Copper and the Environment: A Nano–History

◄ Double paisa of Tipu Sultan, undated, minted at his capital Patan

Image credit: By Rani nurmai

▲ Native Copper
Image credit: Element-collection.com

Copper has been a key resource in human development, and it will likely retain its importance for many years yet to come.

Indeed, copper was the first metal to advance humanity beyond the Stone Age. The social and environmental impacts of copper mining and smelting have been present for at least 7,000 years.[6]

Initially, native copper (comprised of 98% pure copper minerals) was mined, but these rare deposits were quickly exhausted and lower grades of ore were then pursued. Copper ore requires a type of processing called smelting, which extracts the metal from its ore using heat and chemicals, which can lead to further environmental impacts. Ancient copper smelting sites have been found in China, Turkey, Serbia, and Egypt.[7] Arsenic commonly occurs in copper minerals and was combined with copper in early bronze smelting. Ancient smelting sites are still contaminated with high arsenic levels.[8]

140
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OF ORE MUST BE MINED AND PROCESSED TO EXTRACT A SINGLE METRIC TON OF COPPER AT A TYPICAL MINE

Copper mining and production have expanded extensively since the advent of the Bronze Age. The 20th century was characterized by steep increases in copper production and steep declines in copper ore concentrations. The rising social and environmental impacts of copper mining are closely tied to expanding production and declining ore grades. For example, the Holden Mine in the Pacific Northwest region of the U.S. was a top U.S. copper producing mine during World War II. In operation from 1937 to 1957, Holden Mine removed copper ore with an average concentration of 6%.[9] For every 16.6 metric tons of ore hauled out of the Holden Mine, 1 metric ton of copper was recovered. Unfortunately, terrestrial copper ores of this concentration have largely been mined out and concentrations now yield much lower percentages globally.

Today's largest copper mines, such as the Chuquicamata mine in Chile, have ore grades in the range of 0.7%. This means that, without counting the overburden (the rock and soil above the ore deposit that is removed prior to ore recovery), 140 metric tons of ore must be mined and processed to extract a single metric ton of copper.

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Proposed terrestrial mines, such as the site in Intag, Ecuador, have average concentrations beginning at 0.7%, and lower. As ore concentrations decline, the physical inputs required per ton of copper produced, as well as impacts on the environment, are likely to increase.

Figure 1 shows the decline in copper ore grades since 1900, and Figure 2 shows declining world ore grades since 1995 in comparison with the Solwara 1 indicated resource.

Figure 1. Declining copper ore grades worldwide
Source: Mudd, G.M., 2010. The "Limits to Growth" and 'Finite' Mineral Resources: Re-visiting the Assumptions and Drinking From That Half-Capacity Glass. 4th International Conference on Sustainability Engineering & Science: Transitions to Sustainability.

