SEG Near Surface Research Award
Brady Flinchum Application

<u>Abstract</u>

Fresh water, or the lack of it, impacts almost every environment on Earth—its availability governs ecosystems, influences human activity and sculpts landscapes. Groundwater is a significant piece of the fresh water reservoir and in this project I focus on improving the ability to estimate the spatial distribution of parameters influencing groundwater flow and storage, specifically porosity. Although a unique porosity exists in the subsurface, it is difficult to characterize lateral distributions of porosity at depths greater than a few meters. In an attempt to provide porosity estimates across large spatial scales (100's of meters) in the saturated and unsaturated zones I will rely on non-invasive geophysical measurements—but estimates of porosity from different geophysical measurements do not always agree. I compared seismically estimated porosities using a 2D rock physics Bayesian inversion to estimates from surface nuclear magnetic resonance (NMR) on a sandstone and a fractured granite aquifer. The seismically estimate porosities were 5 times higher in the granite aquifer and 3 times lower in the sandstone aquifer (Flinchum et al., 2015). In this study, I seek to understand why seismically estimated porosities are different from NMR-derived porosities—can the difference provide additional information about the aquifer? I hypothesize the difference between the two measurements can be used to differentiate between shallow confined and unconfined aquifers because confining pressure affects seismically estimated porosities but will not affect surface NMR estimates.

To address the hypothesis, I propose a combined geophysical approach using p-wave, s-wave velocities and surface NMR data ground-truthed by lab measurements done on samples. The seismic data will be used to estimate porosity in the unsaturated zone and the surface NMR data will constrain estimates in the saturated zone. I will collect geophysical data on two geologically distinct sites: a confined sandstone aquifer and an unconfined weathered and fractured granite aquifer. To collect samples I will use a geoprobe and a backpack drill and measure porosities in the laboratory by drying and weighing known sample volumes. To obtain porosities at depths greater than the geoprobe can sample, I will utilize existing boreholes and a downhole NMR logging system. Using this unique data set I will be able to estimate unsaturated and saturated porosity over large spatial scales and improve our ability to characterize shallow groundwater aquifers. The results of this project will improve the understanding of the relationship between hydrophysical properties and near-surface geophysical parameters on different lithologies and at large spatial scales. Currently, we have access and resources to run the required geophysical equipment and only require funding for labor, operation and materials pertaining to the geoprobe data acquisition.