A preliminary report on fluoride content in groundwaters of Guntur area, Andhra Pradesh, India

Occurrence of fluoride in groundwater has drawn world-wide attention, since it has considerable impact on human physiology. Its deficiency (< 0.6 mg/l) causes dental caries and excess (> 1.5 mg/l) causes skeletal fluorosis, respectively[1,2]. The paper reports a high fluoride content in the groundwaters of 13 localities in Guntur area, lying between latitudes 16°15′–16°20′N and longtidues 80°22′–80°30′E, located on the eastern part of Andhra Pradesh (Figure 1 *a*).

Charnockites (crystallines) and alluvium (unconsolidates) are the major litho-units in the area apart from granite, quartz, pegmatite and dolerite which occur as intrusives. Lithologs of the study area reveal a black cotton soil layer of about 4 m along with weathered and fractured zones 4, 10 and 30 m, respectively in the crystallines[3]. Varying thickness of sandy clay, loam and clay, occur as intercalations or mixed in at different levels in the unconsolidates. About 70% of the area is canal-irrigated.

Forty nine open/dug well samples (24

Table 1. Fluoride content in groundwaters of the study area

Crystallines		Unconsolidates	
Sample no.	Fluoride (mg/l)	Sample no.	Fluoride (mg/l)
1	1.1	17	1.2
2	1.3	18	1.6
3	1.2	19	2.0
4	1.5	20	0.6
5	2.5	21	0.7
6	1.1	23	0.6
8	1.6	38	0.8
9	1.5	40	0.9
10	1.2	41	2.5
11	1.2	44	1.5
12	1.3	45	1.6
14	1.5	46	1.9
15	0.8	47	2.5
16	1.2	49	0.7
29	1.5	50	1.3
31	2.5	51	0.9
32	1.2	52	1.5
33	2.5	55	0.9
34	1.3	58	0.7
35	0.9	60	2.5
36	1.1	63	0.9
37	1.1	64	0.9
43	1.8	65	1.0
54	1.5	66	1.5
		68	1.9
Mean*	1.32 ± 0.30		1.43 ± 0.22

*Confidence limit, 95%.

