Preliminary analysis of seismic attenuation and heterogeneities in the Weiyuan Shale Gas Field: Peak delay time and Coda Q analysis

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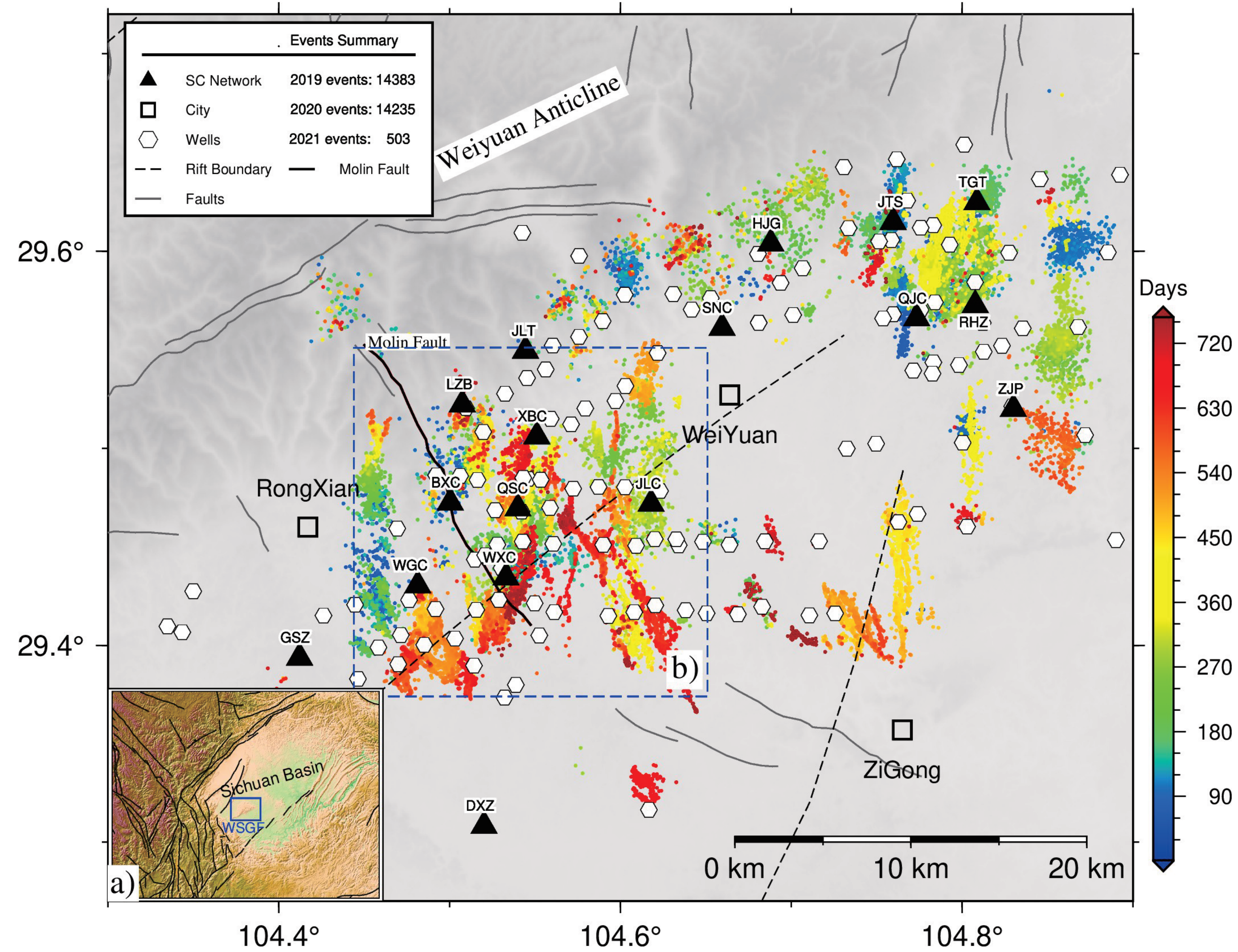
1. Introduction:

Fig.1: Permanent seismic stations and relocated seismicity from March 2019 to February 2021 in the Weiyuan shale gas field (WSGF). Black triangles and white hexagons refer to seismic stations and HF platforms, respectively. Blue square refers to selection of subdata set with better station coverage.

