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How to cite:

Hollsten, Laura. "Mercurial Activity and Subterranean Landscapes: Towards an Environmental History of Mercury Mining in Early Modern Idrija," In: "Mining in Central Europe: Perspectives from Environmental History," edited by Frank Uekoetter, *RCC Perspectives* 2012, no. 10, 21–37.

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Rachel Carson Center for Environment and Society
Leopoldstrasse 11a, 80802 Munich, GERMANY

ISSN 2190-8087

SPONSORED BY THE

Federal Ministry of Education and Research

Deutsches Museum

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

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Mercurial Activity and Subterranean Landscapes: Towards an Environmental History of Mercury Mining in Early Modern Idrija

> Mercury appears sometimes in the form of a fluid metal, sometimes in the form of a hard brittle metal, sometimes in the form of a corrosive pellucid salt call'd Sublimate, sometimes in the form of a tasteless, pellucid white Earth, call'd Mercurius dulcis, or in that of a red opake volatile Earth, call'd Cinnabar; or in that of a red or white Precipitate, or in that of a fluid Salt; and in distillation it turns into a Vapour, and being agitated in vacuo, it shines like Fire. And after all these Changes it returns again into its first form of Mercury. – Sir Isaac Newton, *Opticks*[1]

To humans, mountain rock represents constancy, stability, and long duration; the stable basis upon which various forms of organic life originate. However, mountains have a "life" of their own in the sense that they themselves come into being, grow, and are worn down by the effects of climate and erosion. For instance, the so-called Alpine orogeny began 65 million years ago, and the mountains which were created at that time are still growing.[2] The change is so slow that it is invisible to the human eye. Some of the minerals which constitute the mountain rock, however, are perceived as "quicker" and more "alive" than others. The formation of mercury deposits is a slow process occurring in the earth's crust as magma invades sedimentary rocks during volcanic activity. In the timescale of mountains, mercury ore is found in very young orogenic belts. As it changes from one form to another as described by Newton above, mercury can seem to be alive and active in its native liquid state, for instance, when it occurs as small drops on mercury ore minerals.[3] The citation by Newton reflects the volatile and mobile nature of mercury, which has intrigued people since antiquity. It was (and is) primarily mined from cinnabar ore, which is often found only deep beneath the surface of the earth: about 90 percent of all cinnabar deposits are at depths that require underground mining. In Europe the most important mercury deposits are found at Almadén in Spain, Idrija in Slovenia, and Monte Amiata in Italy. The Almadén mines have been in operation since antiquity, when the Romans extracted cinnabar

1 Isaac Newton, *Opticks, or, A Treatise of the Reflections, Refractions, Inflections and Colours of Light* (London: Printed for W. and J. Innys, 1717), 350.
2 Martin F. Price, *Mountains: Geology, Natural History, Ecosystems* (Stillwater, MN: Voyageur, 2002), 17.
3 Strictly speaking mercury is not a mineral but a mineraloid.

from the area. Idrija is one of the few places in the world where mercury can be found in both its elemental liquid state and as cinnabar (mercury sulfide) ore. A legend about the beginnings of the mine is often repeated in texts about Idrija: according to this, mercury mining began in the 1490s when a tub-maker spotted a small amount of liquid mercury while working at a local spring. This eventually led to a mining operation which came to be the second-largest mercury mine in the world, surpassed only by the Almadén mine.[4]

This paper is a part of an ongoing research project studying the movement of mercury in early modern Europe. Mercury and humans have a long shared past, with mercury occurring in contexts ranging from medicine to technology. In the field of environmental history, mercury offers an interesting opportunity to combine cultural history and the history of science with a history of the ecosystems influenced by mercury mining, transport, and use. Mercury mining has impacted people and their environments in several ways. Besides thoroughly transforming the landscapes around the mines, mercury mining has contaminated the local soil, water, and air for long periods of time. Moreover, mercury has affected the health of the miners, causing a variety of occupational diseases, often leading to an early death. Perhaps more than any other metal (with the exception of gold and silver) mercury carries a very rich environmental and cultural history as a result of its distinctive characteristics. Not only does mercury have certain unique properties, making it a useful metal in a variety of ways, but it also carries a considerable symbolic significance. The mutable and liquid qualities of mercury have fascinated people for thousands of years, involving it in practices of magic, medicine, science, and technology.

