Challenges in Seismic Reservoir Characterization and Monitoring – A Geo-modelling Perspective

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Abstract
The last few years have seen important advances in the field of seismic reservoir characterization and monitoring. Increasingly, 3-D & 4-D seismic information is integrated in static and dynamic reservoir modelling workflows to improve field management. This presentation reviews some of the current best practices and industry trends in seismic-driven geo-modeling.

Pre-stack 3-D & 4-D inversion techniques are routinely used to estimate reservoir elastic properties and their changes over time. Traditionally, the elastic inversion is cascaded with a petrophysical inversion to estimate rock properties such as porosity lithology or fluid type. Recently, new inversion techniques have been proposed for direct inversion of petrophysical properties from seismic data. Whether direct or cascaded inversion for rock properties is performed, rock physics is playing an increasingly important role in seismic-constrained geo-modelling: a Petro Elastic Model (PEM) is used to establish the link between reservoir and elastic properties. In practice, the PEM transform is uncertain and non-unique. PEMs are therefore combined with geostatistics to study the propagation of uncertainties in seismic property prediction. In the past, seismic attributes have been mainly used for static reservoir characterization. With the greater availability of high quality time-lapse seismic data, there is now considerable interest in using 4-D attributes for quantitative estimation of changes in hydrocarbon saturation and fluid pressure in the reservoir. Simulator-to-seismic workflows have been developed to validate flow simulator models by comparing 4-D synthetics with measured time-lapse seismic data. More ambitiously, techniques have been developed recently for joint inversion of production and 4-D seismic data. As seismic information is used more and more for static and dynamic reservoir characterization, a key challenge remains: how do we condition fine-scale reservoir models, having flow units a few meters thick, using seismic data with limited vertical resolution. The issue of "seismic downscaling" has only been partially addressed so far using stochastic inversion approaches.