



Seismic investigation of a South Korean warship sinking and two North Korean nuclear explosions

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A South Korean warship sank on 26 March 2010. The incident was recorded as an M1.5 event at local seismic stations. We analyze three local seismic records and investigate the source properties. The S-wave amplitudes are found to be comparable to the P-wave amplitudes. Seismic waves coupled from shock waves are observed, which allows us to constrain the epicentral distance and explosional-source feature. The coupled shock waves have a dominant frequency of ~ 32 Hz. The shock waves and high P/S amplitude ratios suggest an underwater explosion. The spectral contents of P waves allows us to constrain the source depth in the water. It appears that an explosive source was detonated at a depth of ~ 30 m in the water. Two North Korean nuclear explosion (UNE) tests were conducted in 2006 and 2009. The UNEs were well recorded by dense regional seismic networks in Korea, Japan and China. We examine the regional waveform features observed in the continental margin. We compare the waveforms and spectral contents between UNEs and earthquakes. The P, S and P/S ratios fluctuate significantly depending on the raypaths. Crustal phases (Pg, Lg) are attenuated along raypaths with undulated Moho depths. On the other hand, mantle-lid phases (Pn, Sn) are strengthened along the raypaths. The North Korean UNEs are well discriminated from regional earthquakes around the Korean peninsula using P/S amplitude ratios. Strong overshooting feature is observed in P spectra. It is observed that the 2009 UNE is about 5 times larger than the 2006 UNE.