III. Bottom Sediments

by

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Figure 3.13 shows the distribution of mud in the vicinity of the Belgian coast. In general, only one grab sample per station was available to us. Of course, the aim of this map is not to delineate the bodies of mud accurately. Bastin (1973) drew his map on the basis of continual sampling, a much better method for that purpose. Our mode of sampling is of course better fit to establish differences in physical and chemical properties of the sediments.

Sedimentary facies differences between different areas can only be studied by undistributed samples. Fine grained sediments in the area under consideration probably in places consist of layered sand and clay or mud.

A grab can homogenize a sample in such a way that a false granulometric image appears. Our figures thus only represent the overall granulometric composition of the samples and no further conclusions should be drawn from them such as shear stress, water content, compaction, etc.

A sample with 30 % , > 63 μ (global analysis) could have been taken on a clay or mud layer with a sandy layer some 10 to 15 cm underneath. This appears on the distribution diagrams as bi- and even polimodal distributions.

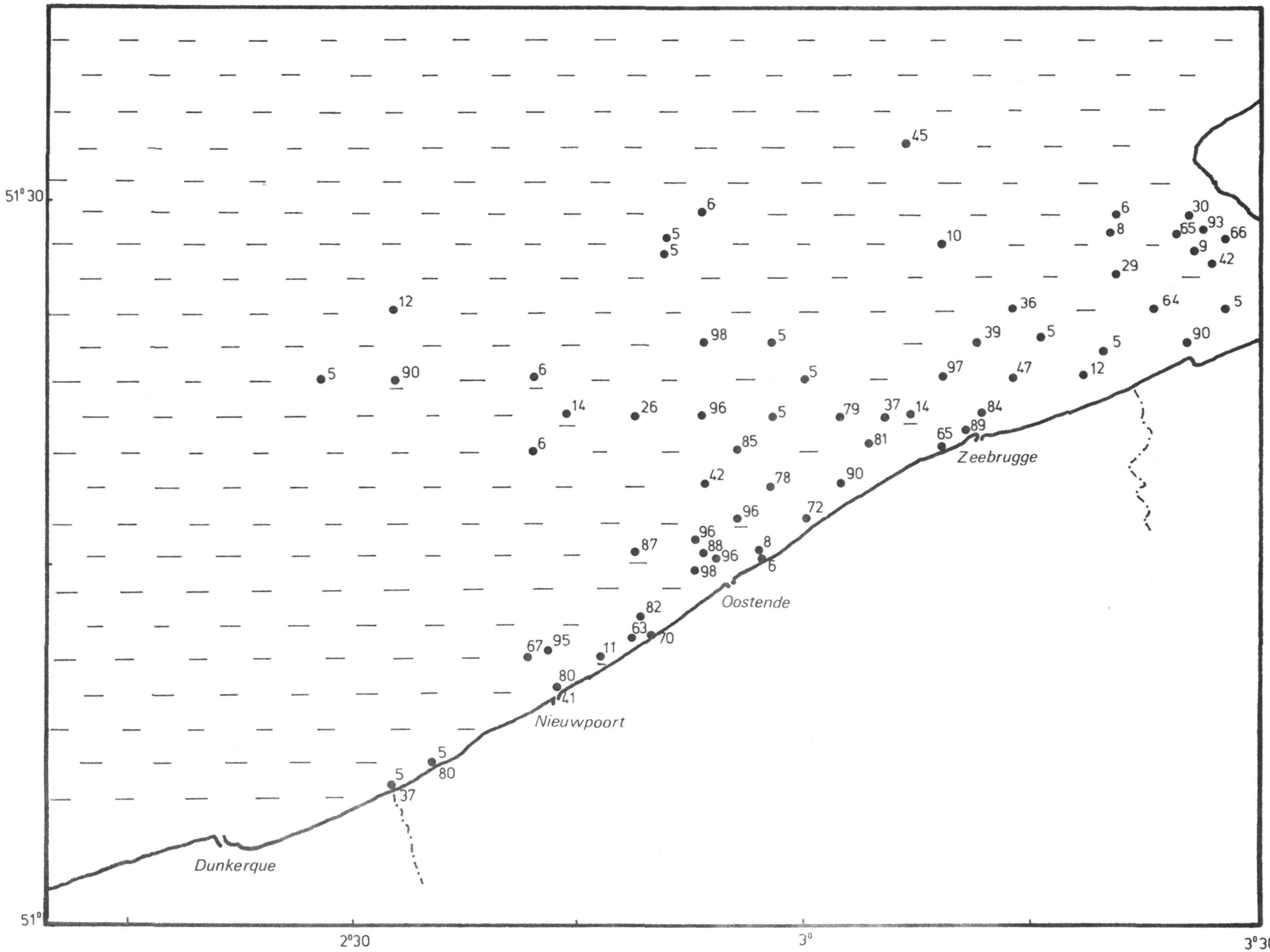


fig. 3.13.- Distribution of mud before the Belgium coast expressed in % silt and clay per analysed sample.

Granulometric analysis was obtained by the method described in the report *A flowsheet for analysis on recent detrital sediments* by F. Gullentops (1972). As to the accuracy : the screens of 63 µ and 32 µ were controlled on sieve opening. Reproductibility of the applied decantation method was found to be at least 1 % . Nevertheless, granulometric analysis for the fraction > 32 µ was only executed as soon as the sample contained more than 5 % > 63 µ .

A comparison between the figures 3.13 and 1 (1972) shows that the turbide area reflects the distribution of mud on the bottom. This is still more apparent on the fig. 2 (1972). A turbidity-muddy bottom sediments link is apparent.

A comparison between the figures 3.9, 3.10 and 3.13 teaches us that mud is lying in places where current velocities of more than 60 cm/s are possible and V_{100}^{min} does not fall under 20 cm/s .

