St. Lawrence TECHNOLOGIES

ABSTRACT

Ore-processing technologies have a great deal of potential for use in extracting contaminants from contaminated soil, sediment and sludge. Unfortunately, there is very little information available on this potential or on the limitations of existing environmental characterization methods in the treatment or reclamation of such contaminated matrices.

The assessment protocol presented here is modeled on ore-processing methods which locate the contaminants contained in the different grain-size fractions and identify their mineral composition and physical properties. The most appropriate and most economical treatment technologies are then selected and their performance verified and validated by means of treatment tests on the target matrices, both in the lab and at the semi-industrial scale.

INNOVATIVE TOOL

ASSESSMENT PROTOCOL OF THE APPLICABILITY OF ORE-PROCESSING TECHNOLOGIES TO TREAT CONTAMINATED SOIL, SEDIMENT AND SLUDGE

MAIN FEATURES

- **Overall approach**
  - Contaminated matrices are considered as low-grade ores
  - Methodology facilitates and accelerates the choice of the most efficient separation techniques
- **Ore characterization**
  - Information on contaminant particle-size distribution
  - Identification of form, physical properties and degree of liberation
- **Ore-processing technologies**
  - Proven and economical technologies based on simple principles of physical separation
  - Demonstrated effectiveness in extracting and reclaiming organic metals and contaminants

Saint-Laurent Vision 2000

Environment Canada Protection Québec Region
Environnement Canada Protection Région du Québec
Université du Québec Institut national de la recherche scientifique INRS-Géoressources
CRM CENTRE DE RECHERCHE MINÉRALE
Federal Office of Regional Development (Québec)
Bureau fédéral de Développement régional (Québec)

PROJECT OBJECTIVES

This project describes a protocol to determine the applicability of ore-processing technologies for the characterization and decontamination of soil, sediment and sludge. Developed by INRS-Géoressources and the Quebec government's Centre de Recherches Minérales, this protocol makes it possible to locate contaminants in the various grain-size fractions and to determine their mineral composition, with the aim of assessing their treatability using equipment employed in the mining industry.

The project was undertaken by the Environmental Innovation Section of Environment Canada. Among other priorities and objectives, this team works to develop guidebooks for assessing environmental technologies, to assist project promoters, consultants, universities, research centres and managers in the planning, designing, assessment and completion of decontamination projects.

This project was also intended to demonstrate the expertise, the analytic capacity and the different types of equipment available at Quebec universities and research centres, and to do treatability testing on soil, sediment, sludge and other industrial and municipal waste.

BACKGROUND

The use of ore-processing technologies for environmental applications such as soil, sediment and sludge decontamination is a relatively new field. One of the advantages of these technologies is that they are based on simple principles of physical separation.

In general, ore-separation technologies — whether by gravity concentration, flotation, magnetic or electrostatic separation — are less costly to operate than thermal or chemical technologies.

Unlike conventional environmental characterization methods, standard ore characterization methods were developed to identify the technologies suitable to the concentration and treatment of ore. These methods were adapted for environmental purposes with the aim of identifying the extractible forms of the contaminants so as to select the most appropriate treatment technologies.

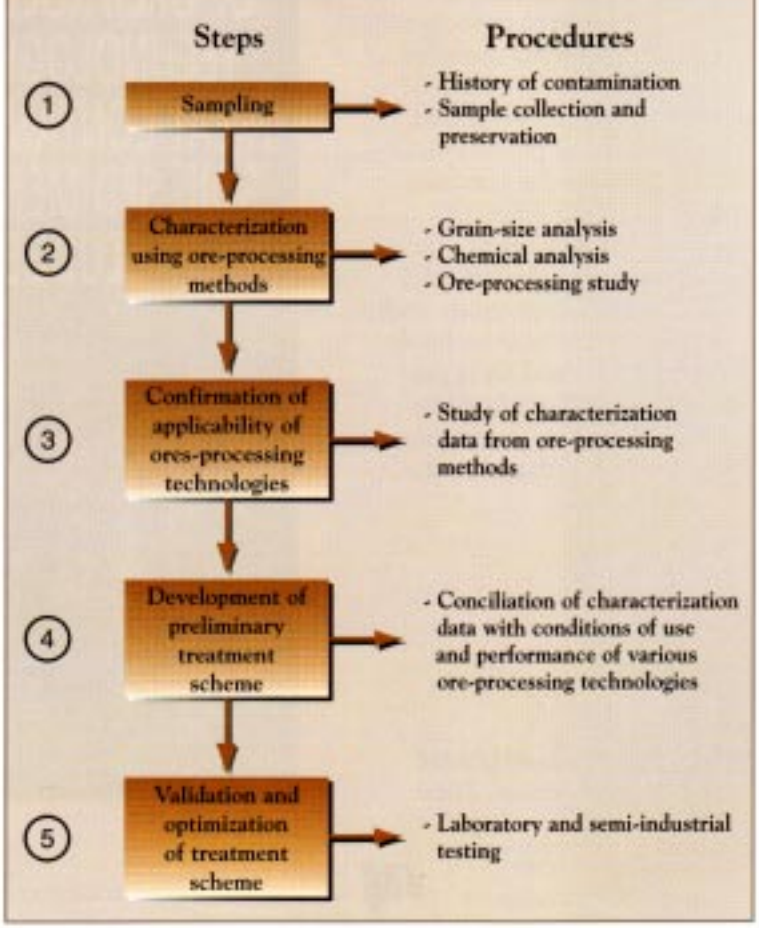
METHODOLOGY

Ore processing is defined as the group of ore treatment processes which concentrate the minerals in question in order to reduce the subsequent volume requiring costly treatment.

