Effect of flocculation on the grain-size spectra of fine-grained turbidites

Trecia M. Schell[1] and Paul S. Hill[2]
[1]*Department of Oceanography, Dalhousie University, Halifax, Nova Scotia B3H 4J1, Canada*
[2]*Habitat Ecology Section, Marine Environmental Sciences Division, Fisheries and Oceans Canada, Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia B2Y 4A2, Canada*

The formation of flocs as settling entities is a significant influence on fine-grained sediment deposition because it produces the same settling speed for all grains small enough to be caught up and incorporated into flocs and results in a bottom sediment that mirrors the size distribution of the suspension (Kranck, 1980; Kranck and Milligan, 1985; Kranck, 1993). The change in grain-size distributions or spectra recorded in bottom sediments reflects the variation in flocculation of the depositing suspension as it evolves with time and distance. The "flocculation limit" (Schell, 1996) is a proxy for determining the degree of flocculation that was active in a depositing fine-grained suspension, and is a useful tool in interpreting the energy regime of the past depositional environment. Conceptually, the floc limit is the upper limit in the size of grains that deposit within flocs. It marks the upper limit of the "flat" portion on a log volume versus log diameter of component grain-size curves.

To test the theory of floc limits, a representative core study on Laurentian Fan/Sohm Abyssal Plain, Wisconsinian age, reddish-brown turbidites was conducted, followed by an analysis of disaggregated grain-size spectra and the determination of their floc limits. Based on these sedimentological observations, we propose two possible mechanisms (gradient versus turbulent shear sorting) that may be responsible for the observed downslope 10-fold fining trend in the flocculation limit. These observations are consistent with the shear sorting model for fine-grained sediments (Stow and Bowen, 1980) by which grains bound up in flocs are sorted during cycles of floc destruction and reformation. With the aid of scaling arguments of the pull apart forces acting on flocs (turbulent shear versus settling), we provide evidence based on the indicative shape of the disaggregated grain-size spectra that turbulent shear sorting for particles smaller than 8 microns becomes ineffective because the shear stress that allows particles this small to deposit is not strong enough to break apart flocs.