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Letters

Underground Disposal of Canada's Nuclear Waste

The article by Tammemagi *et al.* in the June 1977 issue of *Geoscience Canada* reveals some rather disturbing facts: referring to activities of EMR branches (CANMET, GSC), Atomic Energy of Canada Limited (AECL) apparently is considering the spending of $415 to 715 million (1976) on a nuclear waste repository in plutonic rocks of the Canadian Shield.

Obviously, AECL prefers rather questionable "conceptual design studies" by foreign consultants (e.g., RE/SPEC Inc. of Rapid City, South Dakota, and Hagconsult AB, Stockholm, Sweden) over published Canadian expertise which shows the feasibility of certain Canadian salt deposits for underground disposal of nuclear waste - at hardly any cost as the mined minerals would pay the repository.

The cost estimates mentioned above are published in the Proceedings of the 18th U.S. Symposium on Rock Mechanics held in Keystone, Colorado, June 22-24, 1977 (Colorado School of Mines Press, Golden, Colorado 80302; Editors F.-D. Wang and G. B. Clark); the reference paper (Grams *et al.*, Conceptual Design of a Radioactive Waste Isolation Facility in Plutonic Rock, 4B3-1/11) and another paper (Mahtab *et al.*, Stability of a Radioactive Waste Repository in the Canadian Shield, 4B4-1/6), with literally identical acknowledgements, show the role of various members of the association which performed the conceptual design study and the rock mechanics analysis, respectively, for AECL.

The conceptual design is essentially the design developed and demonstrated by ORNL (Oak Ridge National Laboratory) in Project Salt Vault, and dealt with in dozens of publications which are not mentioned; the basic problems which must be resolved prior to any conceptual design of a repository remain open. As Tamemagi *et al.* (p. 73) put it: "unlike salt deposits, which have been studied quite intensively in the United States and the Federal Republic of German, little information is available concerning waste emplacement into igneous rocks".

"A number of other (than ongoing geological) studies are currently underway or planned to obtain the data required to demonstrate the feasibility of the concept . . . " (p. 74). "A fundamental objective will be the delineation of ground water flow in igneous terrain, particularly at greater depth, since virtually no information on this topic is currently available" (p. 74).

It might be questioned by hydrogeologists whether it is possible to obtain the data necessary to prove, beyond doubt, that the "Plutonic Rock" concept is feasible. However, this is not the point stressed here; the point is that the feasibility of the alternate "Salt" concept has been shown in numerous publications, some of which make the three phase evaluation of Canadian salt deposits described by Tammemagi *et al.* a rather expensive exercise without justification.

The phase I studies, designed to select potential sites for radioactive waste disposal in Canadian salt deposits, and completed in March 1976, apparently did not yield any information better than that published by Pearson (1963). This information, supplemented with other published information gained in mining operations in all of the major Canadian salt deposits, is definately sufficient for the reference purpose.

As a matter of fact, late in 1973 the Federal Department of Environment commissioned a state-of-the-art survey on "Ultimate disposal of high-level radioactive and toxic wastes in salt deposits" to be prepared by this writer before March 31, 1974, at the proposed cost of $8,000.00; this survey would have included all the necessary geological information, criteria for disposal site selection, and rock mechanical knowledge which is available, and must be considered in the design of a repository in salt; AECL officials attended the meetings which resulted in a contract - however, early in 1974, the contract was cancelled for unknown reasons, probably because of some empire-building in the EMR branches referred to by Tammemagi *et. al;* another reason may have been this writer's criticism of some of the much publicized conclusions drawn from Project Salt Vault; such criticism was necessary because of contradictory evidence collected in Canadian potash mines, and in salt mines in other countries (Saskatchewan Research Council, numerous reports prepared in 1971/72, particularly E 71-2, E 71-6, and E 72-8).

Published geological evidence (numerous writers, see Baar, 1974, for a summary) shows the rejection of many areas as potential sites for a nuclear waste repository by Tammemagi *et al.* (p. 74) untenable; such rejections are based on "evidence that widespread removal of halite by leaching is still in progress", and on "the presence of economic or potentially economic deposits such as oil, gas, tar sands, potash".

On one hand, "removal of salt due to processes of leaching by groundwater and formation fluids" is considered "a natural hazard, particularly along the margins of most salt basins".

On the other hand, the three areas selected for more detailed (phase II) studies are located along the margins of salt basins (p. 75). The salt basins of

Nova Scotia and New Brunswick are very small, offering nothing but marginal areas; however, due to their location, these basins represent "economic deposits" of salt, and possible potash, and some of them offer excellent possibilities for oil and gas storage in solution-mined salt caverns.

It goes without saying that "the rock units which overlie the salts, where exposed to the surface", have lost their original characteristics as a result of the solutioning of the underlying salt units; for this reason, their study makes little sense. And "in the subsurface, the lithological character of the salt beds and overlying strata" simply cannot be determined by "studying sample cuttings and cores", etc.; this is shown in detail in a book written by this writer: *Applied Salt-Rock Mechanics,* v. 1, The in-situ behavior of salt rocks (Elsevier Amsterdam/New York), published just a few months ago.