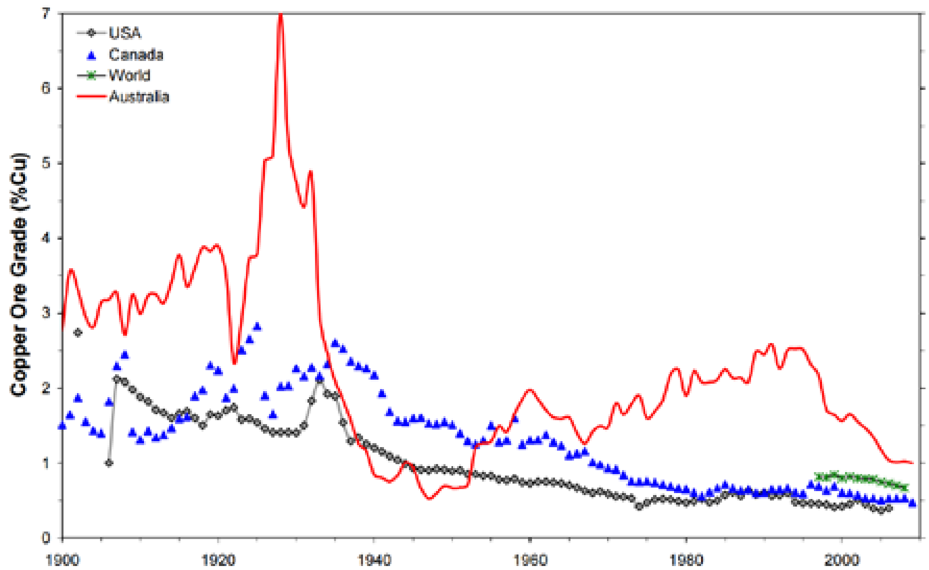
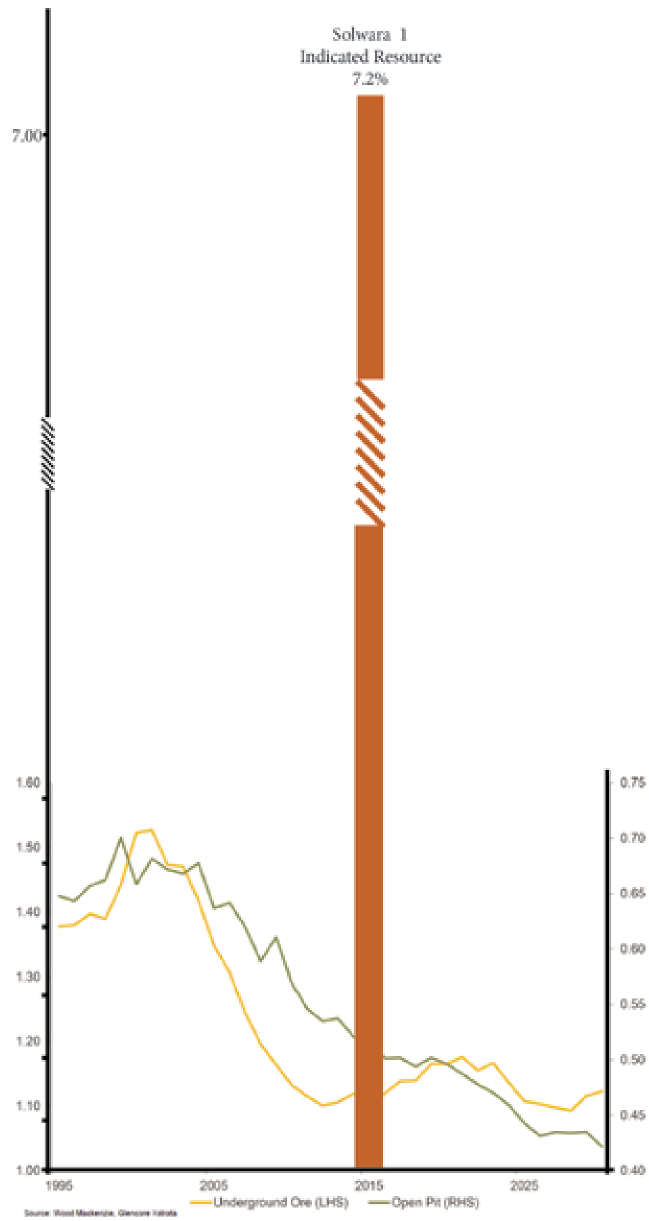


Figure 2. Declining world ore grades since 1995 in comparison with the Solwara 1 indicated resource
Source:Nautilus



Waste disposal in copper mines also generally has a large surface area impact. The compacted rock is blasted loose and expands in volume by 40% or more. The ore, waste rock and tailings are typically re-deposited upon the earth's surface.

As vast features on the landscape, terrestrial copper mines and their accompanying tailings, dams and leach heaps necessarily impact the biota, surface water and groundwater, and they produce significant air and water pollutants, including emissions of global warming gases. All large open-pit copper mines operate in groundwater strata. Some mines, such as Bingham Canyon in Utah, USA are well over one kilometer deep. Like Bingham Canyon, many copper mines are also located at high elevations as copper is commonly deposited in volcanically active periods. In 2013, the Bingham Canyon mine experienced a catastrophic landslide, though fortunately nobody was hurt.[10]

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With few exceptions, people inhabit or directly use the landscapes where copper mines are established. There is a long history of conflict between mine operators and people living within, around, and downstream of copper mines, tailings, and smelter sites. Appendices D and E provide several examples of copper mine and smelter impacts on local communities.

To date, the 7,000-year history of copper mining has been exclusively terrestrial, but companies are beginning to consider deep seabed mining as a means to achieve copper production goals and potentially reduce impacts. Deep seabed mining eliminates many inherent issues associated with terrestrial mining due to a lack of human inhabitants within the mine site and a lack of long-term liabilities remaining after the mine is closed. Additionally, copper deposits currently discovered at the seabed are not buried beneath large volumes of rock and soil that are considered 'waste' material, and therefore require much less overburden removal than their terrestrial counterparts.

Deep seabed mining needs to be conducted responsibly and sustainably with a firm base in solid science and economics that fully accounts for the social and environmental costs and benefits of such mining operations. Careful accounting of these social and environmental impacts provides critical information in understanding the full costs and benefits of these mining operations.