Using Spectral Decomposition to Define Deep Water Depositional Systems, Offshore Nile Delta

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Evaluation of depositional systems in the offshore Nile Delta NEMed concession indicate numerous deep water channel systems throughout the Plio-Pliestocene using various seismic amplitude extractions and seismic facies analysis. Further analysis of these sediment pathways using spectral decomposition seismic volumes have revealed greater details of these deep water systems to significantly decrease the uncertainty not only in lithologic predictions of specific depositional environments, but also for fault delineation and direct hydrocarbon indicator (DHI) evaluation.

Creating a number of spectral decomposition volumes over a range of frequency content from conventional seismic volumes allowed for multi-volume 3D visualization. Rendering varying thickness of the multiple volumes along with varying opacities of each volume, created greatly enhanced images of the deep water depositional systems allowing precise interpretations of specific depositional environments along the sediment pathways. The evolution of an individual sediment system or a set of sediment systems through time can be defined as you move stratigraphically through the volumes.

Definition of fault planes is also increased based on the spectral decomposition volumes. Fault patterns and the potential compartmentalization of hydrocarbon traps are imaged to a greater resolution over various amplitude extractions, seismic time slices and semblance volumes. DHI's in the areas of interest become more distinct from the multi-volume renderings to the extent of indicating probable hydrocarbon-water contacts.

Relations between seismic signals and reservoir properties of tight gas sandstones in North Germany (Permian Rotliegend)

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Introduction: The tight gas reservoir consists of mainly eolian sandstones in 4,4-4,6 km depth with moderate porosities but strongly varying permeabilities in proximate zones. Therefore deep gas exploration is highly dependent on reservoir property information from 3D-seismic signals. A recent DGMK-study succeeded in calibrating 3D-seismic signals with core and log data. Seismic classes (neural network) correlated to permeability, thickness, clay mineral type, amount of bitumen and not to porosity.

Aim: Individuation of parameters controlling relations between seismic signals and reservoir properties. Explanation of large scatter of permeability for comparable samples.

Results: The relations are explained by rigidity variations of grain-clay-cement structures. The effects of sedimentological features and partial fluid saturation can partly be excluded. Different amounts of clay minerals between grain-to-grain contacts: Clay minerals reduce rigidity of grain-clay-cement structures and lead to lower velocities. The higher the amount of load-bearing clay minerals, the lower was p-wave velocity. All samples from wells with high amounts derive from specific seismic classes and had wells of low sonic velocities. Only those boreholes contain a permeability reducing illite-morphotype. This dependence could explain the relation to clay mineral type and permeability. Different shape of grain contacts: The higher the amount of contact to pore space and the lower the amount of long contacts, the lower is p-wave velocity and the higher is permeability (despite equal porosities). The variability in pore geometry could explain the large scatter of permeability for zones of similar lithology and porosity. More explanations are found, e.g. micro impedance of load-bearing clays.

Focused Seismic Processing via Pre-Stack Migration - the Key to Structural Imaging of the Triassic Play in the Slyne-Erris Basin, Offshore Ireland

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In the Slyne-Erris Basin, offshore Ireland, the sub-surface environment for seismic acquisition and processing is characterised by four factors – near seabed heterogeneity due to the presence of relatively thin, high-velocity, volcanic and chalk layers; varying water depth (200-2000 m) and seabed topography; complex geology due to the presence of both Zechstein and Triassic evaporitic detachment layers; and anomalously hard Triassic to Jurassic overburden as a result of uplift from maximum burial depth during the Cretaceous-Tertiary period. The sporadic exploration in the basin to date partly reflects the poor quality of the seismic data and the long learning curve with respect to improvement of the seismic image at the horizon of interest.

Much of the early exploration activity in the Slyne-Erris area concentrated on evaluating Jurassic, rifted, tilted fault block structures - what was then perceived to be the primary play in the basin. However, well 18/20-1, drilled in 1996, discovered a 61m gas column in pre-rift, Triassic, sandstones and proved the presence of a working Carboniferous-Triassic petroleum system. This new play is now the primary hydrocarbon play in the basin with multi-TCF undiscovered resource potential. This paper chronicles the steady incremental improvements in seismic imaging achieved via conventional 2D and 3D seismic processing techniques followed by a dramatic leap in data quality from the application of low frequency, pre-stack migration, processing streams to 3D data sets. Lessons learned and implications for future exploration in the Slyne-Erris basin are discussed in the context of the much improved structural imaging.

Prospect Identification using AVO Fluid Prediction, Relative and Field-based Elastic Inversion in Sarawak, Malaysia

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Murphy Sarawak has approximately 10.500 km2 exploration acreage and acquired the block in 2001, after which several hydrocarbon fields have been discovered. The main reservoirs in this basin are Middle to Early Miocene deltaic sands ranging from 1000 to 2000 meters depth. In this paper we focus on one field and the innovative prospecting workflow that

was applied. The work started by understanding the AVO response of the major hydrocarbon reservoirs in the nearest well D through fluid substitution and forward modeling, for which a shear sonic log was estimated using nearby wells. Then this knowledge was implemented to rapidly high-grade the prospect and predict the most likely fluid content, using the seismic gathers. A Relative Elastic Inversion (REI), which can be used as an alternative to AVO for exploration, reduced the risk further. This REI is compared with a Field-based Elastic Inversion (FEI), performed using well D only. Tying it to well M of the discovery shows the value of the FEI. This well did not exist at the time of the inversion and has encountered gas, oil and water as predicted.
This work indicates that AVO signatures should be used as an integral part of seismic interpretation to predict hydrocarbon occurrences, despite the failures in the past. Caution must be put up front to minimize possible false AVO response. REI can be used at a large scale for exploration purposes – it is an alternative to seismic AVO. It should be followed by smaller-scale FEI for further reservoir characterization.

Seismic Sedimentology for High-Resolution Reservoir Imaging

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The interpretation of 3-D seismic data is vital for depositional facies analysis and reservoir imaging in many petroleum basins. One of the major difficulties facing high-resolution (reservoir or 10-m scale) facies and reservoir interpretations using seismic data is that at fourth- and higher order scale, sequence boundaries are typically not resolved. As a result, sequence correlation and systems tract imaging can be a great challenge. Fortunately, the problems caused by the lack of vertical resolution can be largely overcome by using the horizontal resolution power of 3-D seismic data. Horizontal reflection patterns can resolve thin geologic/depositional features that otherwise could only be detected on vertical seismic sections. Classic seismic facies analysis can thus be supplemented through the study of horizontal imaging of depositional forms and the spatial relationships between reflection patterns. A step beyond classic seismic stratigraphy, seismic sedimentology is the study of sedimentary lithology, geomorphology, depositional architecture, and depositional history by using the relationships between seismic amplitude (attributes) and lithology and between spatial reflection patterns and the preserved morphology of depositional elements. Key techniques include (1) 90° phasing of seismic data or seismic inversion to tie seismic traces and log-lithology profiles, and (2) seismic stratal slicing to image seismic attributes on approximate depositional surfaces. Examples from multiple projects will be presented for application of seismic sedimentology in revealing a basin's depositional history, correlating high-frequency (fourth- and higher order) sequences and systems tracts, identifying subtle reservoirs and new play opportunities, and assisting infield drilling.