Geophysical Research Abstracts
Vol. 12, EGU2010-12875, 2010
EGU General Assembly 2010

Macro and micro scale interactions between cohesive sediment tracers and natural mud.

Kate Spencer (1), Andrew Manning (2), Ian Droppo (3), Gary Leppard (3), and Thomas Benson (4)

(1) Queen Mary University of London, Department of Geography, London, UK (k.spencer@qmul.ac.uk), (2) University of Plymouth, School of Marine Science and Engineering, Plymouth, Devon, UK, (3) Canada Centre for Inland Waterways, Environment Canada, Burlington, Ontario, Canada, (4) HR Wallingford Ltd, Wallingford, Oxon, UK

Understanding the dispersion patterns of fine, cohesive sediment (< 63 micron) is fundamental to the sustainable management of aquatic environments. In order to develop sediment transport models and predict sediment dispersion, accurate field techniques for the measurement of sediment transport are required. Although this is relatively simple for the sand sized fraction, measuring transport pathways for cohesive sediment is more problematic. Cohesive sediment tracers developed for this purpose include synthetic tracer particles (e.g. polymers) and labelled natural clays (e.g. Mahler et al. 1998, Yin et al. 1999, Krezoski 1985; Spencer et al. 2007) and a fundamental assumption is that the tracer has the same physical properties as natural sediment. For the cohesive fraction this means that the tracer must be incorporated into and transported via floc aggregates (Black et al. 2006). A few studies have examined the physical behaviour of cohesive tracers (e.g. Manning et al. in press) but most are limited to the examination of gross settling characteristics (e.g. Louisse et al. 1986) rather than floc formation and behaviour.

This work focuses on a labelled natural clay; a Ho-montmorillonite (see Spencer et al. 2007). The aims of this work were to examine the physical characteristics, internal structure and settling dynamics of the tracer and to determine whether the tracer flocculated and interacted with natural estuarine muds at both macro- and microscales. To our knowledge, this is the first study to present data examining the flocculation characteristics and structure of cohesive sediment tracers and their interaction with natural sediment.

Macroscale floc characteristics such as floc size and settling velocity measurements were obtained using the LabSFLOC - Laboratory Spectral Flocculation Characteristics – instrument. Floc density, porosity, dry mass, and mass settling flux were then calculated. Floc internal microstructure (1-2 nm) and elemental floc composition were observed using TEM (transmission electron microscopy) and EDS (energy dispersive spectroscopy).

The tracer formed macroflocs (i.e. flocs > 160 micron important for sediment deposition) that could not be distinguished statistically in terms of size and settling velocity from natural mud, although the tracer microflocs (< 160 micron and important building blocks for floc growth) were statistically smaller and settled more slowly. Due to the absence of organic matter tracer flocs were spheroidal in shape compared to elongate 'stringer' natural mud flocs.

The interaction of the tracer and natural mud was examined by observing the physical and dynamic floc characteristics of tracer and natural mud mixtures. The microflocs decreased linearly in floc size and sphericity with increasing tracer content suggesting interaction between tracer and natural mud. However, individual microflocs (< 20 micron using TEM) containing both tracer and natural mud were not observed suggesting that this interaction is not on a particle to particle basis, rather macroflocs are comprised of discrete microflocs of pure tracer or pure natural mud. Macroflocs comprising both tracer and natural mud mixtures were larger and settled faster than either the pure tracer or pure natural mud flocs. We hypothesise that this is due to irregular packing of the differently shaped natural mud and tracer flocs.

Therefore, the tracer flocculates and has key characteristics which can not be distinguished from natural cohesive mud. The tracer interacts with natural mud, but because of floc shape the transport characteristics of mixed flocs differ from natural mud. Therefore, although this tracer meets some requirements of tracer technology and is superior to synthetic tracer particles in terms of matching the physical characteristics of cohesive mud, the mixed tracer and natural mud flocs have different settling behaviour. This has implications for the use of cohesive tracers to understand natural mud transport.