Evaluation of rock-magnetic properties for the determination of metal pollution in the sedimentary core of the Kolleru lake, East coast of India

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Abstract: Highly polluted state of the largest freshwater Kolleru lake has been attributed to a large scale industrilization, urbanizations, intense agricultural and aquaculturl practices, and indiscriminate use of fertilizers, pesticides and fungicides. To understand the exact source of heavy metal pollution behind the gradual transformation of this Ramsar wetland site into polluting lake, an integrated analysis involving rock-magnetic, geochemical and microscopic data was carried out on ~70 cm sedimentary core. Results indicate that enhanced concentration of ferrimagnetic minerals shown by high χ, SIRM and Soft IRM values and high concentrations of P, S, V, Zn, Br, Cr and Co in the upper 23 cm of the sediment, in contrast to lower inputs in the bottom part of the core. The calculated average concentration for both the background and polluted zones varies as χ:(20-35)$\times10^{-8}m^3kg^{-1}$, P: 448-4608, S: 1971-7081, V: 185-226, Zn: 94-133, Br: 8.8-25.8, Cr: 131-157 and Co: 23-28 ppm. These elemental concentrations in the upper part of the sediment are quite high in comparison to the average shale and deep-sea clay elemental concentration. The effects of lake eutrophication is seen in the form of increased nutrient levels of organic carbon (C) and nitrogen (N) in the upper contaminated sediments. The occurence of magnetite spherules in the polluted zone confirms airborne particulate contribution to the upper sediments, whereas angular subangular magnetic particles in the background zone propably arising from geogenic sources. Statistical analysis of geoaccumulation index (Igeo) classify P, S and Br concentration of the upper sediments as moderately to strongly polluted states whereas V, Cr as unpolluted to moderately polluted and Zn and Co concentrations being unpolluted. The integrated pollution load index (PLI) reveals an overall 2.5 fold increase of sediment toxicity in the upper 23 cm of the core compared to the stable background. A strong correlation of χ with PLI demonstrate the utility of magnetic technique towards pollution screening. We demonstarte the advantages and disadvantages of rock-magnetic properties to determine anthropogenic pollution mapping with special reference to Kolleru lake sediments.

Keywords: Kolleru lake, rock magnetism, pollution load index, susceptibility