SHORT COMMUNICATION

A NOTE ON THE OCCURRENCE OF HEAVY METALS IN THE AQUIFERS OF GANGA-KALI INTERFLUVE AREA, ETAH DISTRICT, UTTAR PRADESH

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The hydrochemical studies in parts of Central Ganga basin, Etah district of Uttar Pradesh have revealed the presence of heavy metals such as Pb, Cd, Fe, Ni and Cr in the groundwater of shallow aquifer zones. Heavy metal concentrations in the deep aquifer zones are within the recommended limits of Indian Standard (IS) specified for the domestic use. The study shows that the groundwater from the deeper aquifers is suitable for domestic usage.

Study Area

The study area spread over 1106 sq. km in the Etah district of Uttar Pradesh, lies in the sub-tropical climatic zone between latitude 27°33' and 27°53' N and longitude 78°48' and 79°11' E (Fig.1). It occupies the flood plain of the Ganga-Kali interfluves, which is a flat terrain and has gentle slope towards southeast. The ground elevation varies between 171 m amsl in the northwest to 152 m amsl in the southeast. The area is bounded in the northeast by the River Ganga and on the southwest by the River Kali. May and early June are the hottest period of the year which is followed by the onset of southwest monsoon in mid June. July and August are the months of heavy rainfall. The average annual rainfall is 715 mm.

Hydrogeological Framework

Geologically, Bundelkhand Granite forms the basement complex which is unconformably overlain by the Upper Vindhyan of Upper Proterozoic age and further by the Quaternary alluvium. The Quaternary alluvial deposits

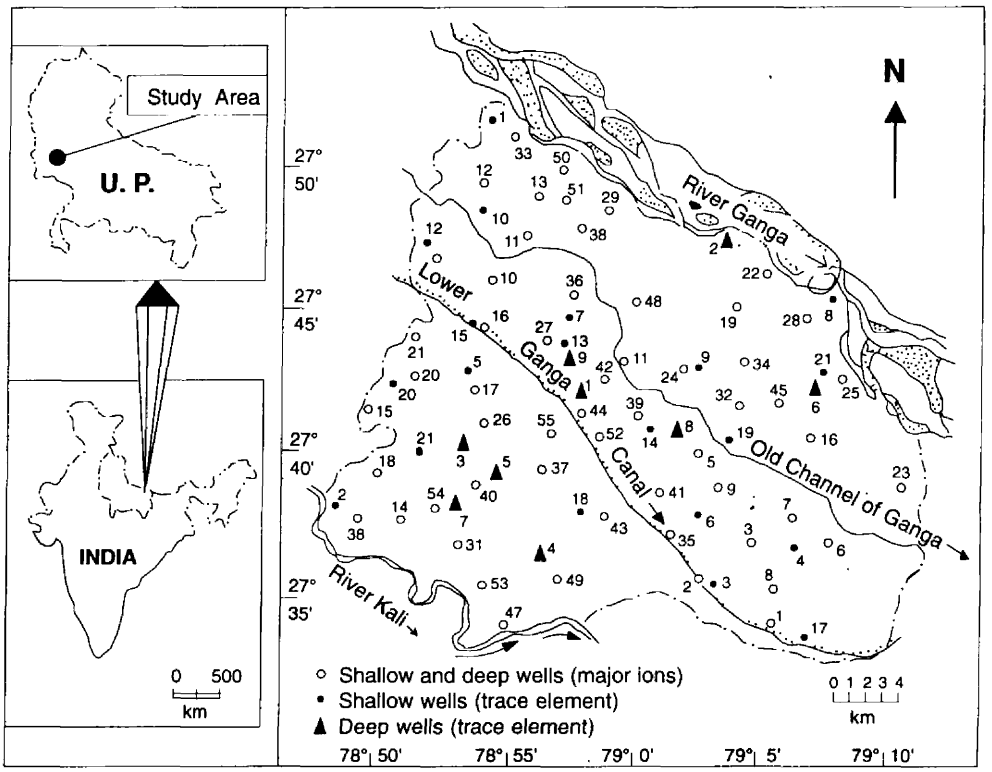

Fig.1. Location map of the study area.

