



# Journal of Sedimentary Research

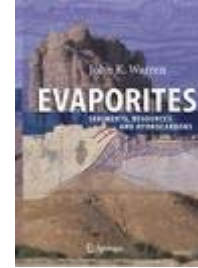
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*Evaporites—Sediments, Resources and Hydrocarbons*, by John K. Warren, 2006. Springer, P.O. Box 17, 3300 AA Dordrecht, The Netherlands. Hardcover, xvi + 1035 pages, 656 figs. Price EUR 99.95; USD 129.00; GBP 77.00. ISBN 3-540-26011-0.



The book is an enlarged (expanded for about 240% in number of pages) version of the earlier book by John Warren (“Evaporites—Their Evolution and Economics”, Blackwell, Oxford, 1999, 438 pages). Most of the 12 chapters are a modified and supplemented version of the earlier volume, but 3 chapters (3, 4 and 9) are entirely new. Some parts of the book are based on the contents of another earlier book by Warren (“Evaporite Sedimentology—Importance in Hydrocarbon Accumulation”, Prentice Hall, Englewood Cliffs, New Jersey, 1989, 285 pages). The recent book is certainly the best, particularly considering its completeness and maturity.

In this new book, Warren—taking advantage of his long-time studies of evaporites—extensively reviews nearly all important evaporite problems and aspects debated in recent literature, and also presents his own concepts and opinions. Both the global and personal views on evaporites are presented and illustrated by countless examples from regional geology. The book thus contains a wealth of information on both evaporites and related earth-science aspects.

Chapters 1 and 2 introduce the reader to the basic characteristics of natural brines, evaporite environments and evaporite deposits, and characterize the chemistry of brine, mineralogy, and texture of evaporite rocks. Chapters 3 and 4 describe in detail (supplemented by numerous photos, cross-sections, maps and excellent satellite images), the environments of a dozen or so well recognized modern sabkhas and saline lakes, mainly from the Mediterranean area, Middle East, Africa, and both Americas. Chapter 5 deals with modeling of the giant ancient evaporite environments and focuses on the specific geotectonic and geometric features of evaporite basins, and on their evolution in time. The architecture of evaporite deposits is shown and discussed in the light of sequence-stratigraphic concepts. Chapter 6 is devoted to halokinesis and salt tectonics, and it is one of the most interesting chapters, showing the complexity of halite behavior after burial, and the influence of salt tectonics on morphology and sedimentation in particular. The halokinetic effects are illustrated by regional examples including allochthonous salt sheets from the Gulf of Mexico, and islands developed on tops of rising diapirs in the Persian Gulf. Chapter 7 presents various aspects connected with dissolution of evaporite minerals, such as karst geomorphology, speleology, formation of solution breccias and pseudomorphoses after evaporite minerals. Chapter 8 discusses fluid flow in buried evaporite deposits, in different tectonic regimes and diagenetic realms, and also the geochemistry of evolving subsurface brines. Chapter 9 concerns halophile and halotolerant microorganisms living in the brines, the fossil record of their activity, and the role of microorganisms in the generation of hydrocarbons and the formation of some ore deposits. Chapter 10 presents oil and gas resources associated with evaporites. Chapters 11 and 12 are devoted to the exploitation of evaporite deposits and show their economic aspects; these chapters also describe some modern saline lakes and evaporite environments (from Canada, China, and Turkey) where non-marine evaporites precipitate and are mined.

The 1035 pages, printed in a double-column format, contain a huge amount of data on evaporites and evaporite environments. The references, mostly from the last three decades and

nearly all from the English-language literature, are listed on 72 pages that by volume are comparable to a book chapter. The reader can find in this reference list almost all original information about evaporites (as far as published in Latin alphabet) and this information is up-to-date. The book is also very well illustrated. It contains 656 figures (both back-and-white photos and elegant computer-style drawings) and 104 tables, and it is really difficult to find a page without a picture on it. The figures are usually composed of several logically arranged parts that were re-drawn from original publications. Many of the figures illustrate the regional geology of evaporites.