The coastal zone which is a favorable area for sedimentation of fine grained material as to current strength, is subject to intense wave activity.

The most persistent wind directions are those of the western sector. The strike of the sand banks is such that the area beyond is protected against long waves.

Nevertheless, it seems that the mud is situated in a zone of partly high current and wave energy. We think that mud sedimentation must occur because of high turbidity. McCave (1971) has already drawn the attention to the fact that irrespective hydrodynamical conditions, settling of mud can start if suspended sediment concentration (mud) is high enough.

The presence of mud in the Belgian coastal waters can be explained by :

1) Streaming water

Concentration and transport of suspended matter towards the coast by residual currents. Most probably, the current direction, resulting from the vectoral addition of the velocities between the eroding and settling current strengths will point in a coastal direction.

2) Wave action

Waves can induce a translating movement in slightly consolidated mud in such a way that this mud is transported without being brought into suspension [Migniot (1968)]. We think that this mechanism should be taken into account here as well.

Nevertheless, reworking by waves keeps turbidity high in some places. In this way, new material becomes available for transport. The high suspended matter concentration area [fig. 1 (1972)] reflects bottom morphology as well. Undeep water extends well far into the sea off the Scheldt mouth, as muddy bottom sediments do.

We think current patterns are of primary importance; they cause high concentrations and induce sedimentation.

Partheniades (1965) and Migniot (1968) have already drawn the attention to the fact that fine grained material will not only be resuspended by waves but grain size distribution will also drastically be reduced (mean fall velocity 5 times smaller). In this way this material becomes extremely fit for transport. Furthermore, it seems to us that sedimentation and erosion are coupled to spring and neap tide periods.

V_{100} of 40 cm/s and more are, during neap-tide only, reached in the Scheur and off the eastern part of the coast. At this time mud-layers can be laid down and preserved so that the degree of compaction can increase. In this way these sediments become more resistant to erosion which can possible occur at the next spring tide.

Figure 3.13 shows that "mud" is always a mixture of silt, clay and sand. The mean of the median of the fraction $> 63\ \mu$ is $176\ \mu$.

Figure 3.14 shows that there is a loose correlation between the grainsize of the sand and its weight percent in the sample : the sandier it is, the coarser it can be. Sand content can thus be correlated with current-strength — wave action, as under these conditions coarse material can be transported.

In the triangular diagram (fig. 3.15) a wedge-shaped dot concentration appears from the sand-corner to the opposite silt-clay side. This means that in our samples a more or less fixed ratio exists between the silt and clay content : ± 65/35 . Both fractions have been transported together in suspension as more or less homogeneous grain complexes.

Samples with a sand content of 35 to 50 % seem to be absent. We think this is due to the admixture of loess-silt. A still closer

