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Determination of Heavy Metal Concentrations in Seabed Sediments of the Dardanelles-Cities Area, Turkey

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Abstract: The Dardanelles (Canakkale Strait) is a water transport channel connecting between the Black Sea (via the Marmara Sea) and the Mediterranean (via the Aegean Sea). The average depth of the Strait is approximately 60 m; the deepest point reaches more than 106 m. The interaction of coastal and submarine morphology with the hydrodynamic regimes exerts a control on coastal dynamic processes depends on NE/SW stretch is flowed by deep and surface water. Mn, Fe, Ni, Cu, Zn, Pb and Al concentrations have been measured from surface sediments collected around 7city coastal locations around. Sediments analysis was conducted on sediment samples and Atomic Absorption Spectrophotometry was used in the analyses of sediment heavy metal concentrations. Elevated concentrations of Mn (927-355.90 ppm), Fe (1.40-2.46 ppm), Ni (30.10-50.90 ppm) and Cu (8.70-23.30 ppm), Zn (34.5076.20ppm), Pb (10.60-21.20 ppm), Al (3.20-4.50 ppm) are present in the tailings. Trace element concentrations in shallow marine sediments of the Dardanelles district of some city are affected by submarine disposal of natural costal mine tailings and unregulated dumping of tailings and wastewater from small-scale. The results showed that metals concentrations in sediments can be considered near the background levels. Metal concentrations were probably caused by decreased rates of marine water flow erosion.

Key words: Trace metal · Marine · Sediment · Pollution · Dardanelles

INTRODUCTION

The Çanakkale Strait (Dardanelles) is a strait in northwest Turkey running in a southeast-northwest direction whereas the continents of Asia and Europe meet. This strait connects the Aegean Sea with the Marmara Sea.

The ecological life is effected some city existing from the Dardanelles' cities. As is well-known, deterioration of the natural environment not only reduces the quality of life but also causes financial loss as well. For this reason, it was decided to investigate the heavy metal concentration in sea-bed sediments of the Dardanelles and the concentrations of Mn, Fe, Ni, Cu, Zn, Pb and Al in the sea-bed sediment samples were determined.

MATERIALS AND METHODS

In the field study carried out on the research ship R/V ARAR, sea bottom samples were taken with 25 kg of grab of the Van Veen type from stations determined on a sea bottom chart on the scale of 1/ 75,000. The ten stations determined on the sea chart were named in series prefixed City names; as shown in Fig. 1. The position of these stations, weather conditions and condition of samples are indicated in Table 1.

The method of Loring and Rantala [1] and Shaw *et al.* [2] was used in the treatment of analyzing the "total metal" of the samples, which were taken from sea and river sediments in the Çanakkale Strait.

The analyses of Mn, Fe, Ni, Cu, Zn, Pb of sea-bed sediments taken from the sea-bed stations given in Fig. 1 by the method determined in Unit One were measured with Shimadzu AA-6701-F Atomic Absorption Spectrometry in air-acetylene flame. However, the Al was measured in nitric oxide (N_2O) acetylene flame and these results are presented in Table 3.

Studies on Heavy Metal Sediments: This study and other research on heavy metals in the Dardanelles are given for comparison. It is seen that the present study had the lowest values in the base of average and dispersion when

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Fig. 1: Map of sampling stations

Table 1: Ecological Parameters of Study Stations from which sediment samples were taken

Station Name	Position of Station	Depth (M)	Wind Direction	Wind Force (Bafor)	Sea	Sky	Barometric Pressure	Temperature (°C)	Humidity
Gelibolu-Açik	40° 22 93 N 26° 38 50 E	34	ENE	4	3	bc/m	1014	11	57%
Eceabat	40° 13 58 N 26° 25 90 E	30	NW	2	2	c/m	1016.5	14.5	57%
Kilitbahir	40° 12 00 N 26° 22 90 E	30	NE	2	2	c/m	1017.5	14.5	57%
Güzelyali-Karanlik Liman	40° 02 05 N 26° 16 60 E	40	NE	2	2	c/m	1017.5	13	57%
Lapseki	40° 21 80 N 26° 42 15 E	30	NE	3	2	bc/m	1016.5	14	55%
Gelibolu0	40° 22 80 N 26° 42 15 E	20	NE	3	2	bc/m	1017	14	54%

