

## Current and Past Mercury Distribution in Air over Idrija Region

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**Abstract:** Mercury in air over Idrija region decreased significantly in last decade. Air concentration of Hg was continuously monitored after Hg mine closure. Hg<sup>0</sup> in air was mapped in November 2003 at over 100 locations in Idrija region during three-day period at different weather conditions. Concentrations were between 2.5 ng/m<sup>3</sup> to over 2000 ng/m<sup>3</sup>. The highest values were observed in near vicinity of former smelting plant as well under its chimney. Elevated concentrations were also observed at some other locations in Idrija town.

**Key words:** air, Idrija, Hg mine, smelting

### INTRODUCTION

In over 500 years of Hg mining history in Idrija over 12 millions tons of Hg ore was excavated from which 100.000 tons of Hg and 7618 tons of cinnabar was extracted (MLAKAR AND DROVENIK, 1971; MLAKAR, 1974; CIGALE, 1997). During smelting of Hg ore more than 35000 tons of Hg was lost into environment mostly to atmosphere as Hg<sup>0</sup> vapors or it was deposited into Idrijca River or on its riverbanks as smelting residue. High Hg concentrations were found in all environmental compartments such as water, air, soil, sediments and vegetation. First extensive research on Hg cycling in Idrija town and its vicinity started in early seventies of past century (KOSTA ET AL., 1974). At the beginning of eighties Hg production rapidly decreased which resulted on investigations on Hg cycling in Idrija. In eighties very few measurements of Hg concentrations in air or

other environmental compartments have been done. After 1990 V. Miklavčič and M. Horvat started with intensive Hg measurements in air over Idrija. In 1994 GOSAR (1996) and coworkers started with first geochemical mapping of Hg concentrations in air. In last decade many researches on Hg is on going. Hg cycling is studied in whole environment together with its impacts on humans and their health.

### RESULTS AND DISCUSSION

In the beginning of mining activities in Idrijca valley (1490-1508) only carboniferous schist with elemental Hg was excavated. Hg was extracted by panning. It is estimated that about 180 tons was lost to environment mostly to Idrijca River. After discovery of cinnabar ore (1509-1785) panning was completely replaced by smelting the ore in simple clay ves-

sels. The Hg ore was smelted on several locations around Idrija, until 1652 new smelting plant was built on left Idrijca River bank. Smelting residues were dropped into Idrijca River. The smelting recovery was 65 %. It is estimated that in that period around 13,000 tons of Hg was lost into environment, mostly to atmosphere and into Idrijca River. In 1787 new smelting furnaces have been built. Until the end of Second World War smelting furnaces have been changed several times. In that period recovery was 75 %, most Hg (around 20,000 tons) was lost into atmosphere, and some of it, sank into ground or dumped as a product into Idrijca River. In

1963 new modern rotation ovens were built. Smelting recovery increased to 92 %. Smelting residues contained 0,005 % (Figure 1). In a period between 1960 to 1995 more data about Hg production and smelting recovery exist (Figure 2). During that period  $4,2 \times 10^6$  tons of Hg ore was excavated from which 9777 tons of commercial Hg was produced. About 243 tons of Hg has been lost into environment. From that amount 168 tons of Hg was deposited in landfill as smelting residue, 60 tons was emitted into atmosphere by flue gases and 15 tons of Hg was released to Idrijca River by condensation water. In 1995 last rotary oven stopped.

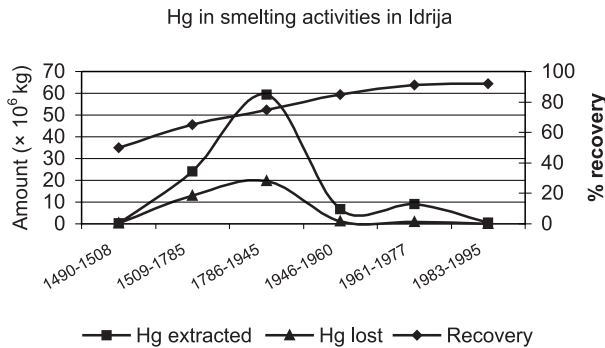


Figure 1. Hg losses during smelting activities in Idrija.

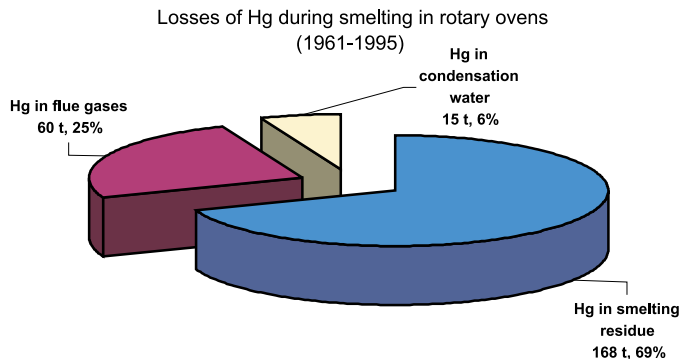


Figure 2. Losses of Hg during smelting of Hg ore in period between 1961 to 1995.

