The Detection of Deep Karst Features Using New Geophysical Technique "MERIT"

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Background/Objectives. High-resolution site characterization (HRSC) techniques use conceptual site models (CSM) to provide a basis of understanding of the subsurface. The role of geophysics in CSM is considered as an option but due to limitations it not widely used. Electrical resistivity tomography (ERT) has demonstrated potential use for CSM in the identification of geology and karst features. However, the current limitations in ERT of decreased resolution with depth and gaps in ends of the survey line(s) limit the widespread use of ERT for HRSC.

The objective of our research was to develop a reliable ERT technique that can provide higher resolution at depth and resolve the data gaps at the end of ERT profiles. Higher resolution at depth would provide more precise understanding of highly variable karst formations. The ability to map the subsurface geology in detail using geophysics would lead to better understanding of potential pathways or potential source areas in karst formations. The authors have developed a unique ERT application called the Multi-Electrode Resistivity Implant Technique (MERIT), MERIT was first presented at the 13th Sinkhole Conference as "Imaging Karst with the Multi-Electrode Resistivity Implant Technique" (D. Harro and S. Kruse 2013).

Approach/Activities. An complete understanding of the complex weathered surfaces and vertical pathways as potential source areas for dense nonaqueous phase liquids (DNAPLs) as well as for light nonaqueous phase liquids (LNAPLs) in karst areas is the one of the goals of the MERIT method. Numerical, laboratory and field case studies along with comparison to surface geophysical methods have been applied to karst formations using the MERIT method and published "Improving resistivity survey resolution at sites with limited spatial extent using buried electrode arrays" (H. Kilfu, S. Kruse, M.H. Loke, P.B. Wilkinson, D. Harro 2015). The MERIT method required the development of specialized data collection and inversion process "Optimized arrays for 2D resistivity surveys with combined surface and buried arrays" (M.H. Loke, H. Kiflu, P.B. Wilkinson, D. Harro. S. Kruse 2015). The optimization of the ERT data using the MERIT method was proven to greatly enhance both the resolution at depth as well as filling in the data gaps produced by the standard ERT inversion process.

Results/Lessons Learned. The research and applications of MERIT have resulted in new method that is greatly improved over surface geophysical methods. The level of detail provided by MERIT to depths of over 100 feet produces a new opportunity for understanding complex karst geology. A CSM based on MERIT would result in focused HRSC and more cost effective assessments and remediation. Case studies of karst/sinkhole investigations using MERIT will be presented.