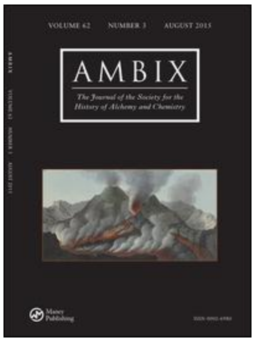

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Making Mercury's Histories: Mercury in Gold Mining's Past and Present

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This article considers the presence and absence of mercury, and why in different social arenas where gold features, mercury can become either pervasive or elusive. To substantiate this argument, the article offers two contrasting examples: (1) presentation strategies at Pacific Seaboard gold rush heritage sites, and (2) the background to the Minamata Bay tragedy and the Minamata Convention's subsequent framing of mercury use in artisanal and small-scale gold mining in the Global South. By unpacking these divergent social histories of mercury use and its consequences, the article identifies the current disconnect between different histories of mercury, and the problematic consequences of this disengagement.

Introduction

Mercury is a pervasive and harmful feature of the biosphere. To a great extent, the presence of mercury in the environment is a consequence of gold mining practices – past and present – although the linkage is not easy to recognise without a historical framework in place. This article addresses such a lack of historical context, and its ramifications. It examines the deep past of mercury use in global gold rush *histories*, and their interrelationship, through the examples of early modern Iberian extraction projects in New Spain, the "gold rush" mining operations of the nineteenth and early twentieth century, and reactions to current artisanal and small-scale gold mining in the Global South to reveal the synergy that emerges at the intersection of the history of chemistry and environmental history. The article argues that whilst mercury pollution is invoked as the rationale for interventions to contemporary artisanal and small-scale gold mining in the Global South, the same harms are not identified at gold rush heritage sites in the Global North, even when local land

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management agencies are grappling with the toxic legacies of past mercury use at these heritage sites.

Two important claims are thus advanced. First, that there is a yawning discrepancy between polished but myopic mining heritage presentations that dwell on technical achievements and nation-building projects, and the painful histories of mercury use and pollution that lurk behind this heritage. Second, that there is an element of social injustice and wilful ignorance in the simplistic, uncritical way that mercury pollution is being addressed as an environmental emergency in the twenty-first century. International agencies, such as the United Nations Environmental Programme, that now want to “make mercury history” are keen to commandeer scientific evidence to justify and promote their policy yet appear to have no interest in acknowledging mercury’s actual histories when these implicate the Global North in mercury’s pernicious and destructive dispersal around the globe.

What follows is an explanation of the volatility of mercury (Part I: understanding mercury), and an overview of early modern mercury usage in Spain and its conquered American territories including the corresponding use of mercury in nineteen-century gold rush contexts (Part II: mercury in the early modern period, and Part III: mercury and gold rush heritage). This discussion sets up the examination of mercury pollution as per the twentieth century Minamata Bay toxic mercury dump catastrophe and the ensuing Minamata Convention that seeks to “make mercury history,” which resituates our understanding of artisanal and small-scale gold mining and environmental policy (Part IV: Minamata – from a Japanese bay to international convention). The article concludes with Part V: reflections on the social history of mercury.

Part I: understanding mercury

Mercury is the only commonly occurring metallic element that is liquid at room temperature. Liquid mercury feels heavy and moves suddenly, splitting into fast-moving globules of metal that are difficult to capture. These properties are encapsulated in the element’s archaic name: quicksilver. Mercury is fugitive in other ways. A globule of mercury left in a closed vessel at room temperature will slowly evaporate to fill the vessel with mercury vapour, until it reaches a saturation point.[1] Similarly, a drop of mercury liquid left in the open air will eventually completely evaporate into the atmosphere. However, if a localised concentration of mercury vapour is high enough, it will start to recondense as microscopic droplets of liquid on any nearby surface. The skittishness of liquid mercury and its capacity to continually volatilise and recondense means that mercury is astoundingly easy to distribute unintentionally, and very hard to recapture once it has been dispersed.

[1] Marcia L. Huber et al., *The Vapor Pressure of Mercury*, NISTIR 6643 (Boulder, CO: National Institute of Standards and Technology, US Department of Commerce, 2006): https://www.govinfo.gov/content/pkg/GOVPUB-C13-66a1ade5407189293018439 3b1802e69/pdf/GOVPUB-C13-66a1ade54071892930184393b1802e69.pdf (accessed 1 December 2022).

Moreover, once mercury vapour or liquid mercury enters an aquatic environment, it is converted by water-dwelling bacteria into methylmercury, a relatively stable metal-organic cation $[CH_3Hg]^+$ that can persist in environments for centuries after mercury has been introduced and converted. Methylmercury is also highly toxic.[2] The presence of methylmercury is a constant threat to the overall health of biota in local ecosystems. Methylmercury biomagnifies, accumulating up food chains, so it is especially dangerous to apex predators, including humans.[3] Though pure methylmercury salts will form crystalline solids, these are not encountered outside of laboratories. In the natural environment, methylmercury is effectively formless. (Notably, an internet search employing the term "methylmercury" reveals no portraits of it as a substance, only schematic diagrams of its atomic structure.) Methylmercury only exists vicariously in the public consciousness, evident through the bizarre behaviour and startling appearance of humans and animals that have ingested toxic doses.[4]

The extreme phenomenological variability in the physical properties of mercury's most prevalent states – metallic liquid, invisible vapour, and stable methyl compound – makes it very difficult for humans as individuals to truly "know" mercury, or to detect its presence. The spectacular visual appearance and haptic experience of liquid mercury grabs our attention, obscuring the far less phenomenologically evident mercury vapour and methylmercury. Conceptualising any gaseous elemental substance that has no colour or smell as matter is a highly problematic exercise, as the history of science demonstrates all too well. One aspect of scientific training is to learn how to identify such gases and trace compounds through mediating instruments. But such scientific material understanding is not widely shared, even in the Global North. As we shall see, this elusiveness of some forms of mercury are extremely problematic.

To better conceptualise this, we now turn to considering ways that mercury is linked to the long sequence of scientific developments in the extractive industries that began during the early modern period, and that intersected with alchemy, assaying, and eventually the rise of chemistry as a professional discipline.

Part II: mercury in the early modern period

Two of mercury's physical properties – its exceptional tendency to combine with precious metals, and its ability to quickly vaporise if heated – once made it a valuable commodity. When solid gold and liquid mercury come into contact, the mercury absorbs the gold, turning into an *amalgam,* which consists of a multitude of small gold-mercury crystals floating in the liquid mercury.[5] As more gold is

[2] Tim Halliday and Basiro Davey eds., *Water and Health in an Overcrowded World* (Oxford: Oxford University Press, 2007), 79.

[3] Luiz D. Lacerda and Willem Salomons, *Mercury from Gold and Silver Mining: A Chemical Time Bomb?* (Berlin; New York: Springer, 1998), 104.

[4] Video clip on industrial mercury poisoning at Minamata Bay, Japan, see *Mercury Poisoning – The Minamata Story* (2010): https://youtu.be/ihFkyPv1jtU (accessed 1 December 2022).

[5] L. D. Michaud, "Gold Amalgamation," *911 Metallurgist* (March 2016): https://www.911metallurgist.com/blog/amalgamation-gold-ores (accessed 1 December 2022).

absorbed, the amalgam turns from a liquid to a paste, eventually becoming a soft solid. Separating the two elements is relatively straightforward. To remove excess mercury, a porous membrane, such as a chamois leather, can be used as a filter. Squeezing a ball of amalgam paste in a piece of chamois produces droplets of mercury on the chamois's surface, concentrating the gold in the remaining amalgam. If the mass of amalgam is then heated, the mercury will be driven off as vapour, resulting in a spongy mass of pure gold metal. The two processes are quick, easy to control, and, if you ignore the pernicious long-term damage to the wider environment and the health of the person undertaking the process, highly efficient.

