Knowing Michigan Like the Back of Your Hands



Dr. Randy Schaetzl University Distinguished Professor Dept. of Geography, Environment, and Spatial Sciences





OUTLINE

Bedrock geology and Michigan's mining "comeback" What's above the bedrock? How do Michiganders use the land, and why? What about the future (as in, *climate*)?





The Michigan Geologic Basin – rocks deposited on an ancient seafloor





What types of rocks are in the Michigan Basin?

47% limestone

- 23% sandstone
- 18% shale
- 12% evaporites (rock salt and gypsum)





x = MAJOR limestone quarry



FIGURE 3. - Projected Limestone Traffic Flow, 1995. Million net tons.

Oglebay Norton Quarry



An incredibly vast (but not deep) quarry



Uses of limestone

- road metal, crushed stone
- steel industry
- cement/concrete
- agriculture (soil amendment)
- dimension stone/landscaping
- rip-rap (large rocks to limit shoreline erosion)

Salt

Over a trillion tons!!!

Michigan – 4th in the US in salt production



Rediscovery of rare mineral deposit by WMU geologists and private company could boost Michigan economy



By <u>Yvonne Zipp | yzipp@mlive.com</u> on September 10, 2013 at 3:50 PM, updated September 10, 2013 at 9:05 PM



KALAMAZOO, MI - You've heard of shovel-ready projects?

Western Michigan University's

Michigan Geological Repository for Research and Education, working in conjunction with the company Michigan Potash, said that it has rediscovered a mineral deposit in West Michigan potentially worth billions of dollars that could establish Michigan as a leading U.S. supplier of a key fertilizer used by farmers worldwide.



From left, William Harrison, Western Michigan University professor emeritus of geosciences. Theodore Pagano, general manager of Michigan Potash, and Linda Harrison, administrator of the WMU MGRRE.

Courtesy of WMU

"This is the United States' only shovel-ready potash project," said Theodore Pagano, a potash geologist, engineer and general manager of <u>Michigan Potash Co.</u> <u>LLC</u>, the company that now controls the Borgen Bed, which lies under 14,500 acres in Mecosta and Osceola counties. "What we're looking at is the introduction of an industry that is critical to the economic health of the state. We'll be producing a Michigan product for Michigan farmers that would dramatically reduce the expensive transport costs on the more than 300,000 tons of potash consumed in our state annually."

At current market prices, the deposit is estimated to be worth \$65 billion, said



Potassium-rich salts in a core of rock salt



Fertilizer Just Got Even More Expensive as Potash Prices Jump

ces

Canpotex

By Jen Sker February 15

Fertilizer ju

Canpotex h shipments a than double 2013, accore Tuesday. Th analyst Ben

The joint ve and Mosaic same price.

POTASH ADDED TO Critical Minerals List

"The US is currently 96% import reliant on this critical crop nutrient. The work of the USGS is at the heart of our nation's mission to reduce our vulnerability to disruptions in the supply of critical minerals. Any shortage of these resources constitutes a strategic vulnerability for the security and prosperity of the United States."

Dr. Tim Petty, Assistant Secretary of the Interior for Water and Science

produce, among other uses.

\$50 million in state funding (2022 bduget)

First In 30 Years: New Michigan Potash Mine In the Works













Iron ore!



The Tilden (Open pit) Iron Mine – employing almost 1000 people





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Tilden Mine eyes expansion of mining operations

ISHPEMING — Owners of the Cleveland Cliffs' Tilden Mine in Ishpeming, are in talks about expanding its mining operation. Their most current proposal is to expand the pit mine and with it create a stockpile of rock that will impact 77.9 total acres of emergent, forested and shrub wetland. This proposed stockpile expansion will also permanently fill 4,661 linear feet of stream in the Escanaba River Watershed.



This increase in the Tilden mining area would inevitably have an impact on iron ore production and the number of jobs at the mine. As of 2023 the Tilden Mine employed 990 people and produced nearly 13.5 billion pounds of iron ore pellets in 2022. The impact of the expansion would have on the production of iron ore pellets and the job market is unknown. As the Tilden Mine and the Union that works at the Tilden, United Steel Workers of America 4974, could not be reached for comment.

Tilden officials held a private meeting, the Tilden Mine Expansion Discussion, with environmental groups and adjacent landowners and farmers.







