A Complimentary Copy from the Editor in Chief
22/12/2012

WATER RESOURCES

Journal Of The Nigerian Association Of Hydrogeologists

November, 2012 ISSN 0795-6495

Publisher
Nigerian Association of Hydrogeologists

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(13)

Water Resources (2005) 16: 25–30 ISBN 0795-6495

Health effects of arsenic and cadmium concentrations in the well and surface waters of Ago-Iwoye, southwestern Nigeria

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Abstract

The concentrations of Arsenic and Cadmium in hand dug wells and surface water within Ago-Iwoye area, Southwest, Nigeria were determined in order to investigate their health implications. Thirty water samples which consist of nineteen from hand dug wells, six from streams and five from rivers were analyzed for their pH, Total Dissolved Solids, Total Suspended Solids, Arsenic and Cadmium contents.

The concentrations of the two trace elements, Arsenic and Cadmium in human blood were also determined. The results show that all the parameters except As and Cd fall within recommended values of World Health Organization for drinking water. Color ranges between colorless to pale yellow. Arsenic ranges from Not Determined (N.D) to 3.15mg/l with a mean of 1.39mg/l while Cadmium ranges from N.D to 3.45mg/l with a mean of 0.82mg/l. TDS and TSS range between 0-0.04mg/l and 0.01-0.5mg/l with mean of 0.015mg/l and 0.067mg/l respectively.

The concentration of Arsenic in human blood ranges between 0.01ug/l and 0.05ug/l while Cadmium is between 0.01ug/l and 0.06ug/l. Well water contains higher concentration of both As and Cd than surface water. The concentration of As and Cd in most of the water samples are above the World Health Organization recommended values for drinking water but their concentrations in human blood are still within the average normal range.

Introduction

Arsenic and Cadmium are both non- essential toxic metals and they have been a concern to public health for decades. The health effects associated with chronic arsenic exposure have been reasonably well characterized around the world. As has been recognized and used as a human poison since ancient times and it is carcinogenic while Cd has been known to cause kidney damage and skeletal deformities amidst other diseases.

These two metals can be present in parent rocks and occur naturally in the environment or may be present as contaminants from metalliferous and smelting, industry, agricultural materials, atmospheric deposition, sewage sludge and other activities of man.

Most of the indigenes of Ago-Iwoye practice farming and derive their main sources of income from agriculture. In order to alleviate the problem caused by labour shortage and for the control of insects and diseases with the ultimate desire for maximum profit, most farmers use herbicides, insecticides, fungicides and fumigants, which are the commonest sources of both cadmium and arsenic.

This paper discuses the possible effect of As and Cd on the populace since As and Cd can be traced to the parent rocks and agricultural materials inputs in the area especially since the area is devoid of any industry that can discharge these metals as effluent.

Physical Setting

The study area (Ago-Iwoye) falls within the Basement Complex of Southwestern, Nigeria. It is located between longitude 6°56' and 7°.00'E and latitude 3°58' to 4°10'N. The study area is within the humid and sub humid tropical climate of southwestern Nigeria. The moist monsoon wind from the Atlantic Ocean, which ushers in the wet seasons, is between early November and February. The important feature of the study area is a high but uniform rainfall of about 750-1000m and average temperature of 21°C. These climate conditions are likely to promote the deep weathering of rocks (Adeyemi, 1985). The relief of the study areas comprises two basic units; the high ridges and low lying terrain which give rise to undulating features of the environment. Rivers Omi, Etigba and Osun drain the study area (Fig. 1). Vegetation is of the rain forest type.

