Electrical Resistivity – Applications for Geologic Site Characterization & Void Detection

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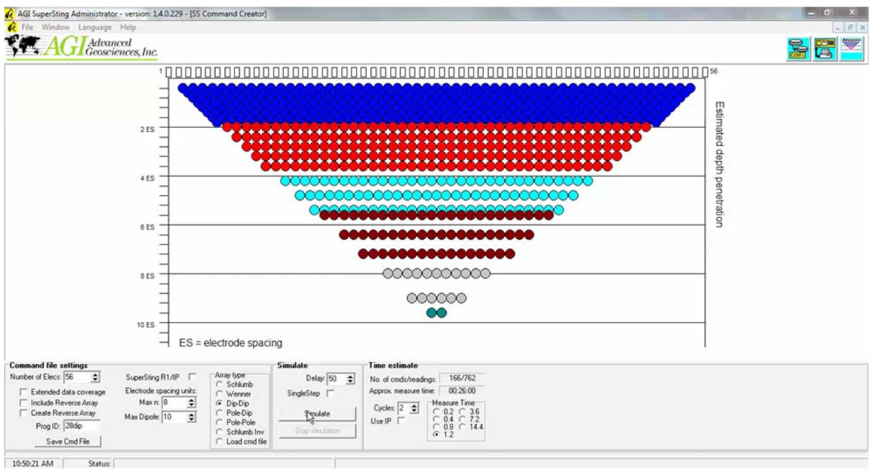
What is Electrical Resistivity?

- Surface geophysical method that measures the electrical resistance of subsurface materials
- Multi-electrode systems incorporate a series of electrodes along a cable, allowing for 2D profiles/cross sections of resistivity
- Electrical current is injected into ground by active electrodes and the resistance of the current is measured at various locations along the line by potential electrodes
- A variety of testing methods (i.e. Dipole-Dipole, Schlumberger, Wenner, Gradient, etc.) can be used to collect data using different combinations of electrodes
- Electrode spacing determines depth of penetration

Dipole-Dipole Method



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Applications of Electrical Resistivity

- General geologic site characterization
  - Differentiate between stratigraphic units, water table, rock integrity
  - Differentiate porosity and variations in grain size within a single stratigraphic unit
- Cavity/void detection, karst mapping, sinkholes
- Hydrogeologic investigations (saturated vs. unsaturated, determine production zones for water supply, fracture mapping)
- Geotechnical investigations
- Environmental investigations (plume mapping, flow pathways, top of rock)

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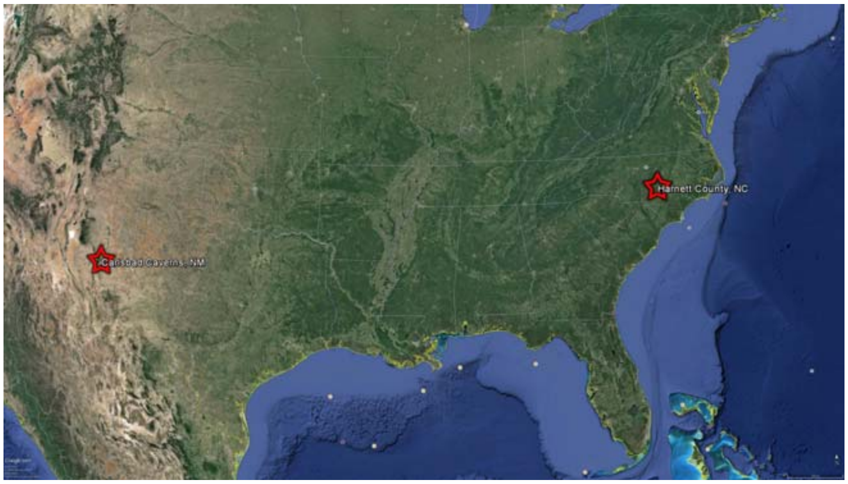
Case Studies: Sand Unit Mapping and Cave/Void Detection



