SPECTRAL INDUCED POLARIZATION AS A MONITORING TOOL FOR BIO-MEDIATED SOIL STABILIZATION PROCESSES

Sina Saneiyan\textsuperscript{a}, Juliette Ohan\textsuperscript{b}, Junghwoon Lee\textsuperscript{c}, Dimitrios Ntarlagiannis\textsuperscript{a}, Frederick Colwell\textsuperscript{d}, Susan Burns\textsuperscript{c}

\textsuperscript{a} Rutgers, The State University of New Jersey – Newark, NJ
\textsuperscript{b} Los Alamos National Laboratory, Los Alamos, NM
\textsuperscript{c} Georgia Institute of Technology, Atlanta, GA
\textsuperscript{d} Oregon State University, Corvallis, OR

Abstract

Rapid growth of human population in the last decades led to the need of urban expansion into lands with problematic soils. Microbial induced calcite precipitation (MICP) is a promising soil stabilization method relying on stimulating soil microbes that are naturally occurring. MICP can enhance soil quality to engineering standards in economic sustainable and environmental friendly manners. Although MICP has been extensively tested and proven in both laboratory environments and field trials, long term field applications still remain challenging, partly due to limited quality control and available monitoring techniques.

Spectral induced polarization (SIP) is a geophysical method established in mining industry and rapidly emerging in environmental applications. Among other geophysical methods, SIP is particularly promising for monitoring MICP processes due to its sensitivity to subsurface biogeochemical processes as well as calcite precipitation. SIP, as most geophysical methods, is a cost effective and environmentally non-invasive method that can offer autonomous and long-term monitoring capabilities.

Previous laboratory tests showed the sensitivity of the SIP method on soil strengthening as a result of abiotic calcite precipitation. Time-domain induced polarization (TDIP) was recently shown to successfully delineate subsurface MICP processes in field applications. This study presents the SIP results of a 15-day field-scale MICP project. The MICP treatment involved the injection of molasses (carbon source for microbial proliferation) and urea in a Ca\textsuperscript{2+} rich aquifer. In this study, we performed daily SIP measurements at the field site (Rifle IFRC site) with 2 parallel (1 m separation) surface SIP lines (23 m long, electrode spacing 1 m). Early results show SIP being sensitive in tracking MICP changes at different frequencies, temporally and spatially. SIP results are in direct agreement with the TDIP results acquired for the same project, while potentially offering more information for the subsurface processes. SIP results are supported by conventional monitoring methods, such as shear-wave velocity, geo-chemical and microbiological monitoring.
Finally, X-ray diffraction analysis on field samples (artificial substrate cores) incubated inside treatment zone, confirmed the production of calcite at the target subsurface zone.