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CONCENTRATION OF ZINC AND LEAD IN THE SOIL AROUND A NON-FERROUS METAL SMELTER KGH "BOLESŁAW" IN BUKOWNO NEAR OLKUSZ

B. Palowski, T. Kimsa, E. Sierka-Koper, R. Ciepał, I. Łukasik

Department of Ecology, Silesian University, Jagiellońska 28, 40-032 Katowice, Poland

A b s t r a c t. The objective of the study was to evaluate zinc and lead contamination in the upper, organic layer of the soil around zinc and lead smelting plant KGH "Bolesław" in Bukowno near Olkusz.

The study material were samples of the upper layer (0-5 cm) of the soil collected at the distance of 10, 25, 50, 100, 150, 200, 250 m, and further from each of the 250 m up to 3 000 m sections in 8 directions: N, NE, E, SE, S, SW, W, and NW.

The most contaminated soil samples were found at the distance of up to about 1 000 m from the subject plant. The most polluted is the NE and SW area. Pollution of the NE area is related to wind direction. The SW area could be a zinc and lead ore outcrop, or else, it was contaminated when used as a dumping ground for the waste from the plant in the past. Heavy pollution of this area with zinc and lead could cause serious damage to living organisms in the area close to the plant.

K e y w o r d s: zinc, lead, soil, smelting plant, contamination.

INTRODUCTION

Industrialisation and economical growth does not only mean progress of civilisation. It is often harmful to environment because of various "by-products". The most unfavourable are the processes of zinc and lead smelting due to gas and heavy metal emission during ore processing. Air pollution affects soil and plants as documented in a number of studies [4,8-10]. Some elements emitted into atmosphere are then accumulated in soil and plants. There is a general concern if the contaminated areas will be able to recover from the pollution induced damage. Heavy metals are cumulated mostly in the organic layer of forest soils, e.g. lead is deposited in the upper 20 cm [1,5]. It is so as its activity and sorption on clay minerals and organic matter is low. Centuries or millennia are necessary to clean the upper layer of the soil from such elements as: lead, mercury, cadmium and others

[1,7]. Because of that, soil degradation does not stop when smelting is finished or when technology is improved.

A lead and zinc smelting plant KGH "Bolesław" in Bukowno near Olkusz was founded in July 1952. The plant produces about half of zinc and lead smelted in Poland. The ore comes from the neighbouring mines of "Olkusz" and "Pomorzany".

The objective of the study was to evaluate zinc and lead contamination in the upper, organic layer of the soil around zinc and lead smelting plant KGH "Bolesław" in Bukowno near Olkusz.

MATERIAL AND METHODS

The study material were samples of the upper layer (0-5 cm) of the soil collected at the distance of 10, 25, 50, 100, 150, 200, 250 m, and further from each of the 250 m up to 3 000 m sections in 8 directions: N, NE, E, SE, S, SW, W, and NW.

The soil samples were then air dried, passed through a sieve (1 mm mesh), and extracted with 0.1 N HCl [3]. After filtration, zinc and lead concentration was measured by the atomic absorption spectrometry (AAS). Each soil sample was prepared in 3 repetitions and the results were calculated as arithmetic mean values. Accuracy of the analytical procedures applied was monitored with a set of samples with known values [6].

RESULTS AND DISCUSSION

Zinc is an essential element for living organisms. The "natural" Zn content in the soil is 30-125 μg/g of soil [1]. In the non-contaminated regions of Poland, it is about 40 μg Zn/g of soil. But in the polluted industrial regions, the reported content was more than ten thousand μg Zn/g of soil [2,7,11].

The highest Zn concentration was 8777 μg Zn/g of air dry soil (Fig. 1). It was found North-East of the plant. The NE and SW areas were the most contaminated (Fig. 2) with zinc.

When the level exceeds 200-300 μg Zn/g of soil, it could impair plant growth [7,9]. The above level of zinc content was exceeded in about 50% of the examined soil samples.

