Environmental risks associated to wind erosion in a metal mining area from SE Spain

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ABSTRACT

Soils and mining wastes from the Mediterranean mining area placed in the Sierra Minera Mountains are highly enriched in heavy metals such as lead and zinc, but also other metals such as cadmium and arsenic. Wind erosion in this area could be considered extremely high and hazards associated to this eroded sediments seems to be high because the huge amount of metals present in this wastes.

Therefore, combination of high erosion rates and high metal concentration in this mining waste, make those environmental risks can be considered high for the surrounding ecosystems, but also for public health of the nearby villages and towns.

In order, to study these wind erosion processes over these mining materials, some experiments for the evaluation of the transportation of soil particles were carried out. Erosion rates in this realm is particularly important during spring months, when increased activity of the eastern winds brings intense soil dragging, with strong effects on the metals dispersion, including the massive removal of sediments.

Keywords: wind erosion; lead; zinc; SE Spain; mining wastes

INTRODUCTION

Lead and zinc are two of the most common toxic elements found in mining and industrial areas, and constitutes, mainly lead, one of the main concerns regarding human health. Degradation of mining soils, because of pollution or direct destruction of soils, it is one of the main problems presented in many regions of the world exposed to intensive mining activity (Alfaro and Gomes, 2001). In this work it was aimed to study the metal enrichment of wind dust in a mining area place in SE Spain.

Mining activity in SE of Spain, in the west Mediterranean, originated more than two millenniums ago. It has generated huge areas affected by heavy metal contamination, especially by lead, which is possibly one of the most important environmental pollutants. The high erodibility, together with the enrichment in heavy metals of the sedimentary mining structures determine a high risk of pollution in subsidiary areas by these soils and sediments (Gomes et al., 2003). These risks are associated basically to hydric and wind erosion.

The "Sierra Minera de Cartagena-La Union" has severe environmental problems regarding heavy metal contents in the water sediments, but also in the wind dust (García et al., 2004). Water, but also wind erosion, is the most important factors that are increasing the risks on the surrounding ecosystems, but also on the public health of the nearby villages and towns as well.

Very little previous data is available on the incidence of the wind erosion and pollution coming from the mining area, surrounding ecosystems and public health. Nevertheless, wind erosion in this area could be considered extremely high and hazardous because the high amount of metals transported by wind (Moral Robles, 2005; Moral Robles et al., 2005). Regarding this, not many studies have been done around the world concerning this problem. Therefore, this research tries to make an innovative contribution on this topic.

Heavy metal contamination in the "Sierra Minera de Cartagena-La Unión", in both water and sediments, has been assumed to be related to the mining wastes that can be found all over the area (García, 2004). In this mining district there are a lot of mining ponds susceptible to erosion, but also high amounts of mining wastes are spread over the surroundings. As a consequence of the extra active mining processes, based on the extraction and treatment of lead and zinc sulphides, galenite and sphalerita respectively, all these mining materials are extremely enriched in toxic heavy metals, such as Pb and Zn (Manteca y Ovejero, 1992). Nevertheless, in contrast to other mining areas (Higueras et al., 2003), contamination in this area is mainly provoked by anthropogenic processes.

MATERIAL AND METHODS

The "Sierra Minera de Cartagena-La Unión" deposits and alteration zones occur within a mountainous landscape in the border of the Mediterranean Sea, and close to a flat area, "El Campo de Cartagena-Mar Menor" of great importance by the agriculture, fisheries and tourism. This area comprises of peaks under 400 m. Precipitation in this coastal realm is about 304 mm (average of 70 years), with a minimum of 113 mm in 1968 and a maximum of 423 mm in 1969, and average temperature is 17.5 ºC (Moral Robles et al., 2005). Wind is an important phenomenon in this area and the main direction varies for each season. The main directions are E-NE, followed by SW and NW.

To evaluate wind erosion and the pollutants associated to air particles, a special tool is needed, a field collector. Several devices useful for these purposes have already been cited by other authors (Goossens & Offer, 2000; Höke & Burghardt, 2001). Nevertheless, these instruments have been mainly designed for evaluating atmospheric pollution in industrial places and, besides, found to be quite expensive and not easily available. Regarding this, it has been considered of interest to design a specific tool for evaluating sediment wind transport in mining areas under semiarid conditions. For that reason, a specifically designed multicollector has been checked under field conditions for evaluating wind erosion in this mining area.

In order to evaluate the toxicity of these sediments, total content was evaluated for the most common and toxic heavy metals of this area, lead and zinc (García, 2004; Peñas et al., 2004). For that, a nitric-perchloric digestion was made, and measured, after filtration, by Atomic Absorption Spectrometry (UNICAM 969) and ICP-MS (Agilent 7500a), with detection limits of 1 ppm for Pb and Zn for the first case, and of 1 ppb when analysis was made using the ICP-MS device. Up to two sampling stations were installed. One of them was placed in mining ponds, and the second one in a natural area (control sampling station).

RESULTS AND DISCUSSION

In mining areas, sediments are full of heavy metals, not only bounded to fine soil fractions, but also to coarse grains (Sterk et al., 1999), with an average values close to 0.7 % of total weight for zinc and close to 0.5% for lead. In the studied case, although only 3-4% of the collected dust were clays, and so with a grain size under 2 μm, there were huge amounts of heavy metals present. This fact seems to indicate that higher grain sizes could be a consequence of cementation of clay and silt grains by iron oxides and hidroxides, or to salt crusts bits plenty of metals (Langston & McKenna Neuman, 2005).

As shown by the AAS and ICP-MS studies, there is not a remarkable association between the sediments weight and lead and zinc content. Regarding this, the analyses of the mineral grains samples display contents of Pb and Zn are not much different, which suggests that the metal distribution on air dust derived from almost the same soil materials for all the directions.

Related studies of this mining area revealed the presence of lead and zinc in this zone (García et al., 2005). Therefore, lead and zinc are enriched or extremely enriched in the sediments and soils of this area. Lead and zinc are enriched up to an average factor of 139 to 932 for Pb, and of 96 to 703 for Zn, compared to normal soil and sediments (Kabata-Pendias and Pendias, 1992). Both lead and zinc are particularly enriched in the mining sediments and wastes that have been stored in mining ponds.

CONCLUSIONS

Extremely high heavy metal values have been collected for this mining area for all the directions, which suggests that the metal distribution on air dust derived from almost the same soil materials for all the directions. The most important metals are zinc and lead, showing values of 6.826 mg kg–1 and 4.546 mg kg-1, respectively. These heavy metal contents mean that at least 1.13 % of all the sediments are pure heavy metals. It involves an extremely high risk of atmospheric pollution but also for surrounding areas.

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