Assessment and geochemical evolution of springs at Hazaribagh District, Jharkhand, India

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Group of thermal and cold springs in Hazaribagh District, Jharkhand with temperatures from 32 to 90 °C and 25 to 27 °C respectively. Three thermal springs and two cold springs are located at Surajkund area, and one thermal spring in Katkamshandi village 15 km from the main town. Theses springs are located in the Archean Chotanagpur Gneissic Complex (CGC) in the eastern part of Peninsular India. pH of the thermal water ranges from 8.3 to 9, which indicates the springs are alkaline in nature. The water types of thermal springs and cold spring are Na-Cl-SO_4 type. Piper diagram suggests that the geothermal waters circulating through the granitic host rocks have their chemistry compatible with that of the host rock. Since the HCO_3 to Cl ratio is less than one suggest that thermal water is believed to be fast ascending without any major mixing with near surface groundwater but for mild to moderate dilution with groundwater. However anion variation shows sifting toward the SO_4 field suggesting addition of SO4 from ancient volcanic rocks of the region (Rajmahal volcanics). Mineral saturation index suggest that thermal water is saturated with silica. Two thermal springs of Surajkund area having similar Na/K ratios indicates that they are fed by the same reservoir. Estimated reservoir temperature based on chemical geothermometers is in the range of 150 to 210 °C.

Dissolved barium distribution and cycling in the Bay of Bengal

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Eight depth profiles of dissolved barium concentrations have been measured in the Bay of Bengal (BoB) along the 87°E transect (~6°N to ~21°N) to track the dispersion of its large influx from the Ganga–Brahmaputra (G–B) river system and the outflow to the equatorial Indian Ocean. A typical Ba concentration–depth profile shows relatively higher Ba concentrations in surface waters (depth ≤5 m) followed by a minimum in the depth interval ~50–150 m and a further increase with depth. The Ba data in the upper layers (depth <100 m), excluding a very high Ba ~112.8 nmol/kg at salinity 24.5 near mouth of the Hooghly estuary, show a North–South trend with a strong and significant inverse correlation with salinity ($R^2 = 0.75$; $P < 0.0001$). This indicates the southward flow of dissolved Ba from the G–B river system that also includes its contributions by particle release and SGD. The subsurface Ba minimum is ubiquitous and most probably is a result of Ba uptake on settling particulates. On the other hand, the Ba concentrations in deep waters (depth ≥500 m) is controlled dominantly by water mixing as suggested by a very strong and significant inverse correlation with salinity ($R^2 > 0.95$; $P < 0.0001$). Exceptions to this conservative behavior are the "hot-spots" of dissolved Ba in bottom waters, which are resulted by the dissolution of sediments at and/or below the sediment–water interface.

Attempts were made to budget the Ba abundance in the Bay of Bengal using a two box model approach, surface (top ~100 m) and deep waters (below ~100 m). Under the steady state the annual Ba influx from the Ganga–Brahmaputra river system seems to be balanced through its removal via sinking particulates as a result there is no lateral outflow of dissolved Ba from the G–B to the equatorial Indian Ocean through top ~100 m of the BoB. Most of this sinking particulate Ba (~95 %) is regenerated again in the lower box, preferentially in the intermediate waters ~100–500 m.

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