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Variation and change in coherency of seismic signals estimated from repeated mining using waveform cross correlation

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The matched filter, i.e. waveform cross correlation (WCC), method is an optimal detection technique for signals from spatially close seismic sources. Signals from close events recorded at common stations are very similar, especially for low-magnitude sources with small characteristic time and length. It is often suggested that signals from remote sources should be less similar mainly because of the variations in propagation paths. However, different parts of the entire seismic signal generated by a given source have varying sensitivity to the propagation path. Many seismic studies and applications are based on the observation that the primary signal retains general characteristics of the source time function. The later seismic phases are rather dependent on the propagation path. The cross correlation between signals generated by hundreds of chemical blasts within a phosphate mine in Jordan has been estimated at 5 regional seismic stations. It was found that the first 3 s to 5 s of signals from different blasts correlate best between all possible parts of the corresponding signals, even for distances of about 20 km. Moreover, the same parts of the P-wave signals are well correlated between different stations (say, HRFI and EIL). This observation favours the hypothesis of high coherency in the initial part of signals at all stations. The revealed coherency of the very short (3 s) waveform templates is a solid basis for detection and further phase association of signals based on cross correlation. Longer templates are more specific and may reduce the detection threshold and spatial resolution of the WCC method by more effective noise suppression. At the same time, various propagation paths within the same geological province may have similar transfer functions producing regular seismic phases with similar shapes independent of source function and position. An extreme example would be a bell having natural frequencies and generating same sounds. This effect may increase the number of false detections from remote sources. We estimated the performance of the short and long waveform templates using detection statistics as well as the results of event hypotheses creation and further event location.