The book generally focuses on the sedimentology of evaporites and on the environmental geology. In particular, the modern evaporite environments are described excellently and extensively, but many more topics of "evaporitology" are presented as well. Some globally important aspects connected with evaporites are discussed, such as the evolution of seawater chemistry and of the global climate, and the relationship of evaporites with tectonic regimes and cycles. The book does not neglect topics such as the brine pools at the bottom of Mediterranean, Red Sea, and Mexican Gulf, the hydrographic changes and associated deep-water halite deposition in the drying Dead Sea, the deposition of native sulphur in caves, and the formation of clathrates in the ocean floor. The readers, particularly those who have no access to a good scientific library, can find a lot of new "hot" information, not only on evaporites but also on stratigraphy, tectonics, hydrocarbon exploration, geophysics, geochemistry, hydrology, geomorphology, speleology, and even microbiology and organic chemistry. John Warren describes all these aspects with great erudition, treating the evaporite rocks in a holistic way and showing them to the readers from various perspectives.

One of the important problems discussed in this book is how evaporites evolve after burial. Many examples from around the world throw light on the processes that left their traces when evaporites formed at the surface, when they underwent ever deeper burial, and when exhumation took place. Warren shows the apparent connection of evaporites with mineral and hydrocarbon accumulations. He demonstrates, with numerous regional examples, how buried halite deposits create the seal necessary for hydrocarbon accumulation and, similarly, how subsurface dissolution of evaporites creates the space—and influences mineralized fluids—necessary for the formation of ore deposits. Nearly all "classical" evaporite formations are, together with the associated mineral and hydrocarbon resources, presented in some details in the book.

Warren commonly expresses his own views and comments on works from other authors. His own original concepts are often added and mixed with the extensive review of the hundreds of modern papers; professional researchers of evaporites (or other earth-science topics) will find many of them really apt, important and inspiring, but perhaps will consider other views by Warren highly controversial. Several aspects—for instance those concerning still debated models and classification of evaporite basins, sequence-stratigraphic models of such basins, models of subsurface fluid flow, some scenarios for the Messinian salinity crisis, and the hypothesis that the Messinian giant selenite twins and supercones are evidence of diagenetic overprinting—are presented as generally accepted, rather than as just his own views (p. 359, Chapter 5). This chapter, in particular, is not an objective and exhaustive review of the conclusions from other workers, but rather a presentation of Warren's personal opinions. Warren also gives or uses his own definitions (which are often improvements, indeed) of many terms; examples are his definitions of evaporites, tertiary evaporites, sabkhas, eolian sabkhas, or rauhwacken.

The book is written in a style that differs fundamentally from the typical scientific paper. Whereas such a paper expresses no emotion, and is written commonly in tiring formal language, Warren—by using a popular or even journalistic style—makes the text interesting and simple. The text is generally easy to read and to understand although, on the other hand, in many parts it is overloaded with scientific terms. What is very valuable for the average reader, is that he describes geological (and associated) processes very vividly and gives a lot of simple instructional illustrations and case stories, which help the reader to understand these processes. For example, to show the essential difference in the movements of salt and ice bodies at the Earth's surface, he compares (after Christopher Talbot) the movements of salt "glaciers" (the namakiers from the Zagros Mountains in Iran) to the movements of "the rolling track of a military

tank” (p. 427). One of the most fascinating chapters to read (for me) was Chapter 12, describing the catastrophes in salt mines and karst areas, which is of particular interest for miners and environmental managers. There are more important data for general education, added to the strictly geological information: the reader can find a lot of data, interesting stories, or remarks concerning the history of science and culture (for instance in the form of remarks about Chinese drilling technology with the use of bamboo, and about mummification in ancient Egypt).

The popular or journalistic style found in many parts of the book is certainly of great value from a communication point of view. It is less fortunate, however, from the point of view of scientific precision. In some places, the author overuses the informal terms (absent in geological dictionaries, but otherwise commonly used in scientific discussions), like calling Foraminifera “forams” (p. 642-643), or employing such terms as “pelletizers” (p. 639). On the other hand some parts of the text are filled with difficult terms that require rather exhaustive knowledge of the modern scientific terminology, and the author explains them in his own words directly in the text, or in footnotes. Some important terms are occasionally described not as in the original definitions; in those cases the source of the information is commonly not given. For example, the limnological terms on pages 116, 126-127, and 670 are described or used rather imprecisely (what is a definition of “monolimnion”?). Such parts potentially can create misunderstandings among some inexperienced readers or students. On the other hand, those who want to know a lot of rare or new scientific terms (like “brimstone,” “depod,” “sciaphile”), or how the term “roho” was created, certainly will be satisfied.

