Full Circle

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A Brief Summary of the Current Status of Mineral Exploration and Development in Minnesota

or…

- April 2010

From Gold

To Iron

To Copper-Nickel…

And Back to Gold.

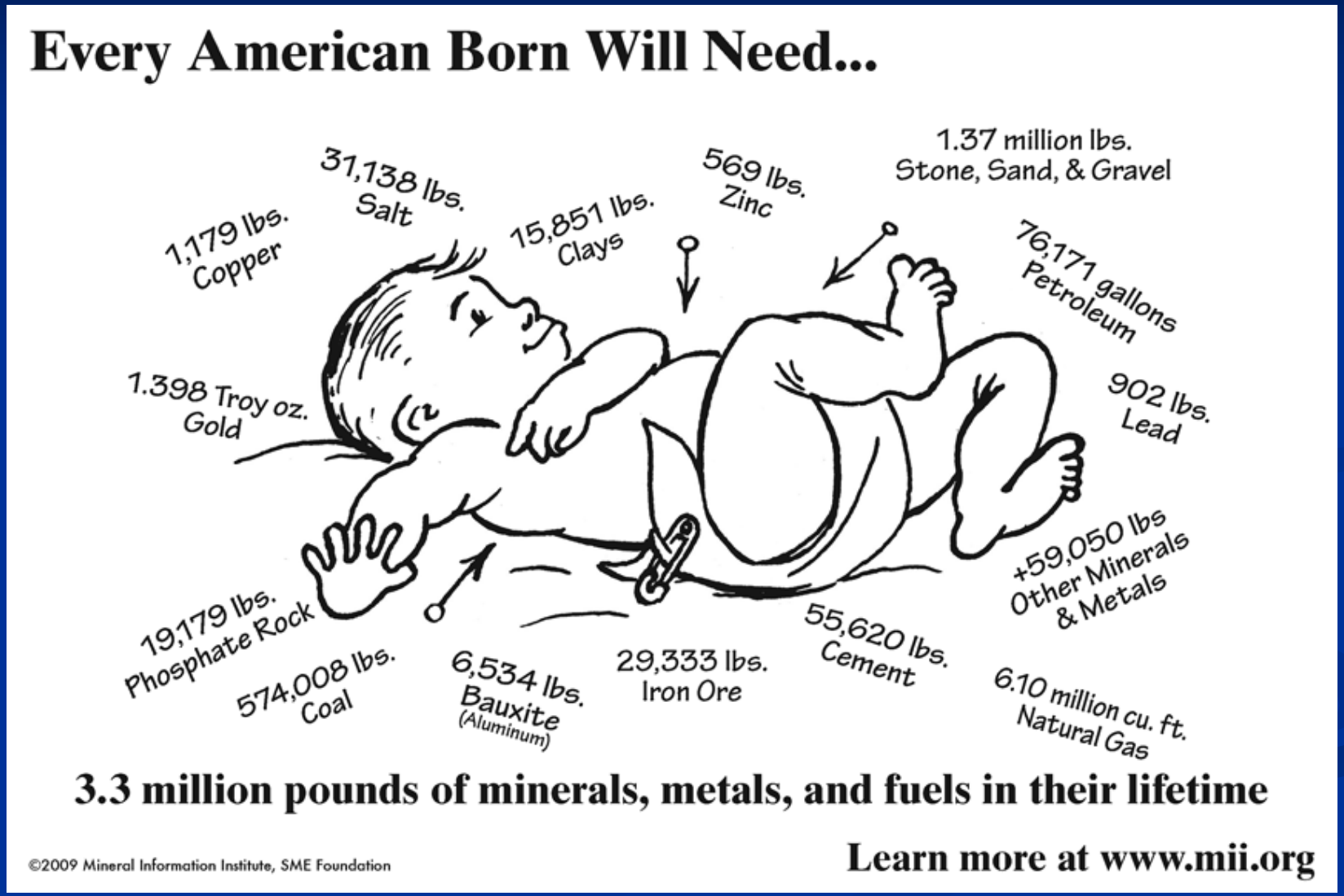
Little American Gold Mine,
Rainy Lake, 1894

Open pit at Mountain Iron, MN

INCO Copper-Nickel Test Shaft, 1967

Copper-Nickel-PGM Exploration, 2008

Why We Need Resources…

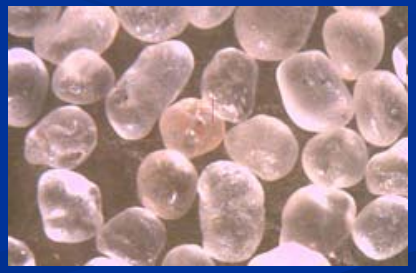


Nonmetallic Resources

Diamonds

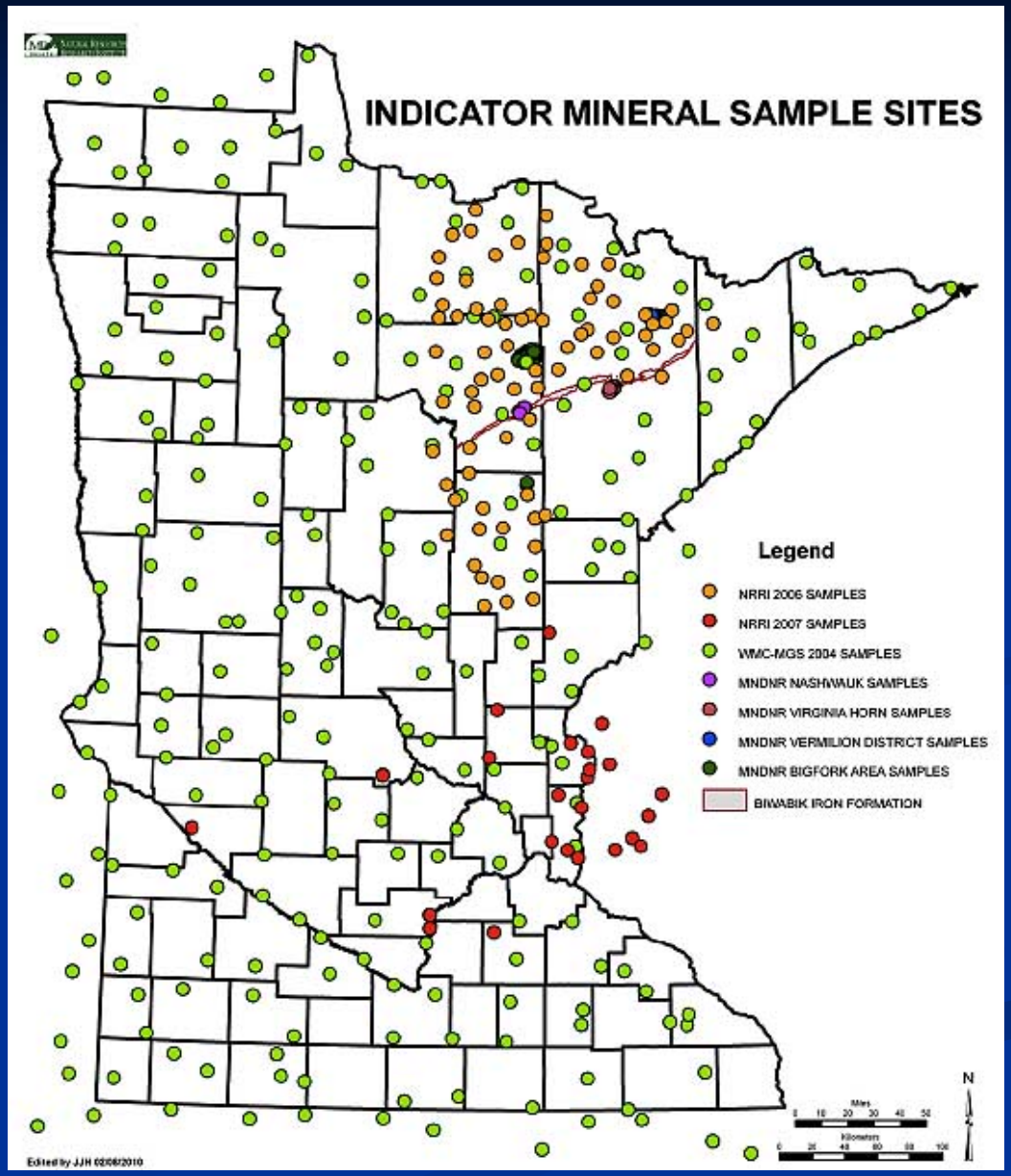
Aggregate Raw Materials

Specialty Sands and Clays



Diamonds

- Past efforts – Western Mining, De Beers
- The potential is there, but no known current activities



Heine et al., in prep.

Sand and Gravel Aggregate Mines In Minnesota

Approximately 300 Sand and Gravel Aggregate Mines

About 50,000,000 tons of sand and gravel aggregate produced annually at a value of $240,000,000 (USGS 2007)

Courtesy MN DNR

Minnesota Crushed Stone

About 11,000,000 tons crushed annually with a total value of $110,000,000 (USGS 2007)

Courtesy
MN DNR

Minnesota Silica Sand

Note: Amount of silica sand mined is proprietary and not available as public information.

Courtesy
MN DNR

Minnesota Kaolin Clay

Note: Amount of kaolin clay mined is not available .

