Systematic Detection of Microearthquakes During Several Moderate-Size Earthquake Sequences in Central and Eastern United States

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Moderate to large shallow earthquakes are generally followed by many aftershocks with their rates decaying with time since the mainshock. Sometimes they are preceded by enhanced microseismicity right before the mainshock occurrence time, known as foreshocks. While foreshock and aftershock properties have been well studied for earthquake sequences along major plate boundary faults, their behaviors and physical mechanisms are not well understood, especially at intraplate regions where the background seismicity rate is relatively low. Here we report our group's recent efforts to apply start-of-the-art earthquake detection methods (e.g., template matching, machine learning) to systematically detect microearthquakes during several recent moderate-size earthquakes in Central and Eastern United States. These include the 2014 M4.1 Edgefield, South Carolina, the 2018 M4.4 Decatur, Tennessee, the 2020 M5.1 Sparta, North Carolina earthquakes, as well as our ongoing IRIS-PASSCAL temporary deployment in the source region of the 1886 M7 Charleston earthquake. In each case, we can detect a few to a few tens of times more microearthquakes than listed in the standard USGS catalogs. In addition, we compute differential travel times and amplitude ratios to relocate those newly detected events and recompute their magnitudes. These newly identified events help to illuminate subsurface fault structures that hosted the mainshock and aftershocks, and improve our understanding of physical mechanisms of foreshocks and aftershocks at intraplate regions. Updated results will be presented at the meeting.

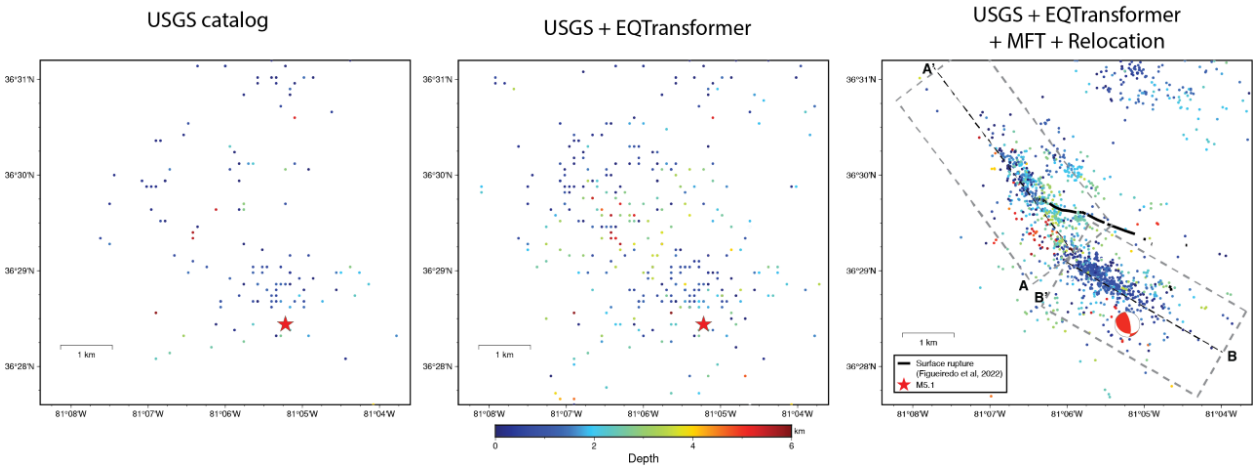

Figure 1. A comparison between earthquakes listed in the original USGS catalog, the USGS catalog plus those newly detected with the EQTransformer phase picking method (Mousavi et al., 2020), and those after the Matched Filter Technique (Peng and Zhao, 2009) and hypoDD relocation. The red star marks the hypocenter of the 2020 M5.1 Sparta earthquake and the solid line marks the surface rupture of the Sparta mainshock (Figueiredo et al., 2022).

Reference:

Peng and Zhao (2009), Nature Geosci., https://doi.org/10.1038/ngeo697
Mousavi et al. (2020), Nature Comm., https://doi.org/10.1038/s41467-020-17591-w
Figueiredo et al. (2022), GSA Today, https://doi.org/10.1130/GSATG517A.1