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Distribution and quantity of suspended matter in Admiralty Bay (King George Island, South Shetland Islands) *)

ABSTRACT: Studies were carried out from December 1978 till February 1979. Quantities of suspended matter in the waters of Admiralty Bay ranged from 2.8 to 182.6 mg/l. The maximum quantities of suspended matter were recorded in the inshore zone, in particular at the mouths of the streams running off from the melting glaciers. In the open regions of Admiralty Bay the average quantities of suspended matter were: 12.4 mg/l in the upper water-layers, from 14.9 to 16.7 at the depth of 10–50 m and less than 10 mg/l in deeper water-layers.

The quantity of suspended matter drifting from the land into Admiralty Bay during austrial summer was estimated as averaging about 2000 tons per day.

Key words: Antarctic, ocean, suspended matter

1. Introduction

In the sea environment an important role is played by suspended matter, i.e. minute particles (0.5 μm — 1 mm) of mineral and organic origin and precipitated conglomerates of complex chemical structure. Changes in the quantity and distribution of suspended matter in sea water have an essential effect upon physico-chemical, biological, sedimentary and other processes occurring in the sea (Horne 1969, Jerlov 1968, Woźniak, Dera and Gohs 1977).

In antarctic waters the quantity of suspended matter averages from 1 to 2 mg/l (Lisicin 1969, Artem'ev and Melnikov 1974) and is at least twice higher than the average quantities of suspended matter recorded in the open waters of the ocean (Lisicin 1974). Studies carried out the east coast of King George Island (Pęcherzewski 1978) during austral summer

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showed quantities of suspended matter ranging from 0.97 to 3.07 mg/l; the quantity of mineral fractions came up to 80% of the total amount.

The aim of the investigation was to collect data on the distribution and quantities of suspended matter in the waters of Admiralty Bay, an area of complex environmental studies (Rakusa-Suszczewski 1980) carried out with the support of the Arctowski Antarctic Station on King George Island.

2. Material and methods

Investigations aiming at determination of the distribution and the quantities of suspended matter in the waters of Admiralty Bay were conducted from December 22, 1978 till February 12, 1979. Altogether 233 water samples were collected from 42 sampling stations localized in Admiralty Bay (Fig. 1).

