

Geothermal Energy

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COORDINATION OF GEOTHERMAL RESEARCH

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Geothermal Service of Canada
Division of Seismology and Geothermal Studies
Earth Physics Branch
Department of Energy, Mines and Resources
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During the period 30 November to 10 December the Geothermal Programme Coordinator, A.M. Jessop and M.J. Drury visited various people and institutions in western Canada. A meeting of the Sedimentary Panel on Geothermal Energy, SPONGE, was held in Calgary on 3 December. From 18 to 25 January the same team visited the four provinces of the Atlantic region.

Edmonton

On 30 November and 1 December visits were made to the Institute of Earth and Planetary Sciences, Dept. of Physics, University of Alberta, to meet with Prof. F.W. Jones and his research assistants. Two contracted studies are in progress as part of the EMR Geothermal Programme, one to collect existing temperature data from well logs in Saskatchewan, and the other to make measurements of thermal conductivity of rock cores. Both projects are progressing well, and after one third of the contract period approximately one third of the budget has been used. The Coordinator asked for invoices to be prepared and to be sent to DSS covering the period of up to 30 November.

Prof. Jones estimates that about 15,000 data from 6000 wells will be collected in Saskatchewan and south west Manitoba. The Manitoba data are included on the microfilm in Regina.

In the conductivity laboratory operations had been temporarily suspended to allow the addition of three new divided bar units to augment the original single unit. This will permit the acquisition of at least 500 data during the course of the present contract. Problems of slow stabilisation of temperature and the Earth Physics Branch (EPB) techniques of using contact fluid and 'Parafilm' wrapping were discussed. A lengthy technical discussion on all aspects of the measurement process followed.

Plans for the following year were discussed. Prof. Jones has been in contact with Dr. Jacek Majorowicz, of Warsaw, Poland, who is interested in working at the university for six months or one year.

The possibility of having Dr. Majorowicz begin the mapping of potential geothermal reservoir, based on a synthesis of temperature and conductivity data of the University and net-rock data of EPB was explored. It was expected that this topic would arise at the forthcoming SPONGE meeting. The Coordinator invited Prof. Jones to prepare a proposal on this work. Dr. Majorowicz would be well suited to perform such a task in Edmonton, since he has worked at EPB as a Post-Doctoral Fellow, and he is familiar with both the data held by and the interests of EPB.

The question of continuation of the two present contracts was also discussed. Since the temperature data collection and analysis is directly relevant to the location of geothermal demonstration projects, and also to oil reservoir research, it was agreed that support should be sought from the provinces or from industry. The conductivity measurement is relevant to geothermal resource research, including the study of water migration by separation of water-borne and conducted heat transport, and it is a good candidate for support from the Geothermal Energy Programme. The present contract for each project is for six months of the 1981-82 year, and it might be possible to support the conductivity project for six months of 1982-83.

Considering the growing realisation of the importance of thermal research to oil exploration, as discussed extensively at the AAPG workshop in Santa Fe, in addition to the value of the University of Alberta group to Geothermal Energy research, it was agreed that every effort should be made to enable the group to remain in existence.

Note added later - political developments in Poland make it less likely that Dr. Majorowicz will be able to obtain a period of leave to work at the University of Alberta.

Calgary

On 2 December visits were made to Imperial Oil Limited and Hudson Bay Oil and Gas Limited (HBOG) to enquire about well data in Prince Edward Island. Imperial Oil Limited was not helpful, stating that all their old wells records are on file at the Atlantic Geoscience Centre, whereas we know from our contractor's report of 1980-81 that these records contain no temperature data. On the other hand HBOG were very cooperative and agreed to supply data from any of their wells that we did not have full details of. This fruitful contact is being maintained.

On 3 December the second meeting of the Sedimentary Panel on Geothermal Energy (SPONGE) was held at the Institute of Sedimentary and Petroleum Geology, by kind permission of Dr. W.W. Nassichuk. A preliminary record of this meeting is to be found in Appendix 1.

