

13. DATA REPORT: COUNTING EXPERIMENTS ON DIFFERENT SIZE FRACTIONS: EXAMPLES FROM SITE 984¹

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INTRODUCTION

For many years, a controversy has existed about the “right” sieve fraction choice for coarse-fraction analysis. A variety of applications of counting data led to a wide range of different choices of mesh sizes. After a series of tests using various mesh sizes, Imbrie and Kipp (1971) decided that the >150- μm fraction (the CLIMAP convention) is the most convenient. Smaller mesh sizes led to high uncertainties, especially in the difficult classification of small or juvenile individuals. Since then, the >150- μm fraction was also used in modern techniques of paleotemperature reconstruction (e.g., the SIMMAX method; Pflaumann et al., 1996). A huge database and the tempting possibilities for paleotemperature reconstructions provided by these works led to a high acceptance of the >150- μm fraction by the scientific community.

Along with the introduction of the CLIMAP convention, Sarnthein (1971) introduced a new method for quantitative component analysis of the coarse fraction. He used whole ϕ° mesh sizes (Wentworth, 1922) between 63 and 2000 μm and quantitatively investigated all fractions for the most important constituents. However, he also recognized an immense increase of misinterpretations of particles <125 μm . Based on his results, Henrich (1989) regarded the 125- to 500- μm fraction as the most representative of the whole coarse fraction in Norwegian Sea sediments. The decision to use whole ϕ° mesh sizes may have been based simply on economics, because standard sieves are available in most laboratories. Many scientists followed this proposal (e.g., Wolf and Thiede, 1991; Baumann et al., 1996; Meggers and Baumann, 1997) and today a large data set exists that is based on the 125- to 500- μm fraction.

After the observation of Heinrich (1988) that massive iceberg discharges occurred with suborbital frequencies, a series of publications about these Heinrich ice-rafting events was released. Researchers used oxygen isotope data as well as planktonic foraminifer assemblages and the abundance of ice-rafted debris (IRD) as paleoceanographic indicators (e.g., Grousset et al., 1993; Broecker, 1994; McManus, et al.; 1994; Bond and Lotti, 1995). In most of these studies, the >150- μm fraction was investigated, as well as the >125- μm fraction at times (Fronval and Jansen, 1996).

At least since these studies, a strong interest in data exchange between different working groups has existed; it is thus very important to estimate the compatibility of the methods. In this study, we present results from coarse-fraction analysis performed on the >150- μm fraction, as well as on the 125- to 500- μm fraction, to test the compatibility between these two methods. Counting data are compared from both fractions of IRD, total abundance of planktonic foraminifers, and percentage of *Neogloboquadrina pachyderma* sin. of total planktonic foraminifers.

MATERIALS AND METHODS

Samples were taken from Site 984, which is located on the eastern flank of the Reykjanes Ridge (61°25.5'N, 24°04.9'W) at 1650 m water depth. Samples for bulk calcium carbonate measurements were taken every 50 cm. To determine calcium carbonate contents, we used a LECO CS-125 infrared analyzer. This device measures only total carbon (TC) contents. To determine total organic carbon (TOC) content, the samples were treated with hydrochloric acid and the %CaCO₃ was calculated using the following equation:

$$\% \text{CaCO}_3 = (\% \text{TC} - \% \text{TOC}) \times 8.33.$$

For studies of the coarse fraction, the samples were freeze-dried using a FINN-AQUA (Iyvocat GT2). A weighed part of the freeze-dried sample was washed on a 63- μm sieve. The dried, remaining coarse fraction was further separated into 63- to 125- μm , 125- to 500- μm , and >500- μm fractions using a ATM-SONIC-Sifter. A whole split of at least 300 particles of the 125- to 500- μm fraction was determined. In a simplified counting procedure, we concentrated on five major categories: IRD (mineral grains and rock fragments), individuals of *N. pachyderma* sin., other planktonic foraminifers, benthic foraminifers, and other biogenic particles. After the counting procedure, all fractions >63 μm were put together and sonic sifted again. We then used a 63- and a 150- μm sieve. Average sieve loss was only 2.6%. The >150- μm fraction was again counted as described above. All particle counts were calculated to grains per gram of dry sediment.

