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Mobilization Mechanism(s) of Geogenic Uranium in a Typical Middle Indo-Gangetic Plain Groundwater

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In recent years, widespread uranium (U) contamination (>30 μgL^{-1}) in Indian aquifers has been reported. However, the sources and mechanism(s) of U mobilization are not well understood. This understanding is critical, as people in this densely populated region are heavily dependent on groundwater for their daily needs. The objectives of this study were to investigate the potential sources of U and to delineate the U mobilisation mechanisms in a typical middle Indo-Gangetic Plain (IGP) groundwater. Initial characterization of groundwaters at two specific sites identified in the region suggested variable contamination of U in the aquifer. For this study, 5 borewells, 50 m each were drilled and porewaters were collected at regular depths using a low flow sampling device to minimize redox changes during sampling. The concentrations of U were >60 μgL^{-1} in all the wells in both shallow (<30m) and deeper aquifers (Figure 1). However, the shallow aquifers were more contaminated than the deeper ones, which correlated well with the oxidation-reduction potential data. These aquifers were found to be highly saline with elevated levels of Na, Ca, Mg, Cl, SO_4, NO_3 and dissolved inorganic carbon (DIC). Specifically, nitrate pollution was nearly 70 times of the permissible limit for drinking water at some places and is one of the major concerns in these aquifers. The presence of high concentrations of nitrate indicates an oxidising environment of the aquifers, which may be one of the reasons for elevated U. Furthermore, elevated concentrations of Ca, Mg, Mn and DIC in these aquifers suggest the possible dissolution of carbonate minerals such as calcite, rhodochrosite and dolomite, which, in turn, may have resulted in an increase in U concentrations in the aquifers due to release of sorbed U from these minerals promoted by Ca-U-CO_3 aqueous complexation. These mechanistic hypotheses from the analysis of dissolved phase data would be further supported by results from characterization of aquifer sediments to identify the potential drivers of U release in these sediments, and will be presented. Inferences from this study will aid in understanding the reasons for U mobilization/immobilization in carbonate-rich aquifers of India.

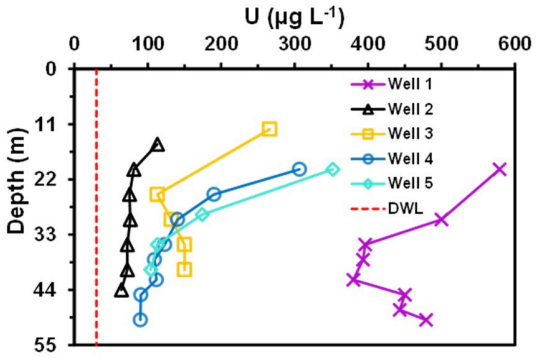

Figure 1. Depth-wise variation of aqueous uranium concentration in different wells of study area in the middle Indo-Gangetic plain, India.