

Michigan Natural Resources: A survey of Production Statistics

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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)
 - U.S. Geological Survey Mineral Yearbooks – 1940-1950 and post-1980 data
 - 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 (\pm 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 (\pm Manganese)
 - Three major trends – Marquette Range (just one mine left – the Tilden Mine); Crystal Falls-Menominee Range; Gogebic Range

Banded Iron Formation
Jasper Knob, Ishpeming, MI



Mesabi Range Northern Minnesota	Gunflint Range Western Ontario	Gogebic Range Wis.-Mi.	Crystal Falls-Menominee Range - Dickinson Co.	Marquette Range Marquette Co.	
				Jacobsville Sandstone	
Virginia Fm.	Rove Fm.	Tyler Fm.	Badwater Greenstone	Baraga Group	
			Michigamme Fm.		Michigamme Fm.
			Hemlock/Felch		Goodrich Quartzite
Biwabik BIF	Gunflint BIF	Ironwood BIF	Vulcan BIF	Menominee Group	Negaunee BIF
Pokegama Quartzite	Basal Conglomerate	Palms Quartzite	Felch Fm.	Menominee Group	Siamo Slate
					Ajibik Quartzite
		Bad River Dolomite	Randville Dolomite	Chocolay Group	Wewe Slate
		Sunday Quartzite	Sturgeon Quartzite		Kona Fm.
			Fern Creek Fm.		Mesnard Quartzite
					Enchantment Lake Fm.
Archean Metaigneous Rocks (2.5 Ga+ in age)				Compeau Creek Gneiss	
				Mona Schist	
				Southern Complex Gneisses	

