CHAPTER 42

OBSERVATION OF SEDIMENTMOTION BY UNDERWATER-TELEVISION

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ABSTRACT

For observation and interpretation of sedimentological movements an Underwater Television set-up is employed, which is discribed in the following paper The so long achieved results and experiences are exemplified

THE TV SET-UP

Since springtime 1968 an Underwater-Television set-up is employed for special sedimentological researches in the Juist-Norderney oceanic region (East Frisian Islands), which is bestowed by the German Research Association (Fig 1). The TV set-up - in transportable execution - is constructed for use in free waters to a depth of 100 m. The main equipments are as follows (Fig 2a/b).

1 TV camera in a cylindrical case of stainless steel, resistant to pressure, with outfit for necessary correct contact when fixing the at times used sight- and lighting-

supplements The TV camera is fitted out with a multipole contact-plug for connection with the camera-cable and the wireless control-transmission for focus. Diameter 76 mm; length 447,5 mm; test pressure 48 atu, weight 6,7 kg in the air and 4,5 kg in the water

1 Supplementary lens for free sight for general free water observations (opening angle 103° in the air and 72° in the water).

2 Underwater widespread lights

1 Underwater photo camera with an underwater flashlight

1 Camera cable, length 100m, diameter 25 mm

1 Control unit with electronic regulator

1 Distribution unit

1 Reproduction unit (screen diagonal. 36 cm)

1 Video tape recorder

Further there are providently kept ready accessories and spare pieces such as tubes, incandescent-lamps, packings, service-box and so on In anticipation it was to be expected, that due to the small range of sight the set-up only can be used from an anchoring ship Therefore the TV camera and the photo camera were mounted in a fourlegged frame (Fig 3), which can be placed on the sea floor by aid of a crane The reproduction-unit, control-mechanisms, video tape recorder and so on were firmly installed on a ship (Fig 4)

PRIMARY INVESTIGATIONS AND EXPERIENCES

In the first half-year of researches (summer 1968) above all the apparativ feasibilities of the TV set-up were tested, specially taking into consideration the particular conditions in the extreme turbid waters of the tidal flat In detail there was to find out

1 The most effectiveuse of the set-up (observations from anchoring or sailing ship) Further the best distances from objectiv to sea bottom had to be found, simultaneously using the most favourable focal depth

2 Ascertainment of the most effectiv search light arrangement to receive the most contrasting pictures as well as the best efficiency of light evolution.

3. Dependency of the TV work on meteorological conditions

4. Dependency of the observations on the different turbidness of the water

These investigations had the following results

1 In the turbid waters of the tidal flat the use of the TV set-up is only reasonable at continuous fine weather and during slack water (Fig.5). As soon as the current exceeds the critical velocity of erosion or sedimentation, the rate of suspension increases so quickly, that it is no longer possible to gain an interpretable picture (Fig.6).

2 After atmospheric disturbances and great water motion also during slack water the rate of turbidity in the tidal flat is for a longer time so intense (up to three and four days), that observations of the sea bottom are not possible

Whereas after continuous fine weather it might be possible to observe the sea bottom during the first and perhaps even the second turbulent tide. At wind forces of more than 6 Bft and at high current velocity connected with high waves an observation of sedimentary movements is absolutely impossible.

3. Even on the most favourable conditions the distance between the objective and the sea bottom must not exceed 35 cm (TV picture 40 x 40 cm).

4. The conditions improve obviously, when the set-up is employed in deeper waters abroad the tidal flats The visibility is much better and the times of observation can be extended (Fig.7). Nevertheless the range of turbidity is so extensive, that the distance objective - sea bottom only may amount to 55 cm (TV picture 60 x 60 cm).

5. These only small distances between objective and sea bottom, available due to the local boundary conditions, don't allow observations from the sailing or drifting ship. As for each observation the anchor has to be set, it is only possible to work stationary and the researches take much time For this reason the TV method in the sediment research is severely limited.

