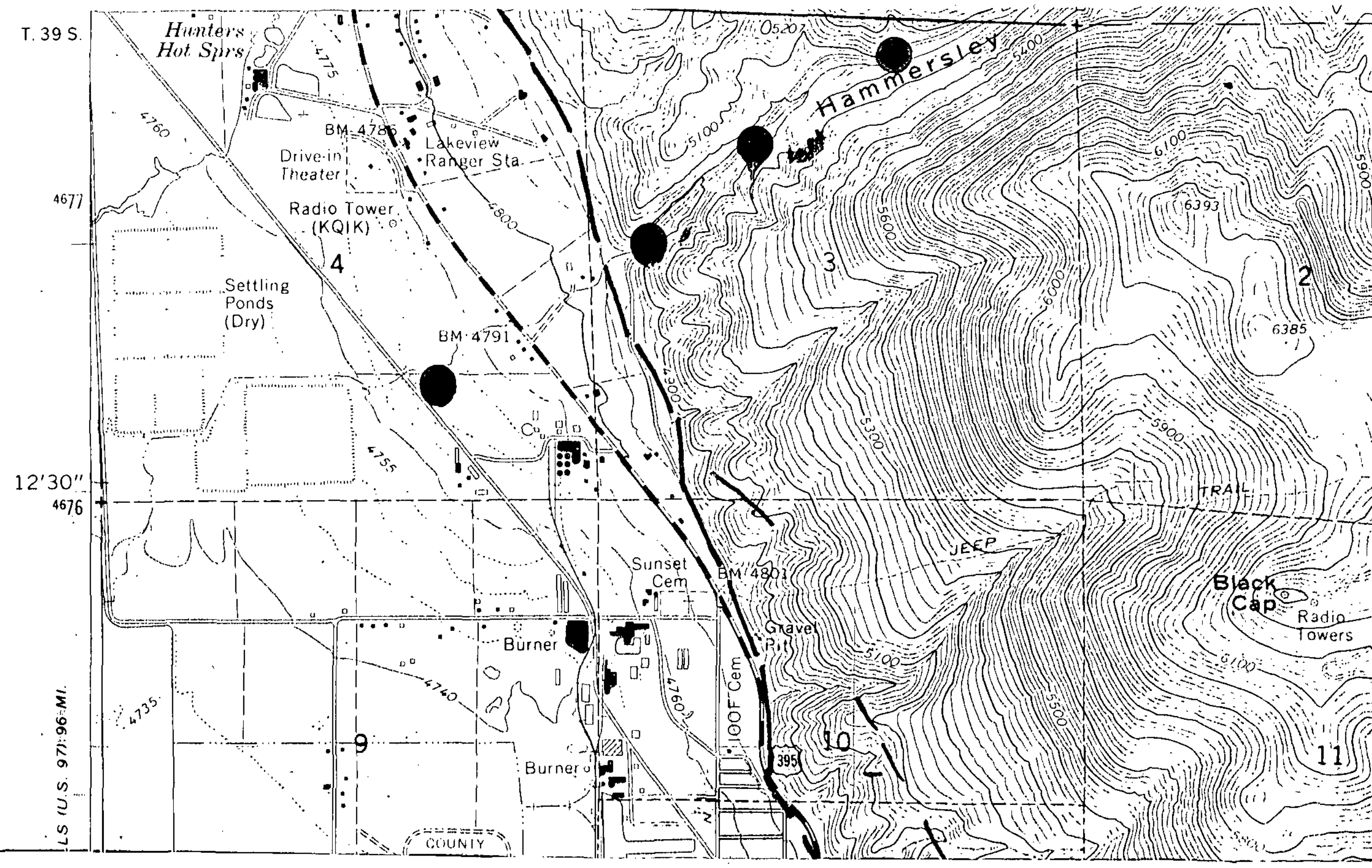
Based on available data, it is believed that the warm thermal waters are the result of migrating thermal fluids along the basin boundary faults which mix with colder ground water. Typical ground water temperatures in the immediate area range from 42° to 48°F. A deep hole to at least 2000 feet in depth is needed in this area to better appraise the geothermal resource. Because of the drilling problems, a much larger hole diameter is warranted and casing is needed to combat the caving conditions. Use of drilling mud did not appreciably help solve the problem to the shallow depths explored.

