Earthquake or Explosion?
Regional characterization of seismic events in North Korea

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NUCLEAR SECURITY TECHNOLOGIES

① Mission

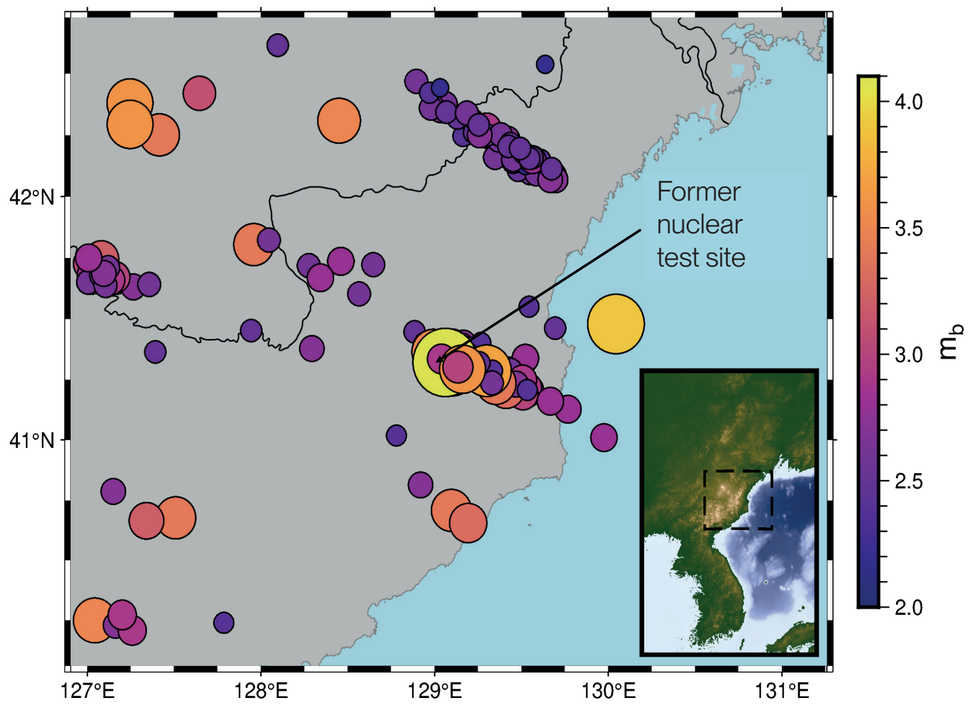
AWE support the Ministry of Defence (MOD) in underpinning the UKs commitment to the Comprehensive Nuclear-Test-Ban Treaty (CTBT)

Our mission is to develop the capability to analyse and advise on nuclear tests globally

Like earthquakes, underground nuclear tests generate seismic signals detected on seismometers

Forensic seismologists develop methods to discriminate between earthquakes and explosions

② North Korea: Earthquake or Explosion?



The Democratic People's Republic of Korea (DPRK) is of interest to forensic seismologists:

a) 6 announced underground nuclear tests in the 21st Century

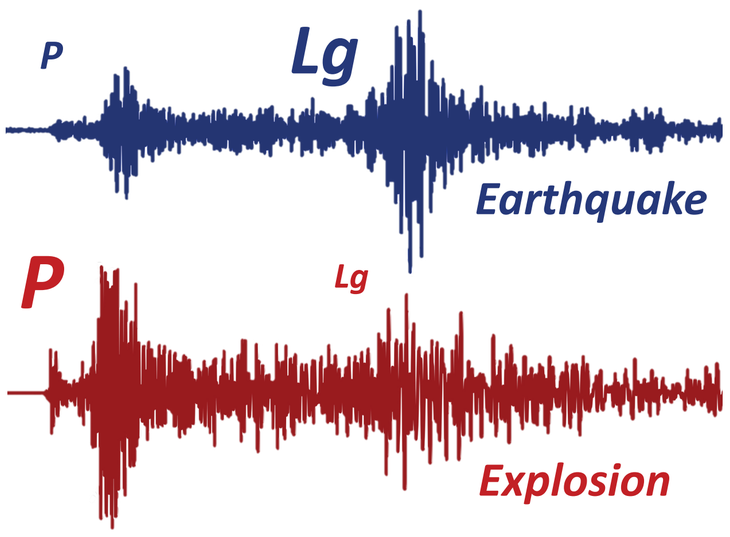
b) >150 naturally occurring earthquakes and mine blasts near the nuclear test site

- These naturally occurring events are only detected regionally (<2000km), but regional seismic source discriminants require careful calibration
- Can we set up a regional discriminant for nuclear tests and small magnitude events in the DPRK?

③ Methods: P to Lg seismic phase amplitude ratios

Theory

- Observations show that explosions generate proportionally more P (primary) to S (secondary)-wave energy compared to earthquakes
- Quantifying the ratio of P to S energy could allow us to characterize a seismic event (i.e. earthquake or explosion?)