Vancouver

On 4 December a meeting was held of the leaders of the four earth science projects, at the offices of the Geological Survey in Vancouver. A review of the status of contracts in 1981-82 is given in Appendix 2, and a plan of expenditures in 1982-83 is given in Appendix 3. Since the old projects in western Canada use old Panel funds, which have not been increased, these projects are severely restricted by the funding level for 1982-83.

The date of the review meeting, to be held in Ottawa, was fixed for 17-18 March 1982, and a tentative schedule will be drawn up shortly by the Coordinator.

A party consisting of T.J. Lewis, M.J. Drury, A.M. Jessop, all of EPB, and Prof. L. Vigrass of University of Regina had intended to visit the Meager Creek drill site on Saturday 5 December, but a rock slide on the Squamish Highway prevented this.

Regina

On 9-10 December the Coordinator visited Prof. L. Vigrass at University of Regina. A utilisation study is in progress, and a final report is due in February 1982. This study is intended to define the engineering requirements for using the output of the existing well as an energy supply on the campus, and to assess the monetary savings to the university. This study is understood to be the final prerequisite to the drilling of the reinjection well.

Atlantic Canada

The authors visited representatives of the governments of Newfoundland, New Brunswick, Nova Scotia and Prince Edward Island between 18 and 25 January, 1982. In addition meetings were held with representatives of John A. Leslie and Associates Ltd., (JALA), and of Noval Technologies Ltd., both of Halifax. The meetings were arranged by the project manager for the geothermal resource assessment of Atlantic Canada in order to bring provincial government personnel up to date with the work, to try to stimulate their enthusiasm once again, and to discuss the directions that the project should take in the future.

St. John's

On 18 January, 1982 the authors visited the offices of the Newfoundland Department of Mines and Energy (NDME). Present from that body were P. Graham

(Manager, Conservation and Renewables), W. Ryan, R. Smith (senior regional geologist), N. Mercer (geologist) and P. Dean (geophysicist). The EMR representatives explained the nature of the contract that was let to John A. Leslie and Associates Ltd. to compile existing relevant data and collect new data from the province. The ensuing discussion centred on what were the prospects for the acquisition of new data. It is unlikely that much will be generated in the near future; however the GSC in Ottawa (contact man: W. Poole) and the NDME are considering a joint study of the Codroy and Deer Lake basins. Such a study is currently being given a low priority by both parties, but Mr. Graham felt that if EMR were prepared to offer some geothermal energy funds for the proposed project, the priority might be increased. There is a possibility that there will be some exploration by industry for oil and gas on the west coast of Newfoundland, but this is not likely to happen for several years.

The question of markets for geothermal energy in the province was also discussed. One location that could benefit from low grade heat resource in the Codroy basin would be Stephenville.

In the afternoon the authors visited Dr. J. Wright of the physics department of Memorial University of Newfoundland. A geophysicist, Dr. Wright has expertise in heat flow studies. He thinks that there is a possibility that small granitic plutons exist beneath sediments on the south coast of Newfoundland. If such plutons were sufficiently hot from their radiogenic elements they might produce a geothermal resource. Shallow water marine heat flow studies might help to delineate such resources.

Fredericton

In the morning of 20 January the authors visited, separately, first Mr. D. Gemmell and second Dr. J. Hamilton (Director, Geological Surveys) and Mr. J. Chandra of the New Brunswick Department of Natural Resources (NBDNR). Mr. Gemmell provided a copy of a report that contained a map of magnetic anomalies, possibly produced by granitic intrusions, in the carboniferous basin of N.B. Mr. Chandra was asked about the status of a proposal he had been preparing for Dept. of Regional Economic Expansion (DREE) funds to study the geothermal potential of the Pokiok and St. George batholiths in southwestern N.B. Dr. Hamilton had passed it to DREE several months ago. He said that at that time DREE were no longer prepared to fund such studies, and had referred the proposal (which had gone as part of a package of proposals that included geological mapping for minerals potential) to Resource Geophysics and Geochemistry Division of GSC in Ottawa. NBDNR were no longer sure of the rules that governed such proposals, nor whether EMR's policy was to conduct such studies itself. EMR (contact: W. Poole) is apparently taking over responsibility for such proposals now that the DREE provisions for earth science agreement with NB are coming to an end. The future of provincial involvement in geothermal energy research is, therefore, undetermined.