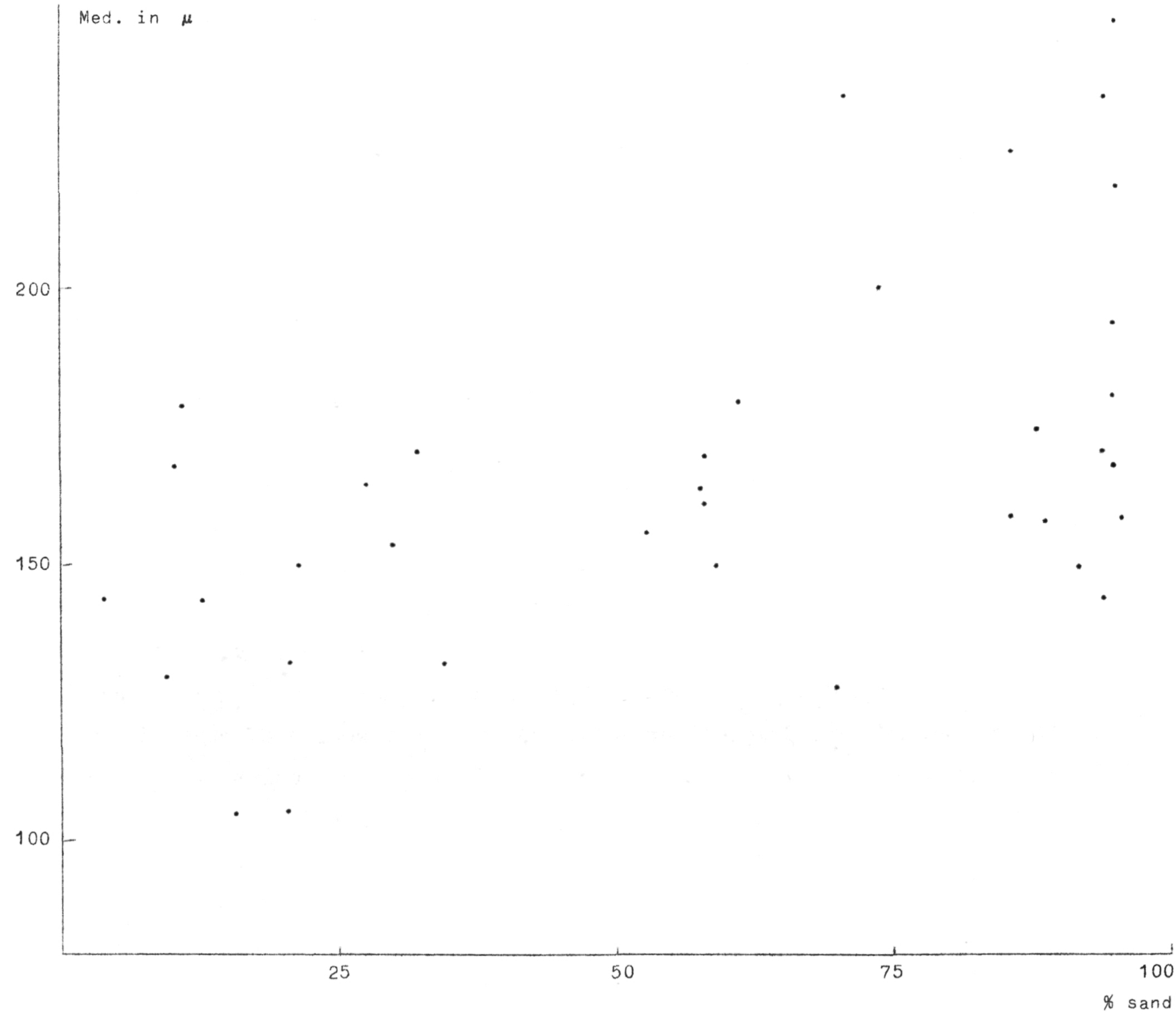


fig. 3. 14.
Relation between the median of the sand fraction and the per cent sand present in mudholding samples.

relationship exists between the fine silt fraction and the clay fraction (fig. 3.16) : the silt-clay ratio is 55/45 .

Samples with more than 45 % < 16 μ show a less good correlation. We think that the admixture of silt is responsible for this too.

However the coorelation between the fraction $\lesssim$ 2 μ and 2 - 16 μ shows again that clay is not deposited separately, but always settles as a mixture of coarser material.

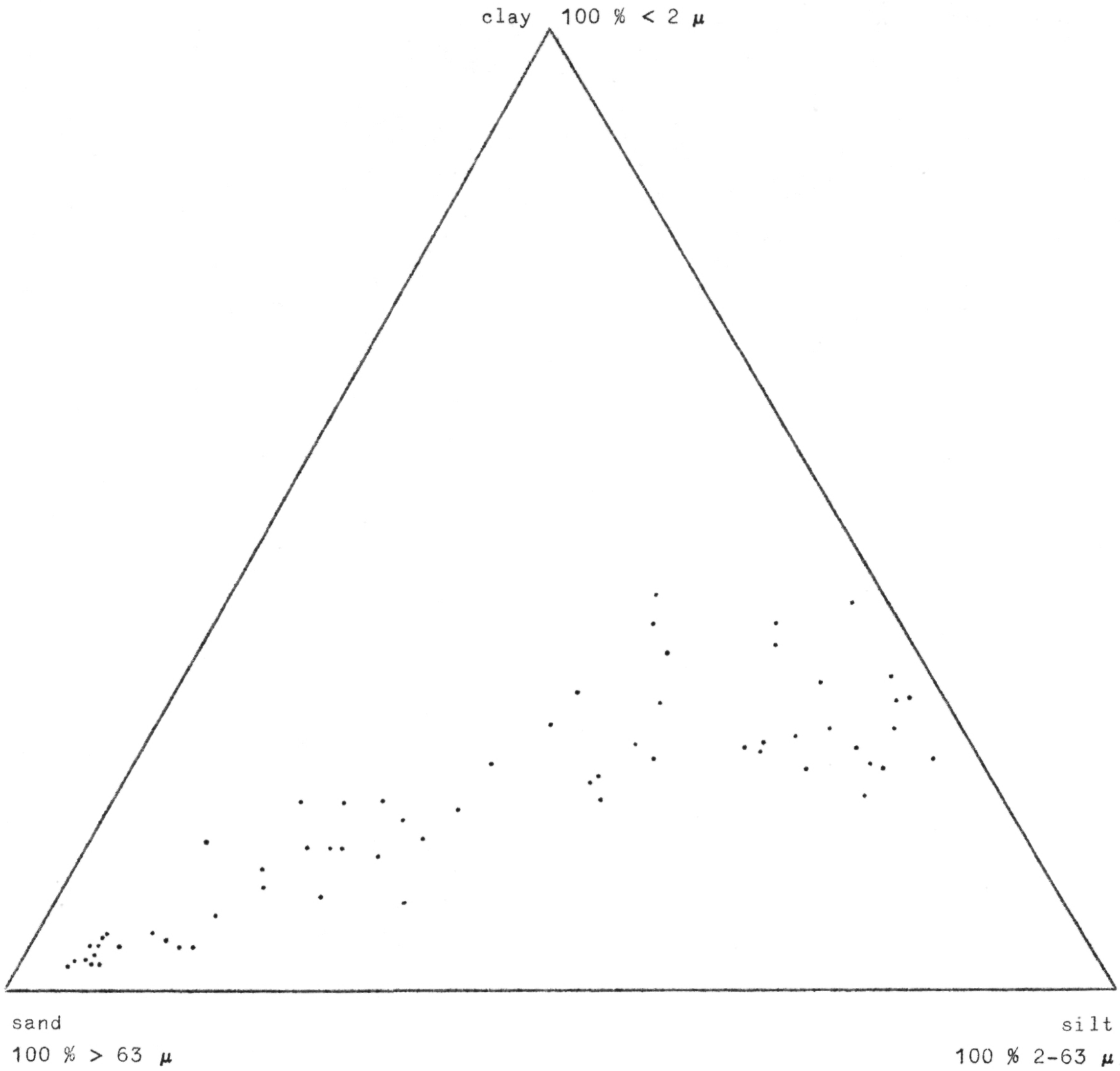


fig. 3.15
Proportion of sand-silt-clay composition of bottom samples.