The Latin name of mercury is *hydrargyrum*, meaning "water-silver," and refers to its mobility and volatility. These properties also earned it the name "quicksilver" in English. Because of its fluid quality, alchemists have associated mercury with the mysteries of matter (mercury, sulfur, and salt were thought to be the three principal substances of the earth, and mercury was believed to be at the core of all metals) and it was even credited with divine properties. In addition, mercury is one of the few metals

4 Mateja Gosar, Tatjana Dizdarev, and Miloš Miler, *Environmental Influences of Mercury Ore Processing—Case Studies Selected at Slovenian, Mexican, Hungarian Group Meeting in Idrija in July 2012* (Ljubljana: Geological Survey of Slovenia & Idrija Mercury Mine, Ltd. – in liquidation, 2012). Accessed 8 February 2013. doi:10.5474/9789616498340. See also Aleksander Recnik, *Minerals of the Mercury Ore Deposit Idrija* (Berlin: Springer, 2013).

that are liquid at room temperature, and it also evaporates relatively easily. It can be combined with other metals to make amalgams, or solutions, of metals, and it has been used in the extraction of gold for this reason. Mercury is also a highly toxic substance which has caused serious health problems in a great number of people during the long history of its use. Moreover, mercury is a pollutant which has profoundly affected the ecosystems everywhere it has been mined, transported, and processed. Finally, mercury mining has bored into the rock and reshaped whole regions, creating a subterranean landscape, most of which is visible only to the people working the mine.

How should the various aspects of mercury mining, transport, and use be studied in the context of environmental history? This article suggests that the concept of mobility might offer a starting point for the discussion. Mercury is a substance which throughout history has moved freely between nature and humans, between nature and culture. The fluid character of mercury makes the problem in separating nature and culture particularly obvious. Like the chemicals described by Jody A. Roberts and Nancy Langston in the theme issue of *Environmental History,* "Toxic Bodies/Toxic Environments," mercury occupies a position on the border between the "natural" and "cultural" worlds.[5] Because of its fluidity, mercury moves around the ecosystem: in the cinnabar rock that is being mined, in the air, soil, and water, as well as in amalgamations, turning up in the laboratories of alchemists, apothecaries' shops, hatters' workshops, and human bodies in its capacity as a medicine, poison, or pollutant. As an important export product, mercury has taken part in the increasing geographic mobility of the early modern world, crossing borders while being transported from one country to another and from one continent to another. Much of this mobile activity has been invisible, partly because it has taken place underground, partly because certain forms of mercury pollution are not visible to the eye.

A useful framework for considering mercury mining in environmental history is suggested by the work of Jane Bennett, who maintains that there is a vitality to metals, and, indeed, to many inorganic substances, a "quivering of . . . free atoms."[6] While this "aliveness" of metals is not readily observable to the human eye in all metals, mercury more than any other metal appears to be alive at room temperature, in the form of a flowing

5 Jody A. Roberts and Nancy Langston, "Toxic Bodies/Toxic Environments: An Interdisciplinary Forum," *Environmental History* 13 (2008): 629–35.
6 Jane Bennett, *Vibrant Matter: A Political Ecology of Things* (Durham: Duke University Press, 2010), 59.

liquid. The idea of "living" mercury was widespread in medieval and early modern times when alchemists believed mercury to be the primordial water of creation, which had the ability to transcend both the solid and liquid states, both earth and heaven, and even life and death. But even without endowing mercury with any magical qualities I would like to adopt Bennett's idea of "thing-power," a concept which invites us to observe the vitality and aliveness of inorganic matter. The concept of thing-power has its roots in materialistic philosophy. Rather than being considered as passive and inert, things are seen as forces that play decisive roles in events. Bennett maintains that far from being passive objects in the world, things in fact affect other bodies and have the power of enhancing or weakening them. Her work suggests moving from a world of nature versus culture to one of "many conative actants swarming and competing with each other."[7] Bennett's "thing-power" has important implications for our views on ecology. It emphasizes the closeness of humans and non-humans, and the entire network of relations of which an ecosystem consists.[8] The ecosystem consists not only of living organisms and inorganic matter such as minerals, but of all the various combinations of them, circulating within and around humanity.[9] Regarding the material world in this non-hierarchical manner highlights ways in which the various bodies in motion affect the environment. It also raises the question of non-human agency in the shaping of landscapes. Michael Egan has noted how studying natural and synthetic chemicals such as mercury in landscapes which are rendered harmful for organic beings by their presence offers new opportunities for reflecting on non-human agency in environmental history.[10] Mercury's transitions and its effects on the ecosystems in which it moves can be seen as an example of human and natural cooperation or partnership. When studying the environmental impact of mercury, neither the groups of people or individuals involved in the mining, trade, and use of mercury, nor mercury itself can be regarded as being the principal agents. The changes are rather a consequence of the interplay between humans and non-humans, where agency can be regarded as relational rather than autonomous. In line with actor-network theory, it can described as an assemblage of human and non-human interaction, resulting in changes in nature and the landscape. Mercury mining consequently offers an interesting opportunity to discuss the nature (in all senses of the word) of various agents in shaping the environment.

7 Bennett, *Vibrant Matter*, 122.
8 Jane Bennett, "The Force of Things: Steps toward an Ecology of Matter," *Political Theory* 32 (2004): 365.
9 Bennett, "The Force of Things," 349.
10 Michael Egan, "Forum: Toxic Knowledge: A Mercurial Fugue in Three Parts," *Environmental History* 13, no. 4. (2008), 636–42.

