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GEOTHERMAL RESOURCE ASSESSMENT IN WASHINGTON

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Introduction

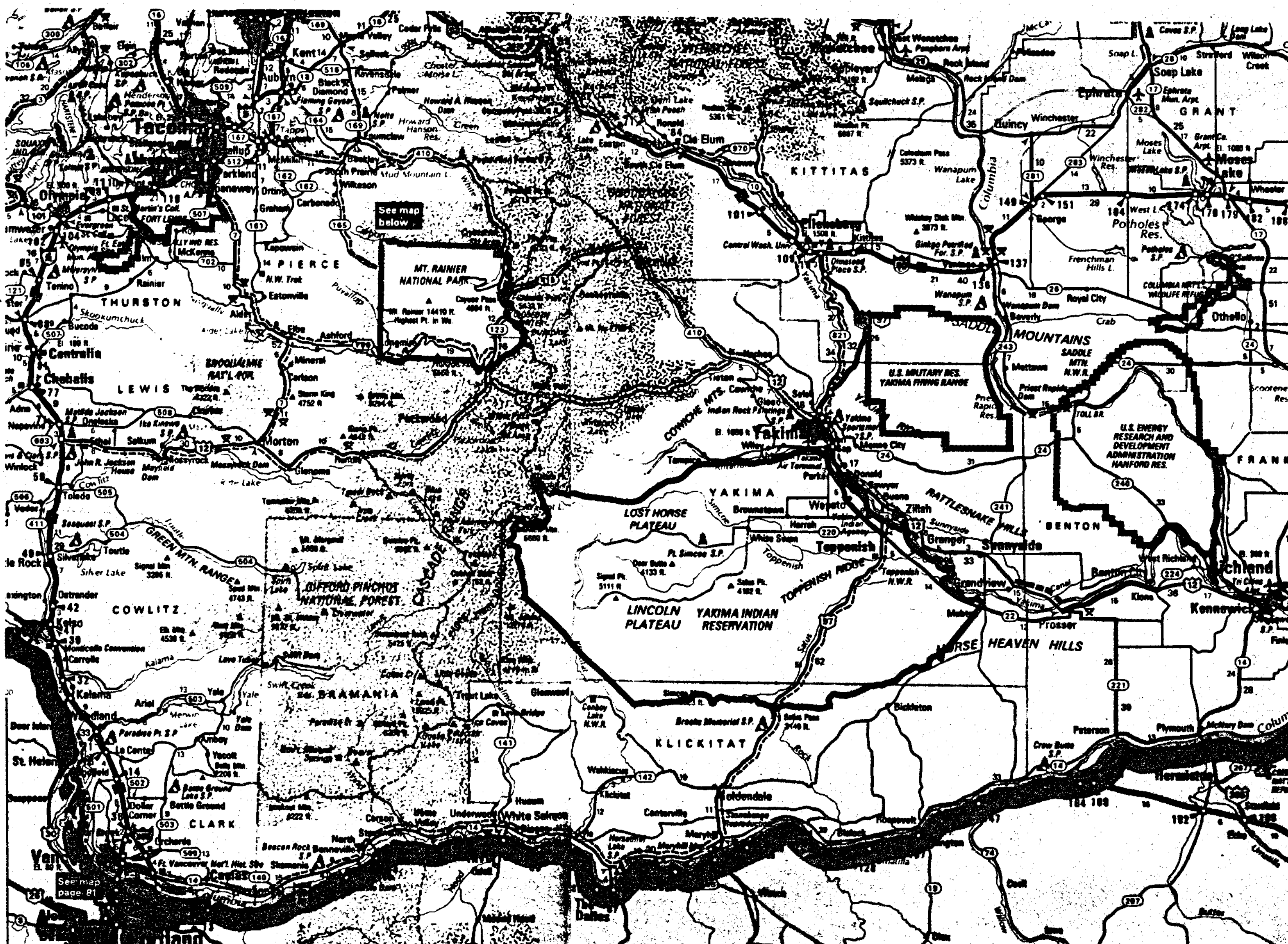
Geothermal resource assessment activities during 1979 have included temperature-gradient and heat-flow investigations, geochemical investigation of mineral and thermal springs, geologic mapping, a resistivity survey, regional gravity measurements, and preparation of geothermal resource maps for Washington.

