NATIONAL REPORT FOR CANADA

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ABSTRACT

Geothermal research and development in Canada in the years 1990 to 1994 has been at a very low level. Government have withdrawn and private industry has not generally been willing to take over. A small number of projects have been completed, and interest has been renewed in the Meager Mountain Volcanic Complex.

1. INTRODUCTION

Geothermal research and development in Canada has progressed at a slow pace in the years 1990 to 1994. The price of oil and natural gas has remained low, the general economy has been in recession, and both industry and governments have reduced research and exploration in order to reduce costs. With the exceptions of direct-use development at Springhill, Nova Scotia, and Carleton University, Ottawa, Ontario, no geothermal project was within easy reach of profitable development. In this economic climate the incentive to commit significant funds to work on the development of new forms of energy has been very small. However, a small number of projects have been progressing slowly, mainly based on initial work prior to 1986. The state of geothermal exploration was reviewed by Jessop et al. in 1991.

Historically, both governments and industry have sponsored research and exploration in geothermal energy. The role of each was drastically reduced between 1982 and 1986 and has not yet recovered.

2. PROVINCIAL GOVERNMENTS

Mineral resources in Canada are under the control of the provincial governments, which have the responsibility for legislation governing exploration and development of geothermal resources. Some provincial governments have geological surveys or the equivalent with the ability to perform research into geothermal resources.

Of the ten provinces, only British Columbia and Nova Scotia have enacted legislation concerned with geothermal energy. These actions have followed as a result of significant exploration and developments within the provinces, and the legislation reflects the nature of the resources. In British Columbia the resources are of high temperature and suitable for electrical generation. The act specifically excludes resources of temperature below 85°C, in order to avoid regulating hot spring resorts (Province of British Columbia, 1982). In Nova Scotia the resource is of low temperature and the use is for space heating. The act is designed to regulate such resources.

Only in these same two provinces has any significant technical work been done on the active projects. A groundwater and heat pump project is in operation in Ontario, and two geothermal wells are sitting idle at Moose Jaw Saskatchewan. These will be outlined in the project descriptions below.

3. FEDERAL GOVERNMENT

The policy of the Federal Government towards energy research changed drastically in 1986. The government elected in that year considered that all necessary research would be done by industry and that government participation was no longer needed. The Geothermal Energy Programme of the Department of Energy Mines and Resources was eliminated. Individual scientists retained an interest in a few projects that were in progress and could still profit from the limited assistance available. By 1994 activity at this level had disappeared. Of the five scientific leaders of the programme, three have now retired and the remaining two have been moved to other duties.

Within the last five years only projects at Springhill, Nova Scotia, and Summerland, British Columbia, have received assistance from federal scientists.

4. MUNICIPALITIES

From about 1980, local interest on the part of municipal governments prompted several attempts to develop geothermal resources on a local scale. In the last five years three projects have been active, at Springhill, Nova Scotia, Moose Jaw, Saskatchewan, and Summerland, British Columbia. All of these were begun prior to 1986, and all have now reached a conclusion. They are described below.

5. CORPORATE INDUSTRY

The largest geothermal project in Canada so far was undertaken by the British Columbia Hydro and Power Authority (B.C. Hydro) between 1974 and 1982. With the withdrawal of governments from geothermal research, any further advance is in the hands of private industry. The technical consultants are still in a position to continue the exploration that they undertook on behalf of B.C. Hydro and others, but there has been little attempt on the part of the energy-related corporations to take up the geothermal quest. In a time of recession and corporate staff reduction, ventures into a new energy source, generally unknown in Canada and perceived to be risky, have been few. The notable exceptions to this have been focused on the Meager Mountain Volcanic Complex, as described below.

6. SPRINGHILL, NOVA SCOTIA

The development of water from the old coal mines of Springhill is described elsewhere in this conference (Jessop, 1995). This was the last significant project started by the research team of the Federal Government before the cancellation of the programme in 1986, but it has been the most successful in terms of developed and profitable use of the geothermal resource. The Federal government sponsored the initial feasibility study, and the Government of Nova Scotia followed with financial assistance in the early wells and technical assistance in the location of the workings relative to the surface. The development of the resource in Springhill has been of great benefit to the industries in the town, and it is an excellent example of how very modest investment by governments can promote economic growth by the development of new technology.