The scaling of the amalgamation process was one of the technological achievements of early modern mining, with the needs of, and innovations in, the mining districts of the Spanish colonies in New Spain and Perú fundamental to its development.[6] The patio refining process was developed in Mexico, in 1554, by Bartolomé de Medina (1497-1580),[7] and a mechanised variation appears in *De re metallica* (1556).[8] Amalgamation became the Spanish empire's precious metal refining process of choice, a decision that led to an exponential increase in the demand for, and extraction of, mercury.

The rise in the demand for mercury was initially met by the mercury mines of Almadén in Spain, the largest mercury deposit in the world, and supplemented by the discovery and exploitation under Spanish rule of mercury deposits in Huancavelica, Perú. The need to quickly expand mercury ore extraction and processing at Almadén during the later sixteenth century caused extreme logistical problems, not the least of which was securing enough labour. This was, in part, due to the health risk of working at the Almadén mercury mines.[9] The supply of mercury was fundamental to funding the Spanish colonisation project of the Americas.[10] The management of mercury from Almadén was brokered between the Spanish Crown and the mine leasees, the Fugger banking firm from Augsburg, which gave the Fugger the right to conscript Spanish convicts as mine labour.[11] Complaints over the harshness of the conditions these prisoners endured led to the creation of a Spanish Royal Commission that investigated the mining conditions at Almadén in 1593.[12] Alongside abusive working practices, the commission found and recorded evidence of severe mercury poisoning, especially amongst the workers managing the furnaces where mercury was released from the mined

6 Allison Margaret Bigelow, *Mining Language: Racial Thinking, Indigenous Knowledge, and Colonial Metallurgy in the Early Modern Iberian World* (Williamsburg, VA: Omohundro Institute of Early American History Culture, 2021).

7 Alan Probert, "Bartolomé de Medina: The Patio Process and the Sixteenth Century Silver Crisis," in *Mines of Silver and Gold in the Americas*, ed. Peter Bakewell (Variorum: Brookfield, 1997), 90–127.

8 Georg Agricola, *De re metallica*, trans. H. Hoover (New York: Kessinger Publishing, 1912).

9 Pablo L. Higueras et al., "The Almadén Mercury Mining District," in *History of Research in Mineral Resources*, ed. José Eugenio Ortiz et al. (Madrid: Instituto Geológico y Minero de España, 2011), 75–88.

10 Bigelow, *Mining Language*, 229–58.

11 Jeannette Graulau, "Finance, Industry and Globalisation in the Early Modern Period: The Example of the Metallic Business of the House of Fugger," *Rivista Di Studi Politici Internazionali*, 75 no.4 (300) (2008): 554–98.

12 Germán Bleiberg, *El "Informe Secreto" de Mateo Alemán sobre el Trabajo Forzoso en las Minas de Almadén* (London: Tamesis, 1985).

cinnabar ore by roasting. Common symptoms recorded during interviews with the convicts included severe pains in various parts of the body, trembling limbs, and loss of sanity. In response to the commission's findings, the convicts were largely replaced by a workforce of slaves purchased from North Africa.

Mercury from Almadén played a key role in the Spanish subjugation of the Americas by providing the technological means to exploit the gold and silver deposits of New Spain. The long-term beneficiaries were the Spanish Crown and the European mercantile elite that bankrolled them. The physical toll on those lower down the social hierarchy and unfortunate enough to be victims of the Spanish judiciary, African slaving networks, or Spanish colonial rule was extreme.

Part III: mercury and gold rush heritage

The nineteenth century gold rushes began in California in 1849.[13] Two years later, goldfields opened up in the British colonies of New South Wales and Victoria in Australia. Over the next fifty years the gold rush came to encompass the Northern Pacific seaboard from the Golden Gate Harbour up to the North Slope of Alaska,[14] and multiple sites across Australia and New Zealand.[15]

The discovery of gold in California in 1849 was immediately preceded by the discovery of the richest deposit of mercury ore in the Americas, located in the hills surrounding the south end of San Francisco Bay. This mining claim, the New Almaden Quicksilver Mining Company (named Neuva Almadén in Spanish), was initially run by a British Textile firm who sold it to a consortium of American investors for $1.75 million. The price paid for the mine (roughly equivalent to $66 million in 2022) was an indication of the value of its mercury deposits to California's burgeoning gold mining industry.[16] The mine's proximity to one of the largest natural harbours in the world extended New Almaden's profitability. Whenever gold was found around the Pacific rim, New Almaden mercury could easily be shipped there.

The goldfields had a profound effect on the subsequent social and political development of the regions in which they were located. Not only did the gold rushes secure the survival and development of the colonies, gold mining became embedded in the foundational narratives and ideology of subsequent settler nation-states. The "California Dream" of sudden success, of "striking it rich," usurped the American

[13] William C. Dillinger, *The Gold Discovery: James Marshall and the California Gold Rush* (California: California Department of Parks and Recreation, 1990); and Benjamin Mountford and Stephen Tuffnell, eds., *A Global History of Gold Rushes* (Oakland: University of California Press, 2018).

[14] Robert L. Spude, "An Overview History of the Alaska-Yukon Gold Rushes, 1880–1918," in *Eldorado! The Archaeology of Gold Mining in the Far North*, ed. Catherine Holder Spude et al. (Lincoln: University of Nebraska Press and the Society for Historical Archaeology, 2011), 9–24.

[15] Simone Bradfield, *Gold Rushes: The New Prosperity* (Sydney: Australian Geographic, 2014); and Lloyd W. Carpenter and Lyndon Fraser eds., *Rushing for Gold: Life and Commerce on the Goldfields of New Zealand and Australia* (Dunedin, New Zealand: Otago University Press, 2016).

[16] Jimmie Schneider, *Quicksilver: The Complete History of Santa Clara County's New Almaden Mine* (San Jose, CA: Zella Schneider, 1992).

founding father's view of slow, incremental wealth generation, which underpinned the notion of the "American Dream" that held sway throughout the twentieth century.

A gold strike provides a convenient coming-of-age story for the fledgling state, presenting its existence as the inevitable consequence of prospectors finding riches in an unforgiving landscape, wresting a living through hard work and initiative, and turning the wilderness into part of the civilised world. At the same time, it delivered a frisson of excitement in the story of the lucky strike that transformed the individual prospector from a marginal nobody into a wealthy achiever. Consequently, many early gold mining sites or historic buildings with a verifiable connection to gold rushes have become valorised as tangible elements of the national heritage, such as the ghost town of Bodie, California,[17] the Historic District of Skagway, Alaska,[18] Sovereign Hill in Ballarat,[19] Central Deborah Gold mine in Bendigo, Australia,[20] and Mrs Heron's Cottage in Otago, New Zealand.[21]

Because of their potential as tourist destinations, many gold rush sites have now been pulled into the orbit of the heritage industry,[22] a process that involves their re-interpretation as an economic resource.[23] Their exploitation as public-facing mining parks throws into sharp relief the conceptual distance between *heritage* and *history*. Heritage presents a positive, comforting, and often stereotypical narrative that supports a target audience's self-worth and reinforces their existing beliefs about the structure of their society.[24] In contrast, history as a discipline relies upon critical interpretation to acknowledge the complexities inherent in the relationship between human endeavours and environmental outcomes, and addresses the shadow side of events, including inconvenient truths, colonial legacies, and the impacts that technological progress and the modernist project have had on disenfranchised social groups and individuals.

Nowhere is the disjunction between heritage and history more evident than at the gold rush heritage sites of Sutter's Mill in California,[25] and the No.8 Gold Dredge near Fairbanks, Alaska.[26] Both of these heritage sites are structured around the simultaneous *presence* of mercury in the environment from past gold rush extractive practices, and the *absence* of mercury in their curation as mining parks.

