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Investigations on the Fe concentration in the waters of the German Bight in connection with the dumping of wastes from titanium dioxide production

by

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Introduction

Since May 1969, at a position 20 - 30 km northwest of Helgoland, special tankers have dumped about 1800 tons/day of waste waters from a plant producing titanium dioxide. Approximately 93 t Fe, 8 t Ti, 500 kg Mn, 25 kg V, 70 kg Cr etc. are released per day into the dumping area as well as large amounts of H_2SO_4. Through reaction with the seawater, Fe, Ti, Mn, Cr, and Al precipitate as hydroxides. These precipitates can scavenge accompanying substances such as for example Vanadium. Thus, on this basis, it is possible to understand the behaviour and the fate of Fe, Ti, Mn, Cr, Al, and perhaps also the Vanadium, by measuring any one of these metals. We have chosen Fe as "tracer", because it is dumped in large quantities and is easy to analyse.

Investigations and Results

During the years 1967 to 1972, the horizontal and vertical distribution of Fe in the waters of the German Bight were systematically investigated. Measurements of the horizontal distribution were performed at a depth of 5 m, as it is well known that the nearsurface layer is particularly important for primary production.

Relatively high total-Fe concentrations occured in and around the dumping area. Nearly the same concentrations were found in the vicinity of the coasts. The high total-Fe concentration of the German coastal water is due, primarily, to the inflow of Fe-rich water from the Elbe and the Weser; other factors contributing are the shallow coastal water depths and the nature of the sediments. In the vertical series, one can frequently observe a strong increase in the total-Fe concentration with increasing depth. This is probably caused by resuspension of fine sediment particles containing Fe, or by particulate Fe hydroxide.

The temporal variability of total-Fe concentration in the German Bight is extremely great: under calm sea conditions particulate Fe sinks to the sea bottom within a period of a few hours to about one day. By far the largest part of the Fe exists in particulate form, only a very small amount of soluble Fe remains in the water. The lowest total-Fe concentration found was about 5 µg Fe/l. Under conditions of turbulence, particulate Fe is resuspended from the sea bottom and is distributed in the whole water column. The largest total-Fe concentration outside the visible wake of the tankers was about 500 µg Fe/l. In addition to this variability which is primarily governed by wind conditions, there is also a short term variability within a period of minutes. This is due to the uneven distribution of the particulate Fe in the water, which takes the form of small clouds.

The highest Fe concentrations were found in the fresh screw water of the dumping tanker. One hour after dumping, the total-Fe concentration was found to be about 7000 µg Fe/l, and after 2 hours, about 2500 µg Fe/l. More data on this subject will be presented at a later ICES-Meeting.

In the titanium waste dumping area and its vicinity, one or more clouds of Fe hydroxide were found at all times. The amount of Fe contained in these clouds corresponded approximately to that which had been dumped with the titanium waste waters during a period of days or weeks. It was established that there was no steady increase in the amount of Fe in the German Bight, either in the water or in the sediment, during the period of the present investigations. Evidently, the Fe dumped is transported by the residual currents out of the German Bight into the open North Sea. In the course of time, a quasi-steady state probably has been established in which the transport of Fe out of the German Bight on average is equal to that entering it. The area of final deposition of the Fe hydroxide has not yet been found. It seems possible that the Fe hydroxide is transported as far as the Norwegian Sea, where it is deposited to the sea bottom in an undisturbed region of deeper water, and is then incorporated with newly deposited sediments.

Illustrations

Illustrations of the results can be obtained from the author during the meeting in Montreal. They are not attached to the paper because the reproduction of the coloured figures is very expensive.

Publication

The complete report of this investigation will be published in "Deutsche Hydrographische Zeitschrift", Vol 28 (1975) Heft 2.