Excessive fluoride in groundwaters of River Sindhanur catchment, South India: a case study from a hard-rock sub-basin with contrasting features

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The catchment of River Sindhanur is a multi-lithic, hard rock terrain located in Raichur and Koppal districts of Karnataka. Metavolcanics and granitic rocks form the major aquifers of the study area, the latter being the major aquifer of India (Sreedevi *et al*., 2006). The area is arid and frequently affected by drought. The eastern part of the study area is heavily irrigated, whereas the western part is rain fed. Groundwaters from the granitic and irrigated area are characterized by excessive fluoride (Table 1) and >55% of the area is affected by fluoride hazard, including many areas with metavolcanics, which *may* be attributed to inter-basin groundwater migration and/or to anthropogenic sources. The fluoride content in groundwaters show moderate to weakly negative correlation with calcium, sulphate, chloride, magnesium, total hardness, total dissolved solids and electrical conductivity, whereas the correlation is moderate to strongly positive with pH, carbonates and bicarbonates (Table 1). Geochemical studies indicate that the chemistry of groundwaters is mainly controlled by evaporation and rock interaction, and more than 50% of the samples are unfit for irrigation. Saturation Indices indicate that even with excessive fluoride content, the groundwaters are still unsaturated with fluoride and thus they can get further enriched with fluoride. A Negative Index of Base Exchange for the majority of the samples indicates lesser time of residence, in spite of which large numbers of samples contain excess fluoride, which *may* be attributed to anthropogenic sources like the use of fertilizers, alkalization of soils under intensive irrigation (Jacks *et al*., 2005), apart from natural sources such as the minerals apatite (Handa, 1975) and biotite (Jacks *et al.*, 1993). Although many defluoridation processes are known, people consuming fluoride-contaminated groundwater have been suggested to make use of a local, cost-effective and easy method of defluoridation which involves consumption of tamarind juice.

Table 1 Statistical data of physico-chemical constituents.

Physico-chemical constituents	Minimum	Maximum	Mean	Correlation coefficient (r) with fluoride
pH	7.35	9.09	8.43	0.47
TDS (mg/L)	60.00	13566.00	1822.29	–0.009
EC (μmho/cm)	93.02	21032.56	2829.06	–0.0082
TH (mg/L)	62.71	3873.57	383.07	–0.19
Ca (mg/L)	3.20	875.00	55.95	–0.18
Mg (mg/L)	9.00	480.00	59.20	–0.17
Na (mg/L)	37.91	1048.22	313.20	0.20
K (mg/L)	0.00	168.80	12.03	0.08
CO_3 (mg/L)	0.00	180.00	46.15	0.66
HCO_3 (mg/L)	70.00	910.00	268.03	0.55
Cl (mg/L)	21.30	3961.80	380.39	–0.12
SO_4 (mg/L)	5.00	760.00	237.46	–0.01
F (mg/L)	0.34	9.59	1.80	

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