Courtesy
MN DNR

Iron Ore

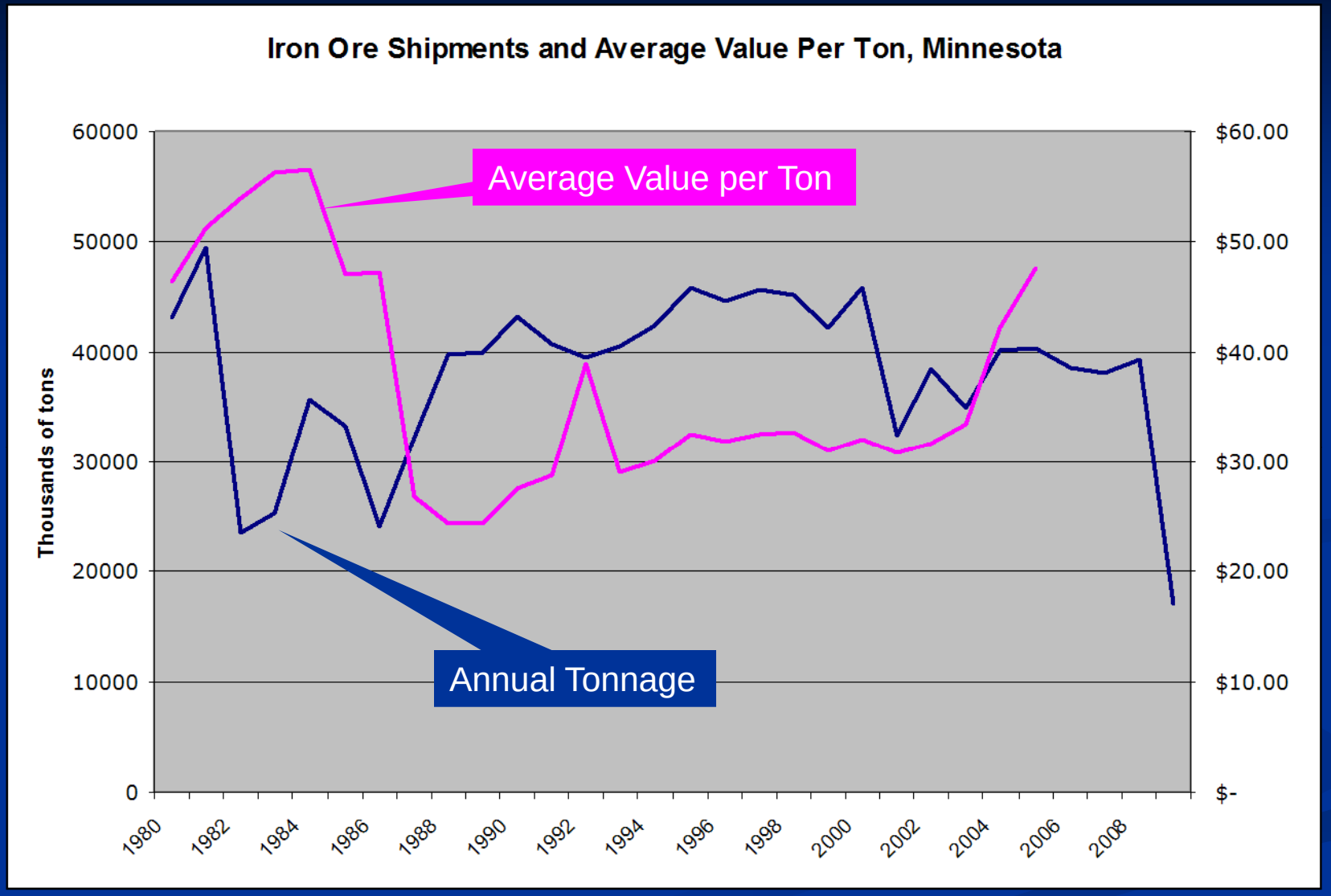
Courtesy Harvey Winkelmann

Active Taconite Mining Properties and New Iron Mining Properties

2008 Minnesota Pellet Production valued at $3.23 billion

MN Revenue November 2009

Courtesy
MN DNR



Source: Skillings Mining Review

IRON ORE – WHY?

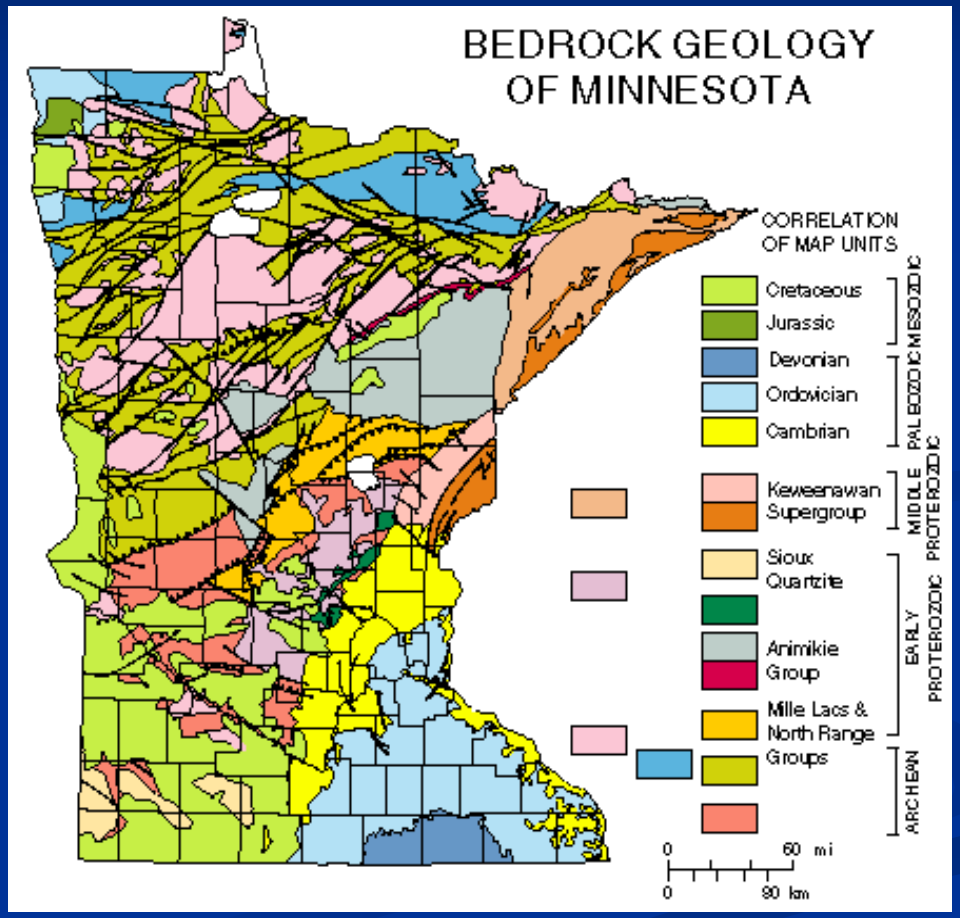
- Long term world steel **production is increasing.**
- Minnesota's **resources are substantial**: 200 years.
- Minnesota has a **strategic location** with respect to North American steel production centers.
- **New technologies.**

Photo: Todd Shorkey

IRON ORE – WHO?

- **Traditional Taconite producers:**
  - **Cliffs Natural Resources** (Hibbing Taconite; Northshore; United Taconite) – capacity: 18 million tons of taconite pellets per year
  - **US. Steel** (Minntac; Keewatin Taconite) – capacity: 22 million tons of pellets per year
  - **Arcelor Mittal** (Minorca Mine) – capacity: 3 million tons of pellets per year
- **New Technology and Ventures**
  - **Essar Steel:** Integrated mine to finished steel plant
  - **Mesabi Nugget:** Direct reduced iron for electric arc furnaces
  - **Magnetation** – Reprocessing old tailings to recover iron fines

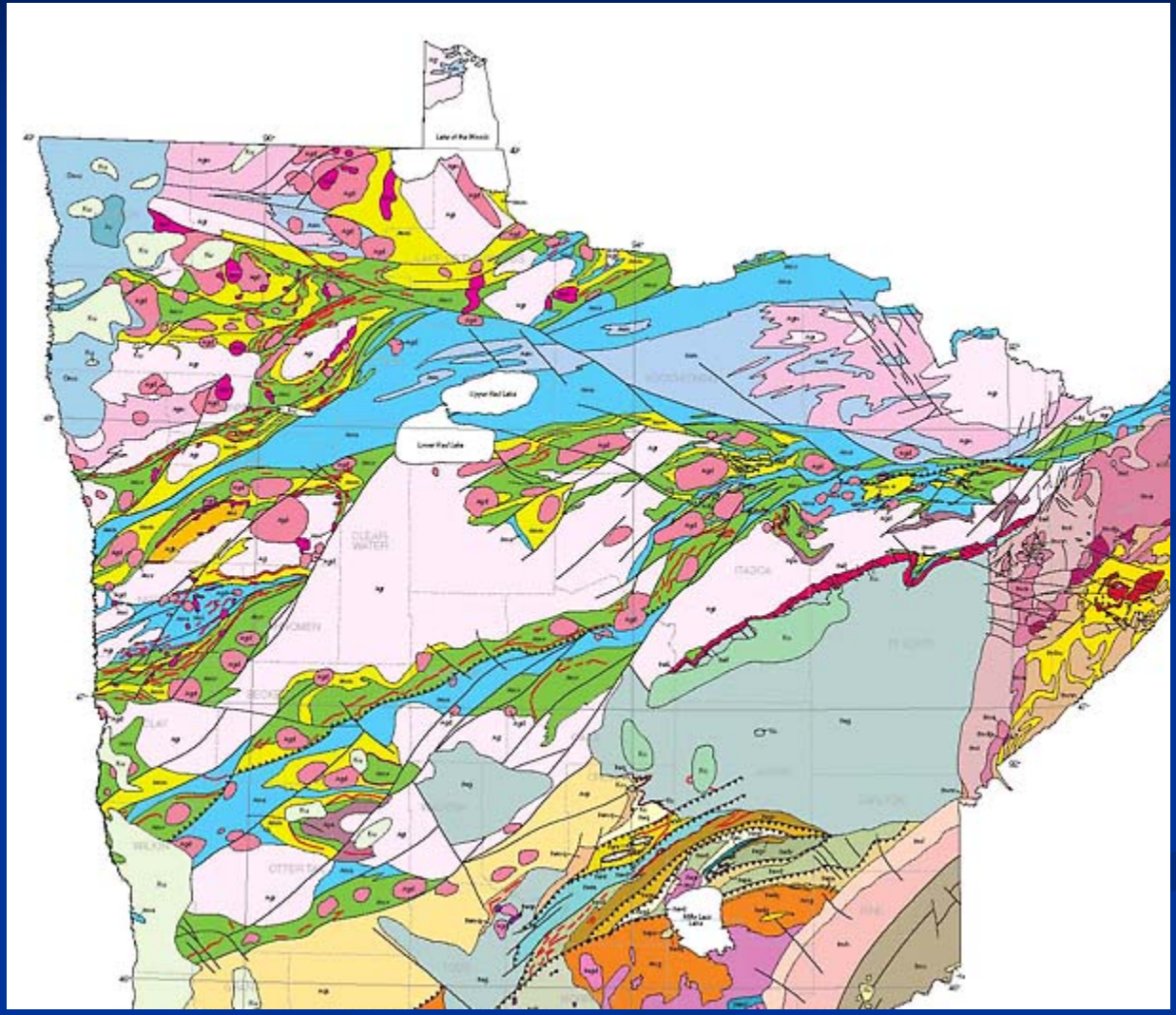
Nonferrous and Precious Metals



Courtesy MN Geological Survey

VMS (Volcanogenic Massive Sulfides)

- Commonly copper-zinc, with possible lead
- Polaris Joint Venture in the 1980s
- Still potentials for discovery