SOME OBSERVATION RESULTS

In the research years 1969 and 1970 it was possible to perform aimed sedimentological observations. Besides general observations of regional movements in the research area it was tried to gain knowledge of the sedimental process on the tidal flats and specially to find an optical definition of the critical velocity of erosion and sedimentation. Without entering into the details of the researches the main results can be resumed as follows

1 Only in exeptional cases the suspended matters and the sediments, transported on the bottom, are separated more or less exactly Considering the hitherto existing observations a thus strict separation actually can ensue only within the compass of high current velocity and therefore strong sediment motion on the bottom (Fig 8a/b) In regions with lower velocities, which nevertheless still are capable of transporting, a differentiation of the motion on the bottom and the transport of suspended matter is not possible Therefore the moved materials have to be consideres as one unity

2. As already mentioned the range of visibility very much depends on the meteorological conditions of the foretides. When the foretides were influenced by storm, the rate of turbidity is intensified still for a longer time Whereas as undisturbed progress of the foretides the rate of suspended matter for the present is still normal, even after commencing atmospheric disturbance and higher current velocity. Therefore at the same current velocity and otherwise similar conditions the concentration of the suspended matter differs very much

3 Of still more importance to the suspended matter are the

seasonable variing biological conditions Thus the rate of suspended matter is much higher on midsummer after full development of vegetation, than for example in winter or springtime After the long lasting quiet and warm summer 1969 in the whole oceanic region of Norderney the rate of suspended matter was much higher than in springtime 1970, which was preceded by an extreme long winter.

4 The physical process of suspension is essentially determined by the suspended matter's appearing not in equal dispersion but in flakes (Fig 9). These flakes are in nearly permanent hovering motion and only settle occasionally for short times during slack water At insignificant turbulence, when the preceding tides had been quiet and the current velocity is lower than some 15 cm/s, the flakes fall to the bottom in a sudden process As soon as the current velocity has risen to some 20 cm/s, the flakes are absorbed by the current.

At the microscopical and chemical analysis of these flakes one could discern particles of different sizes and origin, which adhere to a scarcely visible organic slime, showing a strong positive albumen- and occasionally a cellulose-reaction (Fig 10 a/b). Here it is probably the question of reduction products of marine organisms This supposition is confirmed by the rich bacterial trimming. These slimes, being scarcely perceptible in the microscope, become well visible in the flash light beam and can be observed clearly in the television picture as flakes In volume the slimes preponderate, whereas the quartz crystals and other mineral particles as well as diatom shells, chitin scraps, filaments etc prevail in weight.

Measuring and ascertaining the rates of suspended matters there was not paid enough attention to these flake structures untill now In the floating water these flakes and pure mineral particles are to be found close together During the sedimentation- and erosion-process this different physical deportment of flaky and pure mineral sediments causes different sedimentation- and erosion-phenomena, which however are temporary without transition

5 Seldom the transportation process near the bottom has a continuous run, but the sediment moves in intermittent veils This discontinuity also was to be observed at the progress of small ribs The motion of the sediment increases, when also shells are transported or animals move on the ground (Fig 11 a/b) Thus a small rib disappeared (length some 20 cm, height some 5 cm), which first seamed to be rather stabel, while a crayfish was crossing it The whole sand supply at once turned to suspension

The discontinuity of the transport near the bottom is still additionally intensified, when the sediments come into the waves' sphere of action In this case the sediments move on paths, which relate to the direction of the current and waves When the waves work in the same direction as the current, the motion is rolling Do the directions mould an angle, this rolling progress passes over to a more saw-tooth-shaped path

6. A series of researches was performed, especially tended to the optical ascertainment of the critical velocity of erosion and sedimentation In spite of a great expenditure however, so long it was not possible to undertake a single-valued fixing of these critical velocities The process of sediment reception by the current proceeds most floating, locally however very much differing, without a possibility of observing the beginning of this phenomenon The process of sedimentation is still more opaque, because only very seldom the whole sediment is deposited during slack water With diminishing velocity the process of erosion also does'nt turn slidingly to the process of sedimentation, as before the beginning of sedimentation there exists a higher range of velocity, which does'nt erose the material near the bottom any longer, but still transports more or less suspended matters.

