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Geochemistry of fluoride and uranium co-occurrence in alluvial aquifers of Southern Punjab, India

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Co-occurrences of fluoride (F^-) and uranium (U) have been reported in many countries across the globe. Contamination of groundwater by F^- and U threatens safe drinking water supply as drinking such groundwater causes serious health issues. Globally, studies focussing on the geochemistry of F^- and U co-occurrence using groundwater, sediment chemistry, and stable isotopic ratios are limited. We therefore characterized that in severely contaminated alluvial aquifers of Southern Punjab. Detailed field was conducted for groundwater and sediment sample collection. Samples were analyzed for cation, anion, trace element, and isotope ($\delta^{18}O$ and $\delta^{2}H$) using ICP-OES, IC, ICP-MS, and LWIA, respectively. Sediment samples were analyzed for major elements using WD-XRF and mineralogy using powder XRD. Sequential extraction was performed to determine the F- and U reservoirs in the aquifer sediment. Sodium was the most dominant cation, SO_4^{2-} was the most abundant anion, and Na-Cl and Na-HCO_3 were the most dominant water types. In sediments, F^- was most abundant in clay, followed by sand with kankar and sand. Preliminary analyses of water and sediment geochemistry data suggest that silicate weathering primarily controls the groundwater chemistry of the aquifer. In addition, agricultural activities can significantly contribute Cl^- and SO_4^{2-} into the groundwater. The lower slope of groundwater samples on the $\delta^{18}O$ vs. $\delta^{2}H$ plot indicates evaporative enrichment. Silicate weathering, anthropogenic activities, and evaporative enrichment are responsible for high salinity in groundwater. Sequential extraction reveals that in aquifer sediment, F^- and U are present predominantly in the exchangeable form, in association with Al and Fe complexes. Possibly, ion exchange at higher pH and desorption of exchangeable F^- and U from Al complexes is responsible for the co-occurrence of F^- and U in groundwater.