Lead is considered as redundant or toxic for living organisms. The "natural" content of Pb in the soil ranges from 25 to 40 μg Pb/g of soil. The most commonly found Pb level in non-contaminated Polish soils is about 18 μg Pb/g of soil. However, close to some plants it could reach up to 5 000 μg/g of soil [1,7,11]. The highest concen-

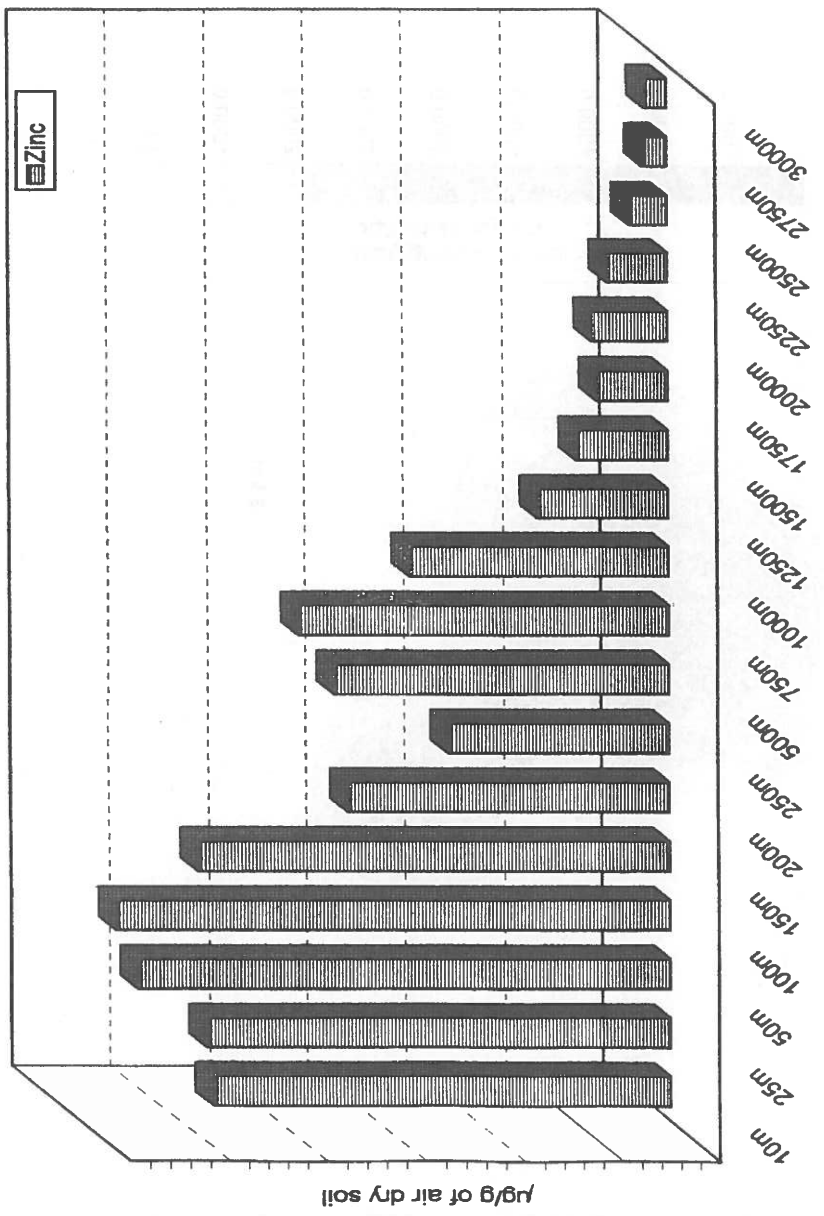

Fig. 1. Mean zinc content in the soil in the vicinity of KGH "Bolesław" in Bukowno (µg Zn/g of air dry soil).