[17] Dydia DeLyser, "Authenticity on the Ground: Engaging the Past in a California Ghost Town," *Annals of the Association of American Geographers* 89, no. 4 (1999), 602–32.

[18] Richard P. Emanuel, "The Golden Gamble," *Alaska Geographic* 24, no. 2 (1997): 1–95.

[19] Michael Evans, "Historical Interpretation at Sovereign Hill," *Australian Historical Studies* 24, no. 96 (1991): 142–52.

[20] Heritage Council of Victoria, "Central Deborah Gold Mine": https://vhd.heritagecouncil.vic.gov.au/places/5996 (accessed 1 December 2022).

[21] Jackie Gillies + Associates, "Mrs Heron's Cottage": https://web.archive.org/web/20150113144237/http://www.jackiegillies.co.nz/projects/mrs-herons-cottage/ (accessed 1 December 2022).

[22] Robert Hewison, *The Heritage Industry: Britain in a Climate of Decline* (London: Methuen London, 1987).

[23] Examples in Michael V. Conlin and Lee Jolliffe eds., *Mining Heritage and Tourism: A Global Synthesis* (London: Routledge, 2011), 108–27.

[24] David Lowenthal, *The Past Is a Foreign Country – Revisited* (Cambridge: Cambridge University Press, 2015).

[25] Dillinger, *The Gold Discovery.*

[26] Maria Reeves, *Alaska Gold: The History of Gold Dredge No. 8* (Fairbanks: Gold Fever Press, 2009).

Sutter's Mill, California

Despite mercury's role as an extractive technology used in gold mining throughout the gold rush era, its presence remains scant and rudimentary at most contemporary gold mining heritage sites. Explanations of the consequence of mercury's introduction into the environment or the long-term harm it is causing the region's biota and local human population are non-existent. This first became apparent to me during a field visit to West Coast gold mining sites in 2009, undertaken to develop a closer understanding of how the mythology of gold was being generated and maintained in different parts of the world. These field observations led to a closer interest in the presentation strategies followed at gold mining heritage sites and eventually my development of the term *contrived dereliction* to describe an approach to mining heritage site management and display where an outward appearance of abandonment and decay is achieved through an ongoing programme of care and maintenance.[27]

The gold extraction technology used by the first gold rush prospectors at Sutter's Mill and in other nineteenth-century gold rushes was primitive by today's standards, consisting of pans, rocker boxes, and sluices. The principal energy input was manpower (literally, as the gender imbalance in gold rush camps was notorious), augmented by gravity-based hydraulic power.[28] The percentage of gold that prospectors managed to extract would be considered appallingly low by current mining standards. However, a prospector's daily haul could often be improved by pouring a slug of mercury into their pan or rocker, or into traps and riffles in the bottom of a sluice. The mercury would amalgamate with any particles of gold. At the end of their working day, all a prospector had to do was collect and heat the amalgam in the open air or in a retort until the mercury had been driven off.[29] That mercury vapour was being released into the atmosphere and a percentage of the liquid mercury was washed away or snagged on rough surfaces of the rock or gravel was treated as incidental.[30]

Sutter's Mill is effectively Ground Zero for the 1849 California gold rush. It is the site where, in 1848, the first gold flakes were found by an engineer clearing a stream bed to locate the best site for a new water-powered lumber mill. The location has since been designated a State Park, and now includes a Gold Discovery Museum with a selection of static displays that attempt to inform visitors about technological and social aspects of nineteenth century gold mining. The most imposing and

[27] Peter Oakley, "Contrived Dereliction: Employing an Aesthetic of Decay at Mining Heritage Sites," in *Cultural Heritage and Tourism vol.2: Engagement and Experience*, ed. Mike Robinson et al. (Taipei: Farterng Culture CO, 2014); Peter Oakley, "A Permanent State of Decay: Contrived Dereliction at Heritage Mining Sites," in *Reanimating Industrial Spaces*, ed. Hilary Orange (Walnut Creek, CA: Left Coast Press, 2015); and Peter Oakley, "After Mining: Contrived Dereliction, Dualistic Time and the Moment of Rupture in the Presentation of Mining Heritage," *The Extractive Industries and Society* 5, no. 2 (2018): 274–80.

[28] See Eugenia W. Herbert et al., *Social Approaches to an Industrial Past: the Archaeology and Anthropology of Mining* (London: Routledge, 1998); and Marion S. Goldman, *Gold Diggers & Silver Miners: Prostitution and Social Life on the Comstock Lode* (Ann Arbor, MI: University of Michigan Press, 1981).

[29] John A. Gould, *Frozen Gold: A Treatise on Early Klondike Mining Technology, Methods, and History*. Whitehorse, YK: PR Distributing, 2008).

[30] Lacerda and Salomons, *Mercury from Gold and Silver Mining*.

photographed structure in the park is a reconstruction of the original lumber mill, a simple but imposing open-sided shed standing on timber piles above the river.[31] Scattered across the park are a selection of period buildings housing displays of horse-drawn vehicles, reconstructed domestic and store interiors, models of mine workings, and pieces of mining equipment. Costume re-enactments are now a frequent occurrence.

During my field analysis at Sutter's Mill, I noted that the buildings held the typical mixture of a somewhat random selection of large-scale and domestic objects that I had come to expect from such local museums. As with similar sites, the collection was evidently dominated by chance finds from local attics and outhouses. These artefacts had usually survived due to a combination of robust construction, functional obsolescence, and marginal value as scrap. It this combination of circumstances that had saved an iron retort, once used for distilling mercury. Now it was installed on a rough-cut wooden plinth in one of the huts, backed by a colour schematic diagram in the style of a 1970s "World of Science" book illustration (Figure 1).

The retort and its backing display were the sole representations of mercury on the Sutter's Mill site. Having worked as a production technician in the chemical industry, I knew such pieces of equipment never existed in this type of isolation when in use. I started wondering. Where had the mercury retort originally been made, and into what assemblages had it been embedded during its working life? What type of architectural structure had housed it? What were the heating arrangements? How had its need for a continual pressured water supply been met? How heavy would the vessel have been when fully charged with amalgam? How much mercury had passed through this one retort over the years? And, crucially, how many *people* had this retort surreptitiously injured or killed through mercury poisoning over the course of its working life? In that moment, the failings of the display as an educational presentation became clear: the display had turned the retort into an uncontentious, reified object.[32] It had now become almost as distanced from the Gold Rush and mercury as a piece of American missionary-style furniture is to California's missionary era.

But whilst mercury is elusive in mining museums such as the one at Sutter's Mill, it is all too easy to encounter in the Californian landscape. In some Central Californian rivers, liquid mercury from mining operations is visible to the naked eye as silver globules in the riverbed gravel. These are excessive levels by any measure. Carrie Monohan, head scientist for the Sierra Fund, notes: "We're not talking about parts per billion coming from a smokestack in China … We're talking about liquid elemental mercury that we can see, and suck up, and get grams of, running through our streams and rivers."[33] Corroborating this assertion, the

[31] Dillinger, *The Gold Discovery.*

[32] To read an extended explanation of museum recontextualisation and object reification see Bruno Latour "Ethnography of High-Tech: About the Aramis Case," in *Technological Choices – Transformations in Material Culture since the Neolithic*, ed. Pierre Lemonnier (London: Routledge, 1993), 372–98.

[33] See Alexandria Herr, "Mercury in Our Waters: The 10,000-Year Legacy of California's Gold Rush" (2020): https://www.kcet.org/shows/earth-focus/mercury-in-our-waters-the-10-000-year-legacy-of-californias-gold-rush (accessed 1 December 2022).