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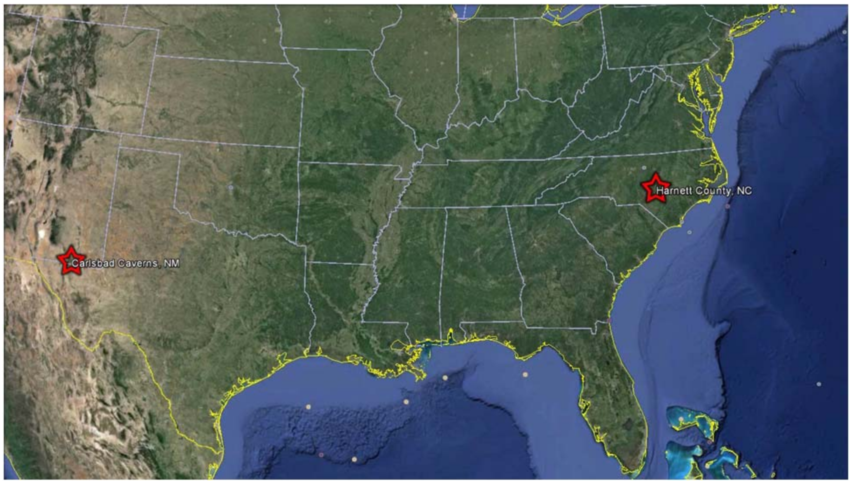
Harnett County Sand Mapping



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Harnett County Project Approach

- Use surface resistivity mapping to provide general estimates of surface sand unit thickness and lateral variability
- Limited site access and time, perform transects where possible to obtain as much coverage across site as possible
- Correlate geophysical data to boring logs
- Provide general estimates of economically viable sand deposits at the property.

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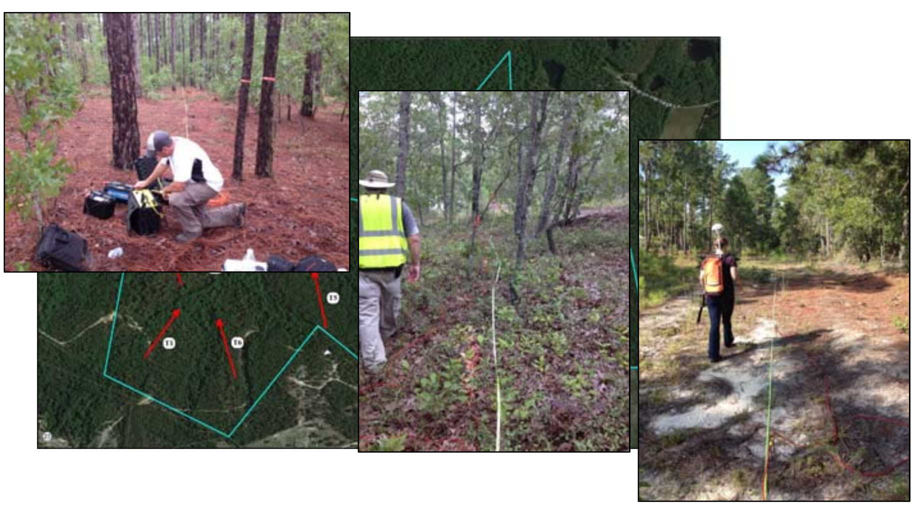
Locations of Resistivity Transects



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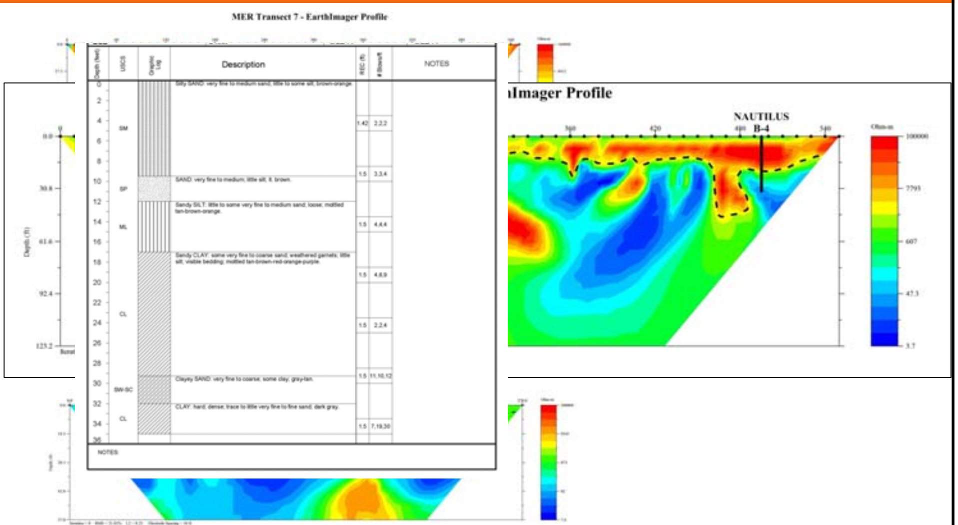
Example Resistivity Results



