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An Integrated Approach to Deal with Change in Microseismic Data

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ABSTRACT

Hydrocarbon exploitation from a naturally fractured reservoir by fast depletion or water flooding can induce significant deformation due to geomechanical response of the reservoir. Rock compaction, increased shear stresses and injection above the fracture pressure can stimulate fault reactivation or generating new fractures, both of which are associated with induced microseismicity. Highly compacting rocks with pore collapse can results in excessive surface subsidence and can cause damages to the wells and surface facilities which, in turn, may lead to major consequences. In this article we present an integrated approach to manage risks associated with an extraction of hydrocarbons in a carbonate field. Tremors and damages on surface facilities resulted from production activities have been observed. Using different surveillance methods in conjunction with geomechanical modeling, the areas with the greatest risk are mapped with better accuracy. A set of different surveillance tools are used to monitor the behavior of the reservoir and the surrounding formations. Using the data collected, the hazards are managed by comparing the predicted performance with the observation to ensure that the field is operating within the safe operating envelope. The surveillance tools used include (a) microseismic network to monitor induced seismic event locations to ensure cap rock integrity (b), Compaction monitoring Instrument (CMI) logging to measure subsurface compaction and (c) combination of GPS and InSAR to measure the surface subsidence. The results are integrated in geomechanical modeling to forecast subsidence and subsurface stress fields. These in turn are used in managing the wells and facilities integrity risks by providing the input to the operational decisions on production and injection. Here we will focus on the added value of the recently deployed deep geophones and the re-locating legacy microseismic events. To understand the changes in the positions of the legacy microseismic events, the same microseismic data sets were processed with various algorithms and a 3D anisotropic velocity model. The new results were analysed and integrated with reservoir properties and CMI. Additionally, we verified the interval over which compaction is determined. The integration of various surveillance data helps validate the new microseismic results and provides better constraints to the geomechanical model.