Application of Geochemistry and Isotope to understand the process of Groundwater Fluoride Elevation in Granitic Aquifer

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Abstract

Groundwater fluoride is the major cause of the endemic fluorosis. Global fluorosis data indicate that that granitic aquifer which fractures controlled hydrology is highly susceptible to contaminate groundwater with high fluoride. Till date there has not been any sincere effort to understand the type of granitic aquifer based on the different type of the granites and their fluoride content. The present paper assesses the different types of granites and their fluoride content. Dissolution of fluoride from these rock types are the major source of high fluoride contamination in the groundwater. The granitic aquifers are also dominated by fracture control hydrology which enhances the chances of rock water interaction and dissolution of fluoride. The mineralogy of the rocks is also favorable due to the presence of biotite and muscovite which are found to have high affinity to donate fluoride during rock water interaction as shown by the following equation. KAl2[AlSi3O10]F2+2OH- = KAl2[AlSi3O10]OH-+2F- (Muscovite) KMg3[AlSi3O10] F2+2 OH- = KMg3[AlSi3O10]OH-+2F- (Biotite) Delineation of the type of aquifer and the geochemistry of the granitic rocks needs to assess to understand the geogenic causes of fluoride in the granitic aquifer along with the water chemistry (pH>8) which enhances the rate of dissolution of fluoride during rock water interaction. Further estimation can be made by the application pf isotopic data particularly 18O, 2H, 3H, 34S isotope which can quantitatively estimate the sources of fluoride and contribution from different sources as well as rock water interaction time.

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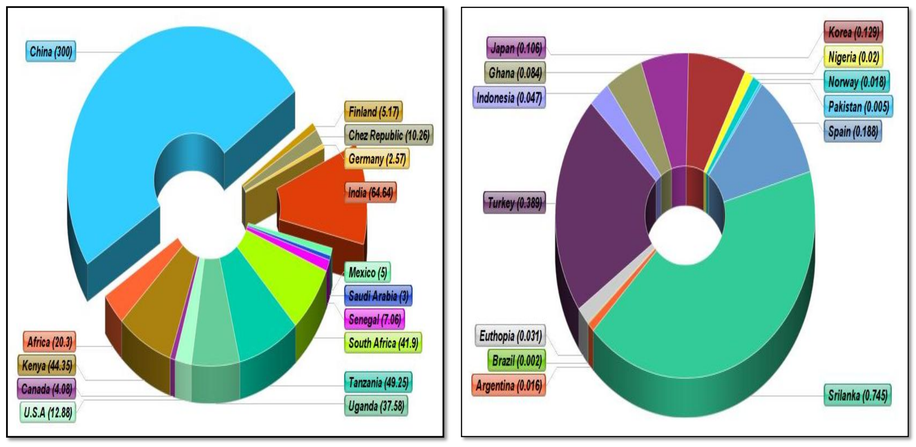
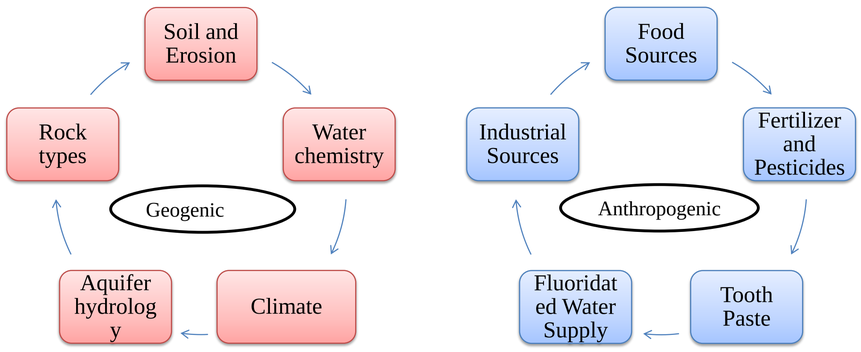
Fluorosis and its endemic nature



High fluoride in drinking water causes fluorosis (F>1.5 ppm) and globally more than 300 million population is effected with fluorosis

Geogenic and Anthropogenic Sources of Fluoride

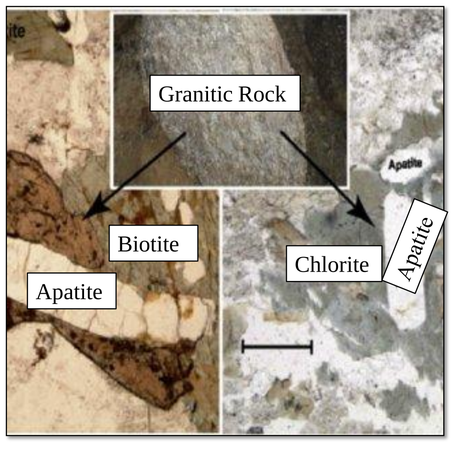


Identifying the Sources of Fluoride

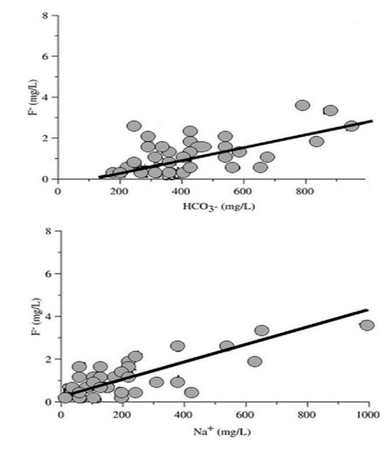
Two key techniques to understand the sources of fluoride is **geochemical** evidences and **isotopic** signature [1]