This publication also shows another statement by Tammemagi *et al.* (p. 72) untenable; the statement reads: "Halite deposits are present in the subsurface of every Province and Territory of Canada. Thus, if salt is selected as the host rock (for a nuclear waste repository), the extensive geological research and development required to establish the first facility could be applied in large part to similar geological terrains in other parts of the country if the requirements for disposal capacity increase in the years to come".

This statement completely disregards some prerequisites which must be met by salt deposits to qualify for nuclear waste disposal. In Canada, only salt sequences in central areas of Elk Point Basin (see Tammemagi *et al.*, Fig. 2, p. 73) meet all the prerequisites; the Southwestern Ontario salt deposits are not suitable for reasons similar to those which led to the abandonment of the ORNL demonstration site (Lyons mine, Kansas): there are too many holes drilled for oil/gas exploration at locations which are not exactly known.

No geological research and development is required to establish a test repository in one of the potash mines in Saskatchewan where all the prerequisites are met.

"Considerable design and supporting research . . . to develop a feasible waste emplacement configuration, repository layout and support facilities" (P. 75) is equally unnecessary.

It is necessary, however, that those engaging in such programs become familiar with the present state of knowledge - as practised in the potash mines in Saskatchewan and outlined in the book referred to.

References

Pearson, S. J., 1963, Salt Deposits of Canada: in Symposium on Salt, Northern Ohio Geological Society, Inc.: Cleveland, Ohio, Northern Ohio Geol. Soc., p. 197-239.

Baar, C. A., 1974, Geological Problems in Saskatchewan Potash Mining Due to Peculiar Conditions During Deposition of Potash Beds: in Fourth Symposium on Salt, Volume One, Northern Ohio Geol. Soc., p. 101-118.

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This is to acknowledge the interest and concern expressed by Dr. C. A. Baar in his comments to the Editor concerning our recent article, "Disposal of Canada's Nuclear Waste" v. 4, no. 2, 1977).

The disposal of nuclear wastes forms an essential link in the utilization of nuclear power to provide energy for our nation but since some of the radioactive elements are toxic and long-lived, the subject is complex and has become topical. To ensure that the wastes will be secure over the time spans of concern, comprehensive geological and engineering studies are necessary. Thus the principal purpose of our brief article was to inform the geoscience community that these studies are being instigated, with the hope that constructive comments would be forthcoming in return.

In addition to the detailed research that is necessary, it is prudent to explore more than one alternative. Thus it is surprising that Dr. Baar has dismissed the utilization of crystalline rock masses such as plutons. In Canada, this rock type forms a particularly attractive host for nuclear waste since plutons are found in abundance throughout the Canadian Shield, which is one of the most stable geological terrains in the world, and also forms over 50 per cent of Canada's land mass. Similar rock formations are being investigated in Sweden, the U.S.A., France, Great Britain and Austria.

In the consideration of salt deposits, thorough research is required. During the past decade, an enormous wealth of data concerning salt deposits has been generated, principally by the search for oil and gas. The objective of Phase I of the salt study was to collate these new data (mostly as yet unpublished), make supplementary observations on available core, sample cuttings and geophysical logs and to combine this information with that already available in the literature. This information now forms a detailed and comprehensive data-base on which decisions can be made concerning more detailed investigations on salt deposits suitable for nuclear waste disposal. It is inadequate to rely on one reference (Pearson, 1963) and published information on salt mining.

Concerning the design of a repository, it is an over-simplification to state that it is necessary to be "familiar with the present state of knowledge - as practised in the potash mines in Saskatchewan". The design of a repository to contain nuclear wastes is more complex than for a conventional mine because the materials to be emplaced are radioactive and generate heat. These factors lead to different handling and transportation requirements; more rigorous ventilation and monitoring systems; and different (and higher) stress fields. Therefore, considerable design and supporting research are required to develop a feasible waste emplacement configuration, repository layout and support facilities.

One final point also requires explanation. The conceptual design studies of the repository have been undertaken, to date, not by "foreign consultants" but by Acres Consulting Services Ltd., a Canadian firm located in Ontario. Acres Ltd. have been assisted by four subconsultants of whom two are Canadian and two are foreign. The combined group has much experience in the design of nuclear power stations as well as in underground structures such as mines, oil storage caverns and underground power stations. Where is the evidence on which Dr. Baar based his statement that the studies of this group are "questionable"?

In summary, we agree with Dr. Baar's assessment that salt deposits have potential for safely containing nuclear waste. However, detailed and thorough

investigations are necessary, in the laboratory and in the field, to provide verification. We also maintain that plutonic rocks within the Canadian Shield warrant considerable scrutiny as a potential host rock for Canada's nuclear waste.

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The deadlines for submission of MS for *Geoscience Canada* are: Issue no. 1, Nov. 30; Issue no. 2, Feb. 28; Issue no. 3, May 31; Issue no. 4, August 31. Contributions and letters to the editor discussing topics raised in previous issues are welcomed.

A copy of the Guide to Authors may be obtained from the Editor or from one of the Associate Editors.

Note
Please note the following errors which appeared in the article "Gravity Mapping in Canada: A Review of Progress" by M. D. Thomas and R. A. Gibb (v. 4, no. 2). On page 78 the diagrams of Figures 2 and 3 are transposed, and on page 80 page of the text of the caption for Figure 7 should read "The distribution of data in oceanic areas is shown in Figure 8", not Figure 5.