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GEOTHERMAL RESOURCE ASSESSMENT OF ATLANTIC CANADA: PROGRESS REPORT, 1983-1984

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The programme for the assessment of the geothermal energy potential of Atlantic Canada is now in its fifth year. Most of the work - the compilation of existing data, the acquisition of new data on an opportunity basis, and the interpretation of the amassed data base has been substantially completed. In 1982 the programme entered its final phase, that of generating new data at specific targets of interest, at considerably greater cost than earlier phases. In 1983 the various earth science projects were, with the exception of a small data-compilation continuation contract, all site- or area-specific. A test hole was drilled on the campus of the University of Prince Edward Island in Charlottetown, a magneto-telluric survey was conducted across P.E.I., and hydrological studies of two small sedimentary basins were undertaken, in New Brunswick and in Nova Scotia. This report summarises the results obtained. Some work recently completed is also briefly discussed.

Prince Edward Island

Fig.1 is a map of Prince Edward Island to show the locations of boreholes from which data have been obtained to date. Most of the temperature data are single bottom-hole data of varying but unknown quality. Temperature gradients indicated by such data are given in parenthesis, the surface temperature having been assumed to be 6°C. High quality data have been obtained by logging boreholes at some locations; gradients derived from these data are shown without parentheses. Temperature gradients across the island are generally very low, with only one value being apparently higher than 25°C, a value near MacDougall to the north-west of Summerside. This is derived from a single bottom-hole temperature. Note that the location of this hole was incorrectly plotted in Drury (1983). Further, in the light of a better estimate of surface temperature, it has ben revised.

Lithological sections are also shown in Fig. 1 for some wells. Sequences are generally shales and sandstones. Depth to Carboniferous basement decreases significantly from east to west, from about 9000m to about 4000m (see map in Drury 1983). In the western part of the island a gravity high, striking north-east to south-west (Garland 1953) is associated with a basement uplift and with the occurrence of volcanic sequences at depths of 1500 to 2500m. The only mapped surface expression of the volcanics is a tholeiitic diabase, dated at 210+/-30Ma (Prest 1972), in the north-west of the Province, and close to the gravity high (Fig. 1).

1. Drilling project

A hole was diamond-drilled and fully cored to a depth of 485m on the campus of U.P.E.I. in October 1983. The drilling had not been considered in the previous geothermal planning meeting, but it was undertaken in response to a request for funding by Noval Technologies Ltd. (now Novacorp International Consulting Ltd.) of Halifax for a proposed 2000m well to provide hot water

for heating a new veterinary college on the campus. It was the author's opinion that the potential for such space-heating at Charlottetown was minimal; available data indicated an average temperature gradient on P.E.I. of 17mK/m (Fig. 1). The University administration, including its president, was keenly interested in the proposal. The author felt that because there was interest, with a potential market in an area where the need for alternative energy resources is obvious, a relatively cheap drilling project to obtain accurate temperature data was warranted.

The hole was drilled by Logan Drilling Ltd. and successive temperature logs were run by John A. Leslie and Assocs., Ltd. Complete details of the project are to be found in the final report by Leslie (1983). The measured gradient is low, 14mK/m, and it is therefore inappropriate to consider further work at the site, at least regarding large-scale space heating. The gradient is significantly lower, in fact, than the average gradient on the island. This probably reflects the thermal refraction effect of a large salt dome centred in Hillsborough Bay.

2. Magneto-telluric survey

In order to obtain a better understanding of the structure of the sediments of P.E.I. a magneto-telluric survey was performed by the University of Toronto, under a contract managed by Dr. E. R. Niblett and funded from the Atlantic region project of the geothermal programme. The survey profile was designed to provide information on the variation of sediment thickness, the potential for regional water flow, and to refine ideas concerning the gravity high in the western part of the island. A report on the results was submitted by Jones and Garland (1984). Their conclusions can be summarised as follows:

i) There is a moderately resistive layer beneath the whole of the island to a depth of approximately 200-400m.

ii) There is a low resistivity layer extending to depths of 1500-3000m beneath the whole of the island. Its resistivity (10 ohm m) is consistent with its being a shale layer.

iii) Beneath the shale zone in the western part of the island there is a zone that is electrically anisotropic. It is probably composed of volcanic/intrusive rock.

iv) The transition laterally from the volcanics to the sub-shale sediments occurs approximately along the axis shown in Fig. 1.

3. Recent work

Further work has been undertaken on P.E.I. in 1984. A 450m borehole was drilled in October near the location of the MacDougall well that indicated a higher than average gradient. Initial logs indicate a gradient of only 14mK/m. It had been thought that the apparently high gradient might be the result of the migration of water from great depth in the east up the contact with the volcanics. If this were so then some areas of the island above the axis of the intrusives might have a reasonable geothermal potential. Population density in the rural area is very low, so that residential space-heating was not being considered seriously, but it had been hoped

that there might be some potential for agricultural processing, for example. The new results considerably dim this optimism, and it appears that the geothermal potential of P.E.I. must be considered to be very low. The utilisation of heat pump technology and relatively low temperature groundwater should not, however, be dismissed.

