Feasibility study of vertical Seismic profiling methods to image the Socorro Magma Body with a large-N nodal array and local seismicity

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Previous work has shown that vertical seismic profiling methods (VSP) can be used to obtain high resolution 3-D reflection images beneath a surface receiver array images using local micro-seismic sources. These examples have concentrated on shallow structures in the upper continental crust ($z < 10$ km) while imaging of mid and lower-crustal features with micro-seismic sources and VSP methods remains unexplored.

In this study, we attempt to image the Socorro Magma Body (SMB) using VSP methods and local seismicity recorded by 801 nodal instruments deployed above the northern portion of the magma body for a period of two weeks. The SMB is a large mid-crustal continental magma body at 19-km depth located within the Rio Grande Rift in central New Mexico. It was originally identified on short-period recordings based on reflected/converted phases arising from the magma body from shallow seismicity and later imaged by the COCORP studies using Vibroseis sources.

A critical step of VSP imaging is to have accurate locations of the seismicity beneath the array. For this reason, it was necessary to visually identify and pick P and S-wave arrivals. In total 98 events were deemed good for P and S-wave arrival picking, with most of these corresponding to regional and local earthquakes, and a few local explosive sources were picked for velocity discrimination. These events are located using a local velocity model. Finally, we apply VSP imaging to only local events that have large signal-to-noise to obtain a reflection image of the magma body beneath the array.