

Monitoring salt caverns through passive seismic surveillance at the Hill Top gas storage facility – Characterization of events source

E. Fortier¹, E. Barbieri¹, E. Matrullo¹, M. Coppenhall², R. Del Potro³

1 BHGE Magnitude, 2 Geostock-Entrepose

Abstract

EDF Energy is currently using the Hill Top salt cavities (Cheshire in North-West England) as a gas storage facility. BHGE Magnitude designed, procured and installed a seismic network in 2015, consisting in ten sub-surface arrays of two tri-axis geophones each. Since then, BHGE Magnitude is responsible for the seismic surveillance of the cavities.

The network architecture enables the accurate detection and characterization of small events ($M_w < 0.5$) in near real time, and therefore leading to the implementation of a specific monitoring protocol. The perceived “minor” seismicity suggest that underground storage is not inducing significant instabilities, even if the risk related to cavities integrity cannot a priori be excluded.

Four cavities are already operational with gas storage. De-brining and gas introduction phases mainly induced an important microseismic activity with 700 events recorded. This micro-seismicity is located near each cavity, at insoluble layers level, with low Richter magnitude below 0.5. This small order of Richter magnitude is an indicator of ‘normal’ micro-seismic activity. The associated source radius below 10 m corroborates the limited size of the geological structures involved.

Focal mechanisms were inferred for strong events (related to high SNR), in order to better understand the source origin. The principal result is the similarities of observed mechanisms, presenting a preferential rupture direction with a primarily double-couple mechanism with ‘reverse’ faulting. This analysis confirms the anisotropic nature of the salt formation that can induce small stress readjustments inside insoluble layers. The gas storage process interferes with the pre-existent local stress field, inducing microseismic activity.

Micro-seismic surveillance is a valuable tool for salt cavities monitoring. It provides with a better understanding of induced instabilities, and is a reliable way to check in near real-time the integrity of the underground storage.

Key words: underground storage cavity, gas introducing, brine, seismic monitoring, micro-seismicity, velocity model, magnitude, source radius, signal to noise ratio (SNR), focal mechanism, double-couple.