Geology and Hydrogeology

Ago-Iwoye is underlain by crystalline rocks of Basement Complex which outcrop in some areas (Fig. 2). The most prominent of these rocks is the banded hornblende biotite gneiss which has been migmatized in some parts and intruded by igneous rocks such as granite and pegmatite. The migmatized banded hornblende biotite gneiss is a member of migmatite gneiss complex earlier described by

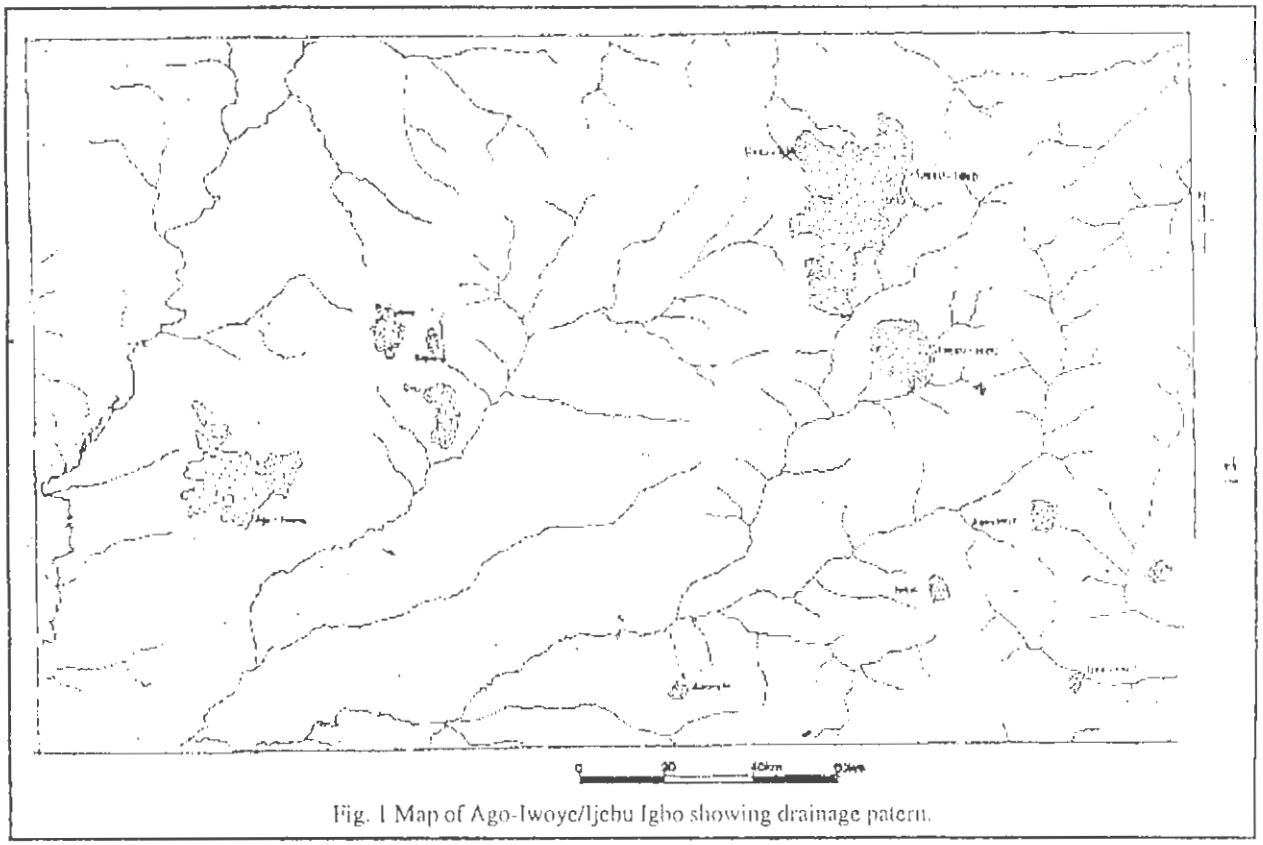

Fig. 1 Map of Ago-Iwoye/Ijebu Igbo showing drainage pattern.

