



## **Hydrogeochemical processes controlling changes in fluoride ion concentration within alluvial and hard rock aquifers in a part of a semi-arid region of Northern India**

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Geochemical signatures from alluvial and hard rock aquifers in a part of Northern India elucidate the chemical processes controlling fluctuations in fluoride ion concentration linked to changes in major ion groundwater chemistry. Majority of samples from the hard rock and the alluvial aquifers for pre-monsoon show both carbonate and silicate weathering, ion exchange, evaporation and rock water interaction as the processes controlling major ion chemistry whereas for post monsoon samples, contribution of silicate weathering and ion exchange process were observed.

Evaporative processes causing the increase in  $\text{Na}^+$  ion concentration in premonsoon enhance the reverse ion exchange processes causing increase in  $\text{Ca}^{2+}$  ions which impedes fluorite mineral dissolution in the premonsoon groundwater samples within the study area. Alternately, it is observed that the removal of  $\text{Ca}^{2+}$  ion from solution plays a key role in increase in fluorite mineral dissolution despite its saturation in groundwater in the postmonsoon samples. Also, ion exchange process on clay surfaces is more pronounced in the postmonsoon samples leading to the uptake of  $\text{Ca}^{2+}$  ion upon release of  $\text{Na}^+$  and  $\text{K}^+$  ion in solution.  $\text{Ca}^{2+}$  ion concentration is inversely correlated with  $\text{F}^-$  ion concentration in both the aquifers in the postmonsoon season validating the role of calcite precipitation as a major reason for the fluoride ion increase.

Moreover, increase in silicate weathering in the postmonsoon samples leads to increase in clay particles acting as suitable sites for ion exchange enhancing  $\text{Ca}^{2+}$  removal from groundwater. Cationic dominance of  $\text{Na}^+$  ion in the post monsoon samples also validates the occurrence of this process. Collectively, these processes set the ideal conditions for increase in the fluoride ion concentration particularly in the alluvium aquifer waters in the postmonsoon season

Keywords: geochemistry, ion-exchange, rock-water interaction, mineral dissolution, weathering.