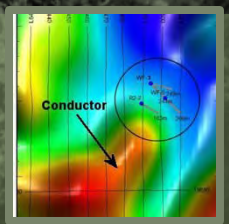
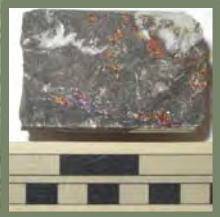


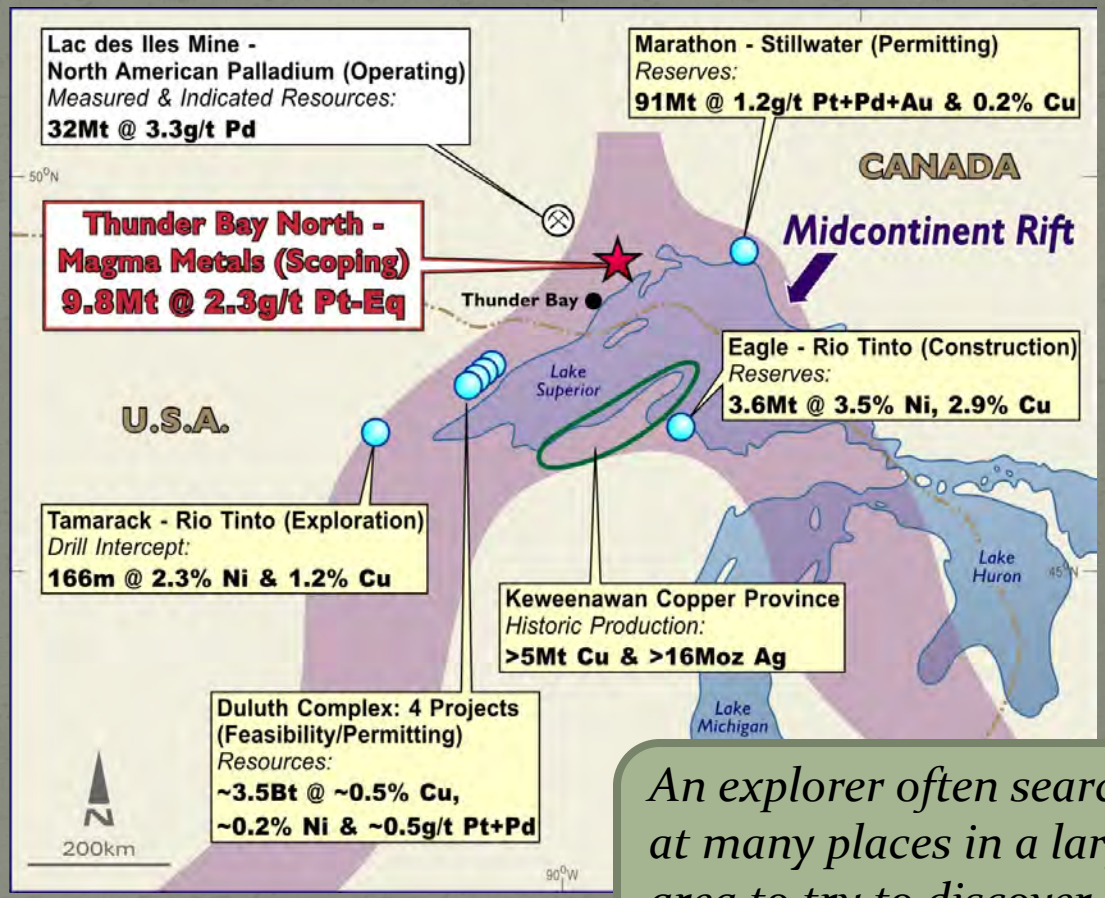
Metallic Mineral Exploration in Minnesota: Typical Exploration Activities



Division of Lands and Minerals
Minnesota Department of Natural Resources

Exploring for Undiscovered Mineral Deposits

Metallic minerals can only be mined economically where geologic processes have concentrated the metals into an ore deposit.

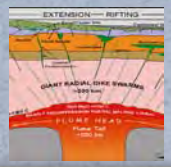


An explorer often searches at many places in a large area to try to discover one mine.

