INTRODUCTION

Research Problem

- 25% of world population drinking supply comes from karst areas, but locations of conduits and groundwater flow directions are not well established in most areas.
- Little is known about how groundwater in conduits or surface water interact with groundwater in the surrounding limestone matrix.
- In the karstic Upper Floridan Aquifer, surface water from the Withlacoochee River floods Madison Blue Spring, causing a spring reversal, where surface water floods the adjoining cave and limestone matrix. Due to the high hydraulic gradient of the river during floods, water from the river will flow into the conduit and exchange from conduits into the porous matrix.
- This seems to be the first study using electrical resistivity tomography (ERT) to study a karst cave system during a spring reversal.

Study Area

- Madison Blue Spring State Park in northern Florida, on the Withlacoochee River. Madison Blue Spring is one of the 27 first magnitude springs in Florida.
- In an unconfined section of the Upper Floridan Aquifer, consisting of pre-Miocene limestone.
- Two survey locations, one over the cave near the cave entrance into the spring, and the other perpendicular to the river.

Map showing the location of Madison Blue Spring in northern Florida. The Withlacoochee River is highlighted in blue, and the associated river basin, covering 5,800 km², is shown in yellow. 19 km downstream from the spring, the Withlacoochee River flows into the Suwannee River.

METHODS

- 2 Survey lines, both 28 electrodes (Entrance: 5 meter spacing, 135 meters total, River: 3 meter spacing, 81 meters total)
- Data was gathered with AGI SuperSting R1 IP and analyzed with a terrain corrected mathematical inversion using EarthImager 2D.
- Surveys were done in early November during normal flow conditions and late January during a flood condition. Flood conditions were determined by monitoring rainfall from the National Weather Service and stage height and discharge of the spring from USGS WaterWatch.
- Electrical resistivity is useful at imaging the presence of water in the subsurface. It is often used to image depth to water table, but due to the difference in resistivity of water and limestone, ERT can be used to image conduits.

Map showing the cave system in red, the Blue Spring at the location of the red dot, and the locations of the two survey lines in blue. The Withlacoochee River runs next to the Madison Blue Spring State Park.

Map created using ArcMap with an orthophoto from National Map Viewer and cave map from cavesurvey.com.

ERT scans showing the inversion outputs of electrical resistivity of the subsurface at the two locations. Elevations are in meters above sea level. The horizontal distances are in meters, from north to south at the entrance, and west to east at the river, with the eastern edge on a bluff over the river.

- These scans shown use the Wenner array for sampling. The array is considered accurate in the depth direction.
- The scans from November are baseline scans of the area. In January the river level was 3 meters higher and pushing water into the conduit and limestone matrix.
- Red areas are sandy areas above the water table where there is high electrical resistivity. The subsurface water has resistivity values between 30 and 70 Ohm*m, shown in blue. The greener areas are likely the porous limestone matrix. The yellow line is roughly the location of the water table.
- Near the cave entrance, it is known that there is a conduit around 45 meters in length对着 our view. The features to the south could be conduits, but have not been explored. In the January scans the conduits are shown as a more pronounced oval shape as compared to January.
- In the survey perpendicular to the river, the scans show that the flood in January raised the water table above the November level. It appears that the water table continues to rise during each day of the study.

Future Possibilities

- Using ERT in a karst area during flood conditions could lead to better methods of conduit location detection. Time series studies can be used to determine matrix porosity when water is observed to be pushed into karst matrix.
- Understanding conduit location and porosity can help to model water flow in karst aquifers, and can be used in understanding contaminant transport in karst areas.

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