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Induced seismicity monitoring of an underground salt cavity under a controlled pressure excitation

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Within the framework of a research project launched to assess the feasibility of seismic monitoring of underground growing cavities, this specific work focus on the analysis of the induced microseismicity generated by a controlled pressure experiment recently carried out in a salt mine environment.

A local seismic array has been installed over a stable underground cavity within a salt layer located in the Lorraine basin (north-east France). The array includes four 3D components and three 1D component geophones (40 Hz - 1 kHz) deployed at depths between 30 m to 125 m in cemented boreholes drilled in the vicinity of the studied salt cavity. The underground cavity under monitoring is located within a salt layer at 180 m depth and it presents a rather irregular shape that can be approximated by a cylindrical volume of 50 m height and 100 m diameter.

Presently, the cavity is full of saturated brine inducing a significant pressure on its walls (˜2.2 MPa) to keep the overburden mechanically stable. Nevertheless some small microsesimic events where recorded by the array and analysed (˜500 events in two years of recording). In October 2005, a controlled pressure transient experiment has been carried out in the cavity in order to analyse the mechanical response of the overburden by tracking the induced microseismicity. The recorded events are mainly grouped in clusters of 2 to 30 seconds of signal duration with non-emergeant first arrivals and rather low frequency content (between 20 to 120 Hz). Some of these events have been spatially located by travel-time picking close to the actual cavity and its immediate roof. Preliminary source spectral analysis suggests rather slow sources possibly related to fluid pressure variations, and/or resonant modes due to the dynamic

excitation of the brine-filled cavity. Rock-debris falling into the cavity from delamination of clayley marls in the immediate roof is possibly another source of seismic excitation. No clear evidence of classical brittle ruptures in the competent layers of the overburden has been observed up to now. Current work is focused on the discrimination of all these possible mechanisms to better understand the damage processes within the rock mass.