Supplemental Material: Small earthquake moment magnitude and implications for frequency magnitude scaling of injection induced earthquakes of the Raton Basin

Andres Felipe Peña Castro [*][1], **Brandon Schmandt** [2], **Margaret Glasgow** [3], **Mohammadreza Jamalreyhani** [4,5],

Ruijia Wang [4], **Elizabeth S. Cochran** [6]

[1]Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico, U.S.A., [2]Department of Earth,

Environmental, and Planetary Sciences, Rice University, Houston, Texas, U.S.A , [3]U.S. Geological Survey, California Volcano Observatory,

Moffett Field, California, U.S.A, [4]Department of Earth and Space Sciences, Southern University of Science and Technology, Shenzhen,

Guangdong, People's Republic of China, [5]School of Earth and Space Sciences, University of Science and Technology of China. , [6]U.S.

Geological Survey, Earthquake Science Center, Pasadena, California, U.S.A

References

Eulenfeld, T. and Wegler, U. Crustal intrinsic and scattering attenuation of high-frequency shear waves in the contiguous United States. *Journal of Geophysical Research: Solid Earth*, 122(6):4676–4690, 2017.

Jamalreyhani, M., Wang, R., Schmandt, B., Felipe Peña Castro, A., and Glasgow, M. E. Evidence for fluid pressurization of fault zones and persistent sensitivity to injection rate beneath the Raton Basin. *Geophysical Research Letters*, 52(13):e2025GL114675, 2025.

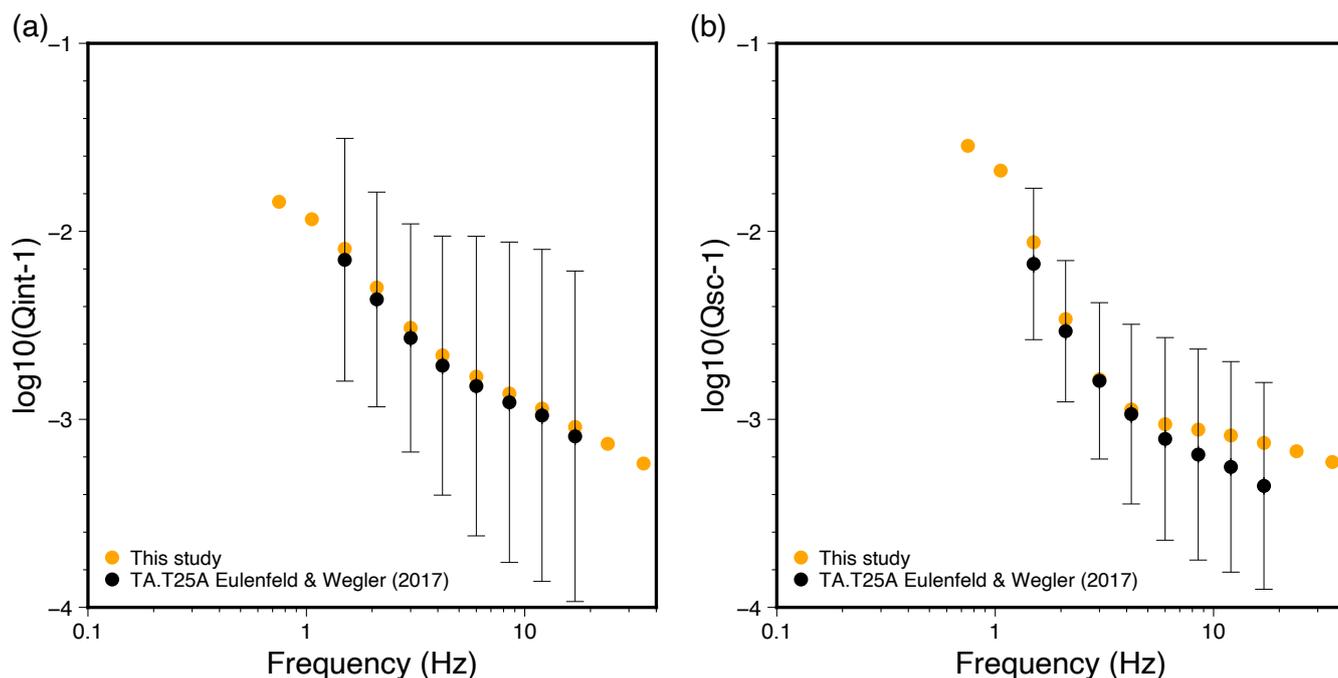*Corresponding author: andresfpenacastro@gmail.com

