令和２年度　環境科学院　修士論文内容の要旨

Heavy metal distribution in particle-size fractions of soils around the abandoned Kabwe mine, Zambia
（ザンビア国カブウェ廃鉱山周辺の土壌の粒度分画試料内における重金属の分布）

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The former lead-Zinc mining town, Kabwe in Zambia is one of the world's worst polluted areas. The dust particles from the past mining activity and the remaining tailing deposit caused high soil contamination of heavy metals. The distribution of heavy metals in particle-size fractions of soils can significantly affect its migration, bioavailability. In dry area, some fine soil particles can become airborne and increase the risk of heavy metal exposure to humans through inhaling. To date, many studies for surface heavy metal contamination assessments have been done in Kabwe, but few concerned with various soil particle size fractions. Therefore, this research aims to examine the heavy metal Pb, Zn and Cu (copper) levels in various soil particle size fractions and discriminate the general spatial distribution of Pb in such different fractions around the Kabwe mine.

A total of 51 topsoil samples had been collected in October 2016 by the activity of the KAMPAI project of SATREPS program from the mine's surrounding townships. All the samples were separated into seven size fractions, including 350–2000 μm, 200–350 μm, 120–200 μm, 50–120 μm, 2–50 μm, 0.2–2 μm, below 0.2 μm. The separation was conducted by sieving and centrifuging. After separation, the samples were digested through hot plate acid digestion and measured by ICP-AES and ICP-MS for the Pb, Zn and Cu, aluminium (Al) concentration. The spatial distribution of each fraction was generated by ArcGIS. In this study, element ratios of Pb/Al, Zn/Al, Cu/Al were used to represent the levels of Pb, Zn and Cu.

This study found that the highest Pb levels mainly occurred in NW-SE direction around the mining area, which is consistent with the previous study by bulk analysis. In the NW direction, Pb levels in all fractions decreased with increasing distance from the mine ($r = -0.31 \sim -0.69$). A transition from Pb enriching in coarser fractions to enriching in finer fractions with increasing distance from the mine was observed. In the SE direction, a similar Pb distribution pattern with increasing distance from the mine canal was also discovered. Both of these indicate finer polluted dust particles from the mine dispersed farther and resulted in extended areas with high Pb level in finer soil particle size fractions. Pb/Al in 0.2–2 μm fraction is mostly higher than 0.02. By assuming this fraction has the comparable Al content with reference materials of silicate sediment, the Pb content in 0.2–2 μm fraction of soils should be higher than 1400 ppm in most of the study areas. It indicates a high risk of lead exposure. The level of Zn is comparable or higher than Pb, but it is mostly in water-soluble form. The Cu level is generally lower than Pb by one or two orders of magnitude, which shows that the contamination of Cu is less severe.