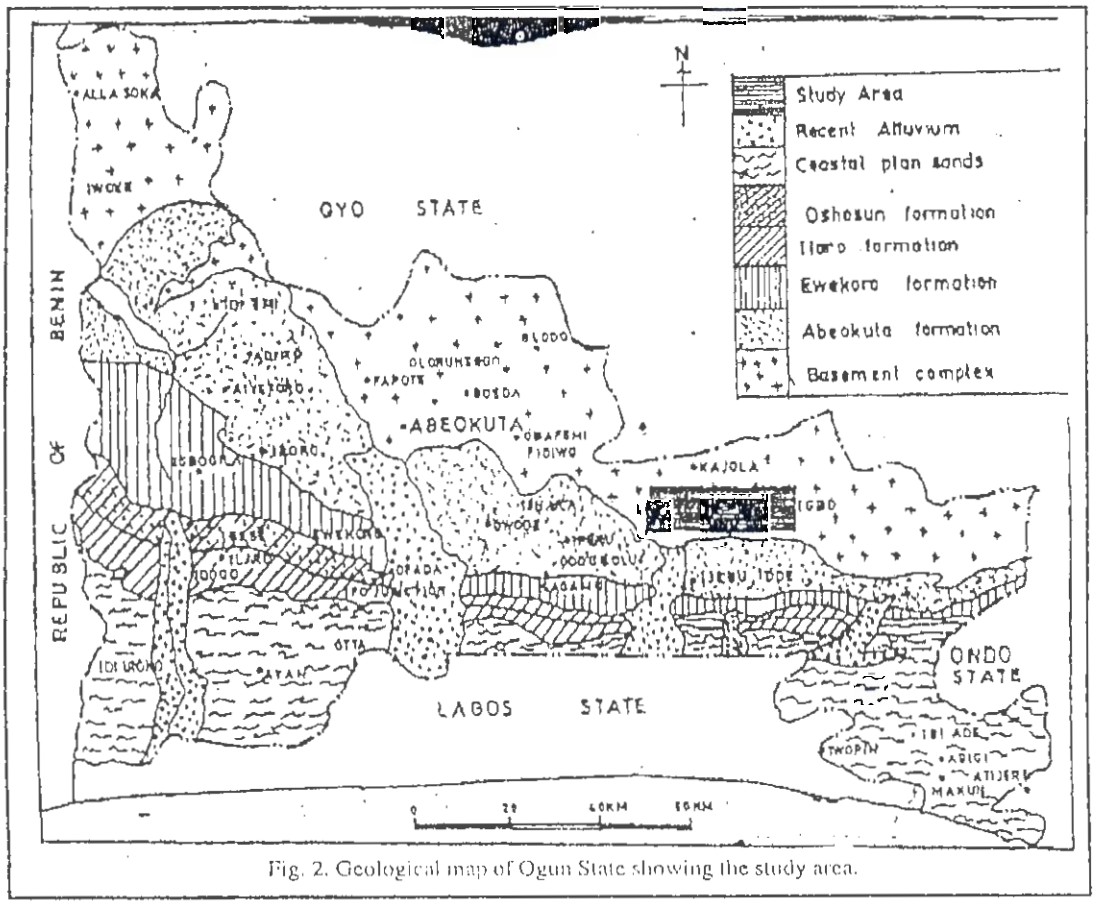

Fig. 2. Geological map of Ogun State showing the study area.

Oyawoye (1964) and dated by Rahaman (1976) as being of Liberian age. The granite and pegmatite are of pan-frican age as determined by Rahaman (1976).

The basement complex rocks are impervious in their fresh form as they are characterized by low porosity and negligible permeability resulting from their crystalline nature. However, appreciable porosity and permeability are developed through fracturing and weathering of the rocks. Rocks found in the study area have been deeply weathered due to the climatic setting. Thus availability of groundwater would depend on the presence of joints and fracture in the underlying bedrock.