A further magneto-telluric survey was carried out in the summer of 1984, with the aim of filling in some detail of the extent of the intrusives and gravity high. A station was also occupied in the Magdalen Islands. The work was performed in-house and again funded from the Atlantic region geothermal project. The data have not yet been fully analysed.

Nova Scotia

A larger number of high quality temperature data have been obtained for both Nova Scotia and New Brunswick than for Prince Edward Island (Drury 1983), which has enabled the selection of specific target areas for more detailed study. In Nova Scotia detailed temperature logs have consistently indicated gradients of 29-32mK/m in the Pictou Basin, a fault-bounded sub-basin that contains up to 2600m of Carboniferous sediments. The area contains the towns of New Glasgow, Stellarton and Westville. Possible markets for geothermal energy include Acadia University, Trenton airport, commercial and municipal buildings and agricultural processing. Detailed temperature data were obtained mainly from holes drilled during a major coal demethanation project by Noval Technologies Ltd. of Halifax. Without their cooperation and encouragement the data that led to the further consideration of the area would not have ben obtained. Unfortunately, little was known of the hydrogeology of the basin. Consequently a contract was awarded, on the basis of competitive bids, to Nolan,Davis and Associates Ltd. of Halifax to undertake a study of the hydrogeological nature of the basin. The contract called for the following:

i) identification of areas of groundwater recharge and discharge
ii) identification of potential aquifers providing water at the rate of approximately 100m^3/h
iii) information on water chemistry
iv) understanding of regional hydrological flow patterns, both at intermediate depths (up to 1500m) and deeper.

A report was prepared and submitted. Its conclusions can be summarised as follows.

The area of interest lies within the Late Carboniferous Stellarton Group graben composed of fluvial interbedded shale, siltstone, coal and sandstone units. Two distinct groundwaters were identified, a shallow system of young meteoric origin, and an older, deeper system of less distinct origin. Within the graben both systems are expected to migrate down-dip towards the north-east, with shale units acting as effective aquitards, particularly at depth. Numerous structural features

surrounding and within the graben will, however, have an impact on the flow patterns. Such features probably short-circuit movement along bedding planes, and also act as conduits for groundwater recharge and discharge. Thick, highly fractured sandstone units at depth are likely to present the best geothermal targets within the Stellarton Group, although yields are not expected to exceed about 10m^3/h from 30m thickness of a saturated unit.

Recently an unsolicited proposal has been received from a combination of Novacorp International Consulting Ltd./Nolan, Davis and Assocs. Ltd. to undertake a preliminary study of the potential markets for geothermal energy in the area. A requisition has been prepared to fund such a study, in the hope that a final report will be available by the end of February 1985.

New Brunswick

Temperature data acquired during field work by Drury and Jessop and under previous contracts has indicated a temperature gradient in the Fredericton Basin of New Brunswick of ca. 26-27mK/m (e.g. Drury 1983). The city of Fredericton and the communities of Oromocto, Tracy, Fredericton Junction and Gagetown are located within the area of the basin. Possible markets include federal, provincial and municipal offices in Fredericton, the University of New Brunswick, and perhaps C.F.B. Gagetown. Agricultural processing and fish farming are also carried out in the area. Considering the area to have both a potential resource and potential markets for geothermal energy, the author felt that a hydrogeological study similar to the one carried out in Nova Scotia was required. A contract was awarded, after competitive bidding, to Water Management Services Ltd. of Fredericton. Terms of reference were essentially the same as those for the Nova Scotian study. A report was received and subsequently released (Water Management Services, 1984). Its conclusions can be summarised as follows:

i) The sediments of the Fredericton Basin range in age from Pennsylvanian to Mississippian.
ii) The principal structural feature is the Fredericton graben, a down-faulted block that occupies the north-west quadrant of the basin.
iii) The sub-basin displays no large identifiable aquifers. On a large scale, however, hydraulic continuity between sequences that are of limited areal extent exists.
iv) Groundwater flow directions are north-eastward and eastward.
v) Potential aquifers are in the Lower Pennsylvanian and Upper Mississippian sediments.Potential flow rates are expected to be in the range 14-28m^3/h.

In the summer of 1984 an in-house magneto-telluric survey was carried out across the Fredericton basin in an attempt to gain better information on its structure. Analysis of the data has not yet been done.

