SEDIMENTS POLLUTION WITH HEAVY METALS. CASE STUDY: BAIA MARE MINING AREA.

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ABSTRACT. Sediments pollution with heavy metals. Case study: Baia Mare mining area. The purpose of this research was to assess the degree of sediments contamination with heavy metals. In December 2013, 8 sediments samples were collected from several areas from Baia Mare. Each of the collected sediment samples was analyzed for pH, redox potential (ORP), electrical conductivity (EC), total dissolved solids (TDS) and salinity with a portable multiparameter (WTW 3210i). In laboratory, using an ICP-OES, all the sediment samples were analyzed for iron (Fe), nickel (Ni), chromium (Cr), cobalt (Co), copper (Cu), zinc (Zn), cadmium (Cd), lead (Pb), and manganese (Mn).According to Romanian legislation the level of Cd, Cu, Pb and Zn exceeded the maximum permissible limit (0.8 mg/kg, 40 mg/kg, 85 mg/kg and 150 mg/kg).Heavy metals are not removed from aquatic ecosystem by self purification and they can accumulate in suspanded particulates and sediments, as a consequence they are a real threath for the human health and ecosystem via food chain accumulation.

Keywords: sediments, heavy metals, Baia Mare, mining area.

1. INTRODUCTION

Consumption of material consisting of mineral compounds (stone or metal) showed a significant increase with the development of human civilization. It is very important because this development leads to an economic and social development (Costin and Vlad, 2008).

Europe has a long tradition in the mining industry, being rich in natural resources (www.euromines.org). In order to benefit from the subsoil natural resources the human society and the environment have to pay for it because mining activities have a negative impact on the environment (Baciu, 2007; Filip, 2008). Recently, the number of studies focused on the heavy metal pollution in sediments have increased all over the world (Hu et al., 2013; Deng et al., 2014; Tang et al., 2014; Ali et al., 2015).

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There are few studies published on heavy metals content in river sediment in mining areas from Romania (Bird et al., 2003).

In order to cover the lack of information in the scientific national literature on heavy metal contamination in sediments from Baia Mare area and also to keep up with new international trends in the field, the main purposes of the present study were: (1) to perform analysis of nine heavy metals (Cd, Cr, Cu, Co, Pb, Ni, Zn, Mn and Fe) content in sediments samples collected from Baia Mare mining area (NW Romania) and (2) to evaluate the heavy metals distribution and to identify hot spot areas. The analysed metals, have the density higher than 5 g/cm^3 and the atomic number higher than 20, as a consequence they are classified as heavy metals (Dinis and Fiuza, 2011).

2. STUDY AREA

Baia Mare town is located in the western part of the Maramures County, in Baia Mare Depression, along the Sasar River, at the foothills of Gutai Mountains (Bălănescu et al., 2002; Damian el al., 2008).

Due to the existence of non-ferrous ore deposits Baia Mare was the capital of mining and metallurgical industry in Romania. All the mines from Maramures county were closed in 2007 but they continue to pollute the environment (Mihali et al, 2013) by acidic mine water leaching and by dispersion of pollutants from tailings pounds and tailing dumps.