(E: East, N: North, W: West. Samples were not taken at Gelibolu but Gelibolu acik)

Table 2: Conditions of ground and sample at bottom station

Station Name	Conditions
Gelİbolu	All bottom is rocky, no samples were taken
Gelİbolu-Açik	Surface is covered with 4 cm of oxide layer and muddy; the underside is grey and some areas are black.
ECEABAT	Surface is oxide with thin sand (1,5 cm of oxide layer; the underside is grey-black sub oxide); the sub oxide transition is plentiful but not clear.
Kİlİtbahİr	This has similar properties to Eceabat.
Güzelyali-Karanlik Lİman	The sandy sediment was sieved. There are very many crumbs on the sieve. It therefore became baggy
Çanakkale	All bottom is rocky, no samples were taken
Lapsekİ	Mud with thin sand; the end of the surface is oxide, its underside is 2 cm of black anoxide.
Gelİbolu0	The oxide layer is sandy between 0.5mm and 1 cm and its underside is black.

Table 3: Concentration of heavy metals in sea-bed sediments of the Dardanelles

	Average of Shale	Dardanelles Blank	Gelibolu-Acik	Eceabat	Kilitbahir	Güzelyali-Karanlik Liman	Lapseki	Canakkale
Mn	850	0.010	402.60	355.90	392.40	397.70	367.50	927.00
Fe	47	1.210	2.46	1.40	1.50	2.10	2.30	2.10
Ni	80	0.020	43.60	30.10	31.00	33.70	40.60	50.90
Cu	50	0.004	14.50	8.70	9.30	12.40	21.70	23.30
Zn	90	0.200	45.90	34.50	35.20	35.50	76.20	45.70
Pb	20	0.010	21.20	13.80	14.40	17.30	14.30	10.60
Al	8	1.700	3.20	3.50	3.90	3.40	4.50	3.20

compared with the study carried out in Saros, the nearest region to our study area. The same situation is valid for the North Marmara Shelf and the South Black Sea Shelf.

When the Mn values of the sea-bed sediments were investigated, no station which reached 850 ppm maximum value according to the average of the shale was encountered. All values except Güzelyali-Karanlik Liman Station were very close to each other. In The Güzelyali-Karanlik Liman Station, a lower value was obtained. The reason for the fall is that a dense concentration was generally reached on the northern part of the Dardanelles. There is even extreme pollution in the Musaköy and Umurbey rivers. Going toward the south, the structure of the main rock also changes.

Güzelyali-Karanlik Liman station is the station in which it was determined that the values of Ni and Al were the least. This station is the farthest from the settlements according to its location and is in a bay called Karanlık Liman having stagnant water from the Dardanelles. Gelibolu-Acik station is generally the station in which the highest concentrations were obtained for all elements. For the values of Fe, Cu and Zn, the station with the lowest values was Eceabat station. In the Gelibolu-Acik station, the values of Pb exceeded the certain limit value.

However, it was determined that the concentration of heavy metals in samples taken of sea-bed sediments in the Dardanelles from all stations did not exceed the extreme value.

RESULTS AND DISCUSSION

The sea-bed sediments of the Dardanelles were presented very low results in Table 4.

It was accepted that the flow was active on the values of elemental concentrations of sea-bed sediments in the Dardanelles. The datum enriching the assertion appears with Mn and Zn. There are eddy flows at the speed of 0.5-0.6 knots from here to the Lapseki coast. These two metals reach their maximum values in the Dardanelles at stations Lapseki and Gelibolu that determined the flow direction of this stream (Mn is 927 ppm at Canakkale, Zn is 76 ppm at Lapseki, the average of the strait; Mn is 360 ppm and Zn is 427 ppm). The heavy metal results from stations Eceabat and Kilitbahir where the flow is fastest and have generally low values. When the variation of concentrations with increasing depth were evaluated according to two stations (Lapseki), Mn and Ni values have decreased values; and Fe and Pb have increased values increasing depth. For the other stations, since sub oxide and oxide sediments were not taken together, the possibility of interpretation dependent on the depth was prevented.

