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Canada Centre for Mineral and Energy Technology | Centre canadien de la technologie des minéraux et de l'énergie

PROGRESS DURING THE SECOND HALF OF 1986 IN THE ENVIRONMENT PROJECTS OF THE CANMET MINERALS PROGRAM

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by

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ABSTRACT

The brief summary of activities described herein is designed to acquaint members of the Joint Panel on Occupational and Environmental Research for Uranium Production in Canada with the main project element objectives and outputs of the environment projects (underground and surface) carried out by CANMET (E.M.R.).

This report covers major outputs achieved by the technical staff of MSL, MRL, and the National Uranium Tailings Program Office, from the last meeting of the Joint Panel, Saskatoon, Saskatchewan, May 27-28, 1986 to the present. Information on past outputs can be found in the following reports: MRP/MRL 79-46(OP), MRP/MRL 79-96(OP), MRP/MRL 80-78(OP), MRP/MRL 80-119(OP), MRP/MRL 81-72(OP), MRP/MRL 81-136(OP), MRP/MRL 82-56(OP), MRP/MRL 82-133(OP), MRP/MRL 83-50(OP), MRP/MRL 83-102(OP), MRP/MRL 84-59(OP), MRP/MRL 84-108(OP), MRP/MRL 85-90(OP), M&ET/MRL 86-1(OP), and M&ET/MRL 86-72(OP).

The descriptions that follow are pertinent to two areas of particular interest to members of the Joint Panel:

a) Radiation Source Identification, Measurement and Control;

b) Methods of Treating Tailings and Control of Tailings Effluents.

The project element numbers that appear on the right hand side of the headings refer to CANMET numbers. Information regarding CANMET research projects is given at the end of this report.

Key words: Environment; Radioactivity.

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RÉSULTATS DES PROJETS DE RECHERCHE SUR L'ENVIRONNEMENT RÉALISÉS DANS LA DERNIÈRE MOITIÉ DE L'ANNÉE 1986, DANS LE CADRE DU PROGRAMME DE RECHERCHE SUR LES MINÉRAUX DE CANMET

par

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RÉSUMÉ

Le résumé des activités présentées dans ce rapport s'adresse aux membres du Comité conjoint de recherche sur les conditions environnementales et le milieu de travail des employé(e)s qui oeuvrent dans le domaine de la production d'uranium au Canada. Il vise à les renseigner sur les objectifs de chaque élément du projet principal et sur les résultats des projets visant l'amélioration de l'environnement (mines souterraines et à ciel ouvert) réalisés par CANMET (EMR).

Le rapport couvre les principales réalisations du personnel technique de LSM, LRM et du Bureau du Programme national de recherche sur les résidus d'uranium, à compter de la dernière réunion du Comité mixte qui s'est tenue à Saskatoon, les 27 et 28 mai 1986, à ce jour. L'information sur les réalisations antérieures est incluse dans les rapports suivants :
PRM/LRM 79-46(OP), LRM/PRM 79-96(OP), PRM/LRM 80-78(OP), PRM/LRM 80-119(OP), PRM/LRM 81-72(OP), PRM/LRM 81-136(OP), PRM/LRM 82-56(OP), PRM/LRM 82-133(OP), PRM/LRM 83-50(OP), PRM/LRM 83-102(OP), PRM/LRM 84-59(OP), PRM/LRM 84-108(OP), PRM/LRM 85-90(OP), M&TE/LRM 86-1(OP), M&TE/LRM 86-72(OP).

Les descriptions qui suivent touchent deux secteurs d'intérêt particulier pour les membres du Comité mixte :

a) Identification des sources de rayonnement. Mesure et contrôle;

b) Méthodes de traitement des résidus et contrôle des effluents.

Le numéro de l'élément de projet qui apparait à la droite des titres fait rapport aux numéros de CANMET. L'information sur les projets de recherche de CANMET est présentée à la fin du rapport.

Mots-clé : Environnement; Radioactivité.

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14.39.03 RADIATION (EMR-2.1, 2.3 & 2.4)

The project element objectives are: to develop radiation instrumentation and to undertake radiation studies to determine radiation levels produced in various mining operations; to identify the major factors affecting the release of radioactive products in mine air; and to develop control methods capable of reducing radiation to acceptable levels.

