Stratigraphic Systems: Their Origin and Application

by Glenn S. Visher, 1999; Academic Press, 6277 Sea Harbor Drive, Orlando, FL 32887; 704 pages, hardbound; $79.95; ISBN 0-12-722360-6.

This book is a comprehensive treatment of stratigraphic analysis of sedimentary facies "for students and professionals working in stratigraphy, sedimentation, petroleum geology, geophysical interpretation, and reservoir engineering" (Academic Press). The author is an experienced geologist who worked for Shell Oil Company, Sinclair Research Corporation, and as a faculty member of the University of Tulsa. His academic background takes him back as a student to John L. Rich (1884-1956) of the University of Cincinnati, father of the clinoform, and Larry L. Sloss (1913-1996) of Northwestern University, father of sequence stratigraphy. I likewise served as his professor at Cincinnati, but taught him mineralogy and petrology as background for sedimentary geology. Later in life we taught short courses together worldwide.

Opening his book for this review, I loved his introduction and beginning chapters. He cites paragraphs from Charles Lyell (1797-1875) and Julian Huxley (1887-1975), and then treats tectonics and stratigraphic sequences in a historical context, quoting from James Hall (1811-1898), J.D. Dana (1813-1895), Abraham Gottlob Werner (1750-1817), and G. Marshall Kay (1904-1975). I like this approach which differs from routine texts which start with the names and classification of sediments and sedimentary rocks and from there move on to environments of deposition. They do not acquaint the students with the identity and concepts of our pioneers. Recently a professor admitted to me that he could not use any of my textbooks in this field and likewise would not use Visher's. His reason: "I teach science not history", he said. Besides, he questioned, as a "practical person" who works with a publisher, "how many textbook copies will these old masters (Hutton, Hall, Dana, etc.) buy?" "Are not they all dead?" I pointed out to him that history is more meaningful even than logic, and the historical background is essential.

The headings of the chapters in this book include Tectonics and Stratigraphic Sequences, Basinal Frameworks, Reconstructing Depositional History, Development of Information Systems, The Development and Use of Stratigraphic Systems, Modalities of Data Integration and Synthesis, and Analyses of Stratigraphic Systems.

The chapter Tectonics and Stratigraphic Sequences is for the most part a history of the development of plate tectonics, beginning with the geosynclinal hypothesis of James Hall and J.D. Dana followed by Marshall Kay, and J. Aubouin, and moves on to geologists of Lamont Geological Observatory of Columbia University, W.C. Pittman III and J.R. Heirtzler, and then to W.R. Dickinson, and R.V. Ingersoll. This chapter includes excellent examples of case histories.

Chapter 2, Part 1 presents the multivariant nature of the origin and history of basins and recommends a useful classification of basins. The basinal classification scheme recognizes eight kinds:

Type 1 - Simple cratonic basins,
Type 2 - Foreland cratonic basins with or without horizontal thrusting,
Type 3 - Successor or rifted extensional cratonic basins with or without wrench faulting,
Type 4 - Cratonic margin depocenters on thinned cratonic crust, with or without horizontal thrusting,

Type 5 - Extensional basins on cratonic passive margins,
Type 6 - Basins at active plate boundaries, including forearc, intra-arc, and retro-arc basins, with wrench faulting cutting perpendicular to the cratonic margin,
Type 7 - Basins at active plate boundaries with wrench faulting parallel to the cratonic margin, and
Type 8 - Progradational deltaic depocenters.

Part 1, Chapter 3 is a section after my own heart. It is a historical resume beginning with the foundation of stratigraphy as explained by Hutton and moves on to the Neptunists and Catastrophists, William "Strata" Smith (1769-1839), and J.F.W. Herschel's (1792-1871) scientific method. Benoit DeMaillet (1656-1738) under the title of Telliamed (the author's name spelled backwards) (Carozzi, 1969) presented the results of his numerous studies of the ocean and of marine sediments. Based on the emergence of a rock from the sea noticed by his grandfather, de Maillet decided that such recent lowering of sea level was part of a more general process. Accordingly, he undertook studies of modern nearshore areas, including observations of the shallow sea floor using a diving apparatus (Friedman et al. 1992). He concluded that what he named "Primitive" mountains have been formed by the action of marine currents when the sea was much higher than today. De Maillet deserves much more credit in the founding of geology, especially sedimentology and stratigraphy, than he has received heretofore.

Establishing of a time-rock correlation framework is the single most important aspect in the interpretation of a stratigraphic history. Time relations in stratigraphy must necessarily be based upon interpretation. If no basis can be found for interrelating observations, a time basis for historical development cannot be constructed.

In Part II, Chapter 4 titled Holocene Stratigraphic Attributes and Patterns, Visher identifies the following keys to interpretations:
(1) Seismic reflection patterns that reflect time-parallel bedding planes and unconformity surfaces,
(2) Graphic correlation of faunal zones,
(3) Sea-level changes that resolve stratigraphic sequences in a time scale as little as 20 thousand years,
(4) Time-related climate zones that can be identified on scales of a few thousand years,
(5) Lithologic markers that reflect depositional events on scales of as little as a few hundred years, and
(6) Rythmic bedding cycles reflecting lunar and solar processes that can be recognized at a scale of a year to a few tens of years.
Parasequence patterns, following Vail (1987), complete this chapter. Additional chapters in this section include stratigraphic paleontology, stratigraphic and petrophysical attributes, and facies mapping.

The next chapters relate to depositional systems, such as continental settings, deltaic sequences, coastal, shelf, deep-water deposits, both siliciclastic and carbonate, and basinal evaporites. The final summary is titled "The Stratigraphic Paradigm". The book includes an appendix with a CD-ROM that helps in identifying or verifying stratigraphic intervals and can be used to make color copies.

Friedman and Sanders (2000) published comments about the relationships between new ideas and geologic terms in stratigraphy and sequence stratigraphy which

users of this important book may wish to consult. Visher does not list A.I. Levorsen (1894-1965) in his book, yet I consider him the father of sequence stratigraphy. The concept that the geologic record consists of widespread, thick units of strata set off from one another by surfaces of unconformity of regional extent formed the basis of what A.I. Levorsen (1954, p. 640-642) termed "layers of geology", which refer to strata separated by surfaces of unconformity. The geologic concept of successive layers of strata, each separated by an unconformity and completely independent of or structurally different from other layers above and below (Levorsen, 1943, p. 907-912), forms the hidden basis of sequence stratigraphy. In his extensive studies of the settings of the petroleum pools in the mid-continent region of the United States, Levorsen (1931, 1933,1934,1941,1943, 1945, 1948, 1954, 1960, 1964, 1967) stressed the importance of recognizing the large-scale, unconformity-bounded tectonostratigraphic units. Levorsen did not propose any names for these large units, but demonstrated their importance in the search for petroleum traps. His geologic analysis of an area began by "peeling off" the geologic record in terms of large units set off by major stratigraphic breaks. He even devised "paleogeologic" maps to show the relationships along these bounding surfaces (Friedman and Sanders 2000).

This important book by Visher is a comprehensive and up-to-date treatment of stratigraphy and sequence stratigraphy. It is well-written and well-illustrated. A comprehensive index is included. I enjoyed reviewing it and will request my students to become familiar with it.

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