Lakeview

Geologic mapping and compilation of three 7½' quadrangles (Lakeview NE, Crane Creek, and Crooked Creek Valley) has been completed except for office routine including final drafting, cross-sections, and geophysical overlays.

The Lakeview area is situated in the northern portion of the Basin and Range geomorphic province with typical horst and graben structure. The oldest rocks exposed in the Lakeview area are in the Warner Mountains at the base of the range east of Lakeview. The rocks consist of a thick section of volcanic rocks, primarily andesite and basalt flows with pyroclastics and related sedimentary rocks. Selected samples of rocks have been sent to UURI for K/Ar dating.

In the Goose Lake graben west of the frontal fault (Fig. 2) that separates the valley from the Warner Range, only unconsolidated to poorly indurated and loosely- to well-cemented Pleistocene to Holocene sedimentary rocks are exposed. These are mainly lacustrine and fluvial deposits of varied texture and composition. The terminus of a large prominent delta deposit is about 3 miles north of Lakeview. This feature extends north and west for several


T. 39 S.
Hunters Hot Sprs
4775
4760
BM 4785
Lakeview Ranger Sta.
Drive-in Theater
4677
Radio Tower (KQIK)
4800
4
Settling Ponds (Dry)
BM 4791
4755
12'30"
4676
Hammersley
5100
5200
3
5600
6000
6100
6393
2
6385
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TRAIL
JEEP
Sunset Cem
BM 4801
Gravel Pit
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miles and in outcrop shows typical cross-bedding, channeling, and fore- and top-set beds. Slight tilting of the layered materials can be discerned and minor faulting has slightly offset some of the layers.

The dominant structure of the area is the roughly N-S trending frontal fault that separates the Goose Lake Valley from the Warner Mountains. Patches of Pleistocene gravels at elevations 5100, 5300, and 5600 feet in the Warner Range tend to indicate that movement along this fault system occurred during late Pleistocene-Holocene time. A less apparent structural grain within the volcanics trends N30W to N60W and in the field is usually seen as narrow discontinuous fractures or faults filled by basaltic dikes.

In the immediate Lakeview area, the frontal fault appears to be a nearly vertical to steeply westward dipping (78°) fractured zone about 50 feet wide which is often hydrothermally altered. The areas of greatest rock alteration have been mapped and will be shown on the final geologic map.

Siliceous sinter representing an abandoned hot spring deposit comprised of opal and agate with occasional cinnabar at least 10 feet thick covers an area of about 1/3 square mile in sec. 12, T. 38 S., R. 20 E., and Sec. 7, T. 37 S., R. 21 E. Minor silica-cemented lacustrine sands also occur in sec. 28, T. 38 S., R. 25 E.

Higher than normal ground water temperatures (to 99°C) including hot springs occur in a narrow north-trending zone along the east side of Goose Lake Valley, north and south of Lakeview. The zone is about 20 miles long and appears to be confined to about 1/2 mile of the frontal fault. The highest temperature springs (70° to 95°C) are localized north and south of Lakeview within the areal limits of the altered rock. Apparently geothermal fluids are migrating upward along the frontal fault and move laterally into the porous segments and issue as springs. Other springs, however, issue at the base of the Warner Range.

Existing hot and/or thermal springs were sampled and chemically analyzed. Chemical data have been sent to the USGS, Menlo Park, California for insertion in the GEOTHERM file. Samples obtained from existing hot wells as well as fluids from temperature/gradient holes have been similarly treated.

Whatever "free" holes that were available for temperature/gradient measurements have been completed (Table I). Eight 6- to 8-inch diameter temperature/gradient holes have been drilled by DOGAMI to a maximum depth of 400 feet (Fig. 2). Temperature depth curves for the logged holes are shown in Figs. 3 and 4.

Temperature gradients have been contoured for the area encompassed by secs. 3 and 4, T. 39 S., R. 20 E., and secs. 32 and 34, T. 38 S., R. 20 E. (Fig. 5). HFU and gradient profiles along Hammersley Canyon (secs. 3 and 4, T. 39 S., R. 20 E. are shown on Fig. 6. HFU, gradient and temperature profiles along Bullard Canyon (secs. 15 and 16, T. 39 S., R. 20 E., are shown on Fig. 7.).

