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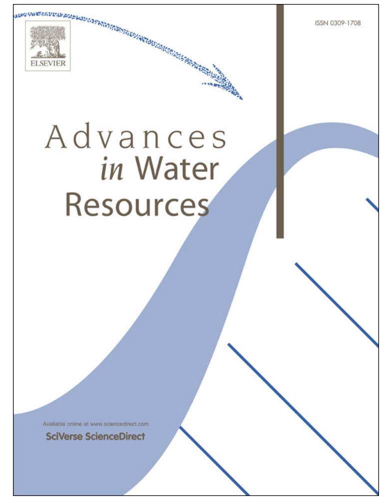

On the cohesive sediment erosion: A first experimental study of the local processes of transparent model materials

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On the cohesive sediment erosion: A first experimental study of the local processes of transparent model materials

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Abstract

An annular flume combined with a microscopic system is used to explore local erosion mechanisms of transparent cohesive beds (yield stress fluids) under shear-induced flowing liquid. The Observations at a microscopic scale for erosion flume experiments are the originality of this work. Our first results reveal that the deformation and erosion dynamics of bed material mainly depends on its miscible state with the flume fluid, its structural organization being associated with mechanical properties and the measurement section. Shear localization within the bed is also observed. Moreover, the erosion rate and the local bed shear stress can vary with time even for an imposed constant global hydrodynamic flow as they result from the coupling between the fluid flow and cohesive bed conditions at the bottom. We also try to link the local resistance to erosion to the local cohesive strength estimated from rheometric microscopic data for the same sample conditions with homogeneous properties.

Keywords: Erosion processes, Cohesive materials, Annular flume, Microscopic scale, Rheometry

1. Introduction

In ports and estuaries, cohesive sediments, generally referred to as *muds*, are eroded in some areas and accumulated elsewhere according to hydrodynamic flow conditions controlled by various natural phenomena (*e.g.*, tide and wind) and human activities (*e.g.*, navigation). The long-term management of these privileged environments, such as prediction of perturbation due to climate change and contaminant dispersion associated with sediment, or dredging operations for navigation, requires a better understanding of sediment transport and behavior.

Numerical modellings are developed to simulate the sediment transport from the scale of the particle to the scale of the estuary [48,51,52,43,54,55,56,57]. It is even now not easy to provide a correct modeling for the processes related to cohesive materials [48] especially concerning the erosion of cohesive beds. The sedimentation and consolidation are processes, in which physical and chemical phenomena appear, leading to the constitution of cohesive bed. Models based on Gibson equation [17, 49, 50] and on the two-phase flow [51] have been recently proposed. Nevertheless, they are still based on the concentration, the permeability and the effective stress. The modelings of the erosion of non cohesive bed were studied with two-phase model [52, 53, 54] by using specific rheology model. Such a modeling remains to do for the cohesive bed. This kind of modeling needs to have a better comprehension of the process at the local scale. For this purpose, cohesive sediment must be characterized carefully by means of experimental approaches.

A major issue of the study of sediment erosion and mechanical behavior is ascribed to its complex nature which is conditioned by a lot of factors like bulk density, salinity, organic content, mineralogical components, biological activities and mechanical history [1,2,3]. In addition, sediment properties vary spatially across the bed and temporally on daily to seasonal time scales [4,5]. This demands even more efforts and attention to study sediment erodibility. In this context, a large number of instruments for erosion tests, ranging from laboratory to in situ flumes, have gradually been developed [6,7,8]. Nevertheless, there still exists a level of uncertainty for each instrument due to a lack of standards for data interpretation and measurement methods [7,9] and due to large measurement errors [7]. The section of the sediment bed is generally designed differently from one