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Soil-Water Problems in Cold Regions

Owen L. Hughes

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Aller au sommaire du numéro

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estimation of sheet erosion, determination of agricultural run-off, characterization of sediments eroded from agricultural lands and soil mitigation measures to reduce pipeline construction damage.

Following lunch, S. E. Yundt of the Proctor and Redfern Group, discussed the apparent mineral aggregate crisis. The main problem, she outlined, is not the lack of resources but the sociological and environmental problems linked to restrictions at Provincial and Municipal levels. Some of the recommendations made during the paper are strengthening of the Pits and Quarries Control Act, development of a provincial mineral-aggregate policy, effective pre-planning by Municipalities to set out areas for mineral resources extraction, improved environmental responsibilities by the industry, enlightenment of the public, control of public participation and a review of the effectiveness of the OMB.

W. J. Wolfe, Cominco Ltd., described the natural occurrence of anomalous metal concentrations. It was noted that these occurrences may exceed levels considered to be polluting by environmentalists. Several case studies of high concentrations were presented and the ability of plants to adapt to or reject the uptake of such concentrations discussed. Geochemical orientation surveys by the extractive industry prior to development are necessary to establish baseline data in order to protect the company should litigation arise concerning suspected pollution.

The groundwater contamination problems associated with bulk storage of road salting compounds in Ontario were outlined by G. Funk of the Ministry of Environment. Mr. Funk described storage methods, structures and handling of road salting compounds and then described an investigation into contamination of a water well and damage to vegetation by salt from an uncovered pile. Hydrogeologic, geophysical and water-quality studies were described in order to show the method of proving the source of the problem.

Grant Anderson of Gartner Lee Associates Limited described the role of the hydrogeologist in the evaluation of potential sites for sanitary landfills. Mr. Anderson described the approach used in regional site selection studies and then described a detailed site investigation at Canadian Forces Base Borden. The study outlined the need for the detailed evaluation of a site even if it appears to have a simple stratigraphy. Once the evaluation is complete, the data can be used to properly design the landfilling techniques, leachate and gas control, monitoring and closure measures.

The conference was, as in previous years, well received by those present. Discussions after the presentations were of great value and indicated an interested, well-informed audience. The fifth conference will again be held in Toronto in November of 1976; further information can be obtained from the author.

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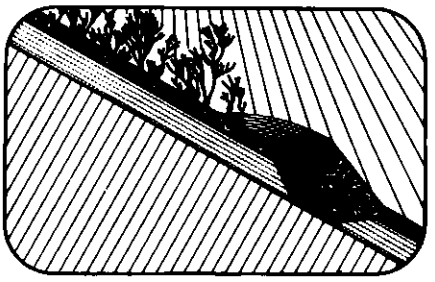

Soil-Water Problems in Cold Regions

Owen L. Hughes
Terrain Sciences Division
Geological Survey of Canada
3303 - 33 St. N.W.
Calgary, Alberta T2L 2A7

A conference on soil-water problems in cold regions was held in Calgary, May 6-7, 1975, sponsored by the Special Task Force of the Division of Hydrology, American Geophysical Union. Heat and moisture transfer in soils of cold regions was the central theme of this conference, which was attended by 82 Canadian, one Japanese, and 19 U.S.A. participants. Regrettably, U.S.S.R. representation was lacking. Although the preponderance of Canadian participants was doubtless influenced by the locale of the conference, it nevertheless reflects major interest by Canadian researchers and practising engineers in problems of freezing soils and the associated problem of heaving. Much of the interest is clearly engendered by current planning and design of oil and gas pipelines and highways in Mackenzie Valley; at least 20 of the participants are affiliated with consulting firms active in such projects. The program and the affiliations of the various authors reflected the broad range of disciplines contributing to current research in soil-water problems of cold regions, including physics, engineering, meteorology, hydrology, agrononomy and geomorphology; even dendrochronology appeared, as an adjunct to geomorphology.

The opening paper, by Sam I. Outcalt and John H. Carlson, described a computer-based mathematical model designed to simulate surface soil energy budget and soil thermal evolution.

Factors involved in the solar radiation budget, turbulent heat exchange, soil heat flux and soil thermal regime are accommodated by numerous subroutines within the computer program. Subroutines can be changed independently, providing great flexibility for evolution of the program as understanding of heat and moisture transfer evolves.

