Passive Seismic Montoring and Stress-Field Variations

Michael Kendall*
University of Bristol, Bristol, United Kingdom
gljmk@bristol.ac.uk

and

Abdullah Al-Anboori
University of Leeds, Leeds, United Kingdom

and

Kristof de Meersman
Veritas DGC, Calgary, Alberta, Canada

Abstract

Passive seismic monitoring or the detection of small earthquakes in oil fields is a relatively new industry technique that provides insights into spatial and temporal variations in reservoir stress-fields. Microseismic activity can be induced by production, injection and regional tectonic processes. Such earthquake activity can delineate faults, identify reservoir compartmentalization, and monitor the progress of injection fronts. The nature of the stress field can be inferred from focal mechanisms analysis and stress-tensor inversion, which are derived from polarities and amplitudes of seismic phases. Microseismic data can be also used to estimate seismic anisotropy in hydrocarbon settings. Anisotropy is an indicator of order within a medium (e.g., aligned cracks or crystals) and as such offers information about the stress field and dynamic processes within the reservoir. Here we present results from downhole multicomponent experiments in two quite different oilfields, one in the North Sea and one in Oman. The Oman dataset is unusual in that nearly 40 sensors were deployed for nearly 18 months. Focal mechanism analyses reveal variations that correlate with lithology and the nature of production. The anisotropy analysis shows that the dominant orientation of the fast shear-wave correlates with lithology, faulting and known fracture trends within the reservoir. Cummulatively, these results show that passive seismic monitoring offers a cost-effective means of monitoring stress changes in a hydrocarbon field.