

The health implication for excess iron in water is fortunately not grave. The real problem with iron enrichment is that it stains laundry, bath tubs, sinks and even human teeth. It can clog well screen of boreholes. Excess lead is however potentially dangerous. Lead has been implicated in diseases like anaemia, liver damage, kidney disease, reduced IQ, behavioural and learning problems in children and irreversible edema¹⁶.

Arsenic is toxic to human health. It has also been implicated in cancers of the bladder, lungs skin, liver and in prostate problems. Non – life threatening effects of excess arsenic in water include stomach pains, nausea, diarrhoea and partial paralysis.¹⁶

The maximum contaminant level MCL for cadmium is 0.015mg/l but the average value is 0.25mg/l which is 50 times more than the MCL. Cadmium (Cd) directly affects the human body in a negative way, particularly the arteries of the body. It is also known to cause stomach irritation, vomiting and diarrhoea and death. Exposure to cadmium over an extended period of time can cause kidney damage¹⁶.

6. Conclusion

The natural waters of Abakaliki are polluted with respect to heavy metals like iron, lead, arsenic and cadmium. The mechanisms by which they are leached into groundwater and surface water bodies in Abakaliki are not yet fully understood. More detailed geochemical investigations need to be carried out to determine these mechanisms so that mitigation measures can be established for dealing with the heavy metal pollution of the waters. It will also be necessary to examine in greater detail the actual health status of the population in order to establish the extent of the problem.

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Table 1: Selected physico – chemical parameters from the sampled sites.

| S/N | Location | Sample No | pH | Temp ⁰ C | TDS mg/l | NO ₃ mg/l | Dissolved Oxygen Mg/l |
|-----|---------------------|-----------|-----|---------------------|----------|----------------------|-----------------------|
| 1 | Ntezi Abu | L2 | 7.4 | 26 | 985.7 | 1.2 | 1072.0 |
| 2 | Prison Hospital | L4 | 7.1 | 25 | 911.5 | 0.2 | 996.4 |
| 3 | Obiagu West | L6 | 7.5 | 27 | 1102.0 | 2.4 | 600.0 |
| 4 | Obiagu Central | L8 | 7.4 | 28 | 1004.7 | 2.8 | 673.8 |
| 5 | Igbagu | L9 | 7.8 | 24 | 827.8 | BDL | 1102.0 |
| 6 | Abakaliki Borehole | L10 | 7.3 | 28 | 902.3 | 3.7 | 1048.0 |
| 7 | Water Works | L11 | 7.1 | 29 | 846.0 | BDL | 1247.6 |
| 8 | Ofeiyi Oku | L12 | 7.3 | 24 | 956.7 | BDL | 1126.2 |
| 9 | Primary School well | L13 | 6.9 | 23 | 975.6 | 0.7 | 997.7 |
| 10 | Rice farm well | L14 | 7.2 | 25 | 1159.8 | 5.7 | 709.8 |
| 11 | R. Iyiokwu | L18 | 7.7 | 21 | 1108.5 | 3.5 | 750.2 |

| | | | | | | | |
|----|---------------------|-----|-----|----|--------|-----|--------|
| 12 | Quarry (Hw) | L19 | 7.6 | 22 | 1334 | BDL | 720.3 |
| 13 | Juju hill (well) | L20 | 7.6 | 26 | 1294 | 4.4 | 620.0 |
| 14 | Ebonyi River | L21 | 7.8 | 27 | 1209 | 3.9 | 576.8 |
| 15 | Limestone Quarry | L22 | 8.5 | 22 | 1001.6 | BDL | 794.0 |
| 16 | AkaeruIyimagu | L24 | 7.9 | 25 | 904.6 | 0.3 | 1014.7 |
| 17 | Military Cantonment | L25 | 6.5 | 22 | 960.1 | 2.7 | 605.0 |
| 18 | Ugbuloke | L26 | 6.7 | 24 | 1001.2 | 2.5 | 1148.2 |
| 19 | Achi Stream | L28 | 7.5 | 26 | 1206.4 | 3.9 | 680.4 |
| 20 | Abia Stream | L30 | 7.7 | 24 | 1108.7 | 3.5 | 794.00 |