Steps

- The aim is to assess the difference between earthquake and explosion P/Lg ratios with frequency

a) Manually pick P-wave arrivals, calculate theoretical S-wave arrivals

b) Calculate Signal-to-Noise Ratio of each phase

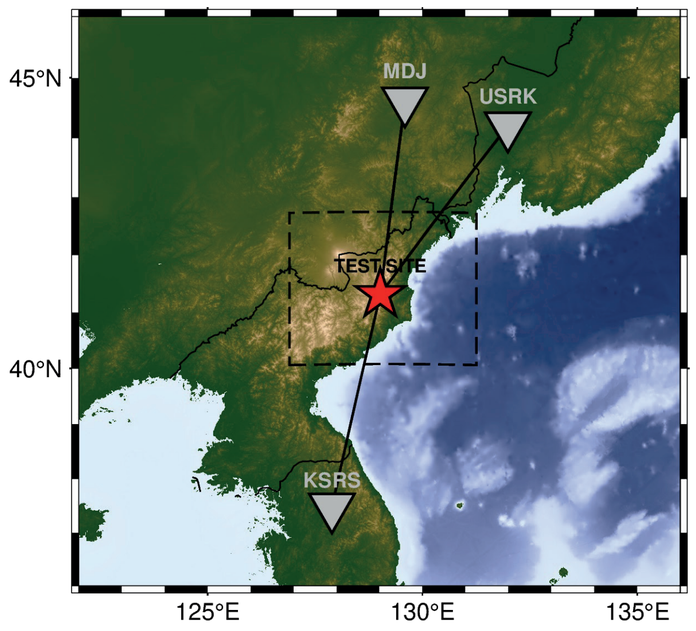
c) Measure root-mean-square P and S-wave amplitude ratios

d) Repeat in multiple frequency passbands from 1 to 18Hz

e) Repeat for each seismic station independently

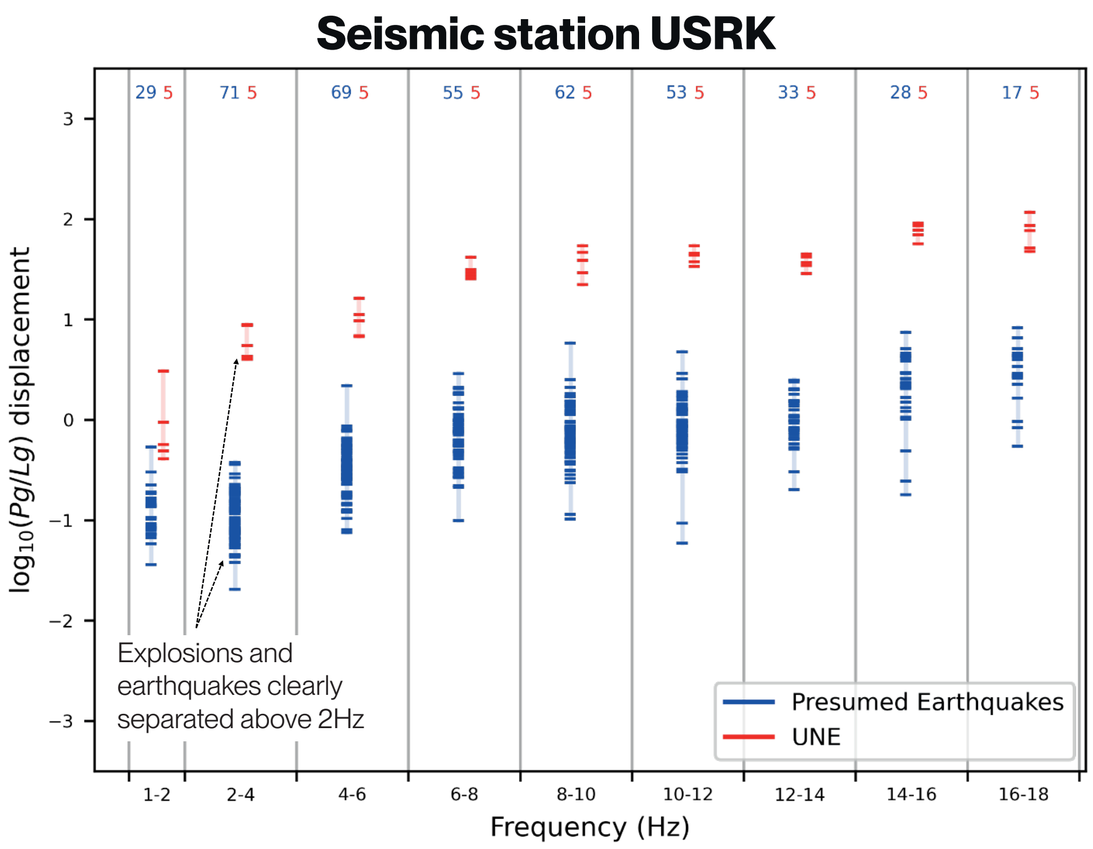
Data

- Events are detected by the International Data Centre (IDC) of the CTBT Organisation
- Investigate detections at three seismic stations



④ Results: Discrimination potential

- P/Lg amplitude ratios are higher for underground nuclear explosions (UNEs) than earthquakes within 45km of the DPRK test site
- Each source population is separated – necessary for discrimination potential
- Seismic station USRK is favoured due to high signal-to-noise ratios and beamforming capability from seismic array



⑤ Impact

- Performance of this discriminant is frequency dependent – in line with previous studies at other nuclear test sites
- Part of ongoing work to improve event screening capability at AWE
- **Supports UK commitments to the CTBT**
- **Enhances MOD capability to monitor nuclear test explosions**

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