CANADA'S ROLE IN INTERNATIONAL SEISMOLOGICAL VERIFICATION OF A COMPREHENSIVE TEST BAN

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At the April 22, 1976 meeting of the Conference of the Committee on Disarmament (CCD), the Swedish delegation tabled draft terms of reference for a CCD - sponsored group of scientific governmental experts to consider international cooperative measures to detect and identify seismic events. The Swedish proposal for a group of experts was supported by those countries active in seismological verification research. It is expected that the CCD will attempt to reach agreement on the terms of reference of the group during the summer session. If this is achieved, the Swedish delegation has suggested that the group hold its first meeting during the summer of 1976 and make its initial report to the CCD before the end of the summer session.

The Canadian delegation, acting on instructions from the Arms Control and Disarmament Division of the Department of External Affairs, gave belated and unenthusiastic support to the Swedish proposal. Official statements on matters such as these are recognized as being tempered by the requirements of a larger diplomatic "game plan". However, Canadian policy on such matters, and in particular the policy guidance provided to the Canadian delegation for discussion of the terms of reference during the summer session and provided eventually to the Canadian representatives in such an experts group, must be based on a clear understanding of the role Canada can and should play in international seismological verification.

The following is an attempt to clarify this role on the basis of historical developments and on going commitments.

I - The Modern History of Seismology in Canada

Canada's role in the development of modern seismology has been highly significant. This is attested to by the following examples of Canadian developments that paralleled the growth of the science of seismology during this century.

(a) The start of the era of instrumental seismology in generally considered to be the turn of the century. Canada began seismograph operations in Toronto in 1897, Victoria in 1898, Ottawa in 1906, St. Boniface in 1910, and Halifax and Saskatoon in 1915.

(b) Developments in Canada, like those in other countries, between the 1920's and the 1950's were made in response to damaging earthquakes. The Canadian program responded in particular to damaging earthquakes in the St. Lawrence Valley in 1925 and on Vancouver Island in 1946.

(c) In 1958, a group of experts met in Geneva to discuss the capabilities of existing seismograph stations. They identified a need to improve and expand the global network. The United States, in responding to this need, developed and installed a world-wide network of 125 seismograph stations during the 1960's. Canada initially accepted one of these stations (at Coppermine) to demonstrate support for the program. During the same decade, however, and for the same reasons (plus a growing need to understand Canadian earthquakes and to undertake studies of the structure of the Earth) Canada developed its own network of 25 standard seismograph stations. The Canadian standard network made a highly significant contribution to the global seismological data base that led to important advances in seismology and global tectonics in the 1960's and early 1970's.

(d) As part of the research and development program in array seismology Canada undertook jointly with the U.K. the installation of the Yellowknife array. Canada undertook sole responsibility for the operation of the array in the mid-1960's and has since refurbished it to its present standard as a sophisticated seismological research facility.

(e) Canada has made significant contributions to many fields of seismological research during these years - to studies of Earth structure, wave propagation, seismic source mechanisms, seismological data processing and seismic discrimination.

(f) The United States commenced a program of modernization of the world wide station network in the early 1970's with the planned installation of seismic research observatories which utilize modern borehole seismometry and digital recording techniques. This program will update about 15 of the former standard stations. Canada is developing a similar station using the modern borehole seismometer and digital data handling facilities initially developed in-house for on-line monitoring and analysis of Canadian earthquakes.

These examples demonstrate that Canada has played an important and independent role in the development of seismology during this century. As a highly industrialized state, Canada has been able to finance this development. But in addition, and of more importance to the science itself, Canada has a large land mass with many favourable seismic recording sites which can provide essential data for all of the varied fields of international seismological research.

II The Canadian Land-Mass and Global Seismology

Many of the developments noted above were undertaken in recognition of Canada's obligation to use its large land mass to contribute seismological data to global programs. In addition to research data that are in constant demand world-wide Canada routinely contributes data to the international agencies for the location of global earthquakes. In a recent international cooperative experiment coordinated by the Massachusetts Institute of Technology to detect and locate as many global earthquakes as possible during a one-month period (the International Seismic Month) Canadian seismograph stations ranked second, sixth, fourteenth and seventeenth among the top twenty stations in terms of data contributions to the location of global earthquakes. These contributions will continue as part of Canada's committment to global seismology.

III The Canadian Land-Mass and Seismological Verification

An international seismograph network that can provide the basic data for the detection and location of underground explosions, is essentially the same as one required to monitor global earthquakes, although closely-spaced stations used to monitor near-by earthquakes would be redundant for the case of the general monitoring of explosions. Thus the relative importance of the Canadian seismograph facilities in the world-wide explosion monitoring system will be at least as great as in the case of global earthquake monitoring. In fact, the basic detection data reported by an individual station is the same irrespective of the source of the seismic event and explosion data would flow routinely into the international earthquake location agencies. An international centre for seismological verification would make full use of this existing data service and Canadian data would be used

extensively for detection and location of possible explosions. This would be the case whether or not Canada was directly involved with the verification center. With some degree of active participation in the center, Canada could at least ensure the accuracy and completeness of any Canadian data used for an important seismic event and have some influence on how Canadian data may be interpreted with respect to the identification of a suspicious event.

Of course, in addition to its significance with respect to global monitoring, the large Canadian land mass is strategically located adjacent to the territories of the two principal nuclear powers, the U.S. and the U.S.S.R. This would tend to make Canadian data of even greater interest than that of most other countries for seismological surveillance purposes.

