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Interferometric location of microseismic events induced by gas storage operations
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Underground gas storage is a common industrial operation that consist in the injection of natural gas in aquifers, underground cavities or depleted hydrocarbon reservoirs. Gas is seasonally injected or extracted to meet the market demand. Although these operations rarely stimulated seismicity, a recent case at the Castor platform in the offshore Spain was accompanied by a significant seismic sequence, culminated with a magnitude Mw 4.3 earthquake (Cesca et al. 2014). Ad hoc microseismic monitoring networks are nowadays extensively used to analyse the induced microseismicity generated by these industrial operations. However, in many cases, the lack of local microseismic monitoring networks limits the performance of the standard data analysis procedures. In such cases, non conventional methods need to be established. Within this context, we extend here the analysis of triggered seismicity related to gas injection at the Castor platform, in September-October 2013, where standard location procedures failed for magnitudes below Ml 2. In this work we relocate these low magnitude events using an interferometry based location method (Snieder and Vrijlandt, 2005). This technique exploits slight changes in the coda waves between two seismic events within a cluster. We proof that microseismic events can be classified in different families by combining a waveform correlation analysis and a clustering technique. Clustered events are characterized by a high similarity of waveforms, which implies a similarity in both source mechanism and location. In these conditions, the analysis of seismic coda recorded at a single receiver can be used to infer a measure of the spatial separation between two seismic sources. Coda waves are radiated in all directions with a radiation pattern determined by the source mechanism and a small change in the source position affects the interference pattern of the scattered waves that constitute the coda. This change in the coda waves is used to constrain the interevent distance for each events pair. Absolute locations can be then retrieved by considering all interevent distances, a procedure which requires at least three reference locations. We discuss the potential of the coda interferometry location approach to monitor triggered and induced seismicity, by relocating about 1000 seismic events of the September-October 2013 seismic sequence offshore Spain, close to the Castor project injection platform. Results are used to discuss the possible proposed faults scenarios.

References:
Cesca, S. et al. 2014, The 2013 September?October seismic sequence offshore Spain: a case of seismicity triggered by gas injection?, Geophys, Jour. Int., doi: 10.1093/gji/ggu172
Snieder, R., and Vrijlandt, M., 2005. Constraining the source separation with coda wave interferometry: Theory and application to earthquake doublets in the Hayward fault, California, J. Geophys. Res., doi:10.1029/2004JB003317

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