To illustrate grainsize variations in the area, two profiles were drawn (fig. 3.17). Stations that were repeatedly sampled are presented here with their mean values. Dotted lines interconnect stations with an appreciable mud-content. The profile along the coast shows clearly that mud-content of the samples increases towards the midcoast. The maximum is reached in the vicinity of the station 1113 (De Haan). A clay percentage of 25 % is frequently found (fig. 3.17). Coarse and medium silt content suddenly increase from 1167 to 1207. Samples with the same

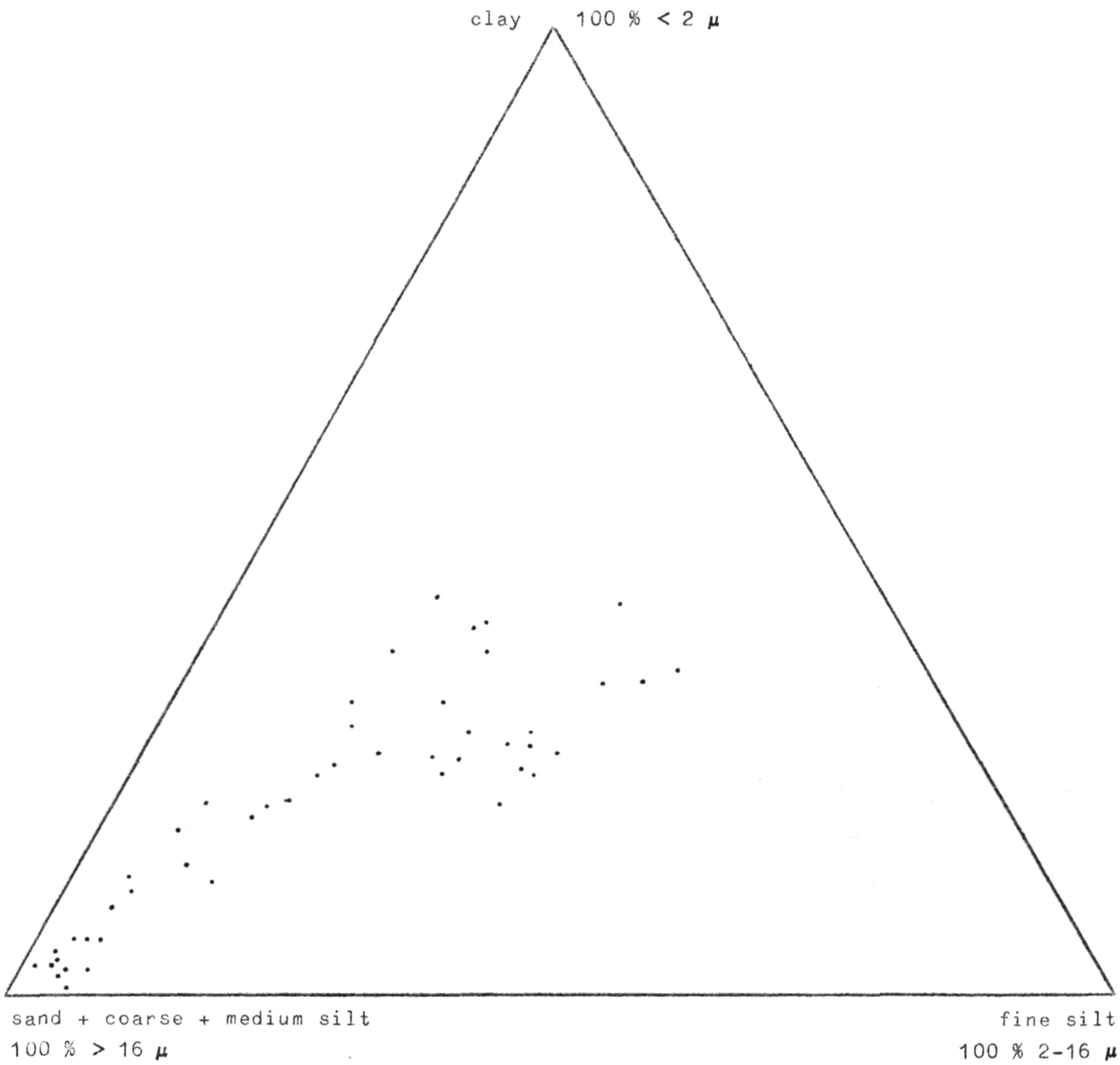


fig. 3.16.
Relation between fine silt and clay in bottom samples.

important coarse and medium silt fractions were found in the Scheldt mud during a separate investigation. We think Scheldt material may be present in the 1207 station.

The relationship between fine silt and clay is obvious in the second profile. Here clay content reaches 40 % .

To clarify the relationship between the different fine fractions, four parameters were calculated : Scr, Scmr, Cr and Ocr. Moreover they may contain some information about the provenance of the material.