RESULTS AND DISCUSSION

A comparison of the weights of the two size fractions is shown in Figure 1. Generally, the contents of the two fractions are very similar to each other, although the percentages of the >150- μm fraction are slightly higher than those of the 125- to 500- μm fraction. Deviations can be observed especially at 3 meters composite depth (mcd), from 22 to 27 mcd, and at 50 mcd. Here, the >150- μm fraction contains as much as 7 wt% more of the dry sediment than the 125- to 500- μm fraction, indicating an enrichment of particles >500 μm . However, most of the samples that were investigated show negligible differences in weight percent between the two fractions.

All counting results are plotted with the bulk carbonate data to demonstrate the range of glacial–interglacial variability we covered with our samples (Fig. 2). In the youngest section, until 25 mcd, the >150- μm fraction shows slightly higher IRD contents than the 125- to 500- μm fraction, which reflects the generally higher weight percentages of the >150- μm fraction (Fig. 1) and, consequently, more >500- μm IRD particles. Only a single data point at 9 mcd reveals higher IRD content in the 125- to 500- μm fraction. This pattern changes in the deeper section, from 25 mcd to 60 mcd. Here, the 125- to 500- μm fraction shows increased contents at 27.0, 42.5, and 53.0 mcd. Generally, the curve shapes of the two size fractions are very

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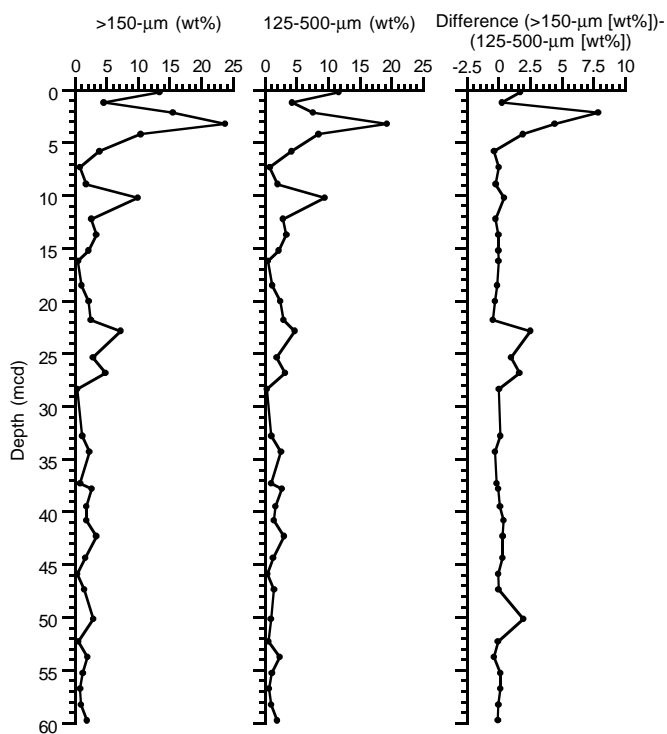


Figure 1. Weight percentages of dry bulk sediment from the >150-µm and 125- to 500-µm fractions and the difference between weight percentages of the >150-µm and 125- to 500-µm fractions from Site 984.

similar. The correlation between IRD counts of different size fractions is significant ($r^2 = 0.618$), as shown in Figure 3. Despite some differences in amplitude, an “in phase” relationship of the behavior of the IRD curves of the two fractions and thus a good compatibility is observed (Fig. 2). Some underestimation of the IRD content in the >150-µm fraction is present at 27.0, 42.5, and 53.0 mcd, where the 125- to 500-µm fraction indicates stronger IRD input than the >150-µm fraction.

