



Tamarack Water Alliance

Sustainability and Copper

<https://tamarackwateralliance.org/>

October 21, 2024

Recycling is a MUST for a Sustainable Future

- ❖ Critical Mineral Mining is FUNDAMENTALLY Unsustainable – Sustainability Requires Recycling!
- ❖ Copper Usage – EVs
 - EV copper usage is primarily in the motor and power bus connecting the battery to the motor
 - Cars in general are already nearly all recycled (crushed) so in the future, we would expect battery and motor extraction for recycling
 - Thus EV (mined) copper demand slowly rises then falls to a small quantity once the large majority of vehicles are electric
 - Total US 2023 EV sales used only 0.53% of world wide copper production (later in the presentation)
- ❖ Copper Usage – HVAC Goes Green – Heat Pumps for Heating
 - <https://www.eia.gov/todayinenergy/detail.php?id=52558> indicates that 88% of US households have AC as of 2020.
 - These over time will convert to heat pumps with a very small increase in copper needed when compressor and air exchange units are recycled
- ❖ Copper recovered from scrap contributed 33% of the U.S. copper supply in 2024

Just by Recycling EV Batteries and Appliances with Motors Could Address the Majority of Copper Needs in the US

Recycling is a MUST

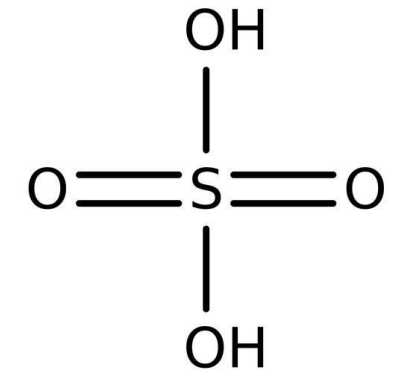
❖ Copper Usage – Power Grid

- Almost all power distribution uses aluminum cables NOT copper (check out the power cable coming into your breaker box).
- According to NREL (<https://www.nrel.gov/docs/fy17osti/66861.pdf>) the National Renewable Energy Lab, only 1 metric ton of copper per Mw of capacity is needed for a large wind turbine
 - Other sources estimate 4x this amount but don't provide the detailed analysis that NREL has done ... seems they are "making it up"
- 2023 US growth of turbine capacity then uses 0.04% of world wide supply
<https://www.eia.gov/energyexplained/electricity/electricity-in-the-us-generation-capacity-and-sales.php>)
- Solar Cells – high estimates abound BUT Navigant Research (https://www.copper.org/publications/pub_list/pdf/a6197-na-solar-pv-analysis.pdf on page 6) indicates that the very large majority of copper attributed to solar cells is in the power distribution which has been going down with new technology and can be replaced by aluminum cable if needed.

Many information sources on this topic GREATLY over-estimate both need for energy as well as the % copper used AND do not account for recycling!

Copper in Minnesota is Generally from High Sulfide Deposits

- ❖ Iron Ore in Minnesota contains some sulfur
 - Taconite mines and coal plants are the largest dischargers of sulfate today in Minnesota.
- ❖ High sulfide concentrations occur in Minnesota copper and nickel deposits
 - Nickel-Copper-Cobalt minerals in MN are bonded to sulfur mined as sulfide ores
 - When these ores are exposed to air and moisture, a chemical reaction occurs that generates **sulfuric acid** that migrates into the surrounding environment and, through leaching, releases heavy metals present in the waste rock, pit walls, and tailings basins of mining operations.
 - The sulfuric acid along with dissolved heavy metals released onto the land will seep into the rich aquifers below and then into streams and lakes at levels that are toxic to fish and other aquatic life
 - Sulfates interact with sulfate-reducing bacteria to produce the more bio-toxic form of mercury, methylmercury, a known neurodevelopmental toxin
- ❖ High sulfide mining poses real threats
 - <https://www.tamarackwateralliance.org/docs/SulfideMining.pdf> and
 - <https://tamarackwateralliance.org/docs/SulfideMining-details.pdf>



Sulfuric Acid
A very strong acid

The chemical reaction of sulfide ore / tailings to sulfuric acid can happen over long periods of time – many 100's of years

