Cross-Borehole GPR for Subsurface Cavity Characterization and Monitoring: Survey Consideratoins and Limitations

*Dan R. Glaser, US Army Corps of Engineers ERDC-CRREL, Hanover, NH*

*Samuel O. Falzone, US Department of Energy, ARPA-E, Washington, DC*

*Alejandro Garcia, US Army Corps of Engineers ERDC-CRREL, Hanover, NH*

*Miriam Wallace, US Department of Homeland Security, CBP-LSS, Washington, DC*

*Kathleen Scarlett,* *US Department of Homeland Security, CBP-LSS, Washington, DC*

*Brian M. Worthmann, US Department of Energy, Lawrence Livermore National Laboratory, Livermore, CA*

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Abstract

Hazards associated with the presence of subsurface cavities can be dire, from the development of dissolution cavities and sinkholes in karst environments, to compromised dam and levee infrastructure, to abandoned mine adits or other unknown cavities at planned and historic construction sites. Various geophysical methods offer means of detecting these anomalies from the surface; however, these methods can lose resolution and signal strength with depth. Cross-borehole methods offer a means of maintaining resolution and signal strength with depth, but rely on additional infrastructure, i.e. the installation of boreholes. In these high-risk areas, the installation of bore-holes is justified to support the detection, characterization, and monitoring of these potentially high-risk subsurface cavities. This presentation will focus on the acquisition of cross-borehole ground-penetrating radar (GPR) data. We will address the various measurement geometries including zero offset profiling, tomography, and reflection, as well as, optimal frequencies for anticipated target size and geologic materials, considerations for borehole installation and placement, change detection optimization, and field limitations associated with signal degradation. Examples will be provided from forward modeling and real-world applications. Additionally, we will present novel expedited signal processing steps associated with a custom software built for void detection.