The Mud Current Meter: Calibration and Uses

University of Cambridge

I. Nick McCave

Godwin Lab for Palaeoclimate Research, Department of Earth Sciences,
University of Cambridge (mccave@esc.cam.ac.uk) and St John's College.

St. John's College, Cambridge

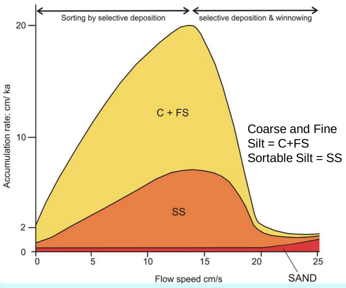
1. INTRODUCTION

- Grain size parameters of fine seabed sediments have been used for inference of changes in benthic palaeoflow speeds[1,2]
- The most commonly used proxy is the "Sortable Silt Mean Size" denoted by $\overline{SS}$, the mean grainsize in the range 10-63 μm (which is non-cohesive silt) [2,3].
- Calibration of size in terms of flow speed has long been desired.
- Here a preliminary calibration of the grain size flow speed proxy based on sediment samples taken adjacent to sites of long-term current meters set within ~100 m of the bed for more than a year is presented.

2. PRINCIPLES

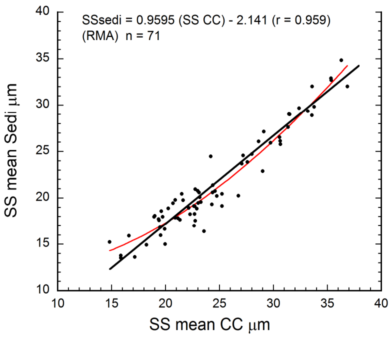
In the deep-sea, size-sorting of sediment occurs under resuspension/ deposition events during and after benthic storms.

At flow speeds below 10-15 cm s^{-1} mean size in the Sortable Silt range is controlled by selective deposition, whereas above that speed removal of finer material by winnowing also plays a role (see figure).



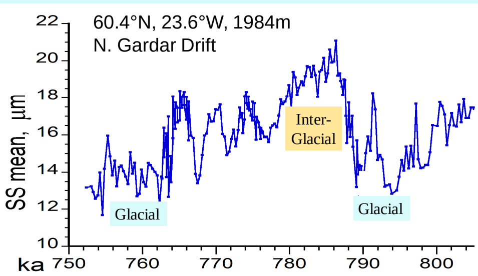
3. METHODS

Sediment samples were obtained from sites where long-term (>1 year) current meters had been set at 50 to 120 mab. These were processed to remove the sand (>63 μm), CO_3 and biogenic SiO_2

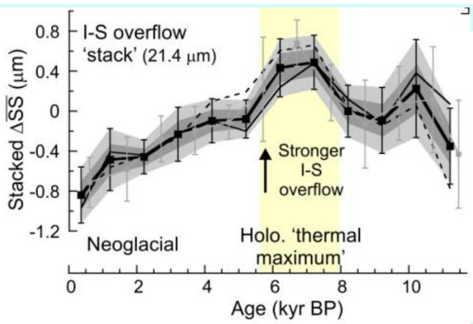


They were analysed by either Sedigraph or Coulter Counter for which there is a good relationship (r ~ 0.96; see above, linear relation) and plotted as Sedigraph-equivalent values