The Springhill Geothermal Committee organised a two-day workshop in October 1992 to publicise their success (Katherine Arkay Consulting, 1993). An experimental review of abandoned mines in two provinces, Nova Scotia and Quebec, has also been completed (Katherine Arkay Consulting, 1995).

7. CARLETON UNIVERSITY, OTTAWA, ONTARIO

Carleton University uses water from sedimentary formations, produced at a temperature of 9.5°C, for heating and cooling of large buildings. The system commenced operation on 22 February 1990. It incorporates six heat pumps, with a total nominal output rating of 800 kW. Heating water is supplied to the buildings at 60 to 65°C. Initial estimates of annual cost savings to the university were $430,000.

8. MOOSE JAW, SASKATCHEWAN

The City of Moose Jaw is on the north side of the Williston Basin, which is a part of the Western Canada Sedimentary Basin. For many years the city had a swimming pool fed by warm water from an abandoned gas exploration well. When the well casing failed the city wished to replace it. A Feasibility study, funded by the Federal Government (Acres International Ltd, 1985) showed the options, not only for a restoration of the pool supply, but also for heating of large buildings in the city centre. Two wells were drilled, as a geothermal doublet, near the site of the old well. One of these was logged for temperature by the Geological Survey of Canada in 1991. Temperature in the producing formation was 51°C at a depth of 1300 m, and the formation pressure was sufficient to provide artesian flow. To date these wells have not been used for their intended purpose. At present there is a private company in the process of raising capital to rebuild the spa.

9. SUMMERLAND, BRITISH COLUMBIA

One of the main industries of Summerland is the growing of fruit and vegetables, both in orchards and under greenhouses. With low-temperature heating, greenhouses can operate in all but the months of mid-winter, when natural light is insufficient. The town of Summerland is above the caldera of an old volcano, there is generally high geothermal gradient throughout the region, and it was believed that the sediments within the caldera could hold an adequate water reservoir in the clastic formation at the base of the Tertiary sequence. Federal and provincial governments combined to provide funding for an exploratory well on the edge of town, near a major greenhouse complex. The well was drilled to a total depth of 956 m, where the temperature was 41°C, but the succession of volcanic flow rocks of low porosity was much thicker than expected and the reservoir rocks were not found. With this depth of drilling the project is unlikely to be economic, although the temperature at the final depth would be quite adequate for the purpose of greenhouse heating. Progress has been reported by Jessop and Church (1991).

10. MEAGER MOUNTAIN, BRITISH COLUMBIA

The Meager Mountain volcanic complex, 160 km north of Vancouver, British Columbia, was the scene of a major exploration effort from 1974 to 1982. This activity culminated in the drilling of three exploratory wells to depths of 3000 m. The experience derived from this work has been summarised by Nevin (1992), who showed the major influence of political and economic factors on the progress of the work, including the termination in 1982 of the participation of the British Columbia Hydro and Power Authority (BC Hydro). The work of 1974-1982 showed conclusively that there is a geothermal reservoir of temperatures in excess of 250°C on the south side of Meager Mountain. At the same time exploration showed the probability of a similar reservoir on the northeast side.

For several years after 1982 there was no further activity at Meager Mountain, since within British Columbia only BC Hydro could produce electrical power. In 1988 POWEREX was incorporated as a subsidiary of BC Hydro. This provided a means of exporting power to the USA. In 1989 BC Hydro implemented a plan to purchase power from independent power producers. These two innovations allowed geothermal resources to compete as energy sources.

Because of these changes in the regulatory structures, interest in geothermal energy has revived, and two sites have been leased for exploration. One is the original site on the south side of Meager Mountain, in the Meager Creek Valley. The other is on the northeast side of the mountain, in the Valley of the Lillooet River. This site takes its name from a tributary called Pebble Creek.

At Meager Creek the geothermal prospect was leased from the province by Canadian Crew Energy Corporation in 1987. Detailed examination of the accumulated data and planning for further testing of the existing wells and further exploratory drilling have taken place, pending the acquisition of drilling permits. The three deep wells are now twelve years old, they were badly completed, and the reservoir was not fully tested (Nevin, 1992). New production wells will probably be needed.

