Geophysical Research Abstracts
Vol. 20, EGU2018-2190, 2018
EGU General Assembly 2018

Effect of iron reduction on swelling of submerged paddy soil

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Shrinkage and swelling of clay soil causes development of desiccation cracks controlling drainage efficiency of paddy fields or the bearing capacity of the ground. While the shrinkage and swelling of soil are induced by the change in soil water potential due to desiccation or flooding, time-dependent volume change is observed in paddy soil even when the water potential is stable. Although the reduction or oxidation of the iron oxides in the soil is a potential factor that causes the volume change under the stable water potential, quantitative importance of the factor has not been clarified. The present study aims to reveal the effect of the change in the form of iron oxides due to reduction on the swelling of paddy soil.

The soil sample was taken from a rotationally cropped paddy field. The texture is light clay and the major clay mineral was swelling smectite. The sample was dried by air and sieved through a 420μm meshed sieve. A part of the sample was sterilized in the autoclave for an hour at 120 °. The sample was kneaded well with water to be paste, molded into core samplers having a diameter of 50mm and thickness of 25mm, and subject to dehydration to -100kPa by the pressure chamber. The shrunken specimens were taken out from the samplers and its side walls were covered with rubber bands to avoid slaking. All the specimens were subject to the prewetting treatment in which the specimens were put on the 5mm depth of tap water for 24h at 2°. The prewetted specimens were completely immersed under the pure water at 2,20,35°. The volumetric change of the specimens after the beginning of the immersion were measured by a form measurement apparatus up to 30 days. The increase in the active ferrous iron extracted by pH3.0- 1M sodium acetate was also measured.

Increase in soil volume due to hydration was observed for all specimens, while the sterilized or the specimen stored at 2 ° stopped swelling by two days after the immersion. The non-sterilized specimens stored at 20 and 35 ° in which biological activity is allowed showed succeeding swelling and progress in the reduction of iron-oxides. Except the rapid swelling just after the immersion, the increase in void ratio at 20 and 35° was proportional to the increase in the active ferrous iron at the same rates, which suggested the reduction of iron oxides covering the soil aggregates loosened the mechanical constraint and induced succeeding swelling. However, the increase in the soil volume before the increase of active ferrous iron was higher at 35° than 20°. Because the effect of temperature on the hydro-mechanical swelling was negligible, the other factors than the iron-reduction probably enhanced the early phase of swelling.