MAPPING A SINKHOLE SITE USING ELECTRICAL RESISTIVITY AND SEISMIC BASED METHODS

Dan T. Jackson; Auburn University, Auburn, AL

Michael J. Kiernan; Auburn University, Auburn, AL

J. Brian Anderson; Auburn University, Auburn, AL

Jack Montgomery; Auburn University, Auburn, AL

Abstract

Groundwater flow in karstic environments can dissolve carbonate rock and form sinkhole features which pose significant risk to existing infrastructure and residential communities. Sinkhole formation is often observed near active quarries, where dewatering operations can alter regional groundwater flow patterns leading to subsidence and increased void formation. In these areas, identifying locations which may be susceptible to sinkhole formation requires an ability to map dissolution features within the rock. Traditional geotechnical explorations are not well-suited to this effort as they only provide subsurface information at discrete points and therefore may miss voids within the rock. Geophysical methods offer a means to produce continuous profiles of the rock surface and possible locations for voids, but interpreting the results of these tests in karstic geology can be challenging.

This study compares results from electrical resistivity and seismic surveys performed near a sinkhole on a large research property in Eastern Alabama. A limestone quarry is located about two miles away from the site and multiple sinkholes have been observed in past years leading to damage to roadways and residential properties in the surrounding community. A large water filled sinkhole was recently discovered in a secluded area of the research property. The features are consistent with a subsidence-type sinkhole that can be caused by quarry dewatering. The sinkhole is located in the middle of a wooded area making traditional methods of site investigation that involve drilling difficult.

For the current study the ground surrounding the sinkhole was surveyed using both electrical resistivity and seismic based geophysical methods. The dimensions of the sinkhole were measured and a depth profile was estimated with a sonar-based depth finder. Geophysical surveys were performed on several sides of the sinkhole to evaluate the subsurface conditions and map void locations. Resistivity surveys were performed using a two-dimensional dipole-dipole array, while the seismic data was processed using both Multichannel Analysis of Surface Waves (MASW) and full waveform inversion (FWI) techniques. Results from the resistivity and seismic surveys were evaluated together to interpret the subsurface and identify likely locations for possible cave features. Potential limitations and sources of error pertaining to each survey type were considered. The results of this study will be useful for planning future investigations and identifying research needs.