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]



2. Land Package
[1 – 5 yrs]

3. Exploration
[1 -10 yrs]

4. Evaluation

A phased approach to mineral exploration allows for cost-effective evaluation of many targets

Mineral Exploration Phase I

The first phase of a typical met exp progra Minnesot four-step process that ca 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

Planning Activities

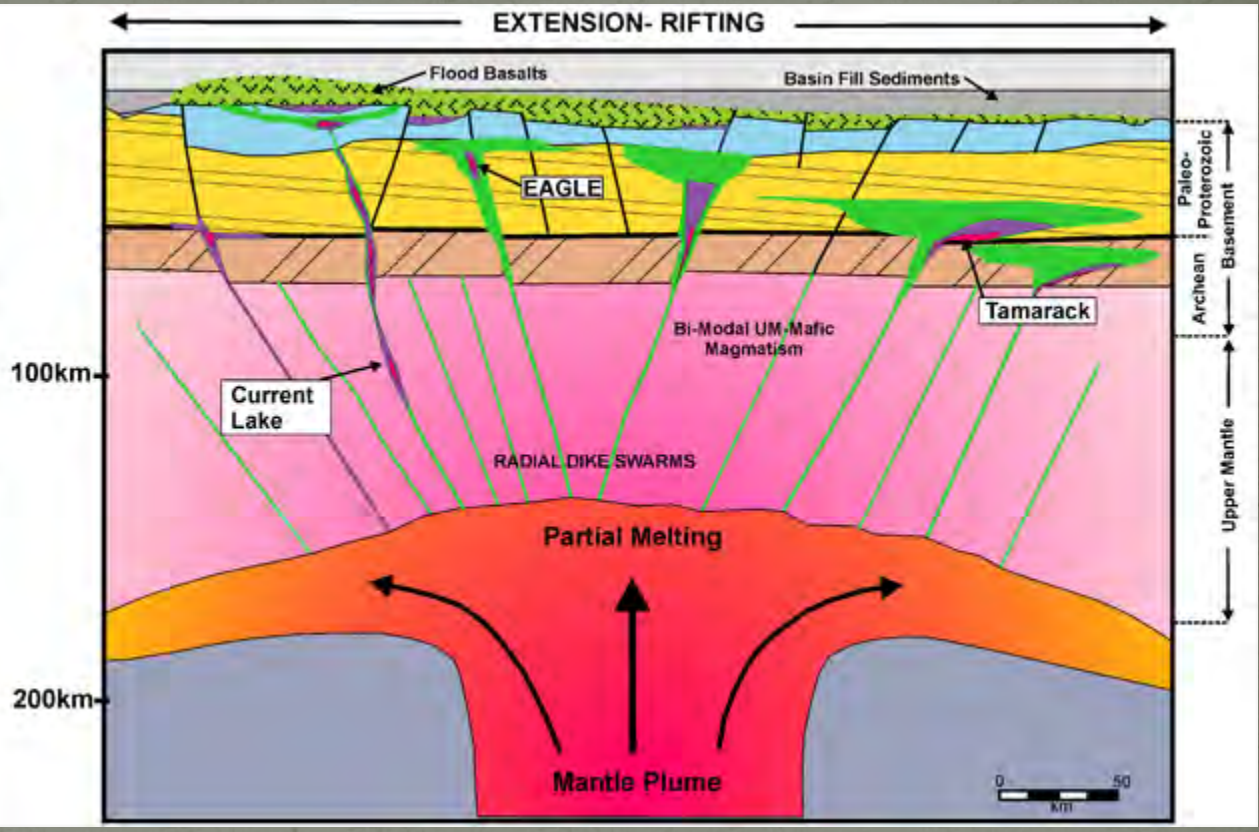
- Develop a business plan
- Identify a concept and exploration model
- Secure financing