At Pebble Andrew E. Nevin and Associates, of San Francisco, acquired a geothermal permit for exploration on the Pebble Creek prospect. In this area the exploration of 1974-1982 did not progress to the point of deep wells. However, the accumulated data indicate that the reservoir is probably as hot as the proven reservoir below the Meager Creek Valley. Since the host rocks are greenstone schist and phyllite, the reservoir permeability should be much higher than that of the granodiorite of the Meager Creek valley, where porosity depends on fractures. The capacity of the geothermal system has not been measured and the site is relatively remote. Progress in the next few years will depend on the funds available for new geophysical studies, access improvement and slim-hole drilling to confirm the reservoir. With favourable technical results and economic factors a pilot plant of 10 MW will be built, followed by a working plant of 100 MW (Andrew E.Nevin and Associates, 1993).

Since the decline in oil prices geothermal resources in the Canadian Cordillera have been forgotten by all but a few. However, the geothermal resources are still there, and as economic factors change these reservoirs will provide an optional source.

11. CONCLUSIONS

Following the exciting days of 1974 to 1986, geothermal research and development has been at a very low level in Canada recently. The low price of oil and natural gas, an extended recession, and governments forced to concentrate on correcting the economic mistakes of the past rather than promoting the economic health of the future have combined to eliminate research into new energy sources. The same factors have forced industry to reduce staff and to focus on the old established methods, rather than risk the expense of innovative work that will produce profits in an unpredictable future.

Geothermal research and development in Canada is likely to remain at a low level for the next few years, until the present economic situation, in Canada and the rest of the developed world, is able to generate optimism and enthusiasm for new ventures.

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TABLE 1. PRESENT AND PLANNED PRODUCTION OF ELECTRICITY

	Geothermal		Fossil Fuels		Hydro		Nuclear		Total	
	Capacity MW$_e$	Gross Prod. GWh/yr	Capacity MW$_e$	Gross Prod. GWh/yr	Capacity MW$_e$	Gross Prod. GWh/yr	Capacity MW$_e$	Gross Prod. GWh/yr	Capacity MW$_e$	Gross Prod. GWh/yr
In operation in January 1995	0	0		113 x10^3		317 x10^3		82 x10^3		512 x10^3
Under construction in January 1995	0	0								
Funds committed, but not yet under construction in January 1995										
Total projected use by 2000	70	570								

TABLE 3. UTILIZATION OF GEOTHERMAL ENERGY FOR DIRECT HEAT IN DECEMBER 1994

1) I = Industrial process heat; C = Air conditioning; A = Agricultural drying; F = Fish and other animal farming; S = Snow melting; D = Space heating; B = Bathing and swimming; G = Greenhouses; O = Other (please specify by footnote)

2) Enthalpy information is given only if there is steam or two-phase flow

3) Energy use (TJ/yr) = Annual average water flow rate (kg/s) x [Inlet temp.(°C) - Outlet temp.(°C)] x 0.1319

Locality	Type[1]	Maximum Utilization					Annual Utilization		
		Flow Rate	Temperature (°C)		Enthalpy[2] (kJ/kg)		Average Flow Rate	Energy Use[3]	Load Factor
		kg/s	Inlet	Outlet	Inlet	Outlet	kg/s	TJ/yr	
Springhill Nova Scotia	D	20	18	28			20	26	
	C	20	18	10			20	-21	

TABLE 5. GEOTHERMAL HEAT PUMPS

1) Thermal energy used (TJ/yr)
= Annual average geothermal water flow rate (kg/s) x [Inlet temp.(°C) - Outlet temp.(°C)] x 0.1319

Locality	Heat Source °C	COP - Factor	Heat Pump Rating MW$_t$ (Output)	Thermal Energy Used in Heating Mode[1] TJ/yr
Springhill Nova Scotia	18	3.6		26

TABLE 4. SUMMARY TABLE OF GEOTHERMAL DIRECT HEAT USES

[1] Inst. thermal power (MW_t) = Max. water flow rate (kg/s) x [Inlet temp.(°C) - Outlet temp.(°C)] x 0.004184

