Université d'Ottawa · University of Ottawa
Institut de l'environnement   Institute of the Environment

Ms. Elizabeth Dowdswell
President
Nuclear Waste Management Organization
49 Jackes Avenue
Toronto, ON M4T 1E2

June 20, 2005

Dear Elizabeth,

Thank you for sending us your report, <u>Choosing a way forward</u>, and the covering letters. We were very pleased to hear from you. The report makes most interesting reading and practically leaves no stone unturned. We are impressed by your thorough evaluation of the three options you identified previously, and your new Adaptive Phase Management recommendation. Your work is particularly significant, thorough and most helpful in the search for a successful solution to the waste problem.

The report as published does not seem to take into account the proposal we made to you in May. Possibly it arrived too late. Our proposal -- we might add -- is mainly based on very many studies in the area of geology although only a few are referred to in our list of references. We note that although the Act requires you to study each of the three approaches on which you have focused, yet it does not prevent you from considering other approaches. We would like therefore to bring to your attention our option, based on geological observations on which your advisers and we differ. To begin with, we cannot agree with the concept of "deep burial" in Precambrian Granite. Instead we suggest that nuclear waste be stored at four major reactor sites (Pickering and Darlington viewed as one), at a depth of 100 to 200 meters. The storage sites would necessarily be located in sedimentary rock, mainly limestone on shale, not granite. We use the term "storage", but with the addition of a clay barrier, the sites could become final disposal sites, if so decided in future.

Our proposal bears some resemblance to Option 2 (storage at nuclear reactor sites), but the words in the report "at or just below surface," (page 54) are far too vague. We gather, and have to assume, that by "just below" it means 10 to 20 meters, not 100 to 200 meters. At Pickering, unconsolidated sediment (soil), is found at a depth of 10 to 20 meters, and bedrock at 25 meters (our reference 8). In a time duration of 60.000 years, this thickness of unconsolidated sediment could be easily eroded away, whereas bedrock erosion would be measured in centimeters. Hence the most critical comments presently directed at Option 2 do not apply to storage in bedrock at 100 to 200 meters. For

555, rue King-Edward C.P. 450, Succ. A
Ottawa (Ontario) K1N 6N5 Canada
555 King Edward St., P.O. Box 450, Stn. A
Ottawa, Ontario K1N 6N5 Canada
(613) 562-5895 • Téléc./Fax (613) 562-5873

example: volumes of rock at 100 to 200 meters are well below the groundwater table, and would be little affected by changes in the level of oceans, rivers, and lakes. For these reasons our proposal actually stands alone (figure 1) and, we suggest, ought to be brought to the public, for further study, review, evaluation and critique.

We come now to the social dimension of the problem. Burial near the reactors site, while more expensive, is by far preferable to burial near remote communities, likely in the vicinity of Aboriginal lands. In addition, the effect on land values within a large radius could be quite negative, while it is hard to imagine the effect on attracting future investments to the chosen community. Then there is the well-known issue of transport. Moving some 1.8 million bundles through many communities in order to reach final destination could result in a political nightmare. Every MP, MPP and town council would be up in arms and eager to go on record as opposed to nuclear waste transport through their constituencies. The longer the distance, the greater the indignation. By contrast, burial near a reactor site should generate very little, if any, social and political friction because the affected communities have already learnt to live with and accept the problem of having to live with nuclear waste in their respective neighbourhoods.

A few observations flowing from the Citizens' Dialogue on the long-term management of used nuclear fuel might be appropriate at this point. We are indebted to the Canadian Policy Research Networks for the following passage we found on page 18 of their report entitled <u>Citizens' Dialogue on the long term management of used nuclear fuel</u>: "....(Citizens) want to learn from the past and not make decisions that could have a long-term negative impact. They are not prepared to make irreversible decisions that will constrain future generations." This ethical position could be interpreted to mean many things, in the search for the optimal option: (a) ruling out what are today remote locations for burial because they could become inhabited areas in the long-run; (b) ruling out the production of nuclear waste in future, so as to prevent the repetition of the problem posed by the accumulation of new nuclear waste; (c) ruling out any proposed solution that would inhibit access to the stored used fuel, or put the other way, keep the used fuel accessible; (d) provide monitoring, adjustment and evaluation at every step of the process. It may also mean choosing an option that one day would allow -- should an appropriate technology be found -- the re-use of the used uranium. We found the Citizens' Dialogue thought provoking and most helpful, worthy of further discussion.