Iron Ore Production in Michigan

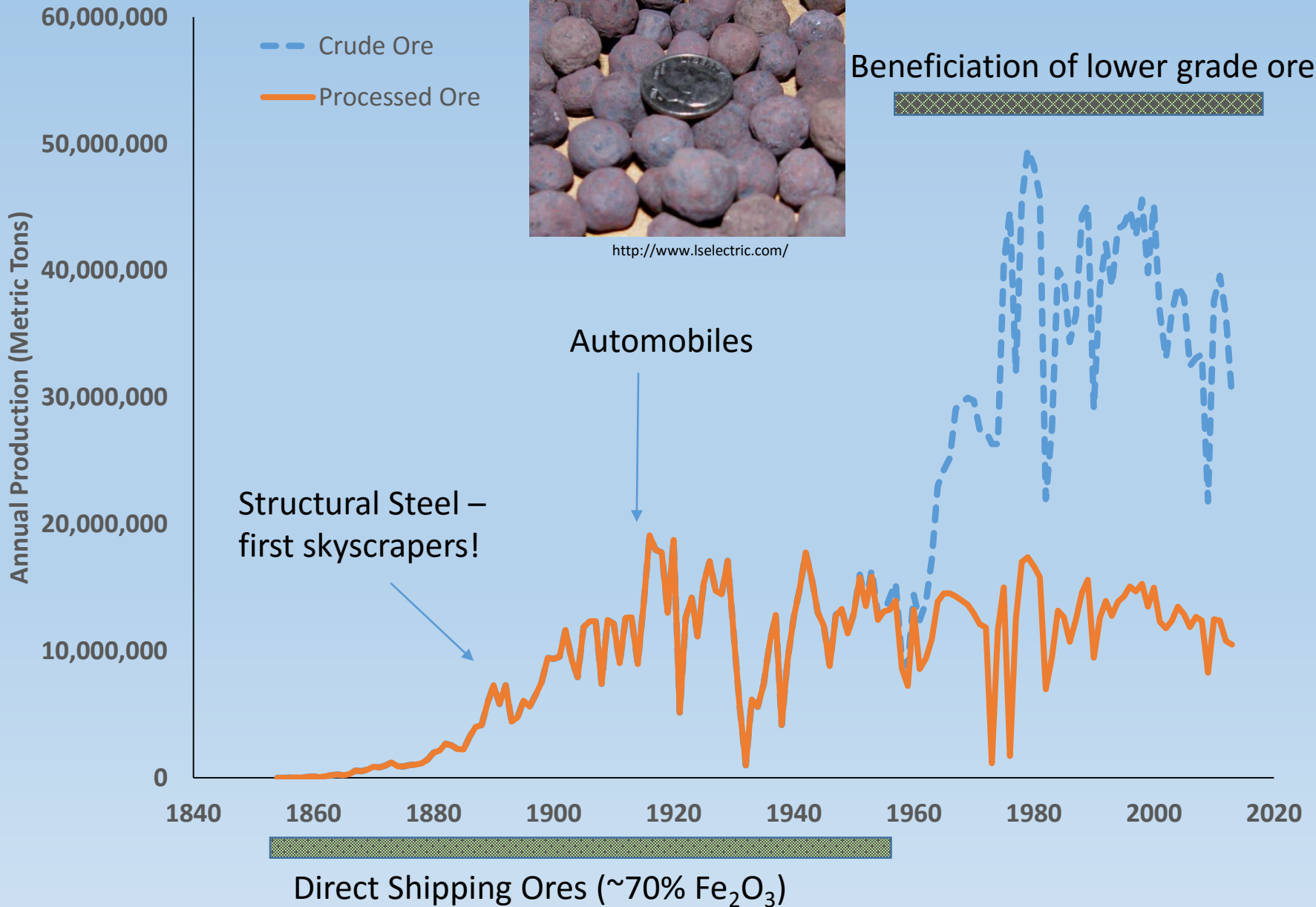


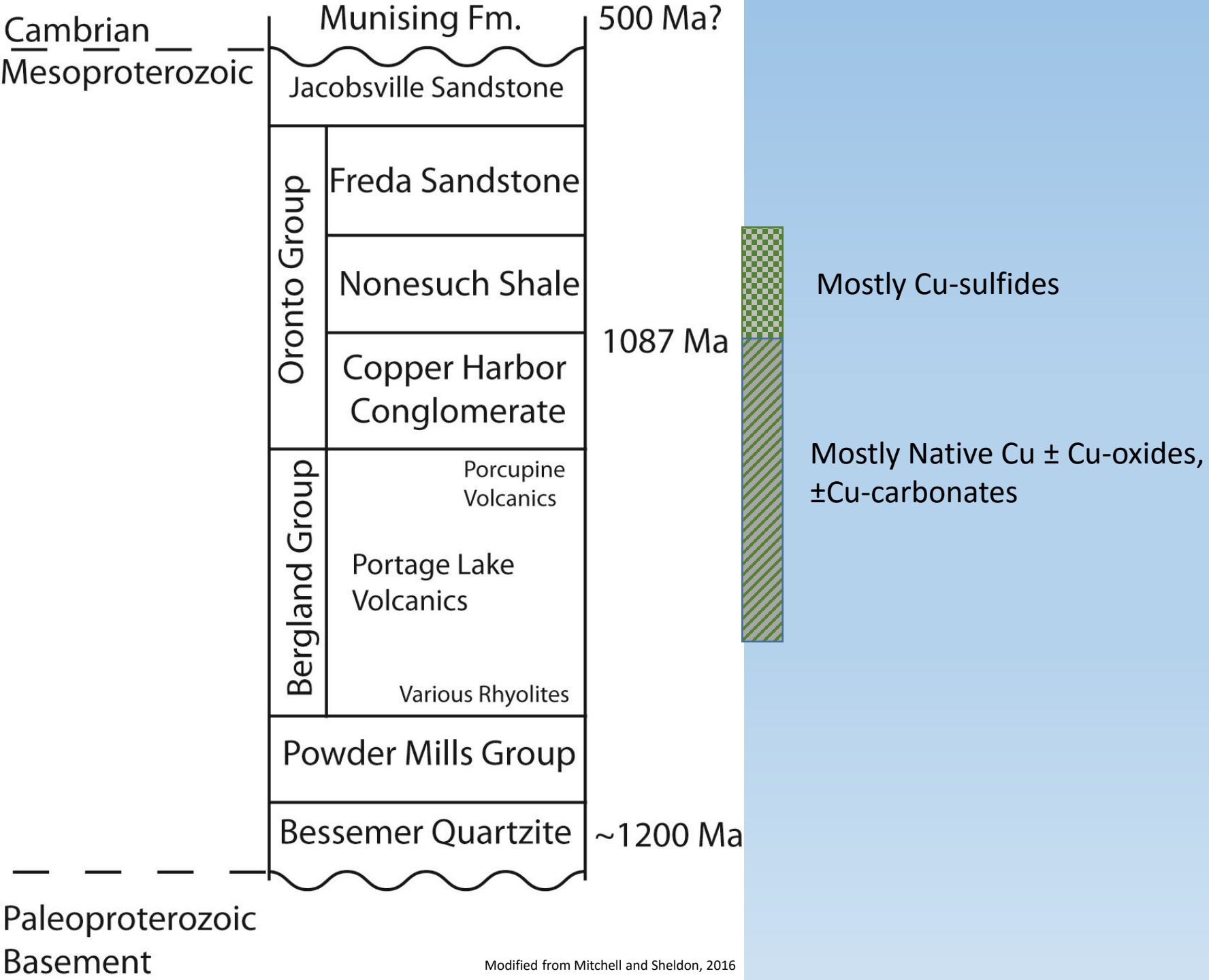
<http://www.lselectric.com/>

Beneficiation of lower grade ores

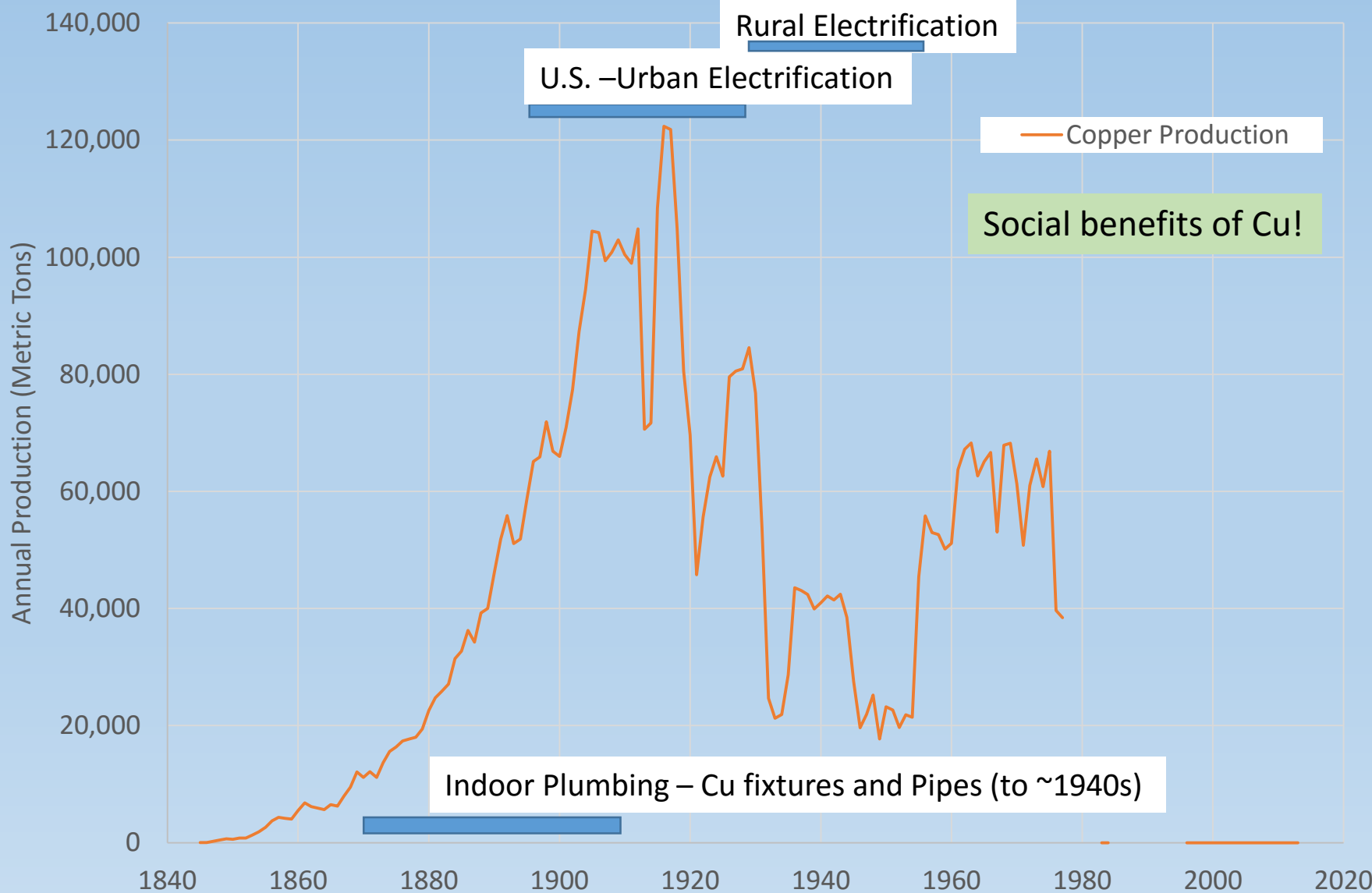
Automobiles

Structural Steel –
first skyscrapers!