[2] Energy use (TJ/yr) = Annual average water flow rate (kg/s) x [Inlet temp.(°C) - Outlet temp.(°C)] x 0.1319

	Installed Thermal Power[1] MW_t	Energy Use[2] TJ/yr
Space heating		26
Bathing and swimming		unknown
Agricultural drying		
Greenhouses		
Fish and other animal farming		
Industrial process heat		
Snow melting		
Air conditioning		21
Other uses (specify)		
Subtotal		
Heat Pumps		
Total		

TABLE 6. INFORMATION ABOUT GEOTHERMAL LOCALITIES

[1] Main type of reservoir rock

[2] Total dissolved solids (TDS) in water before flashing. Put v for vapor dominated

[3] N = Identified geothermal locality, but no assessment information available
R = Regional assessment
P = Pre-feasability studies
F = Feasability studies (Reservoir evaluation and Engineering studies)
U = Commercial utilization

Locality	Location To Nearest 0.5 Degree		Reservoir		Status[3] in January 1995	Reservoir Temp. (°C)	
	Latitude	Longitude	Rock[1]	Dissolved Solids[2] mg/kg		Estimated	Measured
Springhill Nova Scotia	45.5N	64.0W	coal mines		U	18	18
Meager Creek British Columbia	50.5N	123.5W	granodioite	4500	F	290	272
Pebble Creek British Columbia	50.5N	123.5W	schist & phyllite	2000	P	270	

TABLE 7. WELLS DRILLED FOR ELECTRICAL AND COMBINED USE OF GEOTHERMAL RESOURCES FROM JANUARY 1, 1990 TO DECEMBER 31, 1994
(Do not include thermal gradient wells less than 100 m deep)

[1] Type or purpose of well

T = Thermal gradient or other scientific purpose
E = Exploration
P = Production
I = Injection
C = Combined electrical and direct use

[2] Total flow rate at given wellhead pressure (WHP)

Locality	Year Drilled	Well Number	Type of Well[1]	Total Depth	Max. Temp.	Fluid Enthalpy	Well Output[2]	
				m	°C	kJ/kg	Flow Rate kg/s	WHP bar
NONE								

TABLE 8. WELLS DRILLED FOR DIRECT HEAT UTILIZATION OF GEOTHERMAL RESOURCES FROM JANUARY 1, 1990 TO DECEMBER 31, 1994
(Do not include thermal gradient wells less than 100 m deep)

[1] Type or purpose of well and manner of production
Use one symbol from colomn (a) and one from column (b)

(a)	(b)
T = Thermal gradient or other scientific purpose	A = Artesian
E = Exploration	P = Pumped
P = Production	F = Flashing
I = Injection	

[2] Total flow rate at given wellhead pressure (WHP)

Locality	Year Drilled	Well Number	Type of Well[1]	Total Depth	Max. Temp.	Fluid Enthalpy	Well Output[2]	
				m	°C	kJ/kg	Flow Rate kg/s	WHP bar
Springhill Nova Scotia		several	P		19			
Summerland British Columbia	1992	1	E	940	41	--	0	--

TABLE 9. ALLOCATION OF PROFESSIONAL PERSONNEL TO GEOTHERMAL ACTIVITIES (Restricted to personnel with a University degree)

(1) Government
(2) Public Utilities
(3) Universities
(4) Paid Foreign Consultants
(5) Contributed Through Foreign Aid Programs
(6) Private Industriy

Year	Professional Man Years of Effort					
	(1)	(2)	(3)	(4)	(5)	(6)
1990	0.5	-	-	-	-	0.5
1991	0.5	-	-	-	-	0.5
1992	0.5	-	-	-	-	0.5
1993	-	-	-	0.2	-	2.5
1994	-	-	0.25	0.6	-	4.5

TABLE 10. TOTAL INVESTMENTS IN GEOTHERMAL IN (1994)US$

Period	Research & Development Incl. Surf. Exp. & Exp. Drilling	Field Development Incl. Prod. Drilling & Surf. Equipment	Utilization		Funding Type	
	Million US$	Million US$	Direct Million US$	Electrical Million US$	Private %	Public %
1975 - 1984	30	-	5	5	-	100
1985 - 1994	1.7	0.2	-	-	98	2