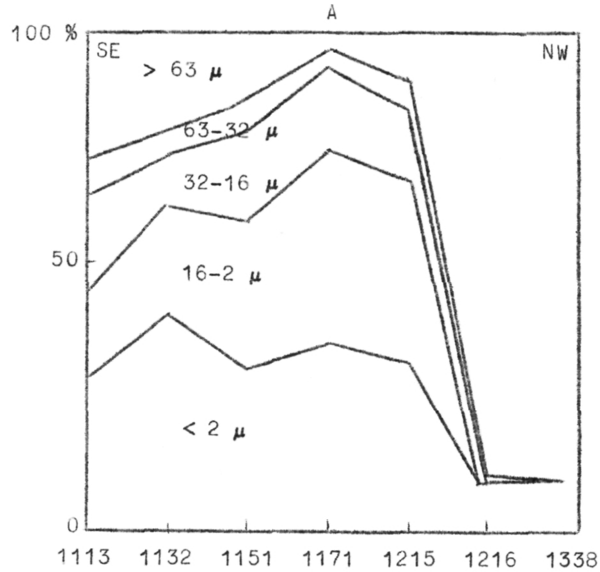
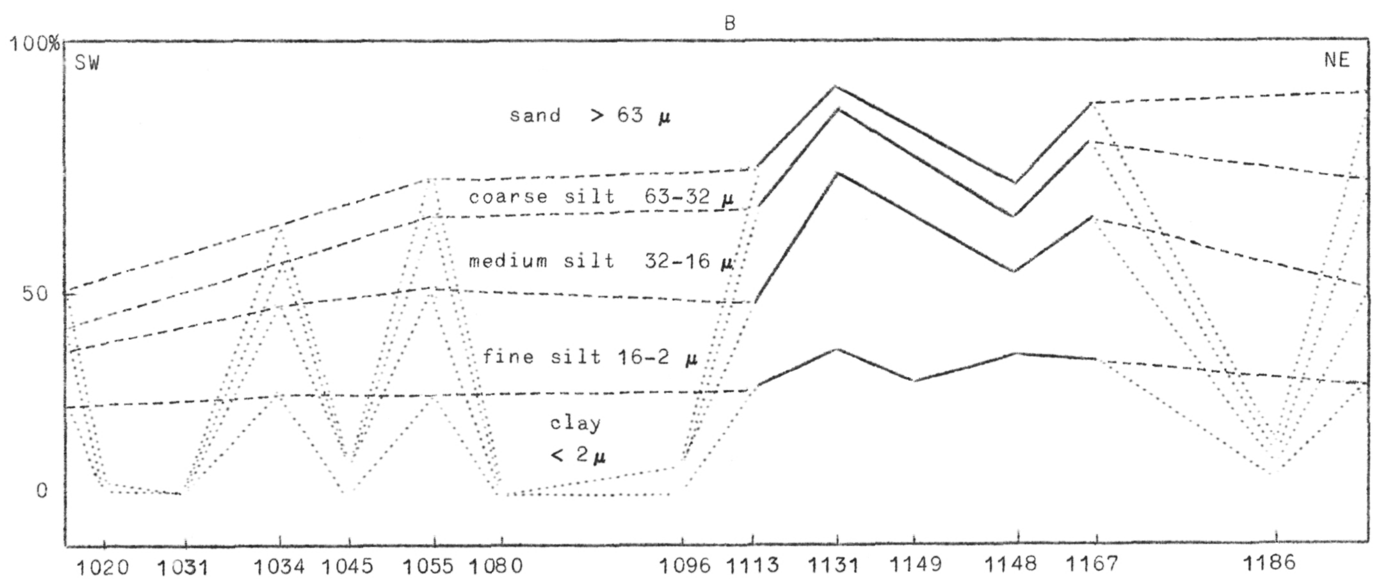


fig. 3.17.

A.- Graindiameter profile normal to the coast in De Haan.

B.- Grain diameter profile along the coast from De Panne to the Schelde mouth.



A brief discussion of the figures 3.18, 3.19, 3.20 and 3.21 is held here.

$$\text{Scr} \quad : \quad \text{silt coarse ratio} \quad = \frac{\text{fraction} \quad 63 - 32\ \mu}{\text{fraction} \quad < 63\ \mu}$$

gives the contribution of the coarse silt fraction to the $< 63\ \mu$ fraction. Values range from 0.01 to 0.29 ; the mean is 0.12 .

