Written reports on the effects of mining activities on the natural environment in Idrija in the 19th Century

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The environmental conditions in the Idrija Mercury Mine and its broader surroundings were strongly affected in the first half of the 19th century by two disastrous pit fires. The fire could only be extinguished by flooding of the pit. The consequences of such flooding was extensive poisoning with mercury vapours, not only among those miners who participated in the fire extinguishing effort and later in the rehabilitation of the pit, but also among the inhabitants of Idrija. During rehabilitation works, the highly polluted water was discharged directly into the Idrijca River, killing all the fish species thriving there. After 1835 the Mine gradually intensified its production. The dumping of increasingly larger quantities of smelting wastes directly into the Idrijca River considerably aggravated the environmental conditions in the river and along its banks. The Mine had begun to pay indemnities in 1788 to affected landowners in the vicinity of the smelting plant. The Mine Administration, supported by the competent ministry and the Higher Mining Office in Klagenfurt, rejected all accusations and proved, evidently with false data, that smelting gases did not contain mercury vapours and that smoke gases were not harmful. Only in 1881 did they finally begin to pay affected landowners a regular annual support in place of indemnity.

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Historical overview and environmental conditions at the end of the 18th Century

Idrija holds a special place among mercury mine localities. Carboniferous shales intercalated with native mercury crop out at the surface in the very bottom of the basin where, soon after the discovery of mercury in 1490, a small settlement first appeared and later developed into the town of Idrija (Fig. 1). In the initial decades of mining activities, even those areas where shales containing native mercury were excavated and ore-processing was conducted, in the form of washing and burning in piles, were later completely built up. Throughout history, the primary (geogenic) and secondary

Fig. 1. Idrija, painted by Goldstein in 1840.

(anthropogenic) mercury compositions became closely interwoven, bringing enormous environmental consequences for the population and environment of Idrija. For this reason Idrija is rightfully called a "mercury laboratory" (Čar & Dizdarevič, 2003).

A considerable amount of information on mercurialism among miners of the Idrija Mine has been preserved in official mine documents. However, the knowledge about and 'recognition' of the effects of mining and ore processing on the natural environment and inhabitants of Idrija and its surroundings developed much more slowly.

The first known writings about the consequences of mercury poisoning in Idrija were published in the 16th century by the reputed physician Paracelsus who visited Idrija in 1527 (Lesky, 1956). The published reports of occasional visitors to Idrija in the 17th century already contain the first remarks on the harmful effects of 'mercury' gases on the environment in the vicinity of the smeltery. Of major significance for evaluating the growing awareness of the harmful effects of mercury and smelting gases on the environment were the reports of Keyssler (1740), a German travel writer, Scopoli (1761, 1784), a naturalist and the first mine physician, and Hacquet (1781), a mine surgeon. Due to the exceptional rise in mercury production after 1785 (agreement between Austria and Spain on the supply of mercury from Idrija), the environmental conditions in Idrija deteriorated rapidly. Landowners in the close and distant surroundings of the smeltery complained about the damage caused to land, crops and livestock. The Mine recognized the damage and began to pay indemnity in 1788. To

our knowledge, the indemnities represented the first 'environmental annuity' that began to be paid regularly for several years in the region of Carniola (Čar & Dizdarevič, 2003).

Environmental consequences of the 1803 pit fire

According to the second six-year agreement concluded between Austria and Spain in 1792, Spain would be supplied with mercury from the Idrija Mine until 1798. However, due to the war conditions prevailing in Europe, the agreement was terminated one year before its expiry date, i.e., in 1797. Although the Mine began to reduce its mercury output, 560 tons of mercury were nevertheless produced in the said year due to accumulated stocks. It was not until after 1799 that the production of mercury actually began to fall, amounting to some 370 tons in 1802. Around the year 1800, the Mine introduced new Leithner vertical smelting furnaces with improved efficiency rates. The number of employees was also reduced. Evidently, the decrease in production and the introduction of new, technologically improved furnaces had a favourable effect on the environmental conditions. In 1798 a special mine committee expressed the opinion that livestock was less threatened and fell ill less frequently, while landowners in the surroundings of the smeltery repeatedly began to breed sheep (Pfeifer, 1989). In 1802, indemnity was being paid to only 13 landowners as a result of - in the opinion of the special committee - the improved conditions.