Finally we have the issue of Aboriginal people, the sanctity of their burial lands, and the very probable rejection of any option which would lead to burial near their vicinity. In view of the Manitoba legislation denying acceptance of nuclear waste in that province, it is very unlikely Chief Phil Fontaine of the Assembly of First Nations would support any option which would recommend burial near native lands. The political consequences of acceptance would be disastrous for any elected chief. However, we could be wrong in this assessment and therefore consultations with people at the Assembly of First Nations in Ottawa would be most desirable, before presenting the final report to the Minister. I am sure you have already given thought to this dimension of the problem.

Before concluding, we would like to thank you for the invitation to the public consultation in Toronto. Mid July is a difficult time for us and therefore we are unable to participate, regretfully so, but in August or September, we would be glad to go into greater depth in the examination of option, here attached for your consideration. We are strongly motivated in helping you to find a solution which will be socially and politically acceptable, and at the same time workable. To this end we are ready to offer every possible assistance in the search of the best option.

With kind regards and best wishes,

Sincerely,

Ralph Kretz
Professor of geology (retired)
University of Ottawa

Charles
Charles Caccia, Senior Fellow
Institute of the Environment
University of Ottawa

enclosure

RECEIVED Jun 22/05

Revised June 2005

An alternative to "Choosing a way Forward":

Storage of nuclear waste near four major reactor sites, at a depth of 150 metres.

"The containment of radioactive wastes ... is the greatest responsibility ever consciously undertaken by the human species"

(from Shrader-Frechette, K.S. 1993. Burying uncertainty. U. Calif. Press, Berkeley.)

We propose that nuclear waste in Canada be stored at a depth of 100 to 200 metres at four reactor sites (Figure 1). The proposal is based on the following considerations, which form a critique of the concept of deep burial in Precambrian granite, that is recommended by the Nuclear Waste Management Organization (Ref. 6).

a) Given that nuclear wastes remain highly toxic for thousands of years (Figure 2), the dispersal of these materials by natural or human events is a major concern. The occurrence of such events would be less likely, should the wastes be placed at depth rather than at Earth's surface. A moderate depth of 100 to 200 metres would suffice, and at the same time create a natural shield to the ionizing radiation that is produced by the wastes.

b) One argument in favour of deep storage (500 to 1000 m) is that conditions of low fracture density, and hence low groundwater permeability, occur more frequently than at shallow depths. But data from mines and drill holes indicate that fractures do occur at depths in excess of one kilometre (Figure 3). Moreover, unpredictable rapid and slow Earth movements in the future could cause additional fracturing. Although the flow of groundwater is, in general, greater at shallow depths (Figure 4) it is well known that groundwater is capable of penetrating to depths of several kilometres, before re-emerging at the surface.

c) For deep storage, scientists at AECL (Ref. 4, p.7) favour a "plutonic" rock, presumably granite. It is unclear why this rock is preferred; it consists mainly of minerals with a low ion-exchange capacity, relative to clay and other minerals found in shale and impure limestone.

d) The argument for storage at a "remote" site (Ref. 5, p. 49, 58) is not clear. A site that is remote to-day may not be remote 10 000 years from now. Humans and all other living objects in remote places should not be exposed to greater risk than those elsewhere.

e) People have expressed concern regarding the transport of nuclear waste through their communities, from existing reactors to a site that will be chosen for deep burial (Ref. 5).

f) Storage in bedrock at 100 - 200 m has technical advantages over deep storage. For example, heat generated by the wastes would escape more readily, and the wastes could be more easily monitored and retrieved.

The proposal is as follows.

On-site surface storage (as at present) to continue for possibly 100 years, providing time for the emergence of new knowledge that is capable of making the waste less harmful.