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

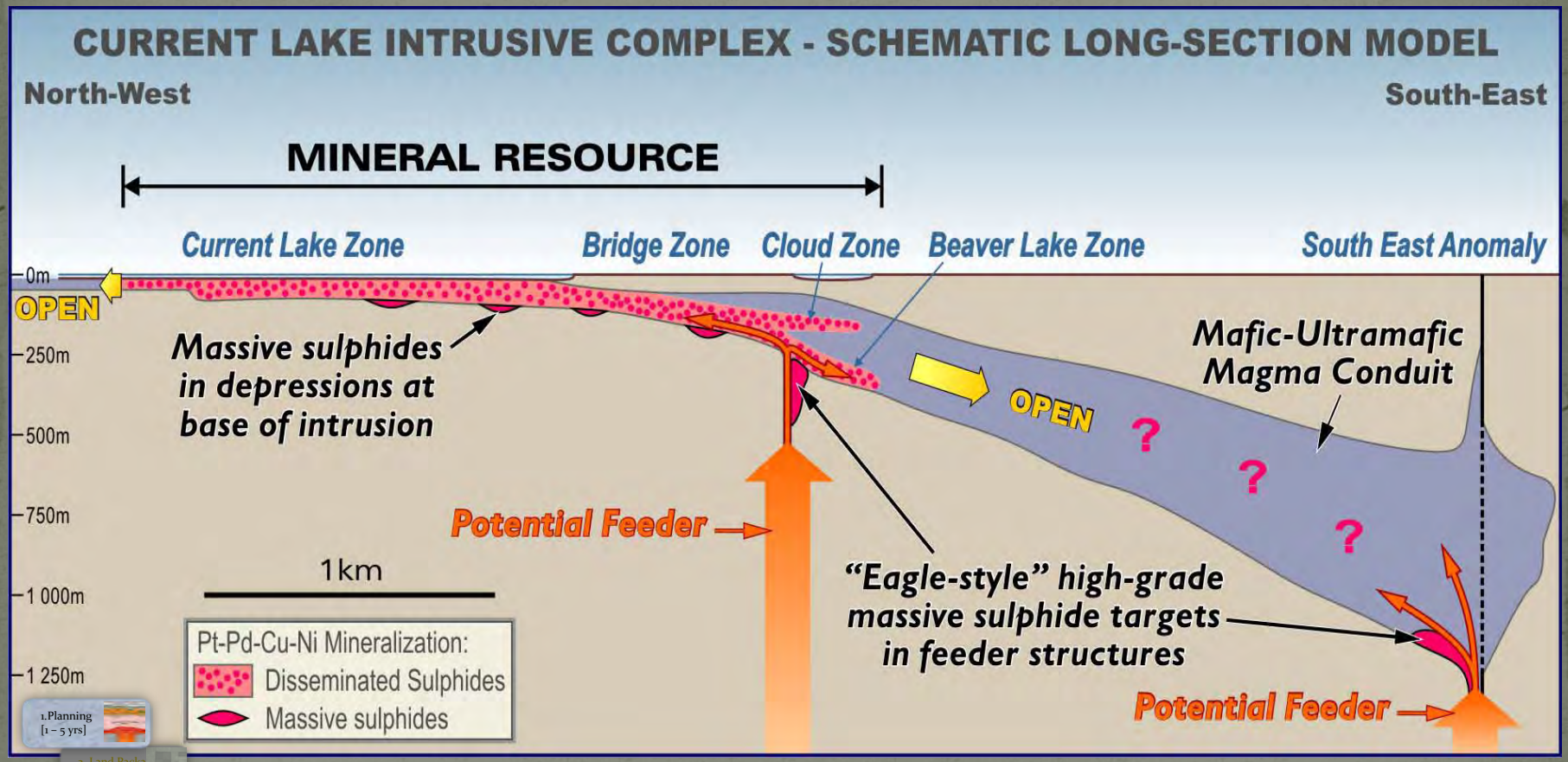
Tamarack Deposit
Rio Tinto
Intersection 166m @ 2.33% Ni, 1.24% Cu + 0.75 g/t TPM

