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Water Type Vis-À-Vis Fluoride: A Study on Underground Water of Kanpur Dehat, UP, India

KEYWORDS: Fluoride, water type, underground water, Kanpur Dehat

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ABSTRACT *The occurrence of fluoride in underground water in India is mainly due to geological factors. In present study underground water from different blocks of Kanpur Dehat area was classified in to different types on the basis of ions present and relationship between fluoride and water types is established. The analysis of piper diagram of all 75 samples collected from different blocks of study area suggest that, cations were clustered within the plot area of 15-93% Na^++K^+, 0-33% Ca^{+2} and 68%-99% Mg^{+2}, while anions felled within the area of 18-99% HCO_3^-, 0-56% Cl^- and 50-99% SO_4^{-2}. The majority of groundwater samples belonged to the Calcium-Magnesium-Bicarbonate type and Sodium-Potassium-Bicarbonate types. The graphical representation of cation- anion balance shows that out of 75 samples 72 samples were within acceptable limit ±10%. It was observed in the present study that elevated fluoride in underground water was associated with Sodium-Potassium-Chloride-Sulphate and Sodium-Potassium-Bicarbonate water types. Also increase in fluoride is associated with increase in Na^+, Cl^-, SO_4^{-2} and decrease in Ca^{+2} and Mg^{+2}.*

INTRODUCTION

Ground water is a replenishable source of water and approximately one third of the world's population use underground water for drinking [1]. Increased anthropogenic activity and intensive use of natural resources resulted in contamination of ground water. These contaminants in ground water exist for hundreds of year due to their slow movement in water aquifers.

In developing countries like India, most of the health problems are found to be associated with the presence of inorganic chemicals and pathogenic organisms in drinking water [2]. Higher concentration of many elements can occur in water aquifers due to variation in the regional and water/rock interactions. Unplanned underground exploitation in developing countries without paying attention to quality issue may pose substantial risk to population and natural environment.

In underground water fluorine is found in the form of complexes with inorganic and organic compounds as fluoride ions. The concentration of fluoride in ground water depends on the geological, chemical and physical characteristics of aquifers [3,4]. In the Indian context, the occurrence of fluoride in underground water is mainly due to geological factors [5]. The excessive fluoride concentration in ground water may persist for very long time; enter into food chain, cause adverse impact on human health. Therefore, it is essential to determine the causal factors of fluoride enrichment in underground water in time as space to mitigate the problem [6]. In present paper water of study area is classified in to different types on the basis of ions present and relationship between fluoride and water types is established which may help in identification of fluoride endemicity of different area having similar geohydrochemistry.

MATERIALS AND METHODS

Total 75 samples were collected and analyzed from 10 blocks of Kanpur Dehat. Detail material and methods as well as results have been provided elsewhere [7]

RESULTS AND DISCUSSIONS

The ionic concentration of major cations and anions found in groundwater of the study area were plotted in Piper's trillinear diagram and Dorov diagram (Figure 1 and 2). Among the total 75 samples, cations were clustered within the plot area of 15-93% Na^++K^+, 0-33% Ca^{+2} and 68%-99% Mg^{+2}, while anions felled within the area of 18-99% HCO_3^-, 0-56% Cl^- and 50-99% SO_4^{-2}.

• The analysis of piper diagram suggested that the following general water types exist in the study area:

- Calcium-Magnesium-Bicarbonate type
- Sodium-Potassium-Bicarbonate type
- Calcium-Magnesium-Chloride-Sulphate Type
- Sodium-Potassium-Calcium-Sulphate Type
- Mixed group (no dominant type of water)

The majority of groundwater samples belonged to the Calcium-Magnesium-Bicarbonate type and Sodium-Potassium-Bicarbonate types.