Table 2: Heavy metal concentration in the waters of the study areas (in mg/l)

| S/N | Location | Sample No | Iron | Lead (pd) | Copper (Cu) | Zinc (Zn) | Arsenic (As) | Cadmium (Cd) |
|-----|-----------------------------------|-----------|------|-----------|-------------|-----------|--------------|--------------|
| 1 | Ntezi Abu (BH) | L2 | 6.9 | 7.5 | BDL | BDL | 1.0 | BDL |
| 2 | Prison Hospital (BH) | L4 | 7.9 | BDL | 0.3 | 0.35 | 0.1 | BDL |
| 3 | Obiagu West (BH) | L6 | 7.8 | 0.5 | 0.5 | 0.44 | 2.3 | BDL |
| 4 | Obiagu Central (BH) | L8 | 9.2 | 10.1 | 0.3 | 0.1 | 4.1 | BDL |
| 5 | Igbagu , (BH) | L9 | 1.8 | 3.2 | 0.4 | 0.11 | 2.4 | BDL |
| 6 | Abakaliki (BH) | L10 | 6.9 | 0.1 | 0.6 | 0.74 | 1.5 | BDL |
| 7 | Water Work Area (BH) | L11 | 3.3 | BDL | 0.1 | 0.41 | 0.7 | BDL |
| 8 | Ofeiyi Oku | L12 | 4.4 | 3.7 | 0.4 | 0.09 | 1.1 | BDL |
| 9 | Primary School (BH) | L13 | 2.9 | 2.3 | 0.2 | 0.09 | 1.2 | BDL |
| 10 | Rice farm (HW) | L14 | 7.8 | 8.3 | BDL | 0.70 | BDL | 0.48 |
| 11 | R. Iyiokwu | L18 | 2.3 | 14.7 | 0.1 | 0.64 | 1.3 | BDL |
| 12 | Quarry (Hw) | L19 | 7.6 | BDL | BDL | 1.12 | 2.6 | 0.24 |
| 13 | Juju hill (well) | L20 | 4.4 | 9.6 | 0.1 | 0.33 | 2.9 | 0.52 |
| 14 | Ebonyi River I | L21 | 3.7 | 13.8 | BDL | 0.27 | BDL | BDL |
| 15 | Limestone Quarry (HW) | L22 | 4.11 | 0.8 | 0.4 | 0.78 | 0.7 | 0.27 |
| 16 | AkaeruIyimagu (HW) | L24 | 5.3 | 0.2 | 0.2 | BDL | 1.7 | 0.07 |
| 17 | Military Cantonment Abakaliki< BH | L25 | 9.0 | 0.6 | 0.1 | 0.81 | 2.7 | BDL |
| 18 | Ugbuloke (HW) | L26 | 0.2 | 0.3 | 0.3 | 0.11 | 0.2 | 0.11 |
| 19 | Achi Stream | L28 | 4.7 | 0.5 | 0.3 | BDL | 1.7 | 0.67 |
| 20 | Abia Stream | L30 | 3.7 | 0.3 | BDL | 0.43 | 0.5 | 0.01 |

Table 3: Comparison of Heavy Metal concentrations in Abakaliki with W.H.O.(2006)¹² & USEPA 2010¹³ standards

| Heavy Metals | WHO Standards 2006 | U.S.E.P.A. (2010) | Average value | Exceeds MCL by |
|--------------|------------------------|-----------------------------|---------------|----------------|
| | Health Based guideline | Maximum Contamination level | | |
| Iron(Fe) | No guide line | 0.3mg/l | 5.44mg/l | 18 |
| Lead(Pb) | 0.01mg/l | 0.015mg/l | 4.5mg/l | 300 |
| Cooper(Cu) | 2mg/l | 1.3mg/l | 0.29mg/l | 0.22 times |
| Zinc (Zn) | - | - | 0.44mg/l | - |
| Arsenic (As) | 0.01mg/l | 0.01mg/l | 1.59mg/l | 159 times |
| Cadmium(Cd) | 0.003mg/l | 0.005mg/l | 0.25mg/l | 50 times |