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



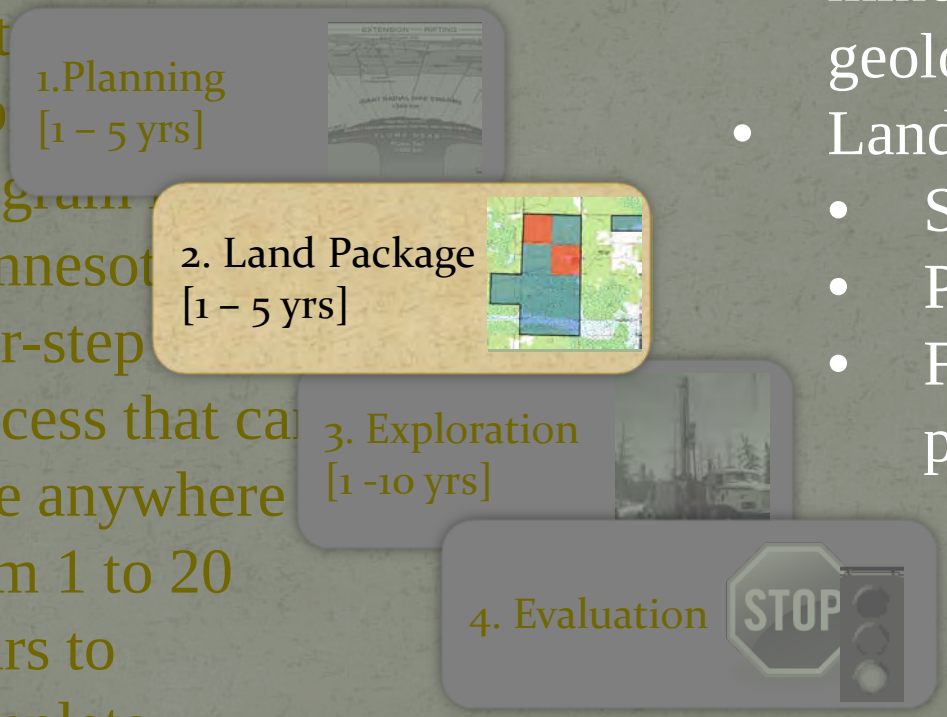
1. Planning [1 – 5 yrs]
2. Land Packa [1 – 5 yrs]
3. Exploratio [1 -10 yrs]
4. Evaluati

An Exploration Model



Mineral Exploration: A Phased Approach

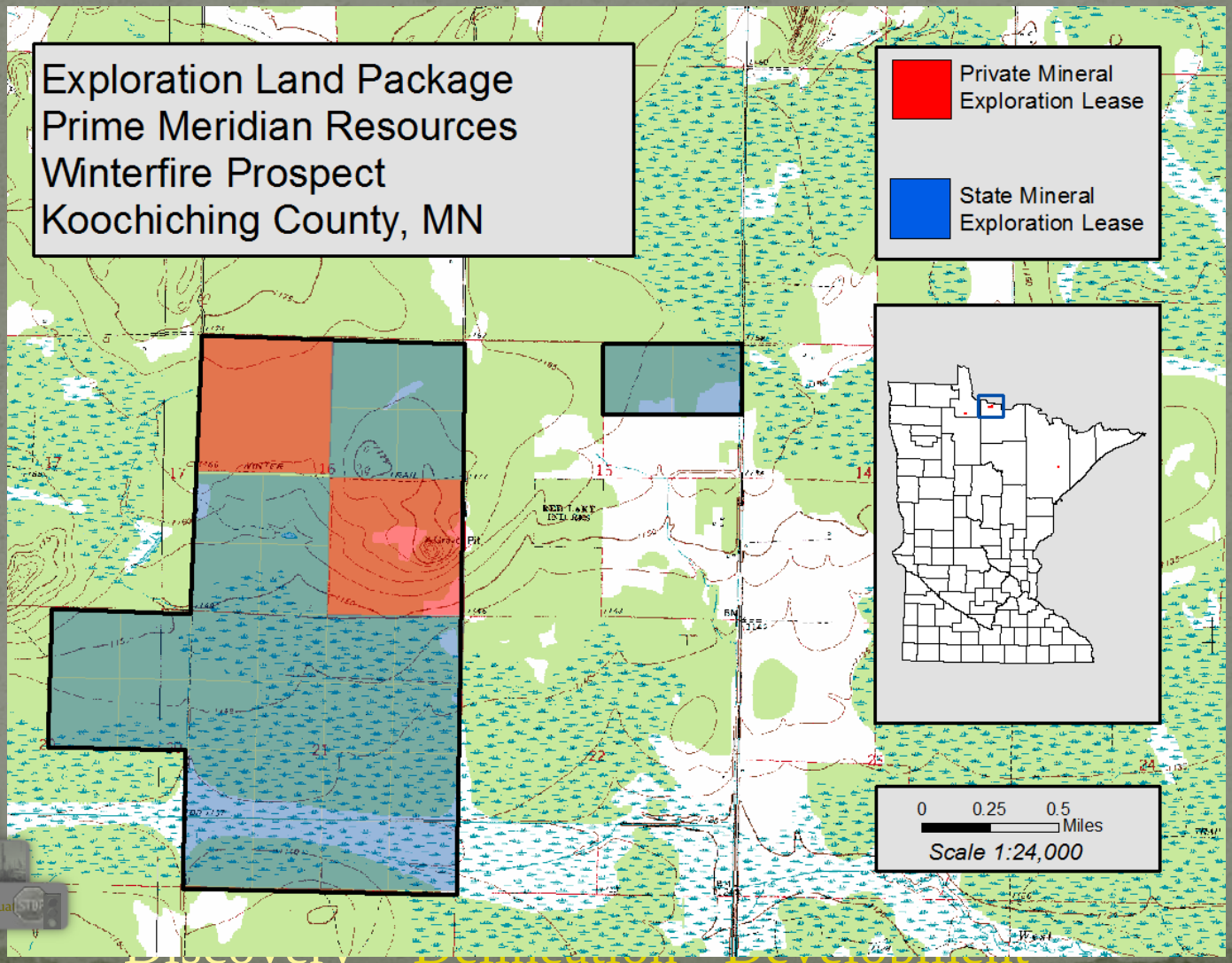
The first phase of a typical met exp progra Minnesot four-step process that ca take anywhere from 1 to 20 years to complete.



