Metallic Mineral Exploration in Minnesota: Typical Exploration Activities

Division of Lands and Minerals
Minnesota Department of Natural Resources
Metallic minerals can only be mined economically where geologic processes have concentrated the metals into an ore deposit.

An explorer often searches at many places in a large area to try to discover one mine.
A phased approach to mineral exploration allows for cost-effective evaluation of many targets.

The first phase of a typical metallic mineral exploration program in Minnesota is a four-step process that can take anywhere from 1 to 20 years to complete.

1. Planning [1 – 5 yrs]
2. Land Package [1 – 5 yrs]
3. Exploration [1 – 10 yrs]
4. Evaluation

Mineral Exploration Phase I
The first phase of a typical metallic mineral exploration program in Minnesota is a four-step process that can take anywhere from 1 to 20 years to complete.

1. Planning
   - [1 – 5 yrs]
   - Develop a business plan
   - Identify a concept and exploration model
   - Secure financing

2. Land Package
   - [1 – 5 yrs]

3. Exploration
   - [1 -10 yrs]

4. Evaluation

Planning Activities
Concept: Using an Exploration Model

Current Lake Deposit
Magma Metals
9.3 Mt @ 2.4g/t Pt Eq
@1.1g/t Pt, 1.1 g/t Pd,
0.3%Cu+0.2% Ni

Tamarack Deposit
Rio Tinto
Intersection 166m @
2.33% Ni, 1.24% Cu +
0.75 g/t TPM

Eagle Deposit
Rio Tinto
4.1 Mt @ 3.6% Ni,
2.9% Cu + 1.6 g/t
TPM

1. Planning
   [1 – 5 yrs]
2. Land Package
   [1 – 5 yrs]
3. Exploration
   [1 – 10 yrs]
4. Evaluation
   [1 – 5 yrs]
An Exploration Model

CURRENT LAKE INTRUSIVE COMPLEX - SCHEMATICAL LONG-SECTION MODEL

North-West

MINERAL RESOURCE

- Current Lake Zone
- Bridge Zone
- Cloud Zone
- Beaver Lake Zone
- South East Anomaly

South-East

Massive sulphides in depressions at base of intrusion

Potential Feeder

“Eagle-style” high-grade massive sulphide targets in feeder structures

Pt-Pd-Cu-Ni Mineralization:
- Disseminated Sulphides
- Massive sulphides

1. Planning [1-5 yrs]
2. Land Package [1-3 yrs]
3. Exploration [1-10 yrs]
4. Evaluation [1-15 yrs]
The first phase of a typical metallic mineral exploration program in Minnesota is a four-step process that can take anywhere from 1 to 20 years to complete.

1. Planning [1 – 5 yrs]
2. Land Package [1 – 5 yrs]
3. Exploration [1 – 10 yrs]
4. Evaluation

Acquire a Land Package
- Secure the rights to explore for minerals over a buried geological target feature
- Land package may include:
  - State mineral leases
  - Private mineral leases
  - Federal prospecting permits
Example of Exploration Land Package

Exploration Land Package
Prime Meridian Resources
Winterfire Prospect
Koochiching County, MN
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1. Planning [1 – 5 yrs]
2. Land Package [1 – 5 yrs]
3. Exploration [1 -10 yrs]
4. Evaluation

Exploration
- Test many buried geologic features to discover an ore deposit in the bedrock
- Use these exploration methods
  - Geologic Mapping
  - Geophysics
  - Geochemistry
  - Drilling
**Exploration**: Explorer surveys many possible sites using a selection of exploration methods
- **geophysics** uses remote sensing to measure physical properties
- **geochemistry** measures chemical content in the landscape around the selected feature
- **geologic mapping** to define the buried geology and the locations, if any, of the metal being sought
- **drilling** obtains samples of the bedrock to measure the metal content and refine the buried geology map
Walk on property to observe, map, and sample any bedrock outcrops
Geophysical Surveys

- Remotely measures the physical properties (e.g. magnetism, density, electrical conductivity) of the buried bedrock
  - From a helicopter or fixed-wing plane
  - From the surface of the ground
  - From within an exploration borehole
  - From the drill core (or bedrock outcrop) sample
Helicopter Survey during Winter 2010-11
Geophysical Equipment
Example of a Geophysical Line
Down – Hole Geophysical Equipment
Example of Geophysics and Selection of Drill Sites
Geophysical Model of Buried Target to be Drilled

1. Planning (1–5 yrs)
2. Land Package (1–5 yrs)
3. Exploration (1–10 yrs)
4. Evaluation
Geochemical Sample:
Glacial till collected below the soil horizons to be tested for platinum and palladium
Drill Rig to Obtain Bedrock Core Samples
Personal Safety Near Heavy Equipment:
Be sure the operator sees you
Drill Bit and Drill Core Sample
Drill Core is put into boxes
Example drill core sample that contains copper
What a geologist learns from a drill core?
Exploratory Boring Location After Drilling
Drill Site Location After Boring Sealed
During Drilling and After
[Same Location After One Growing Season]
The first phase of a typical metallic mineral exploration program in Minnesota is a four-step process that can take anywhere from 1 to 20 years to complete.

1. Planning [1 – 5 yrs]
2. Land Package [1 – 5 yrs]
3. Exploration [1 -10 yrs]
4. Evaluation

Evaluation

• Determine whether the exploration results fit the business plan
• Decide whether to:
  • Continue the project; or,
  • Terminate the lease and move on to a different target. 99% of state leases were terminated after year 10 because no discovery was made.

Mineral Exploration: Phase I
There were 23,757 total forty-acre parcels leased during the 46 year historic data time period:

- **Geochemistry**: was done on 28% of the forty-acre parcels
- **Geophysics**: no estimate because we do not have the digital data to query this
- **Drilling**: was done on 3% (559) of the forty-acre parcels

If any activity takes place, the activity typically would require about a month time period. The impacts are minimal and temporary in nature, such as the cutting down of some vegetation for an access trail.
The End