Subterranean Landscapes

The mercury mine at Idrija was famous in early modern Europe. The English traveler and fellow of the Royal Society Edward Browne visited Idrija in 1669 during his tour of Hungary and the Adriatic coast. He reports to Henry Oldenburg that "there is little considerable in this towne or such as might requite the trouble of travelling unto it, butt only the Quicksilver mines."[11] Browne himself travelled to Idrija specifically in order to see the mine, which he describes in his letter and in *A Brief Account of Some Travels*.[12] Idrija, some 50 kilometers west of Ljubljana, was part of the province of Goritia in the eighteenth century. The mine was not only the most important sight to be seen in the region, it was also the backbone of the economy of the area. Idrija was the site of one of the richest mercury deposits in the world, and for centuries mercury was almost like gold to the province. A mining company began to mine the rich deposits of mercury in Idrija in 1493. In the first years of mining, Idrija was part of the hinterland of Venice, but was annexed by the Habsburg dynasty after the successive battles with Venice which took place between 1508 and 1517. The mine came to be part of the Austrian empire and was administered directly under the Austrian court. The province of Goritia, later Carniola, remained under Austrian rule until the First World War.[13]

Janez Vajkard Valvasor's copper engraving of Idrija in the late seventeenth century provides a visual representation of the landscape that Browne saw in 1669. Valvasor was a scientist and fellow of the Royal Society, born in Ljubliana in the Duchy of Carniola, and the engraving appears in his work *Die Ehre deß Hertzogthums Crain* ("The Glory of the Duchy of Carniola") from 1689.[14] The picture shows how the town was built around the mine, which completely dominated it. The town was situated in a valley surrounded by mountains with a river running through it. The Gewerkenegg Castle, built at the beginning of the sixteenth century to serve as the administrative headquarters and warehouse of the mine, is the most prominent building in the picture. In addition, the picture shows a church and other buildings; in Valvasor's estimation there were about 300 houses in Idrija. According to his description, the population of Idrija in the eighteenth century was about

11 Edward Browne, "Letter to Henry Oldenburg, 15 June 1669, from Palmanova in Friuli" (read to the Royal Society, 28 October 1669).

12 Edward Browne, *A Brief Account of Some Travels in Hungaria, Servia, Bulgaria, Macedonia, Thessaly, Austria, Styria, Carinthia, Carniola, and Friuli* (London: Printed by T.R. for Benjamin Tooke, 1673).

13 Alfred Bogomir Kobal and Darja Kobal Grum, "Scopoli's Work in the Field of Mercurialism in Light of Today's Knowledge: Past and Present Perspectives," *American Journal of Industrial Medicine* 53 (2010): 535–36; Z. Z. Slavec, "Occupational Medicine in Idria Mercury Mine in 18th Century," *Vesalius* 4, no. 2 (1998): 52.

14 Janez Vajkard Valvasor, *Die Ehre deß Hertzogthums Crain* (Laybach: W. M. Endter, 1689).

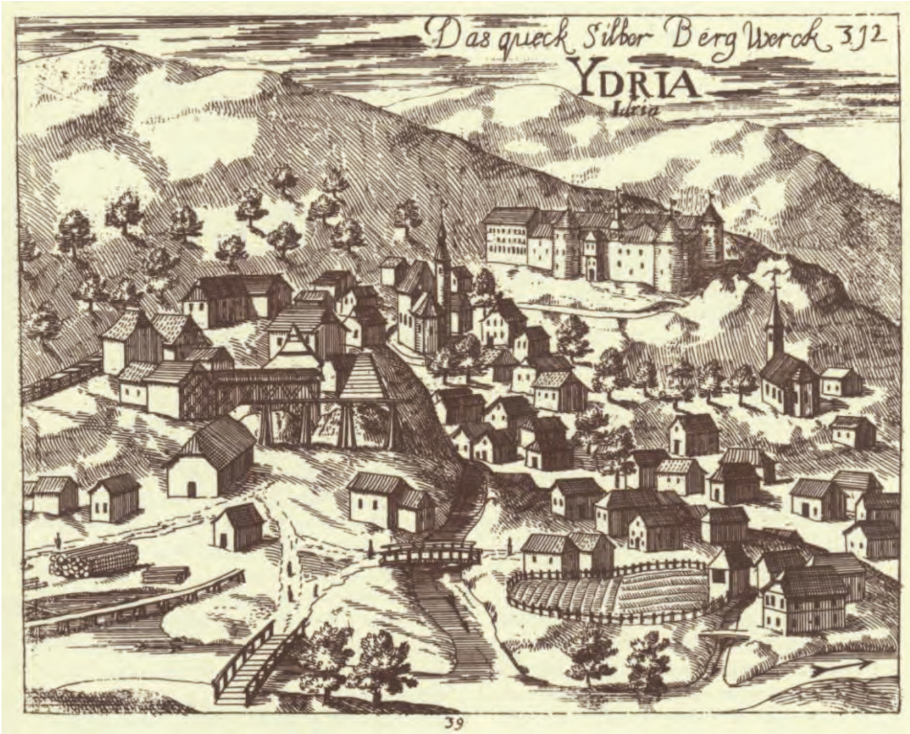

Figure 1: The quicksilver mine at Idrija, 1689. Copper engraving by Janez Vajkard Valvasor.

