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High-frequency Rayleigh Waves from Announced Underground Nuclear Explosions by the Democratic People's Republic of Korea

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A high-frequency Rayleigh wavetrain with frequency ∼ 0.2 Hz is the largest-amplitude signal observed in broad-band instrument-corrected displacement seismograms at three regional stations, MDJ, USRK and INCN, at ∼400-600 km from the six announced underground nuclear explosions by the Democratic People's Republic of Korea ("DPRK1-6"). The Rayleigh wave was identified in particle motions and is concentrated in the frequency band 0.1-0.5 Hz (period 2-10 s). MDJ and USRK, northeast of the test site, show similar spectrograms for DPRK2-6 with small positive dispersion. At these two stations there is a second, lower-amplitude Rayleigh wavetrain with frequency 0.4 Hz, following after ∼5-7 s. INCN, southwest of the site, shows a "C"-shaped spectrogram of the first wavetrain, with minimum travel time at ∼0.3 Hz, but the second wavetrain is not visible above noise except in the record from the largest explosion, DPRK6. Station KSRS, ∼100 km east of INCN but with raypath with an oceanic segment, shows no clear Rayleigh phases at these frequencies. Waveforms and spectrograms at each station are very similar for tests DPRK2-5, with only a slight decrease overall in frequency for DPRK6. Log amplitude/period (log A/T) values in the band in which the waves have maximum amplitude, 0.125-0.25 Hz (4-8 s), show a roughly linear relationship with station surface-wave magnitude (Ms) measured on Rayleigh Airy phases with period 11-13 s.