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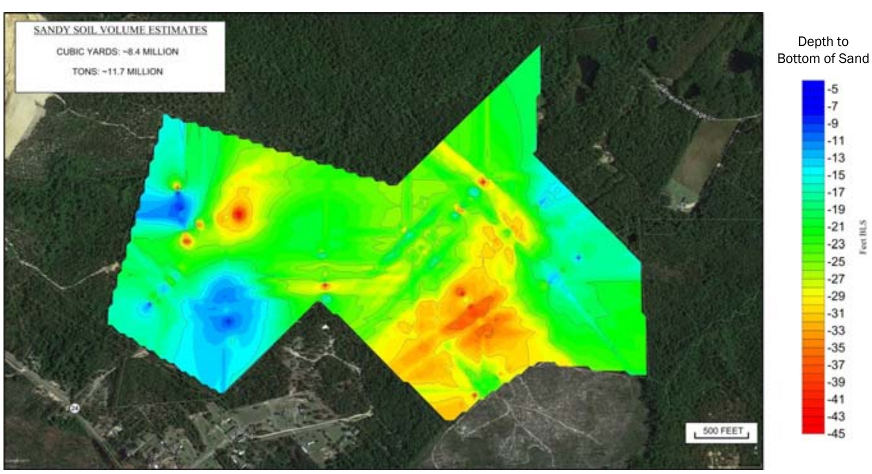
Contour Map of Sand Thickness/Depth



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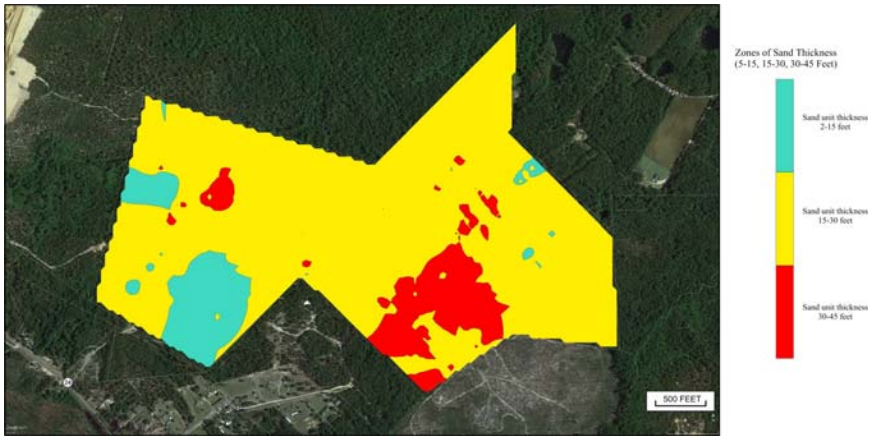
Generalized Sand Thickness Units from Geophysical Data



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Results of Sand Mapping

- The resistivity survey provided reliable electrical data to make geologic interpretations
- Good correlation was made between geophysical data and soil boring information
- Coarse sampling across the 230-acre site provided a baseline, general idea of sand thickness
- Geophysical interpretations also correlated with visual analysis of nearby sand mines

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Carlsbad Caverns Cave/Void Detection