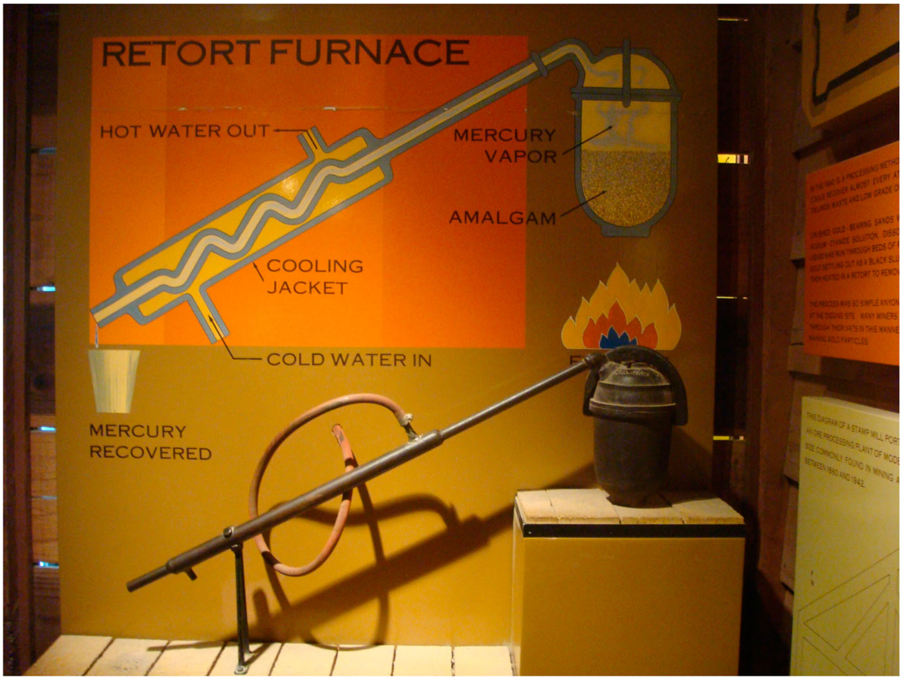

FIGURE 1 Iron retort, Sutter's Mill display. Photo by Peter Oakley.

United States Geological Survey recently surveyed the biota and sediments across California's Bear and Yuba watersheds, subsequently publishing fish consumption advisory figures in an attempt to counter excessive methylmercury bioaccumulation in the watershed's human population.[34] Signs now appearing at water courses across California state the situation more bluntly: PROTECT YOUR HEALTH – DON'T EAT THE FISH CAUGHT HERE.[35] Government agencies have also made landscape interventions to reduce mercury dispersal from contamination hotspots in the Bear-Yuba watershed, including building dams to slow the spread of contaminated sediments. But the dams cannot reduce the underlying level of methylmercury, and these remediation attempts are now being compromised by variations in California's weather patterns. These include flash floods that churn and wash out the heavily contaminated sediments.[36]

34 The Sierra Fund, "Executive Summary. Humbug Creek Watershed Assessment and Management Recommendations" (2015): https://www.sierrafund.org/wp-content/uploads/HumbugReport_ExecutiveSummary_FINAL.pdf (accessed 1 December 2022).

35 Mavern's Notebook, "Mercury and Methylmercury Management" (2016): https://mavensnotebook.com/portfolio/mercury-and-methylmercury-management/ (accessed 1 December 2022).

36 Jeff Masters, "Climate change is increasing the risk of a California megaflood," *Yale Climate Connections* (2023): https://yaleclimateconnections.org/2023/01/climate-change-is-increasing-the-risk-of-a-california-megaflood/ (accessed 30 January 2023).

No.8 Gold Dredge Fairbanks, Alaska

Sutter's Mill is indelibly linked to the beginning of the gold rush era. Another site, this one in Fairbanks, Alaska, relates to the end of the gold rush period. The No.8 Gold Dredge that constitutes the centrepiece of the Fairbanks mining park illustrates how extraction technology evolved in the goldfields over the course of eighty years.

The tenure of the prospectors at each new goldfield was usually short lived. Even in the best scenarios it only lasted about thirty years. One factor was the draw of new gold strikes elsewhere. In Australia, Ballarat's population was boosted by arrivals from California, some of whom later left for Otago, the British colony in New Zealand. This localised boom-and-bust pattern recurred as new strikes across Canada and Alaska were announced. Once the more accessible deposits in each new goldfield became exhausted, the land claims owned by lone prospectors and small partnerships were bought up by corporate mining companies. These corporations wielded the capital to invest in more advanced, efficient, and environmentally destructive machinery that could reach and viably process deeper or lower grade gold deposits. To work deep gold-bearing alluvial sands and gravels, a specialised vessel was developed: the gold dredge.

Dredges greatly scaled up the working principle of the prospectors' hand-operated cradle and sluice box – and they relied even more on mercury.[37] The first rudimentary dredges were built in California in the mid-nineteenth century to reach underwater deposits in riverbeds. From then, dredge design was incrementally improved. The bucket line, a robust digging mechanism consisting of a series of iron scoops that travel round a moveable conveyor, was invented in 1868 in the alluvial goldfields of New Zealand's West Coast.[38] By the twentieth century, it had become a standard feature of dredges operating in the Yukon and Alaska. By that time, dredges had evolved into multistory, electrically powered processing plants that needed a full crew to operate.[39] By 1912, dredges were being built in US steel towns on the Atlantic Coast and transported across the country in pieces, to be reassembled onsite in the Alaskan goldfields.[40]

The No.8 Gold Dredge in Fairbanks was one of a fleet of dredges operating in Alaska that took traditional sluice technology to the limits of its capability. Reworking claims sold by prospectors in a river drainage immediately north of Fairbanks, between 1928 and 1959, the No.8 dredge extracted 7.5 million ounces of gold. The floor of No.8's thirty-six foot (eleven metre) long sluice room was covered in wooden channels; each channel filled with trays and riffle boxes that

[37] Cecil C. Longridge, *Gold Dredging* (London: Mining Journal, 1912).

[38] Engineering New Zealand Te Ao Rangahu, "Gold Dredges Development": https://www.engineeringnz.org/programmes/heritage/heritage-records/gold-dredges-development/ (accessed 1 December 2022).

[39] Government of Canada, "Dredge No.4 National Historic Site": https://parks.canada.ca/lhn-nhs/yt/klondike/culture/lhn-nhs-drague4-dredge4 (accessed 1 December 2022).

[40] New York Engineering Company, *Dredges and Gold Dredging* (New York: n.pub., 1912).