3,000 inhabitants, out of which 365–900 were miners. Many of the buildings served the mining operation in one way or another, whether as laboratories, offices, or warehouses.[15] The picture shows the River Idrijca, central to the mining operation, which was used as a power source for draining the mine and for transport. Piles of logs lie on the river shores. Browne in his description notes the river as being small and shallow, but in rainy times sufficient to convey the fir trees needed for the building of the mine constructions and the roasting of the ore, as well as providing fuel. Of the mine itself, Browne notes that the entrance was in the town (instead of high upon a hill as in many other mines), which is why engines and devices to draw the water out of the mine could be seen in the town's center.[16] One of the buildings in the picture may have been the entrance to the mine: St. Anthony's Shaft, which was dug in 1500, shortly after the discovery of mercury. The entrance building was constructed in front of the shaft at some point in the eighteenth century.

15 Slavec, "Occupational Medicine," 54.
16 Browne, "Letter to Henry Oldenburg."

More interesting than what can be seen in the picture, however, is everything that it does not show. There are some hints indicating that there is a vast landscape underneath the town; for instance, the extensive water draining devices used to pump water up from the mine. Still, with the exception of the entrance buildings, the laboratories, warehouses, and the castle, the main part of the mine, with its pits and shafts, is not visible. By the time of Valvasor's visit, two hundred years of mining had bored deep shafts in the mountain rock, creating a mining landscape where great areas were subterranean and thus invisible. Since the upper deposits were soon exhausted, the miners had to dig deeper and deeper to get to the ore. Consequently, the miners had to descend into a deep pit along a 300-meter-long shaft. At the end of this shaft the miners descended into the first vertical pit, Ahacij's or Attem's Shaft, which was dug in 1536 and closed in 1746. The miners continued their descent into the pit down some 1,000 steps. In the beginning it was 68.5 meters deep, and by the time it was closed in 1746 it had reached the depth of 133 meters. The deepest of the pits at Idrija was the Barbara's Pit, with a depth of around 200 meters. Joseph's Shaft, built in 1786, eventually became 420 meters deep and it connected all 15 levels of the mine.[17]

Edward Browne mentions a "dreadful description" of the Idrija mine by Athanasius Kircher, based on information provided by a Jesuit called Andreas Siserus.[18] His own description is more positive, focusing on the technical aspects of the mining operation. In his letter to the Royal Society he describes his descent into the mine by ladders, making it sound fairly easy. Browne was clearly impressed by the technicalities of the operation, and notes the absence of damp in the mine. He particularly admires the "excellent engines and devices used to pump up the water from the mines."[19] The water systems at Idrija were extensive and sophisticated. Some years before Browne's visit, the Englishman Walter Pope describes the waterwheels at Idrija as the largest he had ever seen. At the end of the eighteenth century, a large waterwheel was built that could pump water from a depth of 300 meters. Although water was continuously pumped out of the mine, there was always the danger of water breaking in. On the whole, the mine was a dangerous place for the miners working in it. The miners descended into the mine by means of ropes and returned by means of freely hanging rope ladders. When too weak or ill to climb, they were lifted up in baskets. The lowest parts of the pits contained toxic and inflammable gases and were badly ventilated.

17 Slavec, "Occupational Medicine," 52–53.
18 Browne, "Letter to Henry Oldenburg."
19 Ibid.

Lanterns were forbidden because of the possibility of fires, which could be fatal and very difficult to extinguish: for example, fires at the Almadén mine in Spain kept it closed for a long time in the 1770s. In spite of these precautions, 30 miners died in 1550 as a result of methane explosions.[20] As a kind of prophylactic measure, a chapel was built in the eighteenth century at the end of the shaft leading to the mine. Here the miners prayed to their patrons St. Acacius and St. Barbara for a successful day of work and a safe return.

