

METALS IN THE ENVIRONMENT RESEARCH NETWORK (MITE-RN) RESEARCH PRIORITIES YEAR 4 AND 5

The MITE-RN program is intended to advance our understanding of risks to the environment posed by metals in the environment. It is anticipated that this multi-disciplinary research network will yield the following benefits:

- ▶ The relative inputs of metals to Canada's surface environment via natural and anthropogenic processes will be more clearly understood.
- ▶ The research will characterize important ecotoxicological endpoints in the context of metal speciation.
- ▶ The MITE-RN will provide a forum for universities, industry and government to work together. The existence of the Network will facilitate the addressing of common concerns and will provide an opportunity for these groups to form relationships that will be critical as Canada seeks to establish a sound risk management foundation for the safe use of metals.
- ▶ The Network will educate and develop a new generation of individuals whose skills and knowledge will be particularly valuable for Canadian industry in the future. The issue of metals in the environment will continue to be of prime importance as risk management strategies are developed. We will need informed people to carry out this immense task.

The results of the Network program will help Canadian industry in the metals resources and electricity generation sectors in their desire to manage their businesses responsibly, while enabling these businesses to thrive and provide meaningful employment to Canadians and a healthy balance of trade for the Canadian economy.

The primary geographic focus of MITE-RN is the Canadian Shield. Core metals are Cd, Cu, Ni, Hg, Pb, and Zn. Research proposals must address one or more of the following issues, which are subdivided into the three major domains of MITE-RN plus ecological risk assessment.

SOURCES RESEARCH DOMAIN

Research activities in the <Sources> Domain initially focussed largely on metal loading to various ecosystems from atmospheric deposition, with the goal of

estimating the proportions of this loading that originate from anthropogenic and natural sources. In Year 4, we have extended this research to include metals derived from natural

weathering processes. Overall, this research targets the origin and the chemical nature of metals posing potential environmental threats, and will help identify the most appropriate risk management strategies. The following research questions were identified in our original proposal:

- ❑ *What is the magnitude of metal emissions from natural sources? What are the metal species present in natural particulate fluxes?*
- ❑ *What are the most appropriate criteria and methodologies for source apportionment, natural vs. anthropogenic, of metal releases?*
- ❑ *What is the speciation of metals deposited from the atmosphere? Is the speciation determined by source characteristics or by transformations during transport?*
- ❑ *Can trace metal profiles in lake sediments be used as historical records of atmospheric deposition?*

PROCESSES RESEARCH DOMAIN

The <Processes> Domain currently includes six projects that focus on partitioning of metals among terrestrial and aquatic environmental compartments. The studies focus on: cycling of metals between soils and plants; bioaccumulation of metals in the aquatic environment, related to organism exposure routes; validation of methods for speciating metals in dilute aqueous solution; speciation of non-essential metals in the rhizosphere; speciation of metals relative to the oxic state of sulphur in water; and, watershed mobility of microelements. The broad questions addressed by <Processes> Domain are:

- ❑ *What are the relationships among total metal, bioavailable metal and bioaccumulation in environmental compartments?*
- ❑ *What is the role of organic and mineral surfaces in metal binding in abiotic compartments of the environment and how does this metal binding affect metal availability?*

A major unifying theme in the <Processes> Domain is relating the bioavailable fraction of metals to either bioaccumulation and/or biological responses, in the field. A second, and complementary theme that integrates the <Processes> Domain is quantifying and modelling the partitioning of trace metals among various compartments of the environment, enabling the prediction of mobility and eventual fate and accumulation.

IMPACTS RESEARCH DOMAIN

In the <Impacts> Domain, we have emphasized research on freshwater ecosystems. Aquatic environments, and in particular sediments, represent a very important sink for metals that are introduced into the surficial environment. As well, aquatic organisms are inherently vulnerable to metal pollution because dissolved metals are recognized to be more bioavailable than those associated with solids. The research includes both laboratory studies under controlled conditions and fieldwork along existing metal gradients (downwind and downstream from past/current metal smelters). At the conceptual level, clear linkages exist among the projects making up the <Impacts> program, e.g.: influence of metal speciation on metal bioavailability; importance of food and/or sediments as vectors for metal uptake; elucidation of metal detoxification mechanisms; detection of sub-clinical metal-induced effects in indigenous aquatic organisms and their predators. The following research questions were identified in our original proposal and are being addressed in the <Impacts> Domain:

- ❑ *How is metal speciation, in the exposure medium and within the exposed organism, related to metal-induced effects at the cellular and individual levels?*
- ❑ *Under conditions of chronic exposure, how does food ration (quality; quantity) affect metal toxicity at the organism level?*
- ❑ *Can metal body concentrations in exposed organisms provide a better insight into metal-induced effects at the organism and population levels of organisation than obtainable from environmental concentrations?*

A major integrating theme in the <Impacts> Domain is the need to link metal bioaccumulation (easily measured both in the laboratory test organisms and in field-collected indigenous organisms) and metal-related effects. A second, and complementary, integrating theme in the <Impacts> Domain is the development and testing of the *Biotic Ligand Model* (BLM).

MITE-RN RESEARCH PRIORITIES ADDED IN YEAR 4

In October 2001, the Network identified four new areas where research might profitably be encouraged (speciation of metals in precipitation; weathering rates and metal transfer from terrestrial to aquatic environments; genetic diversity and adaptation to metals; population level effects of metals in Rouyn-Noranda and Sudbury lakes) and solicited proposals from targeted university and government researchers. Two new proposals (A7, C5) were initiated in Year 4 to address these research goals.

ECOLOGICAL RISK ASSESSMENT PRIORITIES OF MITE-RN

The research projects being conducted under the MITE Research Network are closely aligned with the Canadian paradigm for ecological risk assessment as it

applies to metals. The results of the research projects will feed into a Risk Characterisation to produce the following major products (in addition to the individual reports and publications that are normally produced as part of a scientific study):

- ❑ A reevaluation of the overall risk of metals in the global environment based on the new information gathered by the above noted studies, and incorporation of other relevant and appropriate studies conducted by other researchers (not restricted to Canada or to researchers or organizations with whom linkages have been developed).
- ❑ A revised ecological risk assessment framework for metals in the environment, for both regional (e.g. Canadian Shield) and local risk assessments.

These two products, which integrate the results of the MITE Research Network, will be developed under the guidance of Dr. Peter Chapman (EVS Environment Consultants, North Vancouver, BC., Tel. 604-986-4331) and Dr. Peter Campbell (MITE RN, Research Director, Tel. 418-654-2538).