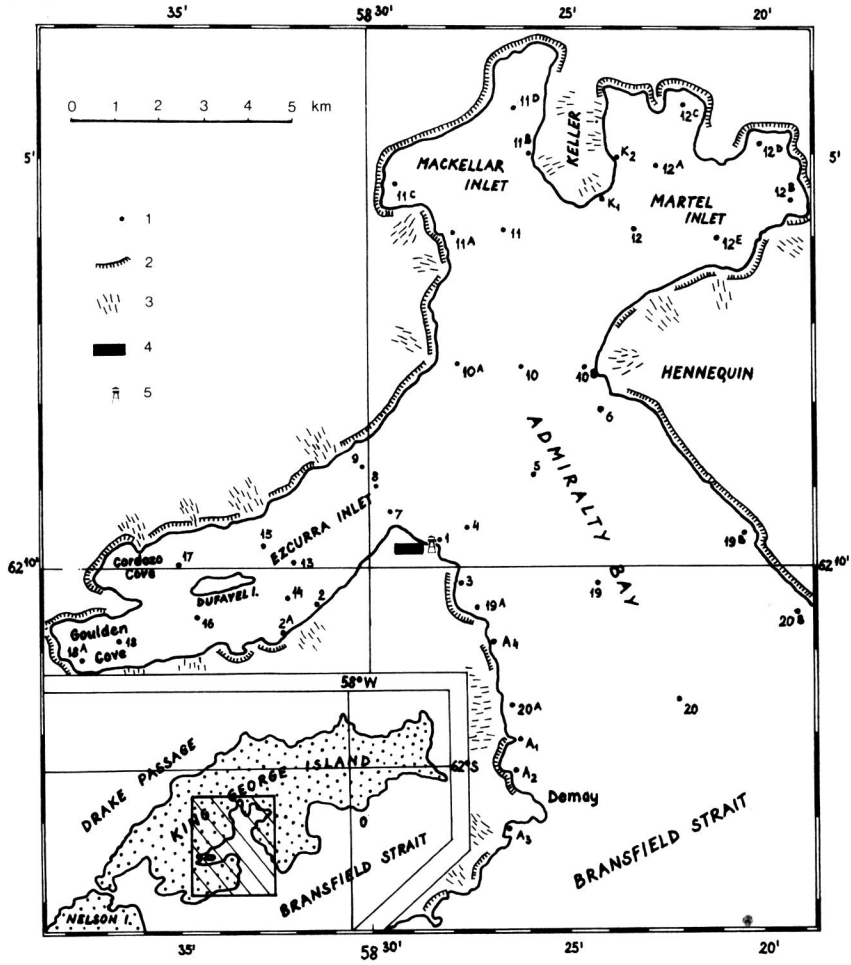

Fig. 1. Localization of sites in the waters of Admiralty Bay and Ezcurra Inlet
1 — Site, 2 — Outline of ice-barrier, 3 — Regions of the occurrence of glaciers descending to the Bay, 4 — Arctowski Station, 5 — Lighthouse

Among 233 samples obtained, 119 samples were collected from the surface waters and 114 from deeper water-layers (at depths of 25, 50, 100, 200, 400, and 480 m). Water samples were collected by a 6-liter bathometer, poured into plastic cans and taken to the laboratory ashore. Depending on the amount of suspended matter the water samples of 0.4 to 6.0 liters were filtered through Whattman GF/C filters (Ø = 47 mm). Next the filters were dried to constant weight at the temperature of about 105°C.

At the sampling sites Secchi disc disappearance measurements were made.

3. Results and discussion

The results of the investigations show that the total quantity of suspended matter in the waters of Admiralty Bay ranges from 2.8 to 182.6 mg/l (Table I), which corresponds approximately to the quantities of suspended matter noted in the Bay of Gdańsk, in the region of the Vistula river mouth.

Table I.

Suspended matter content (d.w. mg/l) in waters of Admiralty Bay, in the period of Dec. 23. 1978 — Feb. 12. 1979

Localization Distance from the shore (m)	Depth (m)	Number of sites	Number of measurements	Suspended matter (mg/l)	
				Range of values	Mean ± S. D.
Inshore zone of the Admiralty Bay (< 300 m)	0	19	72	4.1—182.6	44.1 ± 30.7
Open waters of the Admiralty Bay (> 300 m)	0	23	48	2.8— 27.9	12.4 ± 4.9
	10— 25	9	27	3.8— 20.9	16.7 ± 5.0
	26— 50	9	27	3.4— 19.8	14.9 ± 3.8
	51—100	8	24	3.5— 13.6	9.4 ± 2.8
	101—200	7	21	3.8— 12.9	5.9 ± 2.4
	201—400	4	12	3.2— 7.4	5.4 ± 1.5
	480	1	2	4.6 and 6.1	5.3

The maximum quantities of suspended matter were recorded in the inshore waters — averaging 44.1 mg/l. In the open waters of Admiralty Bay the highest quantities of suspended matter were noted at the depth of 10–50 m deep, in the deeper water layers the content of suspended matter decreases markedly.

Figures 1 and 2 show that the lowest quantities of suspended matter were recorded in Mackellar and Martel Inlets, in the waters flowing into Admiralty Bay from Bransfield Strait and in central regions of Admiralty Bay i.e. in the regions of Section A (from Site 1, to Pt. Hennequin). The maximum quantities of suspended matter occurred at the near-shore areas