Methodology

A total of thirty samples were collected from both surface and groundwater sources across the eight quarters in Ago-Iwoye town that is Imosi, Isamuro, Imere, Igan, Idode, Ibipe, Odesunusi and Imososi (Fig. 3) . Nineteen samples were collected from hand dug wells of various depth and width while 6 and 5 samples were collected from stream and rivers respectively.

The samples were collected using a sterilized locally fabricated plastic water samples. 1.5 liters of water were collected at each location. 1 liter for heavy metal analysis and 0.5 liter for Total Dissolved Solids and Total Suspended Solids. They were preserved in sterilized and properly labeled plastic bottle with plastic stoppers. The samples were collected in November when the effects of dilution were minimal and were taken to the laboratory immediately after physical parameters like pH, color and temperature had been measured insitu.

Six physiochemical parameters were analyzed which include pH, Temperature, Total dissolved solids (TDS), Total Suspended solids (TSS), Cd and As using pH meter, Atomic Absorption Spectrophotometer (AAS) and Titration methods. Human blood specimens were also analyzed for their As and Cd contents in the General hospital located in Ijebu-Ode.

Results and discussion

The results of the physiochemical analyses of both ground and surface water are presented in Tables1 and 2 while Tables 3 and 4 show the results of As and Cd in ground and surface waters respectively.

