VARIOUS MECHANISMS AND EFFECTS OF Cu AND As RELEASE FROM STRONGLY POLLUTED AMENDED WITH SEWAGE SLUDGE

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Introduction

Remediation of metal(loids)-contaminated soils is usually based on the strategy of immobilization via neutralization of acidic pH, precipitation as insoluble compounds or increasing soil sorption capacity by amendment with organic materials or clay minerals (Bolan et al. 2014). Organic waste materials, such as sewage sludge, and composts, should be considered for this purpose. However, some commercially available biosolids contain high amounts of dissolved organic carbon (DOC) that may cause adverse effects, i.e. increased solubility of metal(loids). This effect has already been reported and well recognized in the case of soils polluted with Pb and Cu, but is not well known in the case of As that, being a metalloid, occurring in soils in anionic forms, behaves differently from typical metals Kabata-Pendias 2010). The main aim of this study was to examine the changes in concentrations Cu nd As in soil solutions acquired from soils highly contaminated with these elements, treated with organic materials commonly used as amendments in soil remediation, with special focus on various kinds of sewage sludge.

Methods

Eight soils were examined in this study, of which four - strongly contaminated with As (780-6540 mg/kg) were collected from the site historically polluted by arsenic processing (in Złoty Stok and in Radzimowice), and four – contaminated with Cu (470-1432 mg/kg) were sampled from the surroundings of operating copper smelters in Legnica and Glogów (Karczewska et al. 2013; Karczewska 1996). Soils were mixed with various organic amendments (50 g: 1 kg) - three kinds of sewage sludge (SS-1, 2, 3), two kinds of composts produced of green wastes and municipal wastes (Co-1, 2), and for comparison – with manure (M), and two kinds of forest litter (FL) – acquired from beech and pine stands. The mixtures were incubated in the pots, and soil solutions were sampled with Macro Rhizon suction samplers after 1, 7, 30 and 60 days. Concentrations of Cu and As in soil solutions were measured.

Results

Most of organic materials used in the experiment caused increase in the solubility of both As and Cu in the soils. The strongest effects of their mobilization were observed in the treatment with alkaline , freshly limed sewage sludge (SS-2) (Fig. 1) that contained high contributions low molecular weight organic fractions (DOC). These effects depended also on soil properties, and were particularly well expressed in the case of soils with high pH. Cu mobilization from alkaline soils after their amendment with SS-2 was explained by formation of highly soluble ammine-Cu complexes (Cuske et al., 2016) that caused a dramatic increase of Cu concentrations in soil solutions, up to 700 mg/L or higher.

Quite different were the results concerning As. Stabile, mature and well humified compost or composted sewage sludge (SS-3) as applied to soils, caused As mobilization similar to that observed after soil amendment with immature compost or fresh sewage sludge (SS-1). Application of forest litter in each case

contributed as well to the release of certain amounts of As or Cu into soil solutions. Various mechanisms of mobilization were discussed in relation to the properties of soils and amendments.

The strongest effects of Cu and As release into soil solution were observed within the first week of incubation, after which soil conditions tended to stabilize and the solubility of Cu and As decreased.

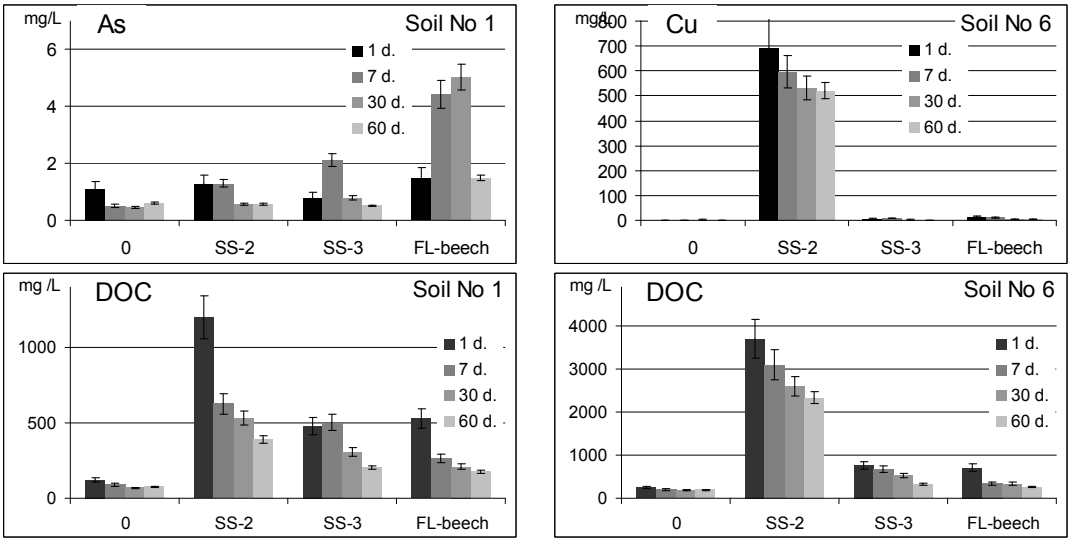

Figure 1. The concentrations of As and Cu, as well as DOC, in soil solutions acquired from soils No 1 and 6 amended with sewage sludge SS-1 and SS-3, and beech forest litter.

Conclusions

The use of organic waste materials, in particular limed sewage sludge for remediation of Cu and As polluted soils must be preceded by detailed studies focused on their possible release to solution. Afforested soils contaminated with As or Cu should be monitored, as decomposition of forest litter may contribute to increased solubility of contaminants. Although these effects are temporary and decrease with time, they should not be neglected because of likely adverse impacts on soil biota.

References

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