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Carlsbad Site Map

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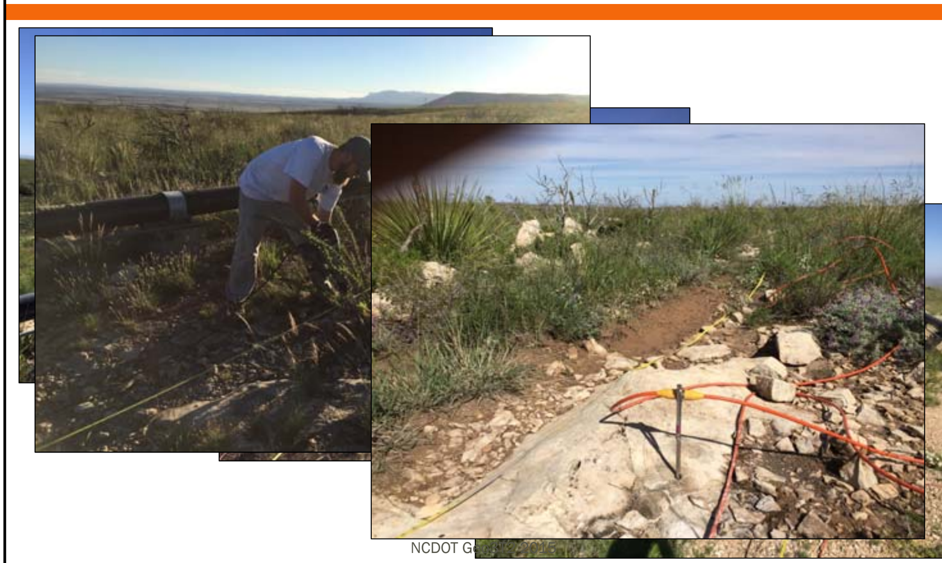
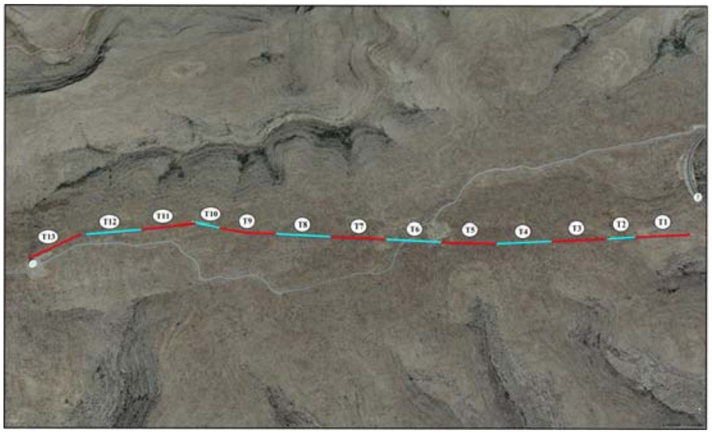
Carlsbad Project Approach

- Perform 2D resistivity mapping along entire length of proposed subsurface water line
  - Use roll-along method
  - Separate results into individual profiles for analysis
- Review 2D geophysical profiles for possible caves/voids
  - Air-filled voids exhibit infinite resistance (theoretically)
  - Effects of possible stalactites/stalagmites and materials surrounding a void can decrease its resistivity
- Perform 3D resistivity surveys at locations of possible caves
  - Series of parallel 2D lines are combined and inverted in 3D
  - 3D models help to further delineate and constrain possible caves observed in 2D profiles