CONCLUSION

The observations of sedimentological processes of motion with the underwater television set-up showed the limits of it's efficiency The extraordinary value of the so long achieved investigations is to be found especially in the fact, that the processes of motion were made visible and partly interpretable.

The sediment transport's predominant dependency on the meteorological conditions of the foretides and specially the development of the suspended matter as consequence to the biological phenomena was unobjectionably discerned and proved

It was not possible to ascertain a connexion between the at times locally measured current-velocity, rate of suspended matters, grain distribution of the sediment near the bottom and so on. A separate treatment of the bottom-near transport of sediments and the suspended matters is only possible in those exceptional cases, in which high velocities put the whole bottom material in rolling, jumbing and at last pushing motion As a rule - in the tidal flats and oceanic regions with low current velocity - the water contents flaky and pure sediments in proportionate distribution, whereat however at low turbulence the density of the suspended matter can increase with depth.

The in past times theoretical formed conceptions to ascertain sedimentological processes of motion, which predominantly depended on the current velocity and the critical velocity of erosion, are - appreciating the observation results, gained with the under water television - only little satisfiing.

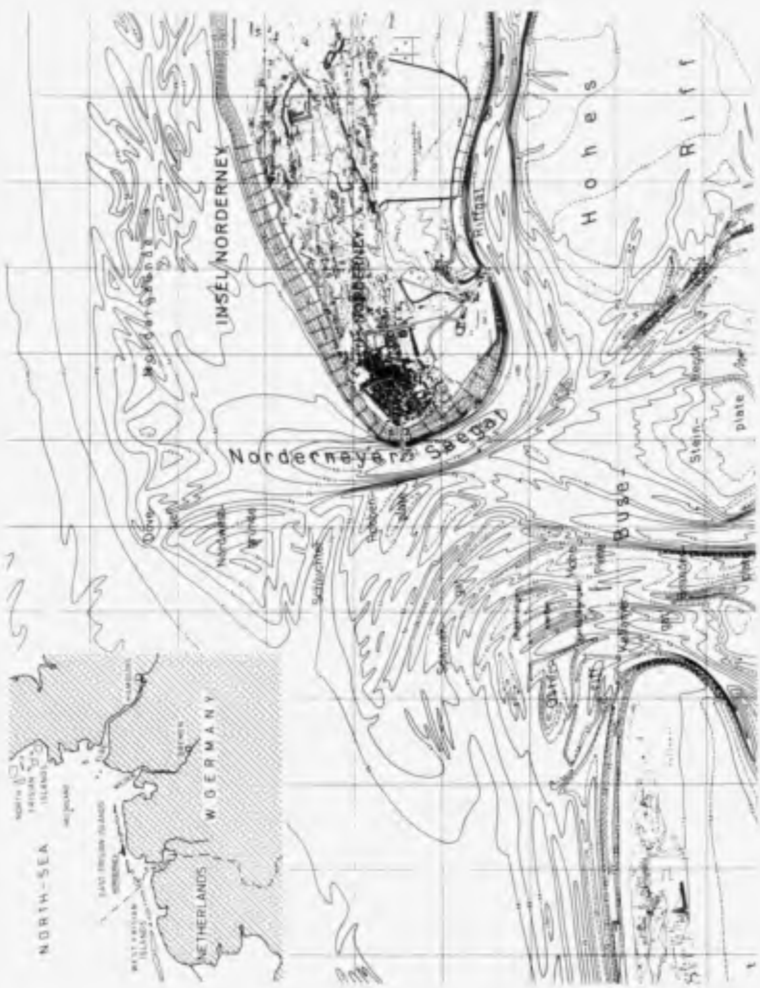

Fig.1 Research region around Juist-Norderney Islands

Fig.2a TV camera (center), photo camera (left), flashlight (right) and searchlights (behind)

Fig.2b Lower deck television set-up with monitor (top), distribution unit (bottom right), control unit with moisture warning inset, operating inset for photo equipment, operationg inset for intercommunication system (bottom center) and video tape redorder (left)