The geochemistry of the rocks, rock-water interaction provides us with vital information to understand the mechanism of the fluoride dissolution into the groundwater [2]

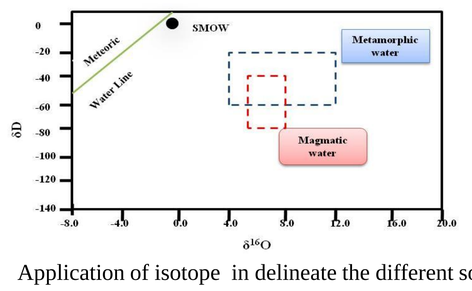
The isotopic signature can quantitatively evaluate fluoride from different sources

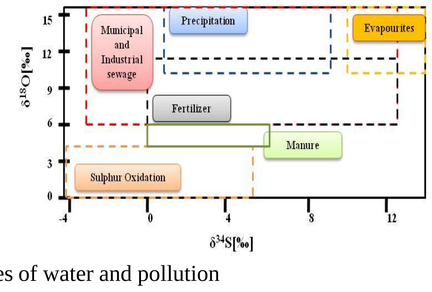


Rock with fluoride bearing minerals [3]



Fluoride vs other parameters of water[3]



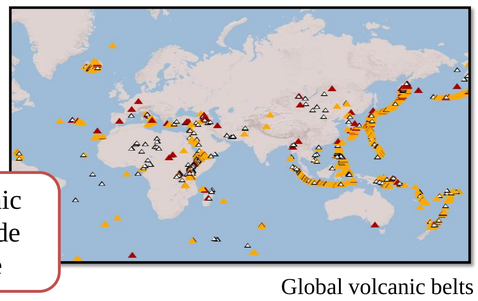


Application of isotope in delineate the different sources of water and pollution

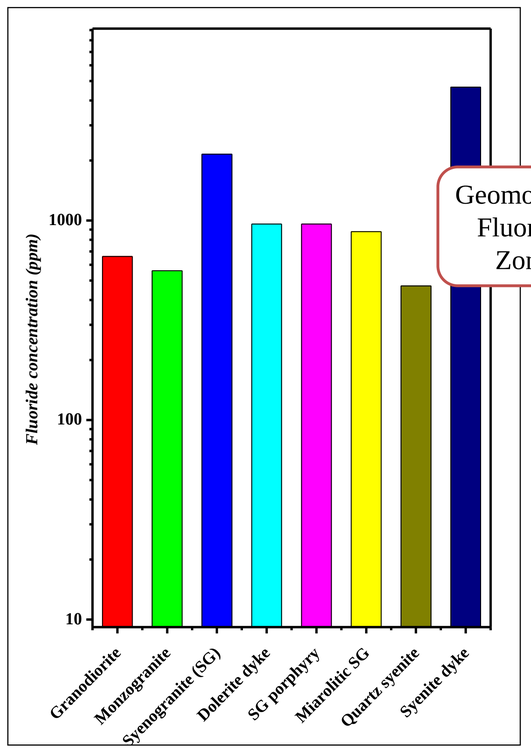
Pathways of Fluoride into the Groundwater

Volcanoes and Ashes

Volcanic Fluoride Zone



Global volcanic belts

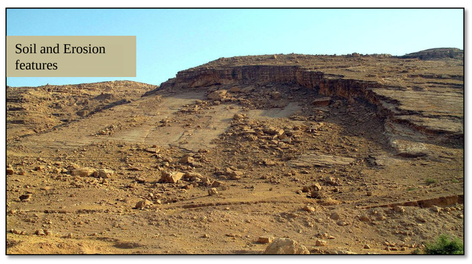


Different types of Rocks (Granitic family+ Others) and their fluoride content .

The volcanic ashes and volcanic soils have high amount of fluoride which gets easily incorporated into the groundwater due leaching of rain water.

Geomorphic Fluoride Zone

Rock Water interaction



Soil and weathering

The rock water interaction and weathering dissociates the fluoride bearing minerals and releases the fluoride into the groundwater.

$KAl_2[AlSi_3O_{10}]F_2 + 2OH^- = KAl_2[AlSi_3O_{10}]OH^- + 2F^-$ *(Muscovite)*

$KMg_3[AlSi_3O_{10}]F_2 + 2OH^- = KMg_3[AlSi_3O_{10}]OH^- + 2F^-$ *(Biotite)*

Conclusions

1. The geogenic causes of fluoride contamination is the largest sources of groundwater fluoride contamination globally.
2. Granitic rocks and aquifers have higher susceptibility of Fluoride contamination due to high fluoride in the rocks.
3. The common way of fluoride incorporation form soil is leaching while rock water interaction and weathering are key mechanism of fluoride dissolution and contamination in groundwater .
4. Geochemistry particularly isotopes can be used to delineate the fluoride sources and its pathways with high precision and accuracy.

Reference

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