Investigating Time Domain ELECTROMAGNITIC INDUCTION Signatures in Porous Media for EVIDEnce of MACRO-SCALE Relaxation

*Dan R. Glaser, USACE ERDC Cold Regions Research & Eng. Laboratory, Hanover, NH USA*

*Randall Reynolds, USACE ERDC Cold Regions Research & Eng. Laboratory, Hanover, NH USA*

*Fridon Shubitidze, Thayer School of Engineering, Dartmouth College, Hanover, NH USA*

*Lee D. Slater, Earth & Environmental Sciences Department, Rutgers University, NJ USA*

*Benjamin E. Barrowes, USACE ERDC Cold Regions Research & Eng. Laboratory, Hanover, NH USA*

We present the ongoing investigation of macro-scale relaxation signatures in frequency-domain and time-domain electromagnetic induction (EMI) measurements. Using a time-domain EMI system with a saw-tooth waveform to increase charging time and enhance any time-dependent relaxation in a porous media, we evaluated granulated pyrite mixtures with silica sand, metal spheres, and clay particles, along with the effects of varying pore-fluid conductivity. Historically, measurements obtained from airborne and towed time-domain EMI surveys have demonstrated a late-time, negative response related to the bulk chargeability; however, there are few attempts in the literature to demonstrate the macro-scale relaxation mechanisms. Our previous efforts to identify macro-scale signatures from the internally developed high- and low-frequency EMI systems (HFEMI and LFEMI, respectively) revealed no clear evidence exists due to the high signal-to-noise ratio in the relatively electrically resistive porous media. The HFEMI system used a frequency range of 1 kHz to 20 MHz. While the HFEMI system can characterize high conductivity targets such as metals over this full range of measured frequencies, low conductivity materials and their associated relaxation phenomena are not discernable between 1 kHz and 100 kHz due to pink noise. A new LFEMI system was constructed to reduce the pink noise. This system was designed to operate over a frequency range of 10 Hz through 1 kHz, which more closely aligns with expected galvanic relaxation signatures of porous media. This new system did significantly reduce the pink noise, but white noise remained, obscuring any possible relaxation signatures. To overcome the noise floor restrictions: metallic spheres were added to the porous material to create electrical conductivity signatures above the white noise, yet the preliminary results from the LFEMI investigation were inconclusive. This presentation provides preliminary results associated with a third, now time-domain EMI, system in a continued effort to identify macro-scale relaxation signatures in EMI data.