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Effects of Bacterial Metabolites and Phyllosilicate Minerals on Crack Healing and Biocementation of Sandy Soils in the MICP Process

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Microbially induced calcium carbonate precipitation (MICP) can improve the engineering properties of soils increasing the shear strength of the soil by creating biocementation while reducing the soil's porosity and hydraulic conductivity. The purpose of this study was to evaluate the effects of additional factors such as the bacterial metabolite and a phyllosilicate mineral on crack healing and biocementation of sandy soil in the MICP process. For experiments, soil cracks were generated by drying wet soils in Petri dishes. To investigate the effects of bacterial activity and metabolites on crack healing, four groups of soil samples were sprayed with deionized water, cementation solution, both bacteria and cementation solutions, and both bacterial metabolite and cementation solutions, respectively. After spraying treatments, it was dried to observe the change in the width and length of cracks. In addition, to investigate the effect of adding a phyllosilicate mineral to improve the strength of sandy soil, MICP was induced in sand mixed with 0-30% montmorillonite (MMT). The bacterium used in all experiments was *Sporosarcina pasteurii*, and the cementation solution was used as a microbial growth medium containing urea and 30 - 50 mM $CaCl_2$. Healing of cracks was confirmed through image analysis, and cementation of soils was confirmed by measuring soil hardness of the sandcake formed by the MICP. The mineralogical changes in the soils were confirmed using XRD and SEM-EDS analyses. As a result of 5 cycles of spraying treatment for crack healing, the surface crack ratio was reduced by about 70% when living cells were included, and by about 79% when microbial metabolites were added. However, the volume of crack reduction ratio was relatively low when treated with water (28%) and cementation solution (48%), respectively. As a result of MICP after mixing MMT with sand, the soil strength increased as the amount of MMT increased. This indicated that a phyllosilicate mineral contributed to soil stabilization as colloids for calcium carbonate precipitation and adhesion between sand particles. Therefore, in the MICP treatment for crack healing and stabilization of sandy soil, the addition of bacterial metabolites and phyllosilicate minerals may enhance the effectiveness of the process.