Geophysical Research Abstracts,
Vol. 11, EGU2009-10608, 2009
EGU General Assembly 2009

3D depositional architecture of a non-tropical carbonate shelf, Eocene-Oligocene, Browse Basin (NW Australia)

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Calciclastic gravity-flow deposits accumulated on continental margins can form potentially very important and attractive targets for hydrocarbon exploration. A correct reservoir characterization of calciclastic slope deposits needs a robust understanding of their sedimentary facies and three-dimensional depositional architecture. Conventional 2D grids often lead to a spatial aliasing whenever the size of submarine gullies and canyons is less than the spacing of the grid. In contrast, high-resolution 3D seismic data are ultimately comparable in resolution to those achieved by multi-beam bathymetry of the present seafloor.
Seismic data from the western part of the Browse Basin, North West Shelf, Australia, reveal the internal geometry and depositional history of a progradational Eocene-Oligocene non-tropical carbonate shelf. The prograding slope system is superbly imaged by two adjacent, three-dimensional multichannel seismic volumes embedded in a two-dimensional multichannel seismic grid. Based on this data, the three-dimensional stratal architecture of prograding clinoforms can be mapped throughout an area of $\sim$ 1000 km2. During progradation the carbonate slope system develops from a distally steepend carbonate ramp with a linear to sigmoidal slope curvature to a carbonate platform with a concave-upward slope morphology. This change in slope morphology is accompanied by a change in the erosion pattern on the clinoform fronts. The submarine canyons of the linear to sigmoidal slope reach a total length between 7 and 15 km, and their width, measured perpendicular to the flow direction, varies between 1.2 km and 0.6 km. In contrast, the concave-upward slope is characterized by relatively smooth foresets, which are dissected by relatively small gullies. The numerous submarine channels on both slope types define a line-sourced system which develops a sedimentary apron along the carbonate ramp. The relatively high sinuosity of some of the channels is not known from submarine channels from tropical carbonate platforms but rather resembles siliciclastic systems. On the other hand, the relative scarcity of well developed levee systems might be attributed to the reduced mud content in cool-water carbonates compared to siliciclastic systems. The spatial control provided by the 3-D seismic volume supports a detailed analysis of the relationship between the overall morphology of carbonate systems and the erosion mechanisms on their foresets. This will contribute to a better understanding of non-tropical calciclastic submarine slope systems.