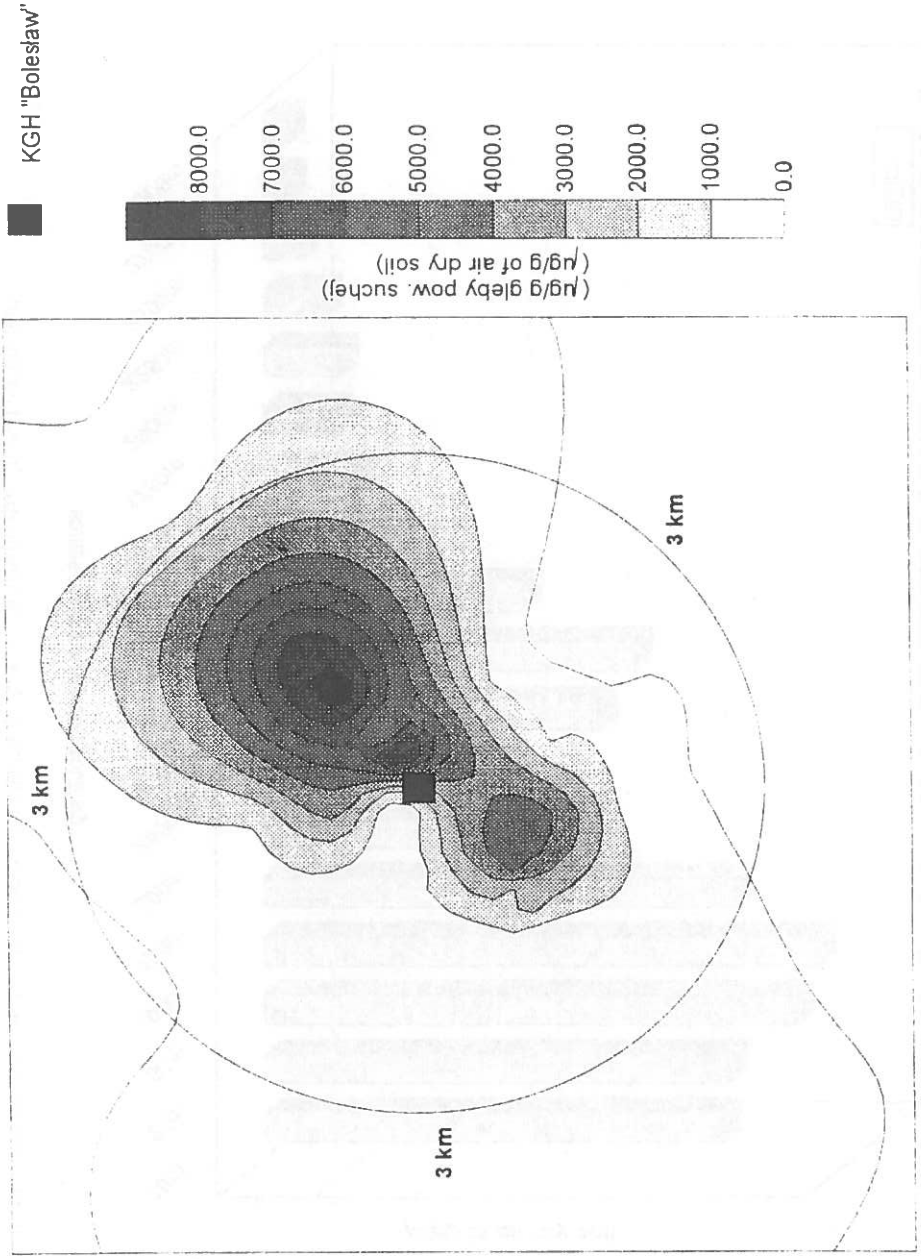

Fig. 2. Zinc distribution in the upper layer of the soil in the surroundings of KGH "Boleslaw" in Bukowno.