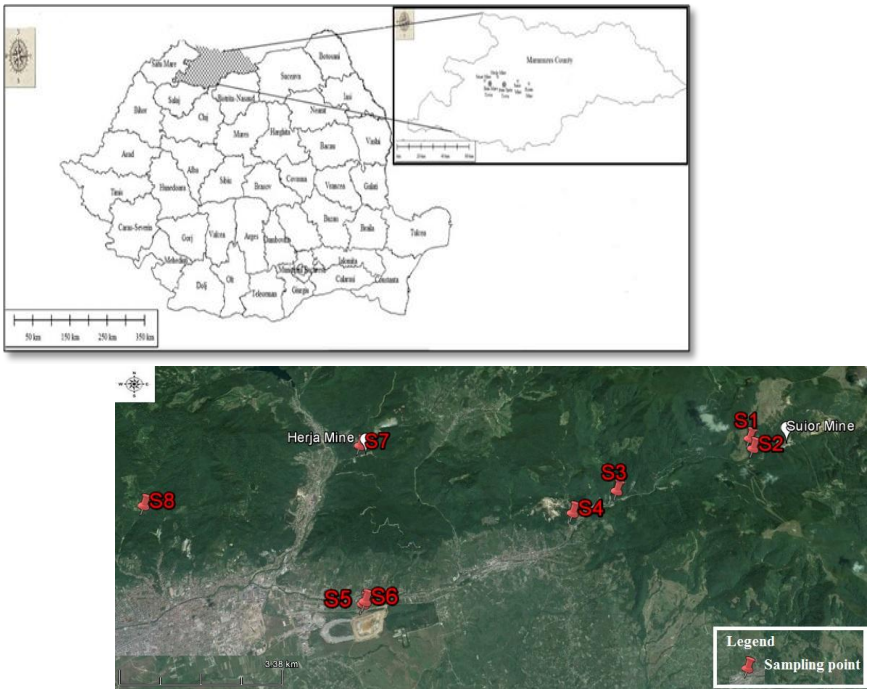

Fig. 2. ***Study area with sampling point***

3. METHODOLOGY

Eight sediments samples were taken in December 2013 from various sites from Baia Mare mining area. The samples consisted in 150-500 gr of sediments. They were collected using a clean stainless steel shovel and put them in polyethylene bags which were labeled and after that transported to laboratory for processing them. The sediment samples used for heavy metals analysis were dried at 105ºC for 24 h, sieved to 2 mm and ground to pass through 200 µm sieve. The samples were digested in aqua regia (HCl: HNO_3 3:1 *v:v*.) (SR ISO 110-47 July 1999) and total content of heavy metals was determined by inductively coupled plasma optical emission spectrometry.

The sediments samples used for determination of physico-chemical parameters (pH, oxido-reduction potential, electrical conductivity, total dissolved solids and salinity) were air dried according to SR 7184-13, July 2001. The physico-chemical parameters were measured in the laboratory measured by a multiparameter (WTW Multi 350i) in a suspension of soil: deionized water of 1:5 *v:v* ratio. Before any determination the device was calibrated using standard solutions for electrical conductivity and pH.

4. RESULTS AND DISCUSSIONS

In Romania in terms of sediments we do not have maximum values regarding the pH, oxido-reduction potential, electrical conductivity or total dissolved solids.

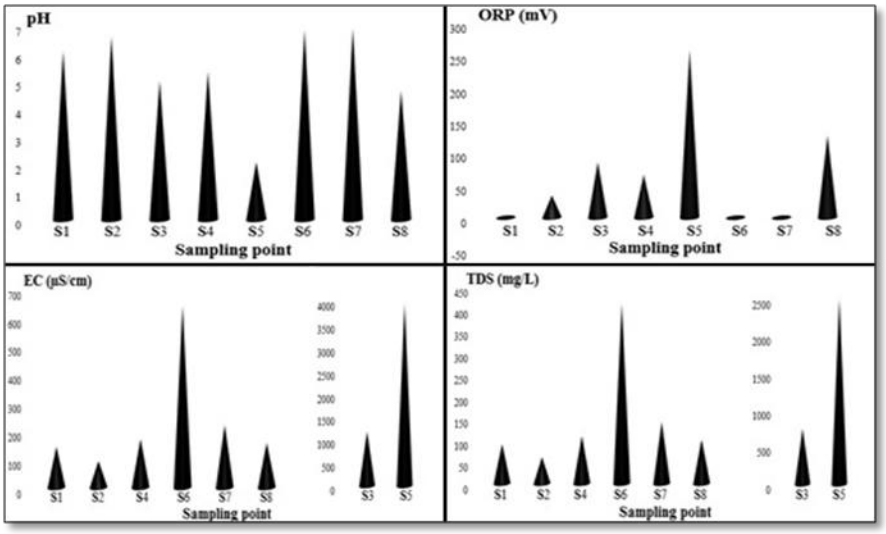

Fig. 3. ***Variation of analyzed physico-chemical parameters depending on the sampling point***

As we can see the highest values for ORP, EC, TDS and the lowest value for pH were analyzed in S5 sampling point which was collected from a channel which collects the drains is around the Tautii de Sus tailings ponds (Fig. 3). The determination of physico-chemical parameters, especially pH, is of great importance because these parameters are correlated with the behaviour of heavy metals in sediments. At acidic pH, high heavy metals leaching from sediments occur.

As shown in Fig.3, the pH sediments ranged between 2.1 and 6.9, being generally slightly acidic to neutral. With the exception of two samples (S5 and S8), the sediments had a relatively low ORP, being below 100 mV. In the samples S5, S3 and S6, the EC and TDS values were high, indicating the presence of high dissolved organic and inorganic salts.

As we can see in Fig. 4 Cr and Ni were found in all sediments samples but none of them exceeded the maximum admissible limit required by Romanian legislation (Order 161/2006). Regarding the Cd concentration it was detected in 50% from sediments samples and all of them exceeded the maximum concentration level. The highest cadmium concentration was analyzed in S3 sampling point which is a channel were untreated mine waters are discharged and moreover that channel flows into the Săsar River. Concerning Zn concentration it was found in all sediment samples and all of them are above the maximum concentration level.

