CANMET’S TAILINGS RESEARCH PROGRAMS
- AN UPDATE -

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CANMET's mandate is, in part, to conduct research and development into mining and mineral processing to support the economic performance and productivity of the industry, while serving the government's objectives for health, safety and the protection of the environment. Within CANMET the Mineral Sciences Laboratories are responsible for mineral processing research and the Mining Research Laboratories handle mining aspects. Over the years, CANMET has provided much help to the industry in areas such as: establishing process designs for mineral extraction, problem solving particular issues and providing technical assistance to overcome specific problems. Less attention has been paid to the long-term questions associated with wastes such as tailings. Beginning, several years ago, with individual projects centered on one specific issue, CANMET's programs have evolved to encompass a broad mandate of all types of tailings. This process is expected to continue and CANMET will add to its research program items of concern to the industry. This paper is intended to outline the extent of the current programs.

Currently, CANMET is working in three main areas. The first, is the National Uranium Tailings Program (NUTP), a Treasury Board funded five-year sunset program due to end in 1986, which is investigating the long-term environmental impact of uranium tailings. The second program is the Reactive Acid Tailings Sulphides Program (RATS) which is investigating the management of acid generating sulphidic tailings. Currently, the last major segment of the work is on the long-term management of potash tailings (POTS).

It is now proposed to consider these three programs in detail.

THE NATIONAL URANIUM TAILINGS PROGRAM

PROGRAM ORIGINS

In 1981, after a year-long study, the National Technical planning Group on uranium tailings research, under the direction of Philip Lapp, concluded that there was not enough
scientific data to predict confidently the long-term effects of uranium tailings on the environment (1). This group of experts, appointed by the Department of Energy, Mines and Resources Canada, recommended that a research program be conducted to fill the knowledge gap. The Government of Canada responded to this recommendation by announcing in 1982 the formation of the National Uranium Tailings Program (NUTP). This is a five-year research program with approximately $8.5 million in funds that is studying the ways to predict the effects on the environment of uranium mill tailings over the long-term (2).

PROGRAM OBJECTIVES

The main objective of the Program is to provide a scientifically credible information base which will assist government regulatory agencies and mining industry to establish long-term management strategies for the protection of the public and the environment. The Program is reviewed and receives advice from a Technical Advisory Committee (TAC) which includes representatives from both Federal and Provincial governments and members of Canada's active mining industry. This group meets on a regular basis and reviews the work done to date and makes recommendations for future work. In addition to providing theoretical and technical assistance, the mining company representatives have also provided practical help which has allowed several projects to proceed smoothly. The TAC has also been a forum for raising issues of joint concern between the industry and various governments involved. Once these issues were identified, the NUTP were able to initiate projects that developed sufficient data to make rational decisions.

General policy direction is given to the NUTP by a Senior Review Board (SRB). This board is composed of the Deputy Ministers of Environment from Ontario and Saskatchewan, the President of the Atomic Energy Control Board, the Assistant Deputy Minister Research and Technology and the Director General of CANMET. It reviews the recommendations of the TAC and the input of the NUTP staff and formulates broad policy outlines that coordinate with the work being done in the individual SRB members' organizations.

The needs of three constituencies, i.e. the regulatory authorities, the mining industry and the public are being kept in mind as the work proceeds. It is these three groups who will judge the acceptability of the risks involved. The
NUTP will provide a solid scientific background against which these judgements can be made.

A secondary objective is to develop the scientific skills required to assess long-term effects of uranium mill tailings in Canada. In particular, it was hoped to encourage the development of environmental research expertise within the private sector. To this end the bulk of the research programs have been awarded by competitive bid to privately owned Canadian consulting and research companies.

PROGRAM ORGANIZATION

The Program is concentrating on determining a means of predicting future impacts of uranium tailings on human society. Other effects such as the formation of acidic effluents from pyrite oxidation, will be given consideration but the principal risk considered will be that to mankind. As making measurement in the future is impossible, a mathematical model is essential to making predictions. However, there will be uncertainty associated with these predictions. The best tools available at present for the quantification of future events and the uncertainty associated with them are mathematically based probabilistic models. The modelling will have to be built-on as much fundamental understanding as possible. Correlative modelling generally will not be adequate because physical and chemical processes can change with time and these changes will not be reflected in the type of modelling.

The Modelling activity is central to the Program, but it is dependent on research into fundamental understanding of the science to develop its predictive equations. It is also dependent on the input of measured values to calibrate and validate the models developed. Additionally, the disposal technology options must be understood to evaluate the consequences of each option and the relationship of performance to cost. Therefore, the Program has been organized into three major sections: Modelling, Measurements and Fundamental Understanding, and Disposal Technology (Fig. 1).