In addition to their patron saints, miners had their own distinct culture, which included characteristic clothing, songs, and dances, as well as many beliefs and superstitions about the mines. Many of these would have reflected their special way of life and the subterranean life they led.[21] In early modern times, the subterranean world was credited with continuous activity. It was generally believed that metals incubated in subterranean caves and mines like embryos. They were to be found in various stages of maturity, ranging from immature metals such as arsenic, metals of middling maturity such as lead, and fully mature metals such as gold. The idea of metals germinating in the bosom of a living earth like embryos or plants was part of an old tradition, common in antiquity and in the European Middle Ages.[22] There were also legends about the spirit of the mines and the supernatural help that could be received if the spirits were appeased. The subterranean landscape was believed to be inhabited by invisible beings who could help the miners find rich deposits but who could also make life difficult for them. For instance, symptoms of mercury poisoning were thought to be caused by spirits taking revenge. Among the supernatural beings were small mountain men or gnomes, described by Georgius Agricola in his sixteenth-century treatise on metallurgy as being dressed like miners, but smaller than dwarfs and believed to wander around the pits and tunnels.[23] These beings can be understood as mediators between the humans and the natural world, represented by the mountain which gave birth to the valuable mineral. One of their tasks may have been to protect the minerals and see to it that they were not excessively exploited. The view of the earth as a living creature also effectively placed restrictions on mining. The precious metals were thought to

20 Slavec, "Occupational Medicine," 53.
21 Peter Burke, *Popular Culture in Early Modern Europe* (1978; repr., Farnham and Burlington: Ashgate, 2009), 63–64.
22 Carolyn Merchant, *Ecological Revolutions: Nature, Gender, and Science in New England* (Chapel Hill and London: University of North Carolina Press, 1989), 114–15.
23 Georgius Agricola, *De Re Metallica*, trans. Herbert Clark Hoover and Lou Henry Hoover (New York: Dover Publications, 1912), 217.

have gestated in the earth's womb, for which reason a variety of ceremonies and sacrificial rituals were connected to mining, reflecting a perceived need to compensate for the deed of plunder. Metallurgy was considered to be a method of hastening the natural growth of what was thought to be living metal and was therefore connected to magic, a belief that explains the special position of the smith in traditional societies. Alchemy was thus a process where the correct combination of mercury and other ingredients would further hasten the maturation of the process and result in gold. Hence the creation of cinnabar or mercury through natural processes, its extraction through mining and metallurgy, and its use in alchemy were all seen as being based on the same principles. Each of these processes is an example of an interplay between humans and the minerals, each exhibiting different degrees of agency.

Mobile Metal

Virtually all mercury is derived from cinnabar, or mercury sulfide (HgS), although in rare cases mercury can also be found as a native metal (i.e., in its elemental form rather than as part of a compound). The red cinnabar at Idrija was so rich in mercury that drops of elemental mercury could be found in samples of the ore. The ore in the mine, according to Browne, was "of a dark color striped with red" and the mercury only became visible when forced out of the cinnabar by fire.[24] Once cinnabar or other metallic ores are mined, brought to the surface, and crushed, mercury can be easily extracted. When heated, cinnabar releases mercury as a vapor which is then cooled and captured as liquid mercury. Because of its changeable character, mercury can assume a variety of chemical forms, including liquid elemental mercury and solid cinnabar in mineral deposits, as well as gaseous elemental mercury in the air and methylmercury in water and sediment.

Mercury has been mined in Europe since antiquity, when mercury was used in ointments and cosmetics. In early modern times, mercury was used not only by alchemists, but also by goldsmiths, who used it for fire gilding, and hatters, who used it in the felting of animal hair. In addition, mercury was used by physicians, who treated their patients with it. Alchemists were important users of mercury mostly up through the sixteenth century, but they continued to practice their art into the seventeenth century.

24 Browne, "Letter to Oldenburg."

The Superintendent of Mines in Sweden, Axel Fredric Cronstedt, and the Counsellor of the College of Mines, Gustav von Engeström, note in their publication *Towards a System of Mineralogy* (1788 translation of the Swedish original from 1758) that "native or virgin mercury was formerly sought for by Alchymists with great anxiety and expence from Idria, for their great object of making artificial gold."[25] According to the authors, who clearly had little time for alchemists, those who were interested in gold had a particularly high regard for Hungarian mercury and its transformative qualities. Not only was the local cinnabar, antimony, and copper thought to be impregnated by gold, but even the vine trees of Hungary were believed to contain gold. Cronstedt and von Engström mention a French "chymist" who claimed to have found gold in the ashes of twigs and stems of vines, and describe how prominent figures in the scientific world believed in occurrences of gold in twigs. The fallacy of this, however, was later demonstrated by Count de Lauragais at the Royal Academy of Sciences in Paris.[26]

Most of the mercury used in Europe came from Idrija, as the Spanish mercury was totally absorbed by the gold and silver mines in South America. Demand for mercury greatly increased in the 1550s with the development of an amalgamation process called the patio process, in which mercury was used to extract silver from its ore. From the seventeenth and eighteenth centuries onwards, the Almadén mine in Spain suffered considerable damage as a result of the depletion of minerals in the extant known deposits and devastating fires, and mercury production temporarily ceased. During this period Idrija increased its production to compensate for the loss. The amalgamation process proved to be very stimulating for the Idrija mine and production was, in the words of mineralogist Ignaz von Born, "pushed and extended with great spirit and exertation."[27] This was a time of prosperity for Idrija. Von Born writes that "the Spaniards, though the profits of their process of amalgamation are to those of ours but as 1 to 10, have no objection to supply even their remotest mines of Peru and Mexico with quicksilver from the imperial warehouses at Vienna, Idria and Trieste."[28] Between 1785 and 1797, up to 700 tons of mercury were exported to Spain yearly.[29]

25 Axel Fredrik Cronstedt and Gustav von Engeström, *Towards a System of Mineralogy* (London: Charles Dilly, 1788), 2:588.
26 Ibid.
27 Ignaz von Born, *Baron Inigo Born's New Process of Amalgamation of Gold and Silver Ores, and Other Metallic Mixtures* (London: T. Candell, 1791), xxxii.
28 Ibid., 158.
29 Ibid.