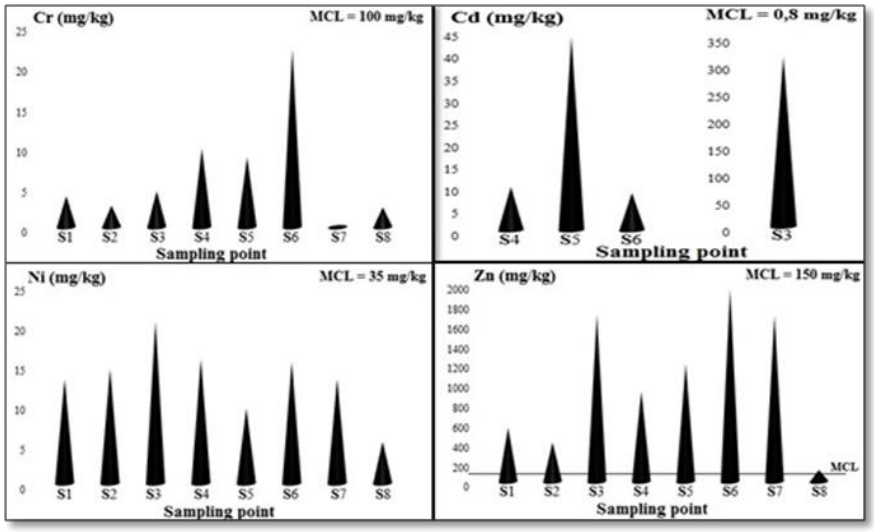

Fig. 4. ***Variation of analyzed heavy metals concentrations depending on the sampling point***

In Romanian legislation there is not a maximum concentration level for Fe and Mn regarding the sediments. The iron lowest concentration and the manganese highest concentration were found in S6 sampling point which represents the sediment from the channel which is around the Tăuții de Sus tailings ponds (Fig. 5).

Iron is balanced with manganese whereby, if the media is alkaline the media will absorb more manganese. As a consequence the increase pH registered in sample S6 (6.8), favouring the absorbtion of manganese in sediments, leading to a higher level of Mn comparing to Fe.

Referring to Pb and Cu as can be seen (Fig. 5) only one sediment samples (S8) is below the maximum concentration level for both the analyzed heavy metal while 87.5 % from samples have a lead and manganese concentration above the maximum concentration level.

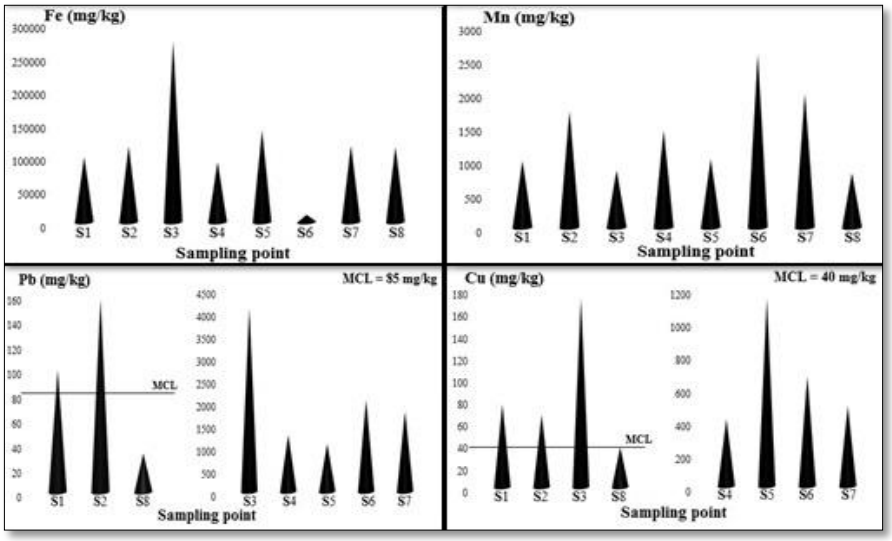

Fig. 5. ***Variation of analyzed heavy metals concentrations depending on the sampling point***

5. CONCLUSIONS

Sediments samples taken from Baia Mare mining area had a high concentration for Cd, Zn, Pb and Cu, it was above the maximum concentration level imposed by Romanian legislation (Order 161/2006). We analyzed high concentration for Fe and Mn, as well but we do not have a required maximum concentration level for those heavy metals.

Based on heavy metals content sampling point S3, S5 and S6 have the worst quality. Sampling point S3 was taken from a channel where untreatred mine waters are discharged and moreover that channel flows into the Sasar River, S5 and S6 sampling points represent the sediments collected from the channels which is around the Tautii de Sus tailings ponds. This sediments degradation can be a result of minings activities conducted in this area, that even if they were interrupted in 2007, they continue to generate pullutants like heavy metals by acidic mine water leaching and by dispersion of pollutants from tailings pounds and tailing dumps.

Akcnowldgements

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