On 15th March, 1803, a fire broke out in the central part of the Idrija Mine. All the miners, except for one, were rescued. All the entrances to the pit, except for Francisca's Shaft, were built up. Six weeks later, the mine entrances were finally reopened and smoke containing poisonous mercury gases began to spread uncontrollably into the environment. Despite enormous efforts, the fire could not be stopped and, in the night from 14th to 15th May, the pit was flooded with water. When the water reached the centre of the fire, a strong explosion occurred, demolishing even the above-ground facilities around Theresa's Shaft. After the fire was finally extinguished, the pit water (yellow in colour) began to be pumped out and was released directly into the Idrijca River (Karsten, 1821).

The pit fire obviously had disastrous consequences for the health of miners. This was reported in detail by Pfeifer (1989) in his book about the health service in Idrija. The fire and explosion destroyed a large part of the pit, whose rehabilitation, aggravated by the severely impaired health of Idrija miners, lasted for a full three years (Mohorič, 1960).

General information about the fire and its consequences in the pit, as well as the effects of mercury gases on miners, was quite frequently published in various reports, newspapers and publications (Karsten, 1821; Rassell, 1825; Hizinger, 1860; Arko, 1931; Mohorič, 1960; Pfeifer, 1989). However, only a few brief comments about the consequences of the fire on the natural environment have been found (Rassell, 1825; Hizinger, 1860; Pfeifer, 1989). By all means the pit fire had disastrous consequences for the natural environment in Idrija and its surroundings, as well as for the banks of the Idrijca River.

A highly suggestive description of the 1803 pit fire was published by the English travel writer John Rassel, who visited Idrija in 1822. In additional to a dramatic

account of the entire fire-extinguishing procedure, Rassel adds a few words at the end of his report about the environmental consequences of the fire: "It took them two years to make the device and pump out the water. It was placed in the Idrijca River, which was found to contain only a small quantity of mercury, but a large share of sulphuric acid and such large quantities of iron that the bottom and banks of the river were coated with a crust of iron ochre along its entire course - from Idrija to its confluence with the Soča River. It was then that all the fish disappeared from the river, with the exception of eels, which evidently resist everything, except, of course, grilling or roasting."

The historian Hizinger (1860) was also unable to avoid describing the catastrophic pit fire and its consequences in his small book on the history of the Idrija Mine. Hizinger concluded his description with the following words: "In connection with the described pit fire, it became evident that all those persons who came into the vicinity of emitted mercury vapours were more or less shaking or had stiff limbs (Steifheit der Glieder). I should mention that the waste water was completely yellow and for this reason all the fish along the entire course of the Idrijca River died." (translation by Dr. Metka Perič, 1997).

The gravity of the environmental conditions in Idrija in 1803 and subsequent years was also reported by Pfeifer (1989). According to archival data, the mortality rate in Idrija in 1804 and 1805 increased slightly, while the birthrate decreased in comparison with previous years. Although no data are available on the direct connection between increased mortality/reduced birthrate and the fire, the occurrences in this period are characteristic and the same consequences were registered in the 1846 pit fire, which is described in more detail below.

First decade of the 19th century

The 1803 pit fire had a strong impact on excavations in the pit and, consequently, on the quantity of mercury produced in subsequent years. The annual mercury output was reduced from almost 400 tons around the year 1800 to approximately 200 tons in 1803. In the period from 1807-1809, on average around 190 tons Hg and 10-20 tons of cinnabar were produced yearly (Arko, 1931). During the French occupation, the unfavourable conditions in the pit gave the occupiers considerable difficulties in increasing Hg extraction to around 260 tons per year. After the disintegration of Napoleon's empire, Idrija was occupied by the Austrian army in October 1813. Exhausted from warfare, Austria immediately began to introduce strict cost-saving measures in the Mine's operating expenses and in its food expenses. Workers were discharged. The already extremely poor social conditions of Idrija miners worsened. The consequence of comprehensive cost-saving measures was the reduction of production to, on average, 175 tons of mercury per year in the period from 1814 to 1820.

The decrease in production by all means had a favourable effect on the environmental conditions in the Idrija region. This is evident from the published travel writings of the reputed metallurgy expert, Karsten (1821): "The smelting facilities lie approximately 1000 steps north of Idrija in the valley of the Idrijca River, along its left bank. The facility is not very large and is quite unique, work in the smeltery begins in November and continues until the end of March. The facility is not operational in

summer, as the smelting fumes would destroy the grass and crops, and would also be a reason for salivation. Moreover, the condensation of mercury vapours is quicker and more thorough in winter than in summer."

