



Characteristics of Regional Seismic Waves from the 2006, 2009 and 2013 North Korean Nuclear Explosions

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The North Korean underground nuclear explosion (UNE) tests were conducted in 2006, 2009 and 2013. The events are the first UNEs in the 21st century. the UNEs were well recorded by dense regional seismic networks in South Korea. The UNEs provide unique regional seismic waveforms with high signal-to-noise ratios. However, the continental crust in the Korean Peninsula changes abruptly into a transitional structure between continental and oceanic crusts across the eastern coast. The complex geological and tectonic structures around the Korean Peninsula cause significant variations in regional waveforms. One outstanding question is whether typical seismic features are still observed in the North Korean UNE records. Another question is whether conventional discrimination techniques can be applicable for the North Korean UNEs. Lateral variations of regional phase amplitudes for the North Korean UNEs agree with both a Pn velocity tomography and a Lg attenuation tomography. P/S amplitude ratios are widely used for seismic discrimination. To understand the regional shear-energy composition, we analyze the frequency contents of waveforms. The shear-energy contents for the UNEs are compared with those for natural earthquakes with comparable magnitudes. We use the average variation of P/S amplitude ratios to minimize the local effects. The result shows that the UNEs are successfully discriminated from earthquakes in the Korean Peninsula.