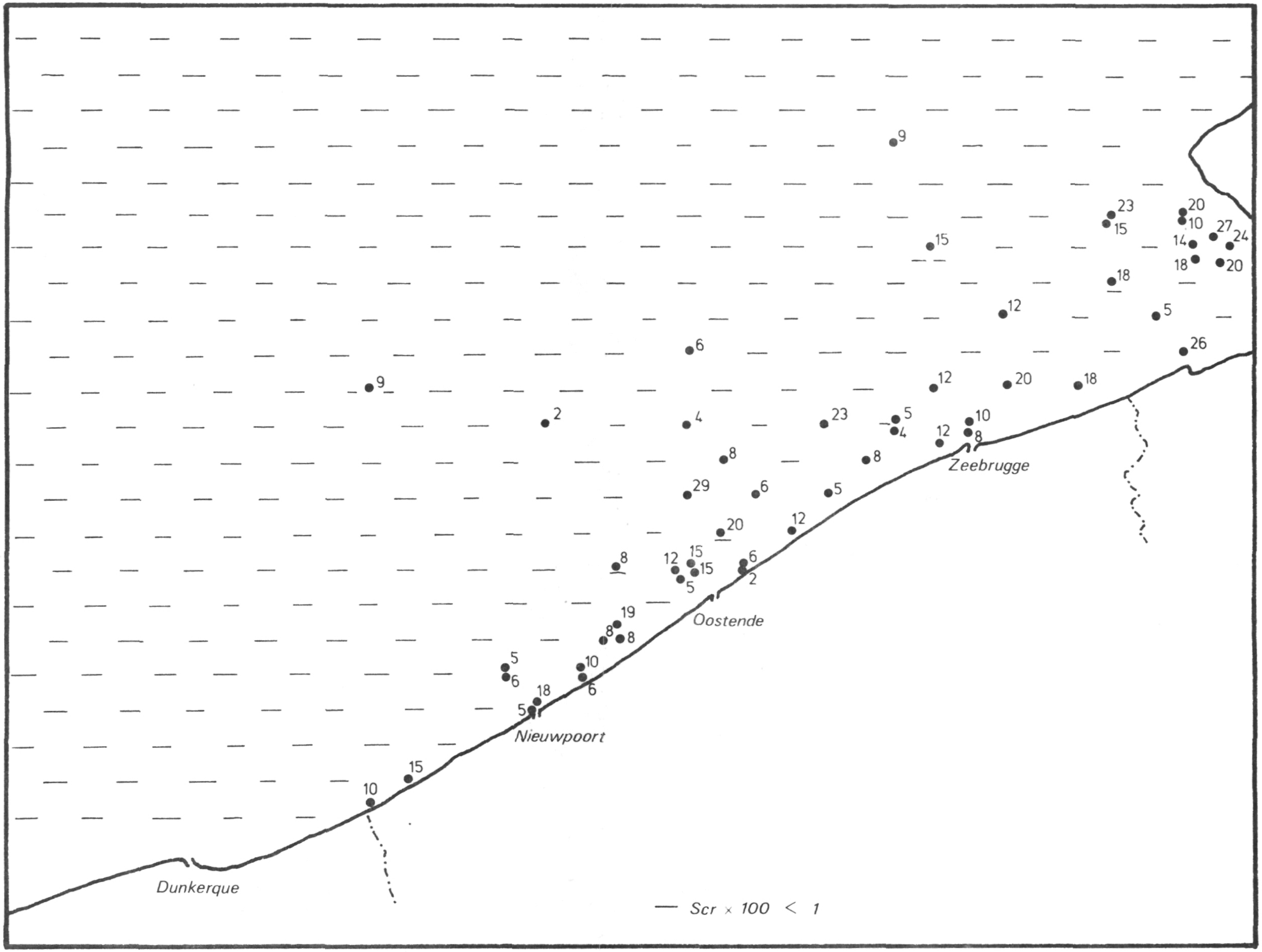


fig. 3.18.- Scr x 100-parameter of the bottom samples.

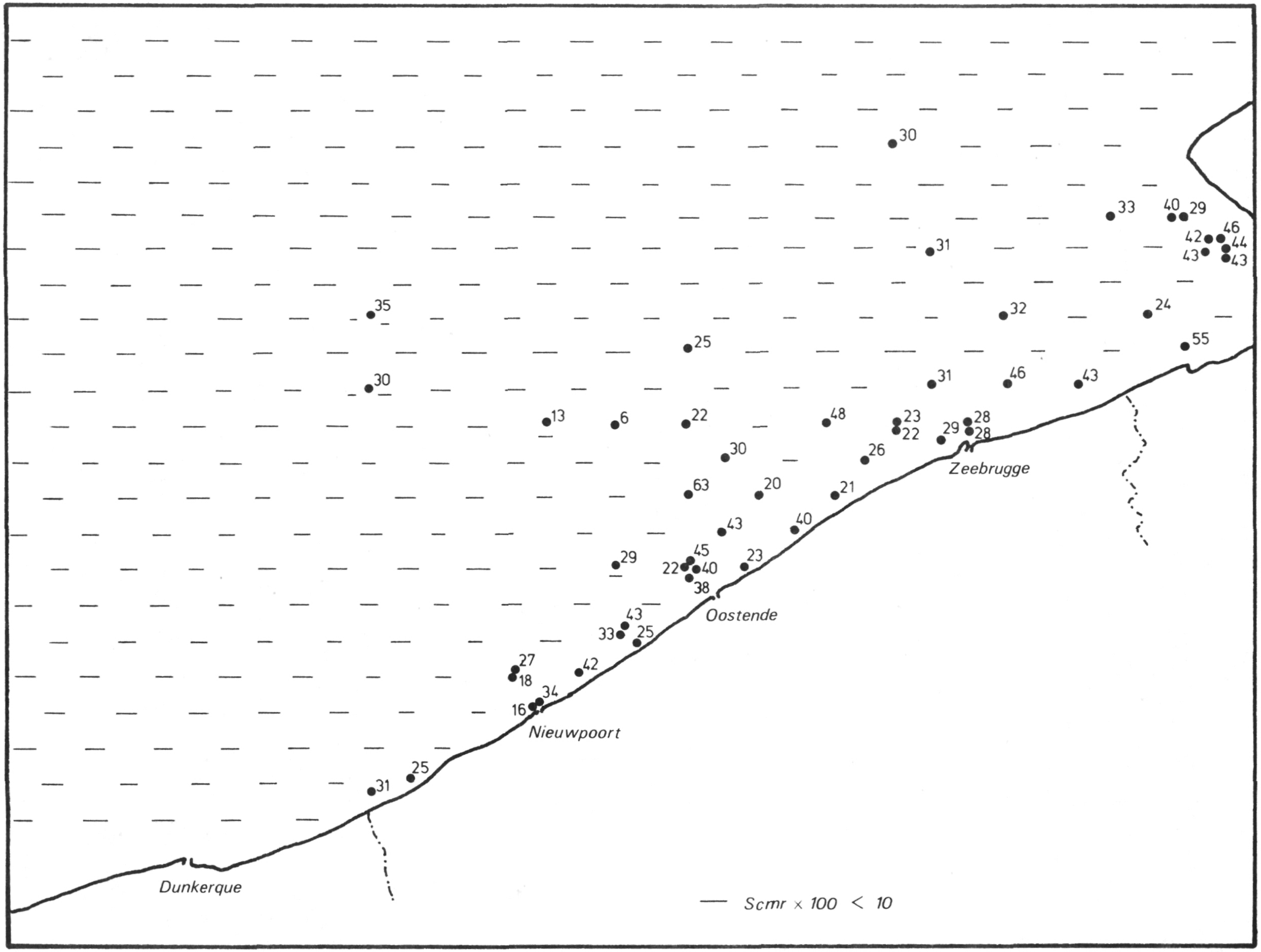


fig. 3.19.- Scmr x 100-parameter of the bottom samples.