MODELLING

Because of the complexity and uncertainty involved, the NUTP is taking a two-level approach to mathematical modelling. This approach is shown schematically in Figure 2.
and involves a series of separate component models at the detailed technical level and they simplify the model linking the components together. The system model does not attempt to couple the component models directly, but couples instead simple models derived from the aggregate results of the more complex component models. In doing this, the NUTP can strive to:

(a) provide a sound scientific basis for component modelling and develop certain specific models;
(b) provide a methodology and a framework (i.e. a systems model approach) for integrating these, making long-term predictions, and answering cost-effectiveness questions and,
(c) provide a general picture for certain types of Canadian tailings and various disposal options.

Developing methodology, however, is often not sufficient to ensure its use. To provide a focus for application to real systems, the intent is to apply the approach through the detailed assessment of some demonstration sites. These assessments would be taken to the point of evaluating the existing situation along with several alternatives for each site, but neither decisions nor recommendations would be made as to the preferred choice since that step is the prerogative of the site owners.

DISPOSAL TECHNOLOGY

The Disposal Technology section of the work is concerned with the actual physical placement of tailings after close-out. The NUTP has concentrated its efforts into technology that is or has been used in Canada. The evaluations of the technology have adopted three points of view: scientific integrity, the effectiveness in reducing contaminant concentrations and the costs. Subject areas such as liners, both natural and artificial, pyrite oxidation, consolidation, tailings covers and stability of structures are being investigated.

It is particularly important to develop a knowledge of a new technology being used in Saskatchewan. These deposits are complex ores with poorly understood tailings chemistry. The tailings management programs use new concepts which are meant to be more effective at reducing the migration elements of concern. The Disposal Technology section is trying to develop a sound understanding of the mechanisms and reactions taking place, and the potential for future effects.
MEASUREMENTS

The Measurements section has two functions. The first is to provide input data for model calibration and validation. These data have been collected from already existing sources and continue to be collected under a number of field programs funded by the NUTP. The second section of the Measurements program is the development of fundamental understanding of the pathways used by radionuclides towards mankind.

Of key importance here, is the chemistry of the source terms. Understanding the chemistry of radium and the other radionuclides is essential to designing a model that can be applied over the long-term. As much as possible, the Program is trying to define the chemistry within the tailings pile, including the interactions between the various components. Of particular interest for the Elliot Lake region is the oxidation of sulphur bearing minerals, including the role played by bacteria. Development in this area is, of course, applicable to the Reactive Tailings Sulphides Program (RATS).

Although atmospheric dispersion modelling has been well studied, the current method is to input field data. The NUTP has been investigating the suspension of dust from the tailings surface with a view to developing a predictive model that will provide the input data required by the atmospheric dispersion models.

Radon has always been the key issue when assessing the impact of tailings placement. A contract to show the dispersion of radon at Elliot Lake will be completed by late 1985. The project to investigate the effect on release rate of radon by vegetating the surface of the path was completed in early 1985, and showed that under Canadian conditions vegetation has relatively little effect. It is likely that the major controlling factor is the moisture content of the tailings. Only in climates where revegetation is able to reduce the water level significantly, will there be an effect on radon release.

The NUTP sees sedimentation as being a major sink for radionuclides. Therefore, a series of contracts have been awarded to study various aspects of the sedimentation process. This will include an investigation of the re-mobilization mechanisms of radionuclides from the sediments after mining and milling have ceased.
The above items give some indication of the types of work undertaken so far. To date, about 100 contracts have been funded by the NUTP. These range from very small contracts to do specific analyses on a small number of samples to major field programs with costs approaching three quarters of a million dollars.

CONCLUSION

The National Uranium Tailings Program is approaching the end of its five-year mandate. At the recommendation of the TAC, priority in the last year of the Program, has been given to a limited demonstration of the Uranium Tailings Assessment Program (UTAP) model at two sites (Lacnor, Elliot Lake, Ontario, and Rabbit Lake, Saskatchewan). The results of these projects will help in deciding what further development or application work, if any, is required.

The balance of the remaining resources are being used to develop a better understanding of the fundamental science associated with long-term consequences of uranium tailings. This is an area in which the government has the responsibility to show leadership. It is doing this, while at the same time encouraging the development of scientific skills within the private research community, by using a competitive bid approach. The currently available resources will allow the development stage of the program to be completed and will result in a functional model tested under limited conditions, to predict the long-term consequences of uranium tailings on mankind and the environment.

THE REACTIVE ACID TAILINGS SULPHIDES PROGRAM

The mining industry has long been concerned with the management of acid generating sulphide tailings during operation of the facility. Management practices were meant to ensure that effluents from these tailings path do not adversely affect the surrounding environment. As the mining operation comes to completion, concern now centers on the measures required to rehabilitate these tailings. Each province has established guidelines and objectives for the reclamation of mine tailings areas. However, each tailings area presents somewhat different problems of control, and many of the factors required to predict the effects of abandonment are not well known.

