Fluoride in fractionated soil samples of Ajmer district, Rajasthan

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The natural abundance of fluoride in soils of the Ajmer distict, Rajasthan was examined. From undisturbed soil, the top 15 cm of the profile was examined and the soil split into fractions based on sand, silt and clay particle size. Clay contained a high amount of fluoride, whereas sand and silts are enriched with much less fluoride. The relation between the soil fractions in observed clay fraction fluoride content matched groundwater fluoride variation. However, the enrichment of fluoride material extracted from the largest soil fraction had considerably lower amounts of clay relative to that from the smaller fractions.

Introduction

Soil is a product of weathering in which environmental factors have been imposed upon a parent material over a period of time.[1] Topography and microbial activity modify the influence of these factors.[2] Very common soil minerals, such as biotite, muscovite and hornblende may contain as much as several percent fluoride and, therefore, would seem to be the main source of fluoride in soil. However, Bowen (1979),[2] believed that micas, apatite and tourmaline in the parent materials were the original source of fluoride in soil. It appears, therefore, that the fluoride content of soil is largely dependent on the mineralogical composition of the soil inorganic fraction. Fluoride solubility in soil is complex and may be controlled by solid phases even more insoluble than CaF_2. In addition, fluoride solubility may be related to the solubility of Al or other ionic species with which it forms complexes.[1] Although exceptions occur, a soil developed in the arid zone is usually more highly weathered than one developed in the humid tropical zone, due to high temperatures.[3] So, an investigation has been carried out to study the pattern of fluoride abundance in bulk and fractionated soils from Ajmer district to compare the results with the combined groundwater fluoride concentration of the same area.

Materials and methods

Thirty-one uncultivated soil samples of Ajmer district, Rajasthan, were brought to the laboratory, air dried, passed through the 2000–200 μm sieves as sand, 200–2 μm as silt and <2 μm as clay, and characterised. Fractionated and bulk soils were digested in a 'Teflon' bomb (1 g sample + 10 ml *aqua regia*), at the given time of 90 min and temperature 60 °C. The digested samples volume was made up to 100 ml with double distilled water in a polypropylene volumetric flask. Samples were neutralised[4] with sodium acetate (2 ml sample + 8 ml 45% CH_3COONa). Each sample was diluted with an equal volume of TISAB, and the fluoride was measured coupled with an ion selective electrode.

Results and discussion

Fluoride in soil fraction

The fractionated soil samples of Ajmer district contain an average of 85% sand, 10% silt and 5% clay. The fractionated soil contains 13 μg g^{-1} fluoride (9–18 μg g^{-1} F) for sand, 30 μg g^{-1} fluoride (19–45 μg g^{-1} F) for silt and 55 μg g^{-1} fluoride (27–129 μg g^{-1} F) for clay. The plotted fractionated fluoride values in a trilinear diagram clearly show fluoride predomination in the clay fraction (Fig. 1). In bulk soil an average of 26 μg g^{-1} fluoride (18–39 μg g^{-1} F) was found. The value of coefficient of variation (CV) was less for the sand fraction (8%) and higher for silt and clay fractions ($\sim$50%), showing heterogeneity with bulk soil. This was the same with the extraction of fluoride from the fractionated soil samples (Table 1). Groundwater fluoride concentrations from the soil sampled region show high variation, 0.3–5.4 ppm and the multiple regression results indicate that the fluoride concentration present in the fractionated bulk soil sample does not correlate well with groundwater fluoride. A moderate correlation was obtained for the amount of clay present in bulk soil *versus* groundwater fluoride ($r = 0.403$). Cluster analysis was often used in exploratory data analysis and the extracted diagram is shown in Fig. 2.

Conclusion

In Ajmer district soil, fluoride was found predominately in the clay fraction. A moderate relationship was established between groundwater fluoride and the amount of clay in bulk soil. If the amount of clay decreases the value of fluoride present in groundwater also decreases. To distinguish the influence of soil at different sampling sites on the overall fluoride concentration levels, an extensive investigation using GIS data evaluation has still to be carried out.

