

*Advances in Carbonate Sequence Stratigraphy: Applications to Outcrops, Reservoirs and Models*

*edited by* P.M. Harris, A.H. Saller, and J.A. Simo, eds., 1999; SEPM (Society for Sedimentary Geology) Special Publication No 63, 1741 E. 71st Street, Tulsa, Oklahoma 74136-5108; 421 pages, hardbound; \$148, \$105.50 for SEPM member; ISBN 1-56576-060-3.

This excellent hardback collects many of the papers presented at an SEPM Research Symposium organized in 1997 for the AAPG-SEPM Annual Meeting in Dallas, Texas. It covers a broad range of applications of sequence stratigraphic concepts to the understanding of carbonates. This book is in line with AAPG Memoir 57 (Loucks and Sarg 1993), but is forward-looking in providing contributions that show how sequence stratigraphy is a comprehensive approach to the study of carbonates.

A careful introduction leads the reader to the main topics of the book. The introduction offers a wide review of the birth and development of carbonate sequence stratigraphy, which includes the roots in seismic stratigraphy, then passes to sequence stratigraphy and its application to carbonates, the evolution of carbonate cyclostratigraphy and modeling, diagenesis and reservoirs, and the paleoceanographic potential of carbonates. The editors conclude the introduction by summarizing the main results of the 17 collected papers. These are organized in five main categories.

**1) Platform to Basin Correlation and Facies Distribution.** In this first group, second-order (10-20 m.y.) sequences in two Carboniferous and Permian basins of the U.S.A. are described by integrating outcrop, well, and seismic data (Sarg, Markello and Weber). Their work provides a sequence stratigraphic framework that can help in predicting the characteristics of reservoirs, traps, and seals in time and space. Schlager's paper formally proposes a new type of Sequence Boundary (Type 3 SB), i.e. the flooding surface separating a highstand tract from the overlying transgressive tract (the so-called drowning unconformity). This convincing proposal is particularly welcome and appears powerful in describing those drowned platforms, where evidence of exposure between highstand and transgressive tracts is lacking. Consequently, it is possible to correlate platforms lacking subaerial exposures with basins lacking lowstand system tracts. The backstepping of a Frasnian platform in Australia is the subject of a paper by Ward. Using outcrop data, Ward documents landward retreat of the platform margin, eroded by massive collapses. His discussion on the causes of this retreat is broad, but does not take into account the possibility that neptunian dykes could be related to gravitational, rather than tectonic, forces as suggested by previous authors, as well as by the last paper of this group. The latter, by Hunt and Fitchen, deals with the modification of the stratal geometry by differential compaction of platform versus basin deposits and shows that many features, such as stratal inflections and fracturing at the shelf margins can be derived from this process.

**2) High-Resolution Sequence Framework Bridging the Gap Between Seismic-Scale and Reservoir-Scale Stratigraphy.** In this section, high-resolution stratigraphic studies

have been applied to seismic-scale outcrops and basins. Smith and Read show the advantage of a basin-wide approach to interpreting high frequency sequences on a mixed carbonate-siliciclastic tidally influenced platform. Rankey, Batchel and Kaufman provide a case study of a mixed carbonate-siliciclastic system developed during icehouse time. Their analysis encompasses shelf and basin, and the dramatic lateral variations of depositional facies are discussed in the frame of high-amplitude eustatic fluctuations. Mazzullo, who studied a Lower Permian ramp succession, has highlighted the glacio-eustatic imprint on facies architecture. His study demonstrates a substantial independence of high-frequency cycles from the tectonics, the latter controlling subsidence variations and related facies changes. Osleger and Tinker discuss a three –dimensional outcrop study of a sector of the Capitan margin. The magnificence of exposures allows them to evaluate the main physical characteristics of high-frequency cycles on the shelf margin.

### **3) Cycle-Stacking Patterns and Their Relationships to Longer-Term Sequences.**

Lehrman and Goldhammer describe cycle-stacking patterns of icehouse and greenhouse platforms. By means of a digital database from diverse ages and settings, the authors analyzed the secular variation of facies stacking patterns, producing different classes of stratigraphic styles. Saller, Dickson, Rasbury and Ebato combine sedimentological, cyclostratigraphic, and chemostratigraphic data to unravel the effects of long-term accommodation changes on short-term cycles in a subsurface Upper Paleozoic carbonate platform.

### **4) Sequence Stratigraphy and Facies of Slope and Basin Carbonates.**

Slope and basin carbonates sometimes help to better resolve the evolution of the platform sequences. Westphal, Reijmer, and Head show the influence of platform physiography (flat-topped vs. basinward sloping) on the sedimentary and diagenetic evolution of a Pliocene slope of the Bahamas. Periplatform sedimentation was cut-off during sea-level lowstands of flat-topped platforms, whereas, a ramp morphology allowed for basinward shifting of the carbonate factory, therefore supplying the slope with sediment. Choi, Simo, and Saylor discuss the sedimentology and sequence stratigraphy of a mixed siliciclastic and carbonate ramp. Their conclusions stress the importance of also considering paleoclimatic and paleoceanographic conditions as controls on facies stacking patterns and sequence development. Van Konijnenburg, Bernoulli, and Mutti carefully describe the stratigraphy and sedimentology of base of slope deposits from the central Apennines. They correlate slope sequences to the adjacent platform, documenting the intimate connection between the two. Mettraux, Homewood, Schwab, and Guillocheau describe the sedimentary evolution of the Upper Cretaceous chalk of the Paris basin in terms of accommodation cycles. High frequency changes in accommodation and sediment supply control facies and porosity in the rocks, producing different seismic signatures.

### **5) Paleoceanographic Factors that Cause Variations in Carbonate Deposition.**

Zempolich and Erba discuss the sedimentology and chemostratigraphy of Middle Jurassic resedimented carbonates at the base of slope of a Southalpine Tethyan platform with the aim of recognizing third-order sequences. They conclude that grain contents and the isotope compositions of the Vajont gravity-driven deposits represent the deep-sea record of the compositional, chemical, and sequence stratigraphic evolution of the adjacent

platform. Mutti, Bernoulli, Spezzaferri, and Stille document that paleo-oceanographic changes greatly influenced carbonate facies evolution. To demonstrate the impact of paleo-oceanographic changes in the sedimentary record, the authors used detailed biostratigraphy and strontium isotope dating of two Lower to Middle Miocene stratigraphic sections located at the margin of two shelves in the southern Apennines and in Sicily. The final paper of Elmer Ferro, Droxler, Anderson, and Mucciarone nicely described the facies evolution of the Belize lagoon across the latest Quaternary. The lowstand of the last glacial maximum was associated with deposition of siliciclastics, when most of the platform was emergent; it was only after rapid transgression that the shelf was colonized by carbonate patch reefs.

The difficulty of organizing such different contributions into categories has produced groups that are not always in harmony. For this reason as well as the richness of contributions and variety of approaches, this book is not easy reading. Its main goal, however, is to propose conceptual advances, and this has been reached in a clear and cogent manner. The strength of this book is to depict a wide scenario of applications of carbonate sequence stratigraphy, showing different methods and key areas. Therefore, this work is a candidate to turn out to be a reference book for all researchers working on carbonates.

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