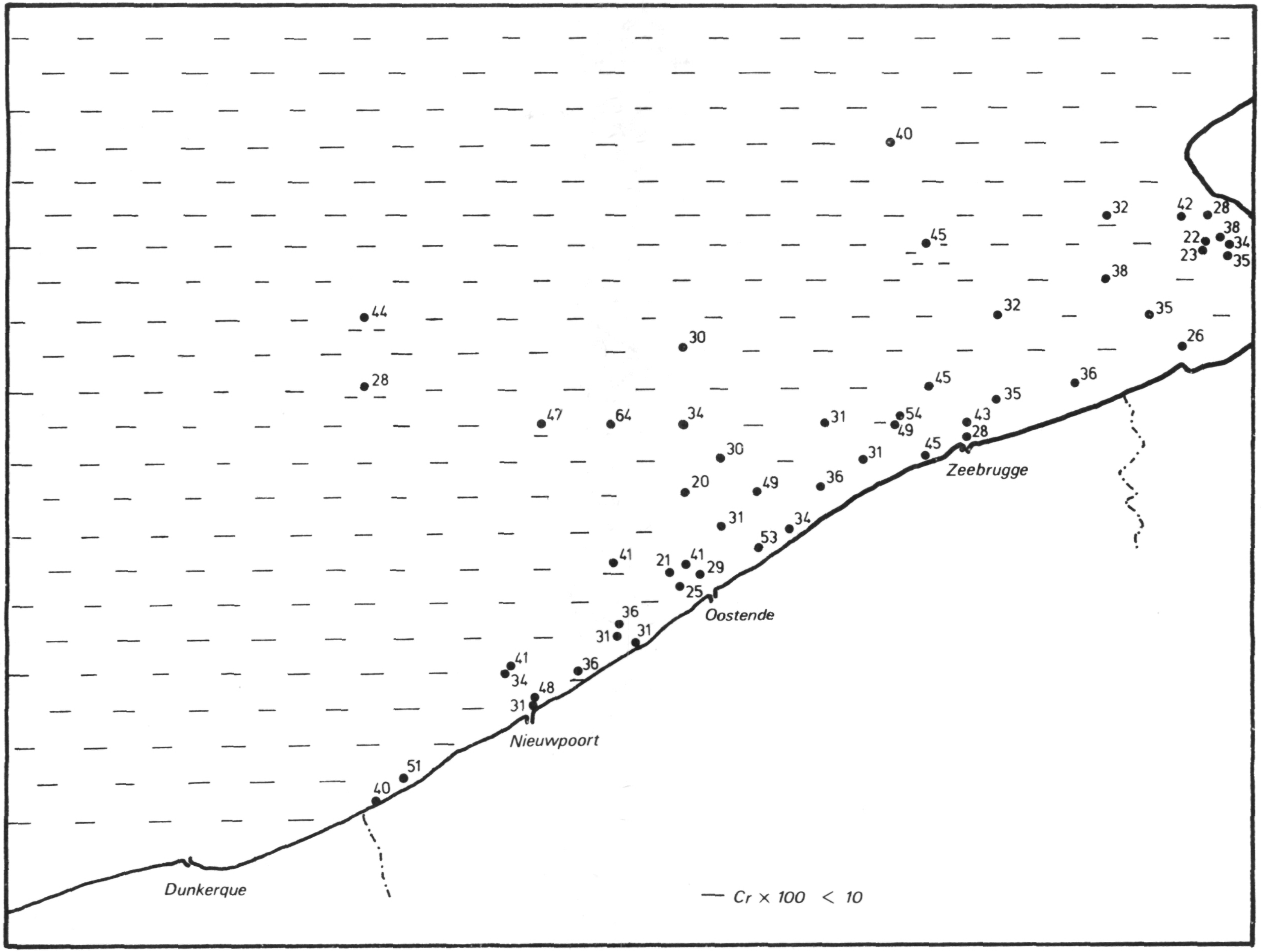


fig. 3.20.- Cr x 100-parameter of the bottom samples.

