# Characterization of Core Samples and Mechanisms of Zinc Leaching in a Waste Rock Dump of Abandoned Mines

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**Abstract**

Mine drainage containing toxic elements discharged from abandoned mines and waste rock dumps is causing pollution of rivers, farmland and groundwater around the world. In Japan, there are many abandoned mines and there is a need to reduce the cost and improve the efficiency of mine drainage treatment. In order to reduce the cost and improve the efficiency of mine drainage treatment, it is necessary to understand not only the characteristics of mine drainage, but also the elution mechanism of toxic elements. In this study, we conducted a drilling survey of a waste rock dump at an abandoned mine where leachate containing zinc has been confirmed, and identified the minerals contained in the drilling core using XRD (X-ray Diffraction) analysis, determined the total potentially toxic metals content, and identified the chemical form of zinc using XAFS (X-ray Absorption Fine Structure) to understand the spatial distribution of environmental information within the dump. We also carried out leaching tests to investigate the leaching mechanism of zinc in terms of the influence of contact with groundwater in the waste rock and the form in which zinc is present, and considered countermeasure options to reduce the concentration of zinc in mine drainage from the waste rock dump. The borehole reached groundwater, and the groundwater quality showed that the contamination was not uniform (table1). The results of the analysis of the drilling core and the leaching test showed that the main cause of zinc leaching in the waste rock dump was the sulfate form, and that the sulfate form of zinc was more abundant in areas with high groundwater concentrations. XRD analysis and SEM (Scanning Electron Microscope) observation confirmed the presence of pyrite, galena, sphalerite, anglesite, and jarosite (containing lead, zinc, and copper). The waste rock contained high concentrations of zinc (1000mg/kg to 53,000mg/kg). The maximum concentration of zinc in the batch elution test was 151 mg/L. Furthermore, XAFS analysis confirmed that the chemical form of zinc in the samples with high elution amounts was sulfate and clay minerals, and SEM observation showed that jarosite was observed, suggesting that the source of elution was sulfate rather than sphalerite. The results of this study suggest that the amount of zinc leaching is affected by groundwater. If the pathway of groundwater inflow into the waste rock deposit site can be identified, and if the inflow of rainwater can be prevented by using a water-proof sheet to prevent the rise in groundwater levels, it is thought that the leaching of zinc that affects groundwater can be prevented, and the load on wastewater can be reduced.

**Keywords:** Waste rock dump, zinc, x-ray absorption fine structure, batch leaching tests

*Table 1 Groundwater quality of cores with high concentrations of potentially toxic metals and cores with low concentrations of potentially toxic metals in waste rock. (August/2021).*

| | pH | EC (mS/m) | $SO_4^{2-}$ (mg/L) | Zn (mg/L) | Cd (mg/L) | Pb (mg/L) |
|---|---|---|---|---|---|---|
| High concentration | 3.6 | 308 | 140 | 7.9 | 0.068 | 1.9 |
| Low concentration | 5.7 | 231 | 110 | 1.5 | 0.013 | 0.001 |