Troubled mining industry now resurgent in Upper Peninsula, Midwest

By Associated Press





Economic Development Economy

A way of life dating back more than a century appeared over in Michigan's Upper Peninsula when the last copper mine closed in 1995, idling more than 1,000 employees and turning this once-thriving company town into a forlorn outpost.

Now a Canadian company is planning a new mine at the site a few miles from Lake Superior, where screeching gulls hover over empty buildings and parking lots are littered with broken glass. If **Highland Copper Co.**'s plans go forward, the White Pine, Mich., area will be astir once more as underground ores are blasted, hauled to the surface and crushed at a mill to extract valuable minerals.

White Pine's impending rebirth is almost miraculous to local residents who have borne the brunt of its demise, but it's part of something even bigger: a surprising resurgence of a mining industry that once was an economic pillar in three Upper Midwestern states but has been in serious decline.

In the past few years, at least six open-pit or underground mines have been proposed or started in Michigan, Minnesota and Wisconsin, the first such ventures in decades. Additionally, four new Minnesota operations are using refined technology to extract iron from waste rock mined long ago. Other companies are exploring the region's ample deposits of iron, copper, nickel and other metals, which have become more marketable because of improved technology and rising demand in the U.S. and China.

"I thought there was no way it was ever coming back," said Dan Kessler, who was 34, married and the father of two young children when the White Pine closure left him jobless. Now, he says, if the project comes through, "I'd like to see the schools open again."



Ni: 220,000 tons Cu: 215,000 tons

Eagle Project Aerial View



NICKEL – THE OFTEN FORGOTTEN BATTERY METAL

28th January 2019 🖨 Nickel

By Anthony Milewski, Chairman, Cobalt 27

The mass adoption of the electric vehicle and the roll out of energy storage systems is underway. Look no further than acceleration of recent electric vehicle (EV) sales and headlines around energy storage systems being sold globally. Over the past five years approximately 5 million EVs have been sold. In the past twelve months 1 million EVs have been sold and over the next twelve months we are on pace to sell another 1.5 million EVs. Battery storage facilities are being connected to wind farms and solar at an exponential rate.

Equity research, media, conferences and commentators alike have primarily focused on the need for lithium, cobalt, graphite and copper in the new energy paradigm. While it is true that each of those commodities stands to materially benefit from the electrification of the automobile and energy storage market, nickel is often overlooked as a key battery metal with interesting supply-demand dynamics in the coming years.

Two chemistries of lithium ion batteries dominate electric vehicle batteries – Nickel-Manganese-Cobalt "NMC" and Nickel-Cobalt-Aluminum "NCA". As between the two chemistries, NMC is used by nearly every automobile maker in the world save it for Tesla. For at least the next decade, the evolution of the lithium ion battery and its NMC chemistry is towards a more nickel rich cathode.

Eagle Mine

Strengthening the local economy





Approximate boost to Marquette County economy over the life of mine

\$570 MILLION

Estimated expenditure on goods and services in the U.P.

1,500_{JOBS}

Every job is expected to create an additional five jobs in Marquette County. **250 Eagle jobs = 1,250 indirect jobs**



Projected payments to state and local governments

Mineral hunters find small nickel and copper deposit in Michigan

Updated: Oct. 30, 2024, 5:11 p.m. Published: Oct. 30, 2024, 7:05 a.m.



A Talon Metals mineral drilling site in Marquette County, Mich., nicknamed 'Boulderdash." The company says it found a shallow deposit of high-grade copper and nickel in September 2024. Talon Metals


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Above the bedrock – mostly sediment brought here by *ice sheets* (glaciers)









≈25,000 years ago (Maximum advance of the ice)



≈17,000 years ago



≈16,400 years ago



≈16,200 years ago



≈15,800 years ago Lake plains – very flat! But very good soils (after they have been drained)

Lake plains – very flat! But very good soils (after they have been drained)









Large acreages of sugar beets on the Saginaw Lake Plain





Michigan's (more than 10,000) lakes – mostly glacial kettles





Kettle lakes





≈15,700 years ago



≈14,000 years ago



≈13,000 years ago







Small sand dune









Aggregate in Michigan - an important glacial legacy

Michigan leads the nation in aggregate production!

Michigan leads the nation in aggregate production!



