Geophysical Research Abstracts,
Vol. 10, EGU2008-A-04037, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-04037
EGU General Assembly 2008

Drowned, buried, but still causing (velocity) problems: a Miocene barrier reef, Browse basin, NW Australia

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Seismic time-depth conversion is a very important component in the assessment of prospects for hydrocarbon exploration. Seismic velocity variations within carbonate sequences have caused considerable time-depth conversion problems by distorting the structure of the underlying reservoir intervals. A case in point is the Cenozoic carbonate succession of the Browse Basin, North West Shelf, Australia. This prograding slope system is superbly imaged by two adjacent, three-dimensional multichannel seismic volumes embedded in a two-dimensional multichannel seismic grid. The dataset includes the record of the development and final drowning of a tropical rimmed carbonate platform on the western Australian shelf during the Miocene and early Pliocene. The contrast in seismic velocity between the reefal structures and the underlying and adjacent facies significantly distorts the geometry of depth-converted seismic horizons in the underlying strata. Due to the high-resolution 3D-seismic data the morphological development of the carbonate platform could be mapped spatially in great detail throughout an area of $\sim$ 1000 km^2. Thereby it could be recognized on reflectivity and coherency horizon slices, that the drowning of the platform did not occur in an instantaneous matter, but lead to the development of several isolated atolls, which rose as relictic structures over the former platform surface. The atolls developed emanating from small isolated pinnacles reefs on the platform surface, which propagated and coalesced with each other to bigger build-ups. In a next stage the isolated build-ups merged to oval-shaped structures with a raised rim and empty-bucket morphology. The atolls were elongated perpendicular to the strike of the platform contour lines. Subsequently the interior of the atoll structure was gradually replenished until a massive, flat-topped atoll had formed.

The aim of this study is twofold. First, to visualize the internal and external seismic architecture of a drowning barrier reef complex to identify specific morphologic features which are indicative for different drowning mechanisms. Second, two use the morphologic information in combination with velocity data from well-logs to define voxel properties for velocity modelling. The final product will be a high-resolution 3D velocity cube that allows instantaneous time-to-depth conversions for all horizons, grids and selected seismic data, essentially enabling the analysis of true geometries (e.g.: thickness, volumetrics, slope angles).