Site Photos

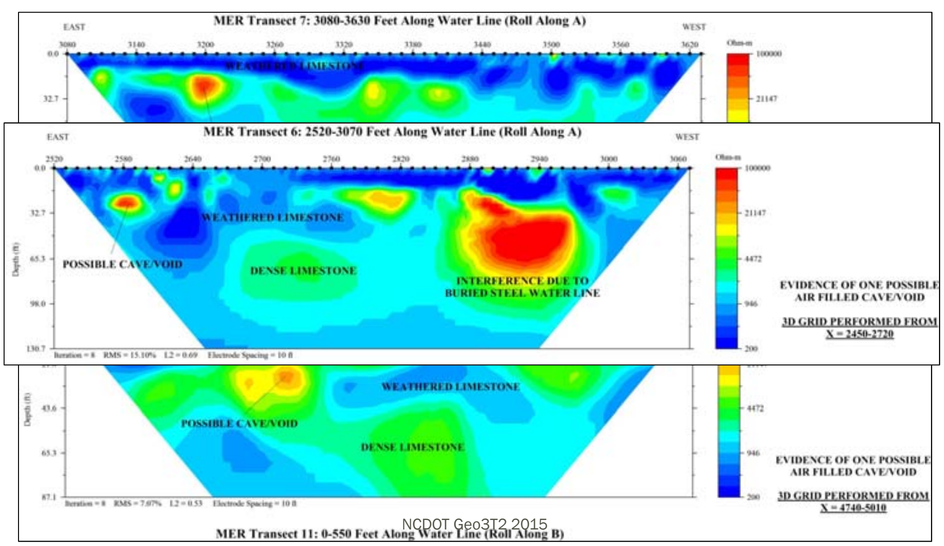


Locations of 2D MER Transects

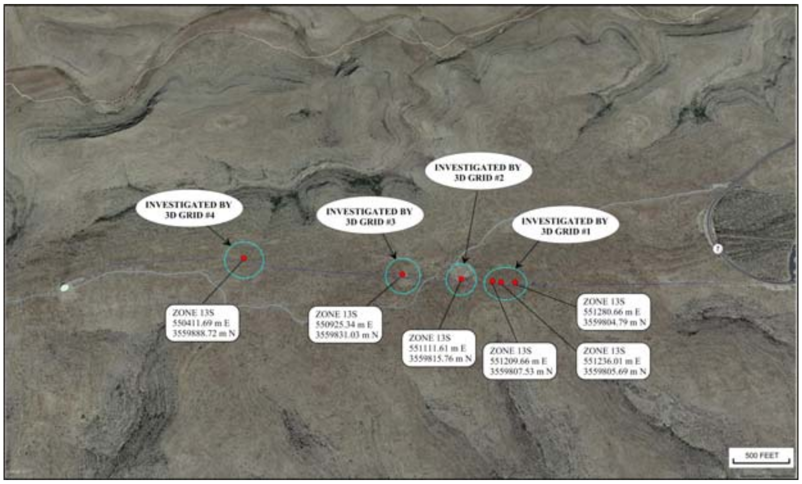


Transect ID	Total Length
T1	550 Feet
T2	270 Feet
T3	550 Feet
T4	550 Feet
T5	550 Feet
T6	550 Feet
T7	550 Feet
T8	550 Feet
T9	550 Feet
T10	370 Feet
T11	550 Feet
T12	550 Feet
T13	540 Feet

Examples of 2D Resistivity Results



Locations of Possible Voids



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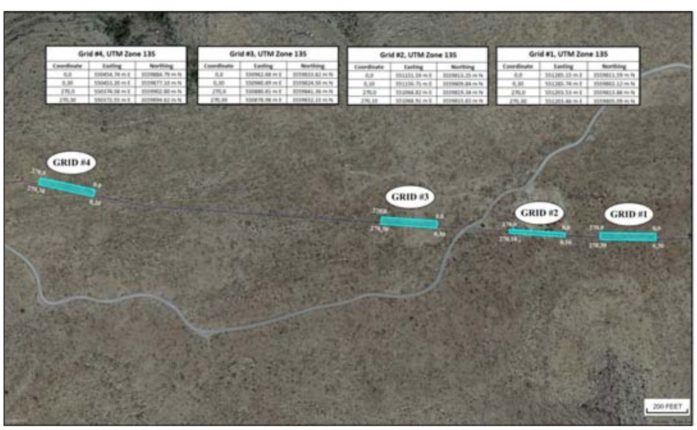
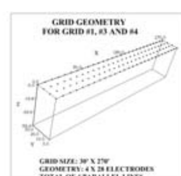
Locations of 3D Grids