2. Provided that no new knowledge is forthcoming, burial at approximately 150 m will proceed at four sites, Pickering (or Darlington), Bruce, Gentilly, and Point Lapreau. At Pickering, Bruce, and Gentilly, the storage sites would be in limestone or shale, at Point Lapreau, in shale or sandstone (Ref. 7). (A drill hole 1 km from the reactors at Pickering encountered limestone and shale at 100 to 200 m (Ref. 8)). Waste from Whiteshell and Chalk River (Figure 5) is transported to Pickering or Bruce, both of which lie outside of a major earthquake zone (Appendix 4).

3. Aboriginal People and their land would not be disturbed. Transport through communities would be minimal. Political acceptance of this proposed solution would be higher.

In conclusion, the principal advantages of this proposal are that little transport of waste is needed, social impact will be minimal, and monitoring far into the future can take place easily and regularly.

C. Caccia
Senior Fellow
Institute for the Environment
University of Ottawa

R. Kretz
Former Professor of Geology
Faculty of Science
University of Ottawa

References

1. WILES, D.R. (2002). The chemistry of nuclear fuel waste disposal. Int. Press, Montreal.
2. STONE, D. *et al.* (1989). A comparison of fracture styles in two granite bodies of the Superior Province. *Can. J. Earth Sci.* **26**, 387-403.
3. CHERRY, J.A. & GALE, J.E. (1979). The Canadian program for a high-level radioactive waste repository: a hydrogeological perspective. *In*, Disposal of high-level radioactive waste: The Canadian Geoscience Program (C.R. Barnes, ed.) Geol. Surv. Canada, Paper **79-10**.
4. AECL (1994). Summary of the environmental impact statement on the concept for disposal of Canada's nuclear fuel waste. AECL-**10721**, COG-**93-11**.
5. Nuclear Waste Management Organization (2004). Understanding the Choices; The future management of Canada's used nuclear fuel.
6. ________________________________ (2005). Choosing a way forward: The future management of Canada's used nuclear fuel.
7. Geological maps issued by the Provinces of Ontario, Québec, and New Brunswick.
8. JOHNSON, M.D. (1983). Deep drilling results 1982-1983, Toronto Region. Ontario Geological Survey, Open File Report **5477**. (Drill hole 83-3 Pickering reached Precambrian basement at a depth of 236 metres.)
9. _______________ *et al.* (1992). Paleozoic and Mesozoic Geology of Ontario. *In*, Geology of Ontario (P.C. THURSTON *et al.*). Ontario Geological Survey V. **4**.
10. AGGARWAL, Y.P. & SYKES, L.R. (1978). Earthquakes, faults, and nuclear power plants in southern New York and Northern New Jersey. *Science* **200**, 425-429.

Figure 1. Choices for the storage of nuclear waste

	Geographic Location (x,y)	
Depth (z)	At reactor sites	At a central locale
Surface or "just below"*	NWMO 2* (each site)	NWMO 3*
100 - 200 m	The present proposal (four sites)	
500 - 1000 m		NWMO 1*

* : Nuclear Waste Management Organization (Ref. 6, p. 51-57).
An additional variable is duration of time (t) in temporary surface storage.

Figure 2. Decay curve of the radionuclides in used fuel (Ref. 1)