The total abundance of planktonic foraminifers reveals some distinct dissimilarities between the two size fractions. At 1.5, 20.0, and 38.0 mcd, the 125- to 500-µm fraction contains distinctly more foraminifers than the >150-µm fraction, dominated by nonpolar species (Fig. 2). Additionally, in the 125- to 500-µm fraction, lower abundances of the polar-adapted species *N. pachyderma* sin. than in the >150-µm fraction were observed at 14, 28, 36, and 39 mcd (Fig. 2). Hence, an underestimation of nonpolar species in the >150-µm fraction in comparison to the 125- to 500-µm fraction must be considered. This could reduce the compatibility of the two methods in detail. For samples from the eastern Labrador Sea, Fillon and Duplessy (1980) and Kellogg (1984) showed that the abundance of subpolar species increases in the smaller size fractions (>62 µm). Biometric analyses of the subpolar planktonic foraminifer *Turborotalita quinqueloba* (Bauch, 1994) proved that the main abundances of this species occur in size classes <150 µm. Paleotemperatures calculated from the >150-µm fraction foraminifer assemblages could therefore indicate colder surface-water temperatures than sea-surface temperature estimates derived from the 125- to 500-µm fraction. A similar finding led Niebler and Gersonde (1998) to introduce a transfer function based exclusively on a >125-µm data set.

Because of strong taxonomic problems, the use of 63-µm sieves was rejected by Kellogg (1984) and Meggers (1995). There is no comparative study between the 125- to 500-µm and the >150-µm