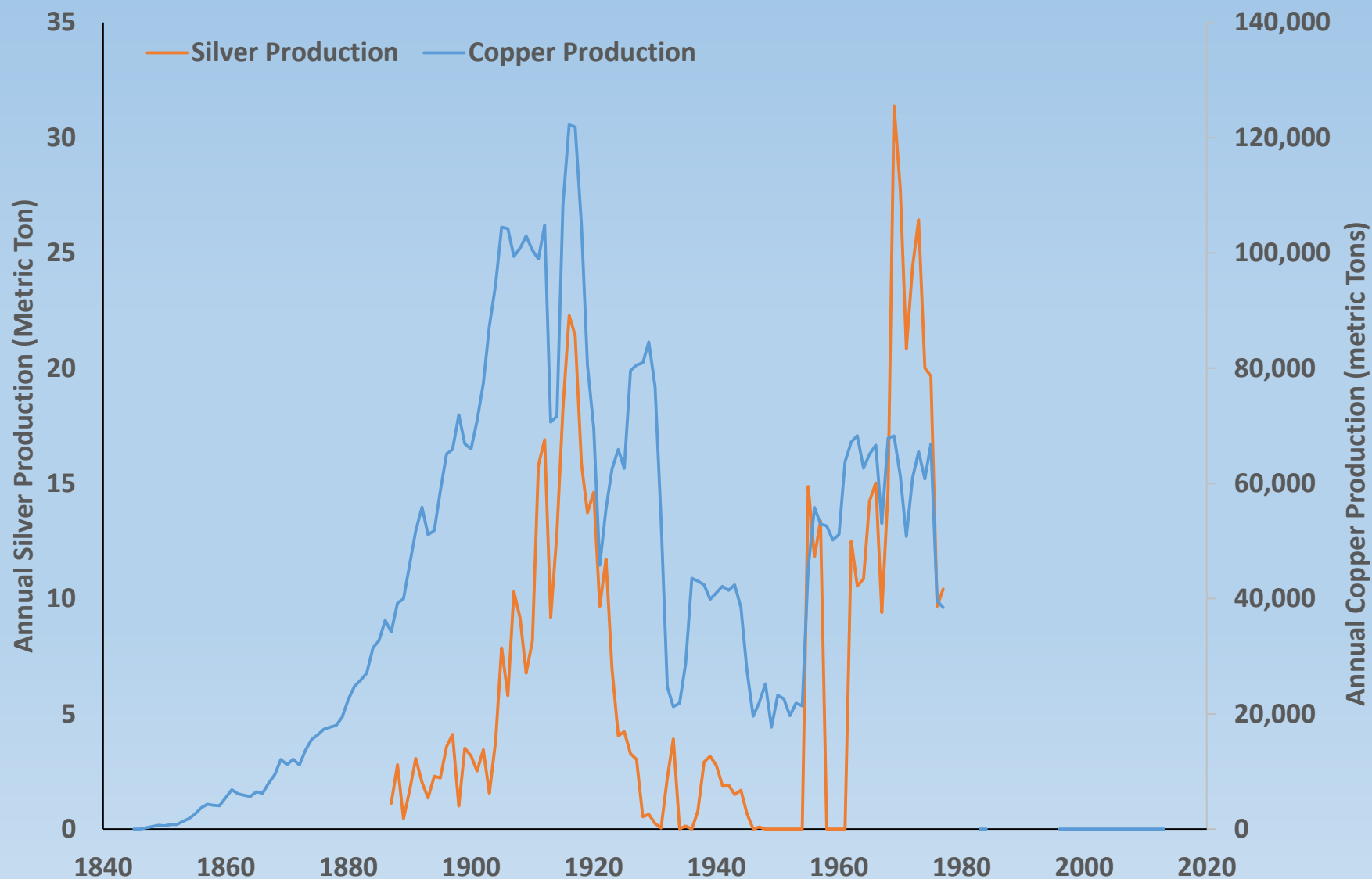




Copper Production in Michigan

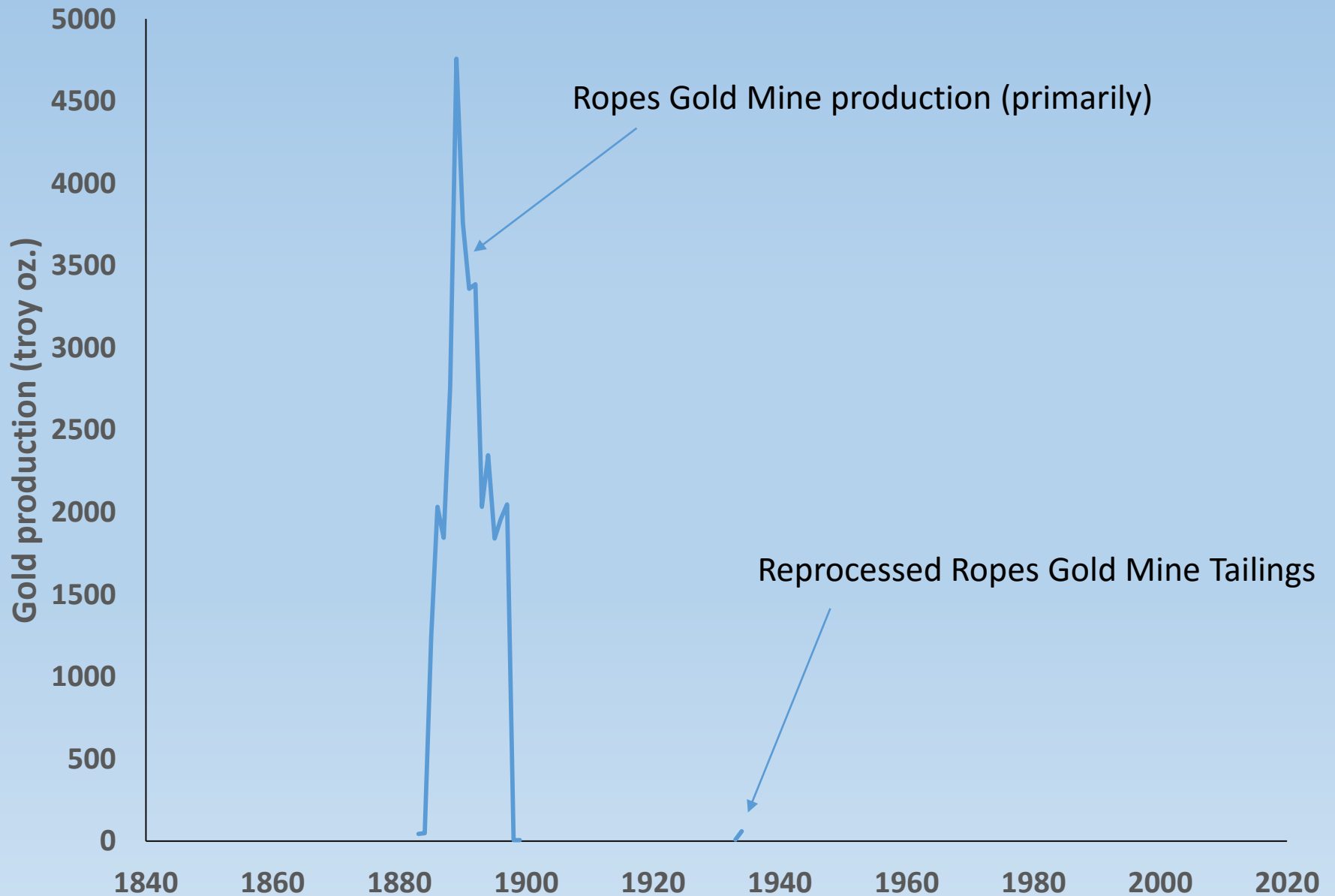


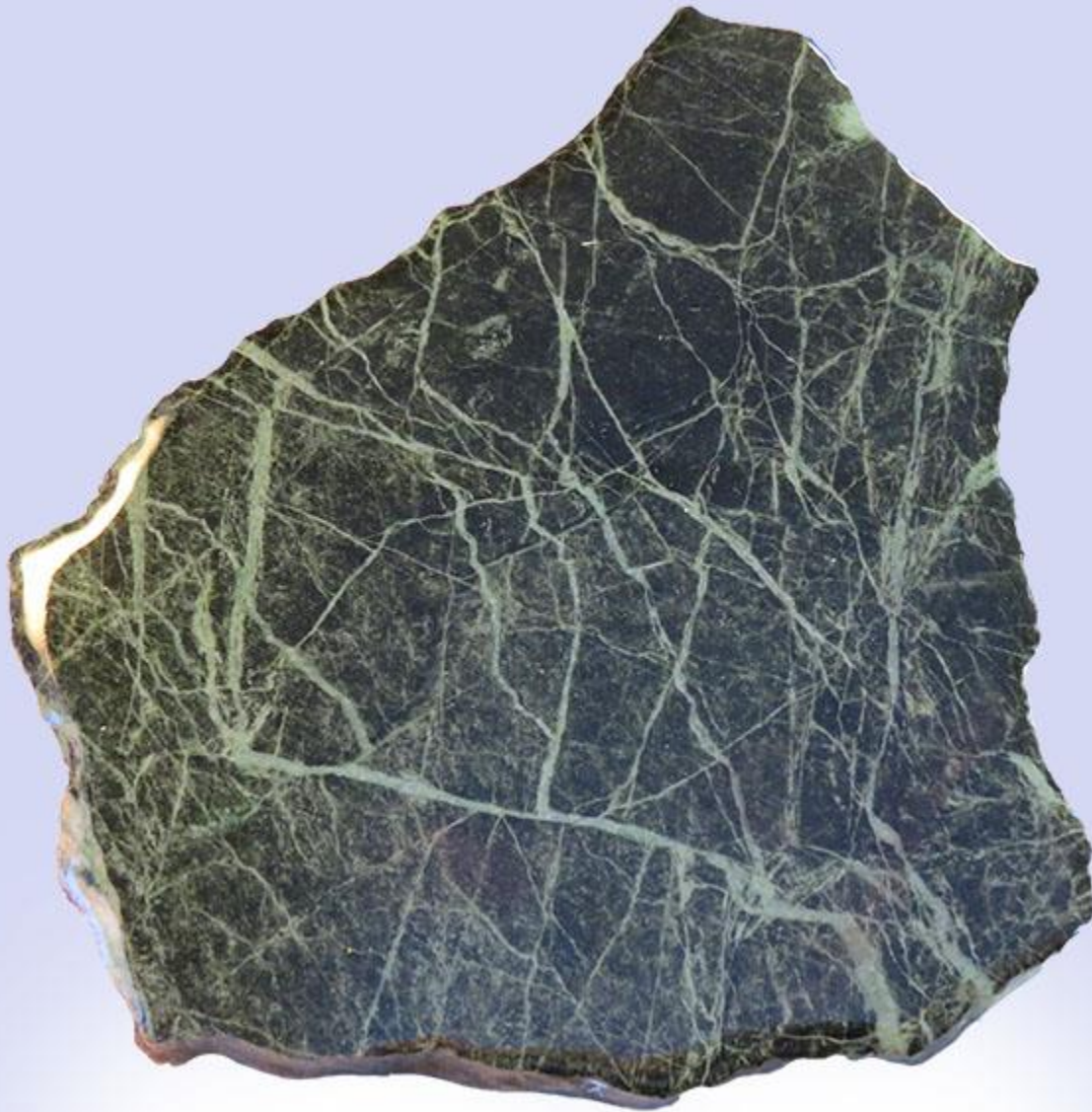
Comparison of Silver and Copper Production



1980-1997 – Cu+Ag production at White Pine – data Withheld

