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Geothermal Energy

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COORDINATION OF GEOTHERMAL RESEARCH

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During the period 26 October to 10 November the Geothermal Coordinator supervised the drilling ~~the~~ of the Coryell intrusives for four days and visited Vancouver, Victoria, Meager Creek, Edmonton, Regina and Saskatoon.

The Coryell Intrusives

A supervisor from EPB was present throughout the drilling programme, for the purpose of directing the drilling and making daily temperature measurements. Preliminary results of this work were very encouraging and showed temperature gradients of about 55 mK/m. This means that a hole drilled as deep as GT-1 at Los Alamos would have a bottom hole temperature of about 175°C. This is only 22°C less than the Los Alamos hole, which is being used as the test for hydrofracturing and hot dry rock experiments. Further measurements will be made to determine how much the observed temperatures in the Coryell intrusives are controlled by water and whether the extrapolation from 500 m to 3000 m is valid.

Vancouver

A meeting was held at the offices of the British Columbia Hydro and Power Authority (BCH) to review the 1978 programme at Meager Mountain and to plan the 1979 programme. Present were J. Stauder and R. Scarth of BCH and J.G. Souther and A.M. Jessop of EMR.

During the field season of 1978 the resistivity surveys of BCH covered the areas that were originally planned with the addition of a line to link the first diamond drill site on the north side of the mountain. This line has been reported to contain some interesting anomalies, but a full analysis is

not yet available. Shallow holes, drilled by percussion equipment were placed along the Meager Creek Valley, but it is not yet clear that these holes were worth drilling. It is hoped that the contractor's final report will provide better justification than is yet available for this technique. The intermediate depth diamond drilling, promoted by the EMR team, produced very encouraging results on the north side of the mountain, where a hole was drilled to 600 m and temperatures up to 103°C were observed. A plot of the bottom-hole temperatures, taken during drilling operations is included as Figure 1. The second hole was begun in deep overburden on the south side of the mountain and reached only 256 m, entirely in unconsolidated material, before the drill rods broke. This drilling has now been stopped. The second hole is completely lined with either casing or drill rods, and will remain open for temperature observation. Data obtained after drilling was stopped showed a maximum temperature of 104°C at 213 m. The data are shown in Figure 1. The maximum indicates a thermal ground-water plume as observed downstream, and suggests that the heat is coming from a deep origin. A full analysis of all these data will be made by contractors and BCH and EMR personnel during the winter.

Several conclusions may be drawn:

1. Field operations of this scale, i.e. K$500, need to be planned and contracted well in advance of the field season, and not when the season has already begun. Fortunately, in this case, only the percussion drilling may turn out to be of doubtful value. The final diamond drilling was in danger of being curtailed by snowfall, although the eventual reason for stopping was broken rods and exhausted funds.

2. Operations of this sort should be the subject of a single contract under the technical supervision of a team of BCH and EMR personnel. This contract must specify clearly whether the originators or the consultants are responsible for final decisions such as drill site locations. BCH, with their lack of earth scientists, have understandably adopted the technique of leaving such decisions to the contractor. A broadly based supervision team of BCH and EMR personnel could make these decisions itself.

EMR to put up money only if involved adequately in decision-process.

3. Diamond drilling to 600 m, based only on the results of geological mapping and interpretation done previously under contract to EMR, produced valuable and definite information and encouraging results. Further use of this technique is warranted. Better cables, able to withstand high temperature, are required.

A statement was prepared by the Coordinator that was acceptable to all present for submission to the management of both agencies. This statement is attached as Appendix 1. It summarizes the present state of knowledge at Meager Mountain and outlines a proposed course of action for 1979-80.

In previous studies all results were to some extent equivocal. Geochemical analyses could only be used on the waters from the small number of springs available, mainly the Meager Creek and Pebble Creek springs. Even these waters have been shown to have undergone re-equilibration with wall-rocks in the path from reservoir to spring, and they do not retain a chemical memory of reservoir conditions. Resistivity and audiomagnetotelluric surveys show electrical anomalies, but in this geologically complex terrain analysis is difficult and low resistivities cannot with certainty be attributed to water reservoirs or to high temperatures.

