

C.I.P.S.

MODELE MATHEMATIQUE D'ETUDE
DE LA POLLUTION EN MER DU NORD.

TECHNICAL REPORT
1973/SED.-SYNTHESE OI

S O R P T I O N B Y S O M E N O R T H S E A S E D I M E N T S

P A R T I I

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About seventy bottom samples of the thousand points system were examined. Their characteristic sorption features with regard to cesium, cobalt and cadmium were investigated. The following values have been determined : the capacity (Q) with respect to a 1 N solution and the distribution constants in seawater with respect to the same ions in tracer quantities. For these determinations we always used radioactive tracers i.e. : Cs¹³⁷, Co⁶⁰ and Cd¹⁰⁹. Both the methods applied and the measuring apparatus used were detailed by the report of last year (Technical Report 1973/SED.-Synthesis 01).

Figure 1 shows the specimens examined and their place within the thousand points system. Most specimens are from locations quite close to the coast for the reason that we wished to begin by examining above all clay and silt specimens since their sorption features are much more pronounced as compared to those of sand-containing specimens. Currently we are also investigating sand-containing specimens in order to get a better picture of changes in characteristic features over the entire area examined.

North Sea bottom samples

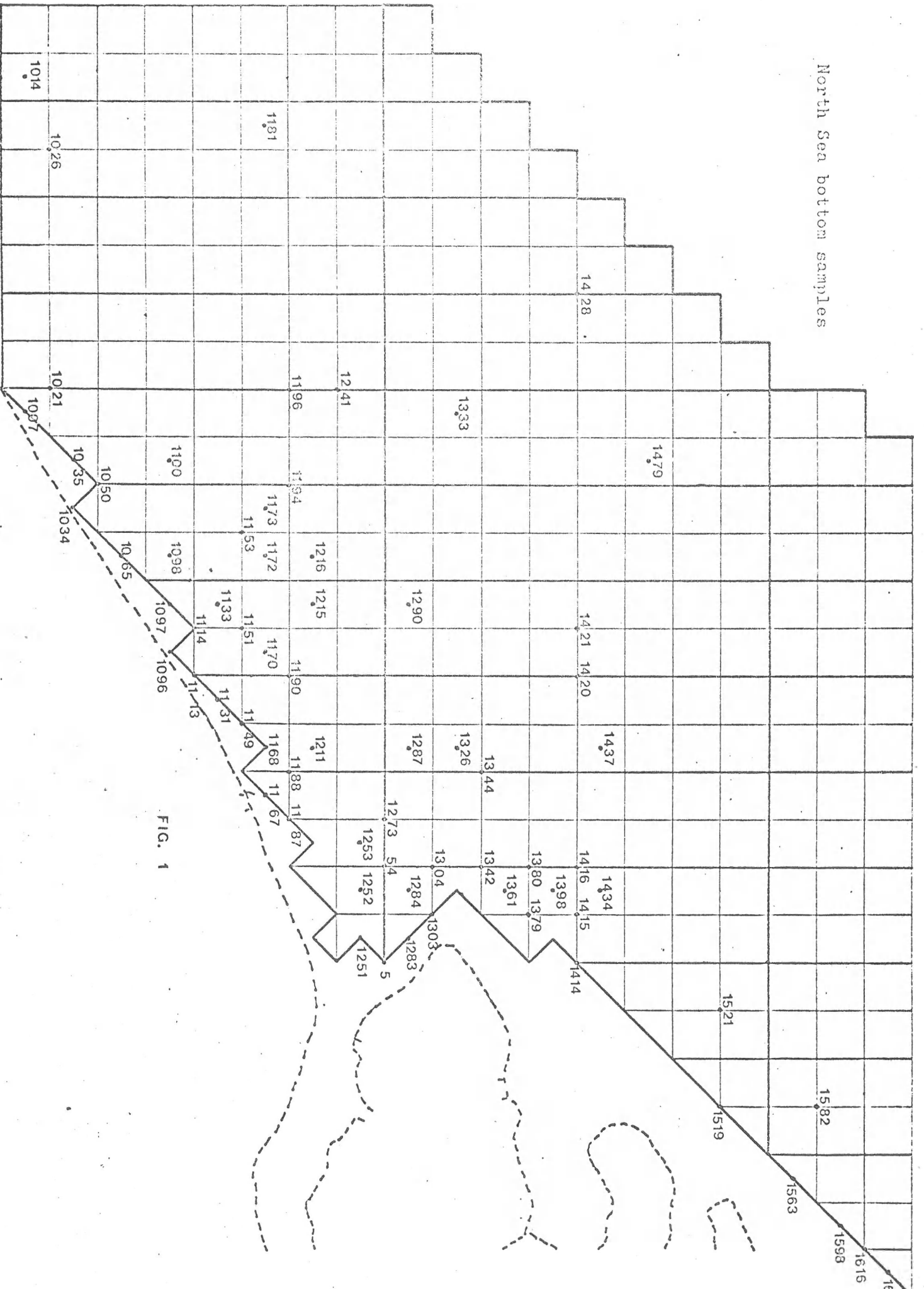


FIG. 1

Figures 2,3 and 4 show the capacity of the specimens with respect to the various elements. The capacity of most specimens has been determined by means of the fraction $< 150 \mu$

For some sand-containing specimens we were forced to apply fraction $< 300 \mu$ because, otherwise, we would have had no material left.

These latter mostly present much lower capacity values.

A comparison of the capacity between the various elements has taught us that we may classify the elements in the following order of decreasing capacity with respect to soil specimens :

$$\text{Co} > \text{Cd} \gg \text{Cs}$$

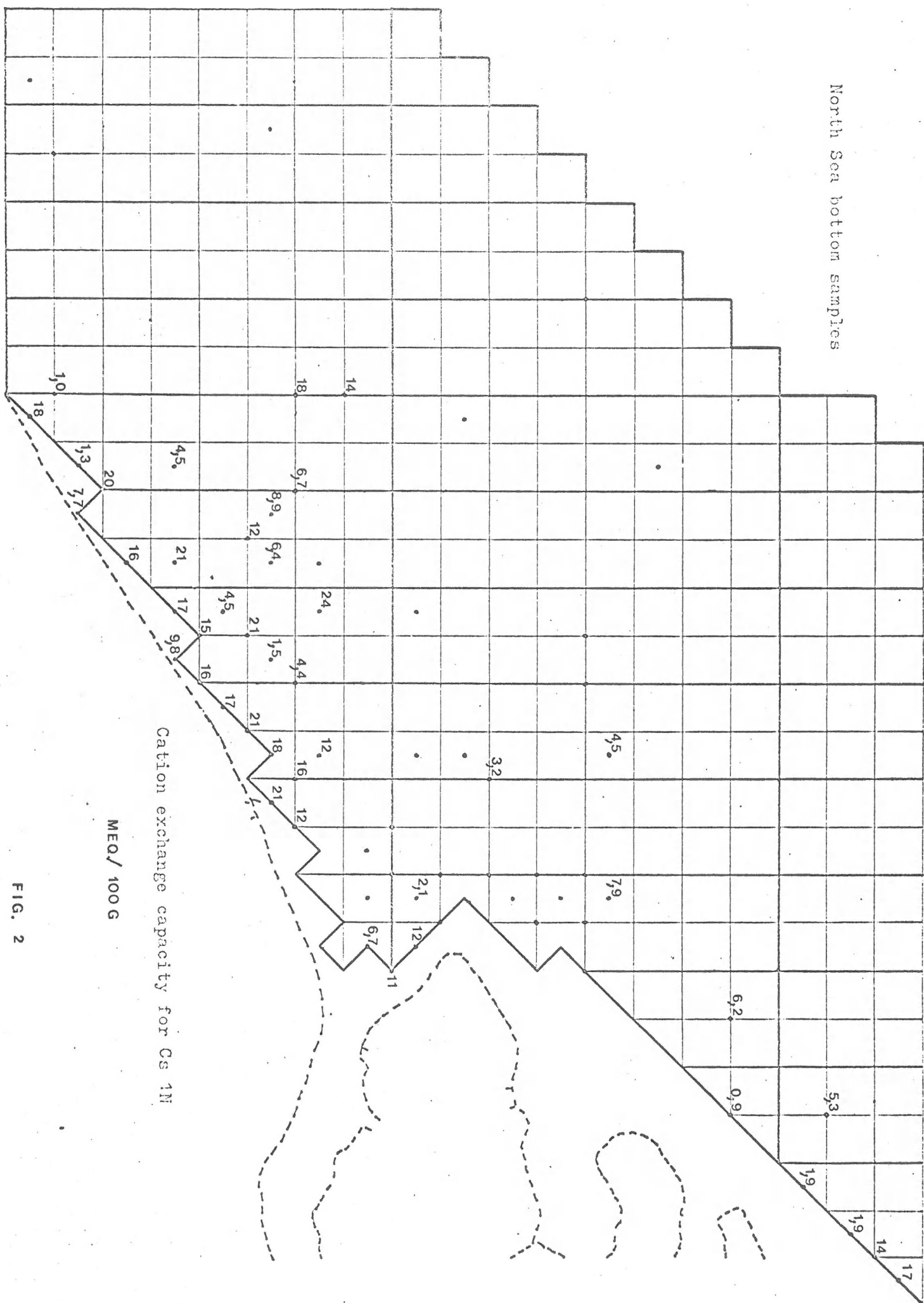
The most striking feature here is the great difference existing between cesium and the other two while the latter two do not differ that much among themselves.

