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Multi-element study of sediments from the river Khai River - Nha Trang Bay estuarine system, South China Sea.

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Major (Al, Fe, Ti, Mg, Ca, Na, K), minor (Mn) and trace (Cr, Ni, Cd, V, Zn, Cu, Pb, Sb, Bi, Sn, Ag, Li, Co, As, Zr, Mo, Hg) elements along with nutrients (TOC, TS, TP) and TIC were first determined in ten surface sediment samples from the Khai River - Nha Trang Bay estuarine system, South China Sea. According to the sediment quality guidelines and reference background values, most of the element contents that were studied were below the threshold levels, while the content of Ag exceeded significantly the hazardous levels in the most of the samples along the river – sea transect. The local anthropogenic and/or environmental sources of Ag within the region need special study. Aluminum and lithium normalization indicated some specific features in the abundance and distribution of the elements along the salinity gradient. The mean grain size of the sediments decreased from the river part to the bay part of the transect. Sedimentary TOC was relatively low (1-2 %) and showed independent distribution along the river – sea transect in relation to the other elements that were studied. Ca, Ba and Sr distribution showed some sporadic enrichment and were largely controlled by the TIC content in sediments. Sedimentary TP, Al, Fe, Mn, Ti, Na, K, Li, Co, Cs, Zn and V varied within the narrow range and tended to increase seaward. These elements are most likely controlled by the accumulation of their fine grained aluminosilicate host minerals and materials at sites determined by hydrodynamic conditions, i. e., in the sea floor depression. TS, As, Sn, Bi, U, Cd and Mo were relatively low in the sediments studied and tended to decrease seaward with the slight elevation in the intermediate part of the transect. These elements can be scavenged by and/or co-precipitated with the dissolved and particulate materials of the river discharge and further deposited on the river – sea geochemical barrier in the course of estuarine sedimentation. The distribution of Ni, Cr, Zr Cu, Pb, Sb, Hg and, especially, Ag was characterized by anomalous high concentrations in the intermediate part of the river – sea transect at sites located in the harbor zone. This might be due to the point anthropogenic pollution from local human activities, i.e. fishing, shipping, fueling, waste and sewage sludge outflow, and, especially, from the construction of new touristic facilities in the Nha Trang Bay. Overall, the abundance and distribution of the environmental/anthropogenic elements are controlled by various estuarine biogeochemical processes characteristic for the marginal filter of the estuarine water mixing zone.