consists of alternate beds of sand and clay down to 360 m bgl Two to three aquifer systems separated by clay beds is observed These aquifers are extensive, thick and have high yield potential The depth to water level in the area varies between 1 80 and 10 85 m bgl The groundwater table ranging from 165 m amsl in the northwest to 142 m amsl in the southeast indicates a regional southeasterly groundwater flow The unconfined aquifers occur within a depth of 50 m bgl and comprise fine to medium sand Deep aquifers which lie below 50 m bgl are semi-confined to confined in nature

Groundwater Quality

Groundwater sampling was carried out in June 1997 Trace element concentrations in groundwater were determined for 23 samples from shallow aquifer and nine samples from deep aquifer For the determination of heavy metals, samples were acidified with 10 ml 0 6N HNO_3 The major ion concentration of 54 samples were determined according to the standard methods (APHA, 1992) The analyses were carried out in the Department of Geology and Department of Applied Chemistry A M U Aligarh

The chemical analysis results have indicated that carbonate, bicarbonate, chloride, sulphate, sodium, potassium, calcium and magnesium vary from 0-32, 120-518, 8-224, 29-289, 20-200, 1-98, 14-175, 6-67, 124-498 mg/l respectively Nitrate was not analysed in the present study The concentration of nitrate (NO_3) from the study area is reported to vary from four to 28 mg/l (Dubey and Hussain, 1991)

The data plot on a Piper trilinear diagram (Fig 2) illustrates the hydrochemical nature of the groundwater The groundwater in the area can be categorised into sodium bicarbonate, magnesium bicarbonate and

