Abstract

Three-dimensional speleogenesis in generally assumed to dominate conduit development in carbonate platforms. However, both mixing zone and vadose CO₂ reactions contribute to persistent porosity and mixing zone dissolution along the southern margins of carbonate development that are observed in many systems. Horizontal and vertical bedrock heterogeneity, and a mixing zone that moves with sea level, complicate efforts to understand linkages between hydrology, geochemistry, and hydrological controls on conduit development. Ultimately, models of carbonate platform speleogenesis must include interactions between all of these parameters over time and space. The objective of this project is to create a simulation platform that enables interactive comparison of observed data with modeled speleogenesis for a coastal environment.

Results

1. Vadose Zone: The role of CO₂ will be evaluated through long-term sampling at selected sites. Caves in the highest elevations relative to past sea levels will be identified by LiDAR by DEM analysis of cave heights. Such sites are most likely to be influenced by mixing zone processes, and will be monitored for CO₂ production for 1 year.

2. Modern Mixing Zone: Geophysical (i.e., temperature, conductivity, TDS) and flow parameters will be collected through the mixing zone to determine the pathways and to assess mixing efficiencies between the sea and vadose systems, and support geochemical modeling of dissolution rates.

3. Paleo Mixing Zone: A statistical analysis of a modern mixing zone model to predict the depth of conduit development at paleo sea levels, which will be tested against existing survey data and re tied with subsurface lithofacies properties.

Methods

Vadose Zone

- **Systems:** The site is generally assumed to dominate conduit development in carbonate platforms. However, both mixing zone and vadose CO₂ reactions contribute to persistent porosity and mixing zone dissolution along the southern margins of carbonate development that are observed in many systems. Horizontal and vertical bedrock heterogeneity, and a mixing zone that moves with sea level, complicate efforts to understand linkages between hydrology, geochemistry, and hydrological controls on conduit development. Ultimately, models of carbonate platform speleogenesis must include interactions between all of these parameters over time and space. The objective of this project is to create a simulation platform that enables interactive comparison of observed data with modeled speleogenesis for a coastal environment.

Modern Mixing Zone

- **Variables:** Various aspects of the carbonate system will be measured, including total dissolved CO₂, TDS, and temperature at various elevations, as well as flow rates. These data will be compared to modeled results to determine mixing efficiencies between the sea and vadose systems, and support geochemical modeling of dissolution rates.

Paleo Mixing Zone

- **Methods:** A statistical analysis of a modern mixing zone model to predict the depth of conduit development at paleo sea levels, which will be tested against existing survey data and re tied with subsurface lithofacies properties.

Figure 1

**Research Objectives**

- **Objectives:** The goals of this project are to understand the controls on speleogenesis in a coastal karstic carbonate aquifer, and the eastern coast contains what may be the most carbonate caves in the world. The project has very limited data, especially at the coastal site. Species are generally found in bays, resulting in a nearly level topography.

Site Location

- **Description:** The project site is located in a coastal karstic carbonate aquifer, and the eastern coast contains what may be the most carbonate caves in the world. The project has very limited data, especially at the coastal site. Species are generally found in bays, resulting in a nearly level topography.

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- **Methods:** The role of CO₂ will be evaluated through long-term sampling at selected sites. Caves in the highest elevations relative to past sea levels will be identified by LiDAR and DEM analysis of cave heights. Such sites are most likely to be influenced by mixing zone processes, and will be monitored for CO₂ production for 1 year.

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Paleo Mixing Zone

- **Methods:** A statistical analysis of a modern mixing zone model to predict the depth of conduit development at paleo sea levels, which will be tested against existing survey data and re tied with subsurface lithofacies properties.

Significance

- **Relevance:** Modern near-surface conduit development will improve understanding of the coastal carbonate systems and the role of sea level changes in the development of such systems.

- **Significance:** Understanding the distribution of conduits informs hydrologic modeling to assess present and future changes in water flow, storage, and discharge.

- **Contribution:** The model produced by this study will improve our understanding of modern carbonate systems and their response to sea level changes.

- **Application:** The project will improve our understanding of modern carbonate systems and their response to sea level changes.

Figure 2

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