

2-D High-Resolution Reservoir Characterization by Seismic Bayesian Inversion of a Tertiary Deltaic Clinoform System in the North Sea

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ABSTRACT

Fluvio-deltaic sedimentary systems are of great interest in exploration because they constitute important potential hydrocarbon reservoirs. However, these systems are among the most complex and heterogeneous ones encountered in the subsurface. Furthermore, the geological units of interest in these systems often have dimensions that lie below the resolution of seismic images.

Here we present a 2D comprehensive and quantitative method that allows characterizing a fluvial-deltaic reservoir at the sub-seismic scale using seismic and well data.

The first step in the method consists of constructing a high-resolution layered model in a well from wireline log data, typically consisting of sandstone and shale layers with variable thicknesses and properties. This layered model is then matched to the seismic data in an iterative process using Bayesian inversion, by changing the layer properties until a satisfactory match is obtained. The resulting layered model has a resolution of up to ten times higher than the seismic data. The clinoform geometry is subsequently parameterized by fitting sigmoids to the reflectors, to be used as prior information. In an optimization step the clinoform geometry is further refined with a limited number of local knots of a polynomial to improve the match with the seismic data. The resulting geometry then guides the prediction of the initial acoustic properties and layer thicknesses from the well to the nearby traces. By continuing to do so along a seismic line, a priori information obtained from the well can be extrapolated sufficiently along the clinoform sequence and the complete 2D deltaic sequence can be characterized.

The novelty in this technique is the combination of the high-resolution Bayesian inversion method which uses data-independent a priori information, thereby greatly limiting the solution space, and 2D geological object parameterization. This low-parameterization inversion approach thus uses geological shapes and well constraints to obtain a subsurface model that can have a substantially higher resolution than the seismic wavelength against relatively low computational costs.