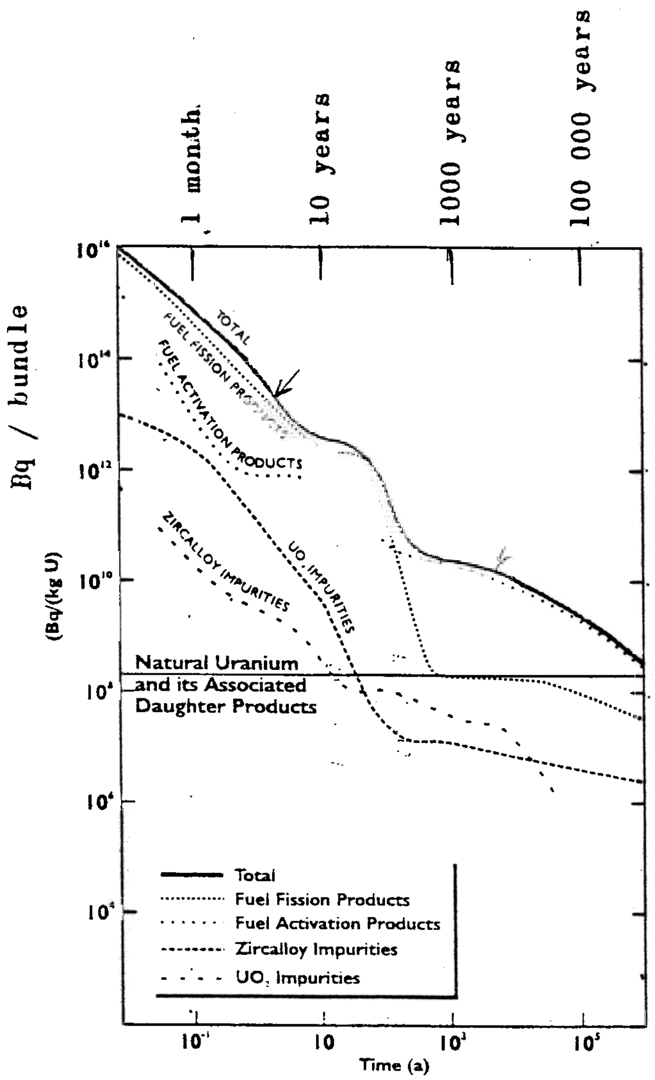


Figure 3. Fracture frequency in granite, with depth (Ref. 2)

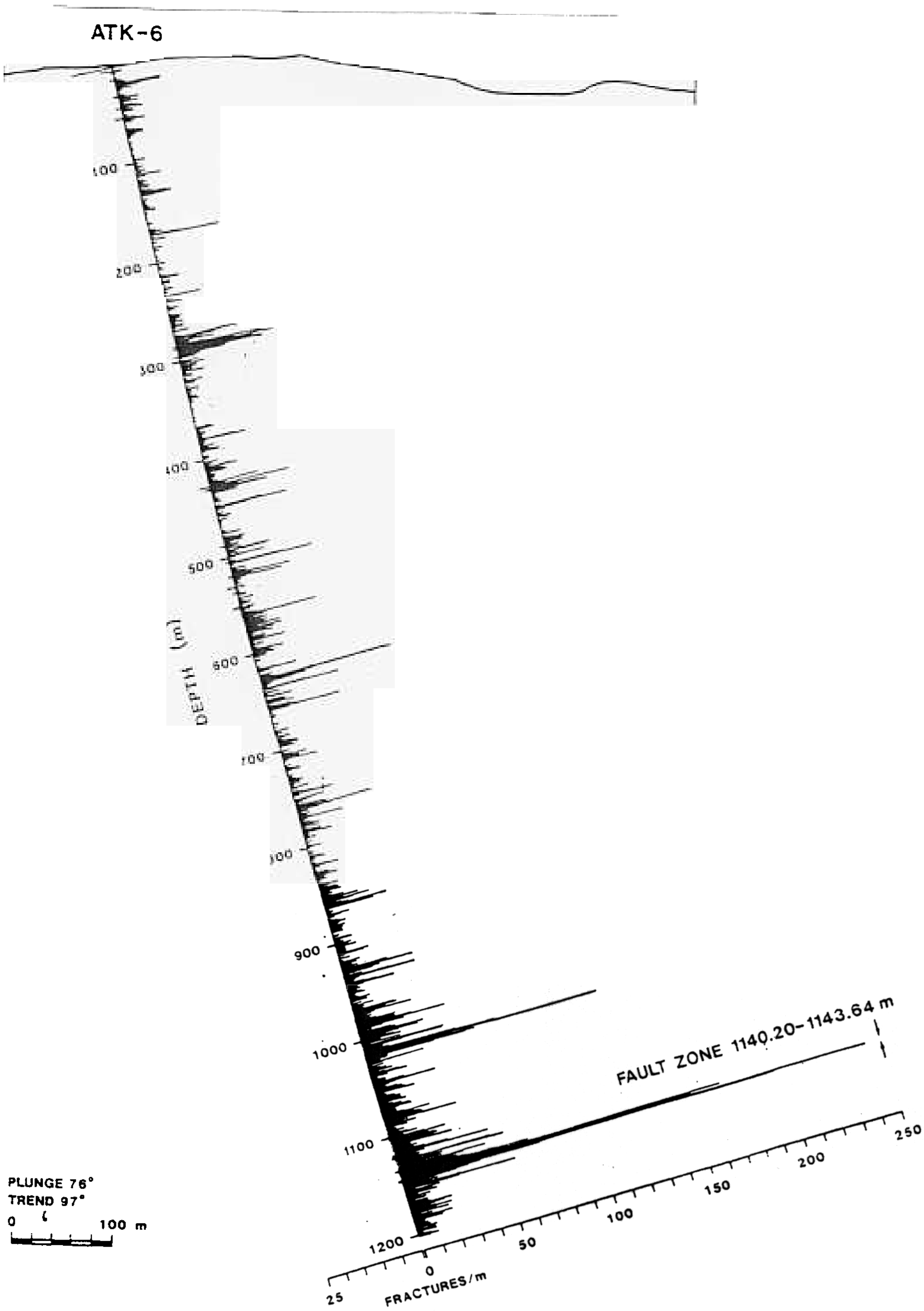
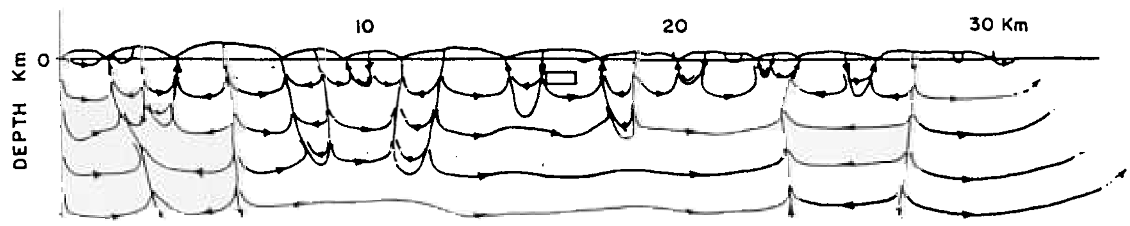


