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Correlation between the Reservoir Dynamics Performance and Production/Injection Induced Microseismicity - A Field Case

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SUMMARY

Mapping passive seismics in Cusiana and Cupiagua fields has revealed a strong correlation between reservoir dynamic performance and production induced microseismicity. Fluid production/injection causes changes in reservoir pore pressure and, therefore, in local effective stresses. The changes in effective stresses cause natural fracture deformations which, in turn, change local transmissibilities and triggers microseismic events. The interplay of these two latter effects determines the relationship between microseismicity and reservoir dynamics (pressures and fluid saturations among other factors).

In 1992, a seismic network was installed on the BP operated fields, Cusiana and Cupiagua, to obtain data for seismic hazard models needed for the design of major field infrastructure. The network is now in its fifteenth year of continuous operation.

The Cusiana-Cupiagua seismological dataset is of high quality, acquired with an average of 10 surface stations, covering a range of magnitudes down to about 1.5.

Over time, the Cusiana-Cupiagua Seismic Network (CCSN) has had several goals and during the past few years, it has become increasingly evident that the network and its data is an invaluable asset for evaluation of conditions relevant to production/injection processes within the reservoirs and adjacent areas.

From the reservoir characterization and production operation standpoints, microseismic monitoring has had two main applications in Cusiana and Cupiagua: (i) to identify production/injection induced high transmissibility pathways and their temporal variations, and (ii) to image the orientation, extension, complexity, and temporal growth of hydraulic fractures.

This presentation is focused on the first of these applications: how microseismicity has been used as a surveillance tool to track movement of reservoir fluids far from the wellbore. A short description of the seismic network is provided. Then, the methodology for data interpretation is discussed. Finally, partial results are presented showing how microseismicity monitoring is being applied to: (i) calibrate numerical models and improve history match, (ii) to assess potential productivity changes due to stress and pore pressure changes through the reservoir life, and (iii) to identify potential pre-existing weak planes reactivation.