Geothermal fluids at 99°C at an estimated flow of 100 gpm were measured for Hammersley Canyon #1. At the Barry hole (T. 39 S., R. 20 E., 27 Dbb), a temperature of 55°C and an estimated flow of 50 gpm were noted.

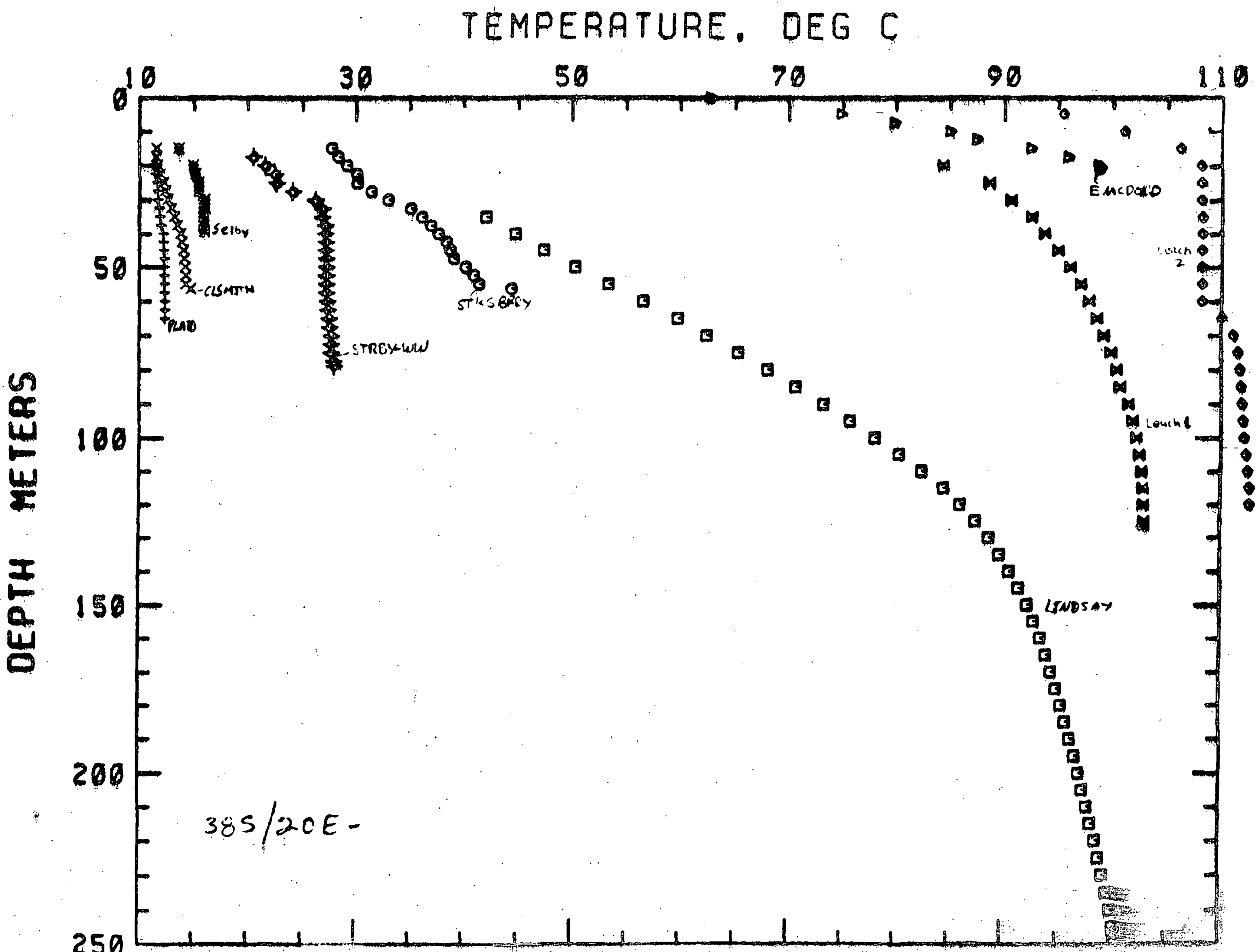
Location	Hole Name	Abbrev.	Least Squares Grad.	Est. Poros.	Ka	Terrain Corrected Gradient	Q (HFU) Least Square	Terrain Corr.
38S20E 21DAC	GPLATO	PL	20.0	---	(3.0)	---	(.6)	---
38S20E 22CBC	CLSMITH	SM	42.0	10%	5.3	---	2.3	---
38S20E 28CAA	SELBY	SBY	98.2	---	(3.0)	---	(2.9)	---
38S20E 33ABB1	DLNDSAY	LN	566.0	---	(4.0)	---	(266)	---
38S20E 33ABB2	STKSBRRY	SB	323.2	---	(4.0)	---	(12.9)	---
38S20E 33CDD	EMCDONLD	MCD	1709	---	(3.0)	---	(51.3)	---
38S20E 33DBC	STRBY-WW	STWW	409.0	---	(3.0)	---	(12.3)	---
38S20E 33DCD	LEACH 2	L2	814.1	---	(3.2)	---	(21.1)	---
38S20E 33DDC	LEACH 1	L1	675.2	10%	3.4	---	22.9	---
