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Discrimination of earthquakes and quarry blasts in the Vértes Hills, Hungary

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Contamination of earthquake catalogues with artificial events largely complicates the seismotectonic interpretations. It is especially true for the relatively low seismicity areas, as Hungary. The Vértes Hills are an interesting region in the country because the earthquake activity occurs in the vicinity of quarries. On 29 January 2011 an earthquake of magnitude ML4.5 occurred on the area near Oroszlány. The mainshock was followed by hundreds of small aftershocks until the end of the year. Magnitude of the recorded aftershocks varied from –0.6 to 3.5. Because of the small magnitudes of the aftershocks and the operating quarries in the Vértes Hills, discrimination of earthquakes and quarry blasts became a key issue. The problem is particularly challenging because the size of the events was low and the number of stations detecting them was limited. Studying the temporal distribution of the events, diurnal periodicity was found both in natural and artificial events that indicate the contamination.
Discrimination based on the hypocentral parameters could not be used because of the location errors and the separation on the base of temporal distribution also failed. Therefore we analysed the waveforms of the events and their Fourier amplitude spectra. Within these we studied the polarity of P wave arrivals, the amplitude ratios of different phases (Rg and high frequency Pg/Sg). We studied the waveform similarities using cross-correlation methods; determined cross-correlation matrix and dendrograms to cluster the events. The earthquakes and blasts were arranged into different clusters. We computed spectrograms and because most of the quarry blasts were carried out by delay-fired technology, we computed binary spectrograms, too. We also studied the scalloping and steepness of spectra. The parameters computed from waveforms and spectra were jointly analysed using the mathematical method of Mahalanobis distance. We found that earthquakes and quarry blasts could be well separated by applying this complex method.