As shown in Figure 1, the assessment protocol of the treatability of soil, sediment and sludge using ore-processing technologies has five phases, each of which comprises different processes and analyses.

Among other things, an ore-processing study can identify mineral composition, determine bulk density, identify particle surface, ferromagnetic property and conductivity, and assess the degree of liberation of the inorganic contaminants present.

FIGURE 1.
STEPS IN THE ASSESSMENT PROTOCOL OF THE TREATABILITY OF SOIL, SEDIMENT AND SLUDGE USING ORE-PROCESSING TECHNOLOGIES



RESULTS

Using information obtained in the characterization study, the applicability of ore-processing technologies is then examined and the appropriate equipment selected.

As shown in Table 1, each type of technology requires precisely defined conditions of use relative to the different properties of the particles. The equipment selection strategy is shown in Figure 2.

The contaminated material must first be separated, either by screening or by classification. Each fraction so separated can then be treated using one or more of the four different technologies shown in Figure 2.

A preliminary treatment scheme is then prepared. It may be validated and optimized based on laboratory or semi-industrial testing.

FIGURE 2.
STRATEGY FOR THE SELECTION OF ORE-PROCESSING TECHNOLOGIES

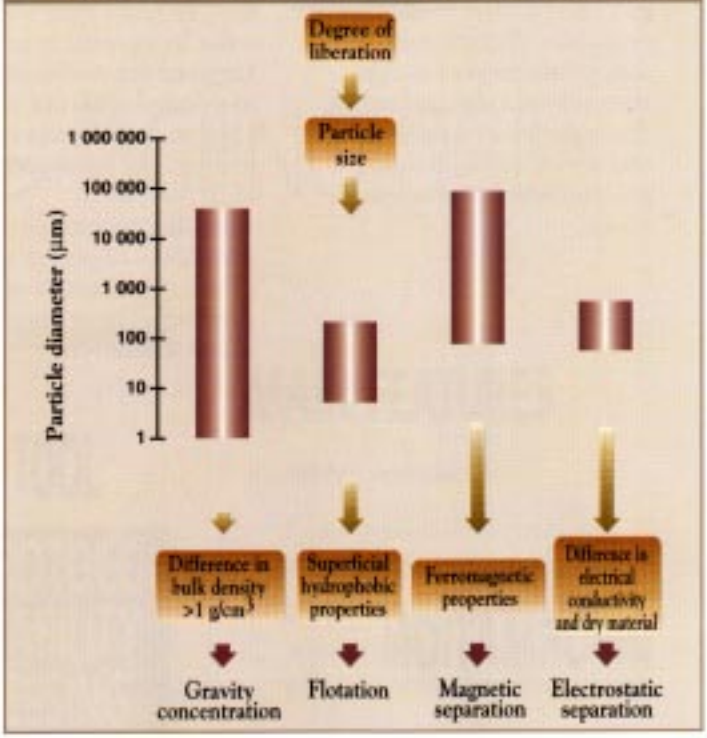


TABLE 1.
OPERATING PRINCIPLES AND CONDITIONS OF USE OF ORE-PROCESSING TECHNOLOGIES

Type of technology	Operating principle	Conditions of use
Gravity concentration (dense media separator, spiral separator, multi-gravity separator, etc.)	Difference in bulk density of ores	- Particle size > 1 µm - Difference in bulk density of materials > 1 g/cm^3 - Elevated degree of liberation of inorganic contaminants
Flotation (flotation cell and column)	Hydrophobic and hydrophilic properties of particule surfaces	- Particle size > 5 µm - Surface of particles to be separated exhibiting natural or chemically-stimulated hydrophobic properties - Average degree of liberation of inorganic contaminants (unagglomerated or melted form, or chemically associated with the matrix)
Magnetic separation (magnetic conveyor, wet drum separator)	Magnetic property of minerals	- Metal contaminants exhibiting ferromagnetic properties (iron, magnetite) - Particle size > 75 µm - Average degree of liberation of inorganic contaminants
Electrostatic separation (electrostatic or electrodynamic separator)	Difference in electrical conductivity of minerals	- Particle size between 60 and 500 µm - Elevated degree of liberation of inorganic contaminants - Materials to be separated must be perfectly dry

POTENTIAL AND LIMITATIONS

Potential

Ore-processing technologies can be used to economically decontaminate soil, sediment and sludge; they may also be applied to the beneficial treatment and reclamation of municipal, industrial and mining waste.

Limitations

An ore-processing approach may be employed where:
- the inorganic chemicals targeted are not chemically associated with the matrix;
- the material grain size is appropriate for separation; and
- the discrepancy between the values of one or many of physical properties of contaminants is large enough to allow separation.

Material with an average particle diameter smaller than 35 µm is not easily decontaminated using the physical treatment processes described in the lengthier final report.

Although, hydrometallurgical and pyrometallurgical technologies are not described in the report, the analytic methods proposed therein may be used to determine their applicability .

INFORMATION

This data sheet is based on research projects of the national scientific research centre INRS-Géoressources and the Centre de Recherches Minérales of the Quebec natural resources ministry. The projects received funding from Environment Canada. Also available, a lengthier document based on these projects, titled:

"*Assessment protocol of the applicability of ore-processing technologies to treat contaminated soil, sediment and sludge*".

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St. Lawrence TECHNOLOGIES

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