Michigan Natural Resources: A survey of Production Statistics

Presented by Dr. Peter Voice with contributions from Dr. Bill Harrison and Mr. John Yellich
Where did this data come from?

• Sifted through:
  • U.S. Bureau of Mines Annual Reports (pre-1900 data)
  • Michigan Geological Survey Annual Statistical Summaries (and predecessor series) – 1900-1940 and 1950-1980 data
    • Note most pre-1938 data was compiled into a volume by O. Poindexter in 1940 – this was used as the main source for these years (save for Gold data – which relied on US Bureau of Mines reports)
  • All coal data pre-1950 was from Cohee et al. 1950 (USGS Circular 77)

• Because of the vintage of many of the sources – had to be very careful with units
  • Salt – sold by the barrel (~250 lbs), then in short tons, then in metric tons!
• Note – we do have some confidential mineral statistics data – to protect the data, we are not releasing the annual data, but we have added it into the total production of the commodity.
Types of Resources

• Mineral Resources
  • Metallic Minerals
  • Nonmetallic Minerals

• Aggregate Resources

• Energy Resources

• Groundwater
Metallic Minerals

• Western Upper Peninsula resources
  • Gold (+ Silver) – associated with peridotite (olivine-rich rock) – very minor resource
  • Copper (± Silver; Nickel, Zinc, Platinum Group Elements)
    • Keweenaw area and west
    • New Eagle Mine (Cu-Ni, PGE)
    • Back Forty Project (at permitting stage – also has some Zn)
• Iron Ore (± Manganese)
  • Three major trends – Marquette Range (just one mine left – the Tilden Mine); Crystal Falls-Menominee Range; Gogebic Range
Iron Ore Production in Michigan

- Crude Ore
- Processed Ore

Beneficiation of lower grade ores

http://www.lselectric.com/

Structural Steel – first skyscrapers!

Automobiles

Direct Shipping Ores (~70% Fe$_2$O$_3$)
**Modified from Mitchell and Sheldon, 2016**

- Mostly Cu-sulfides
- Mostly Native Cu ± Cu-oxides, ±Cu-carbonates

Diagram:
- Cambrian
  - Mesoproterozoic
    - Jacobsville Sandstone
      - Freda Sandstone
      - Nonesuch Shale
      - Copper Harbor Conglomerate
    - Oronto Group
      - Porcupine Volcanics
      - Portage Lake Volcanics
        - Various Rhyolites
    - Bergland Group
      - Powder Mills Group
        - Bessemer Quartzite
          - ~1200 Ma
          - ~500 Ma?
Copper Production in Michigan

- **U.S. – Urban Electrification**
- **Rural Electrification**

Social benefits of Cu!

Indoor Plumbing – Cu fixtures and Pipes (to ~1940s)
Comparison of Silver and Copper Production

Silver Production
Copper Production

1980-1997 – Cu+Ag production at White Pine – data Withheld
Associated with the Ropes Gold Mine area are serpentinized dolomitic marbles, called *Verde Antique*. This was quarried for an attractive dimension stone off and on from the 1880’s to 1920’s.
## Estimated Total Production: Metallic Resources

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Production</th>
<th>Value (2013 $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processed Iron Ore</td>
<td>1,500,000,000 metric tons</td>
<td>$157 billion</td>
</tr>
<tr>
<td>Copper</td>
<td>6,510,000 metric tons</td>
<td>$44 billion</td>
</tr>
<tr>
<td>Silver</td>
<td>29,704,000 troy oz. (~923 metric tons)</td>
<td>$500 million</td>
</tr>
<tr>
<td>Ferruginous manganese ore</td>
<td>820,000 metric tons</td>
<td>$3.8 million</td>
</tr>
<tr>
<td>Manganiferous iron ore</td>
<td>516,000 metric tons</td>
<td>$2.4 million</td>
</tr>
<tr>
<td>Gold</td>
<td>33,600 troy oz. (~1.1 metric tons)</td>
<td>$47 million</td>
</tr>
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</table>
Nonmetallic Mineral Resources

• Mostly LP production – though historic gypsum production in several rock units in the UP
• Rock Gypsum
• Rock Salt
  • Halite – NaCl salt
  • Sylvite – KCl salt (no active production today; historic production ~160,000 tons per year)
• Brines (Mg, I, Br, Ca, Cl) – data generally withheld – as few operators extract these (different magnitudes of production as well – focus on Mg and CaCl₂ compounds)
Willmet Gray #1-31
Osceola Co., MI 31-17N-18W
P#: 35800
Core Interval: 2337.4-2337.6 m (7668.5-7669.5 ft)
Sample of the C Shale (Salina Group) with secondary red halite cements filling a fracture
Samples of the F Salt (Salina Group) – the unit commercially mined in Detroit
Annual Michigan Salt Production

