Detection of P-S travel time and location for Low SNR Event using polarization <quillbot-extension-portal></quillbot-extension-portal><quillbot-extension-portal></quillbot-extension-portal>

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Understanding subsurface reservoirs can be accelerated by detecting more microseismic events with low signal-to-noise ratios (SNR). We propose a new comprehensive approach for detecting low SNR event P-S travel time. To describe the polarization of the waveform, we utilize 3D particle motion analysis in the time and frequency domain. We capture the direct S-wave particle motion depicting a flat shape (planarity) and P-wave arrival polarization perpendicular to the S-wave arrival polarization (perpendicularity). In previous studies, spectral matrix (SPM) analysis was used to characterize the time and frequency domain motion of 3D particles of P-waves for low SNR microseismic event detection. SPM analysis can be used to detect coherent seismic arrivals, however, it is insufficient to detect S-wave arrivals.

We introduce the time delay components of the SPM to separate the S-wave from the ambient noise and detect S-wave arrivals. We term the new SPM matrix as Complex Spectral Matrix (CSPM). By using the CSPM analysis method, we assess the planarity and perpendicularity of the polarization in the time and frequency domains. We define a characteristic function to detect S-wave arrivals by combining two properties, planarity, and perpendicularity, to detect more low SNR events reliably. By setting the threshold values for the P-wave and S-wave characteristic functions separately, we obtain the P-S travel time. We introduce the REAL approach, which uses P and S pickup counts and travel-time residuals to locate seismic events by correlating various arrival phases (Zhang et al., 2019).

We apply our method to 4 hours of field data recorded at the Groningen field in the Netherlands to detect catalog events as well as low SNR events. For four hours of continuous data, our method detected all P-S travel times for two catalog events and five events detected by visual inspection by Mukuhira et al. (2020), in addition to seven new events. Moreover, we successfully located the hypocenter of all events using the detected P-S travel times with the REAL method.<quillbot-extension-portal></quillbot-extension-portal><quillbot-extension-portal></quillbot-extension-portal>

Keywords: Low SNR events, Polarization, Time and frequency analysis, P-S travel time detection, Hypocenter location