High emissions of Hg into environment resulted in elevated levels of Hg in all parts of the environment in Idrija Valley. In early seventies, when Hg production was the highest, Hg concentration in air in Idrija town could reach even 20.000 ng/m<sup>3</sup> (KOSTA ET AL., 1974) (Figure 3). In late 70's and 80's Hg concentrations in air in town decreased rap-

idly to values below 100 ng/m<sup>3</sup> with the same trend of Hg production. Hg concentration reached levels over 1000 ng/m<sup>3</sup> in 1995 by smelting of heavily contaminated soils and residue material. After that time Hg concentration in air decreased dramatically and reaches level of 10 ng/m<sup>3</sup> or even lower at the end of year 2003.

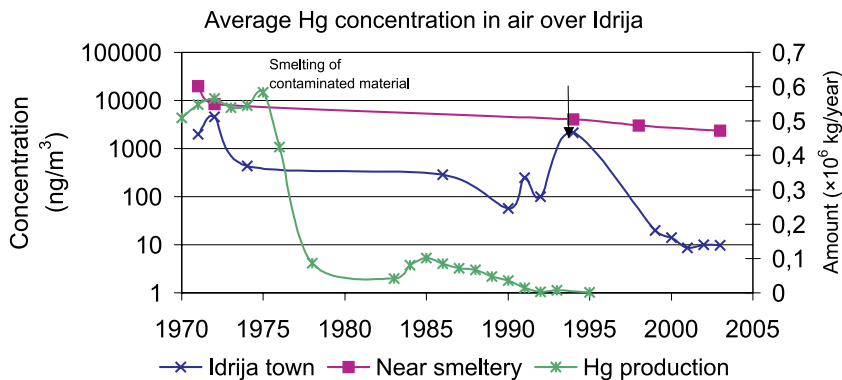


Figure 3. Average Hg concentrations in air in Idrija Town in period 1970-2003.

As a consequence of smelting activities all former smelting plant surroundings is heavily contaminated by Hg. Since beginning of 70's Hg concentration in air near smeltery decreased significantly but still remains high and can reach even today value of 3000 ng/m<sup>3</sup>.

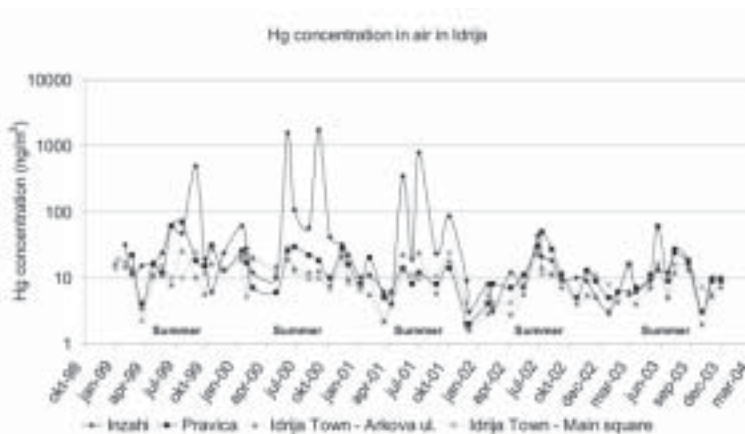


Figure 4. Hg concentration in air near ventilation shafts of Hg mine and in Idrija Town.

Nowadays main sources of Hg in air in Idrija are two still active mines' ventilation shafts, evaporation of Hg from heavily polluted surroundings of former smelting plants, mineralized rock dumps of primary or partially exploited ore, outcrops of the ore deposit, and ore residues treated in various ways (ČAR, 1996).

After the Hg mine and smeltery closure, Hg concentrations in air have been continuously monitored at several locations in Idrija and its surroundings. Monitoring is mostly per-

formed by Hg mine laboratory. Concentrations are measured once per month.

On Figure 4 Hg concentrations in air at some locations in Idrija are presented. Since 1998 only near Inzaghi ventilation shaft, Hg concentrations exceed  $100 \text{ ng/m}^3$  and even in two cases  $1000 \text{ ng/m}^3$ . General trend is at all four locations the same. Higher concentrations have been observed in summer, probably due to higher temperatures and higher evaporation rates. Second cause for higher summer concentrations can be that summers are usually less windy than other year periods.