The diamond drilling of 1978 has demonstrated conclusively that high underground temperature is characteristic of the Meager Mountain complex. The results from these two holes considerably enhance the value of the resistivity surveys, and they provide the firm framework within which the resistivity anomalies may be interpreted. Those present at the meeting considered that a new level of information quality had been achieved, and that this should be exploited in order to reduce the risk involved in full scale rotary drilling.

In discussions with people from countries having established geothermal industries, it is evident that the deep exploration drilling is normally done as a three to five-hole programme. Very rarely is a drill taken to an unproven site to drill a single exploration well. This practice reduces the risks involved. Full-scale drilling at Meager Mountain will be very expensive because of the present lack of access roads and the rugged nature of the country. It is thus necessary to take all reasonable steps to reduce the risk in drilling the first deep well. The scientific and technical personnel believe that the diamond drilling technique should be further exploited for this purpose. A programme of drilling three 600 m holes on each of the north and south sides of the mountain, using two diamond drill rigs is recommended for the first half of the season. By late August a third, heavier, diamond drill rig should be brought in to drill one deep (1500 m) hole, the site of which will depend on all existing information, particularly the drilling immediately preceding. Such a hole can confirm temperature patterns, produce water samples for chemical analysis, provide core for porosity and permeability analysis, and it can vent water or steam to the surface. However, it cannot provide a test of the production characteristics of a reservoir, since the diameter is too small for the volumes of fluid involved.

It will be necessary for the technical working group to maintain close and continuous contact during July and August 1979. It is considered that a

review by foreign experts is still required, and should take place in the winter of 1978-79 or early spring of 1979, before the diamond drilling programme.

Drilling should begin as soon as it is possible to move in equipment, probably about mid-May. In order that the necessary intergovernmental agreements and the process of Departmental and Treasury Board approval can be completed in time, negotiations should begin now. We recommend that the Conservation and Renewable Energy Branch proceed immediately to negotiate an agreement with BCH. — is this a demonstration project or a research & dev. project. What are lines of responsibility now Sladen fund has gone

The costs shown in Appendix 1 are estimated on the basis of a single contract to a primary contractor who will manage the entire work, set up a main camp, and let secondary contracts to drillers, surveyors and loggers. Costs could probably be reduced somewhat by dispensing with the primary contractor, who will not play a large part, and letting contracts directly to the active participants. why not?

Since the date of this meeting it has been pointed out that a highly skilled drilling team exists within BCH. This team is equipped with more sophisticated monitoring and recording devices than normal diamond drillers and is anxious to take part in the work at Meager Mountain. They have considerable experience in drilling for scientific and technical purposes other than mining exploration. Considerable advantages in financial savings and technical operations could be obtained by using this drilling capability, and the implications of this should be explored by the negotiating team. with this what EMR money is welcoming.

Edmonton

The Coordinator visited Mr. G. Mason of the Alberta Department of Energy and Natural Resources. Mr. Mason administers the awarding of contracts to

Alberta Universities from the Heritage Fund for energy research. One of these contracts has recently gone to Prof. F.W. Jones at the University of Alberta for research into the thermal characteristics of sedimentary rocks in a part of western Alberta.

The Coordinator visited Professor Jones on the following day for technical discussions.

Regina

The Coordinator visited Professor L. Vigrass on 8 November at the University of Regina to review progress on the drilling programme and on utilization studies. The site is now fully prepared, to the extent of having conductor pipe (24 in. diam.) run in a hole to 32 ft. The contract with the drilling company is now completed and the rig will move on to the campus as soon as it is finished at its present location.

Note added later: The drill rig began to move in on 18 December.

Utilization studies are progressing in the Engineering Department. As a result of discussions on the rate of cooling of water in moving up the well, A.E. Taylor of the Geothermal Service visited Regina during the following week to contribute his experience in numerical analysis of such systems.

The Coordinator has discussed with staff of the Universities of Edmonton, Saskatchewan and Regina and with Sproule Associates Ltd. the possibility of a meeting in Regina during the drilling period to discuss the future of geothermal research on the Prairies. A date will be decided on later.

Information of Publications

A list of Canadian publications related to geothermal energy is attached as Appendix 2. A list of reports obtained from NTIS Washington and held by Earth Physics Branch library in Ottawa will be circulated shortly.