The State of Washington thus far has received very little attention from prospective geothermal developers. Consequently, the geologic, geochemical, and geophysical data base with respect to geothermal has been either scattered or nonexistent. Our assessment efforts have therefore, been primarily directed toward synthesizing and interpreting existing data and providing regional geophysical and geochemical data bases where none have previously existed.

Attention was focused on the southwestern Cascades of Washington during 1979. In 1980, the focus will shift to the southeastern Cascades and southwestern Columbia Basin, where preliminary data seem to indicate good prospects for direct-use geothermal resources.

Temperature-Gradient and Heat-Flow Investigations

Shallow drilling and measurements of temperature gradients in existing wells were accomplished in the following areas, 1) the Cowlitz River valley


Tacoma
Olympia
Centralia
Chehalis
Kent
Auburn
Kelso
Vancouver
Portland
See map below
MT. RAINIER NATIONAL PARK
See map page 81
PIERCE
THURSTON
LEWIS
COWLITZ
CLARK
SKAMANIA
KLICKITAT
KITTITAS
YAKIMA
BENTON
GRANT
Cle Elum
Ellensburg
Yakima
Toppenish
Sunnyside
Grandview
Prosser
Kennewick
Richland
Othello
Ephrata
Soap Lake
Moses Lake
Quincy
Goldendale
White Salmon
The Dalles
Morton
Packwood
Ashford
GIFFORD PINCHOT NATIONAL FOREST
YAKIMA INDIAN RESERVATION
LINCOLN PLATEAU
LOST HORSE PLATEAU
TOPPENISH RIDGE
RATTLESNAKE HILLS
HORSE HEAVEN HILLS
SADDLE MOUNTAINS
COWICHE MTS.
GREEN MTN. RANGE
U.S. MILITARY RES. YAKIMA FIRING RANGE
U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION HANFORD RES.
Columbia
Skookumchuck
Silver Lake
Mt. Rainier 14410 ft. Highest Pt. in Wa.

between Interstate 5 on the west and White Pass on the east, 2) the Mount St. Helens area, and 3) the Camas area, located in Clark County east of Vancouver, Washington.

In the Cowlitz River valley, useable temperature gradients were measured in about 22 water wells located in the western portion of the valley, generally between Interstate 5 on the west and the City of Morton on the east. Temperature gradients in these wells are generally 30°C/km or less.

Two gradients measured in existing wells located to the east of the City of Morton and gradients measured in five of the six 500 foot deep gradient wells drilled during 1979 between the town of Randle and White Pass (both to the east from Morton) are 46°C/km and higher. This suggests that the transition between "Puget Lowland type" gradients of about 30-40°C/km or less and "High Cascade type" gradients of about 45°C/km or more occurs between the City of Morton and the town of Randle. The transition appears to be fairly sharp (perhaps 5 miles or less in width) and seems to occur closer to Morton than to Randle.

In the Mount St. Helens area, there are no existing wells except for three holes drilled during 1979 by the Division. Gradients have been measured in two of these holes. The temperature gradient for St. Helens No. 1 drill hole, to the north-northwest of Mount St. Helens, is very low at 19°C/km, and appears to be affected by local hydrologic conditions. In St. Helens No. 2 drill hole, to the west of Mount St. Helens, the gradient is 38°C/km. The third drill hole, to the east-southeast of Mount St. Helens, has not been measured because it is inaccesible in the winter.