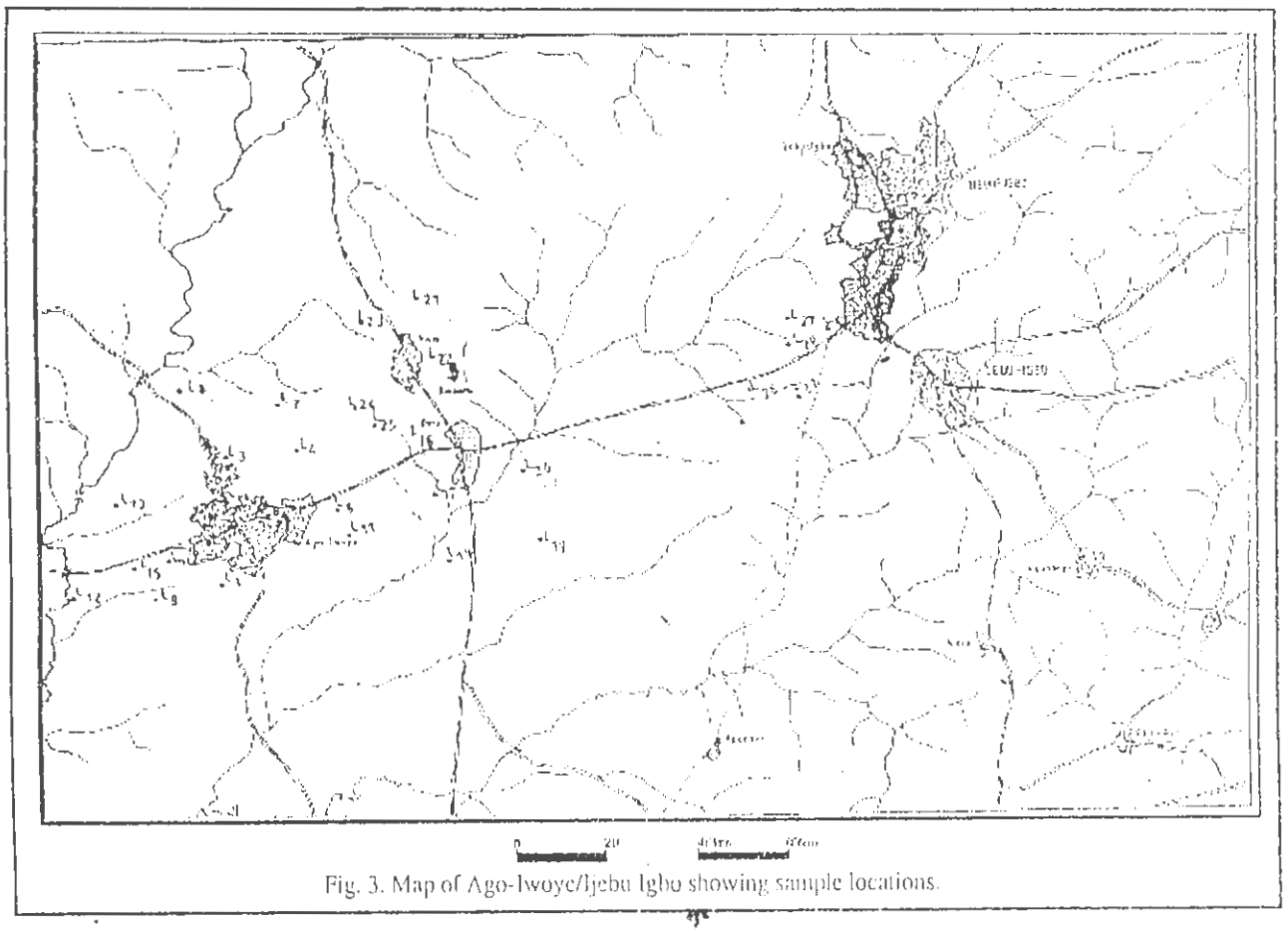

Fig. 3. Map of Ago-Iwoye/Ijebu Igbo showing sample locations.

Table 1. Physiochemical analysis of groundwater in the study area

S/N	TDS (mg/l)	TSS (mg/l)	Depth (m)	Temp. (oc)	pH	Color
1	0.02	0.04	2.63	27.0	8.10	colorless
2	0.00	0.5	2.68	27.0	6.20	colorless
3	0.01	0.135	6.34	25.0	6.30	colorless
4	0.02	0.15	0.78	27.0	7.80	colorless
5	0.00	0.02	3.52	25.0	6.00	colorless
6	0.00	0.01	6.15	28.0	6.80	colorless
7	0.01	0.015	2.79	27.0	7.20	colorless
8	0.02	0.025	0.69	27.5	7.10	colorless
9	0.01	0.020	4.98	21.0	7.20	colorless
10	0.02	0.025	6.87	25.0	6.90	colorless
11	0.01	0.03	4.12	27.0	6.50	colorless
12	0.02	0.025	6.00	28.0	7.10	colorless
13	0.04	0.035	4.10	22.5	7.20	colorless
14	0.04	0.025	0.04	22.5	8.10	colorless
15	0.04	0.03	4.08	27.0	6.10	colorless
16	0.00	0.025	2.14	26.5	6.10	colorless
17	0.01	0.1	4.47	29.0	6.80	colorless
18	0.01	0.035	0.86	27.0	7.20	colorless
19	0.01	0.035	3.40	22.5	7.10	colorless

Table 2. Physiochemical analysis of surface water in the study area

S/N	TDS (mg/l)	TSS (mg/l))	Temp (°C)	pH at 25°C	Colorless
1	0.02	0.01	24.0	6.90	Pale yellow
2	0.01	0.01	22.0	6.50	Pale yellow
3	0.01	0.005	25.0	7.00	Pale yellow
4	0.02	0.00	24.5	7.20	Pale yellow
5	0.02	0.01	25.0	6.80	Pale yellow
6	0.01	0.025	25.0	7.20	Pale yellow
7	0.01	0.01	25.0	7.20	Pale yellow
8	0.01	0.005	26.0	6.50	Pale yellow
9	0.01	0.03	25.0	7.10	Pale yellow
10	0.00	0.15	25.5	6.80	Pale yellow
11	0.01	0.15	25.0	6.50	Pale yellow

Table 3. Chemical concentration of AS and Cd in groundwater within the study area

