Journal of African Earth Sciences 121 (2016) 247–254

Contents lists available at ScienceDirect

Journal of African Earth Sciences

journal homepage: www.elsevier.com/locate/jafrearsci

Water quality assessment of the Asata River catchment area in Enugu Metropolis, Southeast Nigeria

Olawale Olakunle Osinowo

Department of Geology, University of Ibadan, Ibadan, Nigeria

ARTICLE INFO

Article history:
Received 10 February 2016
Received in revised form
5 June 2016
Accepted 8 June 2016
Available online 14 June 2016

Keywords:
Hydrogeochemical mapping
Contamination
Asata River catchment
Regolith aquifer
Inorganic fertilizers

ABSTRACT

Hydrogeochemical mapping of the Asata River Catchment area in the Enugu metropolis, southeast Nigeria was carried out in order to assess the quality of the surface and groundwater and based on the analyses of the hydrogeochemical data, establish the level of chemical contaminations which inhibit the availability of potable water in the area. Forty (40) water samples comprising five (5) springs, nineteen (19) surface (streams/rivers) and sixteen (16) groundwater (well/borehole) samples were collected and analysed for the presence and degree of contamination of nine (9) major chemical contaminants. Hydrochemical analyses indicate that Electrical Conductivity (EC) which has a linear relationship with Total Dissolved Solid (TDS) ranges between 015 and 887 μS/cm, pH between 4.4 and 8.3, nitrate (NO_3^-) ranges between 40 and 130 mg/l and chloride (Cl^-) between 7 and 130 mg/l. The concentrations of the dissolved chemical constituents defined the pollution trend and the rate of dispersion of contaminants. The degree of contaminants followed a simple trend, where the level of contamination of the dissolved chemical constituents is least in sampled spring water, with measured chemical constituents of EC, pH, NO_3^- and Cl^- range from 15 to 354 μS/cm; 6.4–6.5; 4.0–70 mg/l and 8–36 mg/l, respectively. However, the value of the measured chemical constituent of EC, pH, NO_3^- and Cl^- gradually increases down the stream in both the surface (63–354 μS/cm; 4.5–7.7; 7.1–110 mg/l; 8–41 mg/l) and groundwater (56–531 μS/cm; 4.5–7.5; 40–130 mg/l; 7–130 mg/l), respectively. Noticeable peaks in contamination levels characterised sections of the study area where human population or their activities is highest.

The result of the hydrogeochemical mapping indicate that Enugu coal mine operation, the industrial activities, fertilizer applied to plants cultivated on river banks and domestic human wastes which are indiscriminately dumped along river channels are the major sources of chemical contamination in the Asata River catchment area. An adequate water resource management scheme is urgently needed to rescue the shallow regolith aquifer from being permanently damaged. Acts such as construction of uncased toilet pits and septic tanks into the thin shallow regolith aquifer, application of inorganic fertilizers along river bank farms and indiscriminate dumping of untreated industrial and human wastes should also be discouraged.

1. Introduction

One of the major problems facing the inhabitants of Enugu metropolis is the source of potable water. The problem persisted despite concerted efforts by several government administrations to address it. The acute water shortage is related to the challenge of meeting up with the water demands of a metropolis which is experiencing geometrical population and industrial growth. The population of the metropolis is currently place at over seven hundred and fifty thousand (750,000) people and has been projected to exceed 1,000,000 by the year 2020 (Wikipedia, 2016). Enugu metropolis is underlain by the Enugu Shale which only supports thin shallow regolith aquifer of low yield (Egboka, 1985). The aquifer is not prolific enough to yield sufficient quantity of water into boreholes that penetrate it (Agbo and Onuoha 1989; Egboka, 1985). Surface water around the metropolis is heavily contaminated by acid mine drainage of Enugu coal mines, unchecked and indiscriminate dumping of domestic, and industrial pollutants into the streams as well as heavy fertilizer pollution coming from river bank farming culture of the inhabitants. This has in no small measure contributed to the degradation of surface and

E-mail addresses: wale.osinowo@mail.ui.edu.ng, waleosinowo@gmail.com.

http://dx.doi.org/10.1016/j.jafrearsci.2016.06.009
1464-343X/

groundwater around the Enugu metropolis.

Enugu metropolis is the capital city of Enugu-State. It is situated between longitude 7° 25′ E and 7° 37.1′ E and latitude 6° 21′ N and 6° 30′ N, covering an area of about 432 square kilometres. Climate in Enugu part of eastern Nigeria is characterised by wet humid climate, wet season from March to September while dry season spreads from November to February. Annual rainfall is about 953 mm and temperature ranges between 21 °C–35 °C. The three main land use in the study area includes; residential, industrial and agricultural land use. Agricultural land use involves irrigation farming, especially along river banks. This practise also involves the use of both organic and inorganic fertilizer to boost farm production.

River Asata is one of the major rivers that drain the Enugu metropolis. It flows through the main city of Enugu urban. It is a perennial river having many other streams that feed it (Fig. 1). The river is about 19.8 km long; it ranges in diameter from 1.3 m to 5.1 m with average depth of 0.6 m (could be as deep as 1.5 m in some deeper parts of the stream). It has an average discharge of 0.4 m^3/sec. Upstream, the discharge increases down the gradient with discharge rate reaching 1.29 m^3/sec during the dry season. The increase in discharge down the gradient is attributed to contribution of many adjoining tributaries. The river has numerous head streams with spring points at the upper part of the escarpment. These springs exist at the contact between the sandstone and shale unit boundary, located between the Upper and Lower Mamu Formations.