Halifax

The EMR representatives met J. Leslie, the consultant geologist who has the current contract for the collection of data, on the morning of 21 January. Various points concerning the work JALA are doing were discussed. Later all three people visited the offices of Noval Technologies Ltd. (NT) a subsidiary of the Nova Corporation of Calgary. A. Kahil, Manager of Energy

Alternatives and Resource Development, G.P. Isenor, Project Engineer, and R.H. MacDonald, geologist, represented Noval. Drury had talked to these people in September 1981, and learned of their interest in developing geothermal energy as a resource for Nova Scotia. They had subsequently provided some boreholes for JALA to log for temperatures. Talks centred on the philosophy of data gathering and exploration, and on at what stage should a decision be made to drill a test hole. NT would like to prepare a proposal for the NS government that might allow studies to be done jointly between the federal and provincial governments. The EMR representatives said that they would attempt to find out what the new procedures are for setting up such a study.

A meeting had been scheduled with W. Potter of the Nova Scotia Department of Mines and Energy (NSDME) on Friday 22 January. Unfortunately Mr. Potter had been called away on a personal matter; he had arranged for E. Bain, senior energy resource engineer, to take his place. Present also was a geologist, J. Watt. The authors answered some general questions on geothermal energy. Mr. Bain confirmed that NSDME was still interested in the geothermal potential of the province. No provincial funds were available at present for any study, but if a real potential were indicated, Mr. Bain felt that provincial monies could be found. In the authors' discussions with Mr. Potter in 1980, the possibility of the province asking its contractor (Nova Scotia Research Foundation) to measure temperatures in provincially drilled boreholes was discussed. Mr. Bain said that nothing had come of this.

Charlottetown

On the morning of Monday 25 January the authors visited A. Hiscock, operations manager of the Prince Edward Island Corporation and acting director of energy and minerals, PEI Department of Tourism, Industry and Energy. Mr. Hiscock had formed the impression, from the 1981 Leslie report he thought,

that potential sandstone aquifers in PEI were heavily fractured and therefore no use for the exploitation of low grade geothermal energy. The authors corrected this impression, and explained that Mr. Leslie had been unable to compile much on-shore temperature data from PEI. Mr. Hiscock said that there is a possibility that Hudson Bay Oil and Gas and Chevron would be drilling holes on the island later in the year. He would explore the possibility of requiring the companies to acquire good quality temperature data from any future holes. When asked about hydrological studies on the island, Mr. Hiscock referred Drury to Mr. R. Francis, a geohydrologist. Mr. Hiscock then showed the authors the provincial files of well log data, from which they were able to glean temperature data from six wells that were not listed in the Atlantic Geoscience Centre files, and consequently were not compiled in the Leslie Report 1981. These data are to be combined with data obtained from HBOG in Calgary.

In the afternoon the authors paid a visit to Mr. Francis, who provided a list of boreholes that could possibly be logged for temperature gradients. JALA, who are continuing their contract work in the current fiscal year, have been informed of these, and they will attempt to obtain temperature data.

Note added later - four wells in PEI have now been logged by JALA.

Appendix 1

Sedimentary Panel on Geothermal Energy

SPONGE

Record of meeting of 3 December 1981
Institute of Sedimentary and Petroleum Geology
Calgary

A meeting was held at the Institute of Sedimentary and Petroleum Geology on Thursday 3 December 1981 to review activities during 1981 and to discuss the future of geothermal energy research in sedimentary basins.

The conference room was made available by kind permission of Dr. W.W. Nassichuk, Director of the Institute.

A.M. Jessop acted as chairman. A list of participants, with addresses is appended to this record.

1. Record of the last meeting

The record of the last meeting had been circulated to all who had attended, first for comments and finally after revision in response to comments. No further points were raised by those present.

