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Quest CCS facility: Microseismic Observations

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Summary

In August 2015, CO2 injection commenced at the Quest CCS project located near Fort Saskatchewan, Alberta, Canada. Quest is a fully integrated CCS project with a capture target of just over one million tonnes of CO2 per year. CO2 is injected into a deep saline aquifer at a depth of about 2 km below ground.

In order to demonstrate containment and conformance of the injected CO2, a Measurement, Monitoring and Verification (MMV) plan has been implemented. Although Quest is in an extremely quiet tectonic location, induced seismicity has been recognized as a potential risk for all large-scale injection sites. As a result, microseismic monitoring is a key component of the Quest MMV Plan to ensure the continued assessment of that risk and to provide early notice of any changes.

The aim of this presentation is to report on 5 years of microseismic monitoring observations through the pre- and post-start of injection periods and describe the empirical analysis that has allowed the Quest CCS facility to de-risk induced seismicity as a risk to containment.

Microseismic Data

Microseismic data is continuously recorded at the Quest CCS site using a commercial downhole geophone array installed in a deep monitoring well, DMW 8-19. The data are processed to produce trigger files using a common algorithm for event detection and triggering, based on the ratio of short-time-average to long-time-average (STA/LTA) amplitudes. The triggered events are analyzed, classified and reported daily. Categories for various trigger types are defined based on the characteristics of each event. Operationally, the status of the microseismic array is continually assessed by the presence of different and common trigger events, such as surface or regional seismic events. The trigger event is defined to be locatable when it shows clear P and S wave field arrivals. The locatable events are processed and located using an anisotropic velocity model. For the latter, the P-wave velocity was derived from a Vertical Seismic Profile (VSP) survey, and the S-wave velocity obtained from sonic well logs.

Pre-CO2 injection recording of microseismic data began in November 2014. Most of the trigger files generated are related to surface, automatic and noise triggers. These events are used to assess the health of the system. No locatable events were detected during the pre-injection monitoring phase.

The first locatable event was recorded 9 months after start of CO2 injection in July 2016 with a magnitude of -1.3. Using the methodology described above, all locatable events have originated within the Precambrian basement, well below the injection zone. Since January 2017, sustained low level, small magnitude microseismic activity have been observed within the Quest

area of review (AOR). The AOR as defined in the 2017 Quest MMV plan extends 10 km radially outwards from an active injection well. To date, 354 locatable events have been recorded, with an average magnitude of -0.7, a maximum magnitude of 0.8 and a typical occurrence rate of 1-2 events per week. None of this microseismic activity represents a risk to containment.

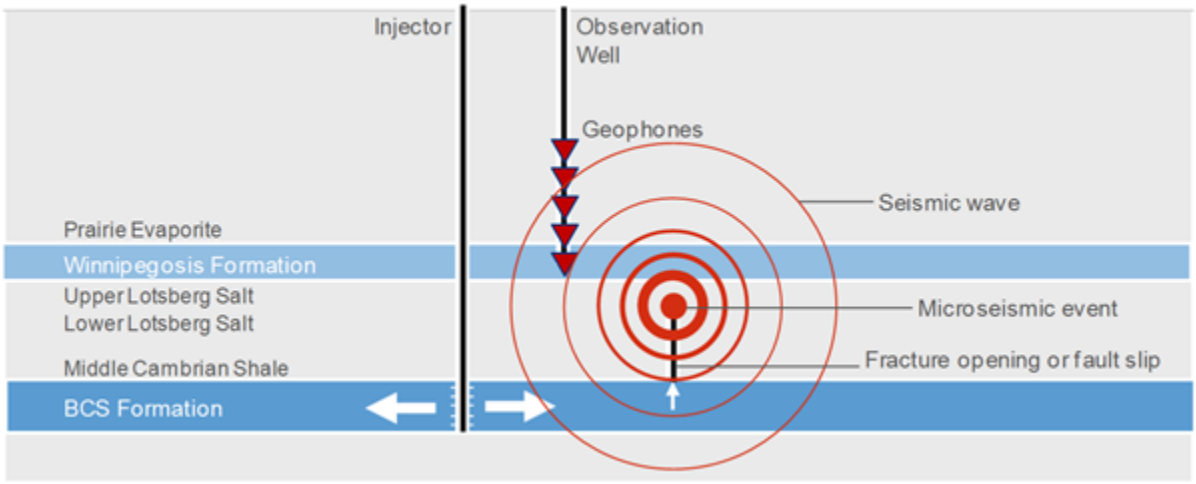

Fig. 1. Schematic of the placement of down-hole geophones in the deep monitoring well relative to the injection well. The array is designed to detect microseismic activity due to unexpected induced fracturing or faulting within the multiple seals of the BCS storage complex.

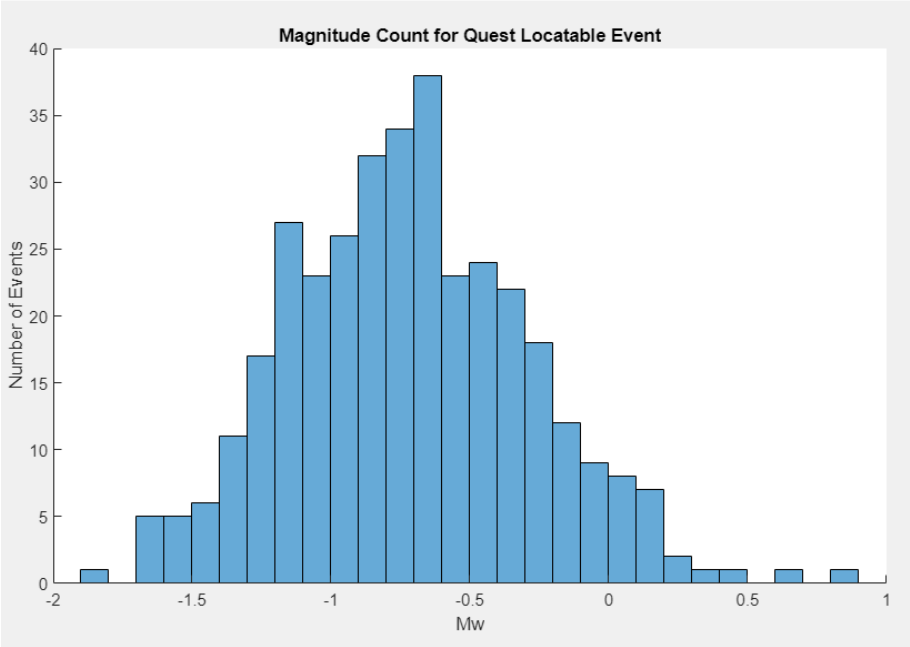

Fig. 2: Magnitude count for 354 Quest locatable events 2014 to 2019.