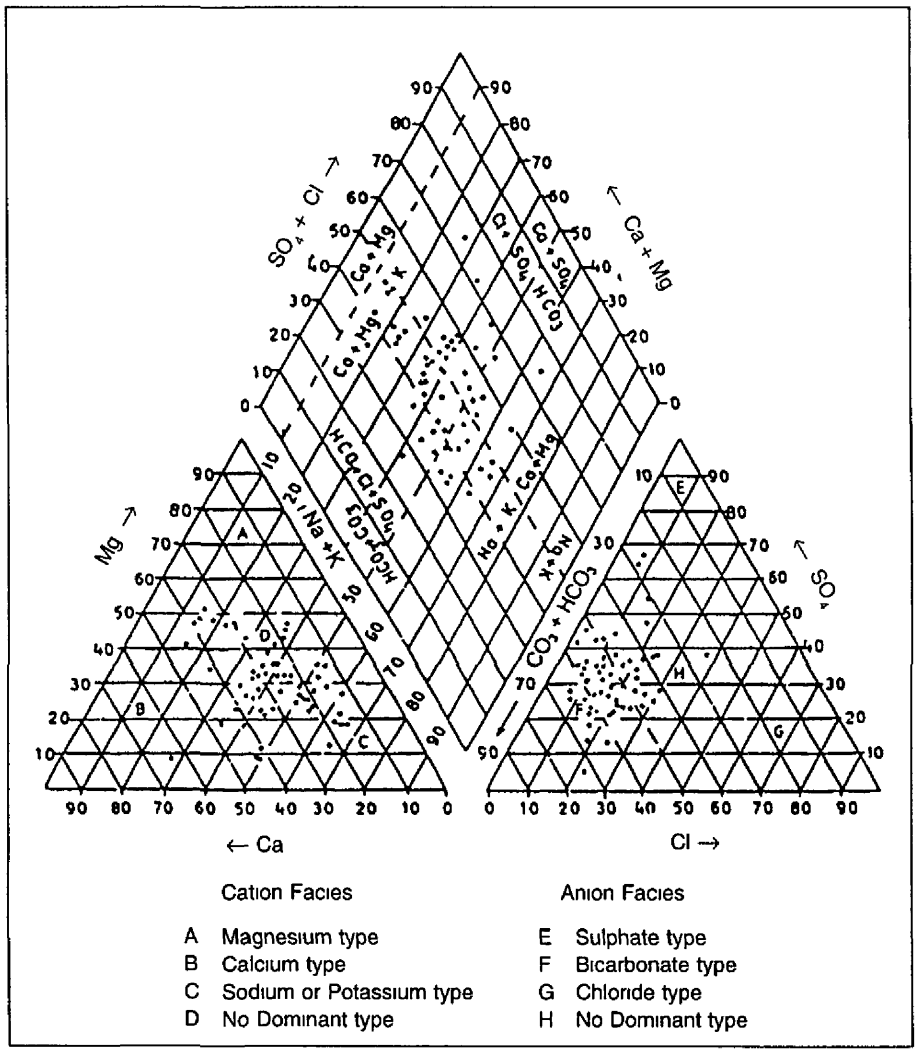

Fig.2. Trilinear diagram of shallow aquifer samples

calcium bicarbonate groups of which sodium bicarbonate facies is dominant throughout. The pH of the water samples analysed ranges between 7 2 and 8.85 and the electrical conductivity between 200 and 1589 μmhos/cm at 25°C.

QUALITY FOR DOMESTIC USE

Water for domestic use must be free from undesirable physical, chemical and biological properties. For the Indian conditions, the permissible values of the various parameters are specified by Bureau of Indian Standards (1991) and WHO (1984). It is seen that pH, EC, TDS, Ca, Mg, Cl, Na, K values are well within the permissible limits.

Heavy Metals in Shallow Aquifers

Table 1 indicates the presence of heavy metals in the samples collected from hand pumps and dug wells which have tapped the shallow aquifers. In four samples the concentration of Fe has exceeded the maximum permissible limit of 1 00 mg/l As against the permissible limit of 0.05 mg/l the Pb concentration in the study area varies from 0.518 and 0.024 mg/l. A perusal of Table 1 shows that concentration of lead in almost all the samples is above the permissible limit Cadmium is a highly toxic non-essential and non-beneficient element to man and animals. The concentration of cadmium has exceeded the permissible limits in 10 out of 23 samples analysed from the shallow aquifers The cadmium concentrations range between 0.006 and 0 018 mg/l.

The concentrations of Cr^{+6} range from 0 to 0.064 mg/l. Out of 23 samples analysed, seven show chromium concentration below the detection limit, four samples above the specified limit while in the remaining samples it is within the permissible limits The concentration of nickel is from below the detection level to as high as 0.08 mg/l. While the concentration of copper in the groundwater ranges from 0.064 to 0.554 mg/l, that of zinc varies from below the detection level to 0.54 mg/l.

Heavy Metals in Deep Aquifers

Nine representative samples from bore wells tapping the deep aquifers in the depth range of 50 to 140 m were

Table 1. Heavy metal concentrations (June, 1997) in groundwaters of shallow aquifers (mg/l)