Figure 1 Comparison of estimates of intrinsic (a) and scattering (b) attenuation versus frequency from values obtained by this study (orange circles) and the TA.T25A station (black circles; Eulenfeld and Wegler (2017)).
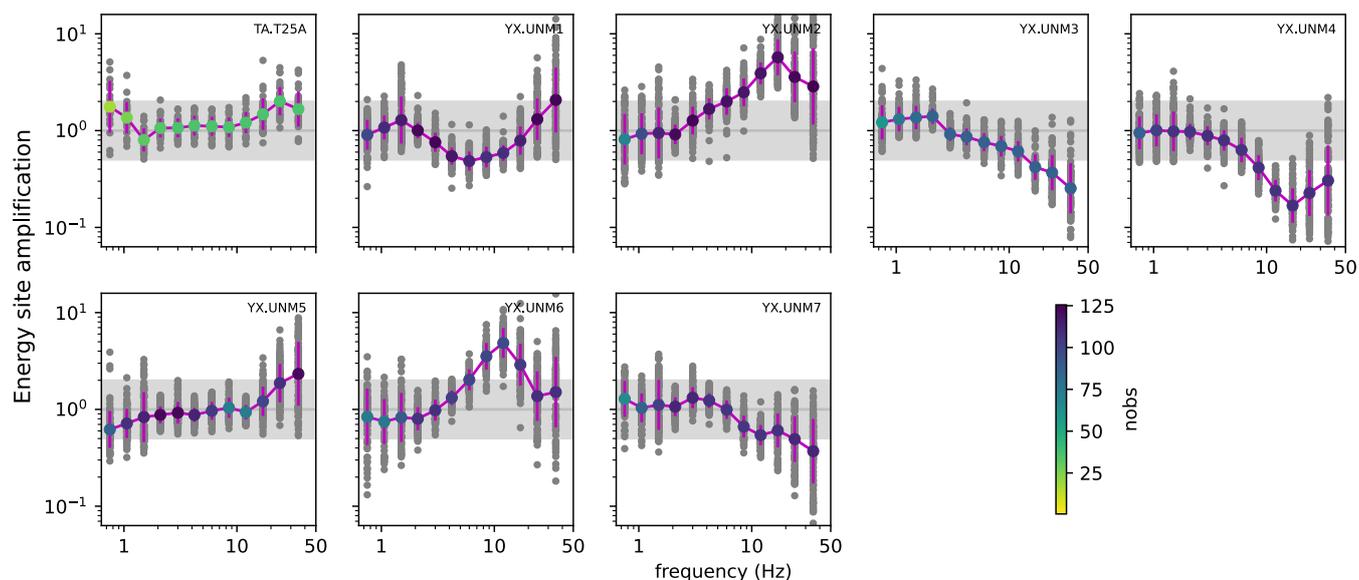