Cation –Anion Balance

For determination of possible errors and inconsistencies in data sets cation-anion balance method was applied. The graphical representation of cation- anion balance shows that out of 75 samples 72 samples were within acceptable limit ±10% only 3 samples shows deviation. Sample no. 14 shows increased anion while sample no. 22 and 42 shows increased cations. (Figure 3)

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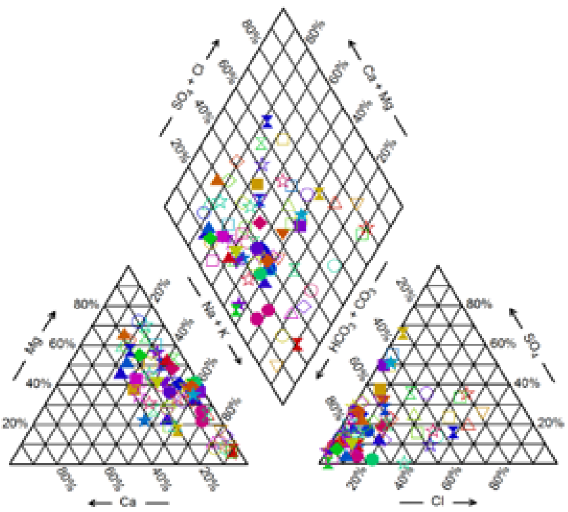

Figure 1 Piper diagram showing major ion chemistry of groundwater of Kanpur Dehat

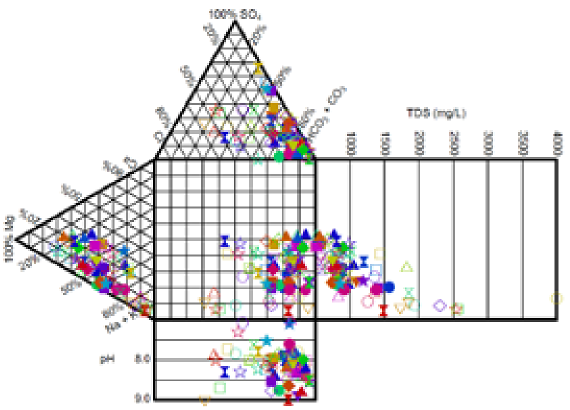

Figure 2 Durov diagram showing major ion chemistry of groundwater of Kanpur Dehat.

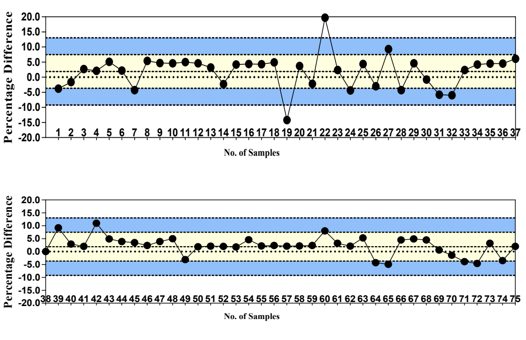

Figure 3 Graphical representation of cation and anion balance (N=75)

Fluoride content vis-à-vis groundwater types

Groundwater with high F^- concentration was generally of HCO_3^- Na^+ type, particularly with poor Ca^{+2} [8]. Several authors have shown that in water with high Fluoride concentration, the amount of F^- is proportional to the HCO_3^- concentration and pH [9-11]. In order to understand the relation between F^- concentration and groundwater type, three Piper diagram had been plotted for F^- > 1.5 mg/l (Figure 4). It was observed in the present study that the elevated Fluoride concentration was associated with Sodium-Potassium-Chloride-Sulphate and Sodium-Potassium-Bicarbonate water types.