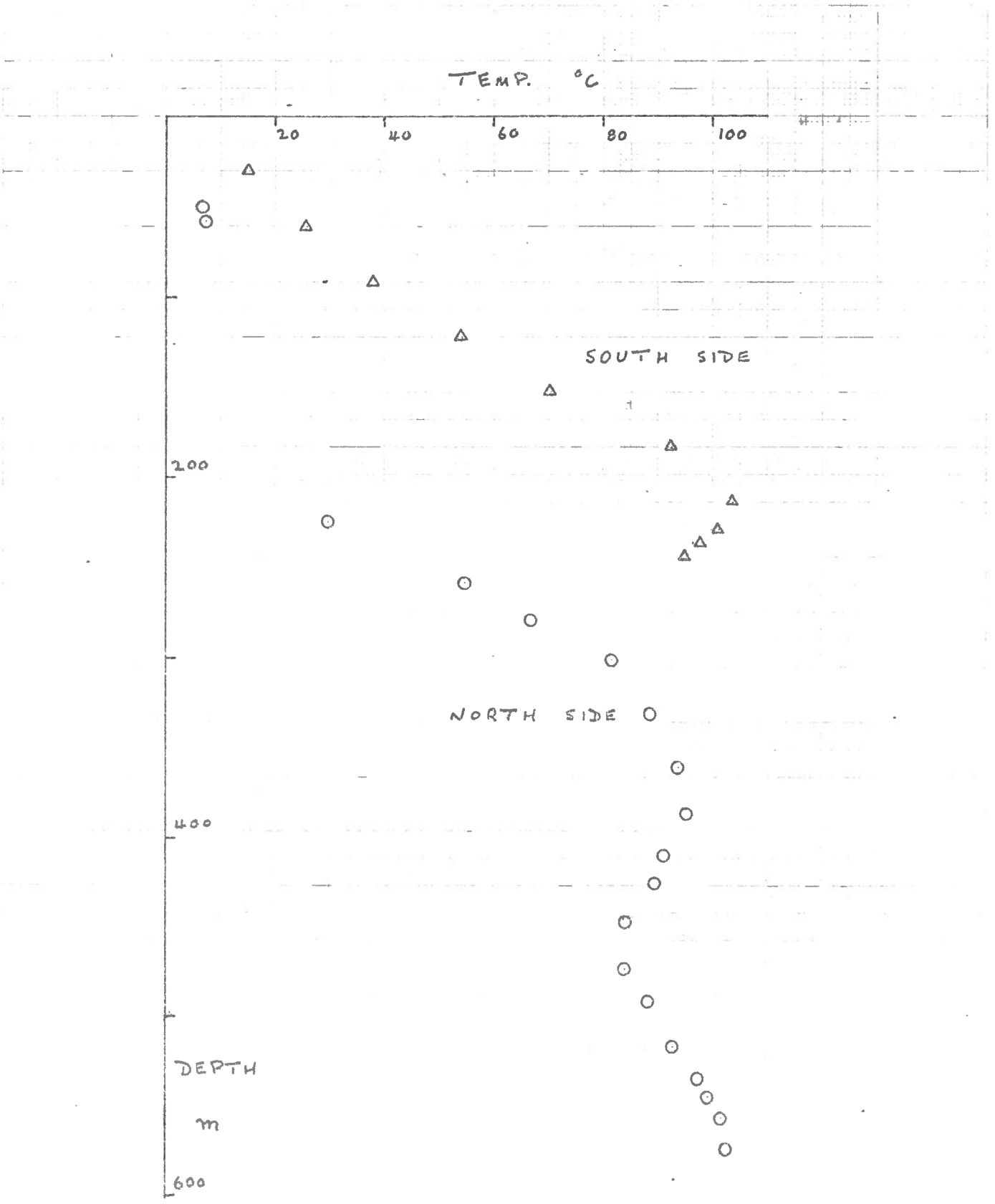

Figure 1 - Temperature From Two Wells Near Meager Mountain

Appendix 1

Technical Requirements for the Meager Mountain Geothermal Project 1979-80

The technical working group for geothermal studies at Meager Mountain met at the offices of the British Columbia Hydro and Power Authority (BCH) on 31 October 1978. Present were J. Stauder and R. Scarth of BCH and J. Souther and A. Jessop of Energy, Mines and Resources (EMR).