Figure 2: Transporting Mercury (Source: Idrija Municipal Museum collections)

Mercury from Idrija was an important factor in the increasing mobility of the early modern economy, involving flows of people, ideas, and material objects. The mercury mined at Idrija was a sought-after export product, and Amsterdam was the main export center where mercury was bought and sold from the mid-seventeenth century onwards. Through its mercury export Idrija became one of the starting points of the so-called Intercontinental Mercury Route. The Mercury Route included the sites of production and the various points on the route along which the mercury travelled from Idrija via Trieste to western Europe. Here it joined the route, which united parts of Southeast Asia and Europe with South America via ports, cities, and transport routes on sea and land. The land transports were hazardous, as Idrija had no road connections until the nineteenth century. The mercury was first transported by horses along narrow rocky paths, either by land to Klagenfurt, or to the seaports of Venice and Trieste, where it was then shipped to the Levant or to Germany, Holland, and Spain, sometimes ending up as far away as Sweden or South America.[30]

30 Slavec, "Occupational Medicine," 52.

Mercury was transported in leather bags during this period. It is difficult to say how safe the transports were and how much mercury may have leaked into the environment during transportation. An incident related in the *Edinburgh Medical and Surgical Journal* indicates that accidents did happen on the often long journeys.[31] According to the report, two ships, the man-of-war *Triumph* and the schooner *Phipps*, picked up a large quantity of mercury from a Spanish ship wrecked off Cadiz in 1810. The report does not say where the mercury originated, but it was probably on its way to the South American mines. According to the report, the *Triumph* took on thirty tons of mercury in leather bags picked up on the shore and saturated with sea water. The bags were kept in a storeroom in the lower regions of the ship. The other ship, the schooner *Phipps*, is reported to have taken a smaller amount of mercury. Within a fortnight many of the bags appear to have decayed and burst, and the mercury thus escaped into the recesses of the ship. As a result, every metallic substance on board was coated with mercury, and an alarming illness broke out among the crew. According to the report, the surgeons, pursers, and three officers who were closest to the storeroom suffered the most, with swollen heads and tongues. The *Triumph* had to be sent to Gibraltar to be cleared, and the sick people were taken to hospital. The other ship, the *Phipps*, was sent to Lisbon, where a hole was bored in its bottom in order to allow the mercury to run out into the sea. As a further measure, every rat, mouse, and cockroach on board was destroyed. The incident was much discussed by physicians trying to explain the phenomena, some attributing the effluvia to the bags having been acted upon by salt water. From a modern day perspective the incident can be categorized as a major environmental disaster. The actions that were taken were intended above all to safeguard the people—the threat to human beings was considered more serious than the threat to the natural world. The sea was not thought of as something which should be protected from the mercury spill.

One eighteenth-century scientist who did address the effects of mercury on the natural environment is the French naturalist Antoine de Jussieu. Jussieu studied the area of Almadén and observed that the mining operations did not emit any exhalations harmful to vegetable life and that the neighborhood was fertile.[32] We now know that plants and mushrooms can accumulate mercury from polluted soils.

31 See George G. Sigmond, *Mercury, Blue Pill and Calomel* (London: Henry Renshaw, 1840), 10–13.
32 Antoine de Jussieu, *Observations sur ce qui se pratique aux mines d´Almaden en Espagne pour en tirer le mercure*. Memoires de l´Academie Royale des Sciences (Paris, 1719), 478.