INSTRUMENT DEVELOPMENT AND TECHNICAL EVALUATION (EMR-2.1)

A contract for the development of a radon daughter/thoron daughter personal dosimeter of the active kind awarded (1985/86) to Thomson and Nielssen (Ottawa) has been completed. The dosimeter can also operate in a passive fashion. This instrument uses semiconductor IC memory technology, i.e., Dynamic Random Access Memory (DRAM) units, to count and store α-particles. The first prototype has been delivered to the Elliot Lake Laboratory (March 1986). An underground technical evaluation of the instrument has been conducted, and the results have been presented at an International Conference (Pittsburgh, May 1986). The dosimeter will also be thoroughly tested in the new radon/thoron test facility (RTTF).

The results of a personal α-dosimetry program at Rio Algom during the period 1983-1985 have been analyzed. The dosimetry program was carried out at two Rio Algom Mines: Quirke II and Stanleigh. Both mines used the CEA track-etch dosimeter. A reduced dosimetry program at Panel Mine was also conducted using the Alpha-NUCLEAR personal dosimeter.

The Elliot Lake Laboratory has conducted the analysis of the data in collaboration with Rio Algom technical staff. Some of the results obtained will be presented at this Joint Panel meeting in Hull, Quebec, 25-26 November, 1986.

NATIONAL RADON/THORON TEST FACILITY (RTTF)

A radon/thoron test facility (RTTF) to be used as the National facility for testing and calibrating radiation instrumentation used for AECB compliance purposes, and other purposes, has been designed. The RTTF has been installed at the new CANMET/Elliot Lake Laboratory site. Full operation of this facility is expected sometime in 1986/87.

The RTTF will feature a wide range of operating conditions such as:

1. Radon, thoron and arbitrary mixtures of both;
2. Radon daughters, thoron daughters and arbitrary mixtures of both.
3. Variable temperature;
4. Variable relative humidity;
5. Variable aerosol type, concentration and size distribution; and
6. Variable air flow rate.
7. Capabilities have been provided for injecting long-lived radioactive dust to simulate underground uranium mine atmospheres. However, no instrumentation for this purpose have been acquired because of lack of funding. The same applies to gas chromatography to measure tracer gases used in plate-out studies, and air residence measurements.

In addition, the RTTF can be operated in a flow-through fashion and in a recirculating mode. Special provisions are being made to allow for automatic, unattended, control of the radiation level by means of a computer system, dedicated sensors, and a specially developed software package.

ENVIRONMENTAL RADIATION LEVEL DETERMINATION (EMR-2.3)

A long-term research program aimed at determining long-lived radioactive dust (LLRD), and radioactive dust (RD) in general, in underground uranium mines (Ontario) and mills is in progress. Thus far, this program has been confined to a reduced number of locations, mines and mining operations.

Because LLRD and RD have become important in radiological protection and health physics, their characterization and quantification cannot be stressed adequately. CANMET proposes to extend studies of LLRD and RD to other areas, particularly Ontario and Saskatchewan uranium mines and mills, in collaboration with interested mining companies.

Recent studies have been conducted on a conveyor belt and a crusher at Rio Algom as part of a Radiation/Respirable Dust/Ventilation program carried out in November 1985 (see below). Further studies have been carried out at an AMOK Ltd. uranium mill (Cluff Lake, Saskatchewan) under AECB financial assistance. More recently, LLRD and radiation studies have been undertaken at Rio Algom in conjunction with the installation of a water scrubber at the crusher/conveyor belt, where previous measurements were conducted, for control purposes (see below).

Long-lived radioactive dust measurements carried out to date include concentration, size distribution, activity level, MMAD and AMAD. Identification has been carried out by means of α-spectroscopy, γ-spectroscopy and fluorometry. The above variables permit the exposure risk from this radiological hazard to be estimated. This work is, therefore, of great practical interest from the radiological protection point of view.

A major study aimed at investigating the relationship between radon progeny Working Levels, WL(Rn), and thoron progeny Working Levels, WL(Tn), in underground uranium mines is at present being carried out at Rio Algom Mines (Quirke II, Stanleigh and Panel Mines). If a firm relationship between WL(Tn) and WL(Rn) can be established, measurement of WL(Rn) alone could be used to calculate WL(Tn). This procedure would result in considerable savings in man-power requirements and time. Knowledge of WL(Tn) is important to calculate the total health risk associated with personal exposure in uranium mines. Total radiation exposure in uranium mines is composed of the following contributions:

radon progeny, thoron progeny, long-lived radioactive dust, and gamma-radiation.

The result of the above investigation will be compared with data collected since 1979, the year when a systematic study of this problem was initiated by the Elliot Lake Laboratory radiation group. Several thousand measurements of WL(Rn) and WL(Tn) have been carried out during the period 1979 to 1985.