Concerning the operations of 1978-79, it was agreed that:

1. The electrical resistivity surveys are now complete except for an area in the vicinity of the first diamond drill hole of 1978, on the north side of Meager Mountain.
2. The diamond drill hole on the north side gave very encouraging results, with a maximum temperature of about 105°C and a temperature profile suggesting a convecting hydrothermal system.
3. It is not yet possible to make a choice between the north and south sides of Meager Mountain as the most probable resource area.
4. Further diamond drilling to intermediate depths (300-600 m, 1000-2000 ft.) should be done to investigate further the thermal anomalies revealed in 1978.
5. In view of the high cost of mobilising and using rotary drilling equipment for a deep (1000-1800 m, 3000-5000 ft.) test well, the deep drilling should first be done by a diamond drill of that capacity.
6. There is time in a single season, from June to November inclusive, to drill intermediate depth holes on both north and south sides simultaneously, to choose a location for a deep hole, and to drill the deep hole.

It was agreed that the program of work for the field season of 1979 should be as follows:

1. Sufficient resistivity surveying to extend coverage to the region of the intermediate depth hole of 1978 on the north side of the mountain to the same quality as elsewhere in the Meager Mountain area.
2. 1800 m (6000 ft.) of intermediate depth drilling, probably three holes of 600 m (2000 ft.) on each of the north and south sides of Meager Mountain. This drilling to begin as soon as road access is available, before the end of May if possible. The time required is estimated to be three months. 6 @ 600 m
3. One deep diamond drill hole at a site to be selected on the basis of all work up to and including the above. 1 @ 1000 - 1600 m
4. A review of all work up to and including the results of the 1978 season by a group of experienced foreign experts.

The representatives of BCH stated they they wished to continue the contracted study of the environmental impact of geothermal development in the area.

The following budget estimate was prepared.

Operations	Cost in $1000 units	
Drilling to intermediate depth		
12000 ft. at $20/ft.	240	
mobilisation	60	300
Drilling deep hole		
5000 ft. at $30/ft.	150	
mobilisation	40	190
Resistivity survey		
field operations	50	
wire supplies	15	
helicopter support	20	75
Camp, transportation, supplies etc.		20
		585

490 drilling

Consultant Costs	
Salaries, overheads, etc.	75
Burden on disbursements, 10% of Operations	60
	720
Review by panel of experts	30
	750

It was agreed by those present to recommend to their respective managements that:

1. An agreement be negotiated by these Federal and Provincial agencies to permit this work to proceed. timing
2. The same BCH and EMR employees present at the meeting be charged with the responsibility for technical management of the project. not a problem
3. A management advisory committee be established to review progress and to determine future policy. ?
4. For the informal cooperative program between BCH and EMR of 1978-79, costs were shared on the basis of BCH 60%, EMR 40%. For the proposed 1979-80 field program a similar sharing of costs could apply to the total cost of the resource assessment work at Meager Mountain. It should be noted that these costs exclude regional geothermal work which is funded separately by EMR and environmental impact studies at Meager Mountain which are funded separately by BCH.

Sources ① EPS joint prov-Fed funds
② Contingency money - Dyne fund
③ Energy R+D. (A level) ? problem

Jan 9/79 Keys recommends ③ as first option if possible being prepared to jump on ①. However could talk to Dyne about ② - but this requires clear Regional decisions.

Appendix 2. Canadian Geothermal Energy Publications

92030 ABDEL-AAL,O.Y. AND HALL,J.M.
OPAQUE MINERAL ALTERATION STATES CORRELATED WITH TEMPERATURE IN AN ACTIVE GEOTHERMAL SYSTEM.
NATURE,272,239-240,1978.

92007 CRANDALL,J.T. AND SADLIER-BROWN,T.L.
DATA ON GEOTHERMAL AREAS - CORDILLERAN YUKON, NORTHWEST TERRITORIES, AND ADJACENT BRITISH COLUMBIA, CANADA.
GEOLOGICAL SURVEY OF CANADA, DEPT. ENERGY, MINES AND RESOURCES, 23PP, 1976.