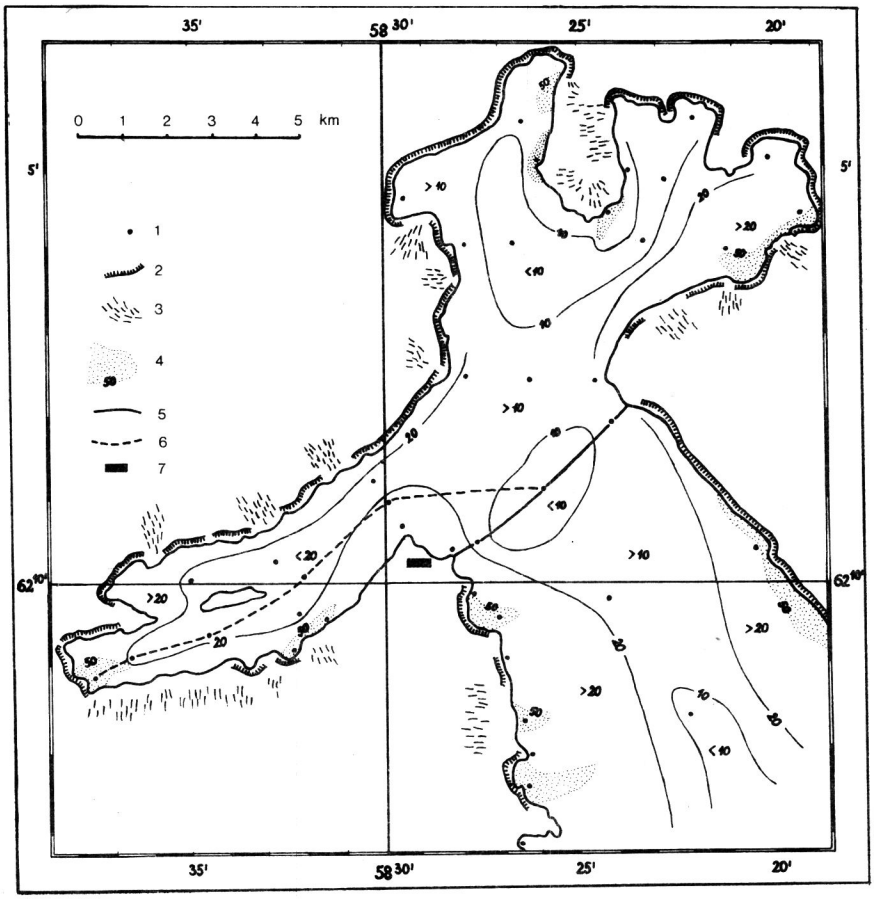

Fig. 2. Distribution of suspended matter (d.w. mg/l) in surface waters of Admiralty Bay 1 — Site, 2 — Outline of ice-barrier, 3 — Glaciers, 4 — Regions with suspended matter content, > 50 mg/l, 5 — Profile *A* (Station Nos. 4, 5 and 6), 6 — Profile *B* (Site Nos. 18*A*, 18, 16, 13, 8 and 5), 7 — Arctowski Station

and in particular in vicinity of the mouths of streams running-off from glaciers, as at the forefront of Ecology Glacier — St. 3 and 19A (> 150 mg/l), not far from Sphinx — St. 20A (101.6 mg/l), or at St. 18A (109.4 mg/l).

The quantity of suspended matter in the open part of Admiralty Bay ranged in the surface waters from 2.8 to 27.9 mg/l, and averaged 12.4 mg/l. Under the effect of strong winds the distribution of suspended matter in the surface layers of the waters of Admiralty Bay is subject to great changes caused by heavy waves and drift currents.

Examples of the distribution of suspended matter in deep sea are shown in Fig. 3 — Profile *A* (from Site 1. to Pt. Hennequin) and Profile *B* (from Goulden Cove to St. No. 5. in Admiralty Bay). The highest quantities of suspended matter were recorded in the west region of Ezcurra Inlet (109.4 mg/l). Nearer the centre of Admiralty Bay the quantity of suspended matter was as follows: 10.2 mg/l at the surface waters, up to 11.2 mg/l

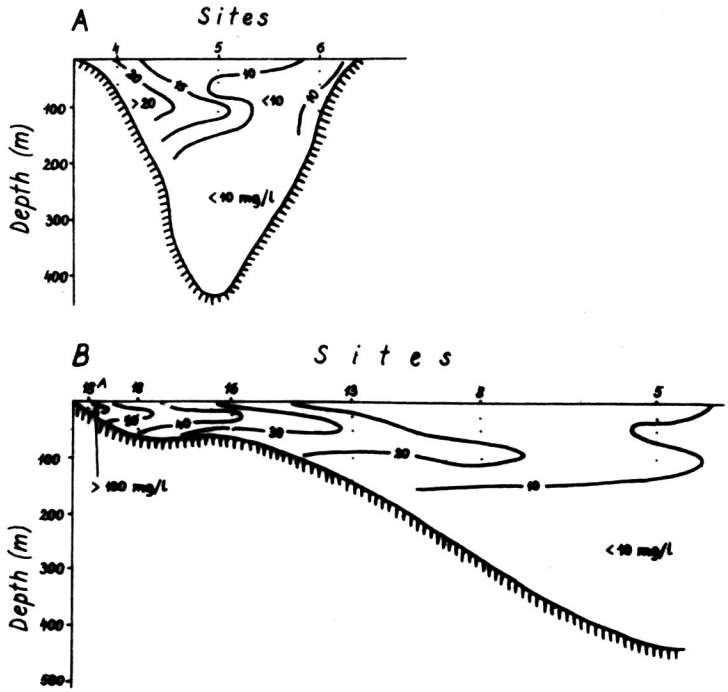

Fig. 3. Distribution of suspended matter in the waters of Admiralty Bay Profiles *A* (Site Nos. 4, 5 and 6) and *B* (Site Nos. 18*A*, 16, 13, 8 and 5)

at the depth of 25 m, 9.6 mg/l at the depth of 50 m, 10.9 mg/l at the depth of 100 m; whereas farther downwards the content of suspended matter decreases gradually to 3.9 mg/l at the depth of 400 m.

