A weathering index to delineate the boundary between low and high arsenic aquifer sediments

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Groundwater pumped from gray Holocene sands often contains high level of arsenic (As) in South and Southeast Asia whereas groundwater in contact with brown or orange Pleistocene sands is low in As. The Holocene to Pleistocene transition is somewhat arbitrary because it is based on sediment color, which is susceptible to change, and rarely directly dated. We explore here the possibility of using a weathering index that relies on the ratios of relatively soluble (or mobile) elements such as Ca and Sr to less soluble (or immobile) elements such as Zr and Ti as a proxy to define the Holocene-Pleistocene transition. The data were obtained with a hand-held X-ray fluorescence analyzer on 214 samples of drill cuttings in the 1.5-75 m depth range from 3 study sites distributed across a 1 km^2 area of Araihazar, Bangadesh, where the bulk organic carbon from 14 locations was radiocarbon dated (**Fig. 01**). The data show that Ca/Zr, Sr/Zr, Ca/Ti, and Sr/Ti ratios obtained from these measurements are systematically 2-2.5 fold higher in Holocene sediments than that in Pleistocene sediments, irrespective of grain-size. The contrast appears to be driven by a combination of authigenic precipitation of carbonates in Holocene deposits and dissolution and flushing due to subaerial exposure in Pleistocene sediments during the last sea-level low stands ~20 kyr BP. This approach may provide a low-cost alternative to radiocarbon dating to distinguish gray Holocene sands from gray Pleistocene sands that were reduced by an influx of reactive dissolved organic carbon.

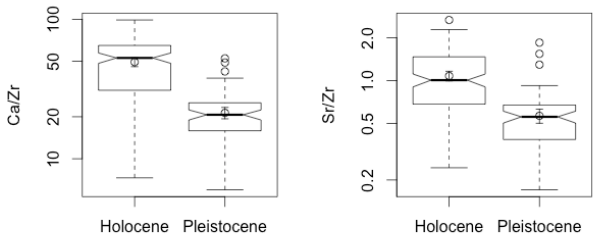

Fig 01. Comparison between Holocene and Pleistocene sediment Ca/Zr and Sr/Zr ratios.