

# Journal of Sedimentary Research

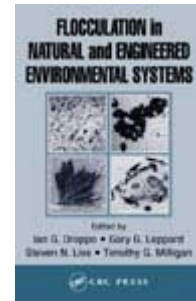
## An International Journal of SEPM

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**Flocculation in natural and engineered environmental systems**, edited by I.G. Droppo, G.G. Leppard, S.N. Liss, & T.G. Milligan, 2005. CRC Press, 464 pp. \$149.95 hardbound, ISBN 1-56670-615-7.



Flocculation is the process of aggregating smaller particles together to form larger composite particles via various physical, chemical, and biological interactions. Most fine particles within natural systems (both fluvial and marine) are subject to flocculation, resulting in increased sedimentation rates, while flocculation is also crucial for engineering processes such as waste-water treatment. Flocculation has therefore been investigated from physical, chemical and biological perspectives within the three disciplines of fresh-water, salt-water, and engineering research. And while a great lack of knowledge still remains in many fundamental processes related to flocculation, these disciplines have traditionally remained somewhat mutually exclusive.

In order to bring these disciplines together, a workshop was held in September 2003, bringing fresh-water, salt-water, and engineering researchers together to focus on the modeling, physiochemical, and biological aspects of flocculation. This has resulted in twenty peer-reviewed chapters containing observational studies, modeling studies, and comprehensive overviews on the physiochemical and biological aspects of flocculation. The main body of the book is divided into three parts, on fresh-water environments, salt-water environments, and engineered systems, respectively. These parts are preceded by an overview on floc analysis methods for the three environments, and the book is closed with a chapter that brings the disciplines together by analyzing their common interests and prospects.

The first part contains seven contributions from the fresh-water research field, mainly focusing on the physical (four chapters) and biological (three chapters) aspects of flocculation though two case studies, two modeling studies and three overviews. The first review (Ch. 2) is a broad overview of flocculation processes in fresh-water ecosystems. It especially focuses on the complex structure and composition of flocs, being a matrix of inorganic and organic colloidal particles, and on how this floc architecture influences the physical, chemical, and biological flow behavior. The role of natural organic matter for colloidal aggregation is analyzed more extensively in Ch. 7 by reviewing the characteristics, the flocculation and stabilization mechanisms, and the interaction of fresh-water colloids. Of specific importance for floc formation are organic polymers (EPS) but, because of their complex nature, Ch. 6 is dedicated to a review of sampling and analysis techniques of EPS. The field studies analyze the effect of storms and seasonal variations on floc formation (Ch. 3) and the effect of spawning salmon on the morphology, settling behavior and characteristics of bed sediments and suspended sediments. Flocculation is modeled in Chapters 5 and 8, in which the evolution of particle size and concentration in flume experiments are reproduced with a flocculation model using fractals.

The second part consists of five chapters on salt-water flocculation research with a biological (two chapters) and physical (three chapters) perspective, most of which are overviews. An overview of the transport of material and chemicals by colloids and flocs, and especially the role of fibrils, is

given in Ch. 9. Ch. 11 gives an overview of the production, vertical transport, and modification of oceanic aggregates in continental margins, focusing on the role of organic matter for the formation and breakdown of flocs in the bottom boundary layer. Models for the coagulation of planktonic systems are reviewed in Ch. 13. The turbidity maximum of Chesapeake Bay is re-analyzed in Ch. 10, introducing a time-varying increase and decrease of flocculation, biologic influence, and floc resuspension to explain sedimentary processes in the Chesapeake Bay turbidity maximum. Chapter 12 presents a flocculation model based on fractal theory that simulates the formation but also the breakdown of flocs by turbulent shear, allowing analysis of time scales required to attain equilibrium floc size. This flocculation model is coupled with a hydrodynamic model to verify it with field data.

The third part of the book deals with industrial systems that have a strong focus on biochemical processes in waste-water treatment through reviews and experimental work. Ch. 14 describes the role of exo-enzymes in the degradation of polymeric organic compounds, whereas Ch. 17 highlights the role of temperature shifts as a regulating mechanism for the de-flocculation in microbial waste-water treatment. The influence of sludge retention time on the surface tension of flocs is treated in Ch. 19, revealing that the surface tension lowers with increasing retention time. Ch. 15 elaborates on techniques to investigate microbial communities within flocs. Atomic force microscopy, a method to examine particle/particle and particle/surface interactions, is applied in Ch. 16 to understand bacterial adhesion. The effects that flocs have on UV disinfection methods are analyzed in Chapter 18.

Overall, the obvious strength of the book is its diversity, bringing fields of research together that can undoubtedly benefit from each other but that have so far remained relatively mutually exclusive. It is therefore essential for researchers who want to broaden their horizon on flocculation mechanisms. The quality of the chapters is high, with good-quality illustrations (including a color section), containing solid scientific research, and introducing some new concepts in the field of cohesive sediment transport. Therefore, the book is also suitable for in-depth exploration of flocculation processes. Considering the diversity of the book, it may be argued, however, to what extent researchers focusing on the physical mechanisms of flocculation benefit from biochemical interactions and vice versa. Additionally, although the individual chapters are very interesting and a significant amount of them are review papers, a drawback is that this is not one consistent book on flocculation but a collection of papers which are of high, but variable, quality. The book is therefore less suitable for undergraduate and graduate students, and is best suited for readers on a professional level. I definitely recommend this book for those involved in fine-sediment transport and flocculation. There are very few text books in the field of cohesive sediment transport and flocculation, and this book is a valuable contribution.

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