Annual Gold Production (troy oz.) - Composite data





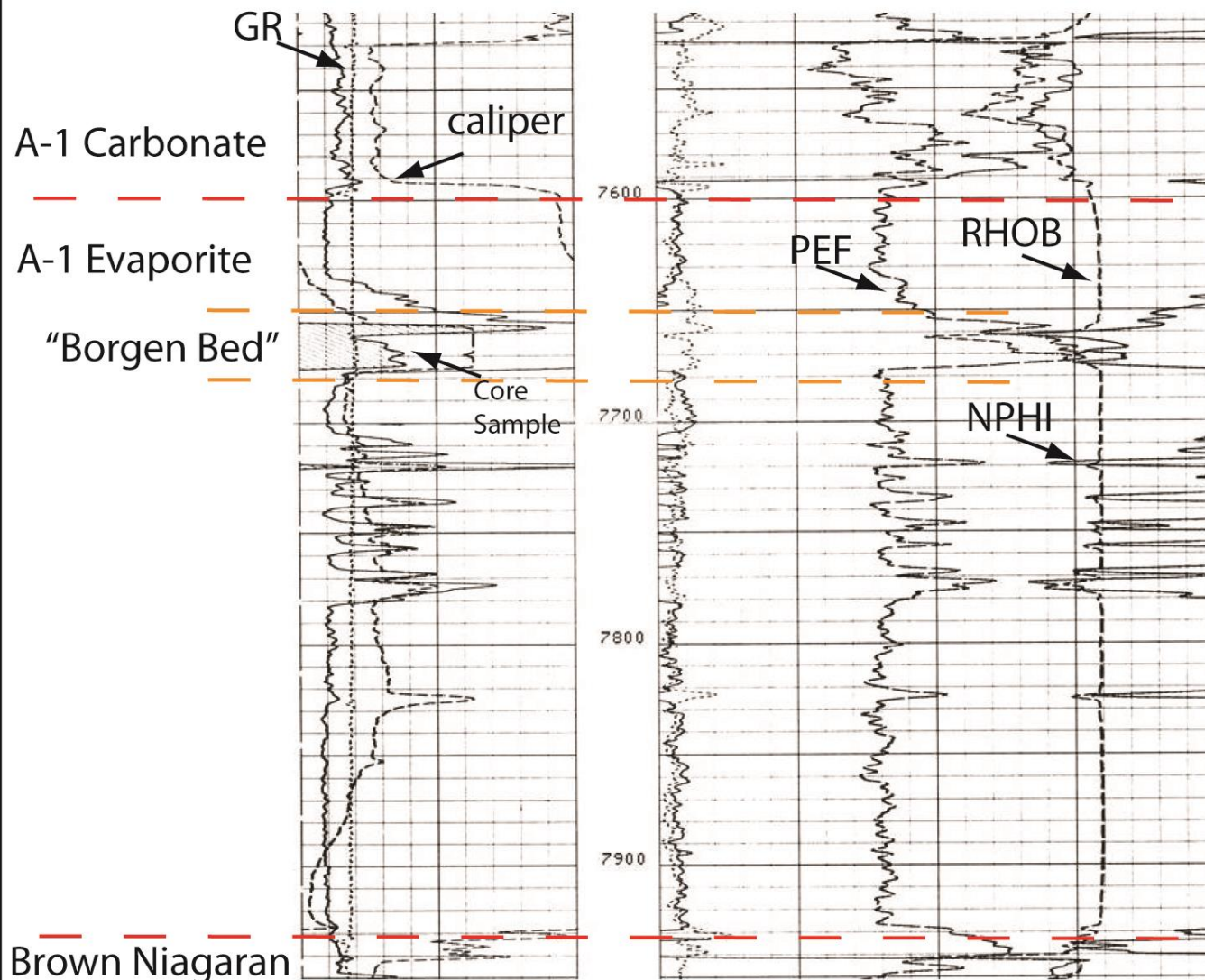
Associated with the Ropes Gold Mine area are serpentized dolomitic marbles, called *Verde Antique*. This was quarried for an attractive dimension stone off and on from the 1880's to 1920's.