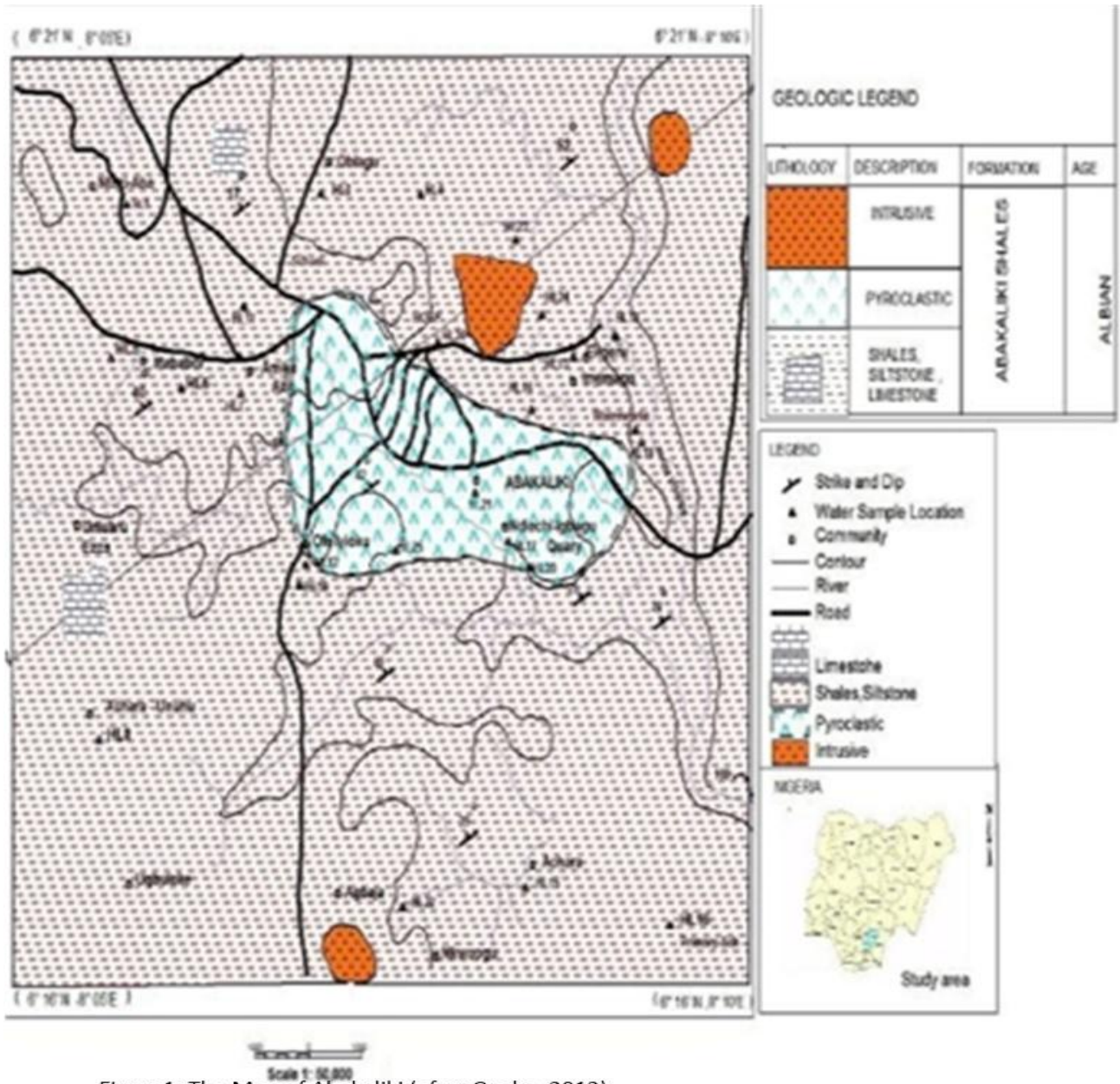


Figure1: The Map of Abakaliki (after Ozoko, 2012)