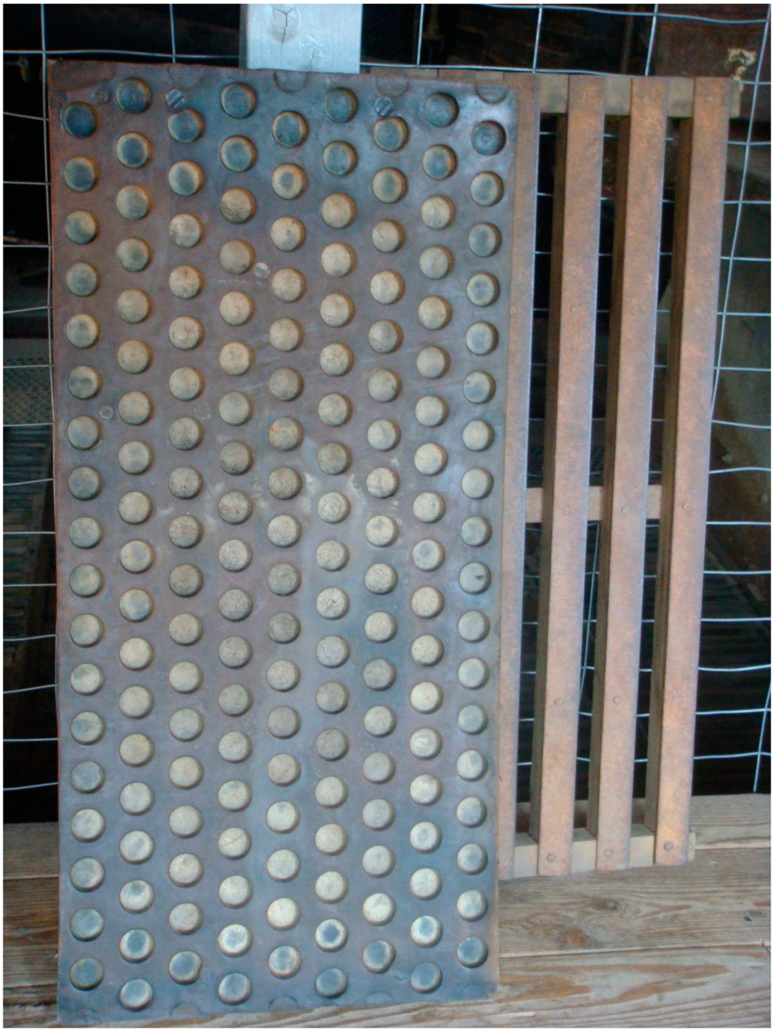

FIGURE 2 Mercury tray, No.8 Gold Dredge display. Photo by Peter Oakley.

caught the gold particles as the silt and gravel washed over them. The top third of every sluice channel was filled with "mercury trays," i.e. thick rubber mats or wooden trays with inch-wide holes gouged across the surface (Figure 2).

Each mat had about one hundred and sixty holes, all half-filled with liquid mercury. During the regular fortnightly "clean-ups," mercury-gold amalgam was scraped from the mercury trays, then taken into the company's refinery in Fairbanks to be retorted to recover the gold.[41]

Alaska's dredges were abandoned in the mid twentieth century and left to rot in the state's harsh climate. Very few dredges now survive. Even fewer are safe to visit.

41 Reeves, *Alaska Gold*.

Exceptionally, the No.8 gold dredge was renovated in the 1970s, and since then has been maintained as the centrepiece of its own eponymous tourist site. The No.8 Gold Dredge site is now owned by Godspeed Properties LLC, a company squarely focused on the Alaskan tourist industry.[42]

As part of my field study of the Fairbanks No.8 Gold Dredge in 2009, I toured the site in the company of a cruise liner inland visit group. Our guide gave a basic explanation of how mercury was deployed as part of the dredging and processing process. Alarmingly, the guide also spoke wistfully of handling mercury in her school laboratory, a reminiscence that elicited similar memories from older participants on the tour.[43] Reminiscences like this are typical of the understandings of mercury in the Global North, informed by casual encounters with liquid mercury in everyday scenarios, such as playing with mercury from broken thermometers.[44] It is worth noting, that in the case of people in their seventies and older, these kinds of encounters would have taken place prior to international disclosure of the Minamata tragedy to be discussed shortly. Even today, the scientific understanding of mercury's toxicity is not well embedded in the general population. Perceptions are sketchy and can become mis-directed. This is evident in the English phrase "mad as a hatter," which is commonly understood to be linked to milliners' practice of "carroting," i.e. using mercuric nitrate to help straighten and matt the short hairs of rabbit or beaver fur in the process of felting hats.[45] Originating amongst French Huguenots, the practice spread to England and America in the eighteenth century, dying out in England at the end of the nineteenth century and in America during the middle of the twentieth.[46] As carroting was undertaken in small, poorly-ventilated workshops, milliners endured long-term exposure to mercury vapour and so suffered from mercury poisoning.[47] Lewis Carroll's famous character from *Alice in Wonderland* is widely assumed to be a personification of the phrase (though he is only ever referred to as the Hatter in the story).[48] The Hatter's erratic behaviour, including his tendency to have explosive temper tantrums when criticised, is symptomatic of the disease.[49] However, later film interpretations of the story have toned

[42] Martin Gutoski, "Godspeed Gold Dredge No. 8 versus Fairbanks Gold," *The American Surveyor* (2021): https://amerisurv.com/2021/02/08/godspeed-gold-dredge-no-8-versus-fairbanks-gold/#:~:text=the%20Gold%20Dredge-,No.,first%20draft%20exhibit%20of%20conveyors (accessed 1 December 2022).

[43] Detailed account in Oakley, "A Permanent State of Decay."

[44] On the extent of past mercury use in school laboratories, see "Mercury Contamination of N.Y.C. Middle and High Schools" (2007): https://downloads.regulations.gov/EPA-HQ-OA-2022-0050-0024/attachment_3.docx (accessed 1 December 2022).

[45] Paul A. Neal et al., *A Study of Chronic Mercurialism in the Hatters' Fur-Cutting Industry*, Public Health Bulletin 234 (Washington, DC: United States Government Printing Office, 1937).

[46] Richard P. Wedeen, "Were the Hatters of New Jersey 'Mad'?", *American Journal of Industrial Medicine* 16, no. 2 (1989): 225–33.

[47] Joseph Addison Freeman, "Mercurial Disease Among Hatters," *Transactions of the Medical Society of New Jersey* (1860): 61–4.

[48] The association of Carroll's Hatter with millinery is retrospective and greatly assisted by Tenniel's illustration (which shows a price label in the Hatter's hat). But the pairing of the Hatter with the March Hare, both of which are associated with madness, and the chapter's title: "A Mad Tea Party," support such an interpretation.

[49] Other notable behavioural symptoms of severe mercury poisoning (e.g. extreme shyness and other introverted behaviour) are not displayed by the Hatter. H. A. Waldron, "Did the Mad Hatter have Mercury Poisoning?", *British Medical Journal* 287 (1983): 1961.

down the more disconcerting elements of the Hatter's behaviour, recasting him as more of a figure of fun.

Such sanitising of historic examples of mercury poisoning means the environments where mercury was deployed (and inevitably dispersed) are not treated with as much caution as is prudent. Mercury contamination remains common in abandoned industrial sites, including inner-city factories, workshops, scientific laboratories, the waterways and alluvial mining tailings in rural landscapes, and in industrial heritage World Heritage Sites and Mining Parks. This was the case at the No.8 Gold Dredge site, where a bare ridge of grey gravel and sand tailings, much of which had once skittered or slid over the trays of mercury in the dredge, snaked off into the distance. How much mercury had evaporated from those tailings over the past half century? And how much is still trapped in this winding pile of debris?

Mining sites, as a type of industrial heritage, offer an extreme example of two related issues found across the heritage sector: the need to attract and then please paying audiences, and the problem of presenting unpalatable and distressing truths to those seeking diversion rather than education. In a world where heritage sites are expected to operate primarily as an economic resource and tourist destination, antagonising the primary income stream is considered unacceptable behaviour.[50] Industrial heritage is undeniably niche, even in the Euro-North American countries where it is most popular. In such contexts, it is easiest to fall back upon a presentation strategy that rests upon the notion of technological progress and technology as spectacle.

Yet such an approach comes at a high long-term cost. The educational potential of mining heritage sites as manifestations of the Anthropocene, and arresting illustrations of the consequences of past uncontrolled resource exploitation, is being squandered. In addition, there is an evident disconnect in the narratives that the sites promote and that which is displayed by the surrounding degraded and polluted landscape. The underlying tragedy is that ignorance of the environmental consequences of mercury pollution does not protect anyone from the consequences of that pollution, as the fishing communities of Minamata discovered to its cost.