Estimated Total Production: Metallic Resources

Commodity	Production	Value (2013 \$)
Processed Iron Ore	1,500,000,000 metric tons	\$157 billion
Copper	6,510,000 metric tons	\$44 billion
Silver	29,704,000 troy oz. (~923 metric tons)	\$500 million
Ferruginous manganese ore	820,000 metric tons	\$3.8 million
Manganiferous iron ore	516,000 metric tons	\$2.4 million
Gold	33,600 troy oz. (~1.1 metric tons)	\$47 million

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 CaCl_2 compounds)

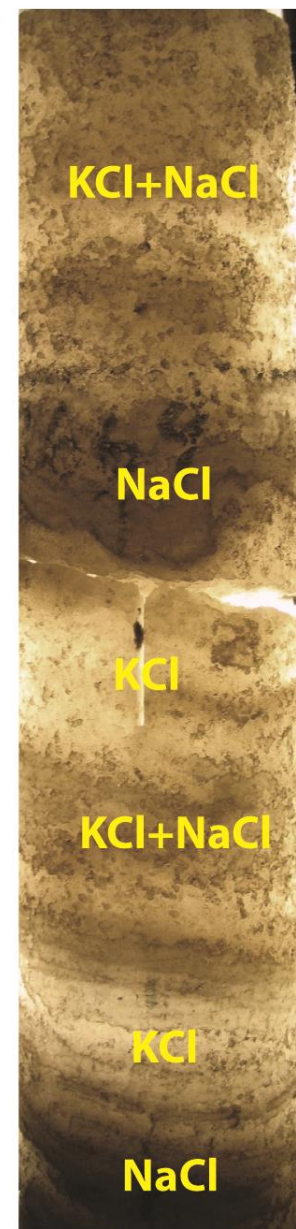


Willmet Gray #1-31

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

A.



B.

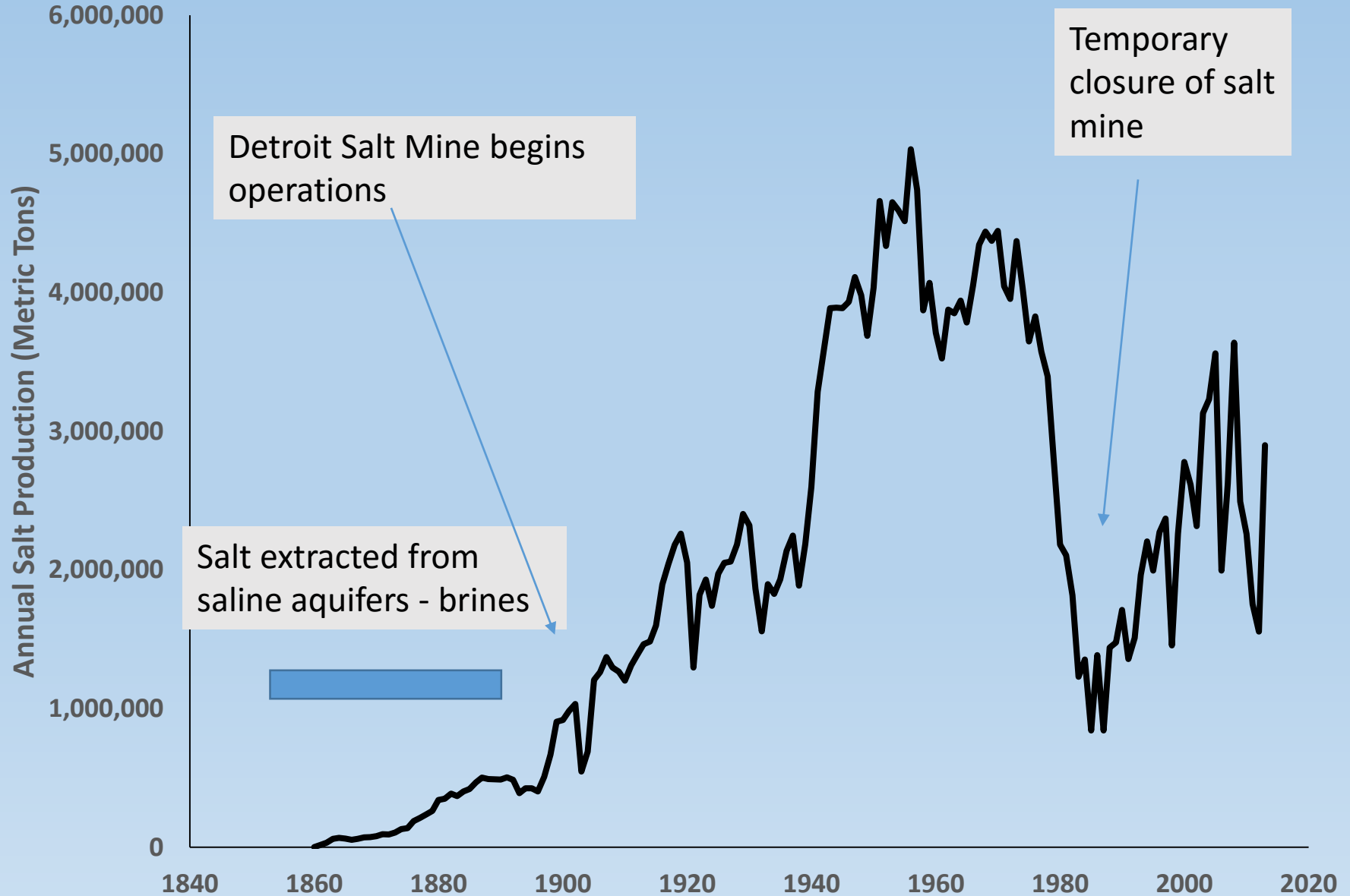


C.



