

Optimising Sample Preparation for the Investigation of Bottom Current Strengths of the Scotia Sea during the Pliocene

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Introduction

• The Pliocene is a period in the Earth's history that ranged from 5.3 to 2.6 million years ago. Even though the temperatures of that time were warmer than current temperatures, it was a period of global cooling. In the late stages of the Pliocene the earth experienced ice accumulation at the poles and the beginning of the ice ages.¹

• Sortable silt refers to the sediment fraction between 10 – 63 μm which can be used to relate information about ocean current speed. Silt between 2 – 10 μm is referred to as "cohesive silt" because they aggregate similar to clay <2 μm . The speed of the ocean bottom current is proportional to the size of the particles.²

• The Beckman Coulter LS 13 320 XR Particle Size Analyser uses laser diffraction for the particle sizing. The principle behind this method is that when the laser light is scattered upon incidence with the particles, the angle of the scattered light is inversely proportional to the particle size. Smaller particles give larger angles.³

• Seafloor sediment commonly contains fossils of microscopic organisms, especially diatoms and radiolarians, which are usually between 20-200 μm in length. Radiolarians contain a skeletal system made of silica⁴, and diatoms have a siliceous cell wall⁵. For accurate grain size analysis, these micro-organisms must be removed from the samples by dissolving in sodium hydroxide.

Method

3g of sediment is measured and wet-sieved at 63 μm then separated into 3 groups:

1. Dry then crushed – samples are allowed to completely dry and are then crushed before beginning the next step of the procedure
2. Wet always – samples are not allowed to become completely dry.
3. Dry then re-wetting to mix – samples are completely dried before adding a small amount of water to mix before continuing the procedure.

Removal of siliceous material

- Add 10 mL 30% hydrogen peroxide and stir with gentle heating to remove organic matter
- Remove the hydrogen peroxide by centrifuging
- Add 35 mL 1.5M sodium hydroxide, stir for 20 minutes then leave in incubator at 60°C overnight
- Place in 85°C water bath for 2 hours, then remove sodium hydroxide by centrifuging
- Add 35 mL 1.5M sodium hydroxide, place in 85°C water bath for 2 hours then leave in incubator at 60°C overnight
- Remove sodium hydroxide by centrifuging and wash the sediment.
- Make a smear slide to view if the siliceous material is absent.

17 samples were run on the particle analyser, 5 from the dry and the dry and re-wet samples, and 7 from the always wet samples.

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Results

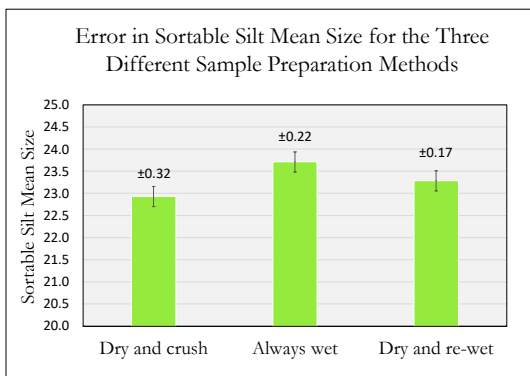


Figure 1: Graph showing the average sortable silt mean size for each method and the standard error for each mean. All the sortable silt mean sizes are around 23 with the dry and re-wet method having the smallest standard error while the dry and crushed method has the largest standard error.

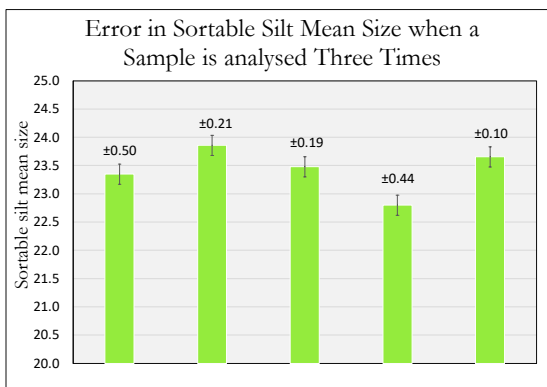


Figure 3: Graph showing the average sortable silt mean size for five samples analysed three times and the standard error in these measurements. These samples are from the always wet and dry and re-wet methods.

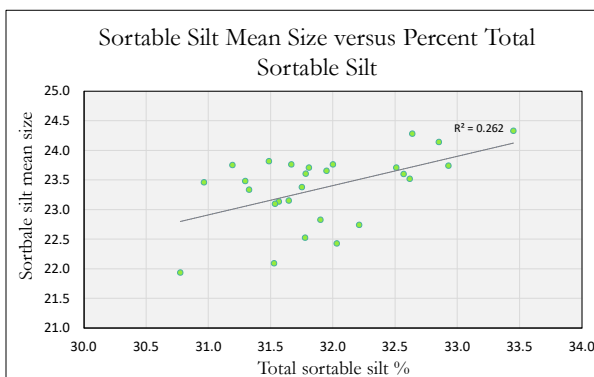


Figure 5: Graph showing the relationship between the Sortable Silt Mean Size and the Total sortable silt percent. Sortable silt mean size and the Total sortable silt percent have a proportional relationship.

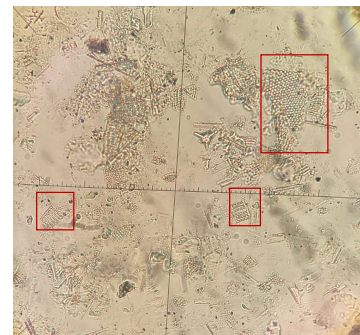


Figure 2: The image shows the microfossils in the samples viewed at x630 magnification before the removal procedure is performed. Examples of the siliceous matter are shown in the red boxes.

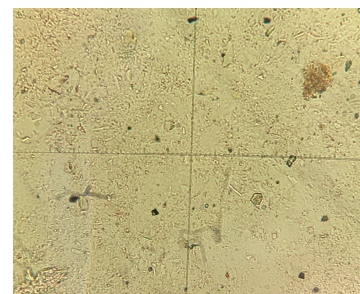


Figure 4: The image shows the absence of the microfossils in the samples viewed at x630 magnification after the removal procedure is performed.

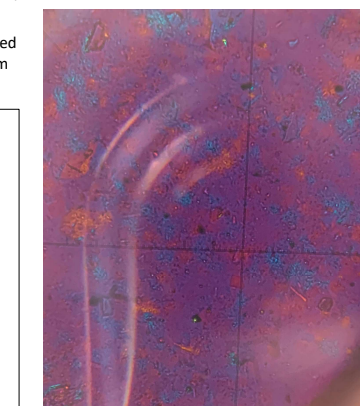


Figure 6: The image shows a sample under polarised light at x630 magnification after the removal procedure was performed. The colours observed are those of clay minerals in the sample.

Main Findings

More samples need to be analysed before we are satisfied with the conclusions listed below:

- The sortable silt mean size for these samples from the Scotia Sea is approximately 23. This corresponds to a strong ocean bottom current.
- The dry and re-wet preparation method produces the most consistent sortable silt mean size results.
- There is variability in the analysis of the same sample multiple times as evident in Figure 3.

There is no significant difference between the averages observed for the three different methods and the variability within the groups.

References

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