

Geochemical controls on fluoride concentration in groundwater from Mehsana district, Gujarat, India

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Geochemical studies on contaminants in groundwater assume importance as they provide the fundamental basis for any mitigation strategy to reduce contamination. Such studies therefore rely on basic understanding of all processes regulating the concentration of contaminants in groundwater.

Primarily motivated by some reports on fluoride contamination in groundwater from the district of Mehsana, Gujarat, India, a detailed chemical and isotopic investigation was carried out to identify the geochemical processes controlling (in general) the groundwater chemistry, and in particular the fluoride concentration.

The geochemical facies of the water samples were classified into three groups viz. 59% Na-HCO₃, 35% Na-Cl and 6% Ca-HCO₃. Fluoride ranges from 0.27 – 12 mg/L (n=78) of which ~35% of the samples were found to have fluoride above the WHO permissible (drinking) limit of 1.5 mg/L. pH in the samples ranges from 7.0 to 8.4 which contributed to the dissolution of fluoride bearing minerals like fluorite and apatite. Fluoride exhibits a positive correlation with bicarbonate ion as was observed in a few earlier studies in India. Co-variation plot of Fluoride and Calcium shows two distinct groups: (i) high Ca and low F—indicative of limited fluorite dissolution, and extensive carbonate weathering, and (ii) lower Ca and higher F—possibly indicative of Ca precipitation as CaCO₃ and Fluorite dissolution. $\delta^{13}\text{C}_{\text{DIC}}$ ranges from -7.3‰ to -10.7‰ (except for two samples with values of -16.4‰ and -12.6‰) indicating a significant fraction of DIC is derived from carbonate weathering.

Saturation index calculation using PHREEQC reveal that 58% of the samples are oversaturated with calcite (0.01 to 0.91) and almost all samples are undersaturated with fluorite (-2.98 to -0.05) supporting the inferences made above. A lower slope of ~5.3 (compared to 8.0) in $\delta^{18}\text{O}$ - δD plot, is also indicative of evaporative enrichment and may have contributed to the enhanced Fluoride in the study area.

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