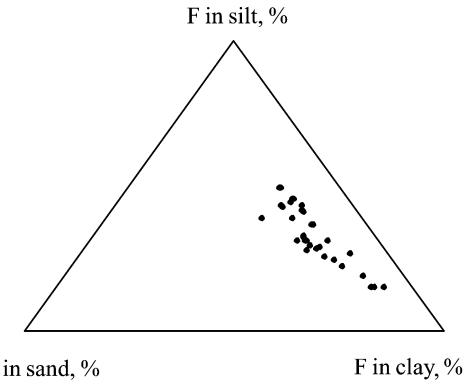

Fig. 1 Fluoride in fractionated soil samples of Ajmer district.

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Table 1 The nature and fractionated soil fluoride concentration with reference to groundwater fluoride

Area	Sand (%)	Silt (%)	Clay (%)	F sand/μg g^{-1}	F silt/μg g^{-1}	F clay/μg g^{-1}	F bulk/μg g^{-1}	F gw (ppm)
Ajmer	98	1	1	14	—	46	26	0.7
Bewar	95	3	2	13	30	35	23	1.0
Kodo	83	15	2	18	28	45	33	1.9
Goela	91	7	2	12	20	58	37	5.4
Akodia	88	10	2	14	23	54	23	0.3
Gulgaon	94	3	2	13	45	47	28	2.0
Kishangarh	84	13	3	15	26	64	23	0.8
Jawaja	92	6	3	12	37	35	22	1.1
Hutikheda	94	3	3	17	28	27	18	0.9
Sikinavadi	72	25	3	14	35	33	21	0.3
Borada	90	7	3	17	25	48	23	3.0
Bandanwada	88	8	4	13	19	—	36	3.7
Bijainagr	88	8	4	13	34	63	22	1.2
Saradhana	85	11	4	15	23	115	37	0.6
Gulgaon	89	7	4	15	29	109	23	0.9
Kekri	79	17	4	9	26	36	22	0.6
Fatehgarh	88	7	4	10	33	36	22	0.6
Arain	88	7	5	15	27	53	27	3.5
Karwa	78	17	5	14	42	103	22	0.4
Ramgarh	83	12	5	15	39	36	20	0.3
Kasir	83	12	5	14	25	41	23	2.8
Bandanwada	86	9	5	10	36	27	18	3.7
Kheri	82	13	5	12	43	39	22	2.5
Sawar	82	13	5	13	22	110	34	0.9
Singawa	85	10	6	13	25	48	28	3.1
Nasirabad	83	11	7	14	25	41	26	2.5
Loharwara	75	18	7	16	31	48	39	1.3
Motipura	87	6	7	15	25	46	24	3.0
Para	78	15	7	11	33	46	26	1.8
Piplaz	84	8	8	10	33	37	22	5.3
Katsura	77	13	10	11	25	129	23	4.1
Mean	85	10	4	13	30	55	26	1.9
Min	72	1	1	9	19	27	18	0.3
Max	98	25	10	18	45	129	39	5.4
SD	6	5	2	2	7	28	6	1.5
CV%	7	50	46	16	23	51	23	76

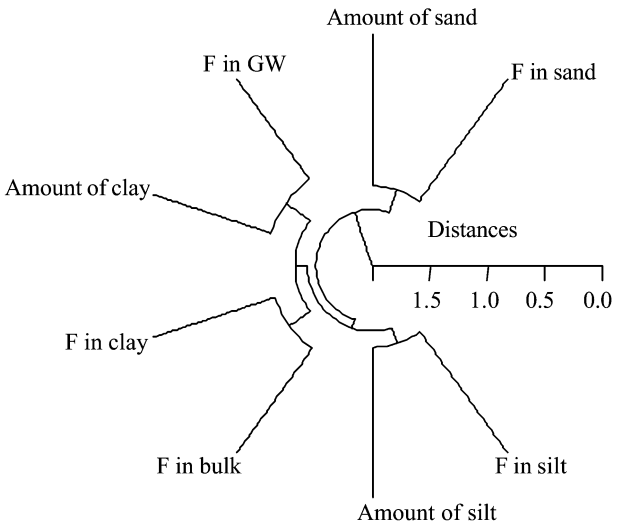

Fig. 2 Dendrogram for the fractionated soils of Ajmer district.

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