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Analysis of Microearthquakes to Identify Weak Points in the Subsurface as Observed from a Salt Dome Study.

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The U.S. Gulf Coast passive continental margin hosts numerous salt domes, in which massive underground caverns have been excavated. Salt caverns are commonly used to store hydrocarbons, but can become mechanically unstable and collapse, thus presenting a hazard, and resulting in major economic loss and the evacuation of residents for safety purposes. One recent example is the Bayou Corne sinkhole in southeast Louisiana that formed in 2012. Based on reports of ground tremors at the Sorrento salt dome located ~31 km from Bayou Corne, we started monitoring the seismicity in February 2020 to help improve our understanding of the subsurface processes and their impact on the mechanical integrity of the salt caverns. Microearthquakes in stable salt domes are few and sporadic with a notable increase in seismicity prior to catastrophic events like cavern collapse. These microearthquakes are usually low magnitude, with partially emergent P-wave onsets as well as P-wave shrouded in the coda of preceding events during swarms. Such characteristics make them difficult to identify with current automatic arrival detection and location approaches. To monitor the Sorrento dome, we deployed a nodal array of 12-17 stations across the dome and collected eight months of data. Interstation distances range from 0.2-1.9 km with the entire array spanning an area of ~11.6 km^2.

We will present results from applying both physics-based and data-based techniques to identifying microearthquakes in the Sorrento salt dome. We interpret our earthquake catalog to show the heterogeneity of the geology around the salt dome and how the dome may respond to human driven changes. Our preferred method for earthquake detection is easy to implement and can be readily adapted for other studies such as mine monitoring, geothermal exploration, and dam monitoring. This project also shows how seismic techniques can be applied to subsurface monitoring for environmental studies.