4D Seismic Monitoring for In-situ Combustion of Heavy Oil Reservoirs

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Abstract

In-situ combustion is a process that is quickly gaining interest in the industry as a relatively straightforward EOR method, especially in heavy-oil reservoirs. Of critical importance to the success of this process is the effective monitoring of the reservoir zone affected by the combustion.

Since in-situ combustion alters the elastic properties of the rocks and generates combustion gases (in addition to the air injected in the reservoir), the seismic response of the affected area is expected to be different before and after this process.

We will show in this presentation the results of the first 4D seismic project carried out in Colombia as part of the STAR pilot project of synchronized in-situ combustion in the Eastern Llanos basin in Colombia. We will present an overview of the design, acquisition and processing of the seismic data and show how the 4D seismic generates a clear three-dimensional image of the area affected by the combustion process. In particular, we will show that the affected area is nowhere close to the nice spherical shape we would expect if the reservoir were homogeneous and isotropic. Instead, the affected area shows preferential flow directions and flow barriers, which demonstrate the heterogeneity and anisotropy of the thin reservoir unit. This information is of the utmost importance to synchronize and optimize the combustion process by optimally placing injector and producer wells to reduce bypassed oil.