Geophysical Research Abstracts, Vol. 9, 03826, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-03826

Outcrop study combined with 3-D Petrel geological and petrophysical modelling of an epicontinental basin

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Within the context of the GECO-project, a joint ENI E&P - University research consortium on the “Geometry of Carbonate Objects”, Triassic Upper Muschelkalk carbonates in the South-German Basin were studied as an analog to the “layer-cake” type reservoir systems in the Middle East.

Similar to these reservoirs, Muschelkalk carbonates were deposited in an epicontinental, very gently inclined carbonate ramp. Reservoir facies consist of skeletal and oolitic carbonate grainstones, and are organised in a pronounced hierarchy of cycles. Based on outrops, cores, GR logs, plugs and thin sections, the integrated study is mainly focussed on facies and petrophysical 3D modelling with the software Petrel.

Previous outcrop sedimentology and correlation suggested simple layer-cake stratal patterns. However, high resolution 3-D modelling of sedimentary body geometries provided new insights into the straigraphic architecture. The apparent layer-cake stratigraphy turned out be a “pseudo-layer-cake”, with very gentle clinoform geometries.

Thin sections and poroperm plugdata show a close relationship between facies and petrophysical properties. Porous facies types are restricted to the high energy shoal-facies, whereas both inner- and outer ramp facies are commonly tight. Stratigraphic cycles seem to have a major impact on the spatial distribution of the reservoir units and the internal poroperm differences within the individual reservoir bodies appear to be mainly controlled by smaller-scale cyclicity.

To compare the impact of stratigraphy and facies on the distribution of reservoir properties three different approaches were used for the petrophysical modelling: a) Un-

conditioned: The grid used here is a relatively simple 3D cube which was subdivided into 180 conformable layers; b) Conditioned to stratigraphic cycles c) Conditioned to stratigraphic cycles and facies.

The volume and dimensions of the reservoir bodies seem to be mainly controlled by the combination of both stratigraphic cycles and a subtle paleorelief, induced by slight differential subsidence of inherited structural grains.