Seismic multiplets induced by flooding of an abandoned coal mine and their implication for seismic hazard assessment

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Induced seismicity in flooded mines is controlled by a wide range of complexly interacting factors linked to mining geometry, seismo-tectonic and hydro-geological settings and meteorological conditions. A detailed understanding of the triggering mechanisms is crucial to reliably assess local seismic hazard and post-mining risk. So, it is the case in the flooded, abandoned coal mine at Gardanne in Provence region, South-East France. Local micro-seismic monitoring highlights the presence of significant periodic seismic swarming activity, including events of magnitudes close to 2 which have been several times felt by the population. Results of previous seismic analysis of data recorded during one of the periods of increased seismic activity indicates that most of the events may be located below the excavated, flooded mine workings and seems to be spatially and temporally correlated with the meteorological conditions (rain) and active pumping operations. Analysis has also revealed the existence of multiplet families, i.e. events merged in groups based on similar waveforms, which indicate similar location origin and source properties.

In this study we present an ongoing detailed analysis of multiplet occurrences using cross-correlation based template matching, classification and relocation techniques. The objective of this analysis is to better understand their spatial and temporal characteristics which allows to estimate the potential of larger dynamic ruptures associated with magnitudes M > 2 and/or a dominance of transient creep. Preliminary results showed the existence of at least 50 multiplet families being active over periods ranging from weeks to several years. We currently examine the spatial dimension for most of these families and compare them with results from source parameter analysis in order to understand if multiplets represent nearby interacting fault segments or repetitive rupture on identical segments (seismic repeaters) resulting from surrounding aseismic creep.