2. MuRAT Tool

MuRAT is a Matlab Package for seismic Attenuation, Scattering and Absorption Tomography using Body and Coda Waves at multiple frequencies.

3. Parameter Selection

Central Frequency: 6 Hz
Direct wave window: 1 sec
Noise Window: 1sec
Coda Window: 4 sec
Minimum P wave arrival time: 2

Fig.2: Three collocated events waveforms recorded on different stations. Red and blue refers to P and S wave arrivals, respectively. Blue dashed line refers to selection of coda windows.
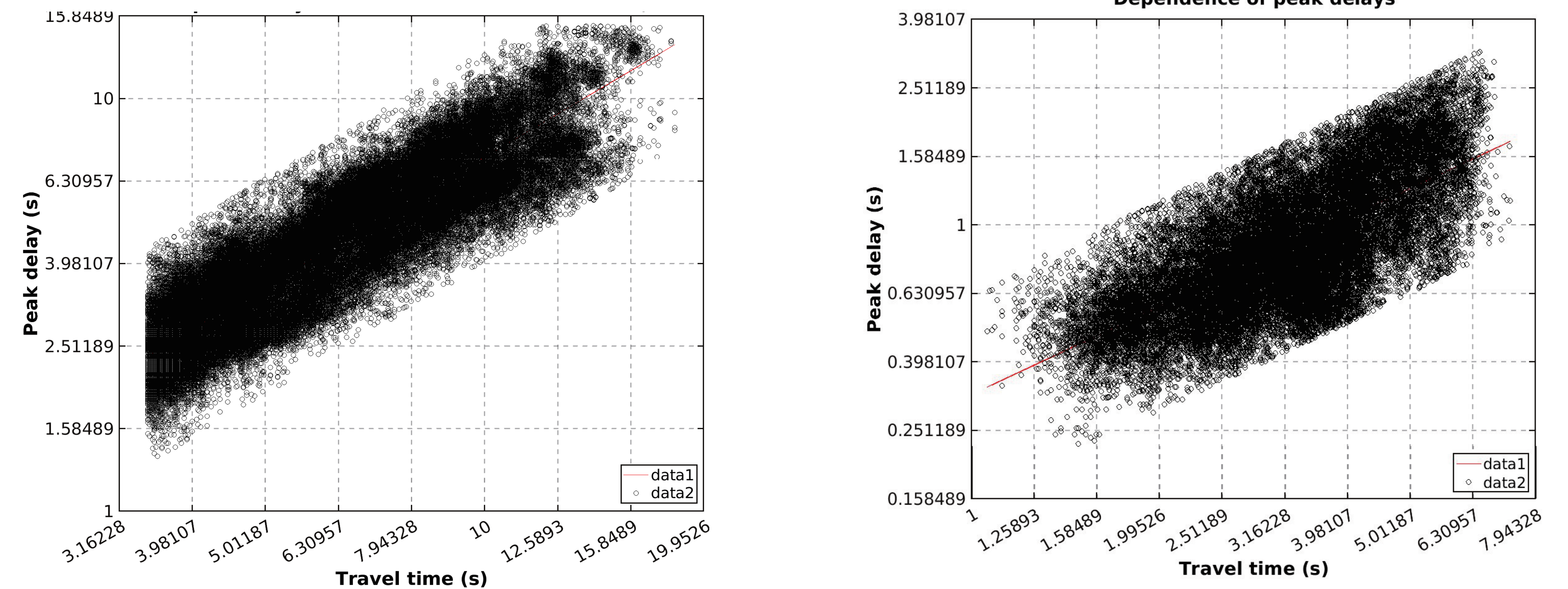
4.Results