2. Review of AAPG Workshop at Santa Fe, New Mexico

A workshop entitled 'Temperature environment of oil and gas' was held at Santa Fe in September 1981, and it was attended by Brian Hitchon and A.M.

Jessop who reviewed it briefly. Three main points emerged from the workshop:

a. There is widespread dissatisfaction with the quality of temperature data from bottom-hole readings, from drill-stem tests and from temperature logs. Acknowledging the fact that measurements are made at a time the temperature in the hole does not match the undisturbed rock temperature, the calibration of instruments and the care with which measurements are made and recorded are of a very low standard.

b. Wide-spread water movement is present in most sedimentary basins. The scale of the circulating systems range from tens to thousands of kilometres, and the total patterns can be very complex.

c. Temperature anomalies are frequently found to coincide approximately with oil pools, leading to speculation that upwelling water and filtering is responsible for the accumulation of oil and to a search for thermally based exploration tools.

3. Review of existing projects

The chairman asked those present to describe current projects relevant to geothermal energy research.

Walter Jones of the University of Alberta is continuing the compilation and analysis of temperature data from industrial sources. A total of 55,000 temperature data from 28,000 wells have been compiled in Alberta, in a project supported by the Government of Alberta, and a temperature gradient map based on averages on a grid of 3 x 3 townships and ranges has been devised. Various

ways of averaging, smoothing and mapping the data are being examined. At the time of the meeting a similar data compilation project for the provinces of Saskatchewan and Manitoba was in progress, supported by Earth Physics Branch. The Hinton and Edmonton areas had been chosen for detailed study because of the coincidence of good temperature gradients and potential markets for heat energy. A four-unit divided bar system was being set up in order to be able to determine thermal conductivity of rock cores, and thus to differentiate between conducted and water-borne heat and to understand the thermal regions of the areas under examination.

Trevor Lewis of the Pacific Geoscience Centre, Earth Physics Branch reviewed briefly the heat flow distribution of southern British Columbia, including the White Lake Basin and other basins in the Okanagan Valley. Two holes were drilled in 1980, close to the Summerland and Kelowna Basins, but in the crystalline rocks to avoid problems associated with water flow, either natural or induced by the hole. Gradients measured were about 30 mK/m, but are expected to be higher in the sediments owing to conductivity contrast. Gradients in the White Lake basin, measured in an old Dominion Observatory Well and several mining company holes showed a clear increase from east to west, from deeper to shallower parts of the basin. This is interpreted as indicating a rising westerly flow of water in the deeper strata of the basin. A hydrological study of the White Lake Basin was being performed by the University of Waterloo.

Lawrence Vigrass reviewed the progress of the Regina demonstration project. The first well was drilled in 1979 to a depth of 2215m, with the intention of using the heat in a large sports building. The well encountered 110m of reservoir rock of good permeability, but temperature was not as high

as expected. The well seems to be the coolest in the area, and this is not fully understood. The content of dissolved solids was 110,000 ppm, rather less than expected, and the water yielded 1.6 m of gas at atmospheric pressure per 100 m of water. This gas was mainly nitrogen, with about 5% helium and minor amounts of methane and carbon dioxide. The presence of 20 ppm hydrogen sulphide and 1 ppm oxygen was a surprise. The well is designed to supply water at 100 m /hr., and this will cause a drawdown of 200m in 30 years.

Since the last meeting, approval in principle for the second well has been received from the provincial government. Final approval awaited the completion of a utilisation study. The second well will be 1800 m from the first, giving a water return time of about 30 years. The sports building has not been approved, and it is now planned to use the heat for domestic hot water (1.5 MW throughout the year, permitting a complete boiler shut-down in the summer) for boiler make-up water (0.4 MW during heating season) and heat for three separate buildings that are not connected to the central system. This study is due to be completed in February 1982, and it is hoped that the reinjection well will be drilled soon after. A theoretical study of water flow in the reservoir is also in progress.

John Sworder commented that hardware supply for use with a 60°C supply is a problem, since it is not normally available in North America. A re-education of the heating engineering community is needed if the use of a low-grade heat from any source is to achieve widespread use. Heating engineers are typically paid 3% of mechanical contracts, and it may be necessary to increase this in order to encourage the development of new ideas.