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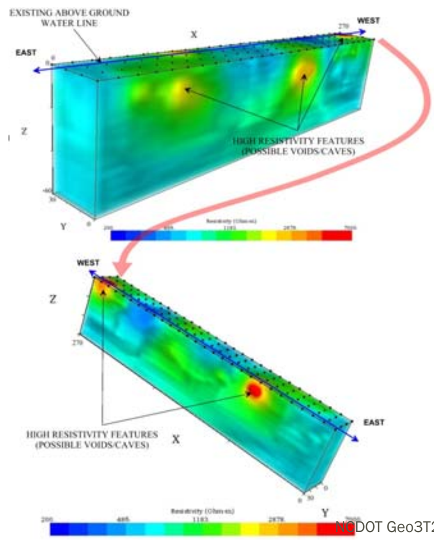
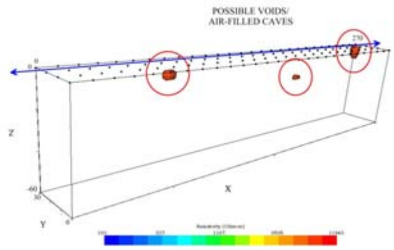
Examples of 3D Model Results

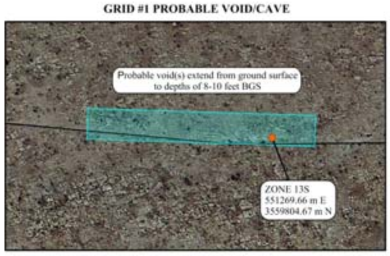




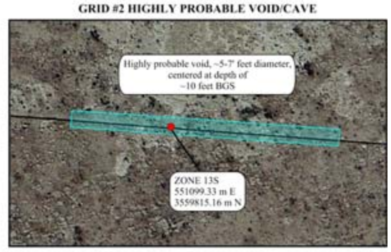
Grid #3, UTM Zone 13S		
Coordinate	Easting	Northing
0,0	550962.68 m E	3559833.82 m N
0,30	550960.69 m E	3559824.50 m N
270,0	550880.81 m E	3559841.36 m N
270,30	550878.98 m E	3559832.15 m N

Final Void Locations and Classifications

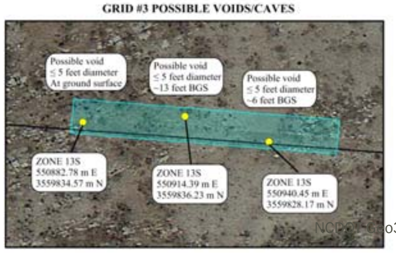
GRID #1 PROBABLE VOID/CAVE



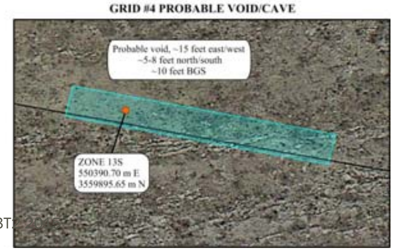
GRID #2 HIGHLY PROBABLE VOID/CAVE



GRID #3 POSSIBLE VOIDS/CAVES



GRID #4 PROBABLE VOID/CAVE



Results of Cave Mapping

- 2D resistivity mapping provided accurate analysis of possible voids along water line route
- Buried metal pipe resulted in interference at road crossing
- 3D surveys allowed for more detailed delineation and classification of voids
  - One highly probable void
  - Two probable voids
  - Three possible voids
- GPS integration provided the NPS with accurate locations for construction design purposes

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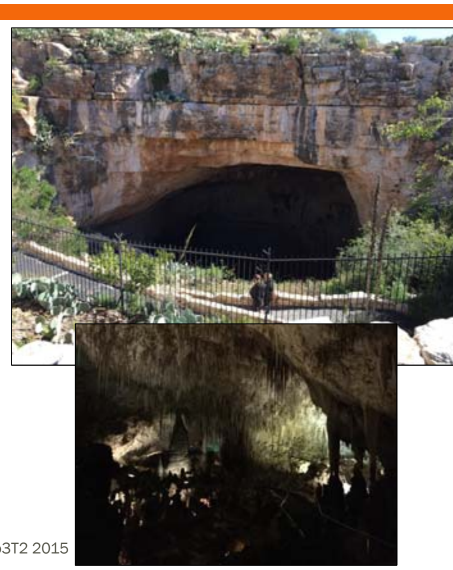
Questions?



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