2. Geology and hydrogeology

Enugu metropolis is located in the eastern border of the Anambra Basin which occupies the lower part of the Benue trough. It is underlain by a thick sequence of sedimentary deposit of Cretaceous age. Seven sedimentary sequences in all, the oldest, which is the Albian Asu River Group, unconformably overlie the Basement Complex rocks of southeastern Nigeria. The Asu River Group is overlain by the Turonian Ezeaku Formation which is immediately succeeded by Campanian Awgu Shale, Nkporo Shale of Santonian age, Mamu Formation, Ajali and Nsukka Formations of Maestrichtian age (Hoque and Nwajide, 1984) (Fig. 2a). The study area is underlain by Enugu Shale, a lateral equivalent of Nkporo Formation (Reyment, 1965). The Enugu Shale is overlain by Mamu Formation and itself overlain by the Ajali Sandstone in quick succession (Fig. 2b).

The rocks in the study area have not been affected by any major tectonic activities, rather gentle late Cretaceous tectonic activities which are indicated as gentle folds, faults and some joint sets (Agbo and Onuoha 1989). De Swardt and Casey (1961) reported the occurrence of fault with displacements ranging from a few centimetres to over 60 m which occur in the coal – bearing part of the Mamu Formation. De Swardt and Casey (1961) also reported some faults which were described as unexposed Nyaba fault. Other faults identified include Hades faults system, Ogbette and Obudu faults (Hoque and Nwajide, 1984; Ojoh, 1990; Uma, 1992).

2.1. Aquifer systems

Three major types of aquifer systems were identified around Enugu and the environs, namely; unconfined, confined and shallow regolith aquifer, situated at the upper, middle and the basal part of the Enugu escarpment respectively. The unconfined aquifer is formed by the thick sandy sequences of the Ajali Sandstone and the sandy beds of the upper part of the Mamu Formation (Egboka and Uma, 1986). This aquifer is prolific with thickness ranging from less

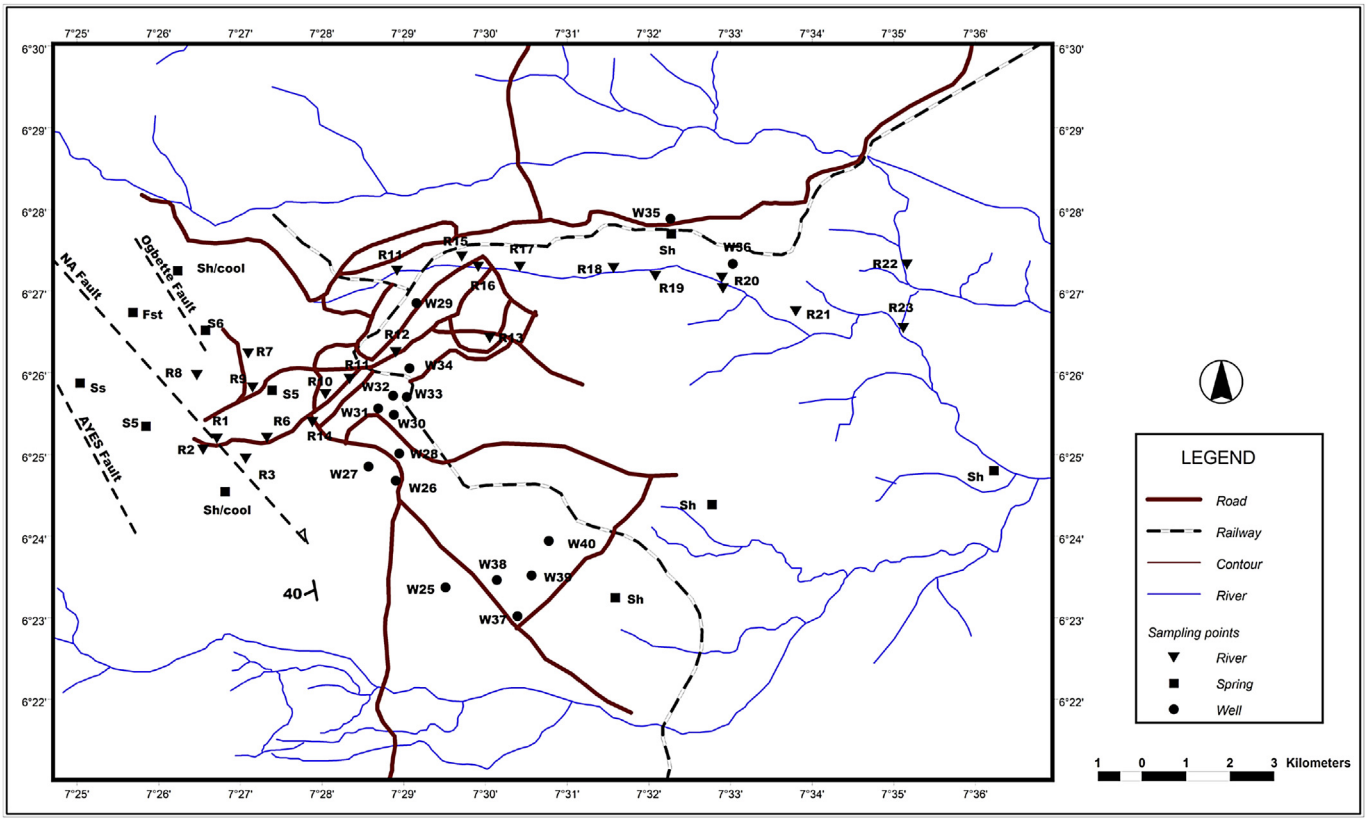

Fig. 1. Dendritic drainage pattern of Asata River Catchment area of Enugu Metropolis.