学位論文の要旨

Abstract of Thesis

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学位論文題目 Title of Thesis（学位論文題目が英語の場合は和訳を付記）

The Recovery of Post-Tin-Mined Soils in Belitung Island, Indonesia
（インドネシア・ビリトン島における錫採掘後の土壌の回復）

学位論文の要旨 Abstract of Thesis

Tin mining resulted in sandy soils that degraded the sustainability of the surrounding environment. After more than ten decades of land reclamation, restoring soil's physical and chemical properties in post-tin-mining areas on the tropical island of Belitung, Indonesia, has been a laborious process. Sandy soils that remained after mining have low water availability. Restoring the soils by adding organic matter is frequently done, but water retention and soil erosion still happen. The starting phase of the soil's physical restoration is crucial to handle well for a successful measure. We aimed to determine which parameter of the soil properties was responsible for the slow recovery process and if other properties indicated more rapid changes. Then, we investigated whether clay particles, in addition to the post-mined sandy soils, can rebuild the water-holding capacity.

We measured the physical, chemical, and biological properties of soils of different periods in the post-tin-mining areas. We sampled soil from three areas: 0, 1, and 6 years after mining and an adjacent natural forest as a reference site. The soil water content, hydraulic conductivity, bulk density, particle distribution, mineral content, and soil microbial composition were measured in the field and analyzed in the laboratory. Later, we took 50 cc of the sampled soils into 50 cc core cylinders with three treatments: adding 1% kaolinite, adding 5% kaolinite, and the control cylinder filled the soils without kaolinite. We incubate all the soils at 34°C to mimic the higher air temperatures on site. The soil aggregate distribution, soil water retention time, soil water retention curve, and soil erodibility (K-factor) were measured in the laboratory. We also captured photographs of the soil using a Scanning Electron Microscope to observe the soil particles.

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The soil showed a fine particle loss and despite the absence of clay, water-holding capacity was significantly increased in the 6-year-old soil. Organic carbon increased by 0.2% after six years of reclamation. Copper, iron, manganese, and zinc in the soils fluctuated less. Minimal amounts of Pb and Cd were found. Soil bacterial communities shift with land age. Actinobacteria were dominant a few years after mining, while Proteobacteria colonized the mined area after six years. The soil treatment by adding clay soils to the mined soils showed an increasing trend of fine particles. Water-holding capacity was significantly increased in the soils with kaolinite addition, with a 5% increment for 0-year and 1-year soils and a 15-20% increment for 6-year soil. Soil water retention time in the 6-year-old soils is ten days longer than in the 0-year and 1-year soils. Soil fine particle amounts raised in the kaolinite addition cylinders were obviously observed. Calculation of the K-factor showed soils with kaolinite added are higher.

This study examined the more profound changes in the soil properties of tropical post-tin-mined land. Soil and bacterial characteristics can be used as markers to monitor the progress of land rehabilitation. Kaolinite application to the sandy soils is able to lift the water-holding capacity performance. At the same time, it can reduce the rate of soil erosion. We found a potential alternative to restore the mine lands, which would accelerate the ecosystem's succession progress.