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Mobility of Cd and Pb in a Closed Mine Area

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ABSTRACT

The different standards of heavy metal concentration in soils have been observed in different countries. The common standards are fallen into the level of total concentration in soil. However, it does not necessarily mean that as higher total concentration, as higher the risk. That is because the only mobile heavy metals can flow into underground water or be absorbed by plants, threatening our health. Therefore, the German federal soil preservation law, enacted in July, 1999 and revised December, 2004 read the precaution value of heavy metals in soil depends on soil texture. That is, any soil of which soil texture is clay has a larger surface area, adsorbing such materials strongly and the heavy metals show less mobility, so the standard level of metal concentration is relatively high. For instance, the precaution value of lead in sandy soil is set to 40ppm while that of clay soil is 100ppm. Consequently, the study was intended to look into any factors having an influence on the mobility of heavy metals in soil and examines the correlation between such factors and soil texture. The soil analysis was conducted on soil collected from Stolberg, a satellite city of Aachen located in the west of Germany. The city of Stolberg has been notorious as the most serious contamination of heavy metals within Germany because many metal mines and metal refining industry were developed from the Roman era to the beginning of the 20th century. The soils artificially added with heavy metals were not used. This is because the heavy metals on these soils show different characteristics from the actually pollutant-accumulated soils in terms of their bonding type and mobility. And, the German Standard was mostly adopted as the analytical testing method. Table 1 summarizes the analysis results on the soil collected from the city of Stolberg, Germany.

Table 1 Analysis results on the Stolberg soil

Item	Result
Soil texture	Sandy
Humus content	7.37 %
Carbonate content	12.85 %
Water content	12.4 %
Maximal water capacity	0.38 g water/g soil
pH ($CaCl_2$)	7.5
Cation exchange capacity	33.2(mmol/z) / kg, z is oxidation state
Total cadmium and lead content	Cd: 500 ppm, Pb: 30000 ppm
Total mobile cadmium and lead content	Cd: 28 ppm, Pb: 5580 ppm

From the results of the analysis, the soils indicated a very high concentration of the entire heavy metals exceeding the standard level. Furthermore, the fact that soils are sandy of relatively large particles increased the risk of heavy metals flowing in underground water due to the easy mobility of ions. However, a great quantity of humus in minute particles was found on the surface, which can prevent the heavy metals from flowing into the ground to some extent. And the pH value of 7.5 prevented the mobility of heavy metals. A large amount of the carbonate content helped maintain a specific level of pH. As the result, the heavy metals in such a soil is not so mobile as can be expected after the soil texture measurement.

Key words: Cadmium, Lead, Soil texture, Soil pH, Humus content