Karsten's writings indicate that there were no major environmental problems in the vicinity of the smeltery towards the end of the second and the beginning of the third decade of the 19th century. The fact that ore was burned only five months a year in this period was understandably not an 'environmental measure,' but the consequence of a strict restrictive policy imposed by Vienna due to the recession in the international mercury market. Another reason was also the very poor mining-geological conditions existing in the ore deposit at the time. Although new investigative and opening works in the pit had already been begun in 1819, the situation did not normalize until after 1823, when the entire Idrija pit was inspected by a special committee of Viennese experts, who gave instructions for further work in the pit.

The production of mercury in the period from 1820 to 1846 was relatively constant. Slightly over 160 tons of mercury was extracted annually. However, in order to maintain this constant rate of production, increasingly greater quantities of ore had to be extracted each year, as the average mercury content in ore decreased from 9% in 1820 to 2% in 1846. Approximately 1800 tons of ore was extracted in 1820 and as much as 7200 tons in 1846 (Arko, 1931; Mohorič, 1960). The burnt ore that was dumped along the banks of the Idrijca River was carried away by flooding waters and deposited in pools along the river course.

Environmental disaster caused by the 1846 pit fire

On 3rd November, 1846, a fire broke out on Hauptmann's level in the central part of the Idrija mine, claiming the lives of 17 miners (Fig. 2). As was the case in 1803, firefighters were unable to extinguish the fire with the usual measures. The fire was finally put under control after all the shafts had been closed and the pit flooded with water. On 26th November the shafts were reopened and the pit water began to be pumped from the pit. Before sending down the first miners to commence rehabilitation works, caged animals (birds and certain mammals) were lowered into the pit to determine whether the air was suitable for the entry of miners. The rehabilitation works lasted several months. Despite the four-hour workday and frequent rotations of miners in highly poisoned working areas in the pit, numerous cases of acute mercurialism were reported. A particularly extensive and detailed description of events following the 1846 fire was prepared by Arko (1931) on the basis of documents from the Mine archives.

Owing to its tragic consequences, the fire aroused considerable attention and was reported by all writers of historical discussions on the Idrija Mine (Hizinger, 1860; Arko, 1931; Mohorič, 1960). However, there were no reports of any eventual consequences in the natural environment. It is, of course, logical that steam and smoke gases containing mercury vapours were once again emitted from mine entrance shafts and mainroads. Pfeifer (1989) reported that entire families residing in the vicinity of mine entrances suffered from poisoning with Hg vapours. Eleven miners' wives were treated for salivation and tremor, which are typical symptoms of mercury poisoning. The highly polluted pit water was again released directly into the Idrijca River.

Although the number of fish killed was not as large on this occasion, the banks of the Idrijca River were coated with limonite far downstream.

Once again, the unfavourable environmental conditions caused by the pit fire led to the deterioration of the general state of health in Idrija. They also affected fertility, which in 1847 decreased substantially in comparison with the period preceding the fire. No data are available on increased mortality in this period.

Fig. 2. Tombstone to the 17 Idrija miners died in pit fire in 1846.

Struggle for recognition of the harmful effects of metallurgical activities on the natural environment

The indemnities which the Mine began to pay in 1788 to affected landowners in the vicinity of the smelting plant were abolished after the 1803 fire due to reduced production and the introduction of strict cost-saving measures. After the departure of French occupying forces from Idrija (1813), landowners in the Idrijca River valley repeatedly, but without success, filed indemnity claims in the period from 1814 to 1818. Afterwards, as the result of reduced mercury production and the performance of smelting activities only in winter, there were no more complaints about damage to livestock and crops for the next 20 years.

After 1831, the gradual rise in mercury prices on world markets led the Mine to increase its production and extend its ore-smelting activities into the spring and summer months. In 1837, landowners in the vicinity of the smeltery repeatedly began to complain about the damage caused by smelting gases to meadows, crops and livestock, but the Mine Administration refused to recognize any indemnity claims. The struggle for the recognition of indemnity claims came to a critical point in the mid 19th century. In 1848, landowner J. Leskovec and 35 cosignatories sent a complaint to the Ministry regarding the damage caused to crops and in particular livestock. The Ministry responded that the complaint was unfounded, claiming that the furnaces in Idrija allowed for the 'complete condensation of mercury.' The landowners refiled the complaint, this time requesting an analysis of the red dust accumulating on the windows, ledges and roofs of houses in the vicinity of the smelting plant. A 'precise analysis' was prepared by the Association of Pharmacists in Ljubljana. According to

its expert opinion, red dust is comprised of "a mixture of iron oxide and pitch, glass fragments, brick and plaster particles, hair and straw," which is why the dust is completely harmless (Perger, 1873). This 'brilliant' analysis prepared by Ljubljana's 'experts' was for many years used by the Mine Administration as a basis for rejecting indemnity claims for damage to crops and livestock.