Walter Young stated that legislation governing the exploration and exploitation of geothermal resources in British Columbia had been tabled in the legislature on Monday 30 November, and he distributed copies. The legislation provides for permits for exploration on a tender and work - commitment basis, and for leases for production. The new act is similar to the oil and gas act.

Mr. Milligan, the project manager for the Mt. Meager operation, stated that B.C. Hydro is planning a 55 MW pilot plant on the south side of Mt. Meager. During the summer and autumn of 1981 a well had been drilled to a total depth of 3040 m. The well had been started vertically but had been deflected to the north, beneath the mountain, to a final deviation of 38° from the vertical. About 500 m of drill pipe had been lost in the bottom part of the hole, and the remainder had been completed with slotted casing. Bottom hole temperature had been observed to be 208°C, but this was expected to stabilise to within the range 250-280°C. The second well had been started 30 m from the first but was aimed in a different direction.

4. Future direction of projects

The University of Alberta hopes to be able to continue its current programmes, but it depends on funding from provincial and federal government contracts. It was agreed that this is a valuable data compilation and analysis programme and that every effort should be made to continue it and to keep the small geothermal team together.

The mapping of geothermal aquifers beneath the prairies is a very large undertaking and will take many years to complete. Guidance on geographical priorities and the level of detail required is needed from potential users.

H. Gorrell and John Sworder had examined the potential for use of geothermal heat in potash mines in Saskatchewan and for space-heat in Grande Prairie and Calgary. Their contracted study had also reviewed the current economics of installation and maps.

It was agreed that, because of the very large area and sparse population, guidance and focus is required by decisions on demonstration projects.

5. Possible demonstration projects

In response to the chairman's question of what kind of demonstration projects could be encouraged the following opinions were expressed:

-J. Sworder said that building heat was highly practical using low-temperature hardware. Input temperature needs to be below about 50°C for use with floor and ceiling heating panels.

-Refrigeration using lithium bromide solution requires input temperatures of 105°C to 140°C, and for lower temperatures an ammonia system needs to be developed.

-Binary electrical generating systems are expensive, but they might be useful in certain remote areas.

-L. Vigrass said that the proposal to replace the well for the heated swimming pool at Moose Jaw is being held up by the Government of Saskatchewan because they do not want two geothermal projects at the same time. This well produced water from Jurassic formations at about 37°C, to be mixed with surface water for the pool from 1928 to 1956. The logic of the provincial position is not understood.

-H. Gorrell said that southern Saskatchewan and northeastern British Columbia are particularly interesting and worthwhile areas to consider.

-W. Young said that he would like to see a demonstration project going in northeastern British Columbia. Water at about 95°C is being produced with gas in the Clark Lake gas field, and it can only be reinjected. Chemical content is similar to the Regina water.

-B. Hitchon suggested the Swann Hills area, where a pulp mill may be needed in the future.

-J. Kleta said that he would like to see application oriented research directed towards demonstration projects in developing communities, with the possibility of government assistance in the capital costs and risks involved.

6. Relations with Oil and Gas research

It was agreed that potential benefits to both sides will result from close contact between geothermal and hydrocarbon research and data compilation. However, it is difficult to find wells that are suitable for accurate temperature logging. B. Hitchon expressed the opinion that industry is interested in research and that it is up to this group to show how geothermal data and research is relevant to their needs.

7. Other business

W. Jones displayed a new EEC newsletter on geothermal matters, and the chairman agreed to circulate details with this record.

The Canadian Geothermal Resources Association was discussed briefly. It was agreed that the Association should remain a Canadian body, and affiliation with the Geological Association of Canada would be better than with the (U.S.) Geothermal Resources Council. The present executive should reactivate the association or give way to others who are prepared to do so.

