

Multi-Transient EM Repeatability Experiment over North Sea Harding Field

Anton Ziolkowski (PGS), Ronnie Parr (BP), David Wright, Victoria Nockles & Christopher Limond (PGS)

Summary

We present results of a multi-transient electromagnetic repeatability experiment conducted over the North Sea Harding field in 2007 and 2008. The segment of the field under investigation had produced 3.9 MMbbls of oil during this time. Processing of the data included deconvolution for the measured source current and removal of the magnetotelluric noise, which increased the signal-to-noise ratio of the recovered impulse responses by about 20 dB. Without any cross-matching of the two data sets the resulting normalised root mean square difference (NRMSD) between the data sets was 3.9%.

The data were inverted using collated multi-trace 1D inversions of CMP gathers with similar results from the 2007 and 2008 surveys. An independent 4D modelling study of the Harding field showed that the 3.9 MMbbls of production between the two surveys had a negligible impact on the EM responses. Therefore we were able to combine the two data sets for inversion using the Top Balder horizon, known from seismic and well data, to constrain the layer boundaries. The Harding reservoir was found in the data with its edges fairly well-defined. The data also showed no resistor at the dry well (9/23A-3).

We also generated time-lapse synthetic transient EM data for different states of the reservoir from the initial state in 1996, through predominantly oil production to 2011, and finally through gas production to 2016. Unconstrained 1-D full-waveform Occam inversions of these synthetic data show that Harding should be detectable and its lateral extent should also be well-defined. Resistivity changes caused by hydrocarbon production from initial pre-production state to production of the oil rim in 2011 are discernible as are more significant changes from 2011 to 2016 during a modelled gas blow-down phase.