92018 EVERDINGEN,R.O.VAN.
THERMAL AND MINERAL SPRINGS IN THE SOUTHERN ROCKY MOUNTAINS OF CANADA.
ENVIRONMENT CANADA,151PP.,1972.

92012 GLASS,I.I.
UTILIZATION OF GEOTHERMAL ENERGY.
UNIV.TORONTO,INST.AEROSPACE STUDIES,REVIEW 40,21PP,1976.

92029 GLASS,I.I.
PROSPECTS FOR GEOTHERMAL ENERGY APPLICATIONS AND UTILIZATION IN CANADA
ENERGY,2,407-428,1977.

92006 HAINES,P.J. AND JESSOP,A.M.
GEOTHERMAL POTENTIAL AND GEOTHERMAL EXPLORATION IN THE CARIBBEAN ISLANDS.
CANADIAN INTERNATIONAL DEVELOPMENT AGENCY,30PP,1975.

92003 HAMMERSTROM,L.T. AND BROWN,T.H.
GEOCHEMISTRY OF THERMAL WATERS IN THE MOUNT MEAGER HOTSPRINGS AREA, BRITISH COLUMBIA.
GEOL.SURV.CAN.PAPER 77-1A,283-285,1977.

92014 HAMMERSTROM,L.T. AND BROWN,T.H.
THE GEOCHEMISTRY OF THERMAL WATERS FROM THE MOUNT MEAGER HOTSPRINGS AREA, B.C.
GEOLOGICAL SURVEY OF CANADA, DEPT. ENERGY, MINES AND RESOURCES, 32PP PLUS APPEND. OPEN FILE ,1977.

92005 JESSOP,A.M.
GEOTHERMAL ENERGY FROM SEDIMENTARY BASINS.
GEOTHERMAL SERIES, EARTH PHYSICS BR.,NO.8,10PP,1976.

92008 JESSOP,A.M.
ENERGY R AND D PROGRAM STATEMENT - TASK 5 - EXPLOIT RENEWABLE ENERGY RESOURCES - PROGRAM 4 - GEOTHERMAL ENERGY.
GEOTHERMAL SERIES, EARTH PHYSICS BR.,NO.4,6PP,1975.

92009 JESSOP,A.M.
GEOTHERMAL ENERGY - PROGRESS REPORT NO. 1.
GEOTHERMAL SERVICE OF CANADA, INTERNAL REPORT 75-1,21PP,1975.

92015 JESSOP,A.M.
THE ROLE OF NON-CONVENTIONAL ENERGY RESOURCES - GEOTHERMAL.
IN - THE CANADIAN ENERGY SITUATION IN 1990 AND BEYOND, PROC.CAN.NATNL. ENERGY FORUM,1977.

92016 LEWIS,J.F.
PRELIMINARY FIELD REPORT OF DRILLING NEAR MT. MEAGER AND MT.CAYLEY VOLCANIC CENTRES - 1977.
EARTH PHYSICS BR.,DEPT. ENERGY, MINES AND RESOURCES, OPEN FILE 78-2, 12PP.+APPEND+DIAGR.,1978.

92023 LEWIS,T.J. AND SOUTHER,J.G.
MEAGER MOUNTAIN, B.C. - A POSSIBLE GEOTHERMAL ENERGY RESOURCE.
GEOTHERMAL SERIES, EARTH PHYSICS BR.,NO.9,17PP.,1978.

92021 MARK,D.G.
SEISMIC REFRACTION STUDY IN THE MEAGER MOUNTAIN GEOTHERMAL REGION, LILLOOET RIVER VALLEY, B.C.
EARTH PHYSICS BR.,DEPT. ENERGY, MINES AND RESOURCES, OPEN FILE 78-3, (PART),11PP.+DIAGR.,1978.

92022 MARK,D.G.
SEISMIC REFRACTION STUDY IN THE MEAGER MOUNTAIN GEOTHERMAL REGION, JOB CREEK AREA, UPPER LILLOOET RIVER VALLEY, B.C.
EARTH PHYSICS BR.,DEPT. ENERGY, MINES AND RESOURCES, OPEN FILE 78-3, (PART),11PP.+DIAGR.,1978.

92019 MCDONALD,J., POLLOCK,D. AND MCDERMOT,B.
HOTSPRINGS OF WESTERN CANADA - A COMPLETE GUIDE.
LABRADOR TEA CO.,161PP.,1978.