Other work

Some other avenues are being explored in the utilisation potential in Atlantic Canada. The author has had two enquiries concerning the feasibility of fish-farming using geothermal waters, and in conjunction with B. Larkin of N.R.C. the possibility of using geothermal water for mine air heating in potash mines of New Brunswick is being considered. Larkin has already had a contracted study of the economic viability of geothermal energy in Atlantic Canada performed (Acres Consulting Services Ltd. 1984). This kind of work is seen as the next stage in the Atlantic geothermal programme, although the resources assessment work is not complete. With the cut in the geothermal R&D budget, it is currently anticipated that establishment of demonstration projects will be the major constituent of future work.

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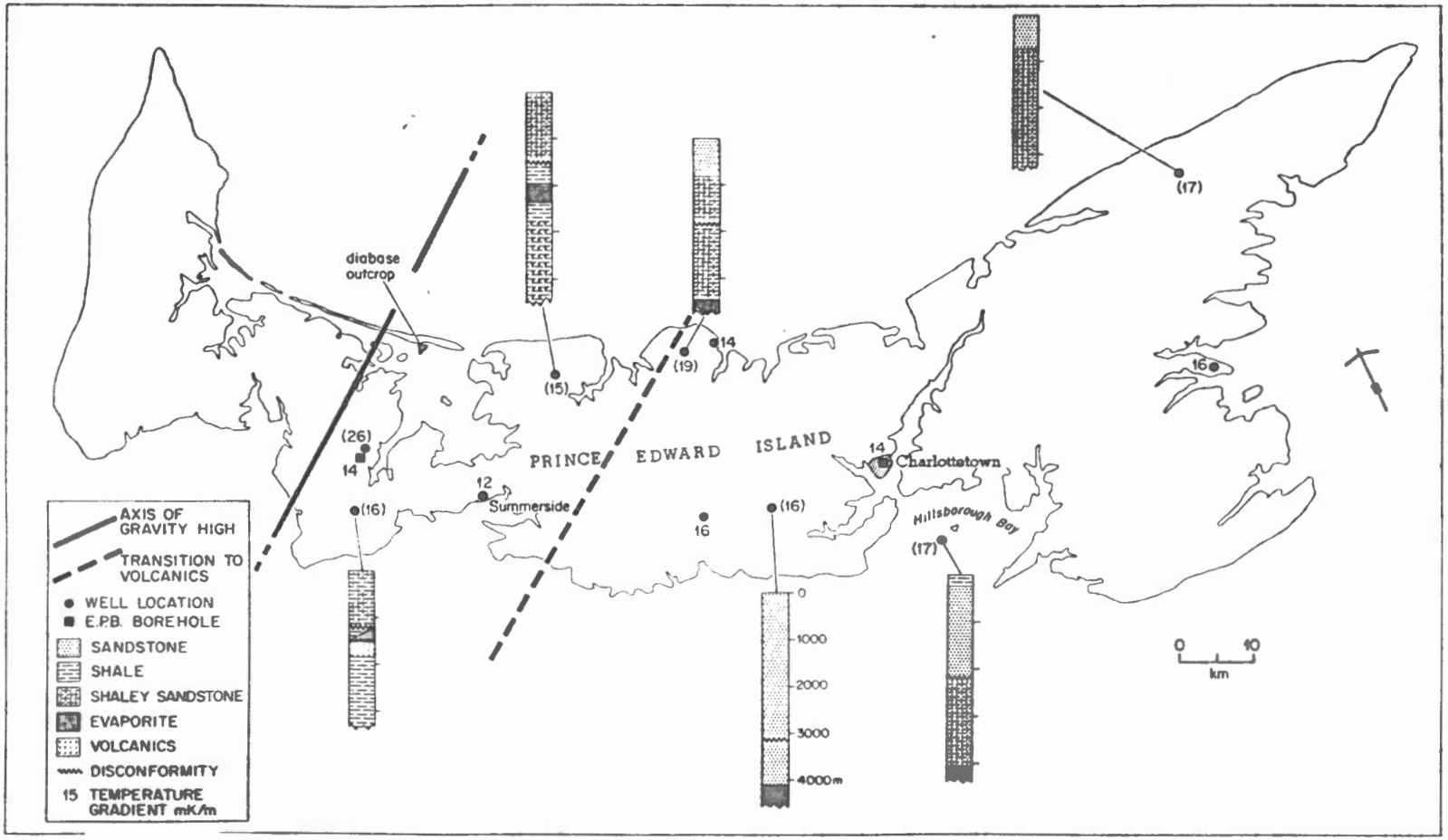

Figure 1. Location of boreholes on Prince Edward Island from which temperature data have been obtained. Temperature gradients are indicated; those in parentheses are from bottom-hole temperature data, the others are from accurate temperature logs. Axis of gravity high is indicated by solid line. Approximate lateral transition from volcanics to sub-shale sediments shown as dashed line. Lithological data for some of the holes are also shown.