IV An Active or a Passive Role for Canada

The present commitments to dissemination of Canadian seismological data include the following:

1. routine data flow to international earthquake location agencies in the U.S. and U.K. as noted above,
2. routine microfilming of all Canadian seismograms for deposition in World Data Centers,
3. a general understanding that copies of any specialized seismological data will be made available at nominal cost on request,
4. routine flow of all Yellowknife array data to the U.K. Blacknest research center,
5. loan of original seismograms to qualified national and international research groups on special request,
6. routine airmailing of Canadian seismograph network data to the U.K., Sweden and the Soviet Union,

7. routine transmission of the Yellowknife event detection log is being arranged for the U.K., U.S. and Sweden,
8. routine deposition of the new borehole continuous digital long period data will be arranged for the U.S. Seismic Data Analysis Center.

Analysis of seismological data is the only non-intrusive means of verification of a ban on underground testing. The list above demonstrates that Canadian seismological data will be used extensively for seismological verification, whether or not Canada has a specific interest in doing so, and whether or not Canada makes a commitment to assist an international cooperative effort. If in the future there is an agreement for international cooperation in seismological verification, the highly developed state of seismology in Canada, the size and strategic location of the Canadian landmass and Canada's existing data exchange agreements make it highly unlikely that Canada can, or should, avoid some active commitment to this cooperation.

V Reasons for Canadian Participation

Nevertheless, there are several questions that should be considered before Canada commits itself to major participation in either the Swedish-proposed experts group or a possible international data centre. Some of the more obvious are:

(a) Do we believe that seismological verification instead of, or in addition to, bilateral and multilateral diplomatic agreements would be a useful formal part of a comprehensive test ban treaty?

(b) If so, do we believe that such seismological verification should be undertaken as a cooperative international effort or rather as a national effort using data that may be available through normal international scientific data exchange agreements?

(c) Even if we do not believe that international cooperation will be a useful part of CTB verification, do we believe that discussions of cooperation, along the lines proposed by Sweden, would be useful dialogue towards an eventual CTB?

(d) Is it generally accepted that Canada would want to retain the option of having an independent view concerning the seismological evidence for a contested event under a CTB? [redacted].

(e) Does Canada want to undertake routine analysis of seismic events under a CTB, either independently, as part of a joint effort with her allies, or as part of a larger international cooperative effort?

(f) The more advanced countries have the national means to assemble and analyse large amounts of seismological data for purposes of independent or joint verification of a CTB. Would the existence of an international centre, specifically devoted to the gathering of seismological verification data, provide a facility for the less-advanced countries to make their own assessments of potential violations of a CTB?

The consideration of these questions will go a long way toward identifying the degree of involvement of Canada in the proposed cooperative efforts, the degree of influence that Canada may wish to have in establishing the procedures of the international data centre, and the level of resource commitment that would be required to achieve these desires.

VI Incremental Resources Required to Implement Various Levels of Canadian Participation

The Earth Physics Branch of E.M.R. devotes significant research effort to on-going work related to seismological verification. This effort is divided among the following activities:

(a) original research on seismological discrimination, array seismology and seismic sources,

(b) preparation of working papers, provision of advice, assessment of other international research and development activities, and other related duties in support of Canadian activities at the C.C.D. and elsewhere,

(c) analysis of Canadian seismological data for individual seismic events (usually explosions) on special request from Canadian D.N.D. officials and from research groups in the U.K., U.S., Sweden and other countries.

Excluding management personnel, who become involved occassionally, this research effort is divided among about five research scientists in the Branch, each of whose primary responsibilities relate to some aspect of Canadian seismicity, seismic risk or earthquake research. Commitments to national programs in these areas preclude significant additional effort by these individuals in support of Canadian involvement with an international cooperative effort of seismological verification. Nevertheless, these individuals would continue to be involved with the cooperative program simply because the skills and experience required cannot easily be found in newly-recruited staff.

As indicated above the actual degree of Canadian participation remains to be decided, but a range of participation options can be described which would provide some information on the range of incremental resources that would be required. Some examples follow.

(a) No additional resources.

Under this option, Canadian participation could not include any large amount of routine Canadian data analysis, dispatching of specially-formatted data or assessment of accumulated international data for seismic events of interest. The routine international flow of Canadian data could be modified and directed toward the international data center, existing research staff could keep a watching-eye on the activities of the center and a small amount of special event analysis could be handled on request from the center.

(b) One staff position, $15K salary and $15K operating.

With one staff position, in a scientific support category, the routine tasks of data reduction and dispatching could be handled on a continuous basis. The distinction between one and no additional staff is essentially related to a 365 day per year commitment to the timely analysis and dispatching of the appropriate data. The $15K operating funds would be required for supplies such as digital tapes, data communications costs and computing charges.

(c) Three staff positions, $40K salary and $30K operating.

With three staff positions a commitment could be made to actively contribute to the cooperative scheme and utilize the data facilities made available by the international centre. The three staff positions would be used for two scientific support and one technical/clerical position, or one scientific support and two technical/analytical/clerical positions, depending on the amount of additional research that may be undertaken in support of the cooperative scheme. A greater commitment of Canadian data could be made than in (b) above and a fairly routine investigation of interesting seismic events could be made using the total data base collected by the international centre. The costs of supplies, data communications and computing charges would each be greater.

The costs noted above do not include:

(1) any additional travel that may be undertaken in association with the activities of international cooperation.

(2) any financial (or man-power) commitment that Canada might make to the operation of an international data centre.