Bio-mineral flocculation of fine-grained cohesive sediments and microalgae in estuaries

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**Abstract:** The transportation and settling of suspended particulate matters in aquatic environments are the key to deal with many engineering and environmental issues, which are controlled, to a large extent, by the flocculation of cohesive sediments. In estuaries and coastal waters, the flocculation of fine-grained sediments is significantly affected by extracellular polymeric substances secreted by microalgae. Thus, we carried out laboratory experiments to explore the role of two typical microalgae (i.e., Skeletonema costatum and Cyclotella meneghiniana) on suspended sediments under various turbulent shear and environmental conditions. Results show that the shear rate is the dominant factor to control the bio-mineral flocculation processes, and the existence of microalgae generally enhances the aggregation of bio-mineral flocs. It was also found that the floc size distributions (FSDs) and mean sizes are apparently influenced by different algal species, but not sensitive to algal concentrations in our study. Moreover, a quasi-Monte Carlo (QMC) based population balance model (PBM) is developed to simulate the FSDs of sediment-algae flocs. The simulated FSDs and characteristic sizes agree well with two analytical solutions and the laboratory experiments. The bivariate QMC model offers a preliminary application for multivariate PBM in bio-mineral flocculation, which promotes a broad prospect to develop advanced large-scale models in the future.

**Key words:** Cohesive sediment; microalgae; flocculation; quasi-Monte Carlo

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