Influence of Humic Acid on Bacterial Response and Microbial Induced Carbonate Precipitation

*Meiqi Chen[1], Sivakumar Gowthaman[2], Kazunori Nakashima[1], Satoru Kawasaki[1]

1. Hokkaido University, 2. University of Jaffna

As sustainable development requires, novel technologies are gaining more and more attention due to their advantages over conventional techniques that have been applied without much awareness of energy and environmental crisis. In the field of geo-engineering, a new direction called biocementation now is developing dramatically, with the exponential growth of related research in recent years. Microbial Induced Carbonate Precipitation (MICP) is one of the most commonly researched biocementation techniques, which achieves cementation of particles by carbonate from urea hydrolysis catalyzed by microbial urease precipitates at the presence of calcium ions. Although current research works are still limited in applying MICP to stabilize sandy soils, more and more researchers are turning their interest into different soils, such as clay soils and organic soils. When it comes to organic soils, the presence of humic substances (HS) would be of particular concern on account of its unique characteristics that hinder cement stabilization and sometimes make normal criteria of soil improvement inapplicable. To investigate the feasibility of applying MICP to organic soils, the influences of HS should be taken into consideration. Particularly, one component of HS, humic acid (HA) has been reported to inhibit urease activity and might disrupt the crystallization of calcium carbonate owing to its great cation exchange capacity. In general, this study attempts to investigate the influence of HA on bacterial response and calcium carbonate precipitation. For this purpose, the following effects were examined: i) Effect of HA addition rate on calcium carbonate precipitation; ii) effect of HA on calcium carbonate morphology; iii) Effect of HA on the response of different strains in calcium carbonate precipitation test. Several sets of precipitation tests have confirmed that bacterial response to HA differs from each species. Basically, the native species were less adversely affected by HA addition than the exogenous one, while one native species seems to be positively influenced as an enhanced precipitation rate was observed. The investigation further revealed that the crystallization of calcium carbonate was hindered by HA, producing lots of small amorphous calcium carbonate particles. An interesting finding is that bacteria seem to have their strategies to cope with harsh conditions, which found expression in their urease activity and the induced $CaCO_3$ morphology. As a baseline study, this research could provide an insightful understanding of possible obstacles and how to overcome them when using MICP to stabilize organic soils, contributing to a wider application range of biocementation for the future.

Keywords: Microbial induced carbonate precipitation (MICP), Humic acid (HA), Bacteria, Urease activity, Calcium carbonate morphology