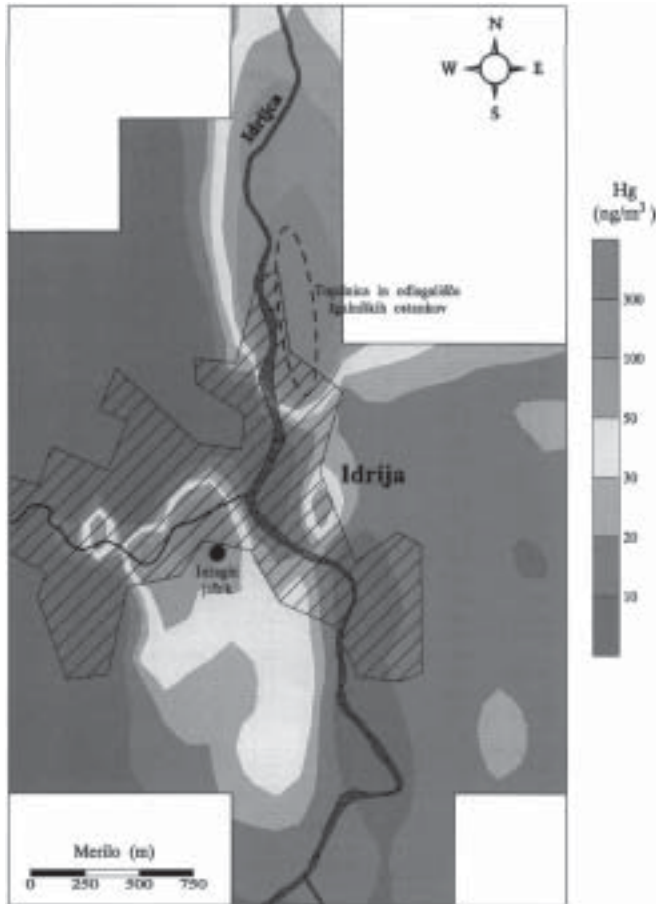


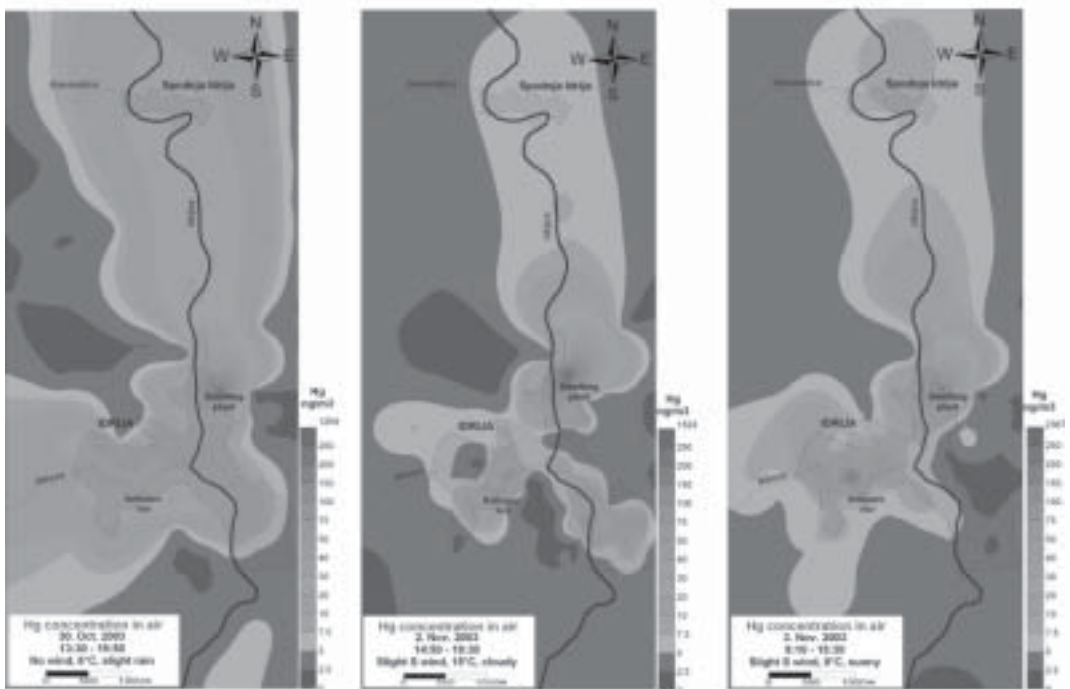
Figure 5. Hg concentration map in air obtained by GOSAR ET AL. in 1994 (1996)

At the end of October and at the beginning of November 2003 Hg concentrations in Idrija and its surroundings were detailed measured. Mercury mapping in Idrija Valley was obtained using two different approaches. Approach by differential absorption lidar technique is detailed described by Groenlund et al. (this issue). Second approach was performed by portable absorption spectrometer installed in car together with GPS. Hg concentrations were measured at more than 100 locations in Idrija and its surroundings (Figure 6). Similar mapping was performed by GOSAR ET AL. (1996) in 1994 (Figure 5). The comparison of results obtained in 1994 and 2003 shows similar spatial distribution but much lower concentrations in 2003. Hg concentration in air in Idrija and surrounding was mostly below

10 ng/m<sup>3</sup>. Near former smelting plant Hg concentrations increased rapidly, even up to 3000 ng/m<sup>3</sup>. It seems that former smelting plant remains main source of Hg in air over Idrija Valley.

## CONCLUSIONS

In last decade, after the last operation of smelting plant, concentrations of Hg in Idrija decreased rapidly and reached levels from more than 1000 ng/m<sup>3</sup> values below 10 ng/m<sup>3</sup>. There are some locations around ventilation shafts, natural outcrops and near former smelting plant where concentrations remains high. It seems that after more than 500 years of continuous polluting by Hg, Idrija and its surrounding slowly recover.



**Figure 6.** Hg concentration maps in air in Idrija and its surrounding.

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