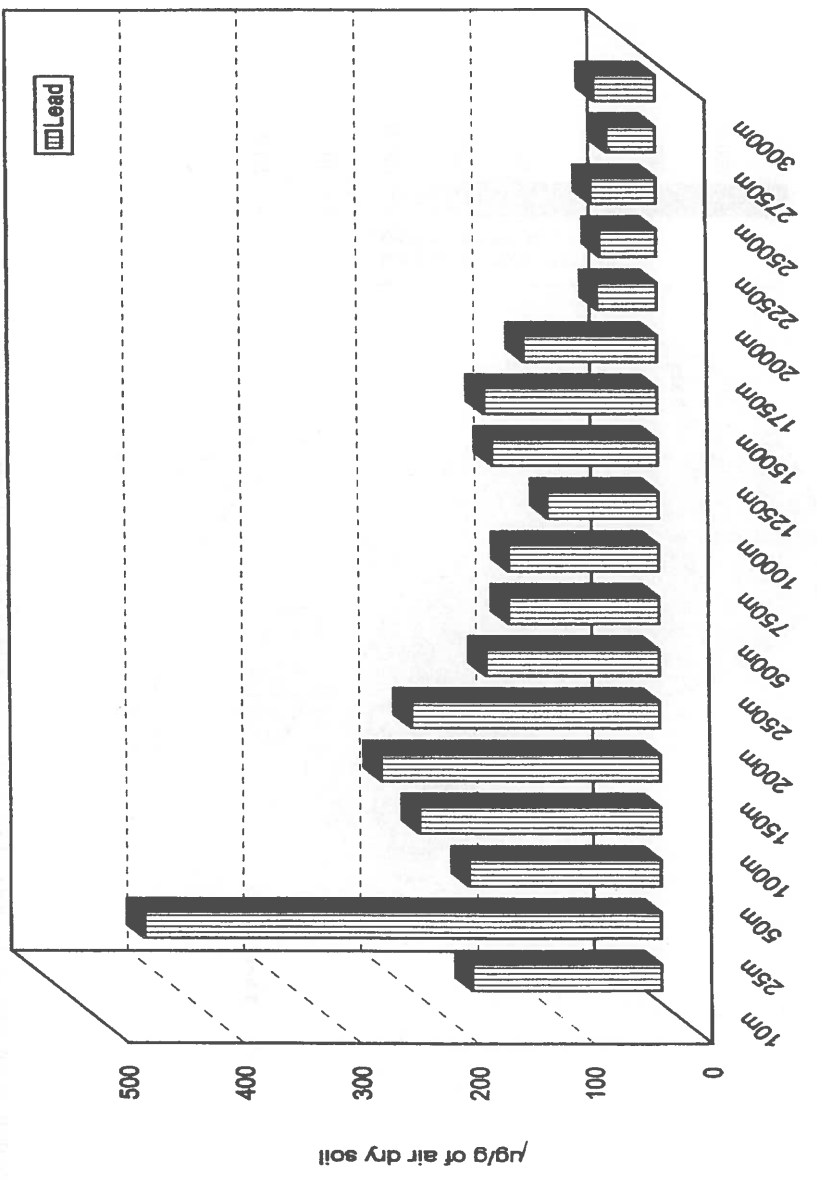

Fig. 3. Mean lead content in the soil in the vicinity of KGH "Bolesław" in Bukowno (µg Pb/g of air dry soil).

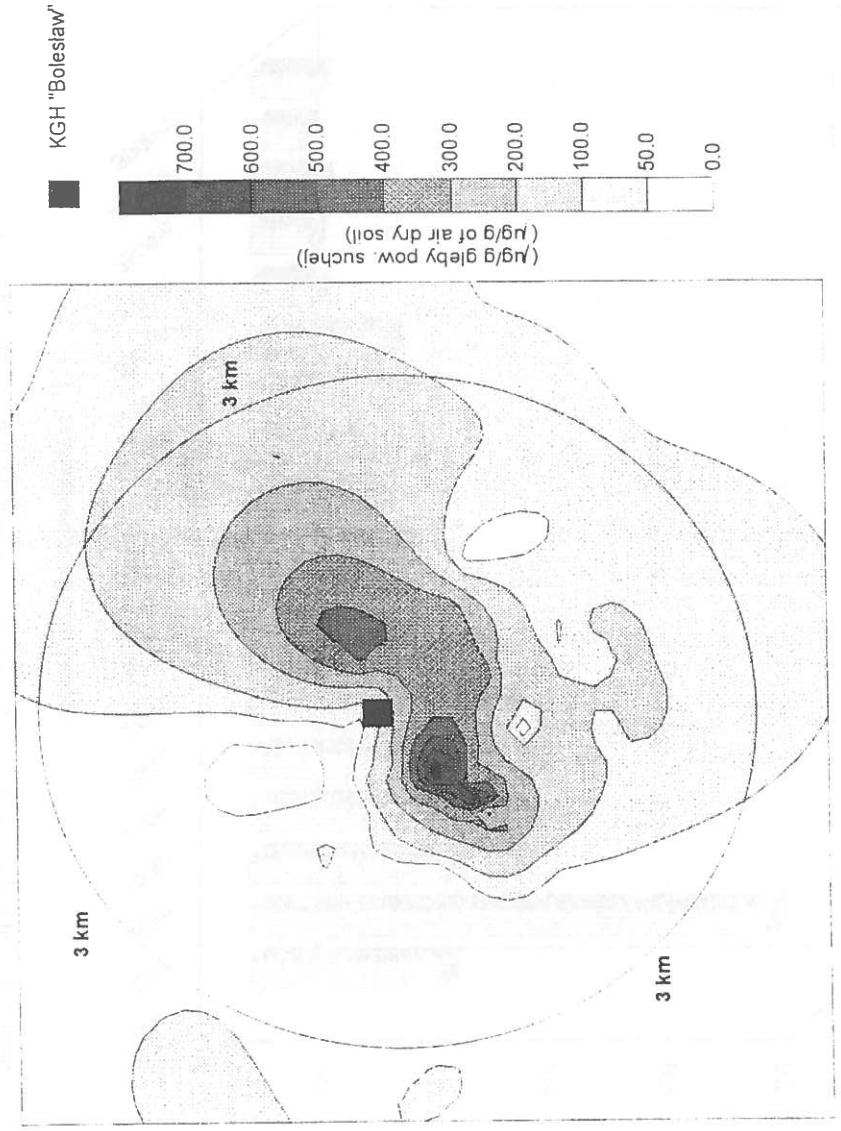

Fig. 4. Lead distribution in the upper layer of the soil in the surroundings of KGH "Bolesław" in Bukowno.

