

Monitoring anthropogenic seismicity in Italy

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Public concern about anthropogenic seismicity in Italy first arose in the aftermath of the deadly M6 earthquakes that hit the Emilia-Romagna region (northern Italy) in May 2012. As these events occurred in a (tectonically active) region of oil and gas production and storage, the question whether stress perturbations due to underground industrial activities could have induced or triggered the shocks was raised. Following expert recommendations, in 2014, the Italian Oil & Gas Safety Authority published guidelines, describing regulations regarding hydrocarbon extraction, waste-water injection and gas storage that could also be adapted to other technologies, such as dams, geothermal systems, CO₂ storage, and mining. These guidelines describe the framework for the different actors involved in monitoring activities, their relationship and responsibilities, the procedure to be followed in case of variations of monitored parameters, the need for in-depth scientific analyses, the definition of different alert levels, their meaning and the parameters to be used to activate such alerts. Four alert levels are defined, the transition among them follows a decision to be taken jointly by relevant authorities and industrial operator on the basis of evaluation of several monitored parameters (micro-seismicity, ground deformation, pore pressure) carried for each area on by a scientific-technical agency. Only in the case of liquid reinjection, the alert levels are automatically activated on the basis of exceedance of thresholds for earthquake magnitude and ground shaking –in what is generally known as a Traffic Light System (TLS). The National Institute of Geophysics and Volcanology (INGV) has been charged by the Italian oil and gas safety authority to apply the monitoring guidelines in three test cases (two oil extraction and one gas storage plants).

The presentation will report about examples of hypothesized and documented anthropogenic seismicity in Italy. Special emphasis will be put on the Val d' Agri (VA), which had been characterized as one of the areas with the highest seismic hazard in Italy. However, the VA hosts also the largest on-shore gas-/oilfield in Europe. INGV is responsible for monitoring the local seismicity (hypocenter, magnitude, PGV, PGA), and potential variations of ground deformation and pore pressure. In 2006 a small episode of induced seismicity ($M_{\max}=1.9$) was reported after starting wastewater reinjection in a 3 km deep inoperative borehole. Beyond the extraction of hydrocarbons and the reinjection of production water, local seismicity may be also influenced by seasonal water level variations of the nearby located Pertusillo reservoir. Particular difficulties in applying the TLS have been encountered concerning uncertainties of the hypocenter location, whose accurate depth estimation is needed to decide the “exact” location with respect to the boundaries of the monitoring domain. Magnitude - a critical parameter used to define a possible step-up in activation levels of the TLS - has inherent uncertainty and can be evaluated using different scales.

A second focus concerns the geothermal energy production in Italy. After the forthcoming privatization of the National energy market and the entrance of multiple operators, the main effort of INGV will be the realization of an integrated monitoring project, able to assess the demands of seismic monitoring in adjacent concession areas. Prescriptions for new production permits to determine the initial blank-level monitoring stage, aimed at assessing background seismicity, may lose significance in case of nearby active production. Different exploitation technologies (vapor-/liquid-dominated plants, EGS), depending on the geothermal characteristics of the single concessions may not uniquely contribute to the seismic hazard.

Discrimination of the local seismicity in terms of high-precision hypocenters, as well as in terms of its natural or anthropogenic origin, will be a great challenge.

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