4. SS data provides plots such as those below[4].

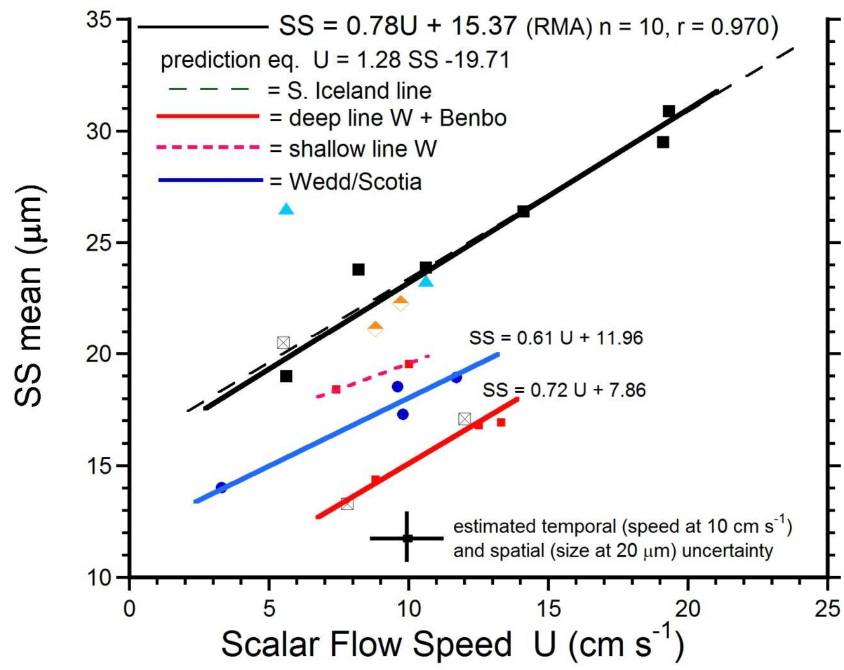


With a glacial-interglacial range of ~7.6 μm the flow speed change is ~ 10 cm/s. Modern speeds in the exact area are not known but probably 10-15 cm/s, thus Glacial speeds would have been < ~5 cm/s



Here[5] normalised records are stacked showing a Holocene decline in ISOW of 1.3 μm or 1.7 cm/s (from ~8 to 6.3 cm/s) south of Iceland. This is a reduction of ~20% in the overflow

MAIN RESULT: Graph of $\overline{SS}$ μm versus mean flow speed U cm s^{-1} averaged over periods of a year or more for a variety of sites, mainly North Atlantic.



The key features of this plot are:

- There is a well defined line with a slope d*U*/d*SS* of ~1.3 cm s^{-1}/ μm containing 10 points ('best line'), 5 of which are previously shown from S. Iceland[5]. The extra points come from Benbo on Rockall Plateau, the Grand Banks Slope (1.5 & 3.2 km depth) and Portuguese slope at 1.3 km.
- Data from Line 'W' south of Woods Hole falls into 2 groups; a deeper group (>3.2 km) on the Continental Rise with a slope sub-parallel to the 'best line' and two shallower points (<2.7 km) on the Continental Slope. Two points from the Rockall Trough (Benbo) fall in the deeper group.
- A further sub-parallel line is defined by 4 points from N and S of the Antarctic Peninsular in the Scotia and Weddell seas, at 2.85-4.57 km depth.
- These data suggest the influence of a deficit of coarse silt (thus finer size for the same speed) at the deeper sites relative to those where supply is more directly from the shelf edge. This could be due to variation in source characteristics, or to removal of coarser silt by prior deposition in a flow system (progressive down-current fining).
- This will make it difficult to apply an absolute flow speed to $\overline{SS}$ data unless there is a local calibration such as S. Iceland, deep Line W or the Scotia Sea, but the apparent constancy of the slope means that *changes* in flow speed could be estimated with some confidence at a given point (see sect #4).

CONCLUSION.

- There are linear relationships between size and flow speed. These do not follow theoretical or experimental predictions.
- Several parallel fits to data are apparent so that relative change in speed may be estimated even though absolute speed may not.
- Sediment source or transport distance may influence the silt flow speed proxy.
- We need more sediment samples from current meter sites. Anyone deploying a CM array should sample the sites first, please! I have lat/longs.

7. REFERENCES

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6. ACKNOWLEDGEMENTS

I thank David Thornalley for a new S. Iceland point, and him & Ian Hall for data in the Sedigraph - Coulter cross plot.