In the Camas area, several gradients measured in existing water wells located to the west of 122°20'W. (about the longitude of the City of Camas) yielded temperature gradients of less than 40°C/km. Two water wells located to the east of 122°10'W. produced gradients of about 53 and 69°C/km. Two gradient wells drilled by the Division near Camas produced gradients of 31-38°C/km and 48°C/km. The former well was drilled in Tertiary volcanics

RESULTS OF HEAT-FLOW DRILLING, 1979, SOUTHWEST CASCADES, WASHINGTON

Well Name	Location		USGS Quadrangle	Spud Date	Completion Date	Elevation M.	Depth M	Bottom-hole Temp., °C	Gradient, °C/Km
	N. Latitude	W. Longitude							
Longmire	46° 43' 46"	121° 51' 05"	Randle 15'	7/25/79	7/31/79	710	100	8.5	69??
Ohanapecosh	46° 42' 54"	121° 34' 39"	Packwood 15'	8/2/79	8/31/79	488	115	11.1	46.5
White Pass	46° 38' 17"	121° 23' 27"	White Pass 15'	8/16/79	8/22/79	1365	150	11.5	49
Packwood	46° 38' 19"	121° 41' 35"	Packwood 15'	8/23/79	8/25/79	366	152	14.0	46
Davis Mtn.	46° 33' 10"	121° 47' 07"	Randle 15'	8/29/79	8/31/79	610	147	7.9	4
Randle	46° 31' 22"	121° 56' 22"	Randle 15'	9/5/79	9/10/79	274	129	14.1	46
Mt. St. Helens #1	46° 15' 57"	122° 14' 13"	Spirit Lk. 15'	9/13/79	9/20/79	780	125	9.9	19
Mt. St. Helens #2	46° 10' 22"	122° 16' 06"	Cougar 15"	11/1/79	11/7/79	1067	154	8.2	38?
Mt. St. Helens #3	46° 07' 37"	122° 09' 09"	Mt. St. Helens 15'	11/8/79	11/15/79	805	131	---	---
Camas No. 1	45° 35' 55"	122° 23' 53"	Camas 7½'	12/11/79	12/14/79	67	152	14.4	31-38
Camas No. 2	45° 38' 20"	122° 26' 25"	Lacamas Creek 7½'	11/28/79	12/7/79	79	72	12.0	48

and sediments and the latter entirely in late(?) Tertiary sediments.

A summary of the data from temperature-gradient holes drilled in the southwest Cascades during 1979 is present in Table 1. Heat flow is being calculated for these wells by D. D. Blackwell of Southern Methodist University.

Geochemistry of Thermal and Mineral Springs

During the 1979 field season 46 springs, representing 15 different spring systems located in the Cascade and Olympic Mountains, were surveyed for temperature, flow, conductivity, and pH. Of these springs, 38 were sampled and analyzed by the Division of Geology and Earth Resources in its newly completed water analysis laboratory. Chemical species measured include specific conductivity, pH, Na, K, Ca, Mg, Li, SiO_2, alkalinity, Cl, CO_2, Br, and I.

Table 2 presents a listing of the springs, their temperatures, specific conductivities, and reservoir temperatures as predicted by the SiO_2-Quartz and Na-K-Ca geothermometers. Detailed descriptions, analyses, and discussions of observed chemistry are presented in the year-end report to USDOE, soon to be available through the Division as an open-file report.

Geologic Mapping

Geoff Clayton, from the University of Washington, is mapping the volcanic geology of the Tumac Mountain-White Pass area, located to the south and east of Mount Rainier National Park. His field studies have been completed and a geologic map and report on the petrology, age relationships, and rock geochemicstry is in preparation.

Resistivity

A resistivity study was conducted in the Camas area by F. A. Rigby of Science Applications, Inc., and R. B. McEuen of Exploration Geothermics. Two regions of relatively low resistivity were found, and drill sites were