Figure 4. Hypothetical groundwater flow system in fractured crystalline rock (Ref. 3).



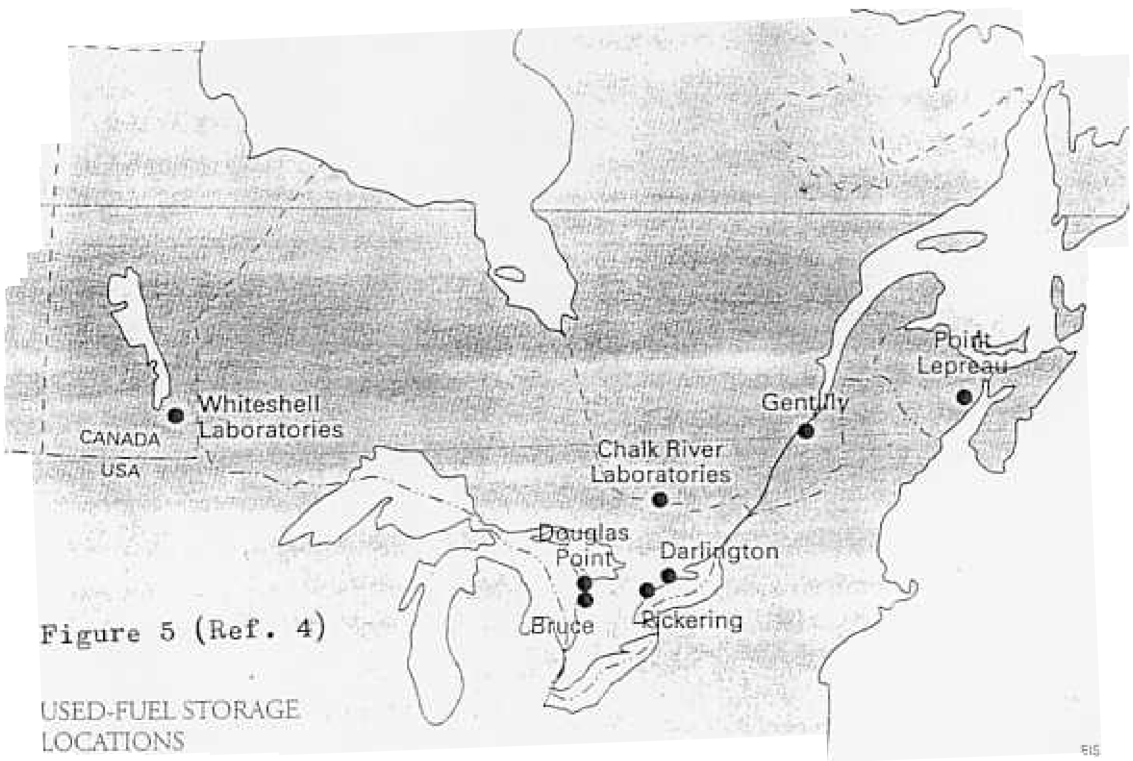


Figure 5 (Ref. 4)

