Abstr. Vol., 15th Int Sediment Congr Int Ass Sediment, Alicante April 12-17, pp 847-849

2D REVERSE AND FORWARD STRATIGRAPHIC MODELLING OF LATE JURASSIC CARBONATE-CLASTIC DEPOSITIONAL ENVIRONMENTS IN THE LUSITANIAN BASIN

Rainer Zühlke (1), Thilo Bechstädt (1) & Reinhold R. Leinfelder (2)
(1) Geolog.-Paläont. Institut, University of Heidelberg; rainer. zuehlke@urz.uni-heidelberg.de; thilo.bechstädt@urz.uni-heidelberg.de; (2) Institut für Geolog. u. Paläont., University of Stuttgart; reinhold.leinfelder@po.uni-stuttgart.de

Geological setting: Late Triassic and Jurassic sediments related to the rifting of the central northern Atlantic are well exposed in the Lusitanian Basin of Portugal. Detailed sedimentological and structural models exist especially for the Late Jurassic (Leinfelder, 1993, Profil, 5, 119-140; 1994, Profil, 6, 1-207; Leinfelder & Wilson, 1989, Geolog. Rundschau, 78, 81-104; Wilson *et al.*, 1989, Amer. Ass. Petrol. Geol., Mem., 46, 341-361; Stapel *et al.*, 1996, Tectonophysics, 266, 493-507). The focus of this study lies on the southeastern subbasin, the Arruda subbasin (25 km SE-NW), where a complete cycle of rift initiation, rift climax, immediate post and late post rift is documented by Oxfordian to early Cretaceous sediments. Sedimentological data come from a large number of outcrops and 5 wells. Large scale geometries are derived from 3 Vibroseis lines (10-25 km each), that cross the basin in E-W and NW-SE direction.

Methodology: 2D reverse modelling and 2D stratigraphic forward modelling (Phil Utility 1.5 opt 4™, Phil 5.2.15™, PetroDynamics, Houston) has been used to examine quantitatively, and in detail the late Jurassic basin development and the whole post-Variscan sedimentary infill of the Arruda basin, i.e. from the late Triassic (Norian, 223 My) to the late Oligocene (25 My) when maximum burial depths were reached. Reverse 2D modelling accounts for flexural loading of the crust and is far better able to determine the basement subsidence history than 1D (Airy) backstripping. This is especially important for rift basins where the subsidence of fault block highs is influenced by sediment loading in adjacent halfgrabens and vice versa. Airy backstripping can not approximate a flexural response of low effective elastic crustal thickness when isostatic loads have a short wavelenght. Airy backstripping results in overestimations of post-rift loads and crustal stretching factors (β)(cp. Nadin & Kuznir 1995, J. Geol. Soc., 152, 883-848; North Sea basin). High resolution 2D reverse modelling has been performed for 10-25 surfaces (Fig. 1). Models account for incremental decompaction of each layer, changes in paleobathymetry and 3rd to 2nd order sea-level changes. The influence of each of these parameters on the subsidence history of the whole basin has been tested. Reverse modelling produces first-order approximations of tectonic/ total subsidence rates in time/space and sediment input volumes that are used for 2D stratigraphic forward modelling. Forward modelling also includes e.g. carbonate production, clastic input from two sides, changes in grain-size and traction/ suspension ratio over time and a large number of other parameters. Stratigraphic modelling allows to quantitatively analyse facies distribution, sequence stratigraphic features and patterns (e.g. unconformities, flooding surfaces, shallowing upward trends, retro-/pro-/aggradation) within the framework of different tectonic/total subsidence histories (from reverse modelling) and sea-level changes (derived from sequence stratigraphic correlations between tectonically independant basins).

Results: The geometry of the Arruda Basin, the locations and lateral shifts of depositional centers and large scale geometries can be adequately reproduced with a geologically reasonable set of input parameters. The creation of accommmodation space in the Late Jurassic of the Lusitanian basin is best reproduced with an effective lithospheric thickness of 4-5 km and tectonic subsidence rates of 30 to 100 m/my (rift initiation, middle to early upper Oxfordian), -110 to 2250 m/my (rift climax, late upper Oxfordian), 0 to 80 m/my (immediate post rift, lower Kimmeridgian) and -15 to 75 m/my (late post rift, upper Kimmeridgian and Tithonian). The Exxon sea-level chart (Haq *et al.*, 1987; Science, 235, 1156-1167) is compatible with accommodation rate changes in marginal part s of the Arruda basin provided that it is modified according to data by Ponsot (1994, Paris-London Basin, Europ. Ass. Petrol. Geoscientists, Spec. Publ., 4, 74-106) and Sahagian *et al.* (1996, Amer. Ass. Petrol. Geol., Bull., 80, 1433-1458; Russian Platform). In the central parts of the Arruda subbasin, accommodation space is predominantly controlled by tectonic subsidence, isostatic compensation and flexural loading. For these areas stratigraphic forward modelling is able to produce a sequence stratigraphic model, that is impossible to infer from the existing field data. During rift initiation carbonate deposition prevails with production rates of up to 100 m/my (shelf), 150 m/my (shelf margin) and 25 m/my (pelagic). During rift climax the input of terrigenous clastics suffocates carbonate production except on small deactivted fans on fault block highs. Volumes of input reach a maximum of 2.1×10^7 m^2/my (2D section) in the late Oxfordian. Even so, the sediment input is exceeded by an increase in accommodation space, so that the basin remains underfilled until the late Kimmeridgian (late post rift). In immediate post rift times, sediment input decreases to max. 4.1×10^5 m^2/my. Carbonate and carbonate-clastic deposition with production rates of 60 m/my (shelf), 80 m/my (shelf margin) and input rates of $1.0\text{-}2.5 \times 10^5$ m^2/my only return in late Kimmeridgian and decrease for the late post rift interval. In contrast to the model of Prosser (1993, Geol. Soc. London, Spec. Publ., 71, 35-66) that links depositional systems to rifting the amount of synrift sediments clearly exceeds input during immediate and early late post rift times.