Every American Born Will Need . . .



Aggregate – different sizes for different applications



















A man walks into a bar with a slab of asphalt under his arm and says: "A beer please, and one for the road."

Most (about half) of all aggregate is used for roads and sidewalks



Other concrete "products" that also need aggregate





Gravel pits and the NIMBY phenomenon



Jeff Daniels joins nearly 500 residents opposing new sand mine near Chelsea





Photo Gallery: Chelsea residents attend hearing on proposed sand mine

By Ben Freed | benfreed@mlive.com

Nearly 500 people, including a state representative and Chelsea's most well-known resident, turned out Thursday night to oppose a new sand and gravel mine Lyndon Township.
Senate Committee holds another hearing on bill to exempt gravel mining from local zoning laws

Michigan Public | By Tracy Samilton Published June 24, 2020 at 12:04 PM EDT





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Michigan agriculture







WHERE are the farms and farmers?



Farms ... on the good soils

Percentage of the Employed Population in Farmer and Farm Manager Occupations

- 0% 0.5%
 0.6% 1.3%
 1.4% 2.4%
- 2.5% 3.7%
 - 0 3.8% 5.8%
 - 5.9% 9.4%
 - 9.5% 17.4%





Michigan ag.... diverse and highly ranked

BUT WHAT are we the BEST at?





TART CHERRIES







CRANBERRY BEANS





SMALL RED BEANS





BLACK BEANS





SQUASH





NIAGARA GRAPES

#1 in the USA in: PICKLES and CUCUMBERS





PICKLES



Vlasic pickles are packed into the jars and cured in Imlay City, which is in Lapeer County over in the Thumb.





RED POTATOES





Also first in per-capita <u>consumption</u> of potato chips!







ASPARAGUS



1st

PL

A C

APPLES FOR PIES





EASTER LILIES

Also impatiens, begonias, petunias, and geraniums

SECOND in production of:

celery hanging flower baskets all dry beans navy beans dark red kidney beans fresh carrots turfgrass peat cucumbers squash









THIRD in production of:

snap beans light red kidney beans apples Christmas trees

FOURTH in production of:

alfalfa haylage all carrots grapes Concord grapes processed carrots processing tomatoes sugar beets sweet cherries

plums/prunes all tomatoes hops pears wine grapes blueberries

FIFTH in production of: SIXTH in production of:

SIXTH in production of: greenhouse and nursery stock pumpkins milk

SEVENTH in production of:

bell peppers eggs maple syrup potatoes wine



Because you might be curious...







In terms of **\$value\$** of commodities,

- Q. What crops are easily the top two?
- A. Corn and soybeans
- Q. What is the top fruit?A. Apples



Q. What is of more \$ value - vegetables or fruit?A. Vegetables

Q. What is the top agricultural commodity or crop? A. Milk and dairy products (\$1.8 billion. Corn is 2nd at \$986 million)



Top Michigan crops (\$ value)

- 1. Corn
- 2. Soybeans
- 3. Hay
- 4. Wheat
- 5. Potatoes
- 6. Apples (#3 nationally)
- 7. Blueberries (#5 nationally)
- 8. Cherries (both types) (#4 nationally)
- 9. Cucumbers (#2 nationally)
- 10. Squash (#2 nationally)





Michigan's Fruit Belt

--areas close to the lake AND on high ground

The "Fruit Ridge"

Grand

Rapids









Michigan's Fruit Belt --areas close to the lake AND on high ground

A MICHIGAN FRUIT Trivia Bowl

- Q. Blueberries are the SECOND most "eaten" berry in the US. Which berry is first?
- A. Strawberries
- Q. Most of Michigan's apples end up as what product?
- A. Juice/cider
- Q. In the US, more _____ are consumed than any other kind of fruit.
- A. Oranges (apples are second)







Michigan ranks...

4th in *Concord grape juice* production 5th in *wine*

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Summers are going to get HOTTER





Projected Temperature-Related Changes 2041-2070 vs. 1971-2000



Projected Temperature-Related Changes 2041-2070 vs. 1971-2000



Projected changes in Michigan's precipitation

 Many more "heavy precip" events
 More winter and spring rain events – and floods!
 Fewer days with snow

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Thank you for your attention.

Mullett Lake, Cheboygan County



Harm de Blij