*39S20E 3ABA	HMSLCAN 3	H3	267.8	10%	3.55	288.8	9.5	10.2
*39S20E 3BCB	HMSLCAN 2	H2	280.1	10%	3.54	303.8	9.9	10.8
*39S20E 3DBE	HMSLCAN 1	H1	976.3	10%	3.68	(991.33)	35.7	(36.5)
39S20E 4AAA	MUNSELL	MU	1831	---	(3.4)	---	(54.3)	---
39S20E 4AAB	INGLDEW	IN	451.6	---	(3.2)	---	(14.4)	---
39S20E 4DAC	SNIDFRWW	SNWW	186.0	---	(3.0)	---	(5.6)	---
*39S20E 4DCA	PRPNCO	PR	134.0	30%	3.0	---	4.0	---
*39S20E 14BBB	BULLCAN 1	B1	111.9	10%	5.6	109.8	6.2	6.1
*39S20E 15AAC	BULLCAN 2	B2	124.2	10%	3.83	(120.2)	4.8	(4.6)
39S20E 15ABD	LKVWSWMP	LVSP	81.7	---	(3.8)	---	(3.1)	---
*39S20E 15BAA	LKVWTNLT	LVLT	125.3	30%	3.28	---	4.2	---
39S20E 15CCB	MTCHTT 1	M1	106.2	---	(3.0)	---	(3.2)	---
39S20E 17AB	UTLEY 1	UT1	61.0	---	(3.0)	---	(1.8)	---
39S20E 22ABA	MTCHTT 2	M2	132.3	10%	4.64	(120)	6.1	(5.6)
39S20E 22ACB	JACKSON	JK	128.4	---	(3.2)	---	(4.1)	---
*39S20E 27DBB	BARRY	BY	850.9	20%	4.12	(800)	35.0	(33.0)