During the long recession period after 1850, the Mine reduced its mercury production, which then remained relatively constant until 1866 (approximately 190 tons annually). Ore was burned only in winter. This was reported by Henty (1866), a journalist and writer who visited Idrija and its mine in October 1866: "The mercury extraction plants are located at a distance of about one mile from the town, but the furnaces are not operational at this time of year because the vapours are so poisonous that they would cause extensive damage to the vegetation and livestock feeding on it. For this reason, works are conducted only in winter, when the vapours fall on the snow cover and are not washed away until spring, when the snow begins to melt" (translation by Metka Petrič, Idrijski razgledi 47/2, 2002). Henty did not have a good opinion about the effectiveness of condensation chambers (Fig. 3), saying: "It is obviously highly deficient, as there would otherwise be much less harmful vapours spreading to the surroundings than there are now."

The rise in production in 1867 aggravated the already poor environmental conditions in Idrija, and the complaints and rightful claims of landowners for indemnity payments reappeared in the period from 1867 to 1871. The Mine Administration rejected all claims with the explanation "...that smoke affects the environment primarily with its smell" and "experience has shown that Hg vapours subside very quickly"

Fig. 3. Shaft furnace (Exeli system, 1872).

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Berg- und Hüttenwesen.

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Ueber die Schädlichkeit des Idrianer Hüttenrauches. (Fortsetzung.) — Unterirdische Wasserhaltungsmaschinen. — Die Steinkohlen Australiens. — Notizen. — Amtliches. — Ankündigungen

Abonnement
auf die
„Oesterreichische Zeitschrift für Berg- und Hüttenwesen"
für II. Semester 1873.

Mit 1. Juli begann das II. Semester. Wir erlauben uns zur Pränumeration auf dasselbe hiermit höflich einzuladen und um gefällige rechtzeitige Einsendung des Pränumerations-Betrages von 5 fl. 42 kr. ö. W. mittelst Postanweisung zu ersuchen, um in der Zusendung des Blattes keine Unterbrechung eintreten lassen zu müssen.

Die Expedition.

Ueber die Schädlichkeit des Idrianer Hüttenrauches.

Von Hugo Ritter v. Perger, k. k. Professor.

(Fortsetzung.)

Derartig gibt die k. k. Berghauptmannschaft ihrer Entrüstung Ausdruck, und vergisst dabei ganz die sonderbaren Begriffe „stinkende Wirkung" und „giftige Schädlichkeiten" im eingeholten Gutachten zu corrigiren!

Da die Klageschrift der Gemeinde von Unteridria vor Allem eine Beschränkung des Hüttenbetriebes auf die kältere Jahreszeit verlangt, so fordert die hohe Landesregierung den Vorstand des k. k. Bergamtes Idria auf, sich darüber äussern zu wollen, ob eine gewisse Beschränkung des Hüttenbetriebes durchführbar sei, ob überhaupt diesbezüglich keine bestimmten Concessionen gemacht werden könnten. Eine Rückäusserung erklärt, es sei eine Beschränkung des Betriebes aus dem Grunde ganz unmöglich, weil dadurch die Production vollständig beeinträchtigt würde. Uebrigens könnte aus jeder Concession, die das Bergamt macht, der Schluss gezogen werden, es sei die Gemeinschädlichkeit von der Schädlichkeit des Hüttenrauches selbst überzeugt. Um das Gegentheil zu bekräftigen, versucht das Gutachten der Bergwerksdirection neue Thatsachen geltend zu machen und erzählt, dass das Quecksilber erst bei 80° R. und selbst bei dieser Temperatur nur mit Hilfe von Wasserdämpfen verflüchtigt. Bekanntlich ist constatirt, Mercur kann bei jeder Temperatur über 0° R. verdampfen, ein einfaches Experiment genügt, um sich von dieser Thatsache zu überzeugen. Doch das Gutachten sagt selbst später, „wenn auch wirklich Mercur aus den Oefen entweichen sollte, so werden die Dämpfe bei 30° R. sicher sogleich verdichtet. Wäre die neue Theorie der Mercurflüchtigkeit richtig, dann könnte bei der niederen Temperatur, welche die Condensatoren haben (8° R.), nicht die Spur des flüchtigen Metalles entweichen, darin liegt ein Widerspruch, den das Gutachten nicht aufklärt. Die specifische Schwere der Mercurdämpfe ist fü den Verfasser der Rückseite eine volle Garantie für das rasch Verschwinden des Mercurs aus dem Hüttenrauche. Mit dieser Ansicht wird abermals zugestanden, der aus den Oefen kommende Rauch ist quecksilberhältig. Aber abgesehen von den Widersprüchen, ist diese zweite Theorie nicht richtig denn eine totale Sonderung des Mercurs, das im Rauche enthalten ist, von den übrigen Stoffen desselben (der Act wenn sie „gasförmigen Bittnern") zufolge des höheren specifische Gewichtes, widerspricht allen physikalischen Gesetzen.