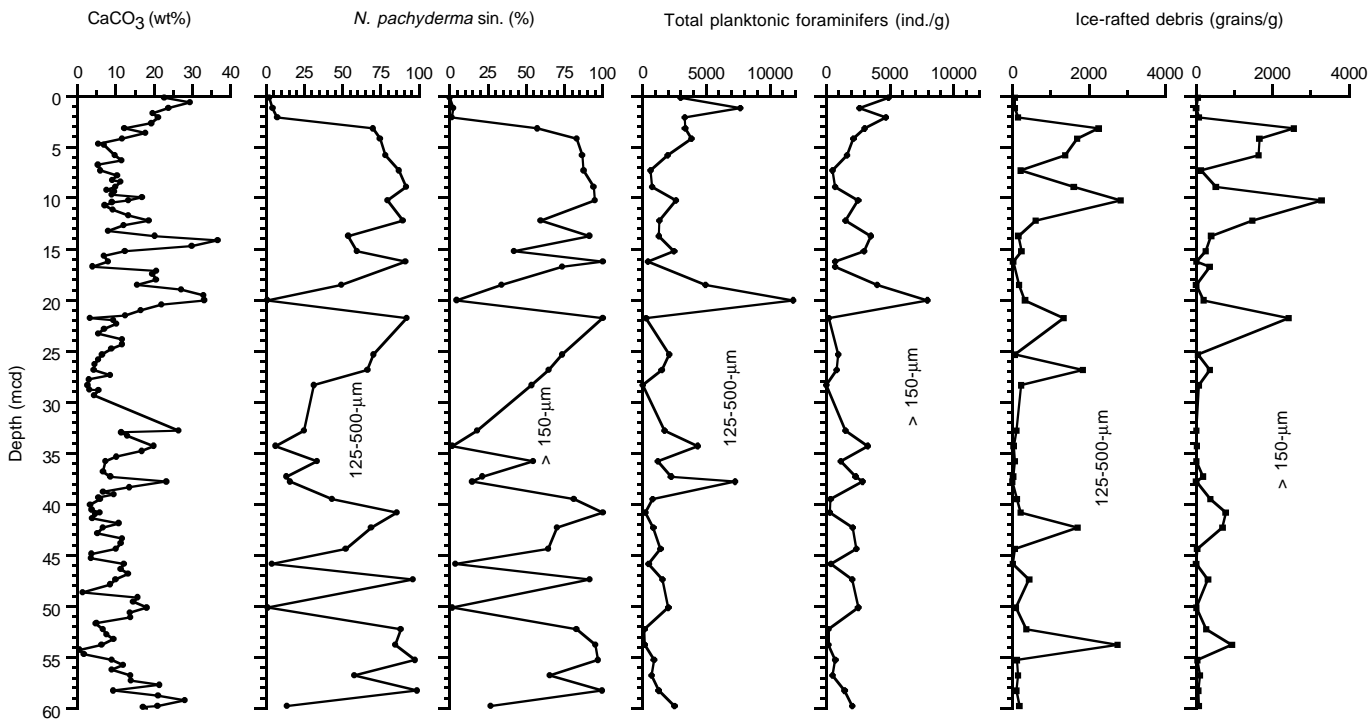


Figure 2. Comparison of coarse-fraction data between the 125- to 500-µm and the >150-µm fractions plotted vs. the CaCO₃ record for Site 984. Ind. = individuals.

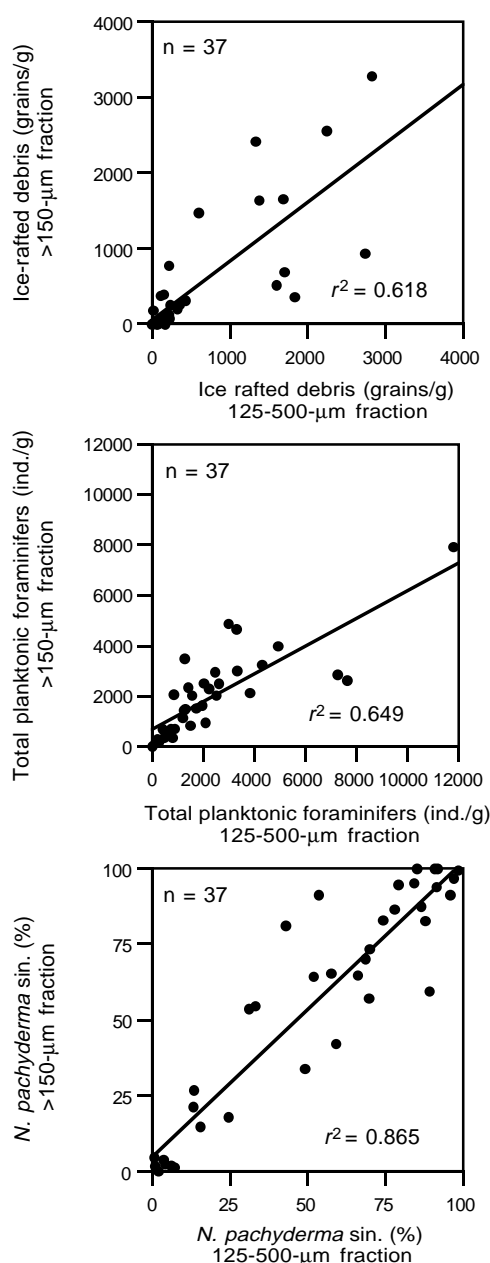


Figure 3. Correlation coefficients between the 125- to 500- μm and the >150- μm fractions.

fractions dealing with the amount of indeterminable species. Kellogg (1984) estimates that this amount is between 0% and 3%. An evaluation of available foraminifer counts (Meggers, 1995; R. Huber, unpubl. data) from the 125- to 500- μm fraction resulted in similar percentages (0%–3.5%). Thus, for the simplified counting procedure that we applied, highly reproducible counting results with low error possibilities can be expected.

In general, the agreement between the two fractions with respect to foraminiferal assemblages is very good. The correlation (Fig. 3) between the abundances of total planktonic foraminifers counted from the 125- to 500- μm fraction and the >150- μm fraction is significant ($r^2 = 0.649$). Additionally, rapid climatic shifts are synchro-

nously monitored by strongly decreasing percentages of *N. pachyderma* sin. at 2, 20, 46, and 50 mcd (Fig. 2) and demonstrate the high comparability of the two fractions. Furthermore, the high correlation coefficient ($r^2 = 0.865$) of *N. pachyderma* sin. percentages between the two fractions proves a generally good compatibility of the two methods for paleotemperature estimations.

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