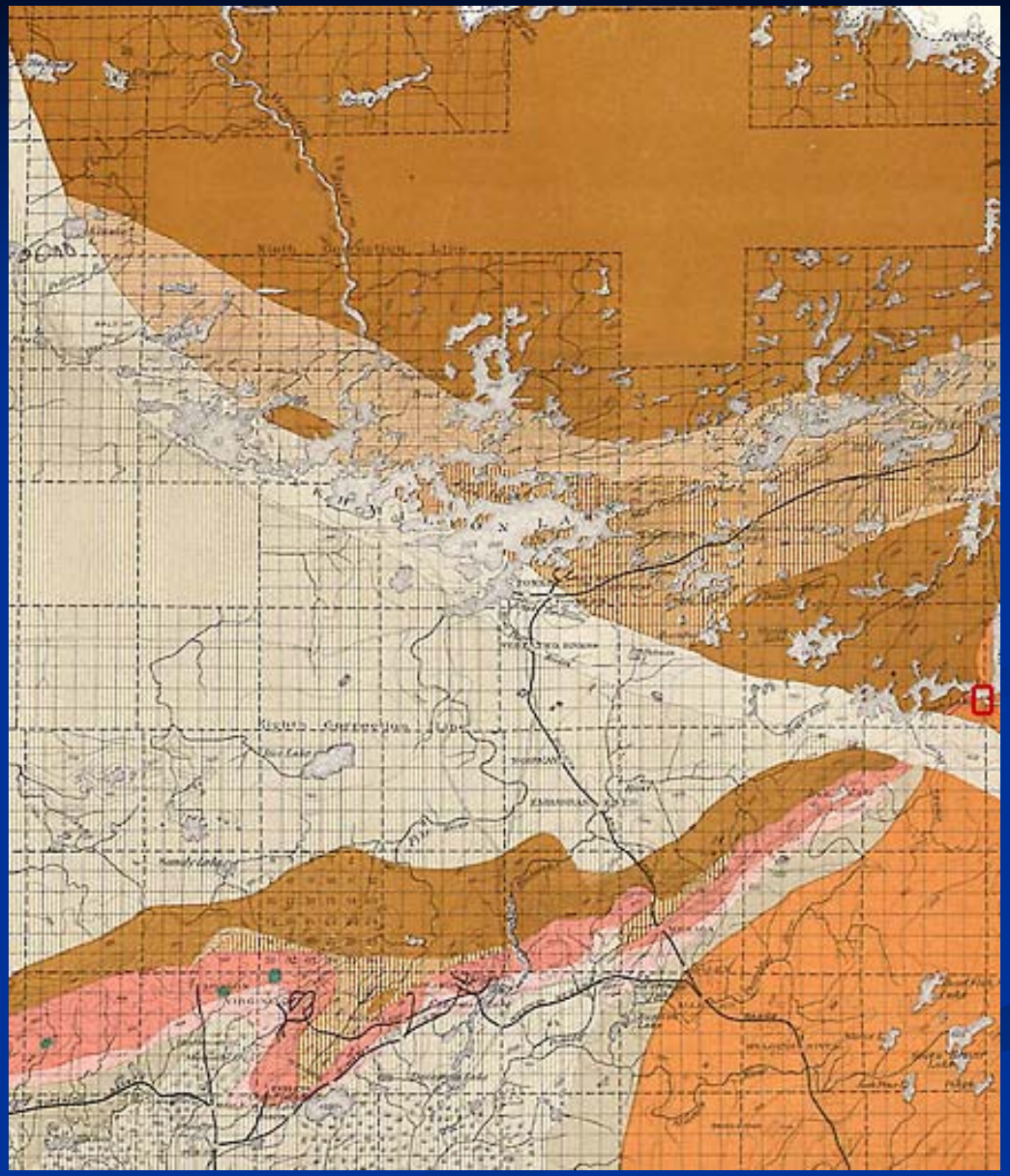
Courtesy MN Geological Survey

Gold

William Rowell

Gold – History and Who

- First metallic mineral exploration in Minnesota in the 1860's was for gold near Lake Vermilion.
- Little gold was discovered, but this gold exploration led to the discovery of the Vermillion Range iron ore deposits mined from the 1860's to the 1960's.



Geological and Natural HistorySurvey of Minnesota:
North Part of St. Louis County, by N. H. Winchell 1899

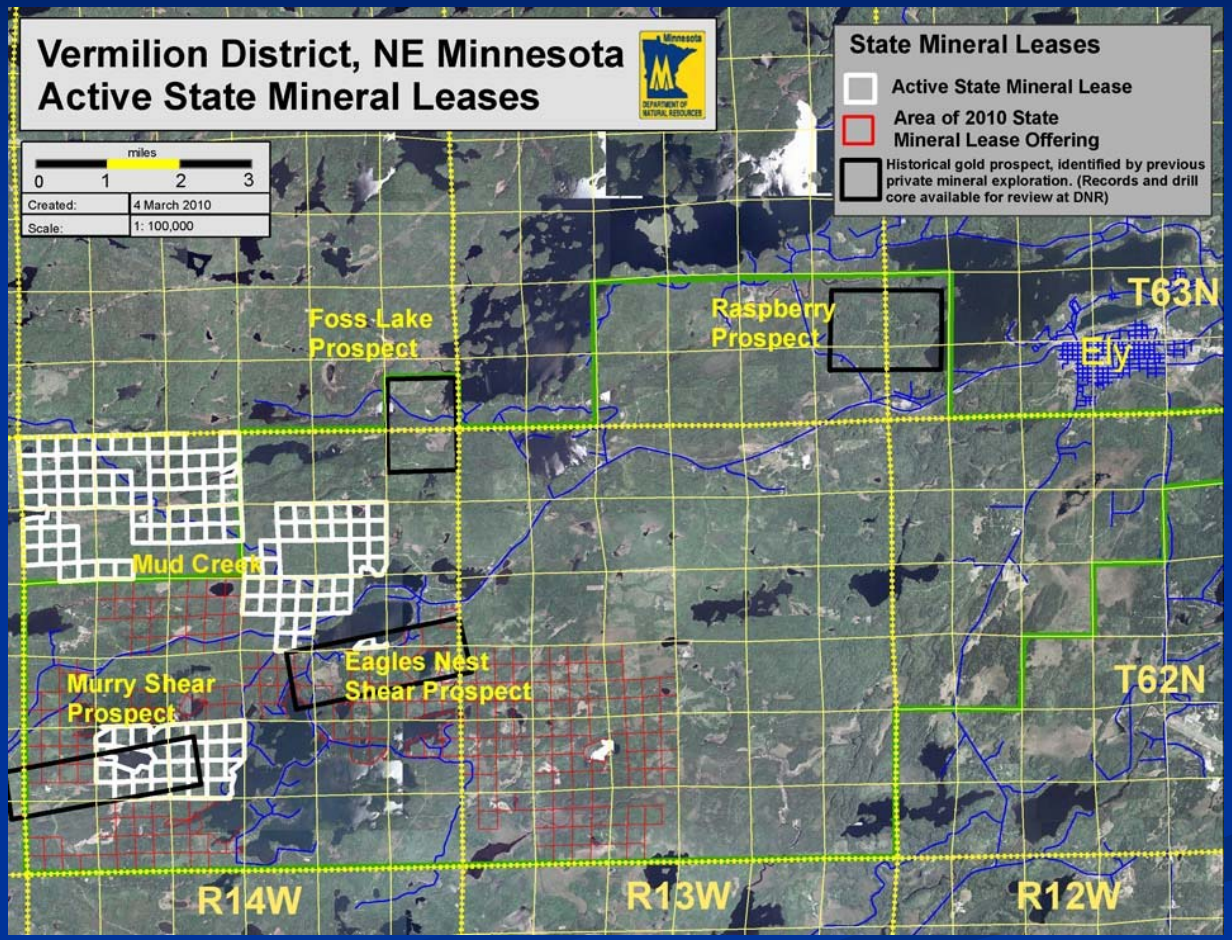
Gold – History and Who

- Interest revived periodically especially in the 1980's when major mining and exploration companies such as Newmont, Kennecott and Meridian explored; but the results were disappointing.
- Reevaluation of geologic data and the availability of new geophysical tools has led to a new round of exploration.

Above: A Geotech Ltd helicopter-born VTEM survey in progress

Gold – History and Who

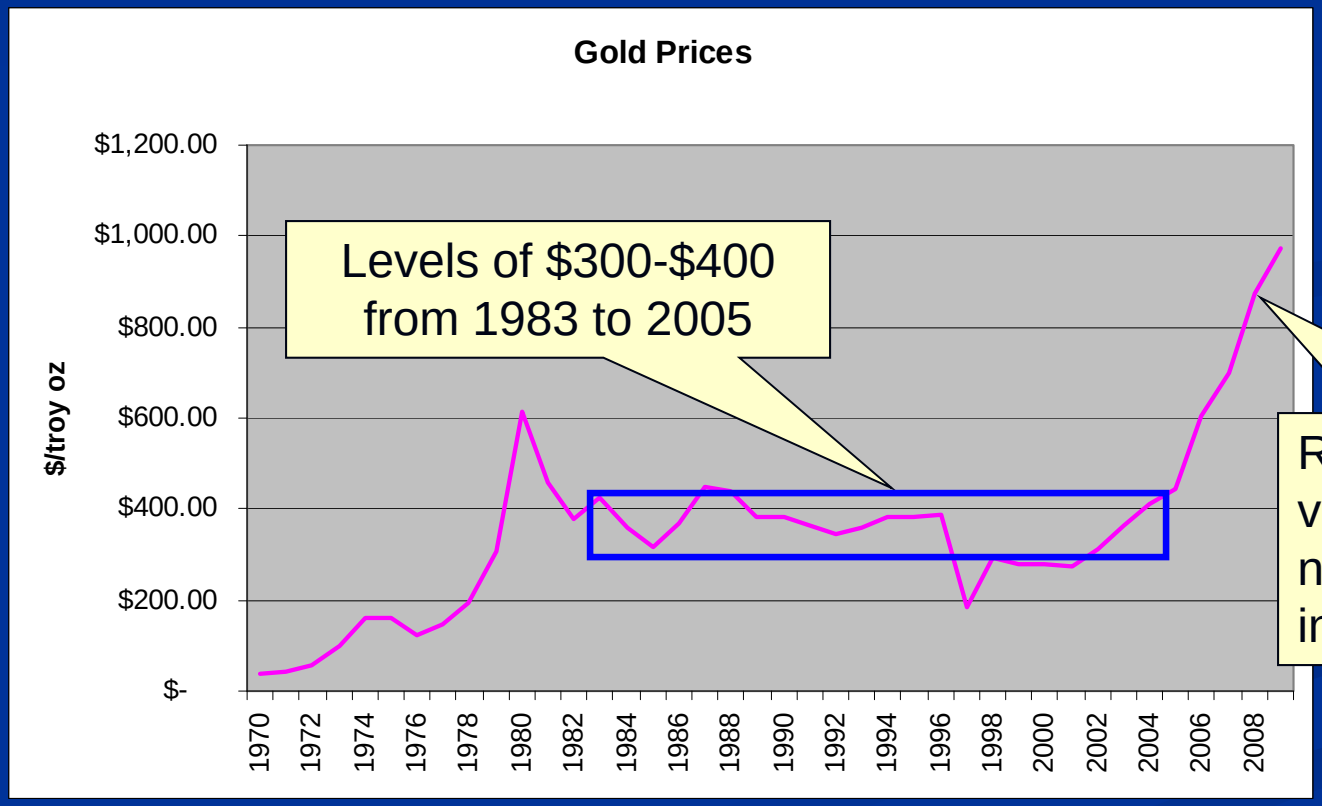
- Principal players now are Vermillion Gold LLC, Prime Meridian Resources, and Agate