Acid Mine Drainage (AMD)

- ❖ AMD is primarily the result of sulfur from mine waste interacting with air/water to create sulfuric acid
- ❖ A literature review on acid mine drainage concluded that “no hard rock surface mines exist today that can demonstrate that acid mine drainage can be stopped once it occurs on a large scale.”
- ❖ Acid runoff from the Summitville Mine in Colorado killed all biological life in a 17-mile stretch of the Alamosa River. The site was designated a federal Superfund site, and the EPA has spent over \$210 million on clean-up.
- ❖ Zortman Landusky mine in north central Montana filed for bankruptcy in 1998 leaving the state of Montana with the liability for \$33 million in long-term water treatment and reclamation costs
- ❖ Torch Lake in Houghton County, MI is now a superfund site
 - The site includes several areas ranging in size from about 10 acres to over 200 acres.
 - Copper mining activities in the area from the 1890s until 1969 produced mill tailings (called stamp sands) that contaminated lake sediments and the shoreline
 - Cleanup, operation and maintenance activities are ongoing.

There are NO examples of high sulfide mines in water rich areas that do not pollute

SOURCES:

- https://earthworks.org/issues/acid_mine_drainage/
- <https://www.usgs.gov/mission-areas/water-resources/science/mine-drainage>
- <https://www.epa.gov/nps/abandoned-mine-drainage-additional-resources>

Copper Mining (High Sulfide or Oxide)

- ❖ Not all copper ores are high sulfide (highly polluting)
 - There are two main copper ore types of interest, copper oxide ores and copper sulfide ores
 - The **most common source of copper ore is the sulfide ore** mineral chalcopyrite, which accounts for about 50 percent of copper production
- ❖ Sulfide copper ores are the most profitable ores because
 - They have high copper content
 - The copper can be easily separated from the unwanted minerals.
 - It is important to note that **sulfide ores are not as abundant as the oxide ores.**
- ❖ Copper oxide ores are not as attractive of an exploration target as the copper sulfide ore types due to their lower grade
 - However low-grade copper oxide deposits can be economically extracted because they can be processed at lower cost than the copper sulfide ores.

Not all copper mining need be from high sulfide (high polluting) mines
Copper Oxide ore is more abundant and can be processed at lower costs

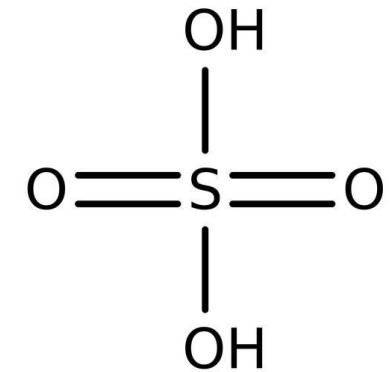
<https://www.nasdaq.com/articles/copper-ore-types-sulfides-versus-oxides-2011-04-23>

If We Must Mine High Sulfide Copper – Where?

- ❖ When high sulfide ores are exposed to air and **moisture, a chemical reaction occurs that generates sulfuric acid** that migrates into the surrounding environment and, through leaching, releases heavy metals present in the waste rock, pit walls, and tailings basins of mining operations.
- ❖ Explore oxide based copper mining areas
- ❖ Copper Mines and processing in dry areas create less concern relative Acid Mine Drainage
 - **Arizona (an arid state) was the leading copper-producing US State and accounted for approximately 70% of domestic output**
 - Globally – the three top countries of copper reserves (Chile, Peru and Australia) are all arid countries generally speaking.