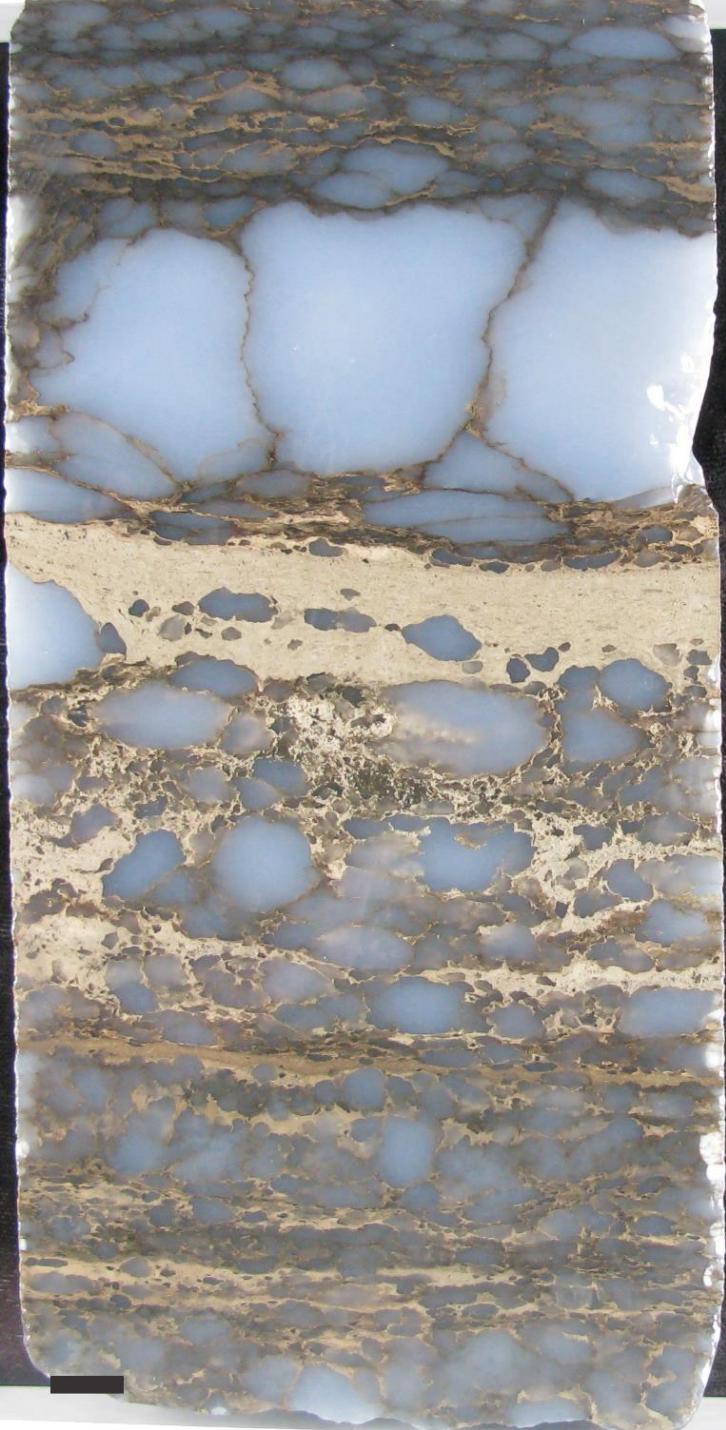
Samples of the F Salt (Salina Group) – the unit commercially mined in Detroit

Annual Michigan Salt Production





Satin Spar Gypsum – secondary precipitant in the Cabot Head Shale, UP

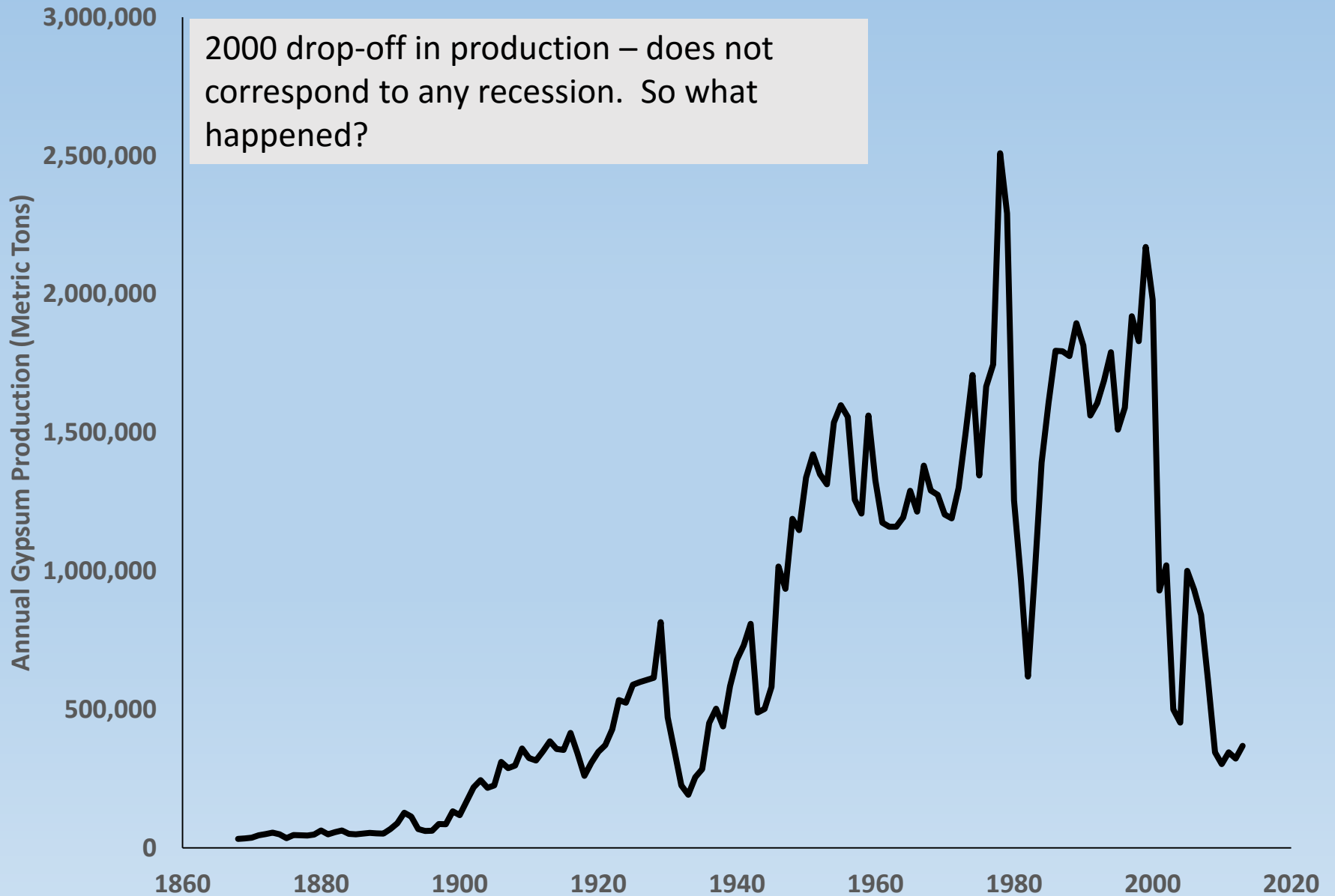


Anhydrite in the Lucas Formation, Detroit River Group



Anhydrite in the Michigan Formation –
the Michigan Formation was
commercially mined in Grand Rapids and
is still mined at Alabaster.