Courtesy, MN DNR

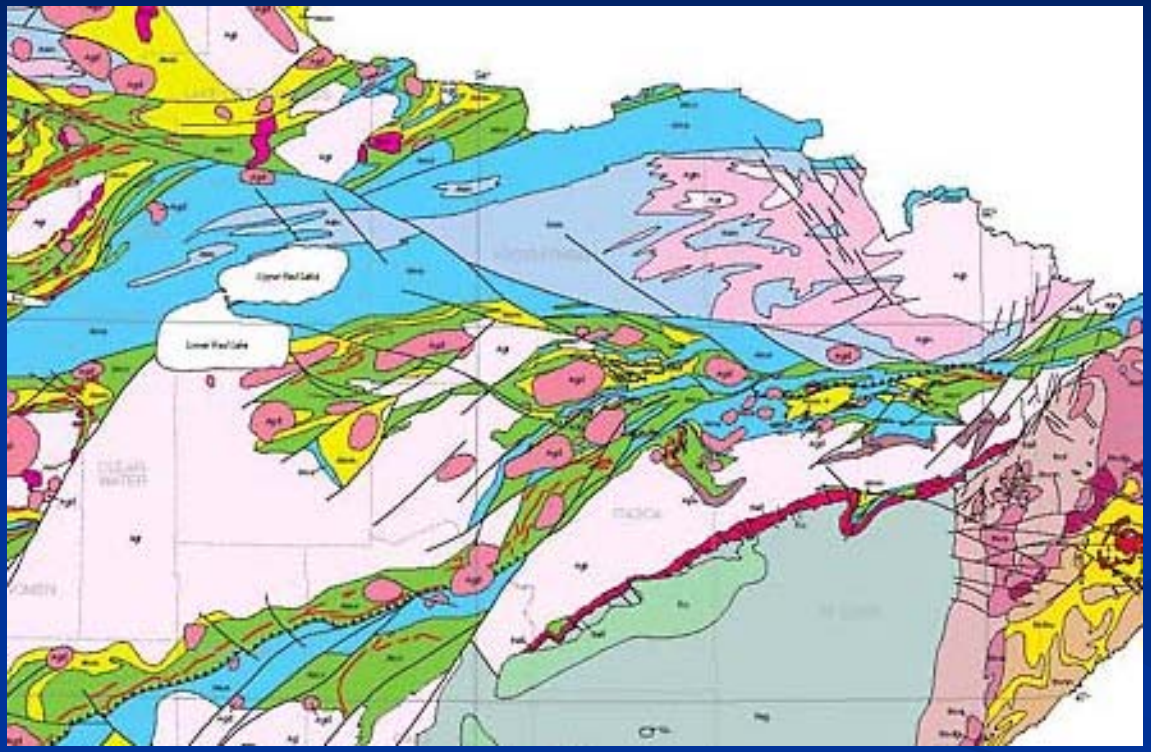
Gold – Why and Where

- Strong upward price movement for gold to +/- $1,150 per ounce
- Better understanding of "orogenic" gold deposits, better tools.



Source: Infomine

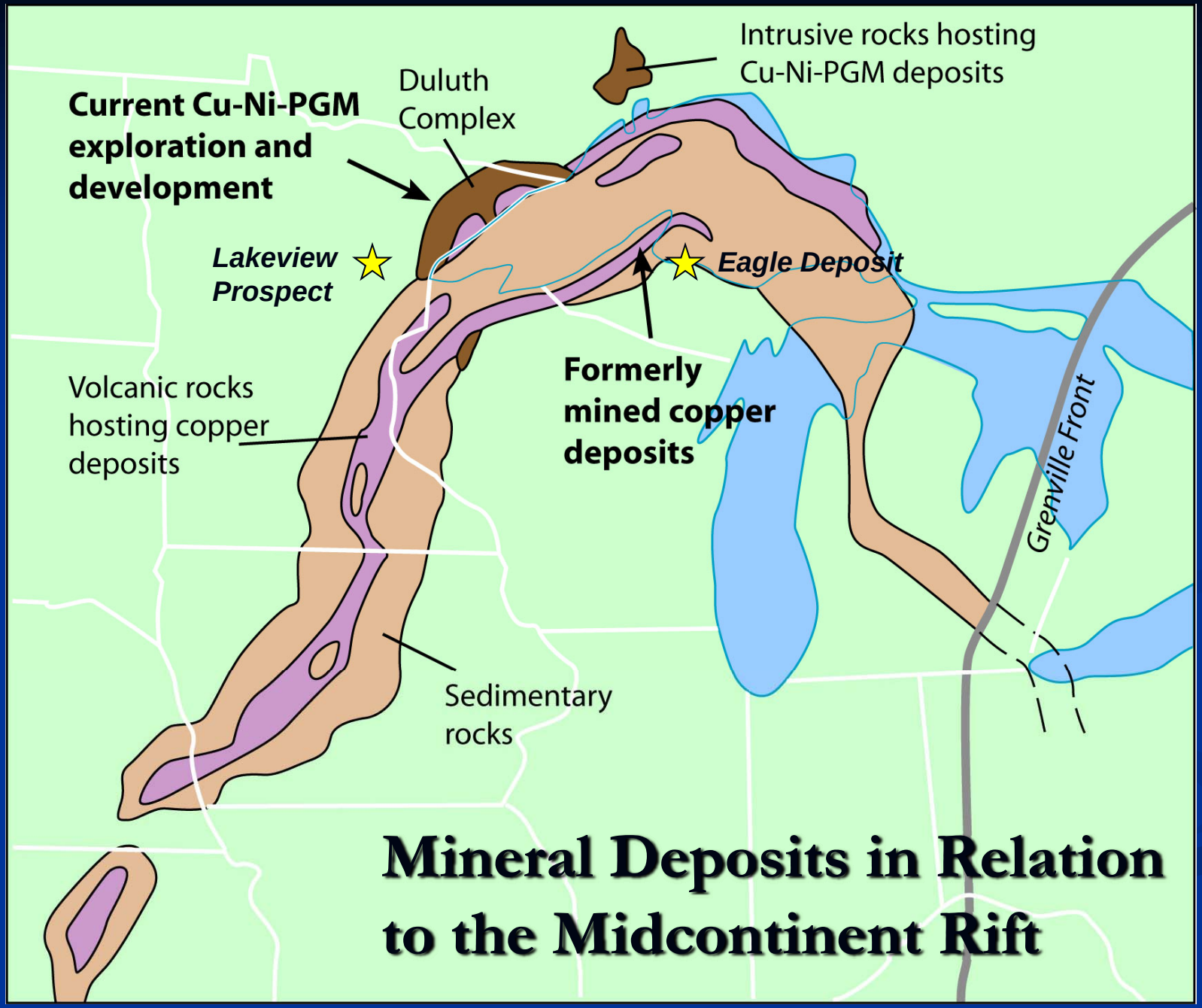
Gold – Why and Where



Courtesy MN Geological Survey

- In the Archean and Proterozoic metasediments and metavolcanic belts north and west of the iron range.

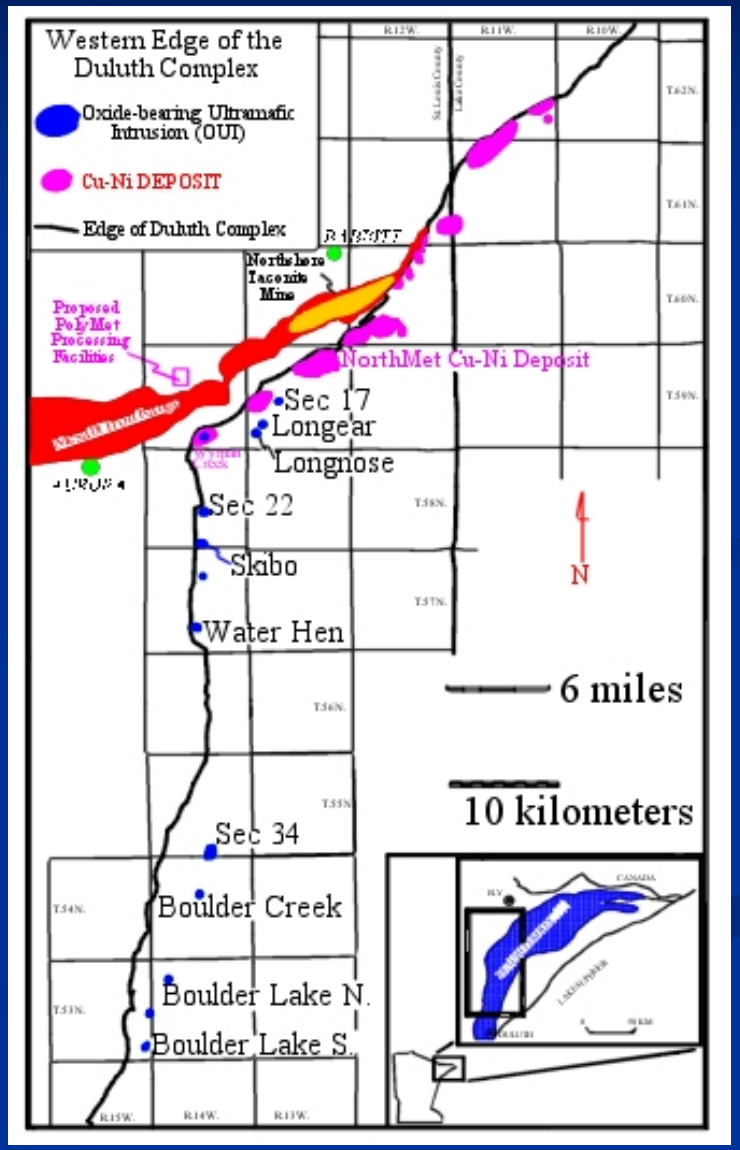
The Midcontinent Rift


Intrusive rocks hosting
Cu-Ni-PGM deposits
Duluth
Complex
Current Cu-Ni-PGM
exploration and
development
Lakeview
Prospect
Eagle Deposit
Formerly
mined copper
deposits
Volcanic rocks
hosting copper
deposits
Grenville Front
Sedimentary
rocks
Mineral Deposits in Relation
to the Midcontinent Rift