Part IV: Minamata: from a Japanese bay to international convention

Minamata disease

Current political and scientific attitudes towards mercury are heavily informed by the events that took place around Minamata Bay in Japan in the middle of the twentieth century. Minamata Bay is part of the Shiranui Sea, which is enclosed by the west coast of Kyūshū and an archipelago of smaller islands. In the 1930s, a

50 Conlin and Jolliffe, *Mining Heritage and Tourism*; and Michael Pretes, "Touring Mines and Mining Tourists," *Annals of Tourist Research* 29, no. 2 (2002): 439–56.

chemical factory owned by the Chisso Corporation started dumping effluent generated during the manufacture of acetaldehyde into the bay (the acetaldehyde was synthesised through acetylene hydrolysis, using mercury sulfate as a catalyst). In 1951, a change in the co-catalyst meant the effluent now also contained methylmercury. The dumped methylmercury quickly accumulated in the bay's fish and shellfish, which were a large part of the diet of local fishing communities.[51] By the time of the first documented case in 1956, the bay's coastal villages were suffering an epidemic of extreme neurological disorders that became known as Minamata Disease. These afflictions were eventually proved to be the result of the effluent from the Chisso factory, following a series of high-profile lawsuits initiated by local citizens and campaign groups.[52]

Emotive images by Japanese photojournalist Shisei Kuwabara and the American photojournalist W. Eugene Smith illustrated the suffering endured by people living around Minamata Bay.[53] These images fuelled growing national outrage at the plight of the Minamata fishing communities and their subsequent dismissive treatment by local and national authorities and the Chisso Corporation. Minamata Disease, and the extent of the link between industrial pollution and environmental damage, came to global attention in 1972 at the first United Nations Conference on the Human Environment, held in Stockholm. When two Minamata disease patients appeared on the conference platform, the extent of their symptoms shocked the audience.[54] The event was instrumental in shaping the early environmental agenda regarding mercury pollution in both political and scientific terms.[55]

In contrast to a developed understanding of mercury's behaviour in local ecologies, mercury's global migration is still poorly understood. When mercury vapour gets caught up in high-altitude wind streams, it can be transported for thousands of miles. Environmental analyses of regional mercury levels have demonstrated that global weather patterns appear to redistribute mercury vapour at a planetary level, with certain regions, including the equatorial rainforests and Artic tundra and taiga, accumulating more mercury than would occur on a random basis.[56] These regions appear to act as global filters, trapping and sequestering mercury. The same appears to have been true of the carboniferous forests of the Paleozoic Era. As a result, coal seams and oil fields can hold relatively high concentrations of

[51] Noriyuki Hachiya, "The History and the Present of Minamata Disease: Entering the Second Half of a Century," *Japan Medical Association Journal* 49, no. 3 (2006): 112–118 (on 113).

[52] Ministry of the Environment, Government of Japan, "Minamata Disease. The History and Measures – Chapter 2" (2002): https://www.env.go.jp/en/chemi/hs/minamata2002/ch2.html (accessed 1 December 2022).

[53] Shisei Kuwabara, *Shashin-kiroku Minamata-byō 1960–1970* (写真記録 水俣病 1960–1970, "Documentary: Minamata Disease") (Tokyo: Asahi Shinbun, 1970); and W. Eugene Smith, *Minamata: The Story of the Poisoning of a City* (New York: Holt, Rinehart, and Winston, 1975).

[54] United Nations, "Report of the United Nations Conference on the Human Environment" (1972): https://documents-dds-ny.un.org/doc/UNDOC/GEN/NL7/300/05/IMG/NL730005.pdf?OpenElement (accessed 1 December 2022). Masazumi Harada, *Minamata Disease* (Kumamoto, Japan: Kumamoto Nichinichi Shinbun Culture and Information Centre, 2004).

[55] Patricia A. D'Itri and Frank M. D'Itri, *Mercury Contamination: A Human Tragedy* (New York: Wiley, 1977).

[56] Lacerda and Salomons, *Mercury from Gold and Silver Mining*.

mercury. This mercury is (re-)released into the atmosphere whenever and wherever fossil fuels are being burnt.[57]

The Minamata convention

The international announcement of the mercury pollution in Minamata Bay and Minamata Disease were defining moments at the United Nations Conference on the Human Environment (also known as the Stockholm Conference) that took place in 1972.[58] The conference led to the formation of the United Nations Environmental Programme (UNEP) in the same year. UNEP considers science as "fundamental to tackling environmental challenges and empowering governments in evidence-based decision-making."[59] This scientific evidence has included a global mercury monitoring project, covering ambient air and human biomonitoring.[60]

In 2013, UNEP concluded the development of a legally binding agreement, the Minamata Convention on Mercury, which came into force in 2017. The Convention announced: "The objective of this Convention is to protect the human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds."[61] The UNEP website goes further and provides a precis of the Minamata Convention's scope and expectations.

> Major highlights of the Minamata Convention include a ban on new mercury mines, the phase-out of existing ones, the phase-out and phase-down of mercury use in a number of products and processes, control measures on emissions to air and on releases to land and water, and the regulation of the informal sector of artisanal and small-scale gold mining. The Convention also addresses interim storage of mercury and its disposal once it becomes waste, sites contaminated by mercury as well as health issues.[62]

In order to advance the Minamata Convention's agenda, UNEP has adopted a new slogan, *Making Mercury History*. In setting this target, UNEP and its subsidiary body, the Global Environment Facility (GEF) have set their sights on what they

57 Rui Li et al., "Mercury Pollution in Vegetables, Grains and Soils from Areas Surrounding Coal-Fired Power Plants," *Scientific Reports* 7 (2017): 46545; and Divya Gade, "Mercury Emissions from Coal-Fired Powerplants," *Environmental Management & Risk Assessment (PH 560)* Paper 4 (2015): http://digitalcommons.wku.edu/pubh_560/4 (accessed 1 December 2022).

58 United Nations, *Report of the United Nations Conference on the Human Environment, Stockholm, 5–16 June 1972* (New York: UN, 1973): https://digitallibrary.un.org/record/523249?ln=en#record-files-collapse-header (accessed 1 December 2022).

59 UN Environmental Programme, "Science Policy": https://www.unep.org/about-un-environment-programme/why-does-un-environment-programme-matter/science-policy (accessed 1 December 2022).

60 UN Environmental Programme, "Global Monitoring of Mercury" (2019): https://wedocs.unep.org/bitstream/handle/20.500.11822/34375/GMM.pdf?sequence=1&isAllowed=y (accessed 1 December 2022).

61 United Nations, *Minamata Convention on Mercury*, Article 1-Objectives, (2013), 2 (following preamble in Japanese): https://treaties.un.org/doc/Treaties/2013/10/20131010%2011-16%20AM/CTC-XXVII-17.pdf (accessed 1 December 2022).

62 UN Environmental Programme, "Minamata Convention: About Us": https://www.mercuryconvention.org/en/about (accessed 1 December 2022).

claim to be the most polluting source of mercury: artisanal and small-scale gold mining, or ASGM.[63]

Artisanal and small-scale gold mining and mercury

In Article 2-Definitions, the Minamata Convention defines "artisanal and small-scale gold mining" as gold mining conducted by individual miners or small enterprises with limited capital investment and production.[64] In practice, artisanal and small-scale gold mining means miners employing the use of manual or basic extraction technologies, most of which would be very familiar to gold rush era prospectors. And one of the materials that artisanal and small-scale gold mining operators have extensively adopted is mercury.