Annual Michigan Gypsum Production



Estimated Total Production: Nonmetallic Minerals

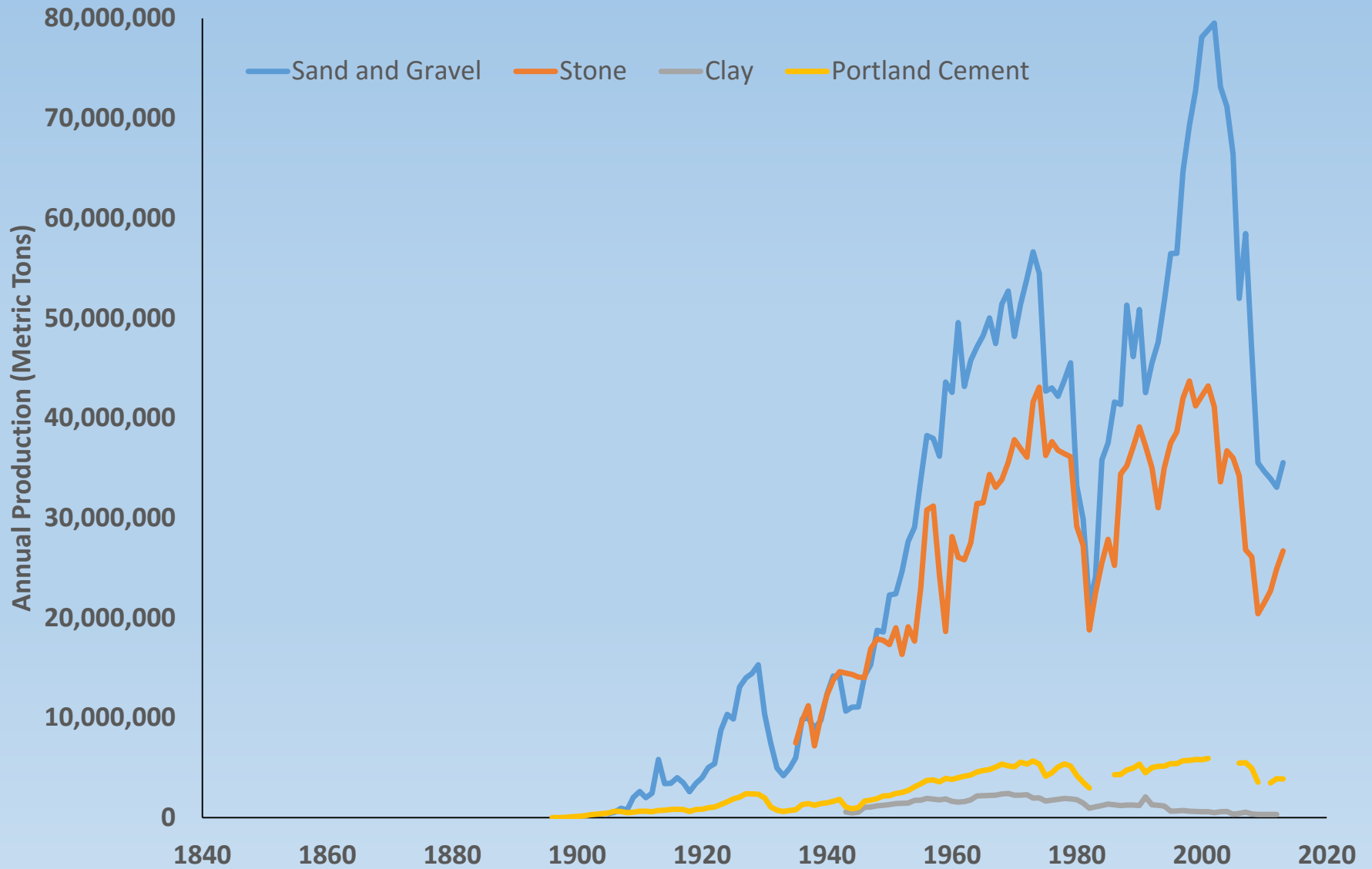
Commodity	Production	Value (2013 \$)
Rock Salt	308,000,000 metric tons	\$14.5 billion
Rock Gypsum	110,000,000 metric tons	\$1 billion

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)

Aggregate Production in Michigan



Sylvania Sandstone,
Sylvania Minerals Quarry, Monroe Co.

