



Discrimination of the DPRK underground explosions and their aftershocks using the P/S spectral amplitude ratios

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We have estimated the performance of discrimination criterion based on the P/S spectral amplitude ratios obtained from six underground tests conducted by the DPRK since October 2006 through September 2017 and 13 aftershocks induced by the last two explosions. Two aftershocks were detected in routine processing at the International Data Centre of the Comprehensive Nuclear-Test-Ban Treaty Organization. Three aftershocks were detected by a prototype waveform cross correlation tool with explosions as master events, and one aftershock was found with the aftershocks as master events. Two seismic arrays USRK and KSRS of the International Monitoring System (IMS) and two non-IMS 3-component stations SEHB (South Korea) and MDJ (China) were used. With the increasing frequency, all stations demonstrate approximately the same level of deviation between the Pg/Lg spectral amplitude ratios belonging to the DPRK explosions and their aftershocks. For a single station, simple statistical estimates show that the probability of any of six aftershocks not to be a sample from the explosion population is larger than 99.996% at the KSRS and even larger at the USRK. The probability of any of the DPRK explosion to be a representative of the aftershock population is extremely small as defined by the distance of 20 and more standard deviations to the mean explosion Pg/Lg value. For network discrimination, we use the Mahalanobis distance combining the Pg/Lg estimates at three stations: USRK, KSRS and MDJ. At frequencies above 4 Hz, the (squared) Mahalanobis distance, D^2 , between the populations of explosions and aftershocks is larger than 100. In the frequency band between 6 and 12 Hz at the USRK, the aftershocks distance from the average explosion $D^2 > 21,000$. Statistically, the probability to mix up explosions and aftershocks is negligible. These discrimination results are related only to the aftershocks of the DPRK tests and cannot be directly extrapolated to the population of tectonic earthquakes in the same area.