S/N	AS (mg/l)	Cd (mg/l)
1	N.D	N.D
2	N.D	0.06
3	1.32	0.11
4	2.68	0.11
5	1.87	0.06
6	0.11	0.06
7	2.42	N.D
8	N.D	N.D
9	N.D	0.31
10	N.D	2.42
11	N.D	3.45
12	2.01	0.12
13	2.67	2.11
14	2.99	1.88
15	3.12	N.D
16	N.D	N.D
17	3.12	3.16
18	2.66	0.14
WHO STANDARD	0.05	0.01

Table 4. Chemical concentration of AS and Cd in surface water within the study area

S/N	AS (mg/l(	Cd (mg/l)
1	3.51	0.28
2	N.D	1.28
3	2.73	N.D
4	2.77	1.11
5	0.14	2.83
6	0.31	1.65
7	N.D	N.D
8	2.12	1.11
9	0.18	1.21
10	N.D	N.D
11	2.76	0.56
WHO STANDARD	0.05	0.01

Table 5. Blood serum analysis in the study area

S/N	AS (ug/l)	Cd (ug/l)
1	0.031	0.018
2	0.01	0.012
3	0.01	0.013
4	0.031	0.04
5	0.051	0.06
6	0.05	0.011
7	0.05	0.042
8	0.031	0.055
9	0.044	0.06
10	0.011	0.012

pH varies from 6.2 to 8.1 which shows that the water in the study area is slightly acidic to slightly alkaline in nature but still within WHO standard for drinking water (WHO, 2005).

Water from hand-dug wells is colorless while surface water is pale yellow and yellow in contrast to the WHO standard which is colorless. This may be due to contamination from the domestic wastes in the study area. The result of TDS ranges from 0-40mg/l which indicate fresh water (Todd, 1980) while TSS ranges between 0 add 600mg/l..

The concentration of As in groundwater ranges from Not Detected (N.D) to 3.12mg/l with an average of 1.45mg/l while that of surface water ranges between N.D and 3.15mg/l with a mean of 1.29mg/l. Cd ranges between N.D and 3.46mg/l with a mean of 1.31mg/l in groundwater and from N.D to 2.8mg/l in surface water with a mean of 0.91mg/l.

The concentration of As and Cd in human blood within the study area is also presented in Table 4. As ranges between 0.01ug/l to 0.05ug/l while Cd ranges between 0.01ug/l to 0.06ug/l.

The concentration of both As and Cd in most of the water samples are above the WHO standard of 0.05ng/l and 0.01ug/l respectively.

Well waters have averagely higher concentration of As and Cd when compared with surface water due to the fact that they tap their water from weathered zone where there is dissolution of weathered parent rocks. This indicates

that the parent rocks in the study area may be the source of these metals. Another source is agricultural materials such as pesticides, insecticides, fertilizer etc since most of the indigenes of the study area practice farming.

The human blood tested shows averagely normal range of Cd and As despite their high concentration in water and this may be due to the fact that not all the metals that enter the system metabolize. More importantly however is the fact that As and Cd have extremely long term biological time of 15-20years in human which means that long term exposure is required before these metals can become toxic in human systems.

Nevertheless As andCd can give rise to acute, subacute and chronic effects when present in anomalous quantities in human blood. The adverse health effects of these metals affect the respiratory, gastrointestinal cardiovascular and nervous systems. Long term exposure could also affect both the kidney and liver, immune, skeletal and cardiovascular systems. Skin disorders in the form of hyperkertosis, hyperpigmentation and depigmentation have been observed in different parts of the world after exposure to drinking water and drugs containing high level of

Conclusion

As and Cd are non essential but toxic metals. They are h priority hazardous substances and human carcinogene has been shown from the data presented in this study t water samples in Ago-Iwoye area have higher concentrat of As and Cd than WHO recommended standards. Th metals could be derived anthropogenically from fertiliz pesticides and herbicides, which have high concentrati of these metals and are extensively used by farmers in t area. Similarly As and Cd are derived from the chemic weathering of the parent rocks. As a result of the relative long life of these elements, the health implications of the metals in the study area are not yet observed.

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