- Detroit Salt Mine begins operations
- Salt extracted from saline aquifers - brines
- Temporary closure of salt mine
Satin Spar Gypsum – secondary precipitant in the Cabot Head Shale, UP
Anhydrite in the Lucas Formation, Detroit River Group
Anhydrite in the Michigan Formation – the Michigan Formation was commercially mined in Grand Rapids and is still mined at Alabaster.
2000 drop-off in production – does not correspond to any recession. So what happened?
Estimated Total Production: Nonmetallic Minerals

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<tr>
<td>Rock Salt</td>
<td>308,000,000 metric tons</td>
<td>$14.5 billion</td>
</tr>
<tr>
<td>Rock Gypsum</td>
<td>110,000,000 metric tons</td>
<td>$1 billion</td>
</tr>
</tbody>
</table>

Brine data – withheld
Aggregate Resources

- Mined statewide – though different qualities, and types of materials quarried at different parts of the state
- Sand and Gravel (fill, glass sands, injection mold sands, brick filler, etc.)
- Clay and Shale (bricks and tiles, ceramics)
- Cement
- Lime (flux, FGD Gypsum)
- Crushed Stone – mostly limestone and dolomite (fill)
- Dimension Stone (~10,000 tons per year)
Sylvania Sandstone, Sylvania Minerals Quarry, Monroe Co.

Glass Sands

Note upper darker layer – glacial till
Traverse Group Limestones – Quarried at Charlevoix
Sawheidle Quarry, near Manistique, MI

Crushed Rock – Dolomite from the Burnt Bluff Group
Stromatoporoid sponge, Engadine Dolomite
Drummond Island Quarry – crushed stone
Antrim Shale Localities near Norwood, MI and Kettle Point, ONT
Ruins of Lincoln Brick Factory, Lincoln Brick Park
Grand Ledge, MI
## Estimated Total Aggregate Production

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<tr>
<th>Commodity</th>
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<tbody>
<tr>
<td>Masonry Cement</td>
<td>10,500,000 metric tons</td>
<td>$1.5 billion</td>
</tr>
<tr>
<td>Portland Cement</td>
<td>307,000,000 metric tons</td>
<td>$27.7 billion</td>
</tr>
<tr>
<td>Clay</td>
<td>91,000,000 metric tons</td>
<td>$1 billion</td>
</tr>
<tr>
<td>Lime</td>
<td>45,295,000 metric tons</td>
<td>$5 billion</td>
</tr>
<tr>
<td>Sand and Gravel</td>
<td>3,326,000,000 metric tons</td>
<td>$25 billion</td>
</tr>
<tr>
<td>Stone (Crushed + Dimension)</td>
<td>2,200,000,000 metric tons</td>
<td>$10.4 million</td>
</tr>
</tbody>
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Energy Resources

• Lower Peninsula Resources – some exploration in the UP – but nothing productive
• Oil
• Natural Gas
• Coal (historic production – none today)
Michigan Natural Gas Production

Note Oil and Gas data – from Bill Harrison’s records

Niagara Reef Gas Production

Antrim Shale – One of the first Unconventional Shale Plays
Michigan Oil Production

Note Oil and Gas data – from Bill Harrison’s records

- Dundee and Traverse Group
- Trenton-Black River (Albion-Scipio)
- Niagara Reefs
- Renewed Trenton-Black River
Michigan Annual Coal Production

Jackson area, Saginaw Valley, and Thumb Region – lots of mines
## Estimated Energy Resources Production

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<tr>
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<tr>
<td>Oil</td>
<td>1,336,000,000 barrels</td>
<td>$116 billion</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>8,086,000,000 cubic feet</td>
<td>$33.6 billion</td>
</tr>
<tr>
<td>Coal</td>
<td>42,000,000 metric tons</td>
<td>$3.5 billion</td>
</tr>
<tr>
<td>Peat</td>
<td>10,000,000 metric tons</td>
<td>$250 million</td>
</tr>
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</table>
Final Thought

• If we had to go back and mine these resources again – at 2013 prices, they would be worth approximately $558,000,000,000