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Appendix 2

Status of Projects in 1981-81

Project 1. Identification and assessment of geothermal resources in non-volanic terrain.	
1.1	Deep drilling in a Tertiary Basin - item abandoned because of lack of funds.
1.2	Shallow drilling in the interior of B.C. - work in progress. Contract has been let and drilling has started at sites most likely to be affected by winter weather after the new year. Expected final cost \$115,000
1.3	Pipe to preserve diamond drill holes as available - few opportunities arising this year. Expected final cost \$5,000
1.4	Geological and radiometric mapping of Coryell syenite - not possible to arrange contract.
1.5	Hydrological study of a Tertiary basin - contract let to University of Waterloo for study of White Lake Basin, and work in progress. Expected final cost \$12,000 DSS charges 5,000 Operating - travel to drilling sites, etc. \$10,000
	Total for project 1 \$147,000

Project 2. Identification and assessment of geothermal systems associated with recent volcanic activity.

- | | | | |
|------|--|---------------------|----------|
| 2.1 | Development of linear Scanning Electrode System (LSES)
- contract let and work completed | Expected final cost | \$63,000 |
| 2.2 | Alteration studies of core from Mt. Meager - work to be done in winter, but scope reduced. | Expected final cost | \$3,600 |
| 2.3 | Trace element analysis of core
- not possible to contract work | | |
| 2.4 | Resistivity measurement at Mt. Cayley using LSES
- item abandoned because of lack of funds. | | |
| 2.5 | Drilling for temp. gradient on Mt. Cayley
- extra funds provided by OERD for this project;
work completed. | Expected final cost | \$34,800 |
| 2.6 | Temperature logging associated with 2.5
- work completed | Expected final cost | \$4,300 |
| 2.7 | Geological and magnetic surveying of
Anaheim volcanic belt - work completed | final cost | \$23,300 |
| 2.8 | Logistic costs of 2.7 - included with 2.7 | | |
| 2.9 | Mercury survey in Anaheim volcanic belt
- work completed | final cost | \$8,100 |
| 2.10 | Resistivity measurements in Anaheim
volcanic belt using LSES - work completed | Expected final cost | \$49,900 |
| 2.11 | Seismic monitoring in Anaheim volcanic belt
- item abandoned | | |
| 2.12 | Multi-Frequency magnetotelluric survey in Anaheim
volcanic belt - item delayed to await equipment development | | |
| 2.13 | Potassium - Argon dating of volcanic centres
- contract let and work in progress. | Expected final cost | \$8,200 |
| 2.14 | Isotope tests of water samples
- no contract let in 1981-82 | | |

2.15	Drainage hydrology study in Garibaldi volcanic belt - no contract let in 1981-82	
	DSS charges	\$16,000
	Operating - travel to drill and field sites, etc.	\$18,700
	Total for project 2	\$230,000

Project 3. Geothermal energy from sedimentary basins.

3.1	Thermal conductivity of rock from western sedimentary basin - contract let and work in progress.	Expected final cost	\$32,000
3.2	Temperature logging at Regina or in oil exploration wells - item abandoned because of lack of funds		
3.3	Temperature data collection in Saskatchewan and British Columbia - contract let and work in progress		\$40,000
3.4	Reservoir mapping - item abandoned because of lack of funds.		
	DSS charges		\$6,000
	Operating - programme coordination travel, etc.		\$5,000
	Total for project 3		\$83,000

Project 4. Geothermal resources of the Atlantic Region

4.1	Analysis of airborne gamma-ray data - awaiting release of open file data	Expected final cost	\$700
4.2	Collection and acquisition of data - contract let, but opportunities are fewer than anticipated.	Expected final cost	\$43,000
4.3	Pipe to preserve holes - no opportunities arising		
4.4	Surface gamma-ray survey - sampling included in 4.2		
4.5	Hydrological study of Cumberland Basin - delayed because of lack of funds		
4.6	Rock fracture study - contract let and work in progress, but spread over two financial years.	Expected final cost in 1981-82	\$6,800
	DSS charges		\$4,000
	Operating - travel etc.		\$4,000
	Total for project 4		\$59,000

Summary

Expected expenditures:

Project 1	\$147,000
Project 2	\$230,000
Project 3	\$ 83,000
Project 4	\$ 59,000
Total	<u>\$519,000</u>