Glass Sands

Note upper darker layer – glacial till



Sand Mining Operation, Southwestern MI



Traverse Group Limestones – Quarried at Charlevoix






Sawheidle Quarry, near Manistique, MI

Crushed Rock – Dolomite from the Burnt Bluff Group

Bayport Limestone, Bellevue, MI





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

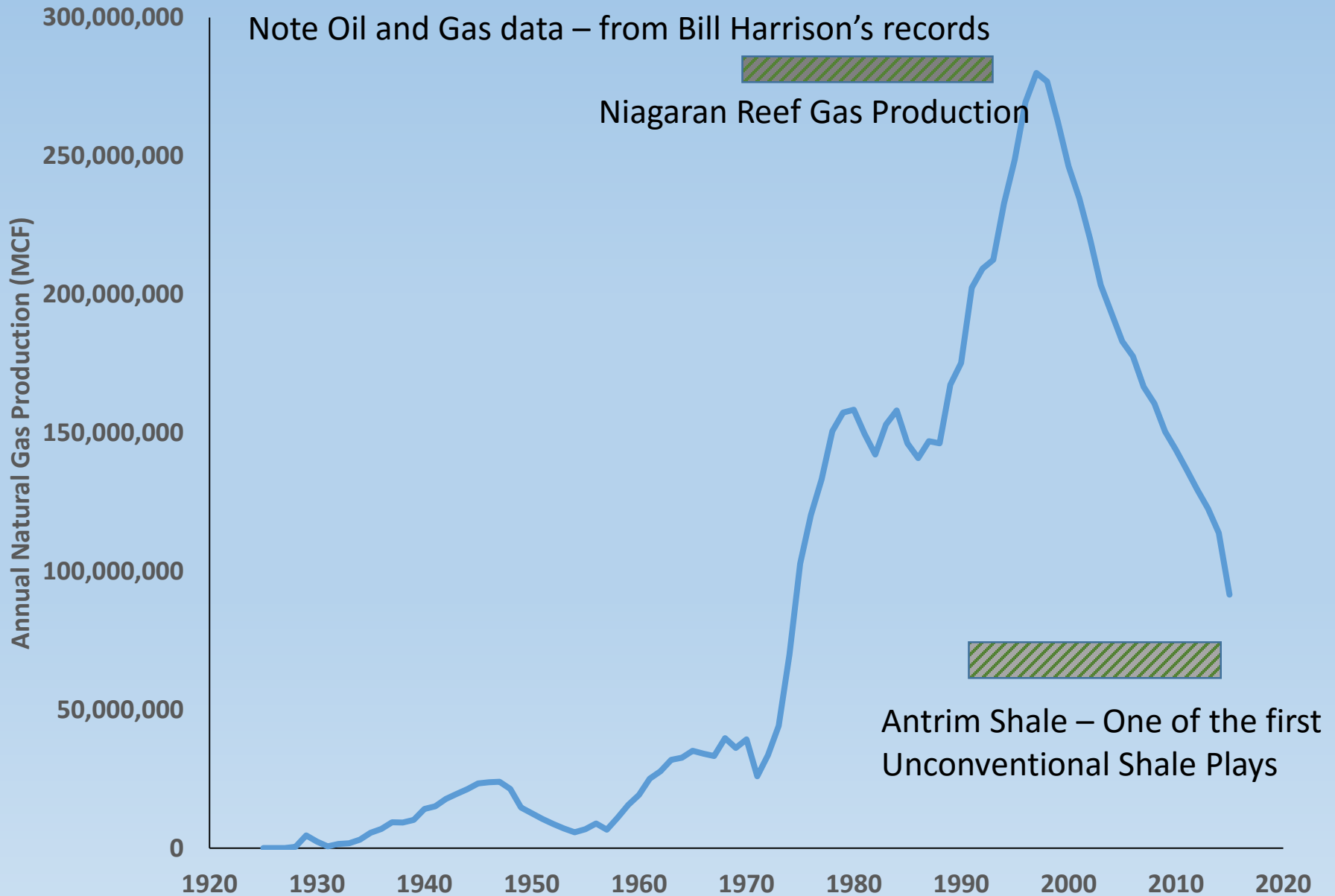
Estimated Total Aggregate Production

Commodity	Production	Value (2013 \$)
Masonry Cement	10,500,000 metric tons	\$1.5 billion
Portland Cement	307,000,000 metric tons	\$27.7 billion
Clay	91,000,000 metric tons	\$1 billion
Lime	45,295,000 metric tons	\$5 billion
Sand and Gravel	3,326,000,000 metric tons	\$25 billion
Stone (Crushed + Dimension)	2,200,000,000 metric tons	\$10.4 million

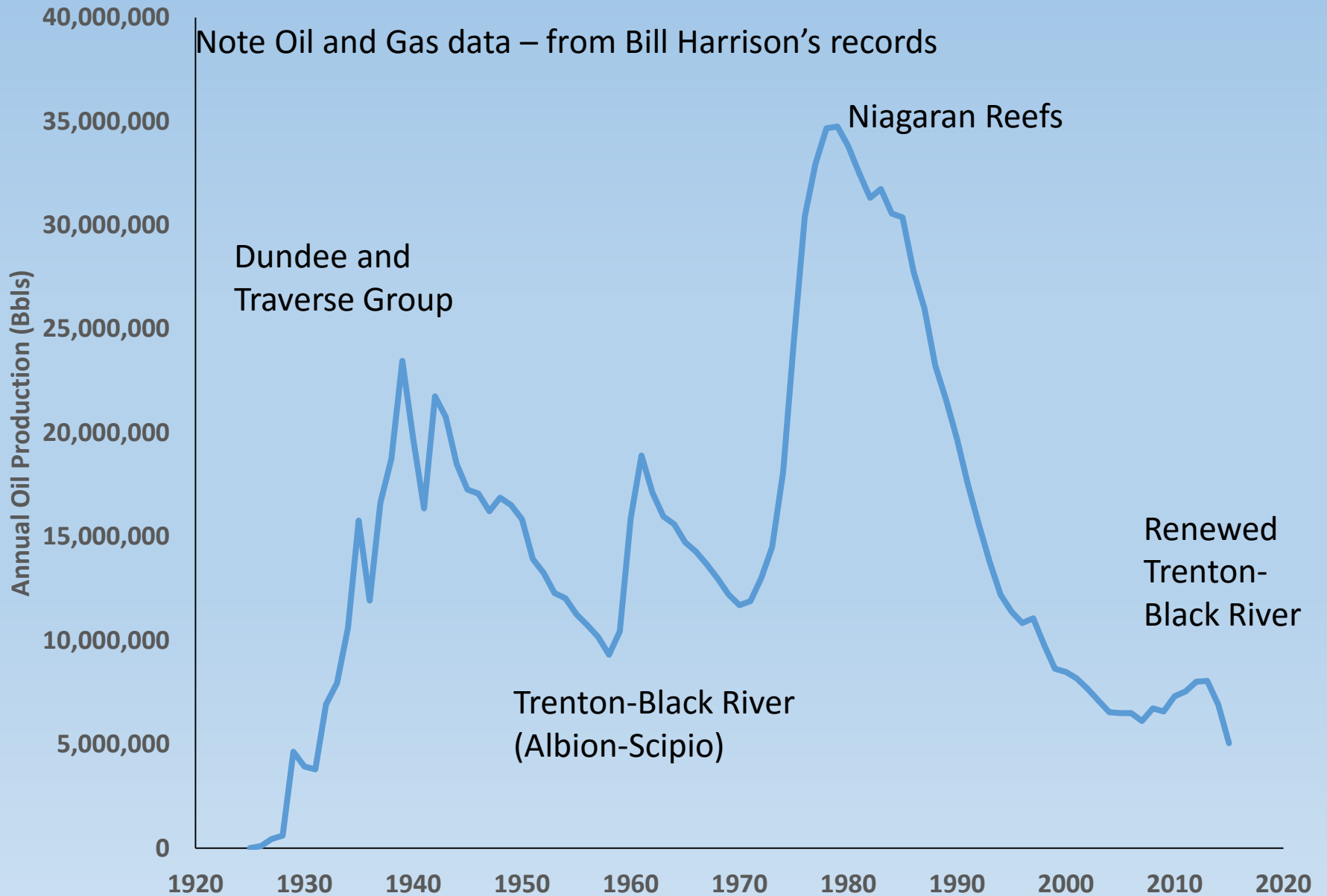
Energy Resources

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

Michigan Natural Gas Production



Michigan Oil Production



Michigan Annual Coal Production





Coal Seam – Saginaw Fm., Grand Ledge, MI

Estimated Energy Resources Production

Commodity	Production	Value (2013 \$)
Oil	1,336,000,000 barrels	\$116 billion
Natural Gas	8,086,000,000 cubic feet	\$33.6 billion
Coal	42,000,000 metric tons	\$3.5 billion
Peat	10,000,000 metric tons	\$250 million

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

