

Results of urine and blood from residents around the Copper Smelter Complex, Tsumeb, Namibia: An example of anthropogenic contamination

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Abstract. A study of urine and blood samples in 154 and 148 individuals respectively from the Tsumeb area has revealed that there is a direct link between Pb, As, Cd contaminated soils and the levels of these heavy elements in the two selected media. The city of Tsumeb had been a producer of Cu and Zn since 1899 until 1999 when the operation closed. During this period the local smelter produced smoke and fumes that contained among other elements, of note were Pb, Zn, Cu, Cd, As and Co. Upon closure in 1999, the smelter continued to process copper ores from Otjihase, Kombat and Matchless mines. Thereafter in 2006, the smelter began to accept copper ores from beyond Namibia's borders. The effects of the smelter complex was observed in elevated concentrations of the mentioned heavy elements in soils around the town. Pathways of these elements into the human body has been determined as through dust and eating vegetables grown on contaminated soils.

Keywords. Arsenic, lead, cadmium, blood, urine, contamination

1. Introduction

Tsumeb had been a mining town since 1899, when the copper and lead ores were earmarked for mining. In 1907, a smelter was erected and became the source of major anthropogenic pollution. The smelter was replaced by another one in the years 1960-62. By that time Tsumeb had established itself as a major mining town in the then South West Africa. Mining ceased in 1999, when Tsumeb Corporation Limited closed the underground workings. However, the smelter has since been refurbished to modern standards and continues to smelt copper ores from afar fields such as Chile, DRC and Zambia.

This smelting of ores produces fumes which contain some elements deleterious to health, which this paper discusses. The concentration of these ores in soils is a source of direct pollution as a result of either dust generated by children playing or vegetables grown in the soils. This has since been proven in studies conducted by Kribek et al. (2004), Ellmies et al. (2007) and Hahn et al. (2008). In these studies, it was shown that soils are highly contaminated by such metals as Zn, Cu, Pb, As, Cd, and Co, emanating from the roasting of ores in the

smelter. The study by Ellmies et al (2007) showed that dust and vegetables were the main pathways for the ingestion of heavy metals in the human body.

This work was specifically done to see how the soil and vegetable contamination correlated with residents in those particular areas of Tsumeb. The map of Tsumeb that is contaminated with Pb is shown in Figure 1. Other thematic maps for Cu, As, Zn, Co were also constructed and showed almost the same pattern.

2 Methodology and Results

The Tsumeb area has been established to contain contaminated soil samples around the area west of the smelter complex. The results of a medical test programme of Tsumeb residents are presented. A total of 154 urine samples and 148 blood samples were collected with the assistance of Tsumeb hospital. The blood samples were analysed for lead and cadmium by AAS and the morning urine samples for arsenic and cadmium by ICP-OES. More than a fifth of the investigated residents of Tsumeb showed lead concentrations in blood exceeding the WHO guideline value (10 µg/dL). The highest values for lead in blood (maximum value 55 µg/dL) exceed the WHO limit by more than five times. Statistics show that every sixth surveyed person exceeds the WHO guideline value for arsenic concentration in urine. The highest detected arsenic concentration in urine of 443 µg/L exceeds the WHO limit of 50 µg/L by almost nine times. Nearly all cadmium values in blood were below the detection limit of 0.1 µg/L. The creatinine-adjusted cadmium concentrations in urine with the exception of two cases did not exceed the guideline values. The analytical results correlate for lead in blood and arsenic in urine. Residents with anomalous high concentrations are mainly confined to Tsumeb-Nomtsoub suburb to the west and the industrial zone to the north of the town. Residents of the Transnamib Hostel just opposite the old smelter show the most critical values. The anomalous values could be attributed to inhalation of contaminated dust as well as the contact with contaminated soil and the consumption of contaminated crops as these parts of Tsumeb are more exposed to dust fall-out from the smelter complex than

the central and southern parts of the town.

In Figure 1 we show the distribution of residents with Pb levels above the WHO limits. These locations in Figure 1 correlate with the contamination plume in Figure 2.