92017 NEVIN,A.E. AND STAUDER,J.
CANADA - EARLY STAGES OF GEOTHERMAL INVESTIGATION IN BRITISH COLUMBIA.
PROC.U.N.SYMP.GEOTHERMAL RES.,SAN FRANCISCO,1161-1165,1975.

92025 NEVIN,SADLIER-BROWN,GOODBRAND,LTD.
DETAILED GEOTHERMAL INVESTIGATION AT MEAGER CREEK.
REPT.TO B.C.HYDRO AND POWER AUTHORITY,18PP.+DIAGR.+APPEND.,1975.

92026 NEVIN,SADLIER-BROWN,GOODBRAND,LTD.
PRELIMINARY INVESTIGATION OF THE GEOTHERMAL RESOURCES OF WESTERN VANCOUVER ISLAND.
REPT.TO B.C.HYDRO AND POWER AUTHORITY,10PP.+DIAGR.+APPEND.,1975.

92027 NEVIN,SADLIER-BROWN,GOODBRAND,LTD.
1976 GEOTHERMAL INVESTIGATION AT MEAGER CREEK.
REPT.TO B.C.HYDRO AND POWER AUTHORITY,18PP.+DIAGR.+APPEND.,1977.

92028 NEVIN,SADLIER-BROWN,GOODBRAND,LTD.
INVESTIGATION OF GEOTHERMAL RESOURCES IN SOUTHWESTERN BRITISH COLUMBIA
REPT.TO B.C.HYDRO AND POWER AUTHORITY,40PP.+DIAGR.+APPEND.,1974.

92010 PHAM VAN NGOC.
MAGNETO-TELLURIC RECONNAISSANCE SURVEY IN THE LILLOOET VALLEY, BRITISH COLUMBIA.
EARTH PHYSICS BR.,DEPT. ENERGY, MINES AND RESOURCES, OPEN FILE 77-20, 22PP.+DIAGR.,1976.

J24 PHAM VAN NGOC.
MAGNETO-TELLURIC PROSPECTING IN THE MOUNT MEAGER GEOTHERMAL REGION (BRITISH COLUMBIA).
EARTH PHYSICS BR.,DEPT. ENERGY, MINES AND RESOURCES, OPEN FILE 78-31PP.+DIAGR.,1978.

92002 READ,P.B.
MEAGER CREEK VOLCANIC COMPLEX, SOUTHWESTERN BRITISH COLUMBIA.
GEOL.SURV.CAN.PAPER 77-1A,277-281,1977.

92001 SOUTHER,J.G.
GEOTHERMAL POTENTIAL OF WESTERN CANADA.
PROC.U.N.SYMP.GEOTHERMAL RES.,SAN FRANCISCO,259-267,1975.

92011 SOUTHER,J.G.
GEOTHERMAL POWER, THE CANADIAN POTENTIAL.
GEOSCIENCE CANADA,3,14-20,1976.

92004 SPROULE ASSOCIATES LTD.
REPORT ON STUDY OF GEOTHERMAL RESOURCES IN WESTERN CANADIAN SEDIMENTARY BASINS FROM EXISTING DATA, PHASE ONE.
EARTH PHYSICS BR.,DEPT. ENERGY, MINES AND RESOURCES, OPEN FILE 77-13, 110PP.+DIAGR.,1976.

92013 SPROULE ASSOCIATES LTD.
REPORT ON STUDY OF GEOTHERMAL RESOURCES IN WESTERN CANADIAN SEDIMENTARY BASINS FROM EXISTING DATA, PHASE TWO.
EARTH PHYSICS BR., DEPT. ENERGY, MINES AND RESOURCES,127PP,OPEN FILE 77-14,1977.

92020 VIGRASS,L.W., KENT,D.M. AND LEIBEL,R.J.
LOW-GRADE GEOTHERMAL PROJECT, GEOLOGICAL FEASIBILITY STUDY, REGINA - MOOSE JAW AREA, SASKATCHEWAN.
EARTH PHYSICS BR.,DEPT. ENERGY, MINES AND RESOURCES, OPEN FILE 78-4, 79PP.,+APPEND+SUB.REPTS.,1978.