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Research paper

A genetic classification of carbonate platforms based on their basinal and tectonic settings in the Cenozoic

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Abstract

This paper reassesses the usefulness of the morphological classification of carbonate platforms into rimmed shelves and ramps. Whilst the existing classifications have value in describing platform margin morphology at any one time, the terms rimmed-shelf and ramp are less successful at categorising the entire morphology and stratigraphy of carbonate platforms. Research on Cenozoic carbonate platforms from a range of different tectono-stratigraphic settings indicates that the basinal and tectonic setting of a platform can be used to erect a first-order, genetic classification of carbonate platforms. The basinal and tectonic setting of carbonate platforms is shown to control their occurrence, the overall 3-D platform morphology, the large-scale stratigraphic features and depositional sequences. Climate, ocean chemistry and biological evolution control grain types, facies and some elements of platform margins but not the larger-scale features considered in this new classification.

From a review of well-exposed outcropping and seismically imaged Cenozoic platforms, it is proposed that eight types of carbonate platform can currently be recognised and characterised based on their basinal and tectonic setting: Fault-Block, Salt Diapir, Subsiding Margin, Offshore Bank, Volcanic Pedestal, Thrust-Top, Delta-Top and Foreland Margin carbonate platforms. These eight types are described using information from Cenozoic platforms worldwide and the controls on their development are discussed. Many platform types (e.g. Subsiding Margin, Offshore Bank, Salt Diapir, Thrust-Top and Foreland Margin) are typical of particular classes of sedimentary basins, others (e.g. Fault-Block, Volcanic Pedestal and Delta-Top) are more widespread in their occurrence and occur in a range of basin types.

The value of this classification is that it is genetic rather than morphological; the classification reflects the entire morphology and large-scale stratigraphy of the platform and the controls on its development. In addition, the platform models can be used to understand the details of less well exposed, or seismically imaged platforms so that they can be characterised and understood in terms of tectono-sedimentary processes. Conversely, the classification also provides valuable information on basin evolution, as carbonate platforms house information on palaeoenvironments, sea-level change and are sensitive recorders of the tectonic environment.

Keywords: Classification; Carbonate platforms; Tectonics; Basin setting; Cenozoic

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1. Introduction

Much research has been focused over the last 20 years on the effects that sea-level change, oceanographic factors and climate have on carbonate platform stratigraphies. Whilst these controls are important at the scale of grain types, facies, depositional sequences and types of platform margin, it is considered here that it is the geotectonic setting of the platform that controls its gross morphology and large-scale stratigraphic evolution. This concept was introduced by Read (1985) and emphasised by Tucker and Wright (1990) and Wilson (2002) but has not previously been investigated in detail. In this paper, eight different types of carbonate platform formed in different basinal and tectonic settings in the Cenozoic are reviewed and presented as models or templates: Fault-Block, Salt Diapir, Subsiding Margin, Offshore Bank, Volcanic Pedestal, Thrust-Top, Delta-Top and Foreland Margin carbonate platforms.

The purpose of this paper is to provide a genetic classification of platform types to run alongside the current morphological classification of ramps and rimmed shelves (Wilson, 1975).

The advantages of a genetic classification based on Cenozoic examples are that:

a) The new classification provides a comprehensive genetic classification that is based on the major controls on carbonate platform development and their occurrence in sedimentary basins that will enable better communication and a greater level of understanding than the current scheme.
b) Where poorly exposed, or poorly understood carbonate platforms are being studied they can be compared to the eight carbonate platform types that are from well-exposed and documented examples where the tectonic and basinal controls are well known. Such comparisons will enable a better understanding of the major controls on the development of ancient carbonate platforms.
c) In subsurface examples the tectonic setting, 3-D morphology and gross stratigraphic features of carbonate platforms may be known from seismic data. However, the internal stratigraphy, nature of depositional sequences and facies associations are often poorly known as this comes from widely spaced well data. In this situation the eight models can be used as templates for more detailed interpretation and understanding, based as they are on reasonably well-understood platform types established from recurring Cenozoic examples.

The widely used morphological classification of carbonate platforms was presented nearly 30 years ago by J.L. Wilson (1975). In this classification Wilson integrated Ahr's (1973) carbonate ramp with his carbonate platform model, with major offshore banks, to provide a framework for the description and interpretation of carbonate platforms (Fig. 1). Subsequently a major development in the understanding of the range of facies that occurs in carbonate platforms and the detail of their spatial arrangements was made by Read (1982, 1985) with his facies models. In addition he clarified terminology by retaining "carbonate platform" as a general term encompassing ramps, rimmed shelves and isolated platforms that has been followed by many subsequent authors (e.g. Tucker and Wright, 1990). These facies models have also stood the test of time with few modifications over the last 20 years. The identification of the stratigraphic effects of relative sea-level changes over time subsequently led to the development of sequence strati-

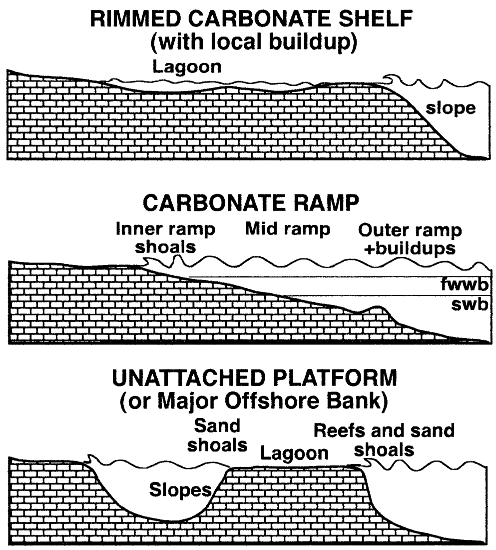

Fig. 1. Morphological classification of carbonate platforms (after Wilson, 1975 and modifications following Read, 1985, and Wright and Burchette, 1996).