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Programs to Enhance and Sustain Safety and the Quality of the Environment In and Around

Orphaned and Abandoned Mine Sites

Natural Resources Canada (NRCan) is an active partner with provinces and territories to address orphaned and abandoned mine-site issues. A formal Memorandum of Understanding signed in March 2000 between NRCan, Newfoundland and Labrador, Nova Scotia, New Brunswick, Ontario, Manitoba and the Yukon has led to the development of a national standard for mine decommissioning and long-term stability. This is one of a number of activities that the department's CANMET-Mineral Technology Branch (MTB) is pursuing to enhance the safety and quality of the environment in and around orphaned and abandoned mine sites.

Some 10 000 orphaned and abandoned mine sites have been identified across Canada, many of which are hazardous and without long-term closure plans. Owners are responsible for preparing closure plans for provincial approval for new and active mines and, in addition, must provide post-closure financial assurance for environmental rehabilitation or stabilization work. Liability for orphaned mine sites that lack identifiable owners lies with the provincial and federal governments.

There is no national inventory of orphaned and abandoned mine sites. Lost mine records and forgotten mine-site locations have left an unknown legacy of problems in many of Canada's old mining camps. Orphaned and abandoned mines represent potential land subsidence, violent cave-ins, and waste dump and tailings dam failures, all of which can have a critical impact on public safety and the environment. Underground and unseen rockmass conditions of abandoned mines are also an issue for land use because they can constitute an unknown hazard when people undertake activities without being aware of the threat they pose. Acid mine drainage (AMD) from orphaned and abandoned mines is also an important environmental issue.

CANMET-MTB currently carries out research on rockmass stability; subaqueous disposal of sulphidic waste rock and tailings; characterization and management of reactive or radioactive waste, including lime treatment sludge, tailings and waste rock; production and characterization of dense stable sludges; site assessments of long-term prevention and control measures; and prediction, prevention and remediation technologies for mine effluents.

Development of a Canadian Standard for Decommissioning Shallow Stope, Hard-Rock Mines

Underground mine openings remain in perpetuity once they have been created. Rockmass movements around near-surface openings are common and often lead to failures that affect people, infrastructures and the environment. It is therefore essential that long-term stability of shallow workings be established with a view to assessing site risk and land use, and to applying long-term monitoring.

A cooperative federal-provincial/territorial project has established a national standard to evaluate the current and long-term impact of rockmass movement adjacent to shallow stopes for the purpose of supporting mine decommissioning and closure plans. The standard is based on established science, best practices and experience, and provides the mining operations and provincial agencies with a document leading to: a clear and complete set of guidelines for preparing and reviewing decommissioning plans; national (uniform) terms of reference; the capability to rank site problems; a toolbox of possible solutions/options that would be common from province to province; and a common national understanding of site management, land use, life and property protection.

Tailings dam with progressive failure — workers conducting tests for research of material properties.

Assessing the Long-Term Environmental Effects of Submarine Tailings Disposal (STD)

CANMET-MTB has been working with the Department of Fisheries and Oceans (DFO) and Memorial University on a three-year research program since August 1999 to examine the environmental impact of marine tailings disposal in Newfoundland. Integration of the physical, chemical, biological and ecotoxicological characteristics of two orphaned and abandoned mine sites in the Notre Dame Bay area will permit a realistic determination of the risks and/or benefits associated with marine tailings disposal. Both sites hosted massive sulphide mineralization. The project is largely funded by the federal Toxic Substance Research Initiative (TSRI) with in-kind contributions from NRCan, DFO and Inco Limited. Some of the activities completed to date involve: compilation of historic operational information; characterization of sites; field sampling of tailings, sediments, waters, flora and fauna; and preliminary sample characterization.

Monitoring the Stability of a Tailings Dam

Time Domain Reflectometry (TDR) is an established technique for monitoring the stability of natural soil slopes that is currently being used by the mining industry to monitor the location and nature of rockmass movements. TDR has the potential to monitor the magnitude and relative location of internal deformation in a rockmass. Scientists are assessing the potential for, and interest in, developing the use of TDR in tailings dams. CANMET-MTB currently has TDR cables installed at sites in Elliot Lake, Timmins and near Val-d'Or, and a fourth installation has been proposed for a site in the Sudbury area. TDR may become a useful tool in addressing the long-term stability of tailings dams.

Arsenic Disposal

CANMET-MTB is collaborating with the Department of Indian Affairs and Northern Development (DIAND) to find an adequate strategy for the permanent disposal of roaster arsenic trioxide dust generated at the Giant mine at Yellowknife in the Northwest Territories. During its 50-year operating life, the Giant mine stored a massive volume of arsenic-loaded waste in underground stopes; however, concerns exist about the fate of the arsenic after the

cessation of mining operations. An extensive mineralogical and metallurgical study on the arsenic dust was completed by CANMET-MTB in December 1999, and CANMET-MTB participated in the Giant Mine Hydrology Experts Meetings in March 2000 and June 2001. A hydrometallurgical project has since been undertaken to generate pure arsenic trioxide for sale to the wood-preserving industry in the United States. A comprehensive survey of arsenic disposal practices in Canada has been completed and will shortly be published in a Canadian metallurgical journal.

