

## Settling velocity tube data series for cruises: Dana D1198, Challenger CH140, Pelagia PE136, Mitra MT0499 and Belgica BG9912

### Co-Principal Investigators

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### Data Originators

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### Content of data series

Parameter	Unit	Parameter code	Number of samples	Number of SVT stations	Comments
Total SPM settling velocity	mm s <sup>-1</sup>	MDSVSVSP	83	118	none
Chl.a and phaeop. settling velocity	mm s <sup>-1</sup>	MDSVSVCP	112	118	none
Chl.a and phaeop. concentrations	µg l <sup>-1</sup>	CPHLFLP1	824	118	none
Total SPM concentration	mg l <sup>-1</sup>	TSEDGVP2	1285	118	none

### Originators' protocol

#### **Sampling:**

The settling velocity tubes (SVTs) were lowered horizontally from the side of the ship using the winch (Fig. 1). Samples from different depths were collected by deploying tubes sequentially, one at a time. For surface and mid-water column sampling, tubes were fired manually. For bottom water sampling, tubes fired automatically upon reaching a height of ~ 1m above the bed. After triggering, the tubes were recovered as rapidly as possible and set vertically on a stand. They were then encased in insulating neoprene jackets to avoid the effects of sunlight on the temperature of the sample and on the phytoplankton population.

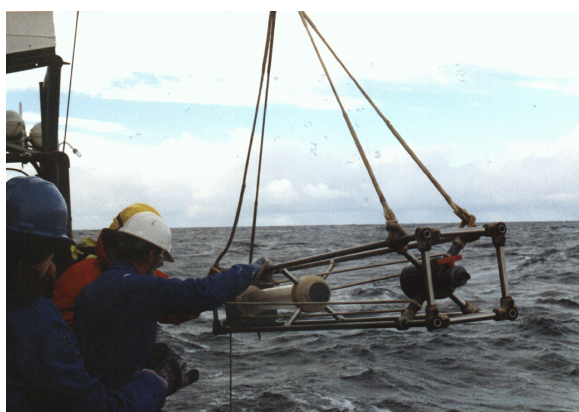


Fig. 1. Deployment of a Settling Velocity Tube during PROVCESS.

#### **Processing:**

Sub-samples (~ 550 ml) were collected from the bottom tap at ten specified intervals. The sample times used were 2, 5, 10, 20, 40, 80, 160, 320, 420 minutes.

In the northern North Sea (cruises D1198 and CH140), for determination of settling rates of total SPM, the entire sub-sample was filtered through a pre-weighed 47 mm Cyclopore etched polycarbonate membrane filter of pore size 0.4 µm. Membranes were rinsed using 150 ml of distilled water, then air

dried before storage. After each set of ten sub-samples, an additional membrane was inserted beneath the last one before filtering and rinsing, thereby acting as a blank. In the laboratory, the membranes were oven-dried overnight at 40° C, then brought to room temperature at ambient humidity before re-weighing. The blank weight can be subtracted from the weight on the filters to correct for any 'handling' error.

In the southern North Sea (cruises PE136, MT0499 and BG9912), sub-samples were also used to determine the settling rates of the phytoplankton population. Sub-samples of a 100 to 250 ml were filtered through 25 mm Whatman GF/F glass-fibre filters with a nominal pore size of 0.7 µm. The pigments on the filter were extracted for a minimum of 18 hours and a maximum of 72 hours (Tett, 1987) in 8 ml 90 % acetone (made up of nine parts Analar grade acetone, one part distilled water). The extractions took place in a refrigerator in darkness. After extraction, the sample was shaken, centrifuged for 5 minutes, re-shaken and re-centrifuged for a further 5 minutes to ensure complete solution of the pigments. Fluorescence of the supernatant was measured using a Turner Design Model 10 fluorometer. Blanks of 90% acetone were also measured.

The measured fluorescence was corrected for the appropriate blanks and range (instrument sensitivity) used. If  $f_0^*$  and  $f_{0(b)}$  are the original fluorometer reading and the blank reading respectively then

$$f_0 = f_0^* - f_{0(b)} / R \quad (1)$$

where R is the range factor.

Total pigment concentrations ( $\mu\text{g l}^{-1}$ ) can be calculated as follows:

$$[\text{Chl}] = K_f f_0 E / V \quad (2)$$

where E is the extracted volume (ml) and V is the sample volume (l).  $K_f$  is a constant for the Turner fluorometer ( $K_f = 0.09$  during the PROVESS data processing).

**Data analysis:**

The raw data, both total SPM and chlorophyll related, were analysed and interpreted using an interactive computerised procedure developed at the University of Wales, Bangor (Jones and Jago, 1996). If the percentage frequency distribution of settling velocity  $W_s$  is  $F(W_s)$ , then after time  $t$  the proportion of a particular settling velocity class which has settled to the bottom of a tube of height  $h$  is:

$$\frac{W_s t}{h}, W_s < \frac{h}{t} \quad 1, W_s \geq \frac{h}{t} \quad (3)$$

So, integrating over all settling velocity classes the total percentage  $P(t)$  remaining in suspension after time  $t$  is given by:

$$P(t) = \int_0^{W_s=h/t} F(W_s) \left| 1 - \frac{W_s t}{h} \right| dW_s \quad (4)$$

It then follows that the cumulative weight percentage settling velocity distribution can be obtained as:

$$\int_0^{W_s=h/t} F(W_s) dW_s = P(t) - \frac{dP}{d \log_e(t)} \quad (2.5)$$

A computer-automated version of the manual/graphical procedure for solving equation 2.5 (Owen, 1976) performs the following steps:

- 1- SPM or pigment masses and volumes for each of the ten sub-samples are used to compute  $P(t)$ , after correction to allow for time variation in water column height as sub-samples are removed.
- 2-  $P(t)$  is plotted against  $\log_{10}(t)$ , (Fig. 2A).