All high capacity values are found in clay or silt specimens and this is true for all elements investigated. It is even possible to assign a specific capacity value to a specimen on sight. However and in order to establish an actual connection between the capacity of the specimens and other properties, we must have the data involved. It is probable that a connection will be found to exist with the grain size distribution of the specimens.

This will permit to proceed with delimiting areas of specific capacities. If a sound correlation should exist between this grain size distribution and the capacity then the data concerned ^a may be regularly included in the soil map. This will require, however, far more points than those investigated up to now since existing maps of a small section of the model indicate very considerable variations in soil structure, in particular towards the coast area.

These capacity values do not offer an accurate picture of what may actually take place on the ocean bottom. They only offer the possibility to fix specific elements under extreme conditions (1 N solution !) from the sediment.

North Sea bottom samples

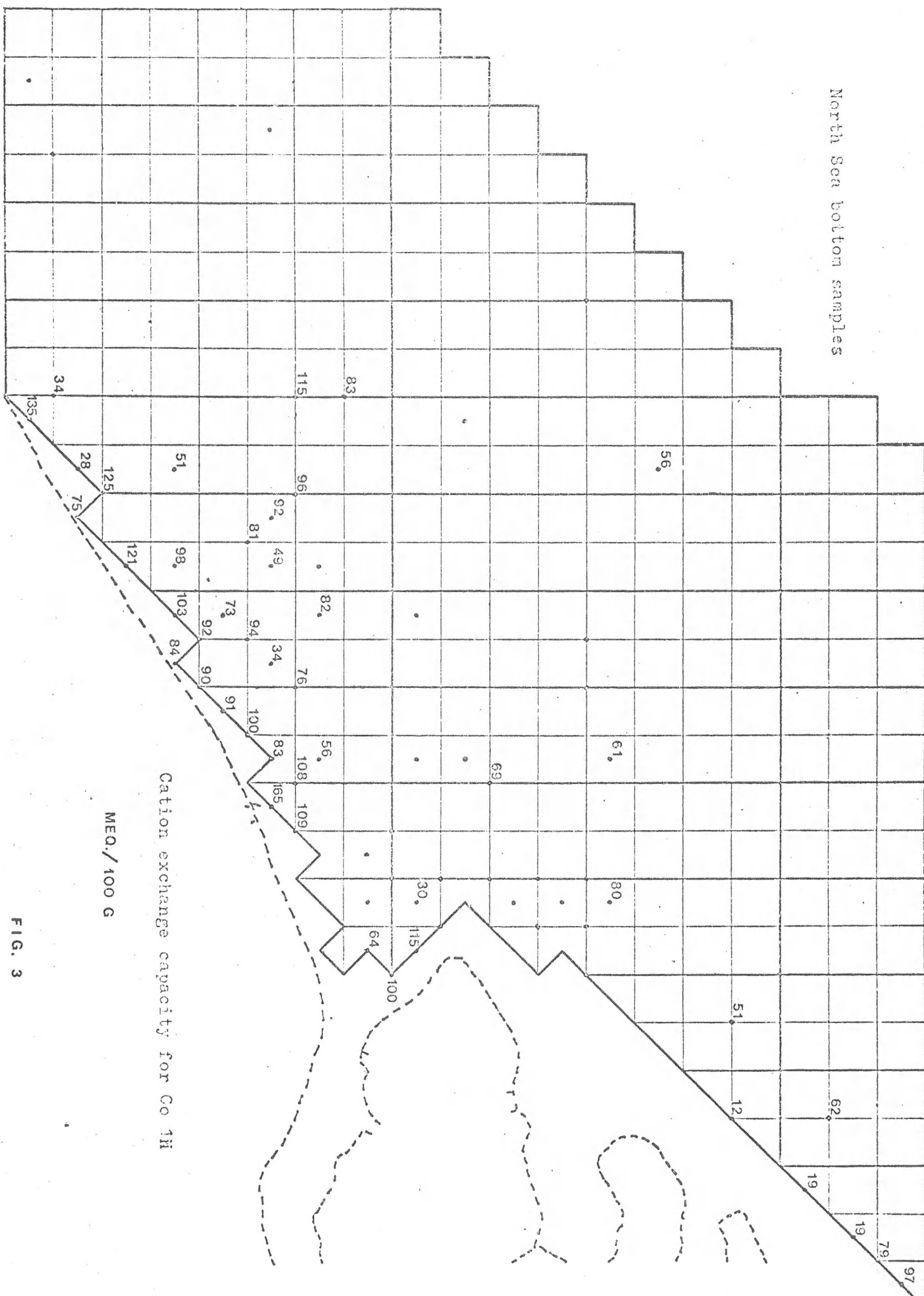


Cation exchange capacity for Cs 1N

MEQ/100 G

FIG. 2

North Sea bottom samples



North Sea bottom samples

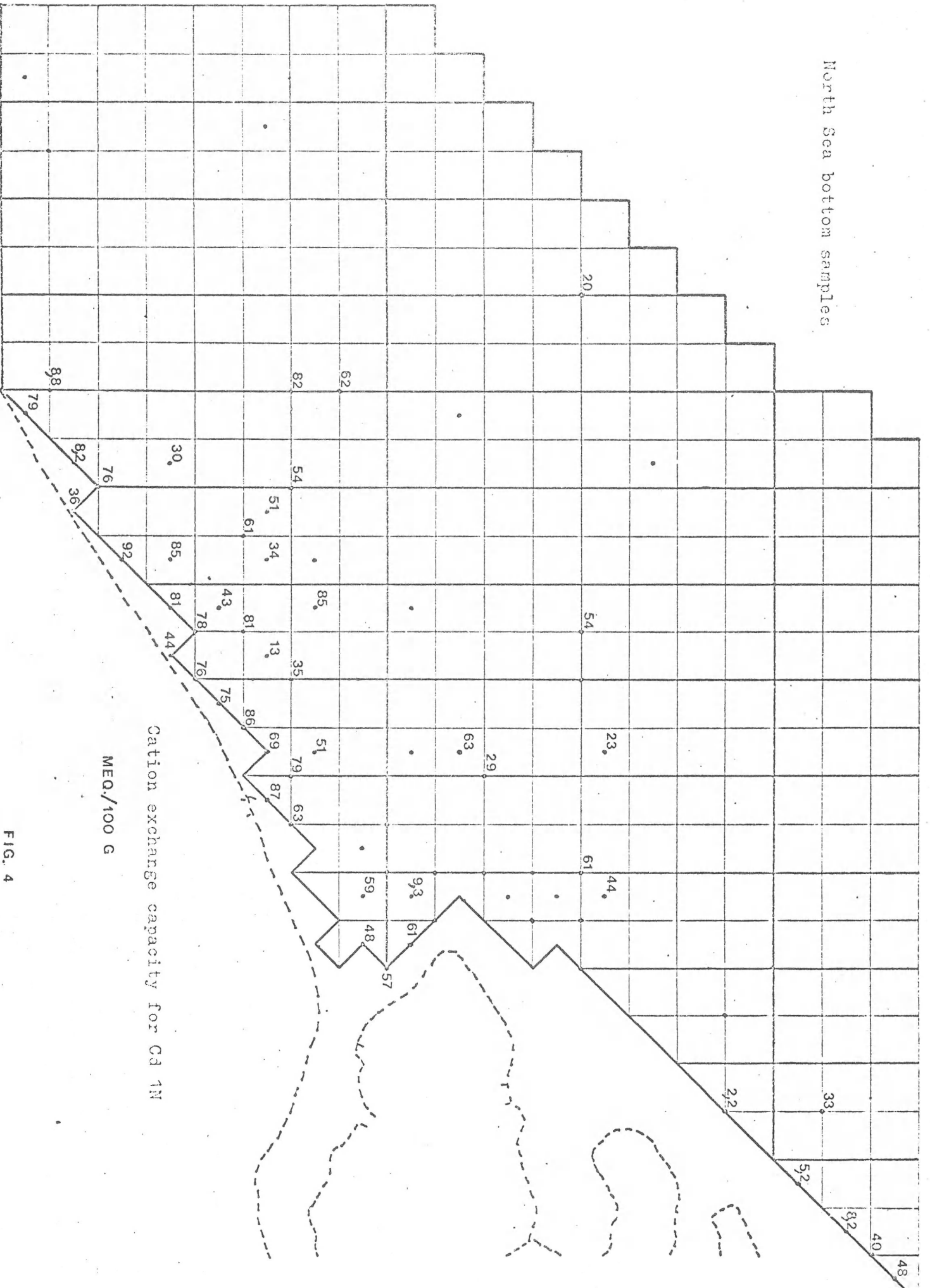


FIG. 4

Figures 5, 6 and 7 show distribution constants (K_d). The following indications have been used : a fraction $< 150 \mu$ and x fraction $< 300 \mu$ of the specimen.

These distribution constants offer a truer picture of what may occur in seawater upon contact with sediments. They have been determined in seawater and with respect to the element in tracer quantities. They show the distribution of the element concerned between the solid and the fluid phase.

Here we do not note the same trend as with the capacities.

Cobalt and cesium are much better absorbed than cadmium . This is true despite the high Na^+ concentration in seawater and notwithstanding the fact that Na^+ decreases the K_d of cesium considerably.

(see : the influence of foreign ions on the sorption of cesium - 1972/SED. - SYNTHESIS 01). Tests are being conducted now in order to investigate the influence of foreign ions on the K_d of Co and of Cd. We may state as of now that Co will be particularly exposed to the influence of existing Mg^{2+} and Ca^{2+} and much less to that of Na^+ . Here, too, will have to be looked for a relationship between the grain size distribution of the sediment and K_d values.