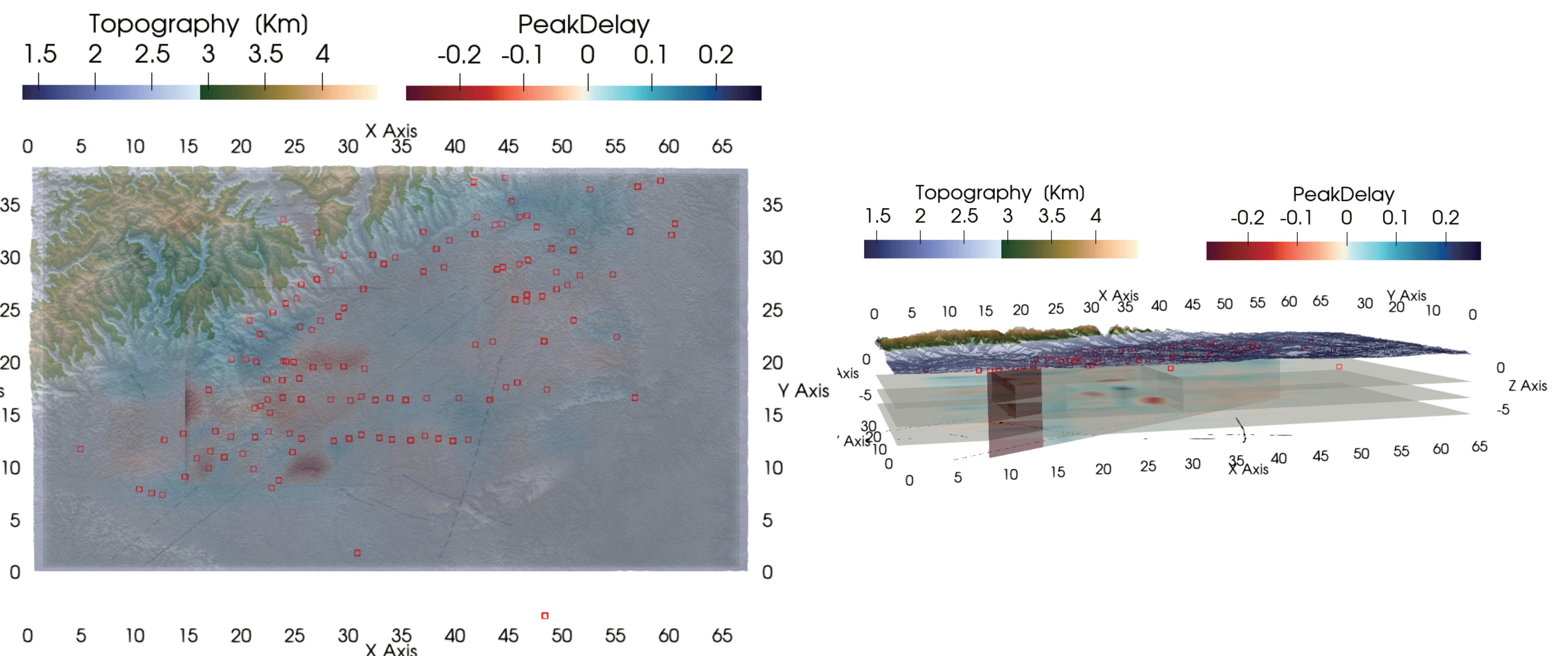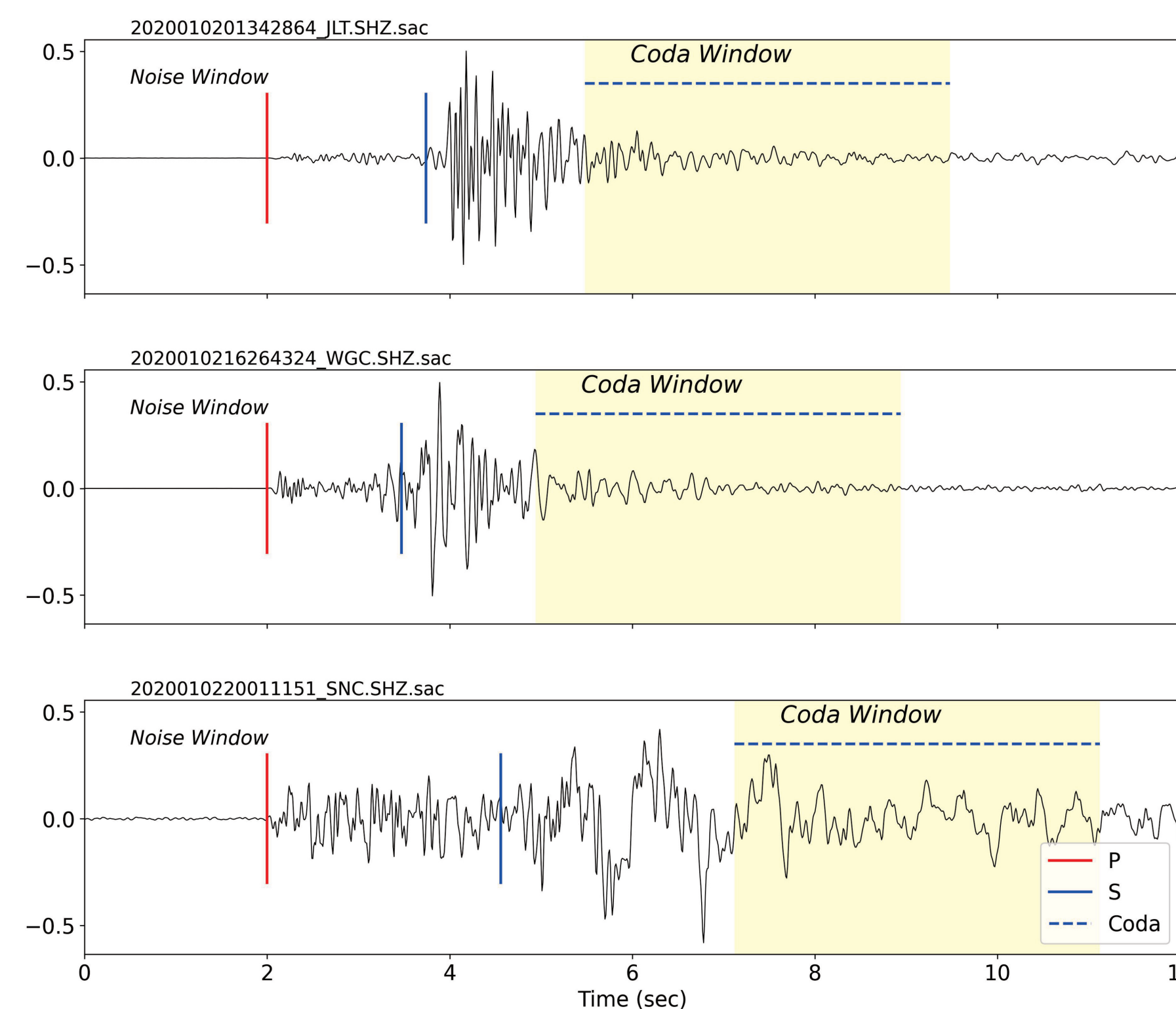Fig. 3: Peak-delay dependence on travel time at 6 Hz for total WSGF and selected subdata set

Fig. 4: Peak delay variations at 6 Hz Frequency. Red square refers to hydraulic fracking (HF) wells. Subset data has better resolution with high ray density, compare to full dataset with sparse network and clustered seismicity.

Take Away messeges:

1. This is the first attempt to utilize the MuRAT tool to monitor the effects of injected fluid on seismic attenuation during the HF process.
2. Careful selection of events and other parameters including central frequency plays a crucial role.
3. We found few confined anomlous zone nearby HF zones and shallow fault zones with high peak dealy contrast.
4. Coda Q analysis and Qc have poor resolution and requires more careful selection of events and signal/noise window length.