<https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-copper.pdf>

Need more exploration and development of oxide based copper
Much of worldwide copper is located in arid areas where mining (as needed)
should be targeted to minimize environmental impact
NOT IN WATER RICH MINNESOTA



Sulfuric Acid

A very strong acid

Copper Mining Summary (from graphs – next slides)

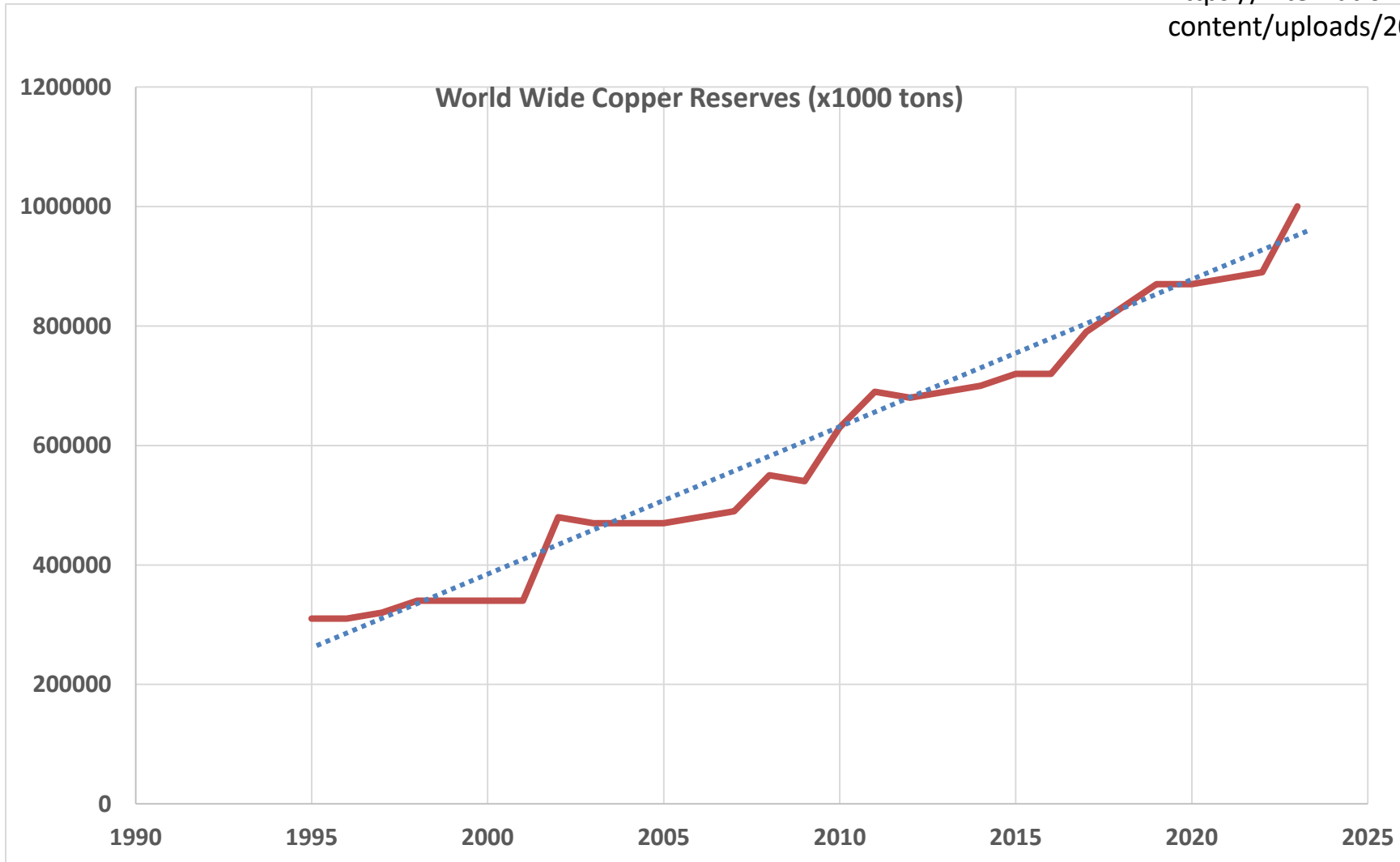
- ❖ World Wide Reserves have been increasing (almost lineally) by 4.12% CAGR for at least 30 years.
 - Increase in WW Reserves from 2023-2024 could build 1.3 Billion EVs
 - There is plenty of copper worldwide – no need to sacrifice Minnesota pristine areas
- ❖ World Wide Production has been increasing (almost lineally) by 2.76% CAGR for at least 30 years.
 - US 2023 EV sales used only 0.53% of WW copper production
 - Current production likely to meet sustainability needs
- ❖ US Copper Reserves represents only 5% of WW Reserves
- ❖ US Copper Production represents only 5% of WW Production and is decreasing as WW production grows

Minnesota copper would contribute a very small (less than 1%) portion of the worldwide market and is unnecessary
WHY DAMAGE MINNESOTA ENVIRONMENTS AND ADD HEALTH RISKS WHEN ITS NOT NEEDED!

