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POTENTIALLY WASTEWATER-INJECTION INDUCED SEISMICITY IN THE VAL D'AGRI OIL FIELD (SOUTHERN ITALY) REVEALED BY A HIGH-DENSITY SEISMIC SURVEY.

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The Val d'Agri extensional basin in Southern Italy, which is one of the regions in Italy with the highest seismogenic potential (up to M7 earthquakes), hosts the largest productive onshore oil field in Europe.

Continuous waveforms recorded during a 13-months-long seismic experiment in 2005-2006 by a very dense seismic network were analyzed by an innovative automatic picking procedure. This allowed us to detect and locate an intense micro-seismicity (about 2000 events with $-0.2<M_L<2.7$), reaching a completeness magnitude of the catalogue of 0.4.

The seismicity shows that while the large normal faults remain almost silent in the past years, small magnitude swarms outline a clear case of reservoir-induced seismicity (RIS) that follows the variation of water level in a nearby impoundment.

Here, we report on the spatiotemporal seismicity distribution associated to a cluster of low magnitude events potentially induced by wastewater injection into a 4 km deep disposal well of the oil field. Hypocenters are estimated by both local earthquake tomography and high precision relative locations. Seismicity occurs within 500 m of distance from the fluid injection site, with all events occurring at about 4-5 km depth in the Apulian carbonate reservoir, within the same sedimentary layer that wastewater fluids were injected into. The seismic swarm started soon after the initiation of wastewater injection activity and it was observed for about two weeks until the end of the monitoring experiment. In this time interval, around 80 small earthquakes ($0.3 < M_L < 1.7$) were recorded and located, with a peak of 25 events per day. Waveform cross-correlation analysis revealed high waveform similarity (correlation coefficient > 0.90) suggesting that event locations and focal mechanisms are very similar. Basing on the waveform similarity we build up a catalogue of "template" waveforms, that we used to search for previously undetected earthquakes, by using a *matched filter* algorithm over the continuous data stream. We ended up with a final catalogue of 213 earthquakes for the June 1st to June 12th time interval. Temporal occurrence of the clustered events seems not to follow an Omori-like decreasing rate, suggesting for those events a triggering process related to fluid injection. After June 2006, when we removed our temporary seismic network, seismicity continued to occur close to the injection site. About 130 events with a maximum magnitude

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of M_L 2.7 were recorded by the permanent network managed by INGV up to the end of 2013. However, hypocenter locations of these events suffer for larger uncertainties.

Because of the high fracturing and permeability of the carbonate units within which induced earthquakes occur, we cannot exclude that broader diffusion of pore pressure and fluid migration along hydraulically conductive pathways could induce larger magnitude events on nearby active normal faults bounding the extensional basin.