Funds available

Original Panel	\$360,000
NEP	\$ 98,000
FE to GSC Vancouver	\$ 50,000
FE from NRC	<u>\$ 7,000</u>
Total	\$515,000

Appendix 3

Projects planned for 1982-83

Project 1 - Identification and assessment of geothermal resources in
non-volcanic terrain

Project leader - T.J. Lewis

Items

1.1	Geological and radiometric mapping of Coryell syenite, contracted as a graduate student project	\$15,000
1.2	Gravity survey of the White Lake Basin	\$25,000
1.3	Shallow drilling; a continuation of the shallow-hole programme of 1981-82	\$50,000
	DSS overhead, 8 1/4% of contracts under \$50,000	
	4 1/4% of contracts of \$50,000	\$7,000
	Operating, including materials and supplies, travel etc.	<u>\$10,000</u>
	Total	\$107,000

Project 2 - Identification and assessment of geothermal systems associated with recent volcanic activity.

Project leader - J.G. Souther

Items

2.1	Drilling for temperature gradient at Mt. Cayley	\$50,000
2.2	Mercury and Arsenic trace-element survey around Mt. Cayley	\$20,000
2.3	E-Scan survey at Mt. Cayley	\$60,000
2.4	Multi-frequency magnetotelluric survey in Anaheim Volcanic Belt	\$40,000
2.5	Schlumberger resistivity survey in Ahaheim Volcanic Belt	\$10,000
2.6	Potassium - Argon dating of selected volcanic centres	\$10,000
2.7	Geological mapping at Mt. Meager	\$4,000
	DSS overhead 8 1/4% of contracts under \$50,000	\$11,000
	4 1/4% of contracts over \$50,000	<u>\$5,000</u>
	Total	<u>\$210,000</u>

Project 3 - Geothermal energy from sedimentary basins

Project leader - A.M. Jessop

Items

3.1	Temperature and net-rock data synthesis	\$40,000
3.2	Aquifer mapping	\$50,000
	DSS	\$5,000
	Operating, including programme coordination travel	<u>\$5,000</u>
	Total	\$100,000

Project 4 - Geothermal resources of the Atlantic region

Project leader - M.J. Drury

Items

4.1	Aquifer study of Cumberland Basin	\$15,000
4.2	Resistivity study of Cumberland Basin	\$32,000
4.3	Data collection continuation of present work	\$8,000
4.4	Drilling in anomalous granites	\$60,000
	DSS overheads	\$7,000
	Operating, travel etc.	<u>\$5,000</u>
	Total	\$127,000

Project 5 - Application and transfer of foreign technology

Project leader - Brian Larkin (National Research Council)

The items for this project have not yet been decided, since the major contract of 1981-82, with SNC Limited, is not yet completed.

Allocated funds \$100,000

Summary

Proposed Expenditures

Project 1	\$107,000
Project 2	\$210,000
Project 3	\$100,000
Project 4	\$127,000
Project 5	<u>\$100,000</u>
	\$644,000

Funds available

Continuing Panel	\$360,000
Inflationary Increase	\$28,000
Continuing NEP	\$98,000
New NEP	<u>\$145,000</u>
Total	\$611,000

The difference between the total proposed expenditures and the total funds available will be resolved by adjustments to the individual items of expenditure as contracts are let and other developments occur.

Several worthwhile items have been totally delayed or reduced in scope because they could not be fitted into the available budget, as follows:

Items reduced in scope owing to lack of funds.

Project 1
Shallow drilling reduced by \$50,000

Project 2
Schlumberger resistivity in Anaheim volcanic shelf reduced by \$40,000

Items delayed until later years

Project 1
Hydrology of White Lake Basin \$25,000

Project 2
Airborne electromagnetic survey \$35,000
Trace element survey of drill cores \$20,000

Project 3
Conductivity of sedimentary rocks \$35,000

Note added later - owing to the probably inability of Dr. Majorowicz to take a fellowship at University of Alberta, this last item may be able to replace item 3.1, but item 3.1 is still desirable and some other person may be found to do the work.