

AAPG Memoir 58 entitled "Siliciclastic Sequence Stratigraphy"

edited by **Paul Weimer and Henry W. Posamentier**, published in 1993 by the American Association of Petroleum Geologists, ISBN 0-89181-337-3, 492 pages.

Review by Christopher G. Kendall

This is a part of a two volume series on sequence stratigraphy. The companion volume is on carbonate sequence stratigraphy. This book on siliciclastics has two stated purposes. One is to provide examples of the applications of the principles of sequence stratigraphic interpretation to real stratigraphic examples, and the other is to present new ways to examine the current conceptual models and extend them. The volume is divided into two parts: in the first part, after the introduction, there are eleven papers on applications of siliciclastic sequence stratigraphy to various geological examples from different parts of the world and different parts of geological sections. In the second part, there are six chapters on recent developments in siliciclastic sequence stratigraphy. In the introduction to this volume, the editors draw attention to how they have tried to provide the necessary documentation needed to enable management and other earth scientists to see how sequence stratigraphy can be applied to siliciclastic systems to improve the chances of finding hydrocarbons in rocks formed in particular depositional settings or geographic settings.

The main point of the book is that the studies provided should aid earth scientists improve their understanding of the basins described and help their exploration evaluation. For instance, Bowen et al. describe the relative success of sequence stratigraphic concepts to explore for hydrocarbons in incised valley fill and turbidite systems, focusing on the incised valley trends of the Pennsylvanian Morrow Formation of southeastern Colorado and the lower Cretaceous turbidite system of the Bidasdorp basin of offshore South Africa. The authors document how incised valley fill reservoirs are developed during low stands and during early transgressive system tract events. They also suggest turbidite systems tract reservoirs form during low stands in association with basin floor and slope fans, citing examples from offshore Southeast Africa. This paper is well illustrated by maps, interpreted cross-sections, interpreted seismic and block diagrams. In the next two papers by Brink et al. and Muntingh and Brown emphasis is given to stratigraphy of the sedimentary fill of southern offshore South Africa for the Lower Cretaceous to Upper Cretaceous sections. It uses the magnificent set of seismic data assembled by Soekor (Pty) Ltd of South Africa. These two papers illustrate higher order frequency fill of basins with multiple seismic lines for this area which show unusually clear high frequency sequences. The authors demonstrate how sequence stratigraphy can really be applied to basin analysis. They show how the development of our understanding of the geography and depositional systems of an area can be used to identify perspective hydrocarbon plays in a basin. These two papers are beautifully illustrated with uninterpreted and interpreted seismic lines, numerous maps and cross-sections and block diagrams, some of which document the interplay between the various hierarchies involved with the high frequency sea level cycles and local subsidence. These two papers are important contribution to our understanding of system tracts and their relationship to eustasy, tectonics and rates of sedimentation. They provide very convincing applications of the concepts of sequence stratigraphy.

Two papers by Tye et al. and by Hewlette and Jordon follow which describe the application of sequence stratigraphy to the Cenozoic fill of active continental margin setting, namely the San Joaquin valley of California. In both papers, well logs, and seismic data have been integrated to identify prospects and evaluate and extend them beyond already existing hydrocarbon reservoirs. The papers are well illustrated by seismic cross-sections and well log descriptions

and Tye et al. also have photographs of core and core descriptions.

Next are two papers on the Gulf of Mexico late Cenozoic by Mitchum et al and Pulham which describe the relationship of reservoir, source and seal and emphasize the economic importance of lowstand systems tracts and their interrelationship with deltaic and prodelta sedimentary delivery. The paper by Mitchum et al. ascribes the sedimentary style to eustatic sea level fluctuation while Pulham's ascribed it to the variation and style to remobilization of delta front and prodelta sediments. Both papers are illustrated by seismic and well log data, block diagrams and interpretive cross-section. The papers are followed by one by Hettingh et al on the analysis of high resolution eustatic variations from outcrops in the Kaiparowits Plateau of southern Utah. This paper is beautifully illustrated by clear line drawings and photographs. The authors mapped continuous outcrops to integrate facies analysis with sequence stratigraphic concepts. This paper is a clear example of the use of sequence stratigraphy to make an outcrop study. A paper by Blum on the Holocene and Pleistocene alluvial deposits of the Colorado River in Texas comes next. The emphasis of this paper is on changes in base level and how these changes are tied to climate, tectonic effects and eustatic sea level variation. The feeling of the author was that changes in sediment supply occur over shorter time scales than relative changes in base level and may reinforce or act in opposition to these trends; the changes in base level being related either to other tectonics and/or to eustasy.