Mercury Landscapes

Ecosystems in the Idrija region are subject to a certain amount of mercury pollution as a result of natural background levels. The mining and smelting activities considerably increased the amount of pollution. In the environment, mercury can migrate between various media, such as air, soil, and water. By the end of the eighteenth century, two hundred years of mercury mining in Idrija had caused widespread mercury contamination.[33] Even by the seventeenth and eighteenth centuries, visitors to Idrija were beginning to comment on the harmful effects of the mercury and smelting gases on the environment.[34] Several recent studies have been done on the effects of mercury on the natural environment in the Idrija area, and analyses of soil samples show that there is still a high degree of contamination today. High values have been found particularly in the Idrijca River valley and at the base of the mountain slopes.[35] However, results from recent reports do not indicate what degree of pollution existed in the soil, air, and water around the mine three hundred years ago. The pollution would have been mainly concentrated in the areas where mercury was mined, roasted, and processed. In view of the inefficient methods of the day, the leakage during this process is likely to have been considerable. As a result of the inefficient roasting methods, the recovery of mercury was very low, and about half of the mercury disappeared into the ground or evaporated into the atmosphere.[36] Of the five million metric tons of mercury ore mined, over twenty-five percent is thought to have dissipated into the environment during the five hundred years of mining operations. In the early days of mining, the excavation and processing of ore were technologically simple procedures. The mercury was extracted by means of roasting the ore, initially in piles like those used in charcoal extraction. Eventually, earthen vessels began to be used in the roasting process and a system involving two vessels was developed. According to Tersic et al., very few changes occurred in the process between 1510 and 1652. There was no need to develop more efficient methods as the quantity

33 Tamara Tersic, Mateja Gosar, and Harald Biester, "Distribution and Speciation of Mercury in Soil in the Area of an Ancient Mercury Ore Roasting Site, Frbjzene trate (Idrija Area, Slovenia)," *Journal of Geochemical Exploration* 110 (2011): 144; David Kocman, Milena Horvat, and Joze Kotnik, "Mercury Fractionation in Contaminated Soils from the Idrija Mercury Mine Region," *Journal of Environmental Monitoring* 6 (2004): 703.

34 Joze Car and Tatjana Dizdarevic, "Written Reports on the Effects of Mining Activities on the Natural Environment in Idrija in the 19th Century," in "VII International Symposium: Cultural Heritage in Geosciences," ed. C. F. Winkler Prins and S. K. Donovan, *Scripta Geologica Special Issue* 4 (2004): 36.

35 Mateja Gosar, "Mercury in River Sediments, Floodplains and Plants Growing thereon in Drainage Area of Idrija Mine, Slovenia," *Polish Journal of Environmental Studies* 17, no. 2 (2008): 227–36.

36 Joze Kotnik, Milena Horvat, and Tatjana Dizdarevic, "Current and Past Mercury Distribution in the Air over Idrija Hg Mine Region, Slovenia," *Athmospheric Environment* 39 (2005): 7577–78.

of mercury in the ore was very high, probably about 17 percent or more.[37] Old roasting sites at various distances from Idrija have been located in recent studies.[38] These are mainly located on flat terrain next to flowing water. The studies show that the mercury contents in the soil at old roasting sites are extremely high, even surpassing previously studied locations at Idrija.[39]

Today it is difficult to estimate the levels of mercury concentration in the air at Idrija in the early modern period. As for the water, there is a description by Walter Pope, who declared in 1663 that "the waste water is so saturated with mercury that it heals itchiness and other similar discomforts."[40] According to Gosar, most of the material was dumped into the river or deposited along its banks.[41] Highly polluted tailings material was washed down the river during floods. Some of the material was carried downstream along the rivers Idrijca and Soca towards the Gulf of Trieste. The amount of mercury pollution in the ecosystem obviously varied according to the intensity of mining at various times in history. One of the peak periods was during the final decades of the eighteenth century when Austria and Spain contracted mercury supplies from Idrija. During the time of high mercury production, landowners in the surroundings of the smeltery complained about the damage the operation caused to their land, crops, and livestock.[42] As a result, the Idrija mine began to pay indemnity to landowners in 1788. According to Car and Dizdarevic, this compensation paid in the Carniola region may very well be the first "environmental annuity" paid on a regular basis.[43]

Mercury in the Body

The mercury pollution affected not only ecosystems but also animals and humans as well. Mercury finds its way into the body through various channels. It is easily absorbed through the skin as well as through respiratory and gastrointestinal tissues. The animals and humans in the Idrija region were constantly exposed to mercury to varying degrees. The animals and miners working in the mining operation would have

37 Tersic, Gosar, and Biester, "Distribution and Speciation of Mercury," 136, 143–45.
38 Ibid., 136–37.
39 Ibid.
40 Cited in Kotnik, Horvat, and Dizdarevic, "Current and Past Mercury Distribution," 7577.
41 Gosar, "Mercury in River Sediments," 233.
42 Ibid.
43 Car and Dizdarevic, "Written Reports," 36–37.

been exposed to mercury gases. However, there were two sides to mercury in early modern Europe. Despite its toxicity, it was also widely used in medicine, applied in liquid and vapor forms from ancient times in many societies around the world, including China, India, Tibet, and the Arab world. The mobility of mercury was believed to make it particularly useful in that it facilitated the passage of other substances in the body as well. The physicians who used mercury credited it with a penetrating quality, believed to enter the deepest recesses, pulling out poisons in sweats, purges, and saliva.[44] Part of its attraction is undoubtedly due to its powerful volatility and showiness, which probably created associations of efficacy. Mercury became increasingly important after the outbreak of syphilis in Europe in the fifteenth century, and its use as a remedy against syphilis continued into the late nineteenth century. Mercury was used in the form of ointments rubbed into the body, as mercury water, and little blue pills.