The study on WL(Rn) and WL(Tn) indicated above will be complemented by an investigation in a local underground uranium mine, of 'overall average' radon and thoron source terms determined from direct experimental measurements aided by a theoretical radiation mine model developed at the Elliot Lake Laboratory and measurement of air residence time by tracer gas techniques.

UNDERGROUND ENVIRONMENT MONITORING AND CONTROL PROGRAM (EMR-2.4)

Radiation, respirable dust and ventilation are three research areas relevant to underground uranium mines. The Elliot Lake Laboratory has recently undertaken a series of combined studies on these areas in collaboration with the local underground uranium mines at Elliot Lake. At present the following items are being studied:

1. Characterization of airborne, and coarse, non-radioactive and radioactive dust, i.e., type, concentration and size distribution, in underground mines as related to mining operations such as mucking, slushing and rock fragmentation;
2. Optimization techniques to control and/or minimize production of dust, diesel particulates and radiation underground;
3. Development of radiation/airborne particulate/ventilation model(s) and dust/ventilation model(s), and verification of these models by field experimentation and ventilation surveys;

4. Radiation studies leading to better understanding of bacterial leaching;
5. Evaluation of personal α-dosimeters and dust instrumentation underground.

An investigation to estimate air residency times by conventional tracer gas analysis and by radiation techniques has been completed at Denison Mines in stopes where flood leaching is currently being practised. Another study to determine the effect of a charged water-spray system on respirable dust, LLRD, and radon and thoron progeny activity concentrations has recently been completed at Rio Algom Mines. Studies in this area will continue in the near future.

A study to evaluate the performance of a wet scrubber in a crusher/conveyor belt area for dust and radiation control purposes has been completed at Rio Algom (see above). The study showed a significant reduction of both variables when the wet scrubber was in operation.

An extension of some of the above items to other underground mines, uranium and non-uranium mines, is being considered for the near future, particularly in Western Canada, e.g., Saskatachewan.

TAILINGS MANAGEMENT TO MINIMIZE ENVIRONMENTAL IMPACT

The project element objective is to develop methods of tailings disposal and surface stabilization of inactive tailings piles, to reduce the detrimental effects of contaminant transport via wind and water erosion, surface runoff, and groundwater infiltration as a subsurface seepage. No further work on uranium tailings has been conducted by the Elliot Lake Laboratory surface environment group other than the work reported on Joint Panel report MRP/MRL 85-90(OP).

NATIONAL URANIUM TAILINGS PROGRAM (NUTP)

The National Uranium Tailings Program has issued over the last few

years a number of contracts. A status report from the NUPT is given below.

INTERIM STATUS REPORT FOR THE NUTP - NOVEMBER 1986

1. INTRODUCTION

Originally the next TAC meeting was planned for November 1986. Following the recommendations from the last TAC meeting (February 1986), the format of the last year of the NUTP was adjusted, primarily to include an application of the existing model (UTAP) to Lacnor and Rabbit Lake. At that time we had planned that information from these applications would be available by November. However, there have been delays with placing these contracts, mainly due to Supply and Services Canada's requirement to re-negotiate contrators' rates. Therefore, the additional information requested by TAC to help them in their decision-making process will not be available until January/ February 1987. We are currently targeting the 18th and 19th February for the next TAC meeting. This interim status report is to provide a brief resume of the progress made as of November 1986.

2. APPLICATION OF THE URANIUM TAILINGS ASSESSMENT PROGRAM (UTAP)

2.1 Lacnor

The contract was let to SENES Consultants Ltd. on August 20th, 1986. To date, SENES have assembled the data, both from the Lacnor study and the literature, to prepare it for transformation and into computer code input. They have written a specification and objective document outlining the major assumptions, the features of the tailings, the pathways to be considered, the major radionuclides to be included, the receptors to be considered and proposed various technology options. Initial review of the component models, input data required, and test programs have also been completed. They have done some scoping runs with the unmodified UTAP and representative data to ensure that the model

outputs are in the correct order of magnitude.

2.2 Rabbit

Beak Consultants Ltd. won the bidding and were awarded the contract on Sept. 2. Between Beak and Eldorado they have agreed on a detailed split of the work for model review and data collection. They have established the additional data requirement and plans are in place to take additional samples and analysis. They have also begun the modelling review.

