REGIONAL CHARACTERIZATION OF EARTHQUAKES AND EXPLOSIONS IN NORTH KOREA

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The characterization of seismic events is important for monitoring compliance with the Comprehensive Nuclear-Test-Ban Treaty (CTBT). Like earthquakes, underground nuclear explosions generate seismic signals that can sometimes be detected at seismic stations located many thousands of kilometres away. Forensic Seismologists use a variety of methods to discriminate between the seismic signals generated by earthquakes, and those generated by nuclear test explosions. For the smallest magnitude events, signals are generally only observed at stations located at regional distances (less than 2000km). Seismic source discriminants using regional signals are region specific, with limited spatial application due to complex waveforms from a laterally heterogeneous crust. The Democratic People's Republic of Korea (DPRK) is of interest for seismologists monitoring the CTBT as it is the only state to have announced a nuclear test explosion in the 21st century. More than 150 seismic events have been detected near the DPRK test site since 2009 (Figure 1). These smaller magnitude events (<4.3 m_b), only recorded at regional distances, are presumed to be earthquakes and mining explosions. Here we investigate whether the *Pg/Lg* body-wave amplitude method can be used to discriminate between signals from these events and the announced DPRK nuclear explosions. By using knowledge of regional signals at the nearby seismic station USRK, we work towards a regional event screening criterion for earthquakes and explosions in the DPRK.

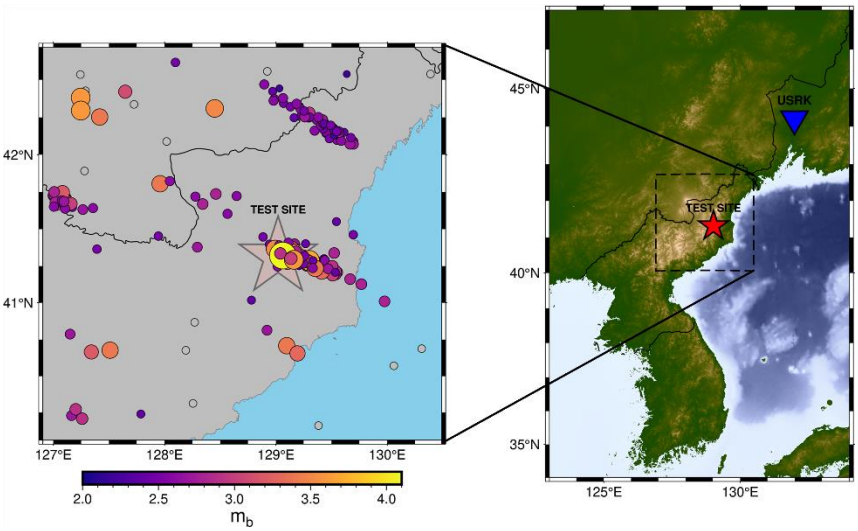

Figure 1: Seismic events detected near the DPRK test site.

The *Pg* phase is the largest amplitude *P*-wave observed at USRK from these events, with the crustally guided *Lg* phase the largest *S*-wave. Using analyst picked *Pg* arrival time windows and *Lg* time windows defined using theoretical group velocities, the root-mean-squared amplitudes of three different components of ground motion can be calculated for each phase. These amplitudes are measured for multiple frequency passbands in the 1-18Hz range to allow investigation of the optimal frequency band for discrimination. The results show that the *Pg/Lg* amplitude ratios of underground nuclear explosions in the DPRK are higher than nearby seismic events in passbands above 8Hz. For events within 45km of the test site, the scatter of ratios decreases significantly for the presumed earthquake population, with a separation between the two populations above 2Hz (Figure 2). This suggests that the *Pg/Lg* ratio can be used to discriminate between earthquake and explosion sources. Furthermore, a set of probable mine blasts produce higher *Pg/Lg* ratios than presumed earthquake and lower *Pg/Lg* ratios than nuclear tests from 6-14Hz. Therefore, it is possible that *Pg/Lg* ratios in this region could discriminate ripple-fired from point source explosions.

This is part of ongoing work to supplement operational event screening criterion used at AWE Blacknest, with the current results suggesting that the ratio of *Pg/Lg* can characterize sources in the DPRK. This research enhances AWE's capability to support the Ministry of Defence, who underpin the UK's commitment to the CTBT.

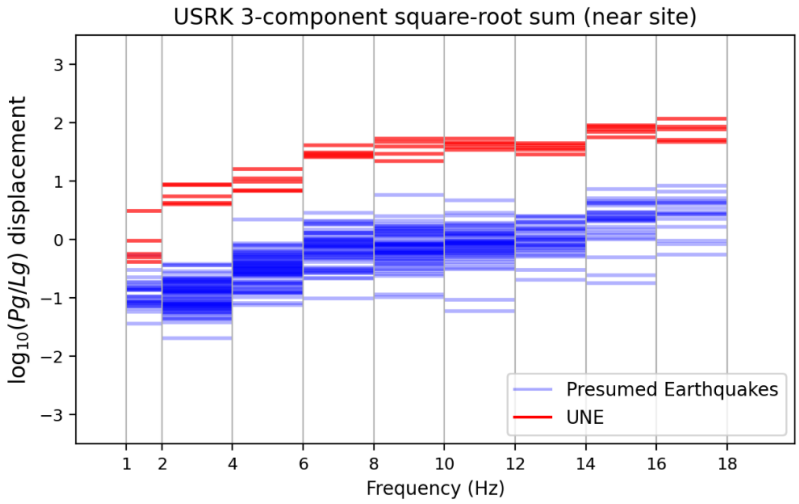

Figure 2: Pg/Lg amplitude ratios of announced underground nuclear explosions and earthquakes near the DPRK test site.