The book contains two papers on the relationship of eolian sedimentology to fluctuations base level. These papers are unusual applications of sequence stratigraphic approach to eolian sediments, using changing base level to the sequences together. The first, by Chang-Shu Yang and Swie-Djin Nio, emphasizes the Rotliegend Formation of the southern North Sea. The authors identify twelve subfacies in the upper Rotliegend Formation of the Netherlands which are related to changes in climatic variation and basin subsidence. They relate sequence boundaries to rapid falls of lake level and lowering of the ground water table. They illustrate the paper with a fine set of color photographs of cores through the Rotliegend sands. Kocurek and Hatolm's paper on eolian sequence stratigraphy also shows how eolian depositional systems are influenced by the presence or absence of the water fall and rates of supply, dividing the systems into dry (no water table), wet (water table) and stabilized (vegetated or cemented material) systems.

A complimentary paper by Liro deals with the lacustrine sediments of the Paleocene lacustrine Wind River Basin of central Wyoming in which seismic and well data are used to delimit the sequence stratigraphy of these rocks. This is done in terms of sequence boundaries, enclosed system tracts and the relationship to variations in lake level. In much the same way that eolian sediments described by Yang and Nio are related to changes water table, so those of the lacustrine systems are too.

The next paper is by Lawrence which is on how computer simulations can be used to better understand the architecture and geometric patterns of basin fill. Lawrence focuses on how subsidence and sediment supply can affect the timing system tract boundaries. Following is a theoretical paper by Wehr diagramming how subsidence and sediment supply control parasequence stacking patterns and clearly illustrating the application of these concepts with an example from the Lower Cretaceous of Western Canada.

Next is a paper by Wood et al. which describes the use of flumes to study sequence stratigraphy and varying changes in base level i.e. relative sea level, through varying the water level in a flume and also varying sediment input, etc. Using this methodology the authors were able to develop incised valleys, highstand systems tracts, and lowstand systems tracts. When a drop in base level exposed a high angle shelf, deep narrow straight incised valleys were created. At the same time, thick lowstand margin deltas formed when this drop in base level exposes high gradient shelves, while low gradient wide shelves have more sinuous incised valleys and form thinner delta deposits.

A paper by Sgavetti details the use of photostratigraphy as means of interpreting sequence stratigraphy of an area. This paper focuses on the Upper Cretaceous and Lower Eocene strata in the South Central Pyrenees and shows how photostratigraphic methods can be used to enhance our understanding the relationship between tectonics, sedimentation and eustasy. Finally there is a paper by Underhill and Partington on the role of tectonic controls on the character of basin fill, emphasizing Jurassic stratigraphy of the North Sea. They show how a sequence stratigraphic frame work created from well data will use the recognition of distinctive and correlatable shale horizons matched to maximum flooding surfaces, rather than the sequence boundaries at correlative unconformities. The authors document the difference between the use of well studies versus seismic studies to determine sequence stratigraphy. This excellent book on sequence stratigraphy will undoubtedly end up by being acquired or at least read by most sedimentary stratigraphers. Though the emphasis of the text is on the clastic realm, there is much to be learned here by most sedimentary stratigraphers. The numerous examples provided by the papers, tie together well and the text reads well. It is well illustrated with the only shortcoming that some line drawings are not as sharp as the others. Not all the papers have this problem. In some cases, the lettering is blotchy and line width is irregular. Maybe it is that stage of my life but my eyes tend to focus on the irregularity rather than on the geological message being provided by the diagrams. This criticism should not detract the prospective buyer from purchasing this volume, since, though annoying, the diagrams are all clear enough to be understood and read. The book will probably become another bible of sequence stratigraphy. Its most important contribution is that it covers such a wide range of depositional environments with so many as illustrations of both seismic, well data and outcrops. It deals with very different techniques for interpreting the sequence stratigraphy of various geological systems. It considers the use of different kinds of data sets, the use of sedimentary simulations, the use of flumes, and a consideration of the importance that tectonics may play in creating stratigraphic sequences . If you practice sequence stratigraphy you should try and acquire this book.