Metal pollution in the Heli Bay, Greece

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Heli Bay is a semi-enclosed Bay, situated at the southern coast of Argolis Peninsula, Greece. The water depths in this area vary between a few and 15 meters. The town of Portoheli, at the northwestern coast, and the surrounding beaches are considered as major and of high standard resort places in Peloponnese.

In order to investigate the environmental conditions in the Heli Bay, dissolved oxygen and pH measurements were carried out. In addition, seafloor sediments collected with a Van-Veen grab were analysed for major and trace elements, including toxic metals. The chemical analyses were carried out using Inductively Coupled Plasma(I.C.P.) after an HF-HNO_3-$HClO_4$ diggestion.

The dissolved oxygen and pH values were found to be within the range of normal coastal seawater. pH varried between 8.1 and 8.6, while dissolved oxygen between 7.5 and 8.4 mg/l.

The geochemical data showed significant enrichments in Cd, Hg, Sb, Ag, Pb, Mo and Cr relative to near-shore normal sediments (GRIMANIS *et al.*, 1977; SCOULOS and DASENAKIS, 1982; VOUTSINOU-TALIADOURI, 1984; VARNAVAS *et al.*, 1987, 1988; PANAGOS *et al.*, 1988; VARNAVAS and CRONAN, 1988). The highest concentrations of Cd and Sb were found at the north western coast, while the maximum Cr value at the northeastern coast of the Bay. The sediments of the central part of the Bay are characterised by anomalously high concentrations of Sb,Pb,Mo and Hg.

The application of factor analysis on the geochemical data showed that factor 1 accounts for 51,3% of the data variance and shows strong loadings on A1,Fe,Zn,V,Cu and Co.This factor represents the clay-fraction of the sediments and demonstrates its strong contribution in the incorporation of trace elements to the sediments. Factor 2 accounts for 15.8% of the data variance and shows strong loadings on Mo, Hg and Pb. Since Mo is an indicative element of reducing conditions it is implied that this factor represents the organic fraction of the sediments. It demonstrates the strong contribution of organic carbon in the incorporation of toxic metals to the sediments. Factor 3 accounts for 11.8% of the data variance and shows strong loading on Si, Cr and P, representing the weathering products of magmatic rocks. Factor 4 accounts for 7.6% on the data variance. It shows loading on Mn, representing the manganese oxides. Factor 5 accounts for 4.3 % and factor 6 for 3.5% of the data variance and they show loadings on Ag and Ca respectively. Factor 5 demonstrates the different origin and behaviour of Ag while factor 6 the low contribution of carbonates to the sediments. (Table 1).

Table 1 : Varimax rotated factor matrix

Factor	1	2	3	4	5	6
SiO_2	-0.18209	-0.10138	0.74986	-0.52093	-0.18583	-0.14658
Al_2O_3	0.80847	0.45804	-0.18220	0.19541	0.20781	0.06873
Fe_2O_3	0.81910	0.48488	-0.17791	0.17055	0.12855	-0.00273
TiO_2	0.66280	0.53362	0.40167	0.08724	0.14984	-0.02154
MnO	0.65527	0.34413	0.27259	0.44890	0.13303	0.05148
CaO	0.12488	0.05713	0.10000	-0.02155	0.18637	0.96101
P_2O_3	-0.03021	-0.19423	0.94768	0.18880	0.02653	-0.08858
Zn	0.90308	0.22327	-0.19418	-0.02282	0.07695	0.13058
V	0.80955	0.42207	-0.19813	0.27309	0.17127	0.01981
Cr	-0.24074	-0.23372	0.93793	0.03815	-0.05317	-0.06052
Cu	0.77090	-0.18720	-0.16315	0.03790	-0.32542	0.25885
Co	0.82341	0.38997	-0.12983	0.28411	0.19142	-0.12117
Pb	0.24829	0.90765	-0.23973	-0.13105	0.07650	-0.01864
Cd	-0.25544	0.14115	-0.02034	-0.90328	0.08923	0.06599
Mg	0.27179	0.89501	-0.18324	-0.03331	0.15076	0.04885
Mo	0.50784	0.79112	-0.23989	0.04528	0.18735	0.09364
Ag	0.17406	0.20181	-0.06693	-0.04503	0.92786	-0.14881

It is concluded that in the Heli Bay significant amounts of toxic metals accumulate on the seafloor. Their association with non-detrital minerals suggests that under certain physicochemical conditions may be released in the seawater from which they can get into the food-chain.

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