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Induced seismicity at the Paralana Enhanced Geothermal System, South Australia

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Induced seismicity is generally associated with geothermal exploitations through different mechanisms like pore-pressure increase, temperature or chemical changes. The locations and source parameters of microearthquakes are increasingly used as a tool to monitor the response of the reservoir subjected to fluid stimulations. However, our understanding of the relationship between induced seismicity and exploration parameters remains limited, notably because it depends on local and regional geological conditions (stress field, rocks properties, extent of fault and fractures ...). In order to make correct interpretation, precise characterization of the geothermal site is then essential. For example, a wrong velocity model will lead to an erroneous earthquake location, particularly in the absence of calibration shots. Similarly, many converted phases could be generated within a complex media, increasing the difficulty to pick phases correctly.

We present here our results on the characterization of a geothermal site, Paralana, in South Australia using complementary passive and active seismic methods. The project aims to exploit natural heating from a radiogenic basement. A ∼4000 m deep well was stimulated during 5 days in July 2011. More than 7000 microearthquakes were induced and recorded by a network composed of 20 stations (boreholes and surface stations). Automatic methods allowed us to process consistently the large amount of data. A minimum of 25 events per hour were detected from the beginning of the injection, increasing almost conjunctly with flow rate. The maximum seismicity rate reached 100 events per hour, the last day of injection.

Active seismic methods were applied to build a 3D velocity model and used to improve the earthquake locations that finally cluster at the bottom of the well. Furthermore, to define the origin of an unknown phase, 3D ray-tracing modeling was systematically applied to test different scenarios. Actual results show that in term of arrival time, these phases most likely correspond to S-to-P converted waves on some interfaces at depth.