* Temperature/gradient holes drilled by DOGAMI

( ) Values are estimates

NOTE: PRELIMINARY DATA, SUBJECT TO CHANGE.

TABLE I


TEMPERATURE, DEG C
10
30
50
70
90
110
0
50
100
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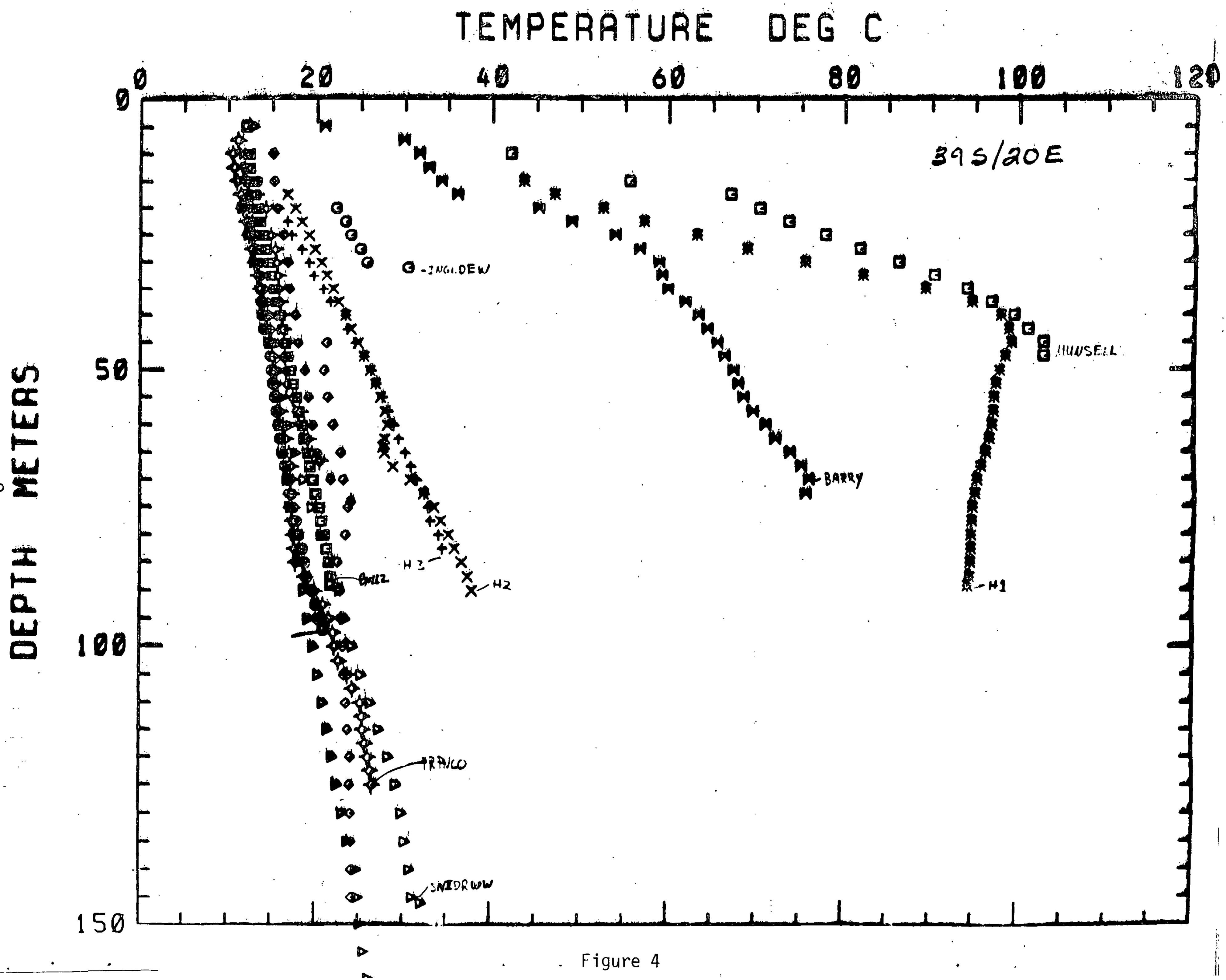
250
DEPTH METERS
Selby
CLSMITH
STRBY-WW
STKSBRY
LINDSAY
EMCDOLD
Leuch 1
Leuch 2
38S/20E -

- 7 -

Figure 3


TEMPERATURE DEG C
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20
40
60
80
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DEPTH METERS
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39S/20E
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BARRY
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H2
H1
BALLZ
FRANCO
SNIDRWW