Figure 2 Energy site amplification as a function of frequency for the stations in the Raton Basin. Observations for individual events are represented by gray dots. The geometric averages are marked as circles, whereas the color represents the number of observations. Note that the geometric mean of all observations, including all stations ,is itself fixed at 1 in each frequency band. The average at 1 is marked with horizontal gray lanes. The light gray boxes span amplifications between 0.5 and 2.
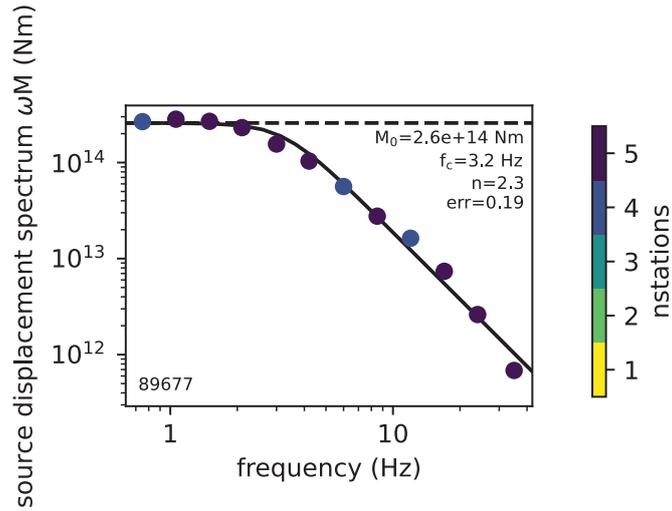
Figure 3 Source displacement spectrum for an earthquake. The seismic moment obtained by Qopen is highlighted with a dashed horizontal line. The circles are color coded by the number of stations used.
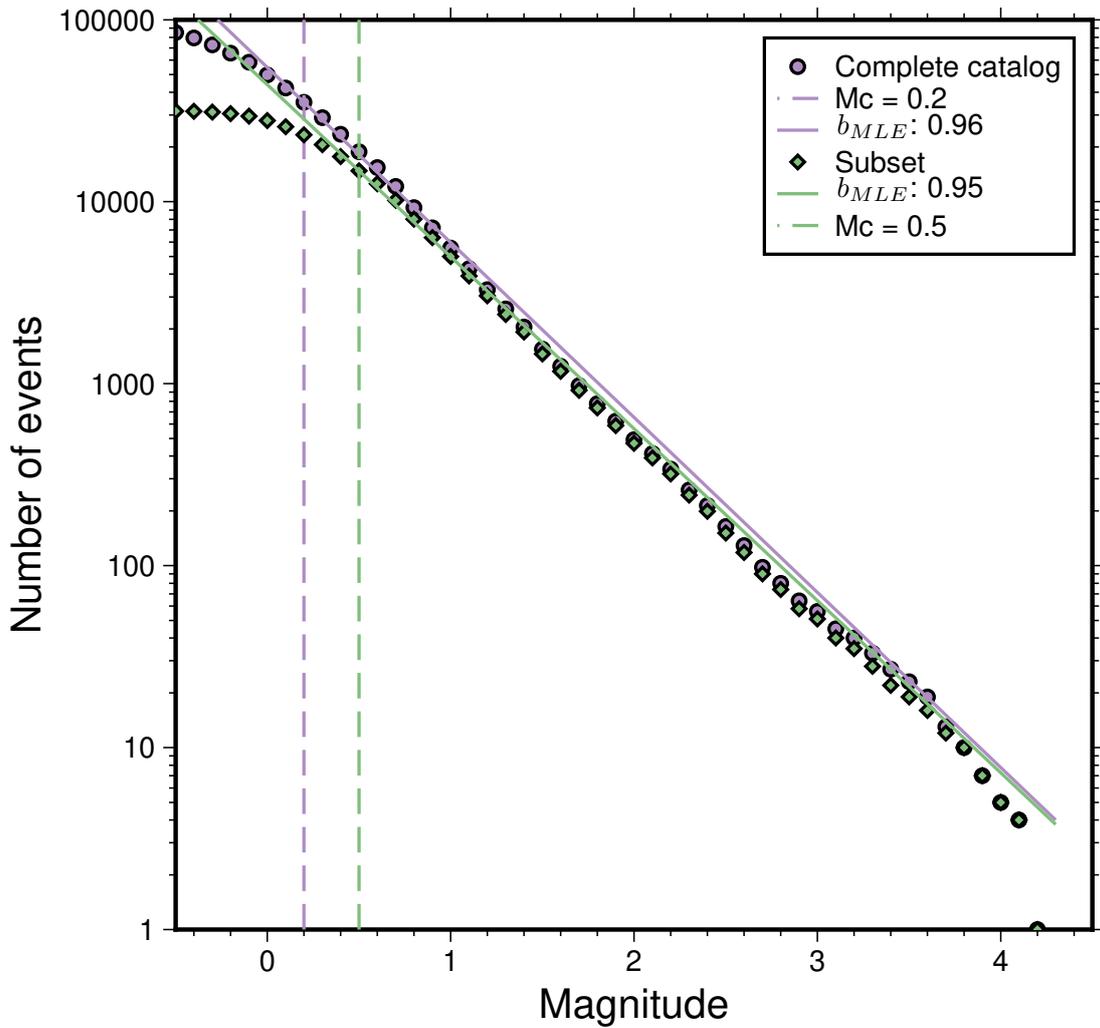

Figure 4 Cumulative Magnitude-Frequency Distribution (MFD) for the complete catalog (purple circles, $n = 95,993$) of the Raton Basin (Jamalreyhani et al., 2025) with local magnitude and the subset of events that have local and moment magnitude estimates. Green circles represent the events in our study with local magnitudes estimate (M_L^{SJ25}, $n = 31,581$). Clear differences between the two MFDs are present mostly below $M \sim 0$.