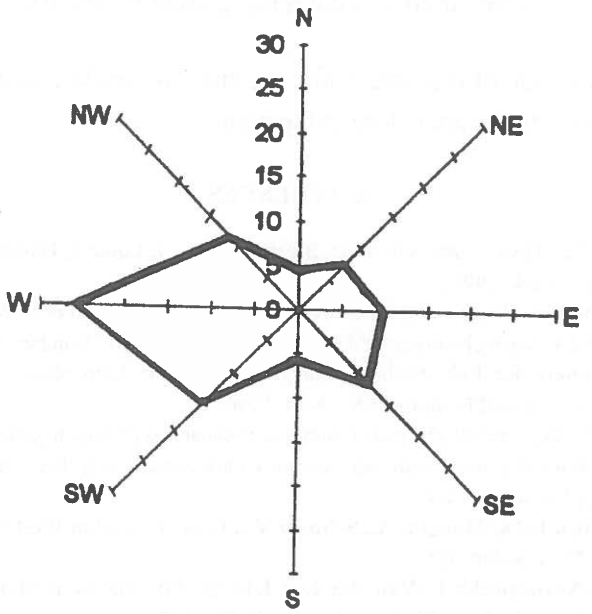

Fig. 5. Wind rose in Bukowno (1961-1994). Data from IMGW Katowice.

tration (1025 μg Pb/g of soil) was found 25 m away from the subject plant (Fig. 3). Lead distribution was the highest in the NE and SW direction (Fig. 4) from the plant.

Dust distribution around an emitter depends on grain-size composition, and direction of wind. The highest zinc and lead content was found NE and SW of the lead and zinc smelting plant. Contamination of the NE area is probably the result of wind in Bukowno (Fig. 5). The reason of heavy pollution of the SW area is not so clear. It could be "natural" in this region, but more probably that it is due to some former man-made changes, e.g. storage of wastes from the zinc and lead smelting processes in the past.

Such a heavy soil contamination with lead and zinc could be the reason for soil degradation and some impairment in the flora, fauna and human population.

CONCLUSIONS

1. The most contaminated soil samples were found at the distance of up to about 1 000 m from the subject plant.

2. The most polluted is the NE and SW area. Pollution of the NE area is related to wind direction. The SW area could be a zinc and lead ore outcrop, or else,

it was contaminated when used as a dumping ground for the wastse from the plant in the past.

3. Heavy pollution of this area with zinc and lead could cause serious damage to living organisms in the area close to the plant.

REFERENCES

1. **Alloway B.J.:** (Ed). Heavy Metals in Soils. Blackie, Glasgov, London, Halsted Press, John Wiley & Sons, Inc., New York, 1990.
2. **Angelone M., Bini C.:** Trace elements concentrations in soils and plants of Western Europe. [In:] Adriano D.C. (Ed.) Biogeochemistry of Trace Metals., Lewis Publ., London, Tokyo, 19-60, 1992.
3. **Barona A., Romero F.:** Relationships among metals in the solid phase of soils and in wild plants. Water, Air, and Soil Pollution, 95, 59-74, 1996.
4. **Ciepał R.:** Kumulacja metali ciężkich i siarki w roślinach wybranych gatunków oraz w glebie jako wskaźnik stanu skażenia środowiska terenów chronionych woj. katowickiego. Prace Nauk. Uniw. Śląskiego, Katowice, 1999.
5. **Dorr H., Munnich K.O., Mangini A., Schmitz W.:** Gasoline lead in West German soils. Naturwissenschaften, 77, 428-430, 1990.
6. **Houba V.J.G., Novozamsky I., Van Der Lee J.J.:** Quality aspects in laboratories for soil and plant analysis. Comm. Soil Sci. Plant Anal., 27(3,4), 327-348.
7. **Kabata-Pendias A., Pendias H.:** Biogeochemia pierwiastków śladowych. PWN, Warszawa, 1999.
8. **Markert B., Wtorova V.N.:** Concentration cadaster of chemical elements in plants of Eastern European forest ecosystems. Biology Bull., 22/5, 453-460, 1995.
9. **Ross S.M.:** (Ed.) Toxic Metals in Soil Plant Systems. John Wiley & Sons, Chichester, New York, Brisbane, Toronto, Singapore, 1994.
10. **Sawicka-Kapusta K.:** Reakcje roślin na dwutlenek siarki i metale ciężkie w środowisku - bioindykacja. Wiad. Ekol., 34, 3, 95-109, 1990.
11. **Terelak H., Stuczyński T., Motowicka-Terelak T., Piotrowska M.:** Zawartość Cd, Cu, Ni, Pb, Zn i S w glebach województwa katowickiego i Polski. Arch. Ochr. Środ., 23/3-4, 167-180, 1997.