3. BUDGET

3.1 Modelling

1720	SYVAC/UTAP (Phase II) Comparison I -	$ 8,600
1731	SYVAC/UTAP (Phase III) Comparison II -	58,735
1706	Phase III Model Develop.	65,948
1707	As/Ni Model	9,305
1728	Lacnor Application	232,707
1729	Rabbit Application	96,465
-	Optimization	30,000
1735	Peer Review	25,000
Sub-total		$526,760

3.2 Disposal Technology

1708	Consolidation	$36,500
1732	Dust (Gunnar)	10,000
1733	Sulphur Oxidation	70,000
1730	Disposal Technology	195,000
Sub-total		$311,500

3.3 Measurement

1710	Ra dissolution	$5,631
1718	SIMS	6,500
1723	Th. Geochemistry	69,429
1724	Biosphere Project	47,735
1725	Bacterial Study	23,200
1726	Thorium Analyses	3,000
1727	Ni/As Chemistry	72,400
1734	Tech Edit French (Analyt. Manual)	5,000
1712	Oxid Limits	31,398
1736	Ni/As Chem II	11,213
Sub-total		$275,506

3.4 Operating

DSS Charges/Travel/Office	$75,969	$ 75,969
TOTAL		$ 1,189,735
BUDGET		$ 1,189,800

4. STATUS OF THE CONTRACTS

4.1 Modelling

4.1.1 SYVAC/UTAP (Phase III) Comparison II

The intercomparison of SYVAC and UTAP at Phase II proved very useful. This new contract will make a similar comparison, but with the final Phase III model. WNRE are currently writing code specifications for SYVAC, from the Phase III model description.

4.1.2 Phase III

The Phase III development work is complete and the full documentation (four volumes) are available.

4.1.3 Arsenic and Nickel Modelling

This work is complete and the report is issued.

4.1.4 Optimization

This is a joint project with the Atomic Energy Control Board to develop an understanding of the technique for selecting the optimum close-out option.

4.1.5 Peer Review

This requisition is out for bid. We are asking the contractor to set-up a skilled technical team that will do an independent peer review of UTAP.

4.2 Disposal Technology

4.2.1 Consolidation

This work has been completed and the final report will be available soon.

4.2.2 Dust Study

This work was done to complement data collected at Gunnar. Samples were taken satisfactorily and are now being analyzed.

4.2.3 Sulphide Oxidation

This contract was intended to establish the effectiveness of various cover types in preventing the diffusion of oxygen and thus the oxidation

of sulphur. At about the time this requisition was issued, the Minister decided to review all proposed contracts. As no decision was received before the freeze up, the requision has been withdrawn. It will be re-issued as a laboratory investigation.

4.2.4 Disposal Technology Manual

This contract was awarded to Steffen, Robertson and Kirsten and work has started. The initial project meeting was held in September and a field trip to two operating mines was made in October. Completion is scheduled for March 1987.

4.3 Measurements

4.3.1 Radium Dissolution

This contract is finished and the report is available.

4.3.2 SIMS

This contract is finished and the contract report is available.

4.3.3 Thorium Geochemistry

The work has been completed and a seminar is scheduled for early November. The report will be available shortly after that.

4.3.4 Biosphere Project

The work is completed and the report will be available by next November.

4.3.5 Bacterial Project

The work has been done and the report is available.

4.3.6 Nickel and Arsenic Investigations

The work is complete and a seminar is arranged for early November. The report will follow shortly after this. An addendum of further studies will be available in early 1987.

4.3.7 French Analytical Manual

The Analytical Manual has been translated and is undergoing technical review. This is expected to be completed before the end of the year.

The French Analytical Manual should be available before March 1987.

4.3.8 Oxidation Limits

The final report will be available late November.

4.3.9 NiAs Chemistry (III)

Follow up studies of kinetic aspects of nickel and arsenic sediment/water transfer in Moira Lake will be completed and reported by March 1987.

ACKNOWLEDGEMENT

The author would like to thank R. John and G. Feasby for supplying material regarding NUTP.

RESEARCH PROJECT

No.

TITLE

INSTRUMENTATION DEVELOPMENT AND TECHNICAL EVALUATION

CODE EMR 2.1

REF.

SCALE

TOTAL PROJECT		CURRENT YEAR	
EST. COST	ELAPSED TIME	MAN YEARS	BUDGET
$	YEAR OF	PROF. TECH.	$

OBJECTIVE

To improve and standardize radiation measurement techniques.

PURPOSE OF WORK — RELEVANCE - JUSTIFICATION - RATIONALE

Radon, thoron and their decay products found in uranium mine atmospheres pose a health hazard to miners. The development of reliable instrumentation to accurately determine radiation levels is of great importance and the major aim of this study.