TABLE 2. — THERMAL AND MINERAL SPRING DATA

Name		County	Location (T/R-¼ sec)	T (°C)	Specific Conductivity	Geothermometers Si-Quartz	Geothermometers Na-K-Ca
Baker Hot Springs	A	Whatcom	38/9E-SW 20	42	820	150	170
" "	B	"	"	--	780	132	169
Bonneville Hot Sprs.	A	Skamania	2/7E-SW 16	36.2	805	102	65
" "	B	"	"	29.2	790	102	---
Goose Egg Soda Sp.	A	Yakima	14/14E-SW 33	9.5	2700	137	124
Kennedy Hot Sprs.	B	Snohomish	30/12E-NE 1	35	---	173	220
" "	D	"	"	38	3200	173	222
Lester Hot Sprs.	A	King	20/10E-21	48.4	520	116	123
" "	B	"	"	44.5	---	---	---
" "	C	"	"	48.4	---	---	---
" "	D	"	"	45	---	---	---
" "	E	"	"	45	500	116	104
" "	F	"	"	45	500	116	119
Longmire Warm Sprs.	A	Pierce	15/8E-SE 29	22	5400	144	164
" "	B	"	"	13.3	600	81	144
" "	C	"	"	25.1	6550	157	170
" "	D	"	"	11.2	1920	127	162
" "	E	"	"	11	---	136	161
" "	F	"	"	19.1	6000	152	160
" "	G	"	"	24	---	138	161
Medicine Cr. Min. Spr.	A	Kittitas	21/17E-SW 22	8.7	300	87	---
Newskah Warm Sprs.	A	Grays Hbr.	16/9W-NW 9	17.5	380	103	---
" "	B	"	"	19	390	104	---
" "	C	"	"	18.5	600	---	---
" "	D	"	"	18.8	---	---	---
Ohanapecosh Hot Sprs.	A	Lewis	14/10E-NW 4	39.5	4400	141	165
" "	B	"	"	45	4500	141	166
" "	C	"	"	43.6	---	142	165
" "	D	"	"	50.1	4650	141	169
" "	E	"	"	37.1	---	---	---
" "	F	"	"	44.3	---	---	---
" "	G	"	"	47.8	---	141	168
" "	H	"	"	30.6	---	136	165
Olympic Hot Sprs.	A	Clallam	29/8W-NW 28	48	320	125	---
" "	B	"	"	48	---	---	142
Orr Cr. Warm Sprs.	A	Skamania	10/10E-NE 19	21.7	175	78	231
Sol Duc Hot Sprs.	A	Clallam	29/9W-NW 32	34	355	114	93
" "	B	"	"	50	342	114	99
" "	C	"	"	40	345	114	98
" "	D	"	"	46	305	109	97
St. Martins Hot Sprs.	A	Skamania	3/8E-SE 21	32	2350	108	102
Suiattle R. Min. Seep	A	Snohomish	31/15E-NE 18	10	2350	69	227
Sulphur Cr. Hot Sprs.	A	Snohomish	32/13E-SE 18	37	480	137	131
Summit Cr. Soda Spr.	A	Lewis	14/11E-SW 18	11.6	8500	140	155
" "	B	"	"	9.7	2000	80	155

recommended to test these two areas. The two Camas drill holes shown on Table 1 are located at or within a short distance of the drill sites recommended by Rigby and McEuen.

Gravity

During 1979 Z. F. Danes of the Univeristy of Puget Sound measured gravity at 743 stations in the south Cascades. The area covered extends from 121°W. on the east to 122°30'W. on the west, and from the Columbia River on the south to the Cowlitz River valley on the north. Computations will continue through the winter with the expectation that a south Cascades gravity map and report will be ready for distribution by June 1, 1980. Dr. Danes has also produced relatively detailed gravity maps for the Camas and North Bonneville areas, located near the Columbia River in southwestern Washington.

Geothermal Resource Maps

Data acquistion, reduction, and plotting for public and scientific geothermal resource maps of Washington are in progress. This work is being carried out with the assistance and cooperation of personnel from Oregon Institute of Technology, National Oceanic and Atmospheric Administration, and University of Utah Research Institute. Information being compiled for the two maps includes well water temperatures, temperature gradients, heat flow, thermal and mineral springs, water geochemistry, faults, Quaternary volcanic rocks and volcanic centers, National Parks, wilderness areas, federal reservations, Indian reservations, lease status, and current and potential geothermal uses.