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Ambient noise characteristics of the Chung-Liao Tunnel area in National Highway No. 3

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Under a uniform scattered wave field, the continuous recording of Cross-Correlation Functions (CCF) between monitoring stations can be approximated by the Green's function between these stations. Therefore, passive seismic noise interference techniques can be employed to monitor changes in the structural properties of the Earth. The Zhongliao Tunnel in the southern section of National Highway No. 3 cuts through two significant active structures, the chishan Fault and the Chekualin Fault. In order to investigate the impact of fault activity on the tunnel's structure, our laboratory deployed a dense array composed of 33 portable seismometers around the Zhongliao Tunnel starting in 2020, conducting seismic observations for an entire year. With an average station spacing of less than 1 kilometer in this dense array, there is a chance to obtain high-frequency Green's functions, enabling monitoring of shallow structures. However, non-uniform distribution of noise energy may cause differences between interference waveforms and real Green's functions. Therefore, this study focuses on the spatiotemporal characteristics of background high-frequency signals, aiming to clarify their sources as a foundation for future research. Through Power Spectral Density (PSD) analysis of the stations, we observed energy drops at night in the range of 1-12Hz , possibly attributed to body waves or surface waves generated by vehicular traffic on the highway. To identify the distribution of noise sources, the research area was subdivided into 121 grid points as potential signal sources. Surface wave and body wave energy decay characteristics were fitted separately to the spatial distribution of that energy, revealing that the predominant seismic mode is surface waves, and the most likely noise source is located at the tunnel entrance, unevenly distributed on the highway. Furthermore, an analysis of the amplitude asymmetry in the cross-correlation functions between stations indicated that the high-frequency signals originate from the tunnel entrance. As there are no specific conditions near the tunnel entrance that can autonomously generate high-frequency signals, we speculate that these signals are still caused by vehicles on the highway. When seismic waves propagate around the tunnel, the velocity structure causes energy to focus at the tunnel entrance, radiating outward. In the future, we will use Eikonal tomography to analyze the velocity structure beneath the array and conduct waveform simulations to test this hypothesis.