Profile *B* (Fig. 3) shows distinctly the retention of the main water current with great quantities of suspended matter at the depths of 20–50 m, initially (St. Nos. 18*A*, 18, 16 and 13); at St. No. 8 the maximum quantity of suspended matter was observed at the depth of 100 m (>20 mg/l). Vertical distribution of suspended matter at St. No. 5 (Fig. 4) ranged from 10.2 to 12.7 mg/l. The maximum quantities of suspended matter were recorded in December 1978 at the depth of 100 m (15.2 mg/l) and in January 1979 at the depth of 20–50 m (14.6 and 15.7 mg/l). Below the depth of 100 m downwards the quantities of suspended matter were much lower, decreasing gradually to the values of 3.2 and 5.4 mg/l at the depth of 400 m deep.

The obtained data indicate great spatial and temporal variation in the distribution of suspended matter in the waters of Admiralty Bay. The highest quantities of suspended matter occur in the inshore zone, principally in the regions of the mouths of the surface and subglacial streams running off from the melting glaciers. The waters of these streams carry along large quantities of suspended matter and rock rubble into Admiralty Bay, forming vast patches of intensely coloured waters clearly visible from a helicopter, from the shore and in air-photographs.

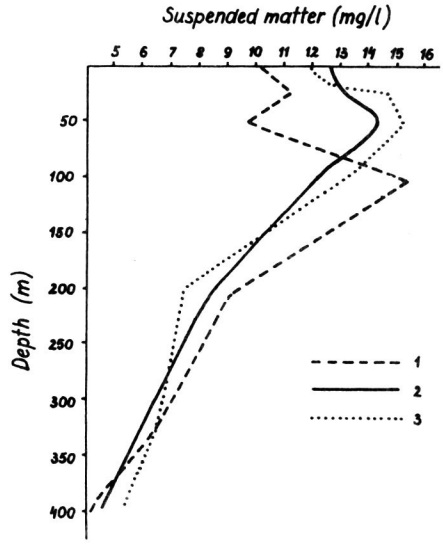

Fig. 4. Vertical distribution of suspended matter (d.w. mg/l) in the waters of Admiralty Bay, during austral summer (Site No. 5)

On the basis of several measurements of the suspended matter content in waters of selected streams flowing into Admiralty Bay, preliminary estimates of the quantity of suspended matter carried into the bay-waters were made; the estimated average inflow of suspended matter carried into Admiralty Bay during austral summer amounts to about 2000 tons per day, i.e. about 1/3 of the average daily inflow of suspended matter brought in with the waters of the Vistula river into the Bay of Gdańsk.

Assuming that melting glaciers in the region under investigation occurs mainly during austral summer, which does not last longer than 100–120 days, we will obtain the estimated value of the annual inflow of suspended matter brought along by streams running off from melting glaciers into Admiralty Bay, as amounting to 200–240 thousand tons. Most likely the given value should be increased by at least 20–30%, i.e. by the value of the quantities of suspended matter brought into Admiralty Bay winds and feeding penguins, and also by the value of suspended matter brough in from Bransfield Strait. Visual observations indicate that with the S to SW winds blowing enormous quantities of suspended matter outflowing from under Polar Club Glacier are carried away eastward, along southern coasts of King George Island, into Admiralty Bay.

The present data show that the average quantities of suspended matter noted during summer in the waters of Admiralty Bay are about fivefold higher than the average quantities of suspended matter recorded in the open antarctic waters (Lisicin 1969, Pęcherzewski 1978) and about tenfold greater than the average values of suspended matter in the open oceanic waters.

High content of suspended matter in the waters of Admiralty Bay is reflected in other processes occurring in these waters, such as increased turbidity which leads to a decrease in the thickness of the euphotic layer. This is corroborated by the measurements of Secchi disc disappearance, which in Admiralty Bay was observed at the depths ranging from 0.2 to 7.6 m.

