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Non-lithogenic (autigenic and anthropogenic) uranium enrichments in the coastal marine sediments of the central Gulf of California

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Uranium geochemistry in the marine environment is considered as promising for a search of proxies for paleooceanographic reconstructions. High water primary production due to the utilization of the dissolved oxygen for the remineralization of settling organic particles generates suboxic or anoxic conditions in the intermediate oceanic waters favouring to the reduction of U (+6) existing in the sea water as truly dissolved form to U(+4) species, characterized by a low solubility and related high affinity to particles and sediments. To verify the possibilities of U enrichments in the marine sedimentary environment of the eastern sector of the central Gulf of Califoria (GC), eleven sediment cores were collected in front of the Santa Rosalia mining region, peninsula of Baja California. Uranium and some other trace element contents in sliced core layers, dried and homogenized, were determined using instrumental neutron activation analysis. Average total U contents in sediments of five cores collected in the open GC in front of Santa Rosalía at the sites with a water depths from 265 m to 1030 m and in the Guaymas Basin (water depth 2019 m) ranged from 1.36+/-0.26 mg/kg (Guaymas Basin) to 9.31+/-3.03 mg/kg (SR63 core, depth 630 m). To distinguish non-lithogenic U from lithogenic one, the normalization of total U contents to the concentrations of Sc in the samples was used, because this element is a reliable indicator of crustal materials, mainly aluminosilicates in the marine sediments. The relative contribution of non-lithogenic (authigenic) U varied from 49.8+/-3.0 % (Guaymas Basin) to 84.2+/-8.2 % (SR62 core) of the total U content in the sediments of the open central GC.

Surprisingly, in three sediment cores from the coastal zone adjacent to the town of Santa Rosalía in water depth range 3-6 m very high concentrations of total U were found, ranging from 54.2+/-7.3 mg/kg (SR4 core) to 110+/-13 mg/kg (SR2 core) and exceeding not only U average abundance in the earth's crust (2.7 mg/kg), but also its levels found for SR62 core, as well as those reported for the natural enrichments of U in the suboxic-anoxic environments, e.g. at Mexico and Peru margin sites (3.04 mg/kg - 24.54 mg/kg, McManus et al., 2006). The relative contribution of non-lithogenic U in the sediments of these three anomalous cores varied from 97.2+/-0.4 % (SR4 core) to 98.8+/-0.2 % (SR1 and SR2 cores) of their total U content. The sediments of these coastal cores were also depleted in organic C (0.05 % - 0.18 %) that is not typical for marine solid phases enriched in authigenic U. Additional surface sediment sampling around samping sites of three "anomalous" cores with these unusually high U levels helped us to define the exact position and contours of the area with U contents in sediments higher than 40 mg/kg, as well as to associate them with the anthropogenic impact, well seen also for Co, Cu, Zn, light lanthanides and europium. The geochemical fingerprints of these anomalously enriched sediments are the same as for solid wastes of copper smelting, which has occurred in Santa Rosalía in the past century until 1984. The tailing/smelting wastes were released into the adjacent sea, forming a thick layer of strongly polluted coarse marine sediments. The shape of pollutant vertical profiles displays that two decades after the cessation of the copper smelting were not sufficient for a self-purification of marine sediments inside a "hot spot".