High-Resolution Sequence Stratigraphy of the Tarfaya Basin, Morocco

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The Meso-to Cenozoic sequence stratigraphy of the Tarfaya Basin has been studied as early as 1977 by Vail et al. (1977). The concept of sequence stratigraphy has developed considerably over the last 35 years (Catuneanu 2006, Neal & Abreu 2009, Catuneanu et al. 2010,). Two major directions of development include high-resolution analysis and quantification of changes in accommodation space. In the Tarfaya Basin, ongoing exploration has increased the seismic and well database, while modern computing technologies offer new options for basin analysis.
This contribution focuses on the high-resolution sequence stratigraphic interpretation and modeling of outcrop, well and 2D-seismic data using Petrel® and OpendTect SSIS®.
Twenty-three calibration wells provided litho-, bio- and chronostratigraphic ties for the Late Permian to Holocene basin fill. High-resolution sequence stratigraphic interpretation is based on hierarchic well log patterns, reflector geometries, terminations and seismic attributes.
The Mesozoic to Cenozoic basin development includes five long-term basin stages, primarily controlled by changes in subsidence/uplift: i) Permian to Pliensbachian rift- and sag, ii) Toarcian to Tithonian early drift, iii) Tithonian Turonian mature drift, iv) Coniacian to Early Oligocene mature drift with initial Atlasian deformation and compression, v) Late Oligocene to Holocene mature drift with major Atlasian uplift and inversion. At least 113 sequences (3rd order) have been identified on the Early Jurassic to recent Tarfaya shelf margin.
The Late Permian to Liassic rift, sag and early drift basin fill (260-180 Ma) includes alluvial, limnic, evaporite and carbonate ramp depositional environments. In the area of the recent shelf margin, the Early Jurassic basin fill contains seven sequences. They comprise Early Toarcian coastal plain mudflats with alluvial intervals and Middle to Late Toarcian prograding clastic to carbonate ramps. The Middle and Late Jurassic stacked carbonate shelf ramps are subdivided by at least thirty-two sequences. Thirty-three Early Cretaceous and up to thirteen Late Cretaceous sequences comprise fluvio-deltaic and inner-outer shelf environments. Offshore, the Cretaceous is bounded by a major basal erosional unconformity, triggered by the collapse of the Jurassic shelf margin. The Paleocene clastic-carbonate and Eocene/Early Oligocene clastic basin fill includes eight sequences. Significant sediment bypass across the shelf top and margin took place during this time. A major regression coincides with shelf margin and upper slope collapse in the Late Oligocene. The Neogene basin fill covers eighteen sequences. The resolution of the sequence stratigraphic model reaches reservoir-scale.
Chronostratigraphic transformations (Wheeler transformations) of seismic reflectors at wavelet resolution allow to analyze the vertical & lateral migration of depositional systems and reservoirs during basin evolution in detail. On- and offshore (salt-) flow in the Tarfaya Basin affected the sediment flux history, the distribution of the main depocentres and the hydrocarbon stratigraphic-structural traps.

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