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



1.Planning [1 – 5 yrs]
2. Land Package [1 – 5 yrs]
3. Explorat [1 -10 yrs]
4. Evalua

Discovery Delineation Development

Mineral Exploration: A Phased Approach

The first phase of a typical met exp program Minnesot four-step process that ca 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

Exploration

- Test many buried geologic features to discover an ore deposit in the bedrock
- Use these exploration methods
  - Geologic Mapping
  - Geophysics
  - Geochemistry
  - Drilling

Exploration Activities Summary

- **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

Discovery – Delineation - Development

Walk on property to observe, map, and sample any bedrock outcrops

1. Planning [1 – 5 yrs]
2. Land Packa [1 – 5 yrs]
3. Exploratio [1 -10 yrs]
4. Evaluati

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

1. Planning [1 – 5 yrs]
2. Land Packa [1 – 5 yrs]
3. Exploratio [1 -10 yrs]
4. Evaluati

Geophysical Equipment

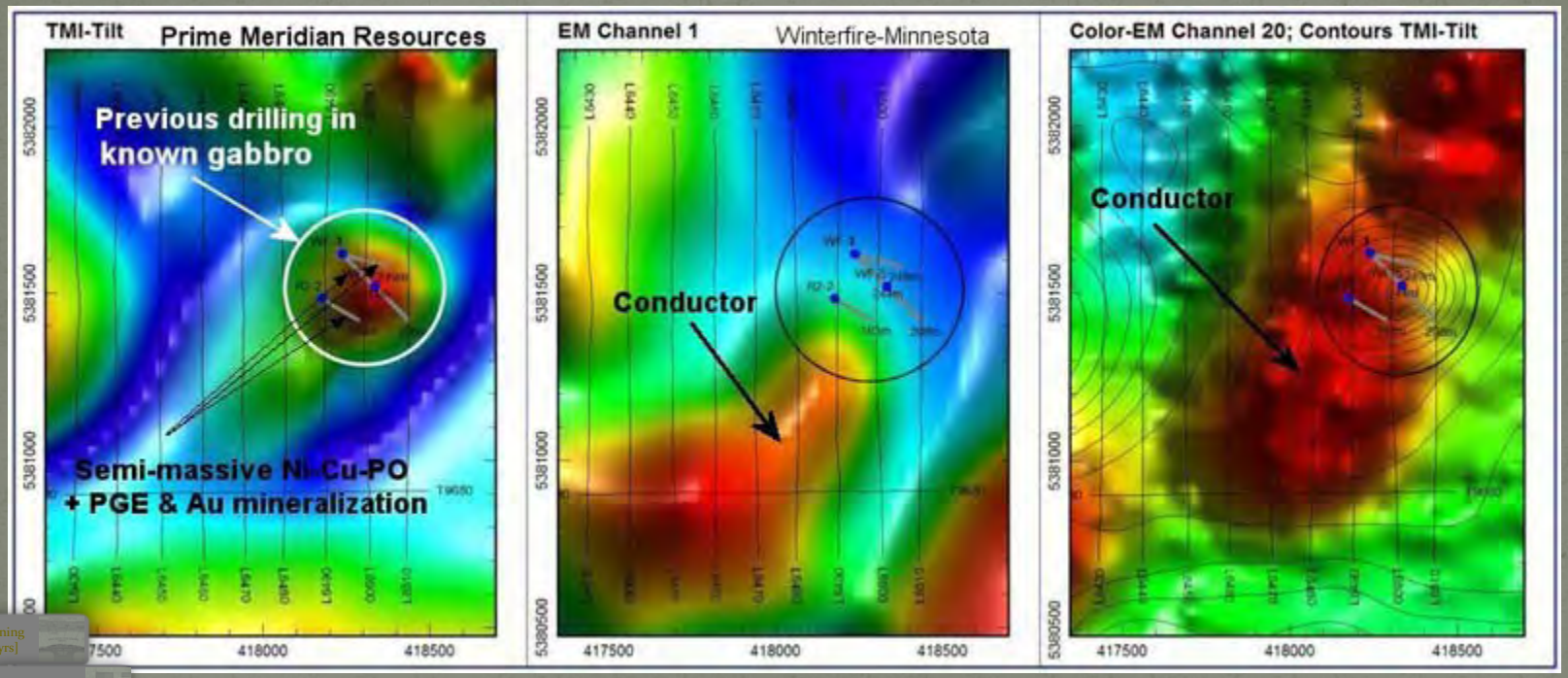
1. Planning [1 – 5 yrs]
2. Land Packa [1 – 5 yrs]
3. Exploratio [1 -10 yrs]
4. Evaluati