Ganz sonderbar nimmt sich nach allen den die Mittheilung der Bergbehörde aus, nach welcher sie selbst im Hochsommer den Ofenbetrieb einstellt „zur Verminderung der Verluste" an Mercur! Nach der entwickelten Theorie verdampft das Quecksilber erst bei 80° R. und im Hochsomm

Fig. 4. Oesterreichische Zeitschrift für Berg- und Hüttenwessen (Perger, 1873).

(Perger, 1873, p. 156). Provincial newspapers wrote extensively about Idrija's environmental problems. Yet the true attention of the public was finally won by an excellent analytical article written by Prof. H. Perger in 1873. The article, comprised of seven contributions published in the specialized journal *Oesterreichische Zeitschrift für Berg- und Hüttenwessen*, informed the professional public on the critical environmental issues in Idrija (Fig. 4). Prof. Perger analyzed the long-standing 'struggle' of landowners in the nearby and distant surroundings of the Idrija smelting plant for recognition of the harmful effects of smoke gases containing Hg vapours, and their rightful claims for indemnity. He revealed the transparent, feigned ignorance of the Mine Administration, which had lasted for several decades and was supported by competent ministries and the Higher Mining Office in Klagenfurt. In a private letter sent to Perger, the Mine Administration stated ".. that it would have to formulate a theoretical opinion on the basis of scientific-chemical investigations on ore and smelting gases and that improved smelting methods would have to be introduced" (Perger, 1873, p. 297). However it was not until the early 1880s that the Mine Administration abandoned its unacceptable opinion about the harmlessness of smelting gases and in 1881 began to pay affected landowners a regular annual support in place of indemnity.

New environmental problems

As already mentioned, ore contained on average 2% of mercury in the 1840s. In the years that followed, the mercury content of excavated ore decreased rapidly, amounting to a mere 0.66% at the end of the century. In this period, however, the

Fig. 5. Smelting plant (Idrija Mercury Mine Archive, 1960).

quantity of extracted mercury increased gradually from approximately 160 to over 500 tons per year. Such an enormous rise in production naturally called for the continuous modernization of smelting procedures, the acquisition of additional furnaces and the intensified excavation of ore. In the 1840s only 7000 tons of ore was burned, while at the end of the century approximately 88,000 tons of ore was processed annualy. All burnt ore was deposited along the banks of the nearby Idrijca River, which inevitably worsened its already poor environmental conditions (Fig. 5). The pollution of the Soča River and the Gulf of Trieste with mercury also intensified. The gradual pollution of the environment with increasing quantities of burnt ore continued until the 1970s, when the dumping of smelting remains into the Idrijca River was finally prohibited.

The relocation of smelting furnaces (Fig. 6) to the right bank of the Idrijca River was conducted gradually up to the year 1880. A chimney was also built high above the smelting plant, on the slopes of Golica hill. Although this improved the environmental conditions in the direct vicinity, the constant winds spread the smelting gases far along the Idrijca River valley and, in poor weather conditions, the entire Idrija basin was covered with smoke. Today, attic dust and soil have been found to be considerably polluted for at least 10 km along the Idrijca River (Gosar & Šajn, 2001).

In the second half of the 19th century, the increased scope of mercury production opened a new problem, the sinking of ground above the Idrija Mine. This was not a negligible problem, as the greater part of the mine lay directly below the populated borders of the town. The first houses and mine buildings on the broader territory of Barbara's wood storehouse, Smukov grič (Mine hill) and the Pront had to be demol-

Fig. 6. During high waters, the Idrijca River carried away the burnt ore deposited on its banks (Idrija Mercury Mine Archive, 1970).

ished at the end of the 19th century. "In 1912 Theresa's shaft was backfilled and the large chimney was demolished because the hill is sinking" (Arko, 1931, p. 249). The sinking of ground above the pit was particularly intensive in the 1970s and 1980s, as in some areas it amounted to as much as 10 cm per year. Following the discontinuation of works in the pit and the commencement of shutdown works in 1988, the sinking of ground is gradually stabilizing and today amounts to approximately 17 mm per year. The demolition of sinking houses was continued up to the 1990s and is not yet completed.

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