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This Week's Citation Classic®

Berner R A. *Early diagenesis: a theoretical approach*. Princeton, NJ: Princeton University Press, 1980. 241 p.
[Yale University, New Haven, CT]

This book shows how the various processes associated with early diagenesis can be formulated mathematically. (Early diagenesis refers to changes occurring in a sediment after deposition but before burial to more than a few hundred meters.) These processes include burial advection, water flow, compaction, interstitial diffusion, bioturbation (stirring of sediment by bottom-dwelling organisms), microbially mediated chemical reactions, radioactive decay, adsorption/desorption, mineral dissolution, and the nucleation and crystal growth of secondary minerals. [The *SCI*® indicates that this book has been cited in over 270 publications.]

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I find it most surprising that this book has been chosen as a *Citation Classic*, both because of my purpose in writing it and because it was published only eight years ago. Is eight years enough for classic status? I believe that the large number of citations is due to the fact that the book fills a vacuum and that there is no other one quite like it. I wrote it at home during the fall of 1978, and the entire exercise from inception to final typing took about six months. I never thought that the material would be widely quoted, and I wrote the book rather in the spirit of a musical composer, seeing whether I could organize my thoughts in the form of a theme and variations. However, with the benefit of hindsight, I can now see why the book became so popular.

For a long time much data had been collected on the properties of sea-floor sediments, especially chemical properties, and their changes with depth in the sediment. In 1964 I wrote a paper[1] that was one of the earliest attempts to make theoretical sense out of plots of chemical concentration (here, dissolved sulfate) vs. depth. Depth in a sediment is equivalent to time if the material accumulates upward via layer-by-layer deposition. For a dissolved species in a sediment, its depth distribution can be described fundamentally in terms of chemical reaction, diffusion, and burial in the sediment, and mathematical expressions for these processes can be derived once one accepts burial as pseudoadvection relative to the top of the sediment pile.

During the 1970s more and more sedimentary data were accumulating in the literature, and a couple of attempts to treat them theoretically were made. Unfortunately, the treatments were generally incomplete or conceptually incorrect, and this led me to publish two papers[2,3] that incorporated compaction and adsorption in diagenetic equations. These two papers, plus ever more data, especially on dissolved components, finally led me to write the book *Early Diagenesis*. Here I tried to systematize sediment data in terms of a general diagenetic equation from which special equations could be derived to describe most every situation. This led to detailed discussion of the mathematical treatment of the variety of sedimentary processes listed above in the description of the book.

Apparently, this theoretical treatment was sufficiently comprehensive and comprehendible that others quickly took to it and used the same theoretical approach to apply the various equations to their own sedimentary situations. Those studying sediments are generally not known for their familiarity with mathematics, and this might explain why a book like this hadn't been written much earlier. Also, I wrote the book so that a relatively nonmathematical sedimentologist, geochemist, oceanographer, or other scientist could fully understand how the equations arose and how they could be applied to sedimentary data. Apparently, I was successful, and one of the stated reasons for my election to the National Academy of Sciences in 1987 was this theoretical work on sediment diagenesis.

For a recent review of work in this field, see reference 4.

1. Berner R A. An idealized model of dissolved sulfate distribution in recent sediments. *Geochim. Cosmochim. Acta* 28:1497-503, 1964. (Cited 70 times.)
2. ————. Diagenetic models of dissolved species in the interstitial waters of compacting sediments. *Amer. J. Sci.* 275:88-95, 1975. (Cited 45 times.)
3. ————. Inclusion of adsorption in the modeling of early diagenesis. *Earth Planet. Sci. Lett.* 29:333-40, 1976. (Cited 60 times.)
4. Surdam R C & Crossey L J. Integrated diagenetic modeling: a process-oriented approach for clastic systems. *Annu. Rev. Earth Planet. Sci.* 15:141-70, 1987.

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