Titanium

Titanium – Where, Why and Who

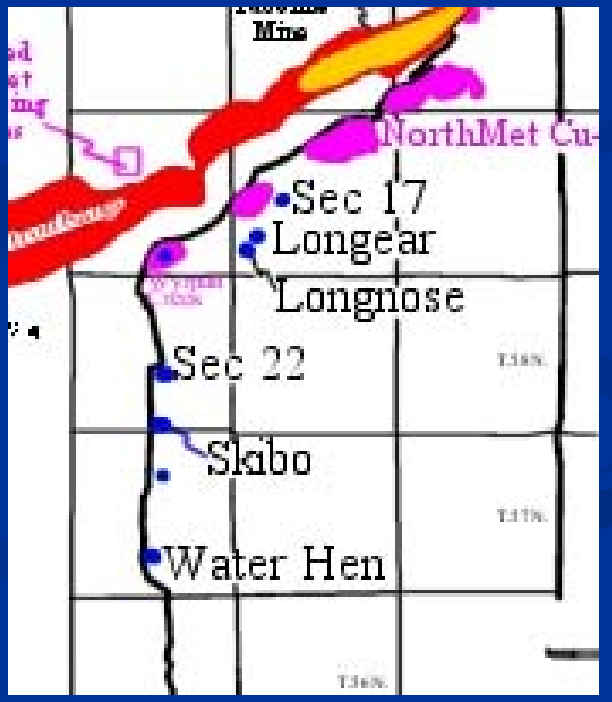
- Minnesota's titanium deposits long known in the Duluth Complex – at least 13 deposits in a belt extending south from the copper-nickel deposits.
- Mixtures of ilmenite and titanomagnetite
- Quite large but low grade
- Have some metallurgical problems



Courtesy NRRI

Titanium – Where, Why and Who

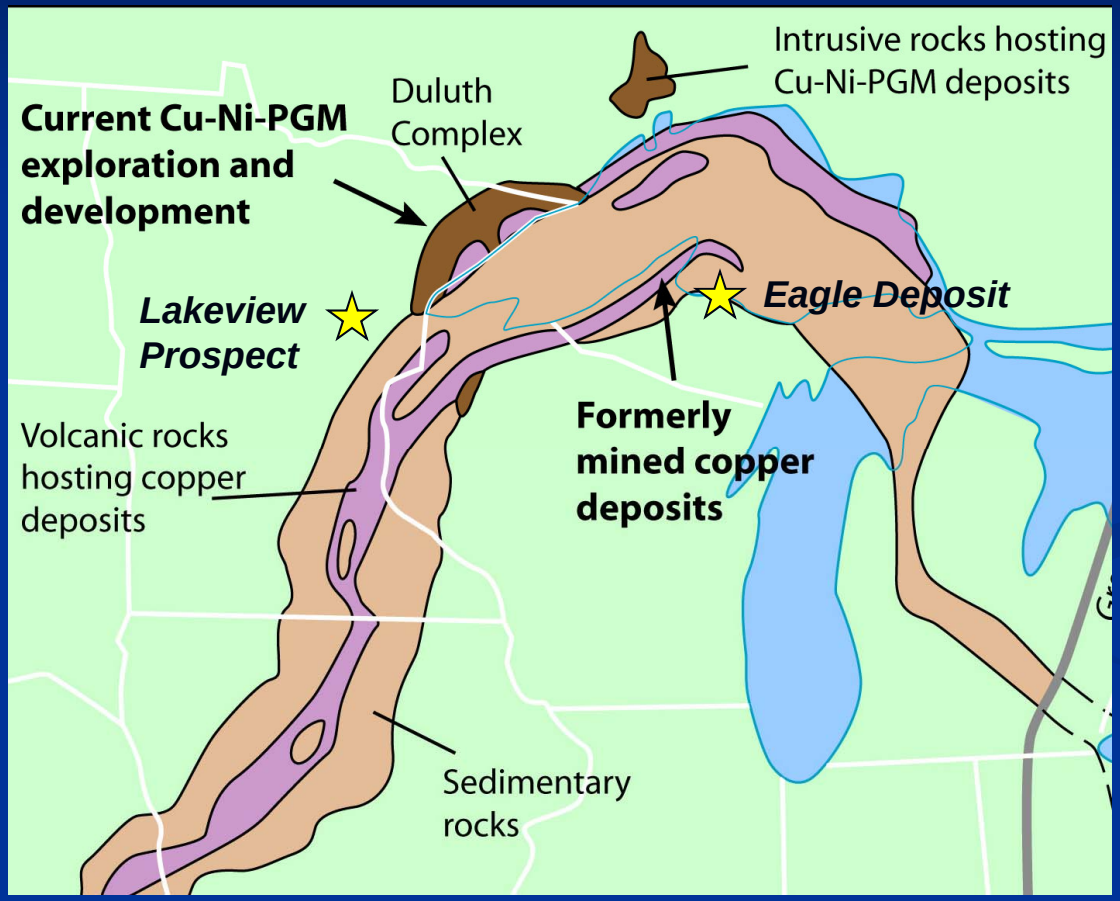
- Titanium oxide is a basic raw material in paints and whiteners. Titanium metal in many strategic and industrial applications because of weight, strength and corrosion resistant properties.
- Current Exploration:
  - Significant drilling program underway by Cardero Resources at Longnose
  - Prime Meridian Resources: Water Hen Project



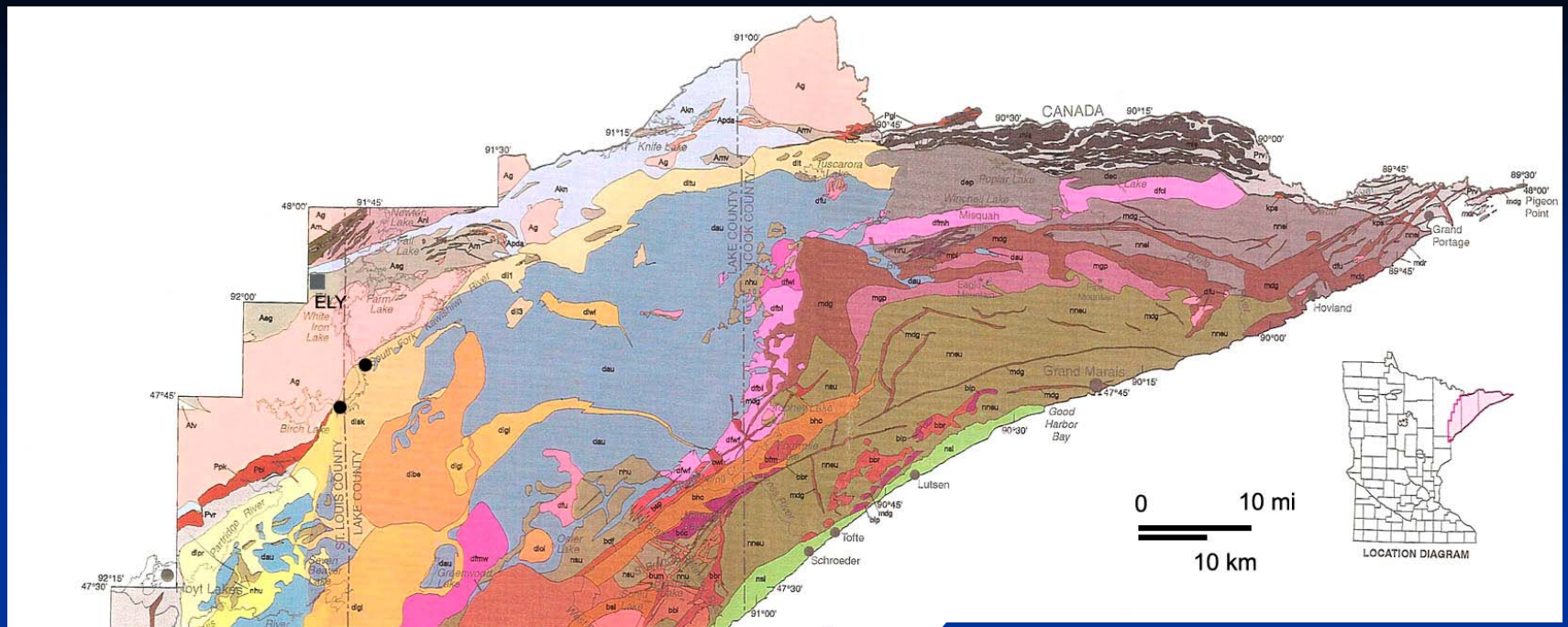
Courtesy NRRI

Copper-Nickel-PGMs

Copper – Nickel – PGMs – Where?