4. Summary

The investigations carried out in Admiralty Bay (King George Island, South Shetland Islands) (Fig. 1) from December 1978 till February 1979 show that the total quantity of suspended matter in the waters of the Bay ranges from 2.8 to 182.6 mg/l and that it is subject to great changes both in time and in space. The maximum quantitie of suspended matter were recorded in the inshore zone (from 4.1 to 182.6 mg/l), in particular near the mouths of surface and subglacial streams running off from the melting glaciers into the bay (Table I). In the open waters of Admiralty Bay the content of suspended matter ranges from 2.8 to 27.9 mg/l, in the surface waters the quantity of suspended matter averages about 12.4 mg/l (Table I, Fig. 2). The maximum quantities were recorded at the depths of 10–50 m (av. about 15.6 mg/l), whereas below the depth of 50 m and farther downards to the bottom the quantity of suspended matter decreases gradually to about an average of 5 mg/l (Figs: 3, 4).

The estimated daily inflow of suspended matter brought along into Admiralty Bay, during austral summer, by the waters streaming down from the melting glaciers amounts to about 2000 tons per day, i.e. about 200–240 thousand tons per year.

The average quantities of suspended matter noted during austral summer are about fivefold higher than the average quantities of suspended matter recorded in the open antarctic waters and at least tenfold higher than the average quantities of suspended matter occurring in the open waters of the ocean.

5. Резюме

Исследования проведённые в Заливе Адмиральты (Кинг Джорж Остров — Архипелаг Южных Шетландов) (рис. 1) с декабря 1978 г. до февраля 1979 г. доказали, что общее количество взвеси в водах Залива Адмиральты колеблется в пределах от 2,8 до 182,6 мг/л и подвергается сильным изменениям так во времени, как и в пространстве. Максимальное количество взвеси установлено в прибрежной полосе (от 4,1 до 182,6 мг/л), особенно вблизи поверхностных или подлёдных устьи потоков плывущих в залив с тающих ледников (таблица I). В открытых водах Залива Адмиральты содержание взвеси колеблется в пределах от 2,8 до 27,9 мг/л при чём, в поверхностных водах количество взвеси равняется в среднем около 12,4 мг/л (таблица I, рис. 2). Максимальное количество установлено на глубине 10—50 м (в среднем около 15,6 мг/л). Зато ниже 50 м и дальше в направлении ко дну каличество взвеси уменьшается в среднем до около 5 мг/л (рис. 3 и 4).

Суточный сток взвеси в Заливе Адмиральты во время антарктического лета плывущий с водами с тающих ледников оценивается на около 2000 т, т.е. около 200—240 тыс. т в год. Среднее количество взвеси установленное во время антарктического лета в водах Залива Адмиральты пятикратно выше среднего количества взвеси в открытых антархтических водах и около десятикратно выше среднего количества взвеси встречаемого в открытых водах мирового океана.

6. Streszczenie

Badania przeprowadzone w Zatoce Admiralicji (Wyspa Króla Jerzego, Południowe Szetlandy) (rys. 1) od grudnia 1978 do lutego 1979 roku wykazały, że ogólna ilość zawiesiny w wodach Zatoki Admiralicji waha się od 2,8 do 182,6 mg/l i podlega silnym zmianom zarówno w czasie, jak i przestrzeni. Maksymalne ilości zawiesiny stwierdzono w strefie przybrzeżnej (od 4,1 do 182,6 mg/l), w szczególności w pobliżu ujść naziemnych bądź podlodowych potoków spływających do zatoki z topniejących lodowców (tabela I). W otwartych wodach Zat. Admiralicji zawartość zawiesiny waha się od 2,8 do 27,9 mg/l, przy czym w wodach powierzchniowych ilość zawiesiny wynosi średnio ok. 12,4 mg/l (tabela 1, rys. 2). Maksymalne ilości zawiesiny stwierdzono na głębokościach 10–50 metrów (śr. ok. 15,6 mg/l), natomiast poniżej 50 m i dalej w kierunku dna ilość zawiesiny zmniejsza się średnio do ok. 5 mg/l (rys. 3, 4).

Szacunkowy dobowy spływ zawiesiny wnoszonej do Zat. Admiralicji w okresie antarktycznego lata przez wody spływające z topniejących lodowców ocenia się na ok. 2000 ton na dobę, tj. około 200–240 tys. ton rocznie.

Średnie ilości zawiesiny stwierdzone w okresie antarktycznego lata w wodach Zatoki Admiralicji są około 5-krotnie wyższe od średnich ilości zawiesiny spotykanych w otwartych wodach antarktycznych i co najmniej 10-krotnie wyższe od średnich ilości zawiesiny spotykanych w otwartych wodach oceanu.

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