Quite low concentration values were obtained in the heavy metal research carried out in our study area compared to other areas (Table 2). It was seen that we had the lowest values in the base of average and dispersion when compared with the study conducted in Saros, the nearest region to the present study's region. As shown in Table 2, the average concentration values of Saros for all elements are higher than the Dardanelles. In addition, the maximum values of Saros for all elements are higher than the Dardanelles. The same situation is valid for the other studies, as shown in Table 2. The dynamism of the strait ecosystem is effective on the base obtaining these values. In other studies, the fact that the values are high in the Northern Marmara Shelf, Southern Black Sea Shelf and eastern Aegean Sea played a role such that the flows are low, the sedimentation is dense and the concentration of heavy metals are high. That the values in the Golden Horn are high is due to discharges of urban origin, which come from the coastal area to the Golden Horn and the excess of the metal concentration is carried by the stream inputs.

The upper flow which is effective in the Dardanelles while the water mass, which is affected by both flows that are effective on the strait's ecosystem. These values in the Dardanelles are low. There are two directed flows, which are both the upper and bottom ones in the strait.

Fig. 2: Map of Flow

Table 4: Some studies on heavy metals in the Dardanelles

	Mn	Fe	Ni	Cu	Zn	Pb	Al
Average of Saros (Sari, Çagatay [3]	451	2.80	60	19	73	22	5.70
Dispersion of Saros [3]	114-1740	0.25-4.60	14-145	6-44	23-154	2-80	0.90-9.60
Average of Dardanelles Cities (this study)	360	2.14	40	15	50	15	4.12
Dispersion of Dardanelles (this study)	157-522	1.42-3.40	25-55	9-22	34-76	8-20	4.84
Average of Dardanelles [5]	545	1.9	36	17	148	29	4..0
Average of Northern Marmara shelf [6]	404	2.97	-	21	71	24	-
Dispersion of Golden Horn [7]	333-565	2.60-3.80	98-167	333-3900	450-8750	124-702	2.30-6.60
Sondaj Dispersion of Golden Horn [8]	334-742	1.04-7.31	73-138	30-446	71-1009	13-531	1.28-9.83
Average of Surface of Southern Black Sea [9]	571	-	48	33	-	7	-
Average f Southern Black Sea Shelf [9]	570	3.28	77	49	87	34	-
Average of Surface of Eastern Aegean Sea [10]	925	2.35	143	18	17	17	-
Dispersion of Eastern Black Sea Sediments [12]	-	2.98-.50%	-	-	-	-	-
Shale [13]	850	4.70	90	50	90	20	8.00

While the speed of the upper flow changes between 0.5 and 5 knots, it is in the direction from the Marmara to the Aegean Sea. The speed of the bottom flow changes between 0.1 and 0.6 knots and is in the direction from the Aegean to the Marmara Sea. According to the average of Shale, in the sea-bed stations in the Dardanelles, it was determined that there is not a dense concentration of heavy metal. As a consequence, we can say that the low concentrations of sea-bed sediments can be attributed to these flows are run down maximum 5 knot velocity to Aegean.

The activity by rivers entering the Dardanelles from the coastline on the heavy metal concentrations in the sea-bed sediments should be taken into account. However, according to our estimates this effect is minimal. When the deep current speed in the Strait of Canakkale exceeds 1-2 knots or when northerly surface currents are caused by southerly water activity, then, marine carrying heavy sediment unless stop, surface draught material with a speed of 4 knots or less, will not enter the deep and will carry until current speeds are 4 knots or less, or the southerly currents have arrived to Aegean Sea.

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