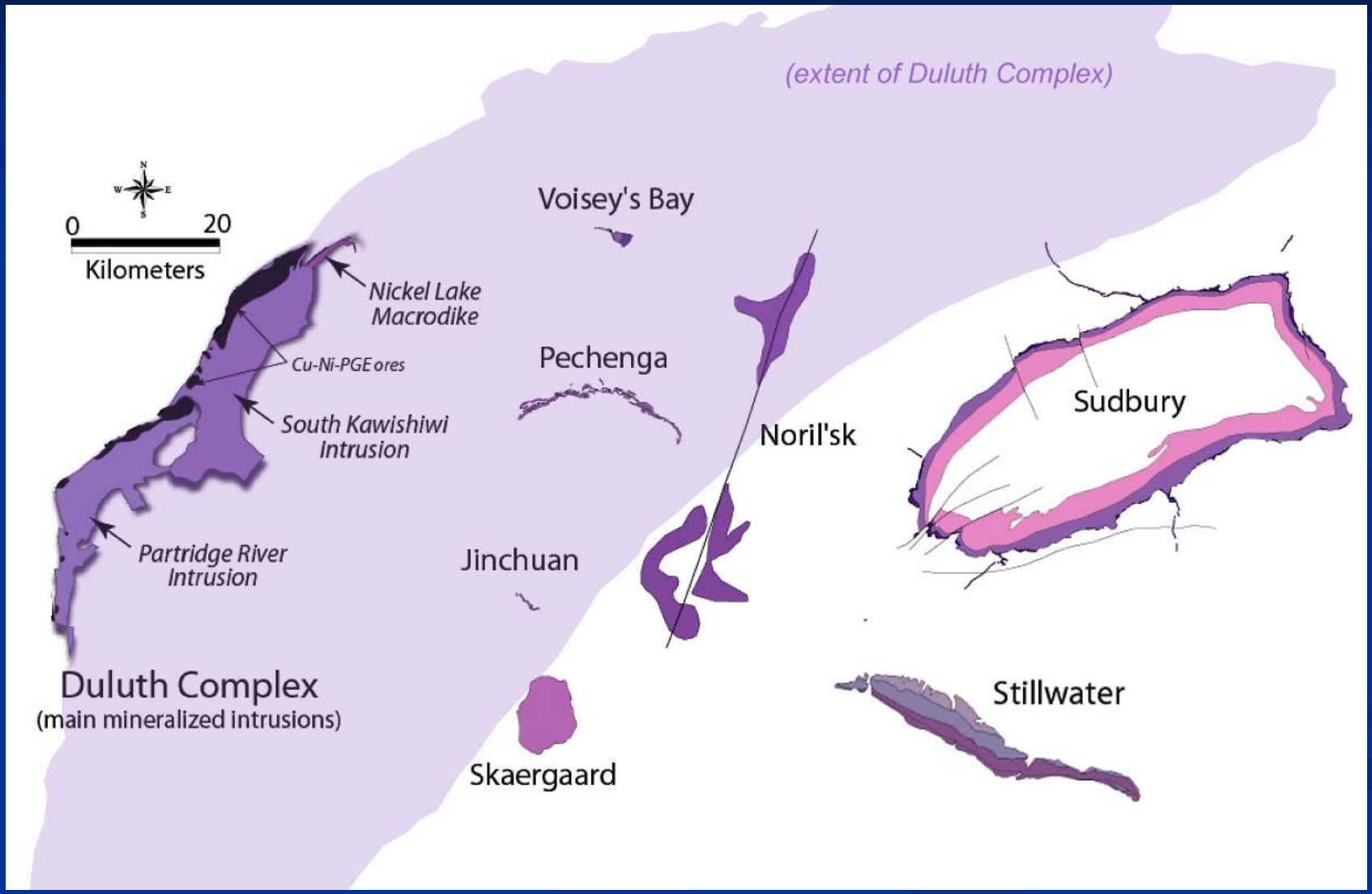
- The Duluth Complex -- Located in the 1.1 billion year old Midcontinent Rift



Courtesy MN Geological Survey

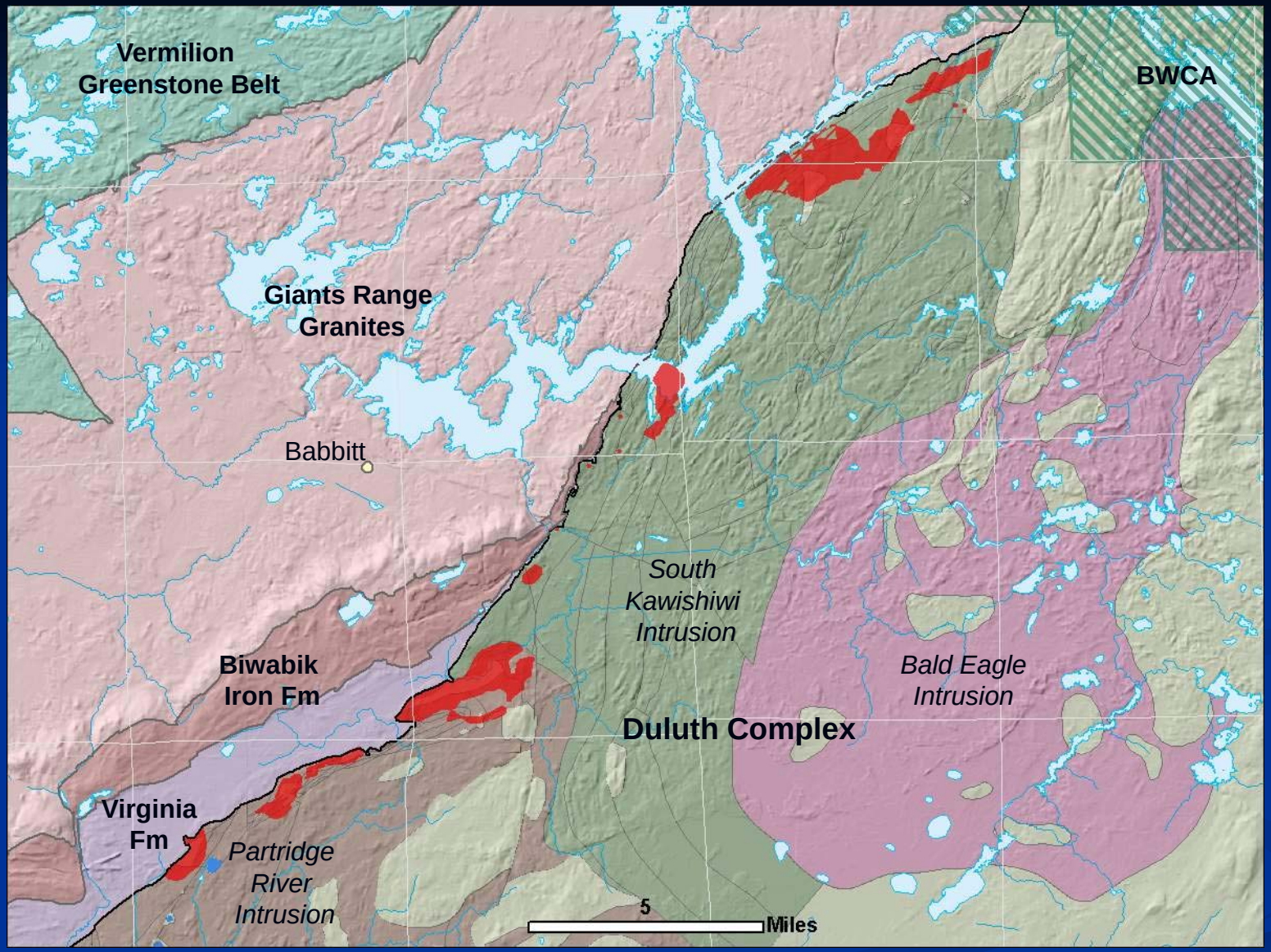
A truly ***complex*** complex composed of at least 12 individual intrusives; the third largest such mafic rock complex in the world.

Comparison of Intrusive Sizes



Revised from D. Peterson, 2009

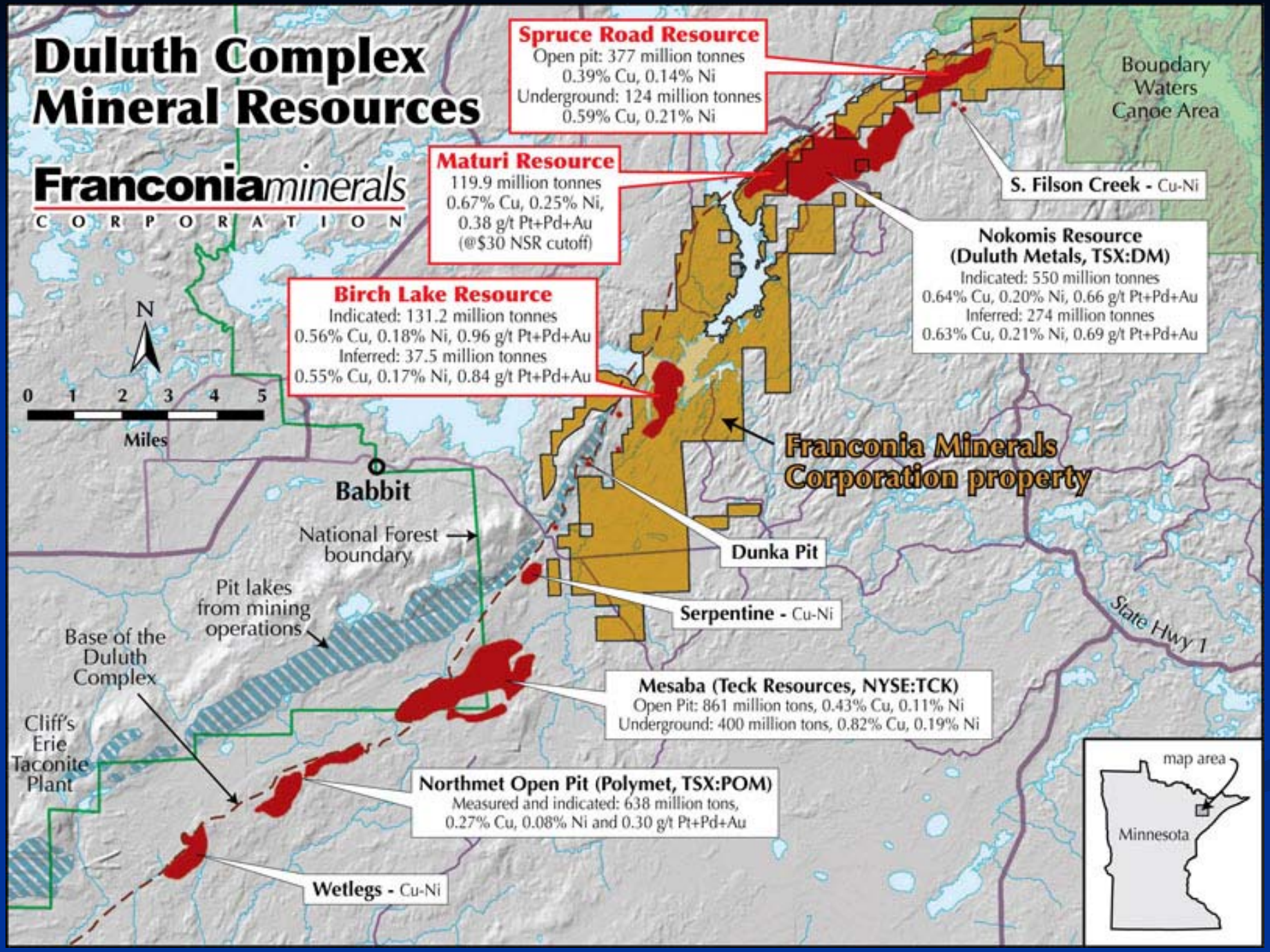
Duluth Gabbro: Outcrop along Spruce Road
(near 1949 discovery)



- Known Cu-Ni-PGM deposits associated with two intrusives, South Kawishiwi and Partridge River