Development of a National Inventory of Abandoned Mines

In Canada, there are some 10 000 orphaned and abandoned mine sites that have not been adequately reclaimed. These sites present potential threats to the environment and public health and safety in the form of acid drainage, metal/toxic leaching, erosion and physical instability. Some of these sites also present a financial liability to the Canadian mining industry and the public in the form of the costs associated with remediation, rehabilitation and monitoring.

CANMET-MTB is collaborating with various stakeholders to cooperatively develop a National Inventory of Abandoned Mines by expanding a previously developed database. As part of a cooperative five-year, $1.2 million project funded under the Northern Ontario Development Agreement, CANMET-MTB created a database of 100 of Ontario's most hazardous abandoned mine sites. Software developed through this agreement permits the storage and retrieval of key mine-site data. Information, including plan sections, reports and graphics, can be easily accessed to highlight key operating statistics and occurrences or to enable the reconstruction of 3D images of mine workings as they relate to surface infrastructures.

Discussions are continuing between different levels of government, non-governmental organizations, Aboriginal and other community representatives, and the mining industry on the development and design of a national inventory of abandoned mines. Databases in each jurisdiction in Canada would link with a central repository of sites, potentially managed by NRCan.

CANMET-MTB, with past experience in database development and close ties with other levels of government, non-governmental organizations, industry and community stakeholders, is well positioned to advance the creation of a national inventory of abandoned mines. Such a database, by acting as a vehicle for sharing best practices between stakeholders, will serve Canadians well and help reduce future liabilities.

Development of a Technical Database on Orphaned and Abandoned Tailings and Mine Waste Rock Sites in Northern Ontario

This project, initiated in 1993, brought together information on orphaned and abandoned mine sites requiring rehabilitation. Activities included field studies, laboratory investigations, database software development, Geographic Information System (GIS) technology, and a literature search. The database includes publicly available information that was evaluated, standardized and augmented by CANMET scientists. A secondary objective of the project was to develop standardized techniques for examining and characterizing waste rock and tailings disposal sites.

The data are selectively focussed on aspects important to evaluating tailings and waste rock piles and providing insights to facilitate the rehabilitation of mine sites.

The database not only looks at the characteristics of individual tailings sites, but also at aspects of the grouped sites of various mining camps. Ultimately, the identification of common trends and scenarios will help in the selection of the best and most cost-effective disposal strategies available to meet short- and long-term environmental impact targets.

The Mine Environment Neutral Drainage (MEND) Initiative

The Mine Environment Neutral Drainage (MEND) initiative is a national research program involving industry, federal and provincial governments, and non-governmental organizations (NGOs). MEND was the first international multi-stakeholder initiative to develop scientifically based technologies to reduce the effect of acidic drainage. A toolbox of technologies is now available to open, operate and decommission a mine property in an environmentally acceptable manner.

The original MEND Program ran for nine years ending in 1997, with technology transfer activities continuing to the end of 2000 under the MEND 2000 program. MEND3 is a one-year program, launched in 2001, to lay the initial groundwork for a possible multi-year research program on acidic drainage. The focus is on outlining gaps in acidic drainage research and technology in Canada and on preparing a prioritized list of research efforts and opportunities that would advance acidic drainage knowledge.

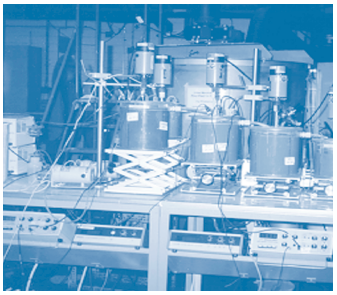
State-of-the-art information and technology developments are provided to users through workshops, technical reports and publications, and online services (http://mend2000.nrcan.gc.ca).

The Canadian mining industry now has a new tool for handling the problems of acidic drainage. The MEND Manual, released in early 2001 in both paper and CD-ROM formats, serves as a single source reference for the diverse and complex research undertaken during MEND. It is a six-volume set, that includes a detailed summary and five technical volumes containing more than 200 technical reports, workshop notes and presentations produced under MEND.

The MEND program has been described as a model of co-operation in technology development for governments, industry and NGOs. The success of the MEND program has established Canada as the recognized leader in research and development on acidic drainage.

Assessment of Acid Mine Drainage (AMD) Treatment Processes

The minerals industry has been faced with the possibility of having to pump and treat AMD effluents for decades. Many sites are either investing in high-density sludge production plants or are retrofitting older plants to reduce environmental liability and operating costs. CANMET-MTB has undertaken a comparison of various high-density sludge (HDS) treatment processes using a modular lime neutralization pilot plant facility. The scope of this work has been defined in consultation with four major mining operations. Four HDS processes have been assessed using both a low-strength, zinc-iron-rich acidic drainage solution and a high-strength, iron-aluminum-sulphate drainage solution. The final effluent quality, lime consumption, sludge density, settleability, filterability, viscosity, neutralization potential, metal leachability, and operating and capital costs will be evaluated for each process.



A front view of the high-density sludge pilot plant. Mechanical stirrers, each equipped with six-blade turbine impellers, are provided for all the reactors.

Additional work has included investigating the use of by-product or waste material (such as pulp and paper mill sludge and cement kiln dust) as a source of neutralization for mine water treatment.

For more information on these programs contact:

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