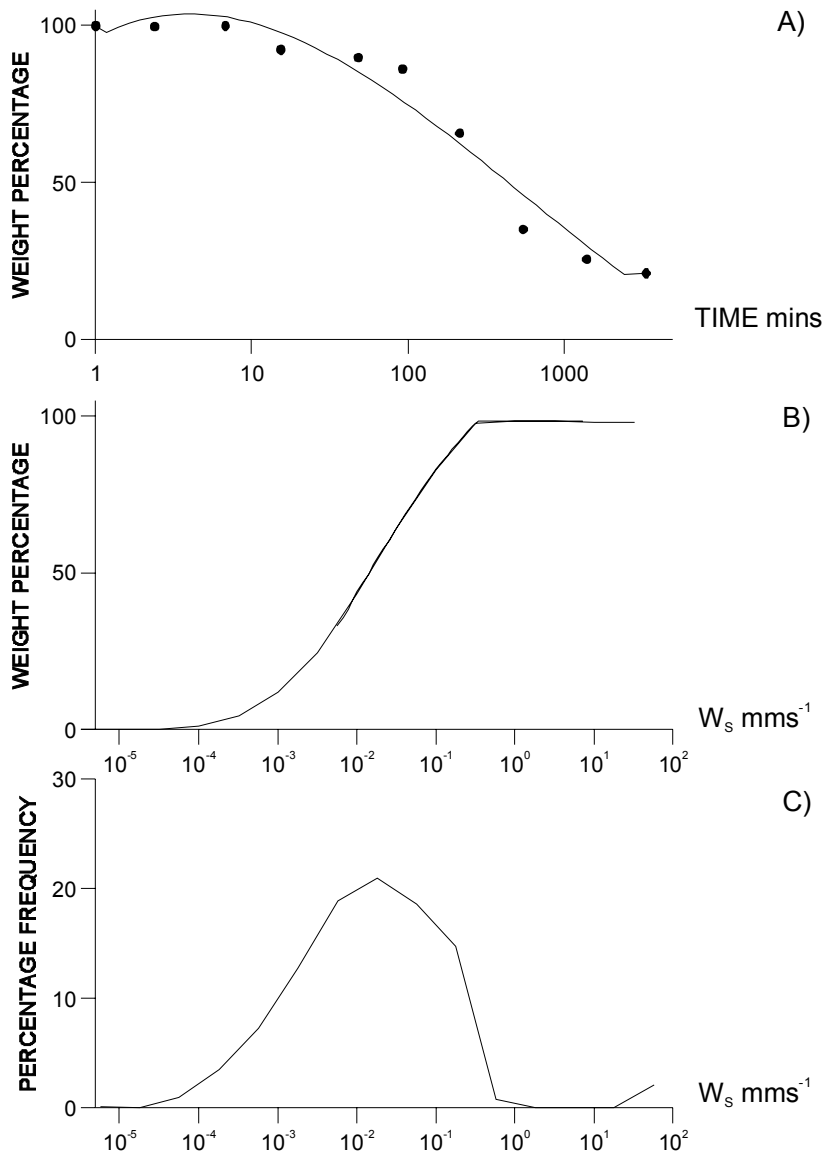


Fig. 2. A typical example of output from the UWB interactive settling velocity data analysis routine.

3- A smooth 'best-fit' curve is then fitted through these data points by an interactive cubic-spline procedure (Fig. 2A). The user selects both number of splines and the intersection points, viewing the result and repeating until satisfied.

4- This curve is transformed using equation 2.5 into a cumulative weight percentage versus log (settling velocity) curve (Fig. 2B). Where necessary (for samples containing significant proportions of very low or very high settling velocity) this is extrapolated assuming log-normal tail-end distributions, between  $10^{-6}$  and  $10^2 \text{ mm s}^{-1}$ . The extrapolated portion is clearly identified in graphical output from the procedure.

5- The weight percentage frequency distribution for the range of settling velocity classes is plotted (Fig. 2C), highlighting the population mode(s).

Median settling velocity is interpolated directly from the curve.

**BODC data processing**

The data were loaded into a database under the ORACLE Relational Database Management System without modification.

**Comments on data quality**

None to report.

**References**

Jones SE, Jago CF (1996) Determination of settling velocity in the Elbe Estuary using QUISSET tubes. *Journal of Sea Research*, 36(1/2): 63-67.

Owen MW (1976) Determination of the settling velocities of cohesive muds. Hydraulic Research Station, Wallingford, Oxon., Report No. IT 161:1-8.

Tett P (1987) Plankton. In: Baker J, Wolff WJ (eds) *Biological Survey of Estuaries and Coasts*. Cambridge University Press, pp. 280-341.