Anxieties in the Global North over artisanal and small-scale gold mining and its use of mercury has been exacerbated by the steady growth in the practice of this form of mining around the developing world. Though the numbers of people involved in subsistence mining is difficult to determine, credible calculations have shown that, overall, artisanal and small-scale mining increased from approximately six million direct participants in 1993 to over forty million in 2017.[65] PlanetGOLD, a programme run by the Global Mercury Partnership (managed by UNEP), estimates that there are currently fifteen million direct participants in artisanal and small-scale gold mining.[66]

Gold is an appealing product for artisanal and small-scale mining operators to target due to the wide geographical spread of surface gold deposits, the relative ease of extraction and processing using mercury-gold amalgamation, and the economic liquidity of the product. The increased activity of artisanal and small-scale gold mining over the past four decades has been heightened by an inexorable rise in the price of gold that started in the 1980s after the post-Gold Standard restrictions were dismantled.[67] This fundamental shift in policy regarding gold hoarding and trading was part of a wider adoption of neo-liberal market policies across the Global North. Alongside these global trends there have been more localised factors, including the collapse of national governments, interminable civil wars, regional droughts, and intensifying desertification. When all these pressures intersect, artisanal and small-scale gold mining becomes one of the few remaining viable economic options open to the newly dispossessed and disadvantaged.

Following a long period of indifference, national and international responses to artisanal and small-scale gold mining and its consequences have become

[63] Global Environment Facility (GEF), "Mercury": https://www.thegef.org/what-we-do/topics/mercury (accessed 1 December 2022).

[64] United Nations, *Minamata Convention on Mercury*, Article 2-Definitions (2013), 3 (following preamble in Japanese): https://treaties.un.org/doc/Treaties/2013/10/20131010%2011-16%20AM/CTC-XXVII-17.pdf (accessed 1 December 2022).

[65] Morgane Fritz et al., Global Trends in Artisanal and Small-Scale Mining (ASM): A Review of Key Numbers and Issues (2018): https://delvedatabase.org/uploads/resources/IIED-2018-IGF-Global-Trends-ASM.pdf (accessed 1 December 2022).

[66] Planet Gold, "ASGM 101: A Primer on Mercury Use in Artisanal and Small-Scale Gold Mining": https://www.planetgold.org/asgm-101 (accessed 1 December 2022).

[67] Timothy Green, *The New World of Gold* (London: Rosendale Press, 1993).

increasingly unsympathetic.[68] Complaints typically revolve around artisanal and small-scale gold mining's informality. In this discourse, artisanal and small-scale gold mining's individualist approach to resource acquisition is cast in a negative light. Political leaders claim artisanal and small-scale gold mining operations undermine their nation-state by depriving it of the revenues that could theoretically be garnered from international mining corporations through mining permits and corporate taxes.

But however dominant and unassailable the Minamata Convention appears in current policy-making discourse, its influence on national governments, industry associations, and NGOs is relatively recent. From a longitudinal perspective, it is only the latest in a line of external pressures that have each redirected the artisanal and small-scale gold mining debate. Two decades ago, the thrust was towards persuading small-scale miners to adopt more advanced technologies, including mercury retorts.[69] The rationale was that artisanal and small-scale gold mining would vanish as its practitioners evolved into smaller versions of the larger mining organisations. As the statistics presented above show, exactly the opposite happened; artisanal and small-scale gold mining numbers swelled. A loss of faith in the "technical tide" approach allowed ethical gold certification programmes to establish a foothold,[70] though the rise of the "non-conflict minerals" agenda (which started to be adopted in legal instruments from the mid 2010s) quickly rewrote the rulebook.[71] That emphasis has now been usurped in turn by a new focus on artisanal and small-scale gold mining's relationship with mercury.[72]

However, debates over how most effectively to limit or eradicate artisanal and small-scale gold mining mercury use, and the technologies that might facilitate this shift, stretch back decades.[73] The Minamata Convention's novelty lies in a renewed focus on formalisation as the solution, though how this will be achieved in practice is far less evident. Indeed, the policy appears to respond more to the

[68] Gavin Hilson and James McQuilken, "Four Decades of Support for Artisanal and Small-Scale Mining in Sub-Saharan Africa: A Critical Review," *The Extractive Industries and Society* 1, no. 1 (2014): 104–18.

[69] Jesper Bosse Jønsson et al., "A Matter of Approach: The Retort's Potential to Reduce Mercury Consumption Within Small-Scale Gold Mining Settlements in Tanzania," *Journal of Cleaner Production* 17, no. 1 (2009): 77–86.

[70] Peter Oakley, "Introducing Fairtrade and Fairmined Gold: An Attempt to Reconfigure the Social Identity of a Substance," in *The Social Life of Materials*, ed. Adam Drazin et al. (London: Bloomsbury Academic, 2015), 155–74.

[71] *OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas: Third Edition* (Paris: OECD Publishing, 2016).

[72] See Martin J. Clifford, "Future Strategies for Tackling Mercury Pollution in the Artisanal Gold Mining Sector: Making the Minamata Convention Work," *Futures* 62 (2014): 106–12; Gavin Hilson et al., "Formalizing Artisanal Gold Mining Under The Minamata Convention: Previewing the Challenge in Sub-Saharan Africa," *Environmental Science and Policy* 85 (2018): 123–31; and Samuel Spiegel et al., "Implications of the Minamata Convention on Mercury for Informal Gold Mining in Sub-Saharan Africa: From Global Policy Debates to Grassroots Implementation," *Environment, Development and Sustainability* 17, no. 4 (2015): 765–85.

[73] See Rickford Vieira, "Mercury-Free Gold Mining Technologies: Possibilities for Adoption in the Guianas," *Journal of Cleaner Production* 14, no. 3–4 (2006): 448–54; Marcello M. Viega, "Mercury in Artisanal Gold Mining in Latin America: Facts, Fantasies and Solutions," in *UNIDO Expert Group Meeting Introducing New Technologies for Abatement of Global Mercury Pollution Deriving from Artisanal Gold Mining* (Vienna: n.pub., 1997): https://content.sph.harvard.edu/mining/files/Veiga.pdf (accessed 1 December 2022); and Sameul Spiegel and Marcello M. Veiga, "International Guidelines on Mercury Management in Small-Scale Gold Mining," *Journal of Cleaner Production* 18, no. 4 (2010): 375–85.

vested interests of national governments, whether they are in the Global North or Global South, than it does to the needs and issues faced by the artisanal and small-scale gold mining communities that are the focus of interest and potentially future action. In UN debates and reports, artisanal and small-scale gold mining operators are being introduced as the cause of the "mercury problem," whilst the background to the miners' current circumstances does not enter the discussion. Through this process, artisanal and small-scale gold mining communities become doubly isolated. As well as being cut off from their personal and community histories, they are also being isolated from the overall history of mining. The use of mercury by operators of artisanal and small-scale gold mining is implicitly being treated as *sui generis*. As this article demonstrates, it is actually the latest manifestation of a long-standing tradition of mercury-gold amalgamation practice. This tradition can be traced back to the early modern era and subsequently underpinned much of the wealth generation and imperial territorial expansion of the nineteenth century. UNEP's approach to "making mercury history" rests on a flawed perception that mercury use in artisanal and small-scale gold mining is just a technological process that is despoiling a pristine paradise, rather than the latest manifestation of a technical trajectory that the Global North had set in motion five centuries before.

Part V: reflections on the social history of mercury

What does the interrogation of these two examples – the nineteenth century gold rusher, and the present-day artisanal and small-scale gold mining operator – tell us about mercury and human relationships with this most fugitive but omnipresent of materials? Perhaps the first and most pertinent point to highlight is that mercury exhibits *complexity*.[74] As a material, it inherently possesses, and is further imbued with, a range of incommensurate attributes; these attributes cannot be collapsed into, or even directly compared with, one another. In addition to being incommensurate, mercury's social attributes are dependent on wider social factors. We treat material attributes such as toxicity as scientifically fixed, but they are really underpinned by social expectations of how far we will allow any specific individual or group to be poisoned, and this tolerance can vary depending on both the understanding of the process and social status of the effected individual(s). As with all standards, the objective definition is the consequence of a subjective set of value judgements.[75] Once toxicity moves from abstract to concrete cases – as happened in Minamata Bay in the 1950s and 1960s, and now occurring with artisanal and small-scale gold mining operators in the Global South – further complicating factors are introduced as disinterested scientific judgements become conflated with liabilities.