Figure 4

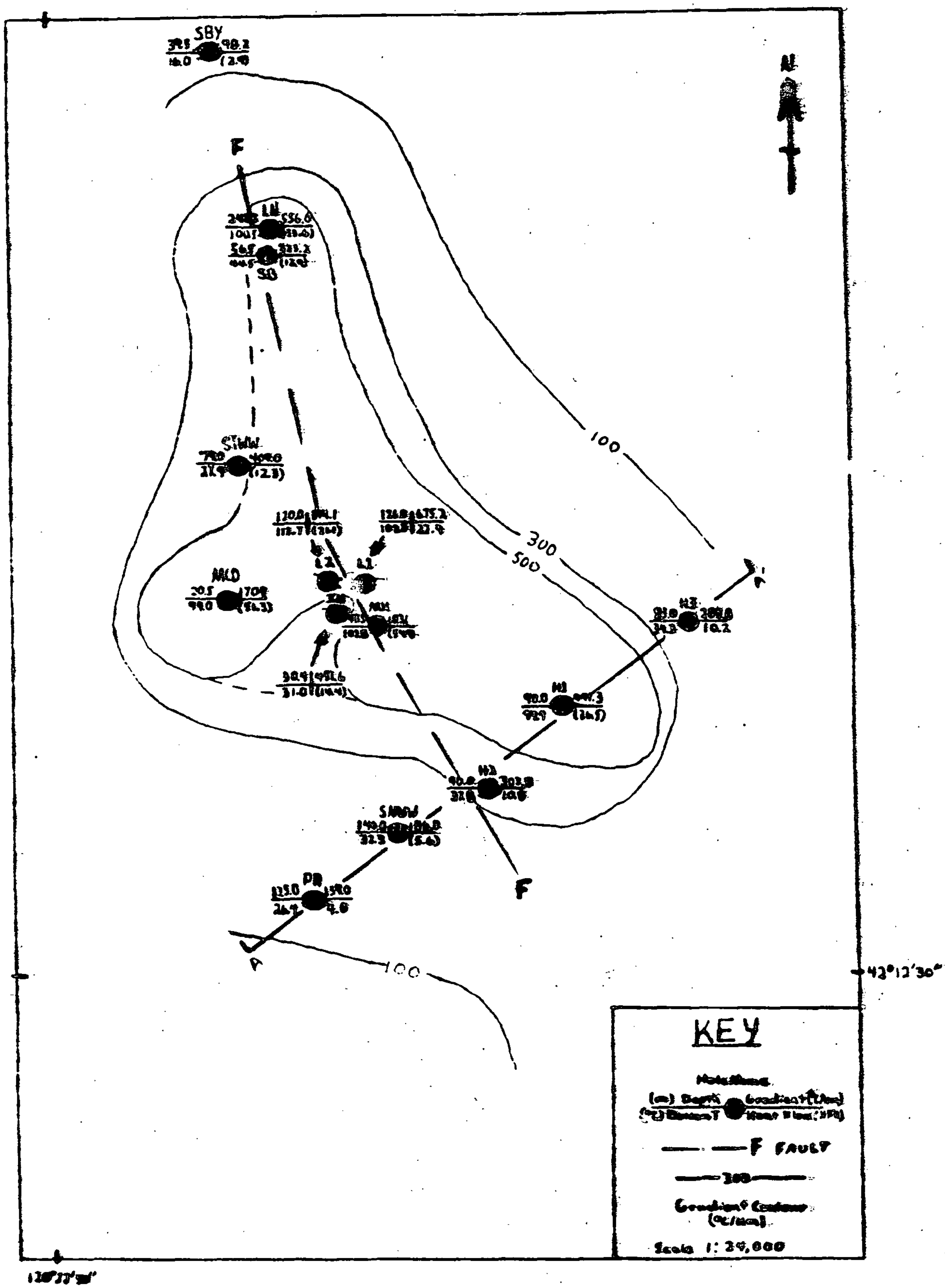
