POOLS OF HEAVY METALS IN SOILS
WITH DIFFERENT VEGETATION COVER AND SOIL MATERIAL
IN FORMER Zn-Pb MINING AREA

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Introduction

Samples of soil generic horizons in former Zink and Lead mining region around Olkusz Ore-bearing Region (OOR) - an area degraded by zinc and lead mining in southern Poland, were collected from 9 soil plots at 49 sites including all major vegetation types growing directly on waste material from the mining, as well as on abandoned agricultural topsoil and sand deposits. Samples were analyzed for physical and chemical characteristics as well as total, available and exchangeable content of sink (Zn), cadmium (Cd) and lead (Pb). The goals have been to study levels of pollutants, assess factors explaining spatial variation and finally relate governing factors to conceptual mechanism.

Background

This study is a part of the larger ongoing research EEA project Vegetation of Calamine Soils and its Importance for Biodiversity and Landscape Conservation in Post-mining areas (FM EEA PL 0265 ) led by the Władysław Szafer Institute of Botany, Polish Academy of Sciences, Cracow, Poland. The aim of the project is to produce a full botanical and ecological description of the vegetation and species composition, biodiversity and patchiness of plant communities, as well as the distribution and abundance of individual plant species. How vegetation depend on physical and chemical properties of soil, in addition to geology, topography, type of land use and terrain is studied.

Results

The total amount of Zn, Pb and Cd, were extremely high (Table 1), especially in the illuvial B horizons, with overall average values way above any permissible norm. Sites with moist or thermophilous grasslands developed directly on waste of gangue and processed ore material contained the most contaminated soils. At these sites the average total levels of Zn, Pb, and Cd were 30.5, 21.4 and 0.21 g kg⁻¹, respectively.

Discussion

Generally, the total levels of heavy metal followed each other and were mainly related to the Iron (Fe) content of the soil (Figure 1), which could be seen as a proxy for the content of ore material. Higher levels of available and exchangeable Pb were found in more acid (forest) soils, while high levels of Cd and Zn were found in soils with high base saturation (BS) and high soil pH (i.e. grasslands). These differences were likely due to that Pb is the least mobile heavy metal in acid soils.

Available and exchangeable content of heavy metals in the soils are clustered together in a dendrogram of all the wasteland soil samples (Figure 2). The exception is for available Pb, which is closer to a clustered of parameters indicating fertile and organic rich soils with high base cation content.

Some preliminary conclusion

One may therefore argue that available and exchangeable Cd and Zn has been leached out of the more acid forest soils but are still held back in the more alkaline soils of thermophilous grasslands.

Table 1
Levels of total, available and exchangeable heavy metals in different soil horizons. All values are given in mg/kg.

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Available</th>
<th>Exchangeable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Zn</td>
<td>Pb</td>
<td>Cd</td>
</tr>
<tr>
<td>A</td>
<td>6 783</td>
<td>2 741</td>
<td>57</td>
</tr>
<tr>
<td>Ap</td>
<td>8 613</td>
<td>5 104</td>
<td>59</td>
</tr>
<tr>
<td>AB</td>
<td>22 863</td>
<td>4 303</td>
<td>185</td>
</tr>
<tr>
<td>B</td>
<td>13 491</td>
<td>5 254</td>
<td>78</td>
</tr>
</tbody>
</table>

Figure 1
Correlation between total content of heavy metals and iron in all sites.

Figure 2
Dendrogram showing the correlation relationships between exchangeable and available heavy metals in wasteland soils and soil chemical characteristics.

For more information see:
http://info.botany.pl/metalflora/index_e.html