Even though mercury was widely used as a remedy, its toxicity has also been known since antiquity. Mercury is a neurological poison causing tremors, extreme mood changes, and eventually restricted vision and loss of hearing. Certain forms of mercury poisoning also cause damage to the liver and kidneys. The first observations of mercury-related diseases at Idrija are made by Paracelsus in *Von der Bergsucht und anderen Bergkrankheiten* (1533). When Paracelsus visited Idrija in around 1527, he found people who were paralyzed, deformed, asthmatic, and trembling, without any hope of recovery.[45] He accurately describes the symptoms of mercury poisoning, such as tremors, loss of teeth, and diseases of the digestive organs, skin, and kidneys. As a prophylactic measure he suggested a kind of respirator that miners could use to protect themselves from the toxic mercury vapors.[46] Before Paracelsus, miners' diseases were often ascribed to mountain spirits.

Mercury poisoning, or mercurialism, was the tragic fate of many miners at Idrija. From the seventeenth century onwards, visitors describing the Idrija mine note the ill-health of the miners due to mercury vapors. Elemental mercury easily became volatile in the limited space of the mine, particularly at its deeper levels, where temperatures were high. The mercury vapors entered the bodies of the miners mainly through inhalation, slowly accumulating in the tissues. Valvasor remarks on the miserable social condition

44 Richard M. Swiderski, *Quicksilver: A History of the Use, Lore and Effects of Mercury* (Jefferson, North Carolina and London: McFarland & Company, 2008), 7.
45 Cited in Kobal and Kobal Grum, "Scopoli's Work," 535–36.
46 Slavec, "Occupational Medicine," 53.

of the sick miners. He recounts how miners working with native ore were in particular danger as the mercury vapors could easily penetrate the human body and completely saturate it.[47] Miners who worked in front of furnaces suffered especially from mercury poisoning. As a result, they became incapacitated and had to resort to begging for the rest of their lives. Although the miners at Idrija were not slaves like some of the miners at Almadén, they most likely had little choice in how they made their living. For many, mining was probably the only possible way of supporting themselves and their families. However, the well-being of the miners was considered important enough for the officials to organize something which could be termed one of the earliest forms of occupational health care. In the mid-eighteenth century, J. A. Scopoli was employed as the first physician at the Idrija mercury mine. This was a time of significantly increased mercury production, which must have resulted in higher numbers of mercury-related diseases.[48] Scopoli recommended that the miners at Idrija should work only six- to eight-hour days at a time when ten hours was considered the minimum for a workday. Scopoli further recommended that miners should be paid enough so as not to be forced to work after hours and that they should stay at home when symptoms of mercury poisoning appeared.[49] This shows that the health problems caused by mercury mining were now being taken seriously and that certain measures were undertaken to remedy the situation. Still, protecting the miners was very difficult in a situation where mercury could be found in the air breathed by miners, in the soil, and in the water.

Mercury saturated entire ecosystems, including human, plant, and animal realms. The whole mining operation created a mining landscape that was shaped by several agents. The miners, digging for cinnabar and exposing themselves to serious health hazards caused by mercury gases, do not come across as the principal agents in the shaping of the landscape. Neither do the supervisors of the operation, nor yet the owners of the mine, represented by bodies such as the Royal Office for Coinage and Mining. Rather, the agents and causes at play were embedded in material networks consisting of both human and non-human beings, both organic and inorganic components. Mercury in its various forms was one of these components, the reason this landscape came into being. And, I would like to suggest, mercury should be credited with what Jane Bennett has called "thing-power" in the process of creating the Idrija

47 Ibid., 54.
48 Kobal and Kobal Grum, "Scopoli's Work," 537.
49 See Slavec, "Occupational Medicine," 55.

landscape. It had “thing power” in the sense that a whole mining operation was created around it, extending from areas deep in the earth to destinations in Europe and beyond. Mercury had power in the sense that it was perceived as a potent mineral with the ability to participate in the creation of gold. In addition, mercury had power in that it was thought that it both cured people from diseases and had the power to make people seriously ill.

The challenge of writing the history of the effects of mercury mining at Idrija or any other mining area lies in following the transportation of mercury, from its extraction from cinnabar mined deep in the earth, to the various processing operations taking place above ground. It lies in combining the themes of mobility, pollution, conservation, science, medicine, and occupational health, and identifying the agents in the networks operating in the ecosystems. This requires further work, both with existing studies on the environmental impact of mercury at Idrija and with primary sources that could clarify further details in the early modern environmental history of mercury mining at Idrija. This will hopefully cast light on how the “mercury landscape” at Idrija was created in networks and partnerships including humans and the mobile mineraloid that made some people prosperous, while at the same time making others sick or forcing them to spend their days in the subterranean landscapes they played a role in creating.