World Wide Copper Reserves

<https://www.usgs.gov/centers/national-minerals-information-center/copper-statistics-and-information>

<https://internationalcopper.org/wp-content/uploads/2017/06/2017.06-E-Mobility-Factsheet-1.pdf>

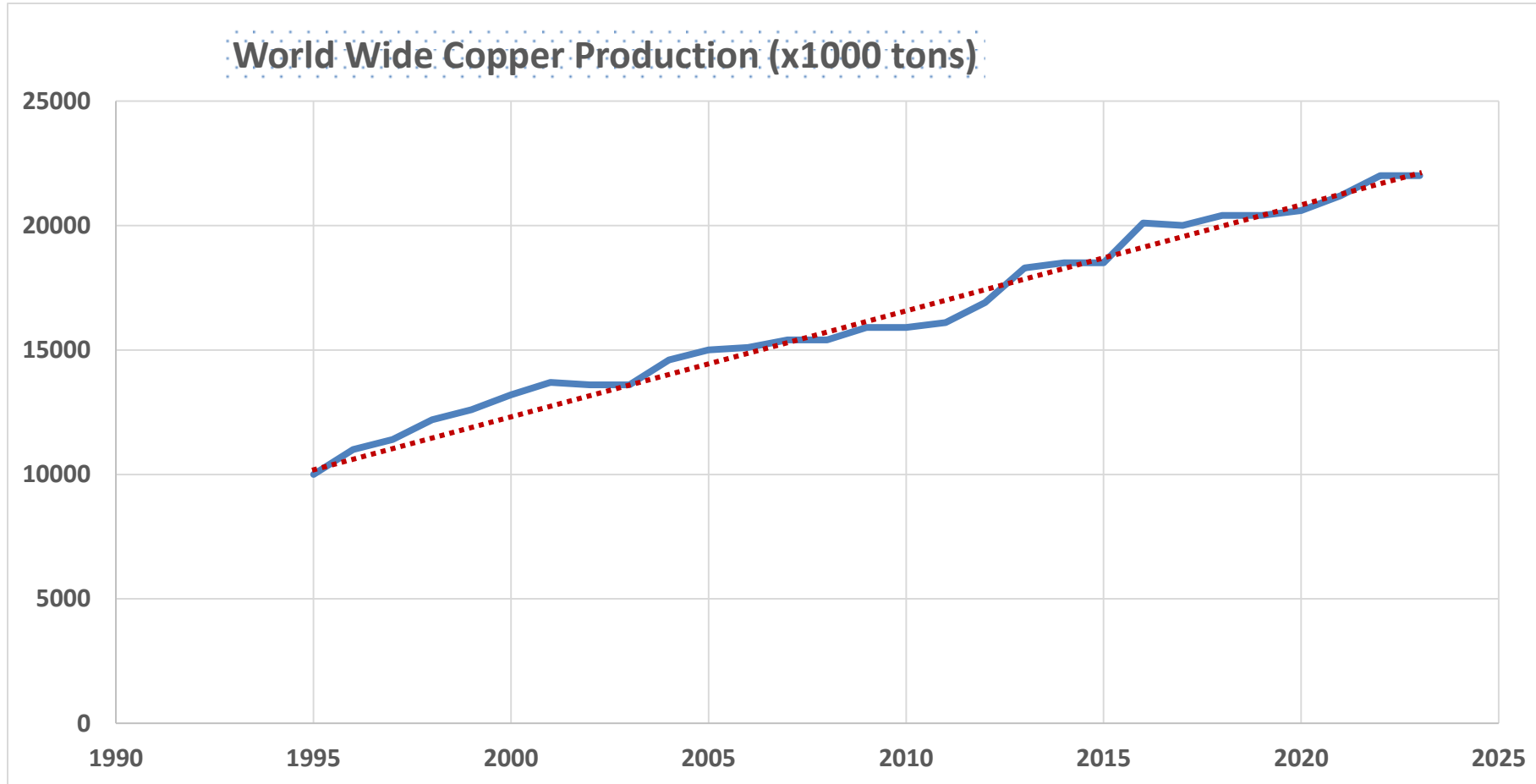


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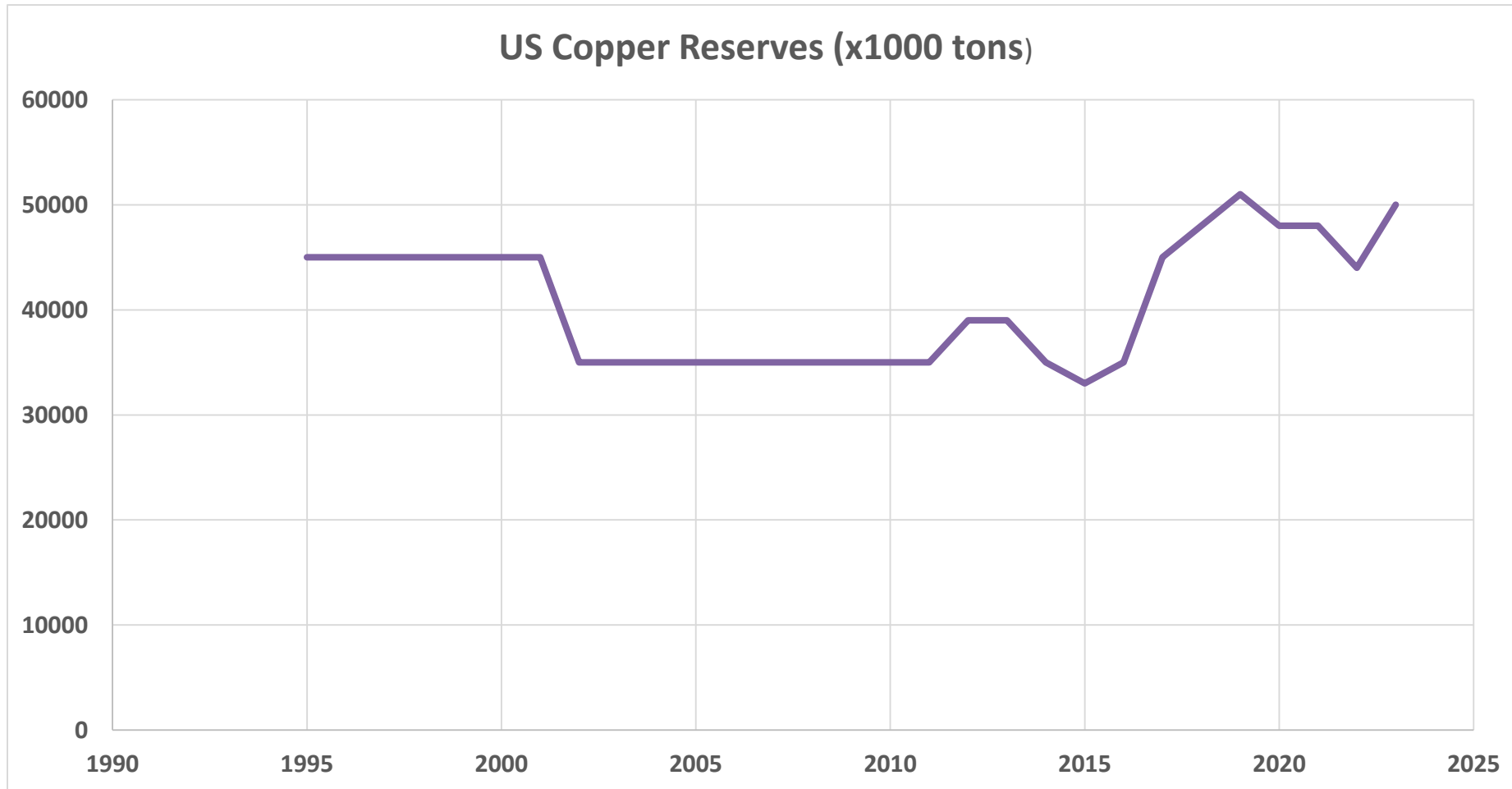