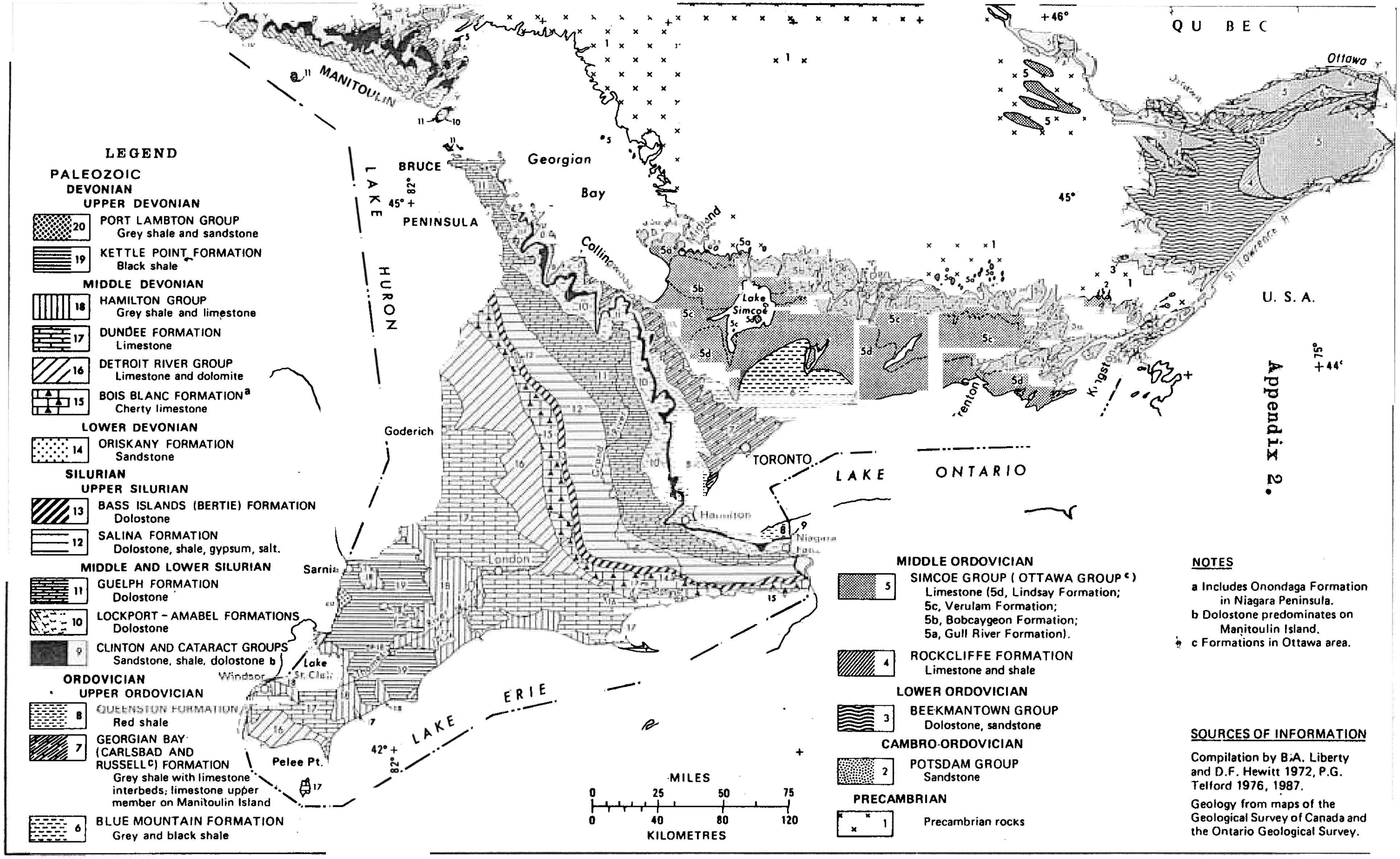
USED-FUEL STORAGE
LOCATIONS

Appendix 1 (Ref. 6)

Storage of Used Nuclear Fuel as of December 31, 2004

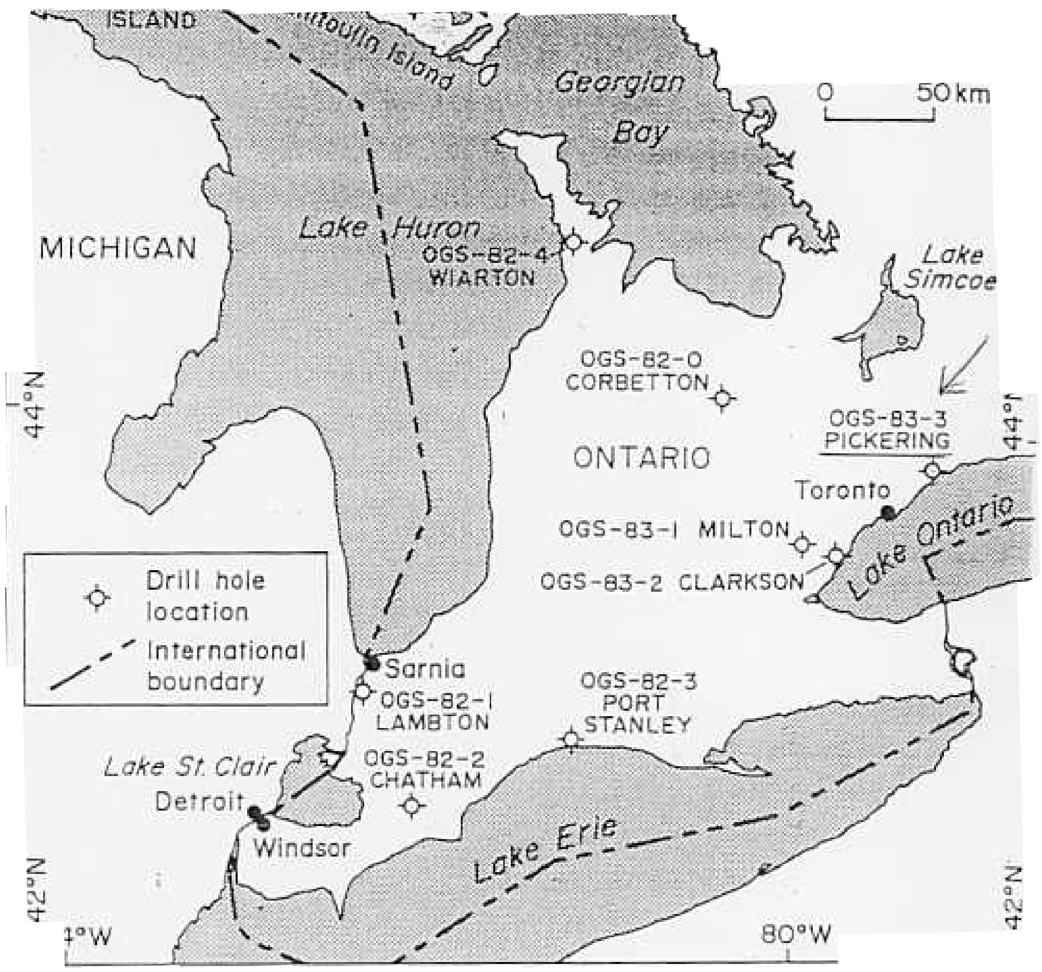
Storage Location	Licensee	Bundles in Reactor(s)	Bundles in Wet Storage	Bundles in Dry Storage	Total Fuel Bundles
Bruce A	Bruce Power[1]	12,480	361,271		373,751
Bruce B	Bruce Power[1]	24,575	369,344	29,184	423,103
Pickering	OPG	36,744	382,332	135,927	555,003
Darlington	OPG	24,960	256,068		281,028
Douglas Point	AECL[2]			22,256	22,256
Chalk River	AECL[3]			4,853	4,853
Gentilly 1	AECL[4]			3,213	3,213
Gentilly 2	HQ	4,560	33,814	60,000	98,374
Pt. Lepreau	NBP	4,560	39,482	63,180	111,562
Whiteshell	AECL[5]			360	360
TOTAL		107,879	1,442,311	318,973	1,873,503