WORK PLAN — TASKS - ACTIVITIES - DECISIONS

		MILESTONE DATES
1.	To complete the development of a mine-based continuous monitoring system, with video terminal link to surface via phone line, for the measurement of radon/radon daughters/meteorological variables.	1987
2.	To evaluate U/G two personal alpha-dosimeters of the active/passive type using DJ and DRAM technology, respectively.	1986
3.	To develop radon (thoron) and radon daughter/thoron daughter monitors compatible with several microcomputer and the CONSPEC sytem.	1987

CURRENT STATUS

1. Modified radiation detectors, and considerably modified software and hardware are now being incorporated into the new continuous monitoring system prototype.
2. Laboratory tests on the final prototypes have been conducted. Instruments have been tested in underground environments.
3. Some contracts to that effect have recently been completed. Data not yet available.

SPONSOR

Energy, Mines and Resources Canada.

Nov./1986

DATE

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RESEARCH PROJECT NO.

TITLE

ENVIRONMENTAL RADON(THORON) DAUGHTER AND RADIOACTIVE DUST LEVEL DETERMINATION.

CODE EMR 2.3

REF.

SCALE

TOTAL PROJECT		CURRENT YEAR	
EST. COST	ELAPSED TIME	MAN YEARS	BUDGET
$	YEAR OF	PROF. TECH.	$

OBJECTIVE

To determine radon(thoron) daughter levels in conjunction with (a) ventilation and meteorological parameters and (b) aerosol and dust load and size distribution in uranium mines for different mining operations; (c) determine (identification and characterization) of radioactive dust, including long-lived radioactive dust (LLRD).

PURPOSE OF WORK — RELEVANCE - JUSTIFICATION - RATIONALE

Radon (thoron) decay products, dust and diesel particulates, in the respirable size range, and LLRD pose a health hazard to miners. Radiation and dust levels are controllable and/or dependent on ventilation conditions, meteorological variables and mining operations. Hence, an understanding of underground atmospheres can only be gained by determining the above variables simultaneously, and by investigating their inter-relationships. The final objective is to monitor the different variables of interest in a continuous fashion by means of a multisensor continuous monitoring system, and to compare radiation levels with theoretical predictions.

WORK PLAN — TASKS - ACTIVITIES - DECISIONS

	MILESTONE DATES
1. To investigate several mine radiation models and compare theoretical predictions with experimental data.	1984
2. To investigate the effect of backfill and other mining operations on U/G radiation levels.	to
3. To conduct LLRD studies in U/G uranium mines in Ontario and uranium mills in Saskatchewan.	1986

CURRENT STATUS

A considerable amount of work has already been done on the above items. Data are available in the form of technical reports and papers. Several oral presentations have also been made. Item 2 was initiated in November, 1983.
Items 1 and 3 are being continued.

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Nov./1986

DATE

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RESEARCH PROJECT No.

TITLE

CONTROL STRATEGY DEVELOPMENT

CODE EMR 2.4

REF.

SCALE

TOTAL PROJECT		CURRENT YEAR	
EST. COST	ELAPSED TIME	MAN YEARS	BUDGET
$	YEAR OF	PROF. TECH.	$

OBJECTIVE

To identify radon and thoron sources and evaluate control techniques at Canadian uranium mines using continuous monitoring techniques.

PURPOSE OF WORK — RELEVANCE - JUSTIFICATION - RATIONALE

Radon and thoron gases, through their decay products, largely determine the radiation hazards associated with alpha-radiation to uranium miners. It is, therefore, important to:

a) identify the sources of radiation by adequate measurement techniques, e.g. continuous monitoring, and

b) to control these sources by appropriate methods in conjunction with continuous monitoring of radiation levels (see item a) to determine the effectiveness of control techniques.

WORK PLAN — TASKS - ACTIVITIES - DECISIONS

	MILESTONE DATES
To monitor (with a continuous monitoring system) different mining operations and inactive mine locations (i.e. areas of no mining activity). In addition to the above, measurements have been performed in areas (active and inactive) where radiation control measures have been applied. Several control techniques have been investigated in the laboratory and are now ready to be tested underground. This work is conducted in conjunction with project EMR 2.3.	1984 to 1987

CURRENT STATUS

Some work has already been done (see EMR 2.3). In addition, a charged water spray system has been used (1985/1986) at a local Elliot Lake uranium mine to reduce radiation levels in conjunction with a dust control study at the same location. Other more conventional methods such as wet scrubbers have also been employed.

SPONSOR

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Nov/1986

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