		Fe	Pb	Zn	Cu	Cd	Cr	Ni
Highest recommended limits (WHO, 1984)		0 3	0 05	5 0	0 05	0 01	0 05	-
Well No	Location							
1	Shahbazpur	0 813	0 20	0 200	0 152	0 006	0 000	0 062
2	Magthara	1 135	0 418	0 282	0 140	0 012	0 032	0 064
3	Chanhka	1 072	0 518	0 540	0 150	0 016	0 060	0 080
4	Aurangabad	1 432	0 486	0 118	0 164	0 014	0 064	0 080
5	Sirsauri	0 632	0 298	0 120	0 140	0 010	0 000	0 064
6	Daryavgan	0 741	0 360	0 080	0 144	0 010	0 028	0 056
7	Shamaspur	0 932	0 238	0 078	0 106	0 008	0 000	0 048
8	Nardaulic	0 303	0 394	0 118	0 276	0 012	0 048	0 064
9	Miaon	0 447	0 482	0 154	0 096	0 016	0 000	0 042
10	Bhikampur	0 508	0 190	0 046	0 146	0 006	0 000	0 042
11	Burhi Ganga	0 640	0 024	0 186	0 012	0 000	0 000	0 042
12	Johari	0 348	0 146	0 000	0 056	0 004	0 000	0 038
13	Ganjdundwara	0 903	0 334	0 426	0 064	0 008	0 040	0 040
14	Patiyali	1 053	0 036	0 084	0 164	0 010	0 057	0 057
15	Padaratpur	0 109	0 354	0 082	0 138	0 010	0 032	0 048
16	Badiaila	0 587	0 516	0 454	0 170	0 018	0 056	0 070
17	Nohin Mushayar	0 251	0 508	0 118	0 272	0 012	0 042	0 070
18	Majhola	0 786	0 390	0 082	0 196	0 010	0 042	0 070
19	Rustampur	0 601	0 436	0 124	0 200	0 012	0 028	0 056
20	Mohanpur	0 349	0 290	0 116	0 132	0 010	0 016	0 049
21	Pinkhuni	0 735	0 206	0 000	0 116	0 006	0 014	0 028
22	Ganga	0 832	0 438	0 148	0 100	0 014	0 000	0 016
23	Sanodhi	0 106	0 342	0 000	0 136	0 008	0 018	0 000

Table 2. Heavy metal concentrations (June, 1997) in groundwaters of deep aquifers (mg/l)

Well No.	Location	Fe	Pb	Zn	Cu	Cd	Cr	Ni
1.	Ulai	0.432	0.170	0.038	0.113	0.011	0.000	0.051
2.	Kadargang	0.314	0.093	0.27	0.092	0.009	0.042	0.032
3.	Singhpur	0.217	0.040	0.019	0.035	0.008	0.031	0.031
4.	Saravl	0.401	0.213	0.043	0.062	0.012	0.009	0.022
5.	Kutubsaria	0.397	0.106	0.021	0.035	0.006	0.018	0.013
6.	Monanpur	0.298	0.097	0.011	0.087	0.010	0.026	0.028
7.	Sidhpura	0.218	0.087	0.039	0.086	0.006	0.036	0.028
8.	Patiyali	0.365	0.971	0.042	0.039	0.000	0.009	0.034
9.	Ganjdundwara	0.273	0.060	0.026	0.046	0.007	0.029	0.037

analysed for heavy metals. The values in Table 2 show that with a few exceptions they are within the permissible limits.

The probable source of heavy metal pollution in the study area is from industrial units located in and around the area. The main industries are Tata Chemical at Gajraula, Tata Fertilizer Factory at Babrala and electroplating units which discharge their effluents directly to the Ganga river very close to the Narora barrage from where emerges the lower Ganga canal which traverses through the study area and recharges the shallow aquifers (Umar, 1990). Besides, the area is extensively cultivated with wide use of chemical fertilizers. The major source of cadmium in soil may be from phosphatic fertilizers (Alan, 1996). Other possible sources of heavy metal pollution are sewage and household refuses.

CONCLUSIONS

The unconsolidated alluvial sediments in the area which constitutes the major aquifer system can be grouped into two categories: the shallow aquifer which is unconfined (<50 m bgl) and the deep aquifer which is semi confined to confined (>50 m bgl). The concentration of major ions in both the aquifers are well within the recommended limit. The study shows that the groundwater of Ganga-Kali interfluves area may be categorised into three major groups: viz. Sodium bicarbonate, magnesium bicarbonate and calcium bicarbonate. Where the sodium bicarbonate facies appears dominant throughout the area.

The concentration of Pb, Cd, Fe and Cr^{+6} in shallow aquifer groundwater exceed the permissible limits which may pose health hazard. In deep aquifer groundwater the concentration of these toxic heavy metals are well within the permissible limit except Pb which exceeds the limit in most of the wells. The higher concentration of heavy metals is attributed to the sewage and industrial effluent discharges.

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