1 OPG manages used fuel produced by Bruce Power which leases the Bruce reactors from OPG.
2 The Douglas Point Nuclear Generating Station in Kincardine, Ontario was shut down in 1986.
3 Chalk River Laboratories (CRL), near Deep River, Ontario is a nuclear research facility with test reactors, fuel inspection and other facilities. Most of the used fuel bundles in the CRL dry storage area are from the Nuclear Power Demonstration (NPD) reactor which was de-fueled in 1987. A quantity of non-standard fuel waste is also stored at the CRL.
4 Gentilly 1, at Becancour, Québec was shut down in 1977.
5 The dry storage facility at Whiteshell, Manitoba houses research reactor fuel rods and some used fuel bundles from the shutdown Douglas Point reactor.



Paleozoic Geology Southern Ontario

Ministry of Northern Development and Mines
Ontario
Mines and Minerals Division



Ontario Geological Survey regional deep drill hole locations in southern Ontario.

Appendix 4. (Ref. 10)

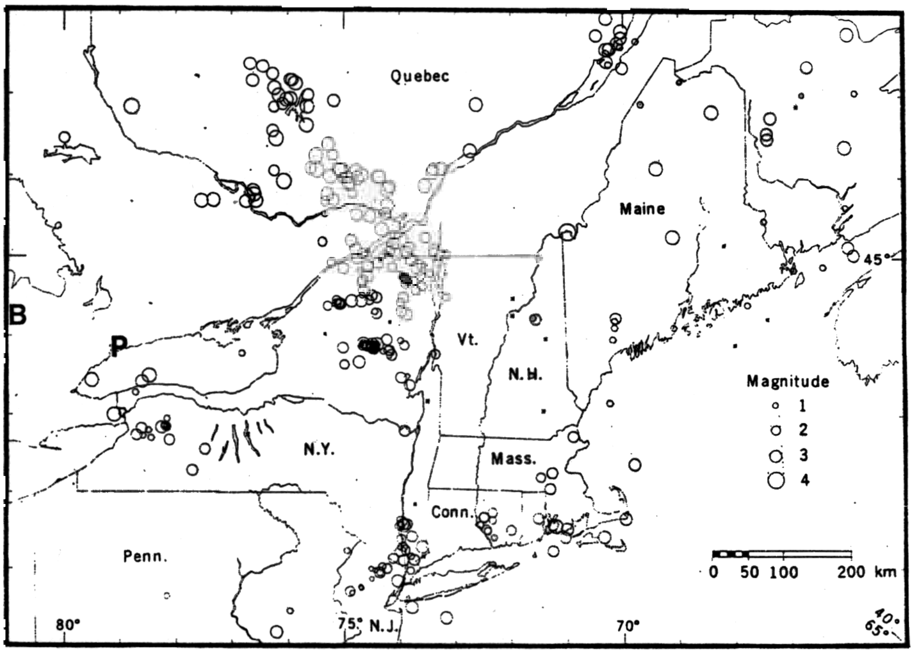


Fig. 1. Epicenters of earthquakes (1970 through 1977) in northeastern North America located by various networks in the area.

P Pickering
B Bruce