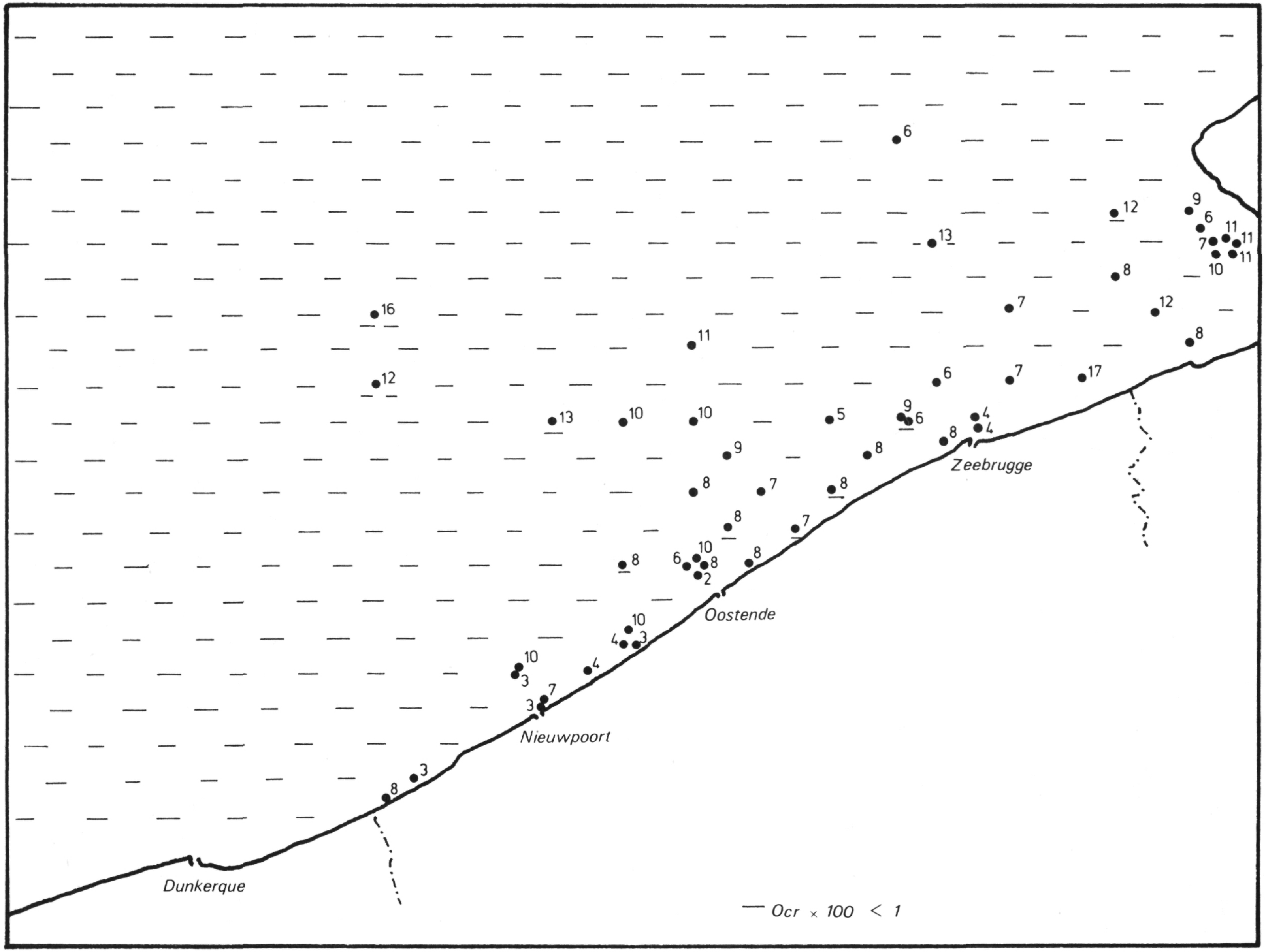


fig. 3.21.- Ocr x 100-parameter of the bottom samples.

This value is appreciably lower than the mean of the corresponding Scheldt mud parameters : 0.30 . At the stations 5 and 7 however, parameters with such high values possibly point to the presence of Scheldt material in these places. We think this should be almost certain at station 5. However, we cannot explain the high coarse silt content of the sample 1133.

$$\text{Scmr} \;:\; \text{silt coarse and medium ratio} = \frac{\text{fraction } 63-16\ \mu}{\text{fraction } < 63\ \mu}$$

records the contribution of coarse and medium silt in the suspended material Ps (fraction < 63 μ). The Scmr values are situated between 0.06 and 0.63 with a mean of 0.32 . Again, these are lower values than those of the Scheldt sediments : ± 0.55 . The Scmr-value distribution is bimodal with a first mode around 0.25 to 0.30 and a second around 0.40 to 0.45 . High values are found again around the mouth of the Western Scheldt and along its western extension. This could be due to the discharge of loess-rich material by the western Scheldt. A certain export of fine-grained material by the Scheldt thus seems possible. Hitherto, deposition of his muddy sediments into its lower part has always been assumed.

At the stations 1049, 1065, 1113, 1114 and 1133, high values were found with a maximum of 0.63 at 1133.

$$\text{Cr} \;:\; \text{clay ratio} = \frac{\text{fraction } < 2\ \mu}{\text{fraction } < 63\ \mu}$$

reflects the contribution of the clay fraction to the fraction < 63 μ .

Cr-values fluctuate between 0.22 and 0.64 with a mean of 0.36 , which is a higher value than for the Scheldt : 0.30 . This might point to the fact that in contrast with the coarser fractions (silt), the fine material (clay) is preferably discharged into the sea.

Some kind of sorting mechanism must thus be active in the lower Scheldt.

High Cr-values were found at the stations 1168, 1188, 1148, 1132, 1172, 1173 and 1007. Here, a more or less clay-rich sedimentation must exist.

We also found that the Cr-parameter is subject to strong variations. Silt-rich as well as clay-rich mud can be found in one and the same station (N° 1097 and 5, for example). This makes us think that the numerical values of this ratio may be strongly influenced by local and temporary hydrodynamical conditions, rather than by the provenance of the material.

$$\text{Ocr} \ : \ \text{organic clay ratio} = \frac{\text{organic fraction} \ (H_2O_2)}{\text{fraction} \ < 2\ \mu} .$$

It is presumed that organic material is found in the clay-fraction, therefore the organic fraction is expressed as a percentage of the clay fraction. The Ocr-values fluctuate between 0.02 and 0.17 , the mean is 0.08 . The corresponding value for the Scheldt basin is 0.24 .

Seawater is generally oversaturated with oxygen, so the oxidation of organic compounds is easier in seawater than in riverwater.

Values for this parameter higher than the mean were found at the Scheldt mouth in N° 1186. When reworking occurs, organic matter in the sediment is repeatedly brought into contact with oxygenated water. So farther offshore in deeper parts of the sea where no reworking occurs, a higher organic matter content of the clay appears : N° 6, 1173 and 1941.

The optical investigation of the light mineral decalcified fraction was started as well. The most abundant grains of course are quartz (60 to 70 %), feldspars (± 20 %), silex (to 10 %). Chlorite, glauconite, silex and heavy minerals are the less important grains. Carbonate material easily makes up 50 % of the sample when not treated with HCl .

The countings are too incomplete to allow interpretation. Results can be found in Table 3.2. We can say that at this first glance the muds of the Belgian coast seem to be mineralogically homogenous. This is in accordance with the ratio analysis.

Remarkable anyway is the relative high chlorite content.

Table 3.2

% light minerals - composition per sample of the 32-63 µ fraction
(% quartz = 100 % - sum of the percentages of the other minerals)

Mineral species	Sample number															
	1007	1283	1113	1034	1131	1151	1097	1168	1114	1050	1149	1187	1065	1098	1132	1188
Orthoclase	9	9	10	10	6	9	7	8	6	9	7	6	6	9	7	9
Plagioclase	8	5	5	6	5	10	10	7	8	10	10	9	5	8	9	7
Silex	7	3	5	3												
Chlorite	5	3	5	4												
Glauconite	2	1	1	2						No executed						
Heavy minerals	1	3	1	2												
Opaque	3	2	4	2												
Quartz	65	76	69	71												

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