The Reactive Acid Tailings Sulphides Program originated as a request from the metal mining industry in 1983. The
purpose is to investigate the problems associated with the abandonment and long-term management of acid generating tailings. A contract report defined the issues and recommended a research program (3). The report also proposed a concept of an industry/government cost-shared approach which was supported by CANMET.

Initially meetings were held between representatives of the mining industry and CANMET, where it was decided the program should emphasize the integration of a broad spectrum of practical tailings management investigation under field conditions. The objective would be to produce an inventory of practical techniques which would enable the impact of acid generating tailings to be sufficiently reduced as to allow the ultimate abandonment without the need for continuing intervention.

In March 1985, a contractor was retained to design a specific program of work to meet the objectives of the Reactive Acid Tailings Sulphides Program, to assess the projects proposed by the mining industry for joint funding, and to incorporate any other investigation or research work consistent with the program objectives (4).

Initial inputs to the program were obtained through a series of meetings between representatives of the mining companies having acid generating tailings and officials of the provincial agencies concerned. These meetings allowed the industry representatives to outline the work which they felt necessary to address the long-term management of acid tailings and, also, provides for a general exchange of information with provincial officials in the context of regional objectives. Meetings were also held with the NUTF staff to ensure that there would be little overlap and that both programs would complement each other.

The results of these efforts showed that there were more than 500 million tonnes of sulphide tailings, covering 81 000 ha stored in various locations throughout Canada. During the past twenty years the mining companies have expended considerable efforts and funds to rehabilitate tailings areas, mainly through vegetation, but in many instances acidic effluents are still being generated. This supported the need for further research and development in the technology for the long-term management of these tailings. Therefore, it was recommended that a three to five year program be implemented to include the following activities:

a) Technology transfer to ensure that information
concerning well established technologies is available to the mining industry (revegetation, containment disposal and effluent control practices);

b) Development of predictive techniques related to physical and chemical behavior of tailings;

c) Development of more effective methods for the disposal of tailings;

d) Development of methods to inhibit and control the generation of acidity and,

e) Assessment of these specific benefits and effects of revegetation as an inhibitor of acid generation.

It was estimated that the total cost of this program would be about $2.5 million for contract work (from the government) and an equal amount for field services from the mining companies.

Currently, there are three projects underway. They are as follows:

a) An examination of the Waite Amulet Tailings of Noranda Mines to determine the physical and chemical state of sulphide tailings which have been vegetated for over seven years. The project will determine the quality and quantity of effluents through the path to the environment.

b) The revegetation of the Levack Mine tailings of Inco Limited. In this project it is hoped to encourage the establishment of wetlands and vegetation on highly acidic sulphide tailings.

c) A project at the Fecunis tailings of Falconbridge aimed at reducing acid generation and metals release from sulphide bearing tailings using waste rock, organic covers and chemical treatment. A second objective is to establish a swamp on Fault Lake sulphide tailings.

In addition to these projects, float tailings were established as an osmosis barrier over the pyrrhotite tailings at Cominco Limited in Kimberley, B.C. Vegetation is now being established on these tailings and the results will be evaluated at a later date.

POTASH TAILINGS IN SASKATCHEWAN

The potash industry in Canada was started in the 1960’s and is concentrated mainly in the Province of Saskatchewan.
Approximately 150 million metric tonnes of tailings are now on the surface from the production of 100 million tonnes of potash. In the past little was known of the fundamental nature of potash waste and their interaction with environment. In 1981 the Potash Corporation of Saskatchewan (P.C.S.) formed an environmental affairs section and is now spending almost $1 million annually on research studies on the disposal of waste. CANMET has already shared a number of contracts with P.C.S. which have carried out research in the following areas:

1. Investigation of the physical and chemical properties of salt tailings and associated clays.
2. Identification and description of two case historic of potash tailings on surface and in underground environments.
5. Insitu Permeability Measurement of Potash Tailings.
7. Investigation into Weathering of the Surface of Potash Tailings in Saskatchewan.

These projects have been designed to establish a sufficiently broad database on which to make decisions about long-term management practices. This process is ongoing and is expected to continue for some time into the future under the Mineral Development Agreement between the federal government and the Province of Saskatchewan.

SUMMARY

CANMET, by virtue of its major effort into tailings research, is upholding the Government's responsibility to assist the industry overcome major generic problems. By adopting a cooperative approach between the industry, the regulatory agencies and the government research staff at CANMET, the resultant research programs have been more efficient and effective. In addition to a better use of limited research funds, the sharing of technical information and programs has resulted in a better coordinated, more focussed program. Unnecessary duplication is being avoided and the items with highest overall priority are being resolved first. CANMET recognizes that other types of
tailings beside potash, sulphide and uranium tailings exist in Canada and it is hoped that work can be done in these areas in the future. However, at this time, the existing programs will continue to have the highest priority and continuing work is planned for the near future.

REFERENCES
