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Reconstruction of the pollution history of Mumbai mudflat sediments using magnetic, chemical, and ^{210}Pb dating methods

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The onset and rise of urban and industrial pollution in Mumbai was reconstructed from an anthropogenically contaminated mudflat sediment profile situated at Thane Creek estuary using magnetic parameters, polycyclic aromatic hydrocarbon (PAH) data, metal contents and the ^{210}Pb dating technique. The 1.8 m vertical section at Airoli, which is located in the north-eastern part of Thane Creek in the Navi Mumbai area reveals an increase of magnetic susceptibility (χ) from background values of (20-50) to (75-100) $\times$ 10-8 [m3 kg-1] in the anthropogenically affected zone above $\sim$93 cm. A sharp rise of χ from (75-100) to (130-215) $\times$ 10-8 [m3 kg-1] subdivides the anthropogenically affected zone at a depth of $\sim$63 cm. Characterization with rock magnetic parameters (SIRM, Soft IRM and S-ratio) reveals a significant contribution of ferri(o)magnetic phases in the upper zone. Based on the magnetic classification, sampling intervals for cost-intensive PAH and metal analyses were determined. Steadily increasing contents of PAH and metals of anthropogenic origin are observed above the boundary depth at $\sim$93 cm. For example, Pb, Zn and Cu as well as their pollution load indices (PLIS) increase continuously towards the top of the profile. A sediment accumulation rate of 1.2$\pm$0.3 cm/yr provided by ^{210}Pb dating dates the $\sim$63 cm boundary to 1951. Increasing industrial activity, including the establishment of a coal-fired power plant in 1956, and refineries between 1955 and 1960, correlates well with the substantial increase of χ, PAH and metal contents. Scanning electron microscopy (SEM) investigation on magnetic extracts from the contaminated zone reveals the presence of magnetic spherules derived from industrial high-temperature processes. These spherules and other anthropogenic particles which are embedded in the upper part of the sediment section are responsible for the magnetic changes along the profile. The visual observation of a significant amount of anthropogenic particles in the younger sediment part supports the information provided by magnetic data as well as the enhancement of anthropogenic pollutants with respect to an increasing environmental stress in the Mumbai region.