Example of a Geophysical Line

1. Planning [1 – 5 yrs]
2. Land Packa [1 – 5 yrs]
3. Exploratio [1 -10 yrs]
4. Evaluati

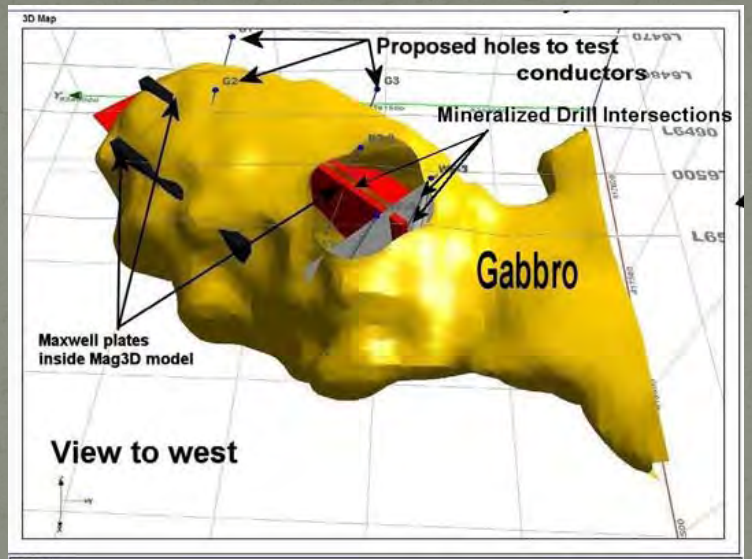
Down –Hole Geophysical Equipment

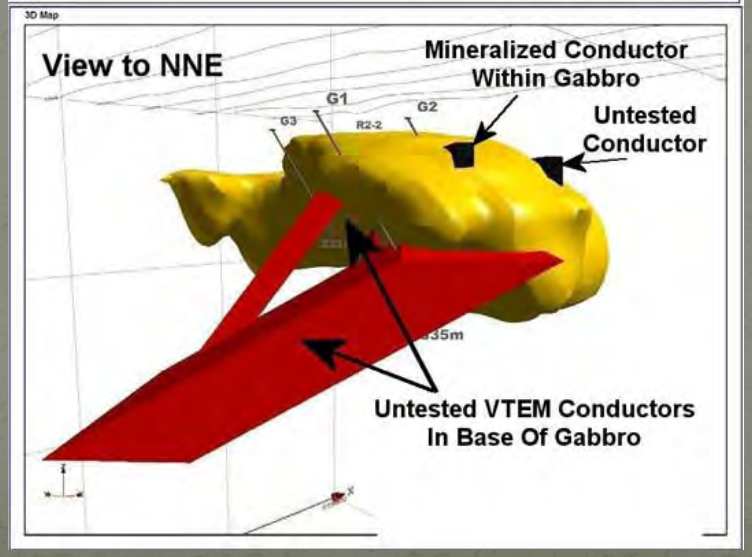
Example of Geophysics and Selection of Drill Sites