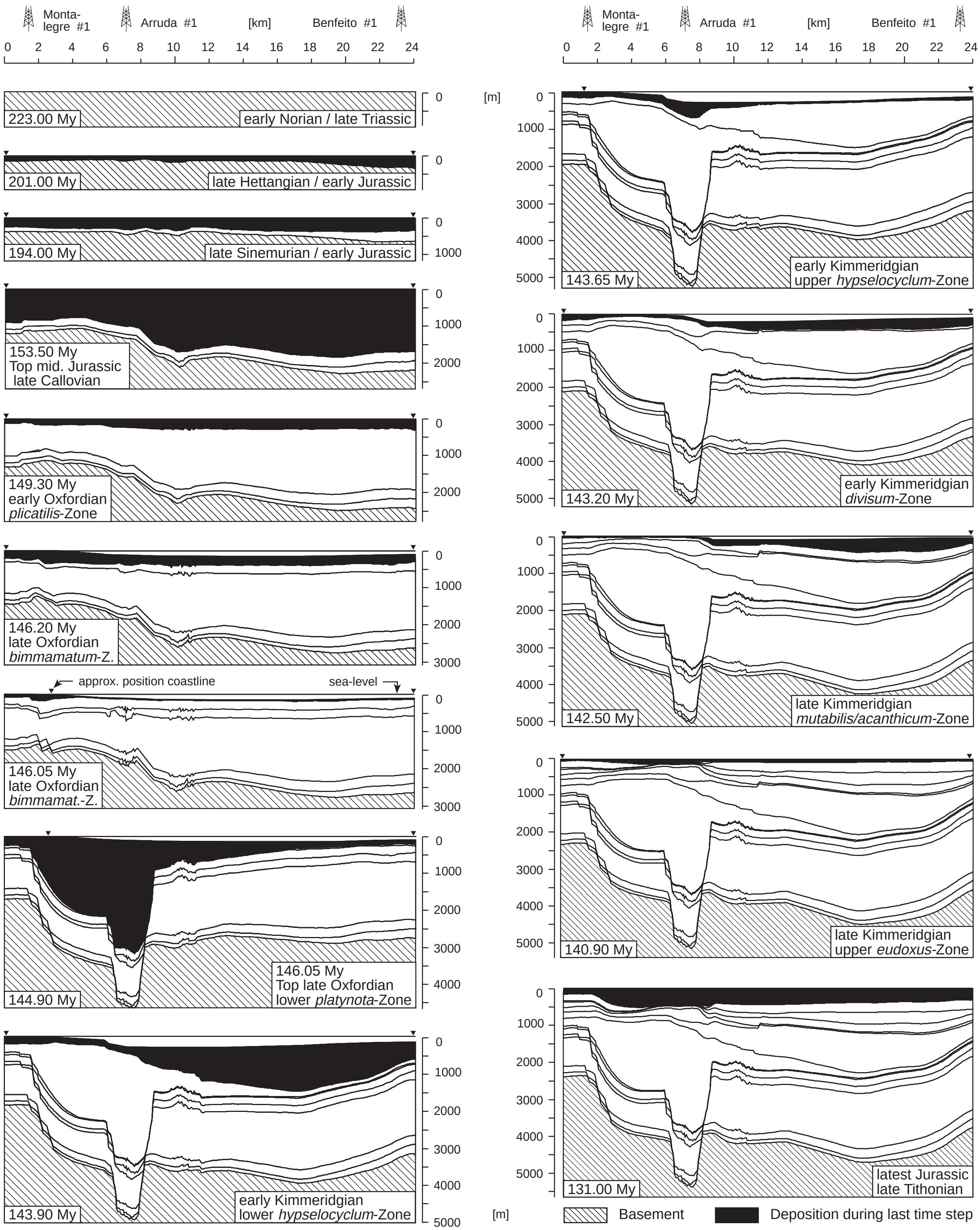

Figure 1: 2D reverse model of the Arruda Basin (late Triassic to late Jurassic, selected time slices). Outcrop data of the late Kimmeridgian and younger basin infill have been added and/or projected into the modelling transect. Paleowater depth/topography <+50/<-50 m is not represented due to the small scale. For seismic line AR 9/80 see Leinfelder & Wilson (1989, Geolog. Rundschau, 78, 81-104).