Developing a New Stratigraphic Forward Model to Understand and Predict Carbonate Platform Geometries and Facies Distribution in Syn-Rift Settings

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ABSTRACT

Characterization of the architecture of syn-rift carbonate platforms is challenging. Conventional analysis methods, based on outcrop and subsurface data alone, may be insufficient due to the large variability of rock properties and processes influencing carbonate reservoir over short-range. The aim of this research is development of a new approach, integrating stratigraphic and seismic forward modelling with quantitative geological observation, to improve our understanding of the processes governing carbonate platform growth and facies architecture on syn-rift carbonate platforms. The starting point of the new approach is Carbo-CAT (Burgess, 2013), a stratigraphic forward model that has been further developed in this study to incorporate key mechanisms affecting carbonate platforms development in rift basins. Orpheus, a new sub-routine enabling a realistic representation of sediment erosion, transport and deposition, has been written and included in Carbo-CAT. ExtSubs, a Carbo-CAT sub-routine for extensional fault modelling, has been improved for a more accurate representation of fault linkage and relay ramp evolution. The overall model grid size and resolution has been increased. We have used Carbo-CAT to model syn-rift carbonate platforms in the Lower Carboniferous of the Pennine Basin and North Wales. A detailed structural and sedimentological analysis has been performed on outcrop and subsurface data, to determine how normal faulting may have controlled facies distribution and geometry in the carbonate platform strata. Using the acquired quantitative data to constrain Carbo-CAT parameters, two 3D stratigraphic forward models are developed, representing land-attached and isolated carbonate platforms developed in an extensional regime. The next research step will be the population of the 3D-models with petrophysical data and subsequent development of a seismic forward model. A comprehensive characterization of the seismic response of stratigraphic architecture and the seismic signature of carbonate lithofacies will be performed. The final outcome will represents a useful support tool, assisting seismic interpretation and inversion in complex syn-rift settings. Burgess, P. M. (2013). CarboCAT: A cellular automata model of heterogeneous carbonate strata. Computers and Geosciences, 53(February), 129–140.