1. Planning [1 – 5 yrs]
2. Land Packa [1 – 5 yrs]
3. Exploratio [1 -10 yrs]
4. Evaluati

Geophysical Model of Buried Target to be Drilled





1. Planning [1 – 5 yrs]
2. Land Packa [1 – 5 yrs]
3. Exploratio [1 -10 yrs]
4. Evaluati

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

1. Planning [1 – 5 yrs]
2. Land Packa [1 – 5 yrs]
3. Exploratio [1 -10 yrs]
4. Evaluati

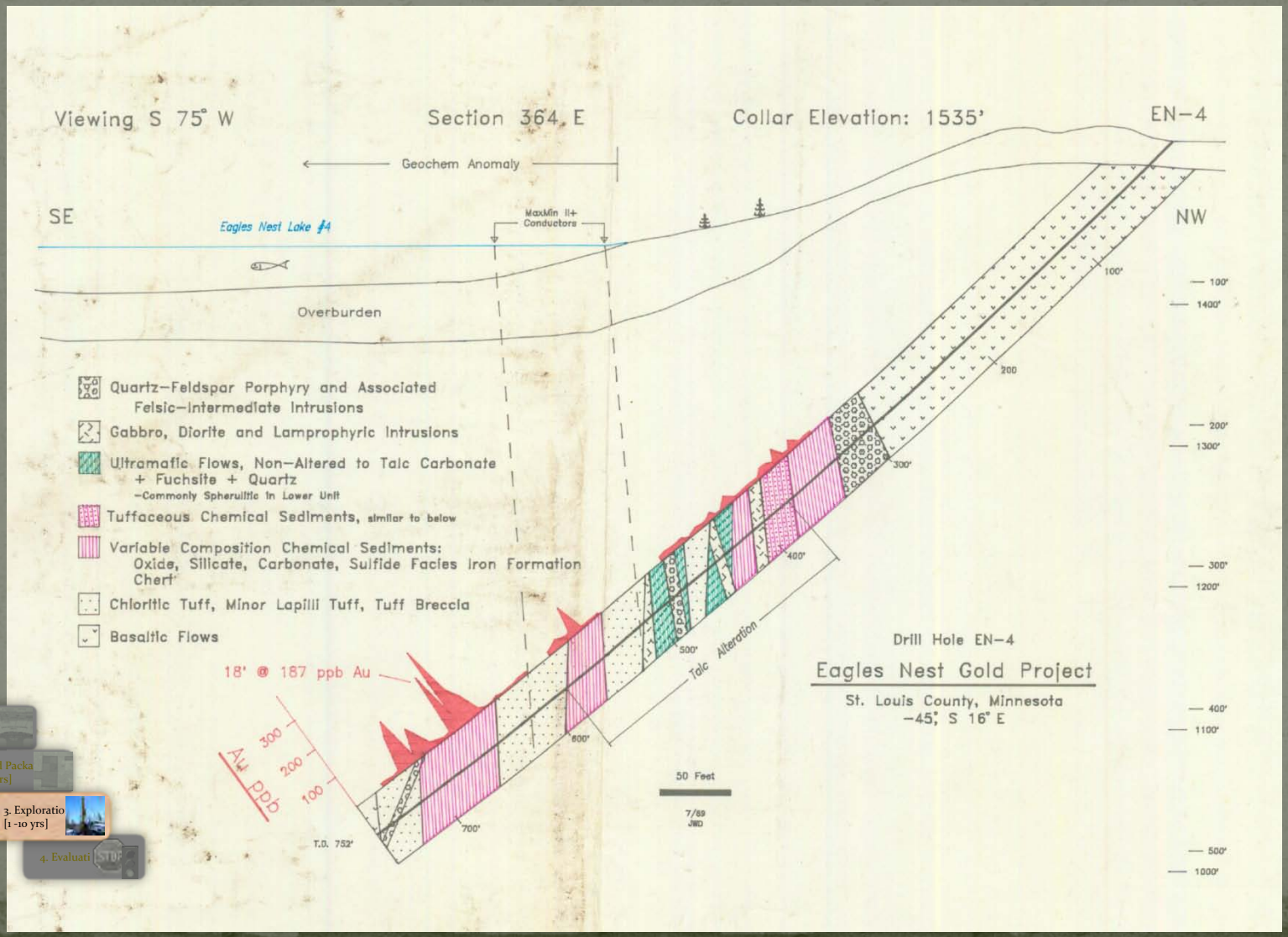
Drill Bit and Drill Core Sample

Drill Core is put into boxes

1. Planning [1 – 5 yrs]
2. Land Packa [1 – 5 yrs]
3. Exploratio [1 -10 yrs]
4. Evaluati

Example drill core sample that contains copper

What a geologist learns from a drill core?