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US Copper Reserves (x1000 tons)

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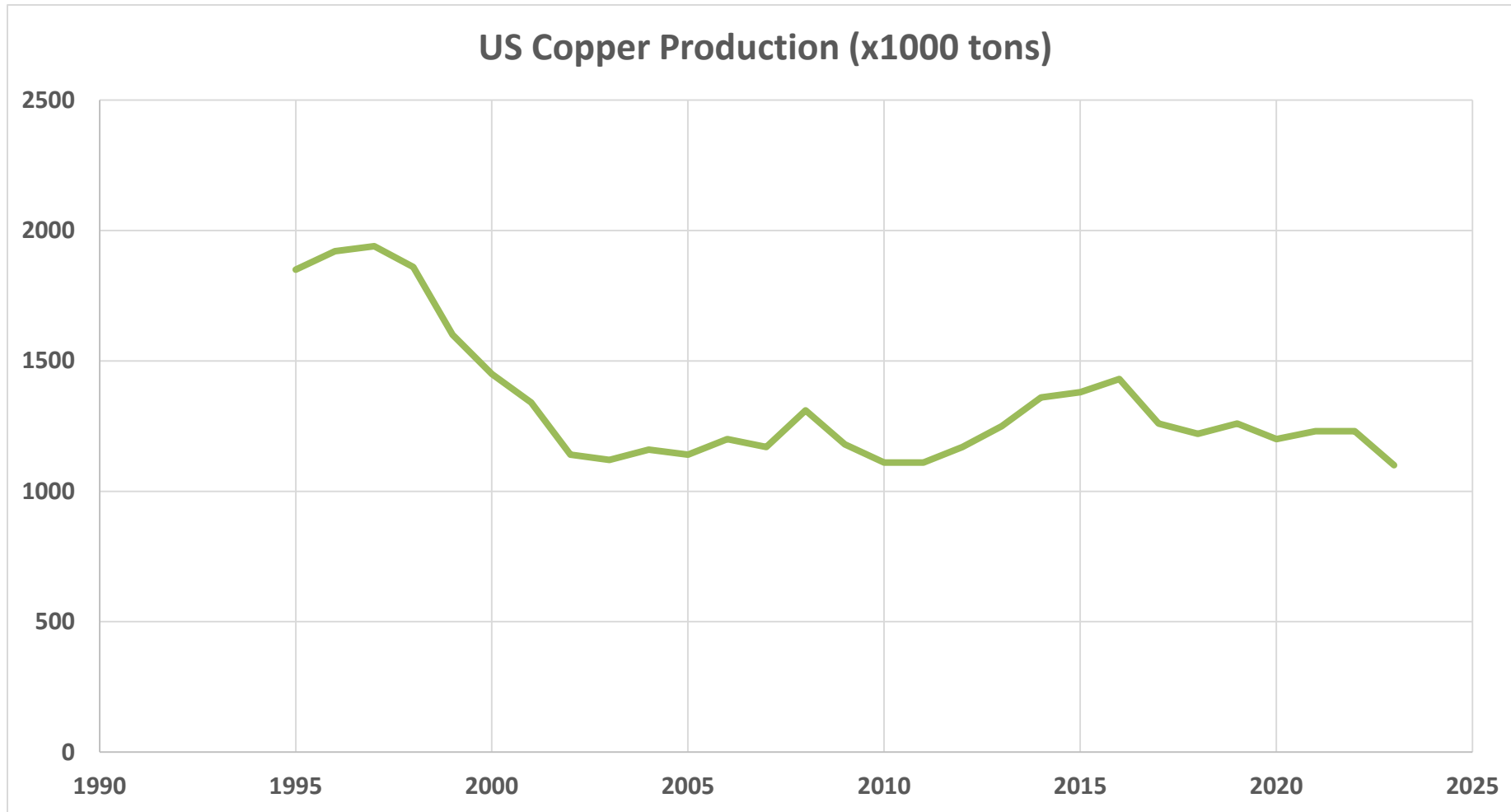


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