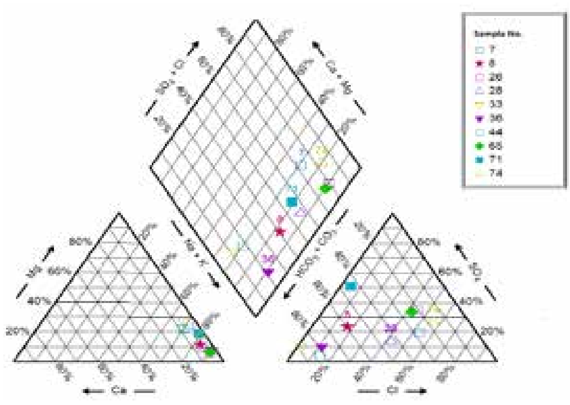

Fig 4: Piper diagrams showing water types with respect to F^- >1.5 µg/mL

The above mentioned observation suggested that an increase in Na^+ concentration in groundwater is associated with increase in F^- concentration, is also depicted in pie diagram (Figure 5). It is clear from this diagram that the ratio between Na^+ and Ca^{+2} (i.e. Na^+: Ca^{+2}) increases from 4.72 to 21.79 as the F^- content in groundwater increases from < 0.6 µg/mL to > 1.5 µg/mL. The increased fluoride ion concentration in groundwater is associated with increased Chloride and Sulphate ion concentration (Figure 6) as reported by earlier researcher. Anion exchange (OH^- for F^-) is the dominant process in the sedimentary basin which leads to base exchange (Na^+ for Ca^{+2} and Mg^{+2}) resulting in an increase in Na^+ content [8]. Further, the fact that high concentration of Na^+ increases the solubility of F^- bearing minerals [8, 12] explains the enrichment in F^- concentration with increase in Na^+ content in groundwater of the study area.

CONCLUSIONS

The presence of fluoride concentration in underground water is often indentified only when people exhibit symptoms of fluorosis. Existing sampling done by government and non government bodies has been selective and unstructured, taking some samples from villages in district and from few water pumps in each village, may not produce a complete statistical out come to identify high fluoride patches of aquifers. Therefore, extensive sampling and their stastical analysis is required to find fluoride occurrence in underground water of some specific area. And this analysis can help to identify fluoride endemicity in the area which has similar hydrogeochemial characteristics. Various low cast safe fluoride removal technologies need to develop in order to provide safe drinking water in remote rural areas [13].

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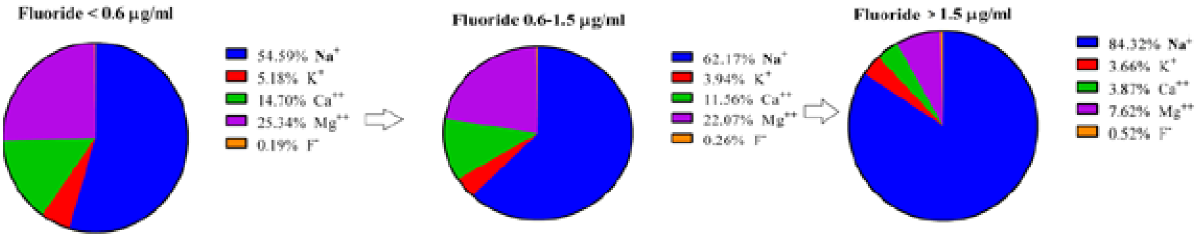

Figure 5 Pie diagram showing relation between F- and major cations

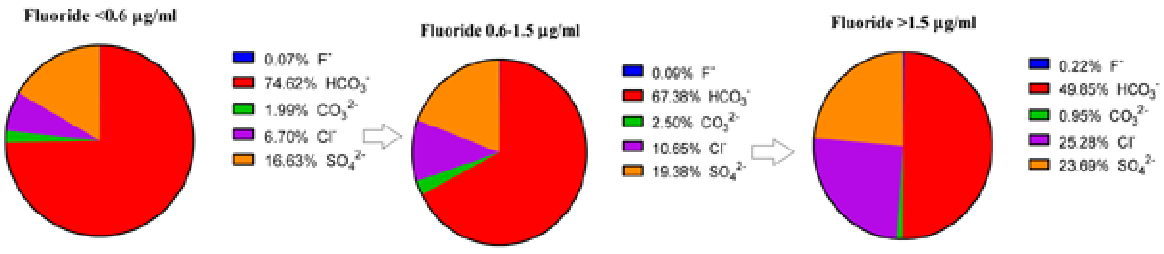

Figure 6 Pie diagram showing relation between F- major anions

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