1. Planning [1 – 5 yrs]
2. Land Packa [1 – 5 yrs]
3. Exploratio [1 -10 yrs]
4. Evaluati

Exploratory Boring Location After Drilling

1. Planning [1 – 5 yrs]
2. Land Packa [1 – 5 yrs]
3. Exploratio [1 -10 yrs]
4. Evaluati STOP

Drill Site Location After Boring Sealed

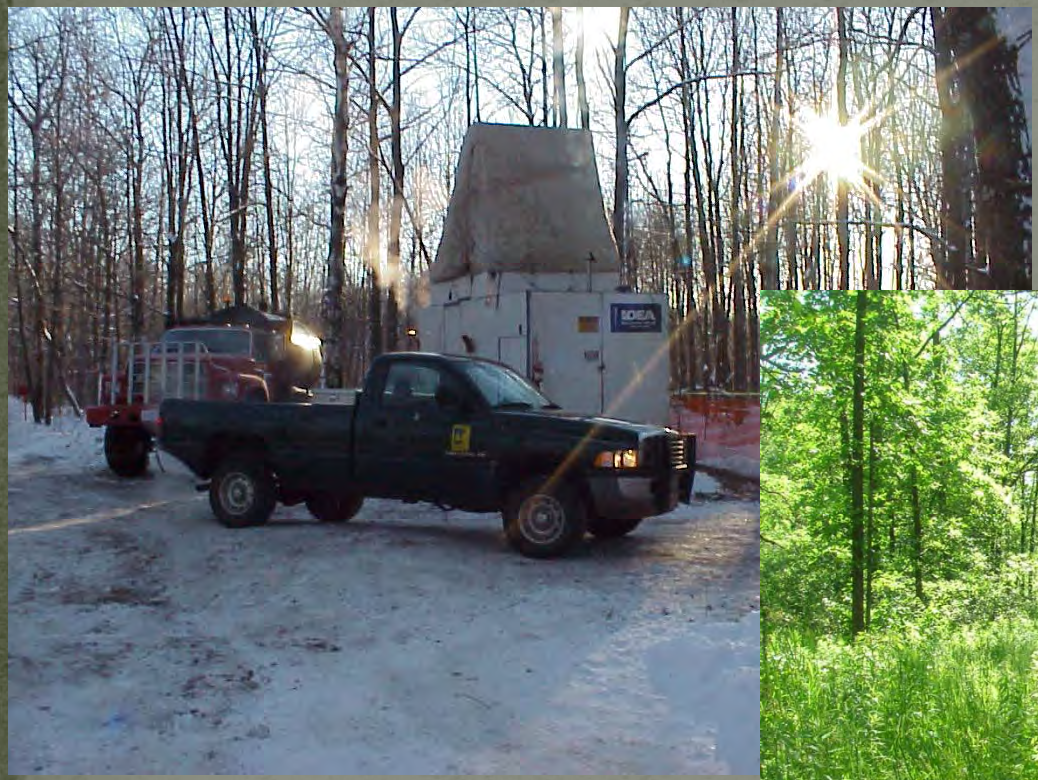
1. Planning [1 – 5 yrs]

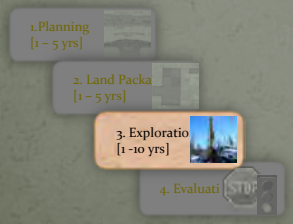
2. Land Packa [1 – 5 yrs]

3. Exploratio [1 -10 yrs]

4. Evaluati

During Drilling and After
[Same Location After One Growing Season]





Mineral Exploration: Phase I

The first phase of a typical met exp progra Minnesot four-step process that ca 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

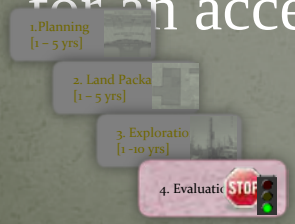
- Determine whether the exploration results fit the business plan
- Decide whether to:
  - Continue the project; or,
  - Terminate the lease and move on to a different target. 99% of state leases were terminated after year 10 because no discovery was made

Summary of Impacts of Exploration from State Lease Data

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