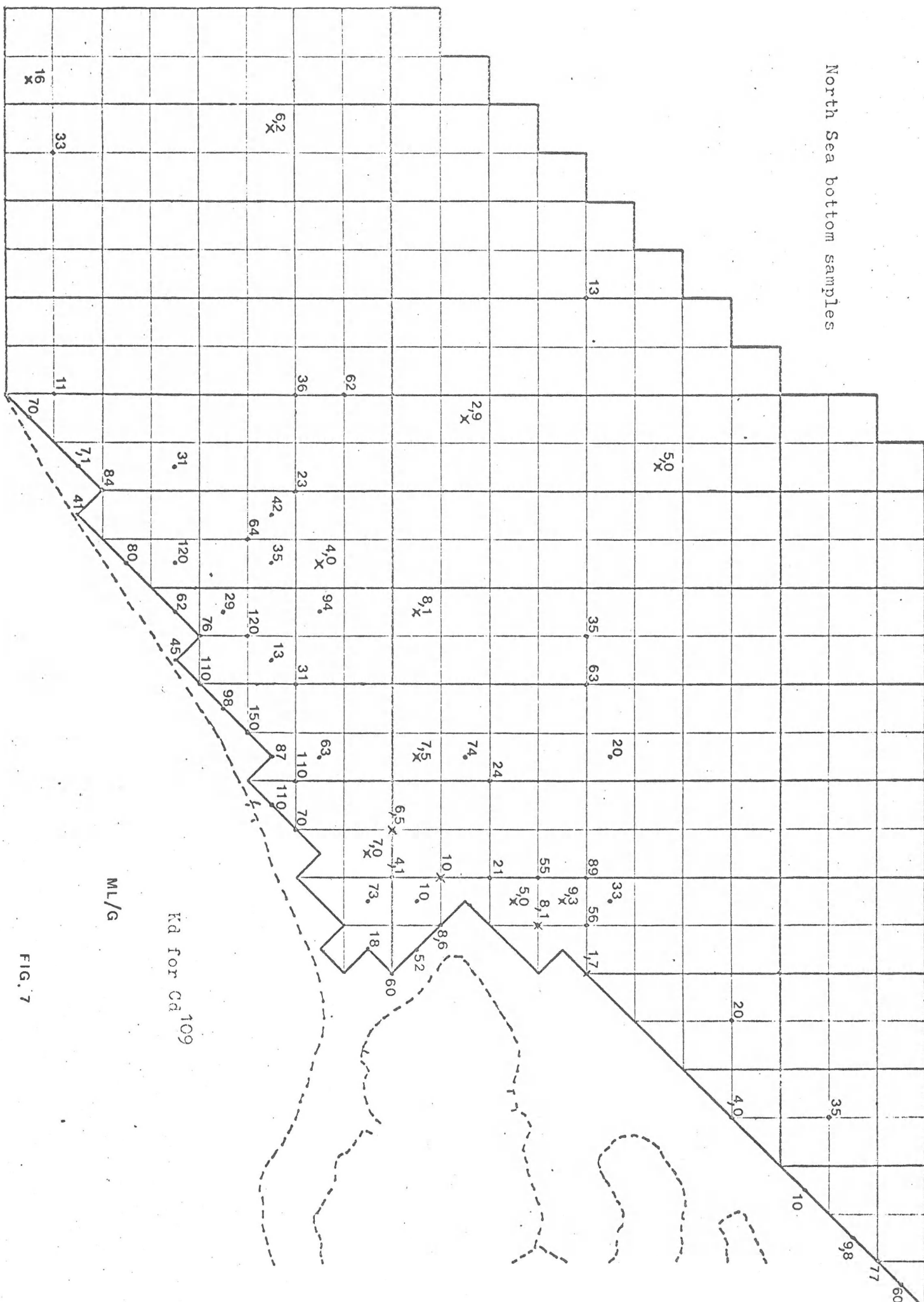
Here, too, we note that sand-containing specimens offer the lowest and silt-rich specimens the highest K_d values where the elements investigated are involved.

Considering the number of specimens examined and the considerable differences in soil structure, it will remain impossible, however, to indicate areas on the maps. This explains why the maps show but the value determined at that specific point.

FIG. 5

FIG. 6

North Sea bottom samples



In order to bridge the gap existing between capacities determined by 1 N solution and distribution constants determined by tracer quantities, we determined in seawater the K_d for five specimens with an increasing concentration of the same ion. Figure 8 shows the influence of the Cs concentration on K_d determined by means of Cs^{137} tracer while figure 9 shows that of Co on K_d determined by means of Co^{60} tracer. In the case of cobalt, this influence is much less pronounced as compared to cesium where K_d values decrease at a much faster rate. These findings agree with the low capacity values we determined for cesium as compared to the other elements.

This may also indicate that other reactions (precipitation ?) than just an exchange of ions occur where both other elements are concerned, while the much more soluble cesium is not affected by these secondary phenomena. Elution tests are conducted in order to get a clearer insight in this matter.

^{137}Cs sorption versus cesium concentration