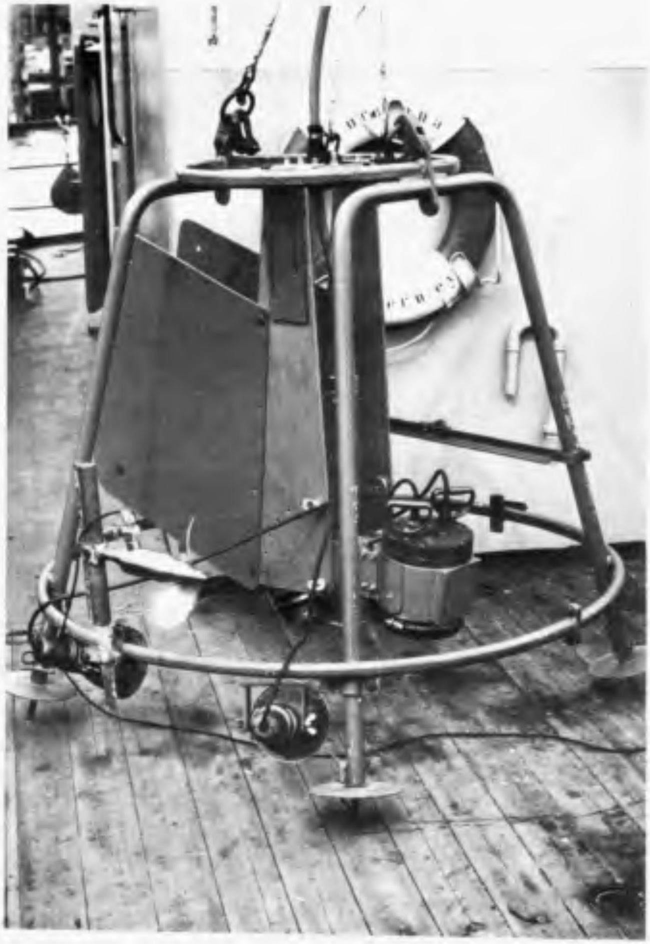

Fig.3 Four-legged support frame on deck

Fig.4 Workship "Burchana" of the Norderney Researchstation, where the TV set-up is installed.

Fig.5 Bottom in a narrow channel of the tidal flat during slack water. The ground is covered with flaky sediments. A small area of sand in the left-hand section of the photograph is still uncovered.

Fig.6 At great water motion in the tidal flat it is impossible to gain an interpretable picture.

Fig.7 Sea bottom in the north of Norderney island (water depth some 26 m). The visibility is much better than in the tidal flat.