Field experimental work was described from two areas; Hokkaido, Japan and Hanover, New Hampshire. S. Kinosita described field-scale experiments at Tomakomai, Hokkaido, Japan where ice lens formation in freezing soil, as determined by actual measurement in cored samples, was found to be in good agreement with predictions based on measurement of the heat balance of the freezing layer, and with predictions based on measurement of pore-water gradients. Richard L. Berg, described instrumentation installed under a newly constructed road at U.S. Army Cold Regions Research Laboratory, Hanover, N.H. and reported raw data from the winter of 1974-75. These and subsequent data will be used for validation of a heat and mass flow model or models to be developed at a future "brainstorming" session of C.R.R.E.L. scientists and other experts. The Tomakomai and C.R.R.E.L. test sites exemplify a growing trend toward full-scale testing under field conditions, a trend best exemplified in Canada by the construction and operation of a total of four test oil and gas pipeline facilities (in Calgary and Mackenzie Valley).

Conventional analytical techniques assume a sharp interface between frozen and subjacent unfrozen soil, although it is well known that in many soils the two are separated by a transitional zone in which part of the pore water is unfrozen. Aspects of this problem were treated in papers by D. D. Kent, D. G. Fredlund and W. G. Watt, by E. Bresler and R. D. Miller, and by T. E. Osterkamp. The last of these involved preparation of thin sections 0.4 to 0.5 mm thick of soils containing ice lenses. Microscopic examination of the thin sections demonstrated existence of liquid-filled pores at three-grain boundaries. The refined thin-sectioning technique should prove of interest to glaciologists, to geomorphologists studying ground ice, and to pedologists studying cryogenic soils.

Other papers ranged from a theoretical paper by P. H. Groenevelt and B. D. Kay "Hydrostatics of frozen soils", in which expressions for envelope-pressure potential and frost potential were derived in terms of soil void ratio, moisture ratio, ice ratio, and moisture ratio equivalent, to a review by E. C. McRoberts and J. F. Nixon of field, laboratory and theoretical evidence of a "shut-off pressure" (a concept of immediate practical significance in engineering design where ice-segregation and heave are potential problems) and a review, together with new data, of the effects of salt in pore water on freezing of soils, by D. E. Sheeran and R. N. Yong.

Knowledge of both supra-permafrost (active layer) and subpermafrost hydrology in the wide range of terrain, soil and climatic conditions encountered in permafrost regions are surely essential to assessment of potential soil water problems in those regions. However, only one paper, "Physical transfer processes in Subarctic soils influenced by forest fires", by D. L. Kane, James N. Luthin and George S. Taylor, reported research in hydrology in a permafrost environment. Hopefully, the appearance of but one paper on permafrost hydrology, at a conference devoted to soil and water problems in cold regions, results from the short time that has elapsed since the Permafrost Hydrology Workshop in Calgary in 1974, rather than from neglect of the subject.

Similarly, only one paper, by W. E. S. Henock, D. N. Outhet and M. L. Parker, treated cryogenic landforms (landforms produced mainly by freezing and heaving of soil). Such landforms, especially those forming actively, would seem to be ideal subjects for full-scale field laboratory study, and to warrant greater research effort than they are presently receiving. Again, only one paper, by B. D. Kay, D. B. Hans and J. B. Gait, treated organic soils, with which Canada is abundantly endowed (or cursed). Physical properties of organic soils vary greatly both areally and stratigraphically, and the hydrology of organic terrains is much more varied than is generally recognized. It is indeed unfortunate, as noted by the authors, that "there have been few studies which have characterized, in detail, the thermal and hydrological properties of different organic materials".

The closing paper by H. L. McKim, D. M. Anderson, R. L. Berg and R. Tuinstra described the LANDSAT Data Collection system. The system provides the capability "to collect, transmit and disseminate data from hydrologic, meteorologic and environmental sensors from virtually any remote site".

In a panel discussion at the close of the meeting, chaired by D. M. Anderson, Anderson identified coupled heat and moisture transfer as the continuing major research problem in soils of cold regions, and pointed to the complementary problem of translating scientific findings into practical engineering problems and vice-versa.

Peter Williams suggested that research capability of an individual in one discipline was seriously limited by inadequacy of training in allied disciplines, noting that no university offered training programs that combined such subjects as physics, soil mechanics, hydrology and geomorphology. Williams' suggestion was perhaps supported by the pattern of discussion of individual papers, in which participants tended to discuss papers in their particular fields, with only limited cross-communication evident.

In private discussion following the conference, one participant suggested that research with effective cross-communication between disciplines could best be effected by bringing a multidisciplinary international team together in a single institution to focus on a specific problem. To this reviewer's knowledge, details were not spelled out to show how such a team would differ from a substantial number of groups now existing within industry, academia and government. It does seem, however, that such a team, properly organized and focused, with a budget equal to a small fraction of the cost of one Alyeska Pipeline or one Mackenzie Valley Pipeline, might yield major economic and scientific dividends.

Copies of the proceedings can be purchased by writing to James N. Luthin, Department of Water Science and Engineering, University of California, Davis, California, 95616. Price $10.00.

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