A drawback of the commonly vivid writing style and its fluency and lightness, is that some sentences lack precision (e.g., “The word bromine comes from the Greek bromos meaning stench and was discovered in 1825 when Antoine Balard extracted it from seawater bitterns,” p. 849; the formal subject in this sentence is “word,” not the element bromine, so that the quoted sentence means that Balard discovered and extracted the word from seawater). In some parts of the book the author creates or uses imprecise, or at least controversial terms, or phrases like “meromictic perennial brine sheets that were a few tens of centimetres or more deep” (p. 297); such a shallow brine cannot be meromictic). Many informal terms are put in brackets and remain poorly explained. On the other hand, in many cases brackets are unnecessary (e.g. “thinolites,” “glendonites,” p. 246).

The highly differentiated and really extensive contents make the book a kind of encyclopedia covering almost all subjects and aspects associated with evaporites. It is a pity that this encyclopedic value of the book remains somewhat hidden; the lack of accuracy in defining some scientific terms and the fact that the explanatory definitions are scattered over too many parts of the book are some of the reasons. Moreover, the citation style in many fragments of the book makes it difficult or even impossible to find the original source of information. The sources are not given for at least 15 tables and figures, and are also lacking for many fragments of the text. Some self-citations do not lead to the original sources either (Fig. 2.1). Another problem is that the index is neither exhaustive (let alone complete) nor truly informative; it also contains some typos such as “endoheic.” It seems to be unfinished. In relation to the volume of the book, the index is relatively short, and its 17 pages contain numerous regional geological names, but some (for me) important terms related to processes or structures, commonly used in the book, are missing, although some other terms are unnecessarily listed twice (e.g. “tumuli,” or “alabastrine;” but “alabaster” is absent in the index). “Selenite” has only the sub-meaning “Holocene,” and only one page containing this term is indicated. There is no “selenite” among the many sub-terms of “Gypsum.” Some important terms are hidden among sub-terms (e.g. “stylolite” and “enterolithic” in “Anhydrite”). What is more important, only one or a few pages (but not all) with the terms listed in the index are indicated.

No such large book can exist without controversial fragments or mistakes, but the reader may expect that important information or new data be documented. This is, however, not always the case. For example, the source of the phrase about the size of “more than 10 m long” gypsum crystals from the Miocene of Poland and Mediterranean (p. 23), and of “8 m long” gypsum crystals from Pulpí in Spain (p. 526) is not given, and can therefore not be checked. Such sizes are, however, highly overestimated, and in the case of the Polish Miocene simply unrealistic.

There are also mistakes, coming apparently from uncritical acceptance of the views or pictures by other authors, like in Figure 10.10, where the Berriasian is treated as being partly Late Jurassic.

The book is not free of misprints and, as the number of misprints is commonly proportional to the number of pages, there are many misprints. Many of them are trivial but a some are important; they concern information such as the chemical formulas of some minerals (p. 565) and mineral names (pages 3, 455). There is also a misprint in the name of the famous geologist who introduced the term “diapir” in the world literature (p. 376). Native authors cited in the book can find some spelling mistakes (or misprints), like in the name of German geochemist who constructed a diagram known later as the Jänecke diagram (“Janecke” on pages 71-73). Some geographical names are incorrect (“Romanian Alps:” p. 376) or misprinted (“Montmarte,” p. 845). Some papers cited in the text (e.g. “James et al. 2005,” p. 565) are not in the reference list. Some papers are cited in the references in an incomplete way (e.g. “Richter-Bernburg 1957”). Some information (like on stratigraphy) collected from the older literature is not valid any more. Some information is repeated in different parts of the book.

These misprints and controversial fragments do not discredit the really great informative value of this book. Warren prepared a book of a size that is usually published by a group of at least several experienced authors, and he gave us a really great thing, viz. a comprehensive volume that is up-to-date, containing a synthesis and presentation of almost all modern achievements in the study of evaporites. This blend is supplemented by the great knowledge of the author, also covering related disciplines of the earth sciences.

Concerning the very differentiated content, its large size and its accessible style of writing, the book is of value for a wide group of readers, not only for specialists. Even an ordinary reader will find something interesting in it, if only to see something interesting as a tourist while travelling. But tourists are, obviously, not intended as the main readership. The book is to be recommended to all scholars, beginning and experienced alike, who study or begin to study evaporites, particularly if they are looking for updated information on recently discussed topics and new concepts. I can also recommend this book to other earth-science professionals, particularly sedimentologists, oil and gas explorers, mining geologists, and environmental geologists. The book can be useful in academic practice. Teachers in particular can find a lot of good illustrations and instructional information for classes.

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