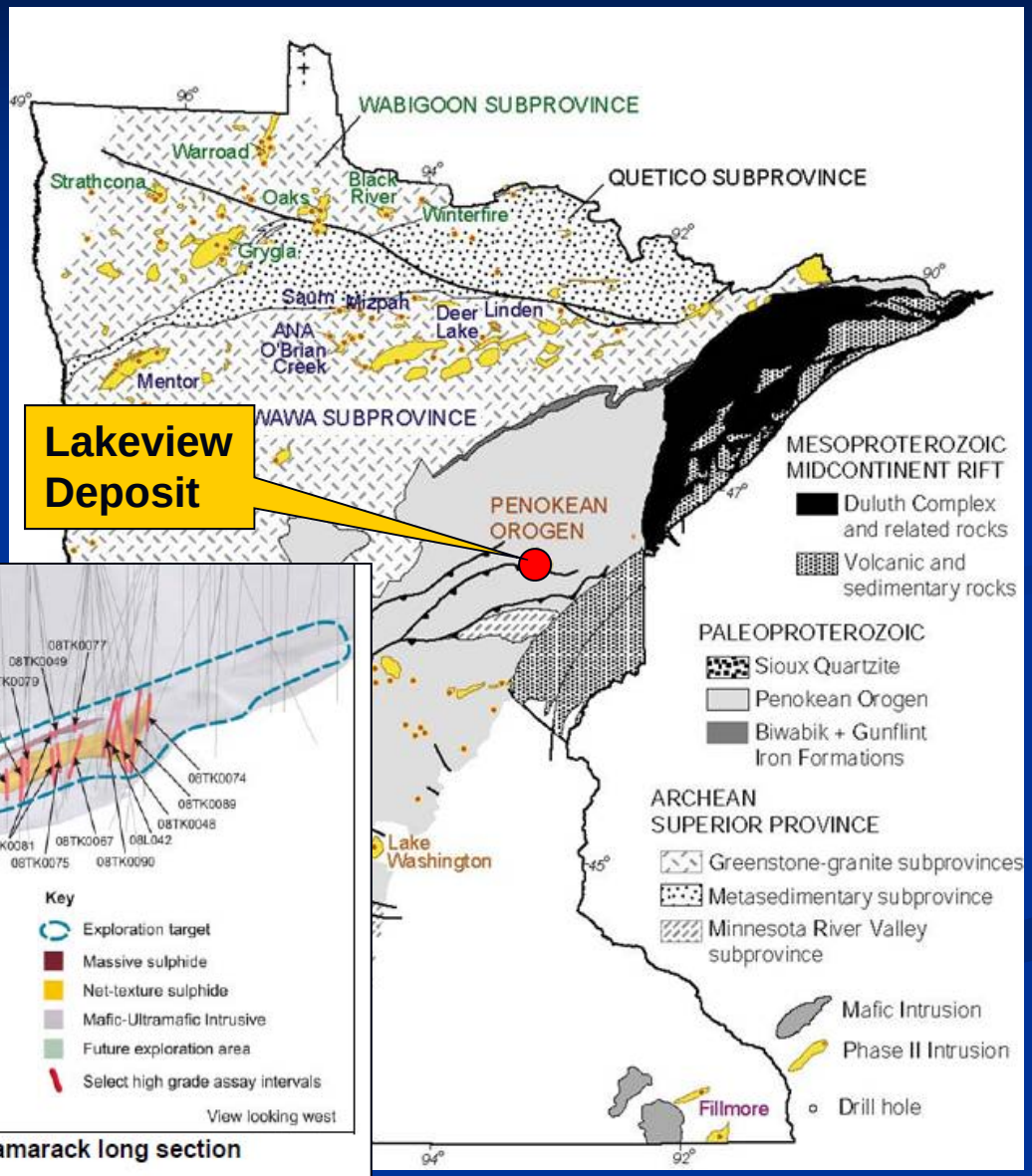
Copper – Nickel – PGMs – Who?

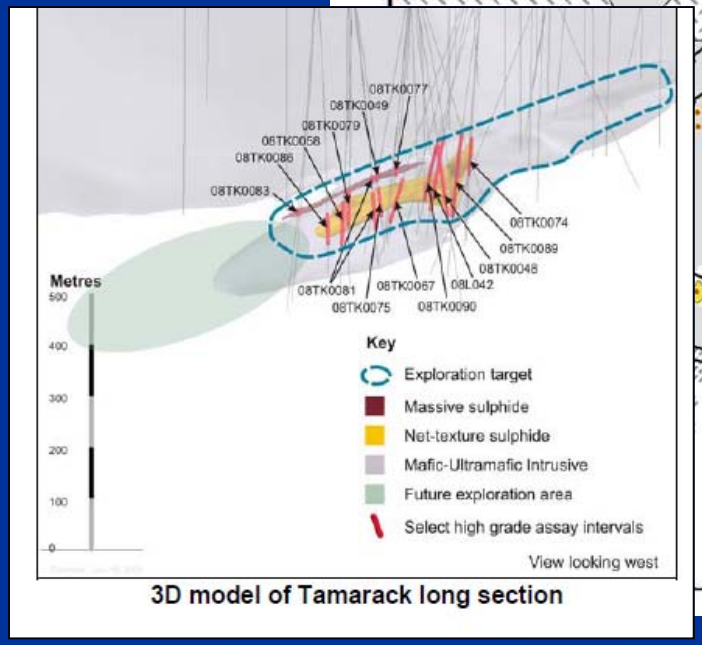
- In the Duluth Complex:
  - Teck – **Mesabi Deposit**
  - PolyMet - Glencore – **NorthMet Deposit**
  - Duluth Metals – Antofagasta – **Nokomis Deposit**
  - Franconia Minerals – **Birch Lake Deposit, Maturi Deposit and Spruce Road Deposit**.
  - Prime Meridian Resources – **Water Hen Deposit**
  - Encampment – **Serpentine Deposit**


Duluth Complex
Mineral Resources
Franconiaminerals
CORPORATION
Spruce Road Resource
Open pit: 377 million tonnes
0.39% Cu, 0.14% Ni
Underground: 124 million tonnes
0.59% Cu, 0.21% Ni
Maturi Resource
119.9 million tonnes
0.67% Cu, 0.25% Ni,
0.38 g/t Pt+Pd+Au
(@$30 NSR cutoff)
Birch Lake Resource
Indicated: 131.2 million tonnes
0.56% Cu, 0.18% Ni, 0.96 g/t Pt+Pd+Au
Inferred: 37.5 million tonnes
0.55% Cu, 0.17% Ni, 0.84 g/t Pt+Pd+Au
Boundary Waters Canoe Area
S. Filson Creek - Cu-Ni
Nokomis Resource
(Duluth Metals, TSX:DM)
Indicated: 550 million tonnes
0.64% Cu, 0.20% Ni, 0.66 g/t Pt+Pd+Au
Inferred: 274 million tonnes
0.63% Cu, 0.21% Ni, 0.69 g/t Pt+Pd+Au
N
0 1 2 3 4 5
Miles
Babbit
Franconia Minerals
Corporation property
National Forest
boundary
Dunka Pit
Serpentine - Cu-Ni
Pit lakes
from mining
operations
Base of the
Duluth
Complex
State Hwy 1
Mesaba (Teck Resources, NYSE:TCK)
Open Pit: 861 million tons, 0.43% Cu, 0.11% Ni
Underground: 400 million tons, 0.82% Cu, 0.19% Ni
Cliff's
Erie
Taconite
Plant
Northmet Open Pit (Polymet, TSX:POM)
Measured and indicated: 638 million tons,
0.27% Cu, 0.08% Ni and 0.30 g/t Pt+Pd+Au
Wetlegs - Cu-Ni
map area
Minnesota

Copper - Nickel - PGMs – Where?

- Outlying Intrusives:
  - Aitkin and Carlton Counties – Rio Tinto/Kennecott's Lakeview Deposit; similar to Rio's Eagle Deposit in Michigan
  - Many other outlying intrusives





3D model of Tamarack long section

Courtesy NRRI and MN DNR

Copper – Nickel – PGMs – Why and Why Now?

- Minnesota's Huge Resource
- Metallurgical problems solved through use of Hydromet process in place of conventional smelting.
- Continued rising demand and strong prices

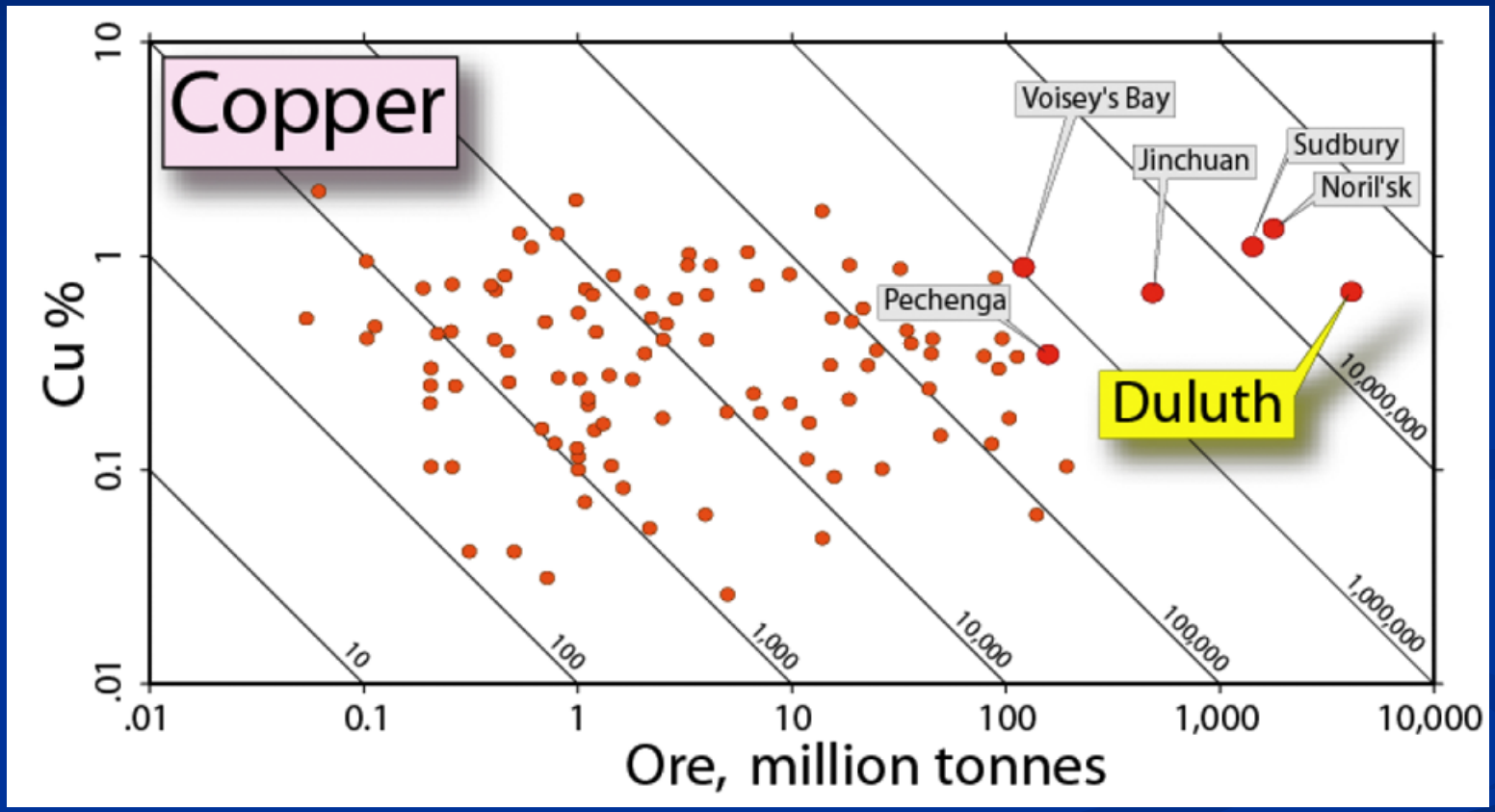
Copper – Nickel – PGMs – A Huge Resource

- Drill indicated and inferred
  = over **4 billion tons**
- World class deposits
- Large low grade deposits suited to low cost bulk mining methods. (PolyMet and Teck open pit, Franconia and Duluth Metals underground.)