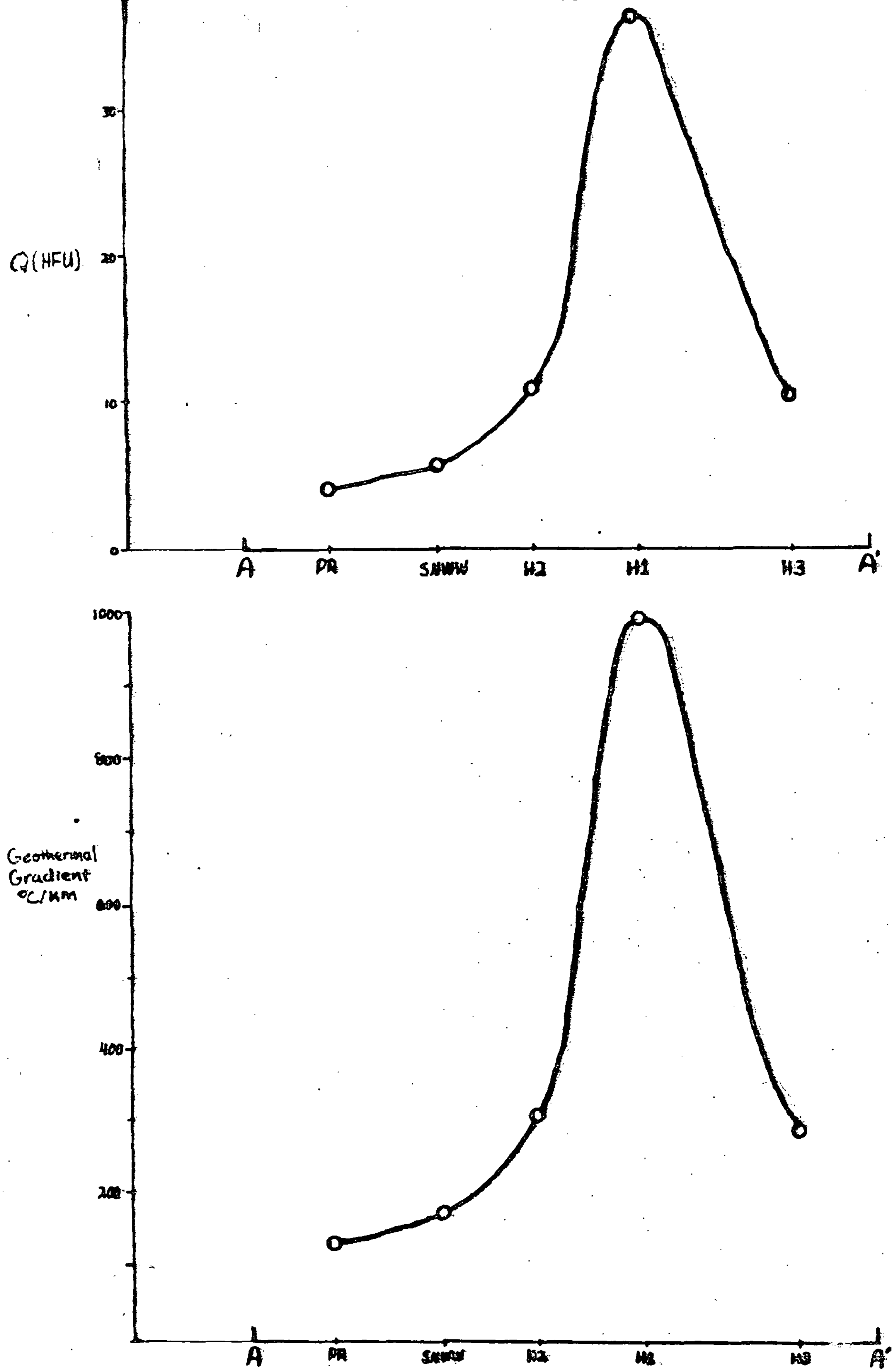


