Seismic Geomorphology and Evolution of the Early-Mid Miocene Isolated Carbonate Build-Ups, North West Shelf of Australia*

Muhammad Mudasar Saqab1 and Julien Bourget2

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1iCRAG, University College Dublin, Belfield, Ireland (mmsaqab@gmail.com)
2CEG, University of Western Australia, Crawley, Australia

Abstract

Almost half of the world’s petroleum production is from carbonate reservoirs, with many discoveries in isolated platforms. Although major discoveries continue to be made in these play types, many areas remain understudied. Analysis of extensive 2D and 3D seismic data reveals the presence of about sixty isolated carbonate build-ups (ICBs) of early-mid Miocene age spreading over a wide area of the north-western Bonaparte Basin. Individual build-ups are ~ 100 m thick, with an average diameter of 3 km. Integration of full-volume 3D seismic attribute analysis with extensive biostratigraphic and lithological data from exploration wells allow examining the evolution of ICBs and their associated morphologies at high-resolution. The development of ICBs took place above a seismically flat surface. The stratigraphic architecture of the build-ups typically consists of: (1) mid Burdigalian initiation (Tf1/CN2), (2) lateral expansion during late Burdigalian (CN3), and (3) backstepping and drowning during Langhian (Tf2/CN4). This is followed by a sub-aerial exposure probably corresponding to the major eustatic fall during Serravalian. Only small patch reefs (pinnacles) developed afterwards during the late Miocene. The various growth phases of ICBs correspond to sea level fluctuations, and major changes in global climate and oceanography. The role of local tectonics in the initiation and demise of these carbonate platforms is minimal. Growth of the ICBs is synchronous with establishment of tropical carbonate factories elsewhere along the Australia’s North West Shelf that suggest an acme of reef development during the early to middle Miocene.

References Cited


Seismic geomorphology and evolution of early-mid Miocene isolated carbonate build-ups, North West Shelf of Australia

Muhammad Mudassar Sajid, Julien Bourgef

Source: University College Dublin - School of Geosciences

Abstract

The study focuses on the seismic characteristics, evolution, and spatial distribution of isolated carbonate build-ups (ICBs) along the northwest shelf. The seismic data reveal the presence of a large number of ICBs within the Miocene stratigraphic interval, characterized by a dense network of channelized geomorphologies. The ICBs are distributed over a wide area (>25,000 km^2) and are spread across multiple stratigraphic horizons, indicating their post-rift thermal sag phase origin. The seismic facies analysis suggests that the ICBs consist of mid-Burdigalian (CN3) rudist banks, containing abundant massive and branching coral debris along with algal remnants and benthic foraminifera. The ICBs are associated with coalescing bodies of isolated patch reefs (pinnacles) and isolated carbonate build-ups, which are associated with high-amplitude anomalies. The seismic facies analysis also shows evidence of backstepping and drowning of the ICBs during the late Langhian (Tf2/CN4).

Geological settings

The North West Shelf is an extensive area flanking the shelf and was accompanied by the onset of carbonate rocks underlain by discrete basins, namely the Northern Carnarvon, the34. The term geomorphology provides excellent morphological details of the ICBs and new insights into their stratigraphic location of the ICBs does not seem to be related to antecedent topography, at least at the resolution of sectional and map-view geometries on 2D and 3D seismic data in the northwestern Bonaparte Basin. The ICBs occur within the same stratigraphic interval, and are spread over a wide area (>25,000 km^2). The overall thickness of the Miocene sequence is relatively uniform in the Bonaparte Basin, indicating a relatively constant sedimentation rate. The Miocene sequence is characterized by a large number of discrete seismic horizons, which are associated with the ICBs. The seismic facies analysis shows evidence of backstepping and drowning of the ICBs.

Seismic facies

During early-mid Miocene, sea-level changes were in the order of 30 to 60 m and mostly governed by eustasy. The regional paleogeographic reconstruction, through integration of these new results with data from the Timor Sea region, suggests that the ICBs developed during the early-mid Miocene period (ca. 18–15.5 Ma) in the NW Bonaparte Basin. These results in combination with observations of Rosleff-Soerensen et al. (2015) in the adjacent Browse Basin, suggest that the formation of the ICBs was associated with the evolution of the shelf edge. The ICBs are associated with the growth of the shelf edge, which is characterized by a large number of discrete seismic horizons, indicating a relatively constant sedimentation rate. The Miocene sequence is characterized by a large number of discrete seismic horizons, which are associated with the ICBs. The seismic facies analysis shows evidence of backstepping and drowning of the ICBs.

Eustasy:

During early-mid Miocene, sea-level changes were in the order of 30 to 60 m and mostly governed by eustasy. Eustasy is the relative sea-level changes that are due to the expansion and contraction of the ocean basins. Eustasy is driven by changes in the volume of seawater due to changes in the Earth's mass and gravity. Changes in the volume of seawater can be caused by changes in the Earth's temperature and salinity, which can affect the density of seawater. Changes in the Earth's temperature and salinity can be caused by changes in the Earth's climate, which can affect the amount of precipitation and evaporation. Changes in the Earth's climate can be caused by changes in the Earth's orbit and rotation, which can affect the amount of solar energy that reaches the Earth.