[74] For a more extensive discussion of complexity as an analytical tool, see Oakley, "Introducing Fairtrade and Fairmined Gold," and John Law and Annemarie Mol, eds., *Complexities* (Durham, NC: Duke University Press, 2002).
[75] Lawrence Busch, *Standards: Recipes for Reality* (Cambridge, MA: MIT Press, 2011).

Mercury's ability to poison humans was known by Europeans during the sixteenth century, the symptoms of mercury poisoning were carefully documented by the 1593 Spanish government commission. Yet use of this knowledge was framed by social conventions around the worth of an individual's life. Criminals and slaves were treated as expendable when more mercury was needed to keep the expanding system of precious metal extraction functioning to advance the Spanish imperial project. Centuries later, a similar fate befell the unfortunate artisanal milliner, whose profession had come to incorporate a tradition of exposure to mercury, despite a widespread, if superficial, recognition of its inevitable and deleterious consequences for human health. Medical professionals working in different countries repeatedly documented the physiological effects of carroting, yet this had no discernible effect on the industry's reliance on mercury for over a century.

During the twentieth century, initial indifference over the wellbeing of the fishing communities of Minamata Bay is a central feature of the Minamata tragedy. While much is made of Minamata's impact on global consciousness and its role in the rise of environmental awareness, it is important to keep in mind that the Chisso Corporation continued to pour methylmercury into Minamata Bay with impunity for twenty years after the first cases of Minamata disease came to light.

Despite the increasing recognition of the seriousness of the pollution in Minamata Bay, the matter of environmental remediation or compensation was not so easily resolved. Lawsuits continued for decades, as the definition of who was eligible, and the extent of their payments, was repeatedly revised. Uncertainties over who should be defined as suffering from Minamata Disease – not all suffers exhibited the same symptoms – led to restrictive payouts. Chisso also consistently acted in bad faith as the situation in Minamata continued to deteriorate. The company attempted to postpone action despite its own scientists having proved by experimentation in 1959 that exposure to its factory's effluent induced Minamata Disease in cats. The results of these experiments were kept secret, only coming to light due to a chance observation by visitors in 1962. In 1959, as a result of a directive from the Japanese authorities, Chisso installed a "treatment plant" it knew would not remove the methylmercury, then provided a fake sample to external observers.[76] The extent of Chisso's deceitful and criminal actions and the company's withholding of information to avert blame – information which could have been used to reduce the extent of the tragedy – only became clear during the reparation trials held in the 1960s and 1970s. Despite the historicising of the Minamata tragedy, for many victims the campaign for social justice is still ongoing. They are still faced with obfuscation and denials of full responsibility from Chisso,

[76] European Environment Agency, "Late Lessons II Chapter 5 – Minamata Disease a Challenge for Democracy and Justice" (2013): https://www.eea.europa.eu/publications/late-lessons-2/late-lessons-chapters/late-lessons-ii-chapter-5/view (accessed 1 December 2022).

which chooses to describe the victim's afflictions using the disingenuous term, "Mad Hatter's Disease."[77]

Chisso's attempts to deny full responsibility for the dispersal of mercury into the environment of Minamata Bay offers insight into the mechanisms at work in the elision of mercury from the gold rush narratives of the Pacific Rim. The explanation of how gold mining has resulted in widespread ecological destruction and long-term contamination of the environment is not a pleasant story. It is also a difficult story to reconcile with the currently dominant narratives of settler nation building projects. Tourists to Alaska fantasise about visiting an untamed wilderness. The mercury-contaminated post-industrial landscape remains out of view. In addition, explanations of the extent of gold rush mercury pollution may have the politically unpalatable side-effect of raising interest in comprehensive landscape restoration. Mercury decontamination at such scale has never been attempted, nor have the costs of such an undertaking been calculated. Reducing the mercury contamination in Minamata Bay to "reasonable" levels took thirteen years.[78]

Viewed as a whole, these hidden, missing histories of mercury provide us with a new perspective on the nature of the Minamata Convention as a social phenomenon. Presented in the abstract and based on objective scientific evidence of elevated levels of mercury, the case for action seems obvious. But this does not take into account the geographical and social disparity between the international development community and the daily existence of its target groups. It may be couched in new terms, but the Global North is still telling the Global South how to behave, demanding the unconditional prohibition of technologies that the Global North started developing in the early modern period, and has comprehensively exploited for centuries. But such technical knowledge cannot be unlearned so easily, especially when the end-product – gold – continues to be so actively coveted by the same Global North that is demanding such abstinence. Perhaps the most important lesson of mercury's story is that it shows us where the limits to scientific influence can be found and a offers a glimpse of what lies beyond its reach.

In terms of an individual person's lifespan, or even the duration of an entire culture, the notion of *Making Mercury History* – somehow cleansing the entire global environment down to the last drop of mercury – should be recognised as pathetically unrealistic. As we now know, once released into the environment, mercury in the form of elemental liquid or toxic methylmercury can endure over millennia. Mercury circulates through biota and weather systems, mostly dispersed as miniscule traces, but on occasion agglomerating at levels high enough to have a catastrophic effect on the living organisms that are acting as its temporary host.

77 Chisso Corporation, Financial Results for FY2004 (on 14, column 1): "The national government and Kumamoto Prefectural Government have taken measures such as the moratorium on payment of the existing Mad Hatter's disease-related sovereign debts in each fiscal year to enable our company to make repayment to the extent possible after paying the compensation to the patients of the disease from ordinary profit.": http://www.chisso.co.jp/english/investors/other/80th_e.pdf (accessed 1 December 2022).

78 Y. Hosokawa, "Remediation Work for Mercury Contaminated Bay – Experiences of Minamata Bay Project, Japan," *Water Science and Technology*, 28, no.8–9 (1993): 339–48.

Whenever and wherever mercury comes to rest, in aquatic sediments, on tropical forest floors, or scattered across the polar wilderness, it can always be re-disturbed by natural events or human interference. Contemporary mercury levels in bodies and biota are a consequence of the way in which we have mined, manipulated, and redistributed mercury around the planet over past centuries. Current levels of mercury contamination across the globe can be considered one of the indicators of the validity of the Anthropocene as a geographical and temporal concept. In the Anthropocene, even the mercury once safely locked into carboniferous geological formations is being returned to the atmosphere. Humans have now affected all flora and fauna at a chemical level. Mercury is one of the few elements with no biological function, yet it is now found in all organisms.

An alternative reading of *Making Mercury History* would be one that fully acknowledges the historical entanglements between mercury's past and present. There is a need to demythologise mercury's current use by artisanal and small-scale gold mining communities. The current simplistic and emotive accounts of artisanal and small-scale gold mining's engagements with mercury may help build a consensus for action in the constituencies connected to international development. But they do so by demonising the miners in ways that further marginalise these already subaltern and disempowered communities. A less antagonistic stance would promote a more grounded and realistic approach to international policy-making around the practice of mercury amalgamation in artisanal and small-scale gold mining across the Global South. There is an urgent need for more widespread recognition that the technological understanding that underpins current practice was accumulated and exploited by practices of early modern European mining. It is also imperative that there is greater acknowledgment that elevated mercury levels in the Global South are not necessarily just a consequence of recent artisanal and small-scale gold mining operations. In addition, mercury's physical availability was, and largely still is, being facilitated by global trade networks. These were fostered initially by colonial, and subsequently by neo-liberal, ideologies and policies. It is only once we understand that we are all entangled and implicated in the global presence of mercury that the current dysfunctional distinction between "Them" (the subsistence small-scale miners scraping a living in the Global South) and "Us" (the materially comfortable inheritors of wealth accumulated through centuries of gold mining across the globe) can effectively be broken down.

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