

Geochemical Characteristics and Chemical Toxicity: Appraisal of Groundwater Uranium With Other Geogenic Contaminants in Various Districts of Punjab, India

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Abstract : Monitoring of groundwater in Tarn-Taran, Bathinda, Faridkot and Mansa districts of Punjab state, India is essential where this freshwater resource is being over-exploited causing quality deterioration, groundwater depletion and posing serious threats to residents. The present integrated study was done to appraise quality and suitability of groundwater for drinking/irrigation purposes, hydro-geochemical characteristics, source identification and associated health risks. In the present study, groundwater of various districts of Punjab state was found to be heavily contaminated with As followed by U, thus posing high cancerous risks to local residents via ingestion, along with minor contamination of Fe, Mn, Pb and F⁻. Most health concerns in the study region were due to the elevated concentrations of arsenic in groundwater with average values of 130 µg L⁻¹, 176 µg L⁻¹, 272 µg L⁻¹ and 651 µg L⁻¹ in Tarn-Taran, Bathinda, Faridkot and Mansa districts, respectively, which is quite high as compared to the safe limit as recommended by BIS i.e. 10 µg L⁻¹. In Tarn-Taran, Bathinda, Faridkot and Mansa districts, average uranium contents were found to be 37 µg L⁻¹, 88 µg L⁻¹, 61 µg L⁻¹ and 104 µg L⁻¹, with 51 %, 74 %, 61 % and 71 % samples, respectively, being above the WHO limit of 30 µg L⁻¹ in groundwater. Further, the quality indices showed that groundwater of study region is suited for irrigation but not appropriate for drinking purposes. Hydro-geochemical studies revealed that most of the collected groundwater samples belonged to Ca²⁺ - Mg²⁺ - HCO₃⁻ type showing dominance of MgCO₃ type which indicates the presence of temporary hardness in groundwater. Rock-water reactions and reverse ion exchange were the predominant factors for controlling hydro-geochemistry in the study region. Dissolution of silicate minerals caused the dominance of Na⁺ ions in the aquifers of study region. Multivariate statistics revealed that along with geogenic sources, contribution of anthropogenic activities such as injudicious application of agrochemicals and domestic waste discharge was also very significant. The results obtained abolished the myth that uranium is only root cause for large number of cancer patients in study region as arsenic and mercury were also present in groundwater at levels that were of health concern to groundwater.

Keywords : uranium, trace elements, multivariate data analysis, risk assessment

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