Figure 5



Profiles - Hammersley Canyon

Figure 6

Profiles Through Bullard Canyon

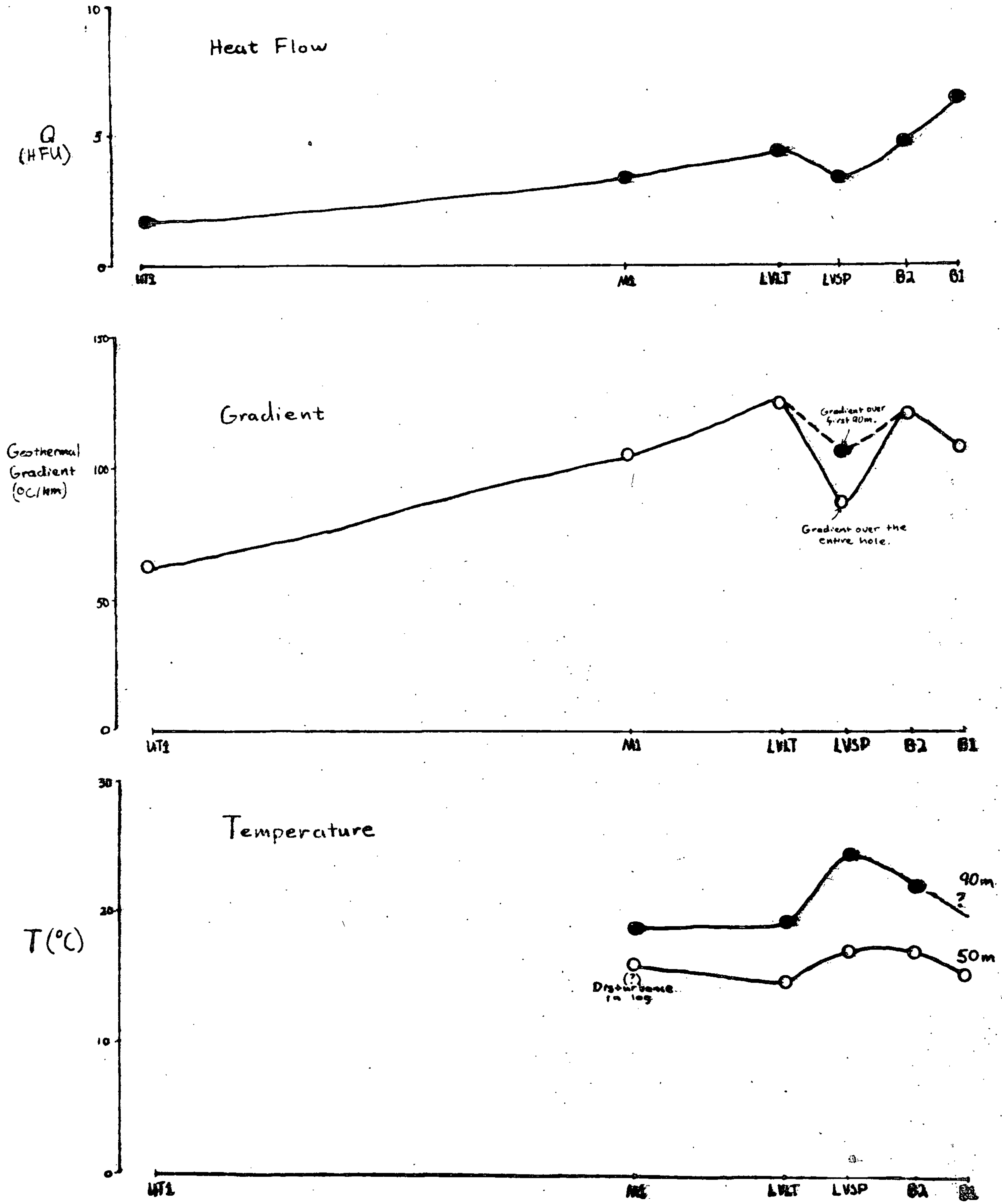


Figure 7

Based on the temperature/gradient holes and associated data obtained by DOGAMI, the area east of the frontal fault (horst block) to a distance of at least .75 mile wide (Fig. 2) appears to be underlain by a low to intermediate shallow geothermal resource. Thus, exploration that has been previously restricted to Goose Lake Valley can be extended eastward. Geothermal fluids apparently occur in fractures and joints on the horst block associated with the frontal and the intersecting northwest trending faults. Many of the fractures seen in outcrop and in cuttings are filled with calcite and possibly acidizing may improve permeability.

Based partially on the foregoing and on geologic studies of their own, Northwest Natural Gas Company tentatively plans to drill three 1000-foot-deep exploratory holes this year (farm-out from Gulf Oil Co.) at the following locations: near the Leach wells in sec. 33, T. 38 S., R. 20 E.; at the site of Hammersley Canyon #1 in sec. 3, T. 39 S., R. 20 E.; and north of the Barry hole in sec. 27, T. 39 S., R. 20 E. The latter hole is programmed to intersect the frontal fault near total depth.

Besides the City of Lakeview, Lake County has shown interest in utilizing the geothermal resource for space heating/cooling and industrial applications for contemplated industrial parks.

It is recommended that an exploratory hole be drilled in the area underlain by the siliceous sinter in sec. 12, T. 38 S., R. 20 E. This was not done in the current study due to the lack of drilling funds.

If you have any questions or need additional data, please call me or Joe Riccio.

Sincerely yours,

Donald A. Hull
Principal Investigator

DAH:lk