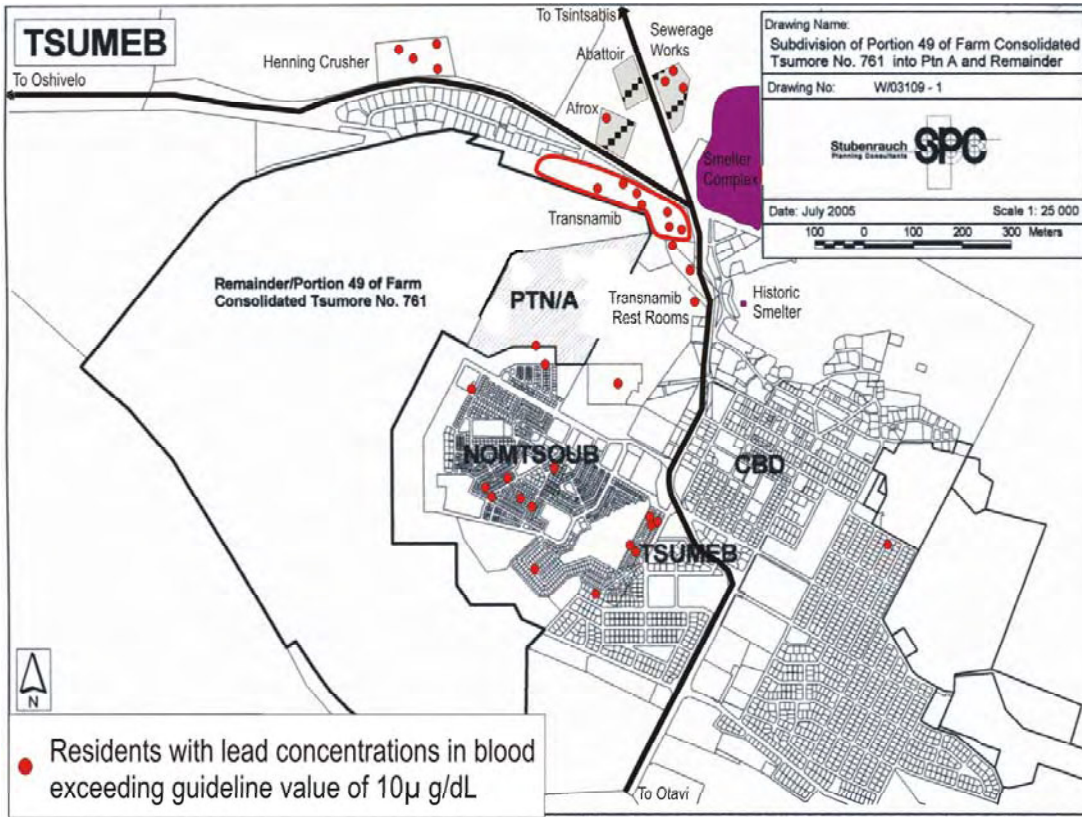


Figure 1. Residents with Pb concentrations exceeding 10 micrograms per decilitre (after Hahn et al., 2008).

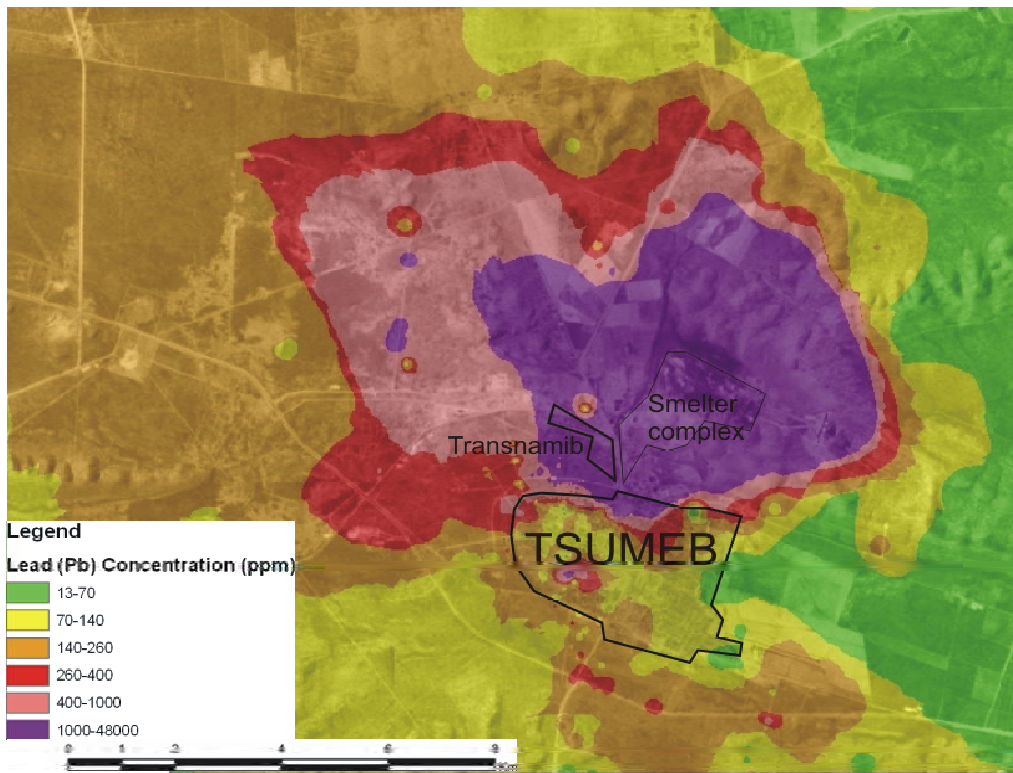


Fig. 2. Lead contamination of surface soils around the Tsumeb smelter (GSN, 2007).

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