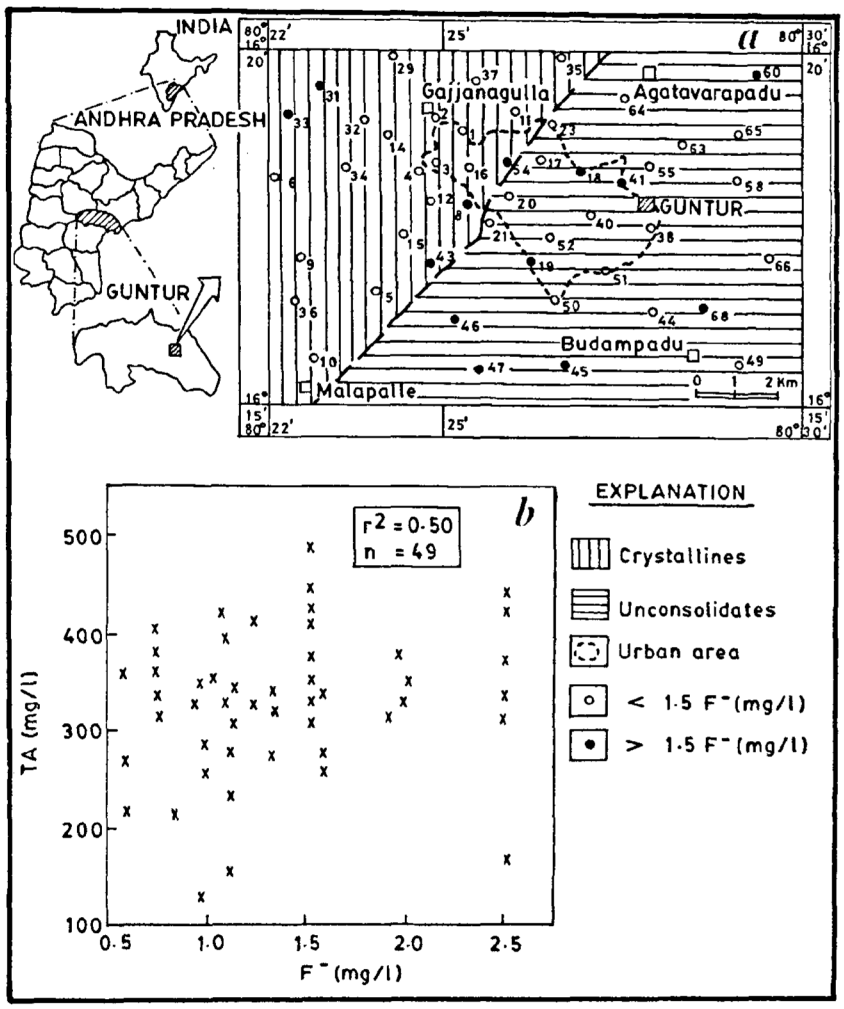

Figure 1. Geology and fluoride concentration (*a*) and relation of fluoride to TA (*b*) in the groundwaters of Guntur area.

Table 2. Salient features of the study area[3]

Parameter	Rock samples* 1	2	3	Soil leachates (10)	Saturation index in groundwaters (49)
Apatite (%)	0.27	0.70	0.13	–	–
Fluoride (mg/l)	–	–	–	0.71–1.35	–
$CaCO_3$	–	–	–	–	0.11–1.51
CaF_2	–	–	–	–	2.07–3.37

*Charnockite; Number in parentheses denotes samples.

from crystallines and 25 from unconsolidates) analysed for the fluoride content (Table 1). Table 1 shows wide variations in fluoride (0.60 to 2.50 mg/l) in the groundwaters; and in 26.5% of the samples, it exceeds the recommended limit (1.5 mg/l) prescribed for drinking purpose. Groundwaters in the unconsolidates have higher (1.43 mg/l) fluoride content than in the groundwaters located in the crystallines (1.32 mg/l). Leaching of the fluoride bearing apatite present in the country rocks (0.13–0.70%) of the area (Table 2) contributes the fluoride to the groundwaters[4]. The source for fluoride in the soil (0.71 to 1.35 mg/l) appears to be the clay minerals, which promote ion-exchange of the different elements present in the soil and circulating waters during the weathering process[5]. Other factors such as intensity of irrigation, pH of the draining solution, alkalinity, dissolved CO_2 and pCO_2 in the soil enable leaching of absorbed fluoride from the clay minerals of the soil[6–8].

Evapotranspiration and residence-time of water in aquifer are other factors for further enrichment of fluoride. Alkaline waters dissolve fluoride-bearing minerals under simultaneous precipitation of $CaCO_3$ (ref. 9). A positive saturation index for $CaCO_3$ (0.11 to 1.51) and CaF_2 (2.07 to 3.57) in the study area (Table 2), suggest a precipitation of these solid phases due to high rate of evapotranspiration (1778 mm), and a positive correlation (Figure 1 *b*) between fluoride and total alkalinity (TA) show an increase of fluoride from the dissolution of fluoride-containing minerals with alkalinity (pH: 7.2 to 8.6)[10]. As observed by earlier workers[7–9], the combined effect of evapotranspiration and long-time contact of the waters in the aquifer (due to low-hydraulic conductivity of the weathered zone) activate the process of dissolution.

However, the concentrations of fluoride in groundwaters are not uniform in the area (Table 1), due to the variations in (a) the presence and accessibility of fluoride-bearing minerals to water and (b) the weathering and leaching processes[4–11].

Since the fluoride content in the groundwaters of some localities is greater than the safe limit, the present study recommends defluoridation of water employing Nalgonda Technique[12], which is cheaper and simpler among various methods available besides educating the people about the health-implications of fluoride content.

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