HOLOCENE DEPOSITS IN THE NORTHERN NORTH SEA: EVIDENCE FOR DYNAMIC CONTROL OF THEIR MINERAL AND CHEMICAL COMPOSITION? –A COMMENT–

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ABSTRACT

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When studying superficial sediment samples of the North Sea, one should discriminate between areas with different oceanographic and sedimentary history. The demonstrated relationships between the chemical compositions and the grain-size distributions of the samples are not the same for the distinguished deposits. The variations are therefore not the result of one single hydrodynamic regime acting throughout the North Sea, but point to differences in source material. In the north-central North Sea the grain-size distributions, and consequently also the associated chemical parameters, reflect the succession from Weichselian arctic to Holocene temperate marine conditions. The abundance of planktonic Foraminifera is also due to the postglacial evolution. The ratios of illite to smectite suggest a change in source area of the clays.

In a paper dealing with examinations of a number of box and gravity cores from the North Sea JOHNSON & ELKINS (1979) reported a relation between the bathy metry and the grain-size distributions of the surface and subsurface samples: coarser sediments ($M_z > 62\ \mu m$) were found at shallower depths and finer sediments ($M_z < \mu m$) in deeper areas. They attributed these particle-size variations to hydrodynamic processes; tidal currents and storm waves were thought to have winnowed the fine-grained material from the heights and redeposited in the nearby depressions. Various parameters of the sediment composition appeared to be associated with the grain-size data, and consequently the clay mineralogical and chemical composition of the Holocene sediments in the northern North Sea were interpreted as reflecting the hydrodynamic regime. The same explanation was given for the ratios of planktonic to benthonic Foraminifera. Two radiocarbon datings of mollusc shells of 7480 BP and 4780 BP were believed to represent the ages of the sediments, and this led to the conclusion that the hydrodynamic factors had not changed significantly since 5000 to 7000 years ago.

These interpretations illustrate the risks of carrying out sedimentological investigations without having a thorough knowledge of the stratigraphical positions of the samples. In the north-central North Sea, from where most samples by Johnson and Elkins originate, several shallow seismic units are present, which show differences in their textural character and represent the postglacial period (JANSEN, 1976; JANSEN ET AL., 1979). The distinguished Hills Deposits, Fladen Deposits, and Lower and Upper Witch Deposits mirror a transition from a highly arctic marine to a temperate marine environment comparable to the actual one. The major sedimentation ended around 8500 BP.

From Johnson and Elkins' maps with the core locations the stratigraphic positions of their samples were inferred; they were attributed to both the Hills Deposits, the Fladen Deposits, and the Lower and Upper Witch Deposits. It appeared that the grain-size data from the north-central North Sea fit in very well with the data from our cores (Fig. 1) and that the samples from the Norwegian Channel, the Atlantic continental slope and the southern North Sea should be treated separately. Starting from the stratigraphic interpretation the compositions of the samples can simply be explained. Instead of representing one single hydrodynamic regime acting 5000 to 7000 years ago, the grain-size distributions reflect the entire postglacial evolution of this area as described in

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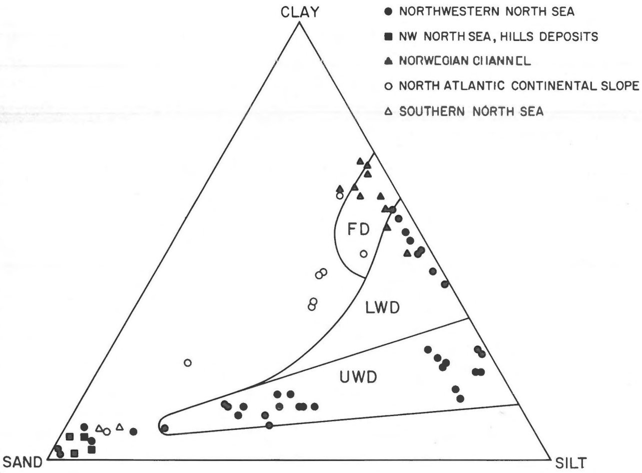

Fig. 1
Ternary diagram of textural data of samples from the North Sea, after Johnson & Elkins (1979), compared with data by Jansen et al. (1979). FD, LWD and UWD indicate the areas covered by the data of the Fladen Deposits, Lower and Upper Witch Deposits respectively.