Metallurgical Advances for Duluth Complex's Cu-Ni Ores

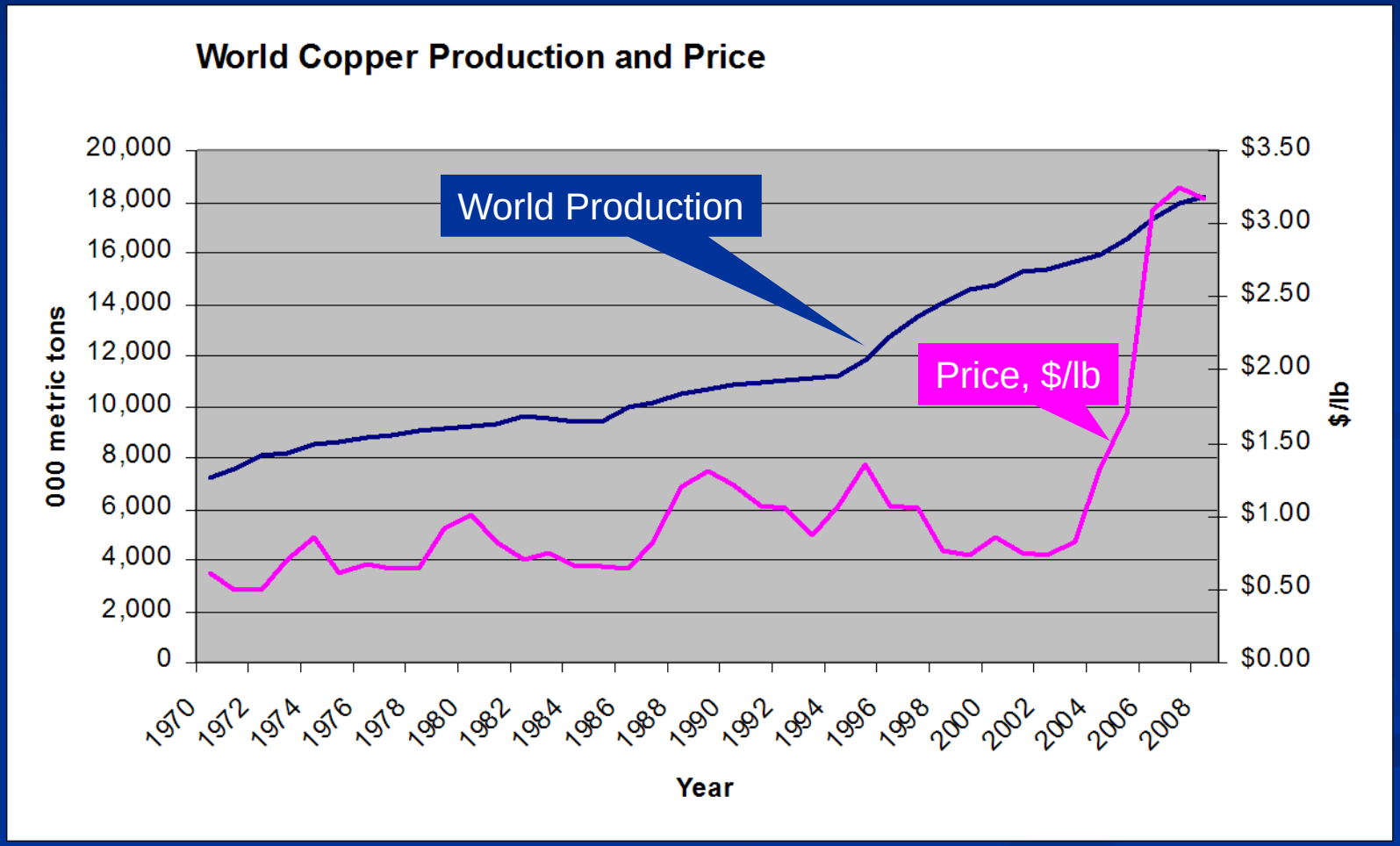
- Interlocked copper and nickel sulfides do not permit good separation and inhibit conventional smelting
- Advances in hydrometallurgy allow treatment of bulk concentrates.
  - Lowers energy consumption
  - Lowers environmental impacts
  - Allows possible downstream value added manufacturing

Copper: % vs Ore Tonnage



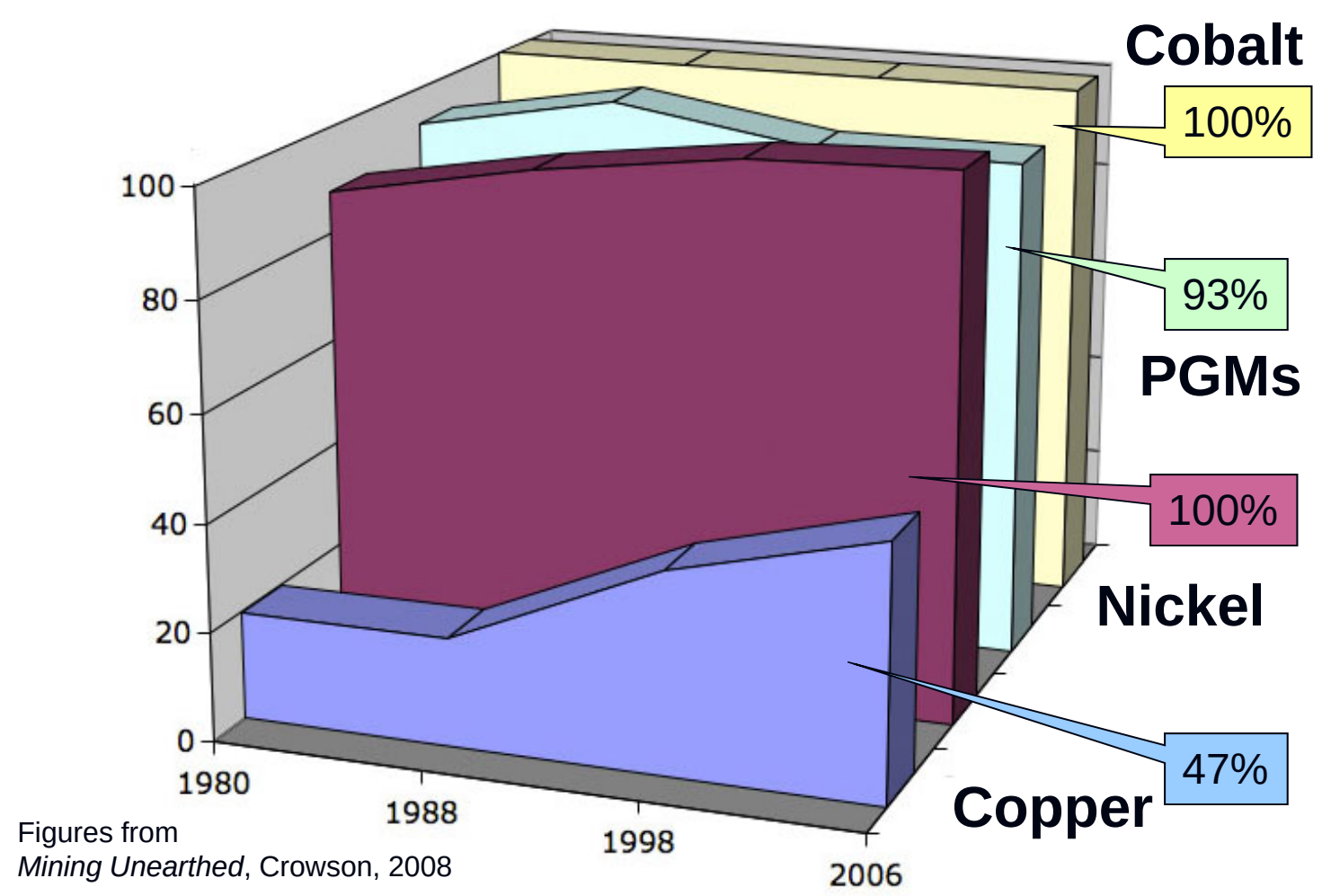
Courtesy D. Peterson, 2009

Copper: World Production & Price



Sources: Infomine (price); USGS (production)

Copper-Nickel-PGMs – Why?
U.S. Import Dependence



Figures from
Mining Unearthed, Crowson, 2008

Why is a New Non-Ferrous Mining Industry Important to Minnesota and the Nation?

- **Benefits to Minnesota**
  - ***Jobs, jobs, jobs*** – direct and indirect – long term and high paying
  - **Tax revenues**
    - Occupation and sales taxes
    - Net proceeds tax
    - Ad valorem taxes
  - **Royalties**
    - To State's School Trust Fund on state owned minerals
    - To Superior National Forest and local communities on Federally owned minerals

Why is a New Non-Ferrous Mining Industry Important to Minnesota and the Nation? (2)

- **Good Resource Conservation Ethics**
  - Mine known mineral deposits where they are found; extract the maximum practical amount of product
- **Good Environmental Ethics**
  - Mine minerals where environmental regulations mandate good environmental protections
- **Good National Strategy**
  - Lessen dependence on foreign imports of strategic and critical metals and minerals