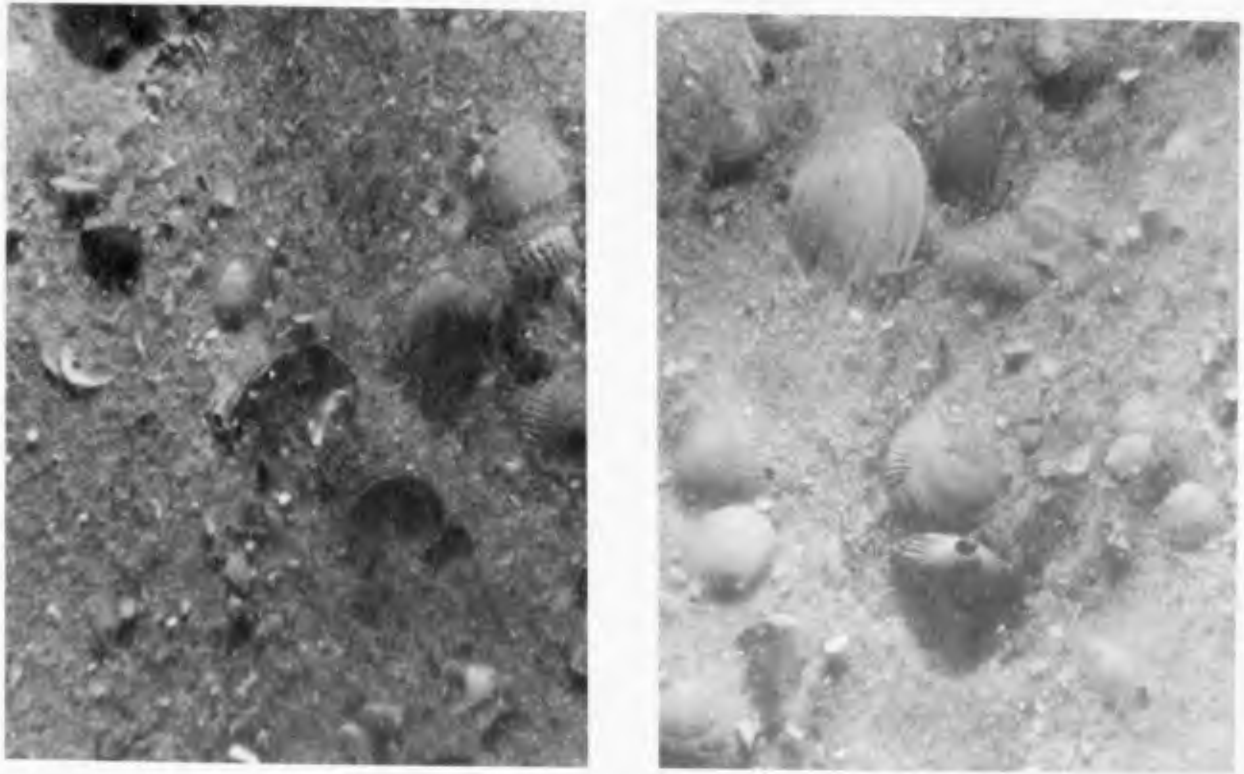

Fig.8a/b Two photographs of the same spot in a narrow shannel with high current velocity (some 80 cm/s). Sand and shells jump, roll and slide along. The temporal distance between figure a and b is four seconds.

Fig.9 Flaky material covers the bottom for a short time during slack water.

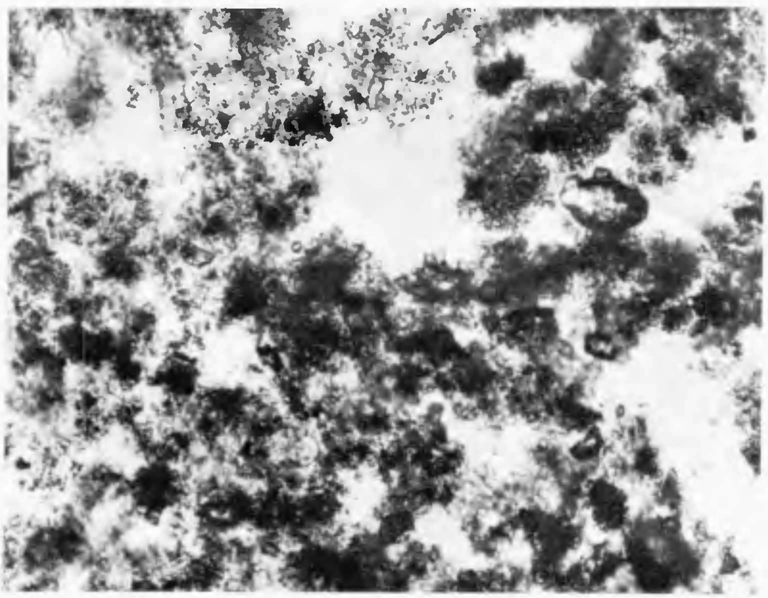

Fig.10a Flake in microscopical enlargement. In front mineral particles (sand, diatom-shells etc.) in black and durty grey, in the light grey background organic slimes.

Fig.10b The same flake in still higher enlargement (about 10 times larger) with mineral and organic ingredients.

Fig.11a Ripplemark abroad the tidal flat in 18 m water depth, current velocity some 20 cm/s.

Fig.11b The same ripplemark one minute later.