JANSEN ET AL. (1979). For the Atlantic continental slope and the Upper Witch Deposits, and probably also for the Lower Witch Deposits, the Si percentages of Johnson and Elkins' samples (their Fig. 8) increase with increasing sand plus silt content, while the opposite is the case with the contents of Al, Ti, K, Fe, and Mg, all mainly constituents of the clay minerals. Consequently the chemical compositions originate from sorting under the different regimes. However, the relationships are not the same for the groups of samples, which points to differences in source material. For the north-central North Sea this is also illustrated by the illite/smectite ratios, which increase towards the coarser samples. These ratios suggest relatively large amounts of illite in the Upper Witch Deposits and of smectite in the older Lower Witch Deposits and Fladen Deposits, and are probably due to a change in source area of the fine sediments during postglacial times.

Also the described variations in the contributions of planktonic and benthonic Foraminifera are mainly the result of the historical succession of events, and not of dynamic factors controlling the particle-size distributions of the sediments during a single period. The entrance of planktonic Foraminifera occurred during the formation of the Lower Witch Deposits, and high quantities were attained in the Upper Witch Deposits (JANSEN ET AL., 1979). This is in agreement with the observation by Johnson and Elkins of larger abundances in the silty sediments. The samples with a mean size $< 2\ \mu m$ partly belong to the Lower Witch Deposits, and originate for the rest from the Norwegian Channel. This distinction accounts for the broad range of the planktonic contributions, low in the Lower Witch Deposits and probably high in the Norwegian Channel.

Both mentioned radiocarbon datings are from molluscs from the Upper Witch Deposits at the Fladen Ground area. The pollen assemblages of these deposits, which show no signs of reworking, demonstrate that the fine-grained allochthonic material is more than 8400 years old (JANSEN ET AL., 1979), and therefore the lower ages of the carbonate result from the admixture with younger organic compounds. The datings are in accordance with two radiocarbon profiles from cores of unmentioned locations at the Fladen Ground area by ERLENKEUSER (1978, his Fig. 3), who showed that about the upper 15 cm of the sediment are subject to reworking.

Concluding it is stated that the superficial sediments in the North Sea cannot be taken as a whole, for they represent several deposits of different ages. The discovered relations of their textural, mineralogical, chemical, and micropalaeontological compositions with the bathymetry of the sea floor is misleading, since these compositions obviously reflect the successive postglacial sedimentary processes and not the hydrodynamic regime of a certain period during which most deposits were formed. The morphology of the sea floor also mirrors the geological history, and this explains the connection between the bathymetry and the sedimentary character of the (sub) surface.

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REFERENCES

Erlenkeuser, H. 1978 The use of radiocarbon in estuarine research. In: Biogeochemistry of estuarine sediments; Proc. UNESCO/SCOR workshop. (Melreux, Belgium, 29 November-3 December 1976) – UNESCO (Paris): 140-153.

Jansen, J. H. F. 1976 Late Pleistocene and Holocene history of the northern North Sea, based on acoustic reflection records – Neth. J. Sea Res. 10: 1-43.

Jansen, J. H. F., J. W. C. Doppert, K. Hoogendoorn-Toering, J. de Jong & G. Spaink 1979 Late Pleistocene and Holocene deposits in the Witch and Fladen Ground area, northern North Sea – Neth. J. Sea Res. 13: 1-39.

Johnson, T. C. & S. R. Elkins 1979 Holocene deposits of the northern North Sea: evidence for dynamic control of their mineral and chemical composition – Geol. Mijnbouw 58: 353-366.