Determination of sediment transport paths on a macrotidal shoreface: comparison of the "Gao and Collins" method with near-bed current measurements

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The determination of sediment transport directions is a major issue in the study of coastal and marine sedimentary environments and is of primary importance in applied fields such as coastal engineering and coastal management. Sediment transport directions can be inferred from near-bed current directions or from the observation of bedform asymmetry, but the acquisition of such data usually needs complex and expensive instrumentation like electromagnetic or electroacoustic current meters or sidescan sonar. Other methods based on the spatial variations of grain-size distributions have been developed for trying to identify sediment transport pathways. Following MacLaren and Bowless (1985) who proposed to use a combination of mean size, sorting and skewness for determining grain-size trends between pairs of sediment sampling sites, Gao and Collins (1992) developed a procedure resulting in a two-dimensional pattern of residual transport vectors. Although the Gao and Collins method produced satisfactory results in various coastal environments (e.g., Pedreros et al., 1996), this approach also resulted in poor correspondence with known sediment transport directions in several circumstances.

A study was carried out in the southern North Sea (Fig. 1) in order to test the Gao and Collins method on a macrotidal shoreface where sediment transport is strongly controlled by well defined, shore parallel, reversing tidal currents. 21 samples of the uppermost 8 to 10 cm surficial sediments were collected in the coastal zone, east of Dunkerque, in water depths ranging from about 0 to 6 m. The sediment transport pattern derived from the grain-size trend analysis was compared with near-bottom current measurements obtained with an InterOcean S4 electromagnetic current meter deployed at 0.65 m above the bottom in about 4 m water depth, approximately in the middle of the sampling area.

The transport pathways defined by our grain-size trend analysis show a good agreement with the tidally-driven near-bottom currents measured during the field experiment which were setting alongshore, either to the east-northeast (flood currents) or to the west-southwest (ebb currents) (Fig. 2). Our results suggest that the grain-size trends observed in the surface sediments probably reflect the last transport event, as shown by the comparison of calculated transport vectors with the directions of near-bottom currents measured in the vicinity of the sediment sampling sites, 16 of the 21 sediment samples having been collected during flood-tide, and the remaining sediment samples during ebb-tide. In addition, comparison of threshold shear velocity for sediment movement with estimates of bed shear velocity obtained from near-bottom current data recorded simultaneously with sediment sampling indicates that sediment transport was still occurring when sediment samples were collected.

The results of this study suggest that the Gao and Collins method can be very efficient for determining the transport pattern of the last sediment transport event when sampling is limited to the thickness of the active layer of sediment remobilization. This method may not be suitable, however, for defining time-averaged net transport directions, excepted where sediment transport is unidirectional or strongly dominated by flows oriented in a prevailing direction.

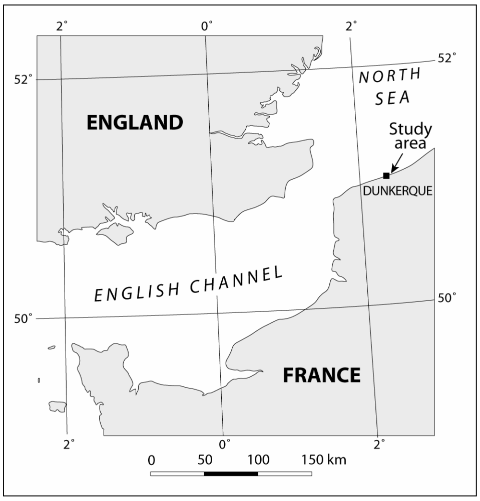

Figure 1. Location map of the study area.

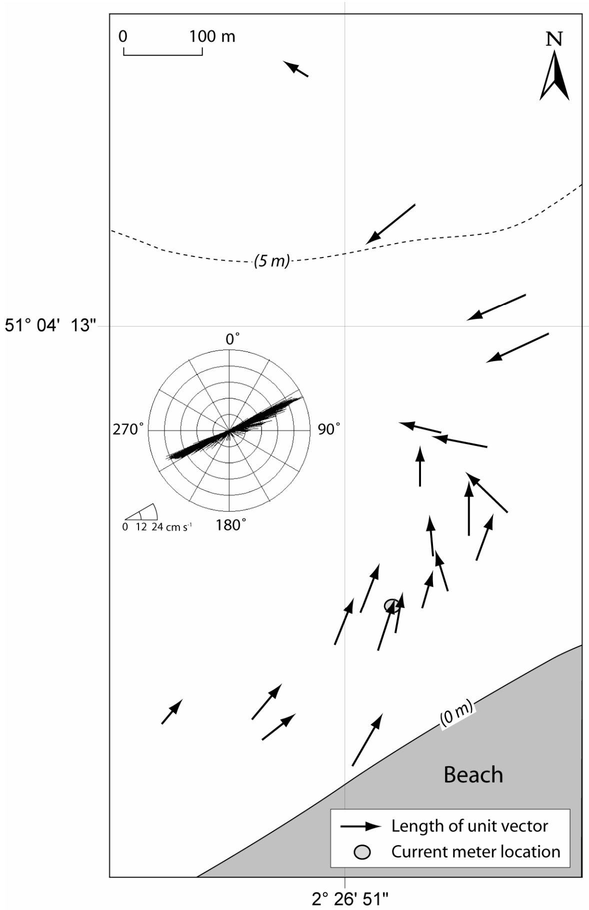

Figure 2. Pattern of sediment transport vectors inferred from grain-size trend analysis (Gao and Collins method) and directional distribution of near-bottom currents measured during the field experiment (rose diagram) from 16 to 25 May 2001.

References

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