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Discovering Thoughts, Inventing Future

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Keywords : groundwater, geochemistry, volcanic rocks, international standards, domestic use, nairobi city.

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GEOCHEMISTRY OF GROUNDWATER IN THE VOLCANIC ROCKS OF NAIROBI CITY

Strictly as per the compliance and regulations of :

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Caroline Onyancha [α] & Zachary Getenga [σ]

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Keywords : groundwater, geochemistry, volcanic rocks, international standards, domestic use, nairobi city.

I. Introduction

Nairobi City the Capital of Kenya lies on the eastern flank of the Kenya Rift Valley. The geological succession includes metamorphic and igneous rocks as well as interbedded sediments. The metamorphic rocks originate from folding and high temperature and pressure metamorphism of ancient sediments in the period between late Precambrian and Lower Palaeozoic. Following the metamorphism and folding, the area was subjected to erosion that lasted for more than 400 million years, leaving an erosion surface dated to end Cretaceous Age.

In the Upper Miocene times, volcanic lava started flowing across the eroded surface from the edge of the newly-formed Rift Valley. This led to the formation of welded and vesicular phonolitic and trachytic tuffs. At some stage during the formation of the volcanic rocks, the area being at the edge of the rift valley was covered with water. Lacustrine sediments were formed in between the volcanic flows that were cooled under subaqueous conditions. Some of these sediments have been found to contain ostracod shells and are rich in obsidian. At the later stages of the volcanism, the lake(s) dried up and some pyroclastic volcanic flows were deposited under aerial and dry conditions. The pyroclasts covered most of the existing rivers whose alluvial sediments have been encountered in boreholes across the study area. The north- South trending rift valley faults affecting the volcanic rocks have been concealed by the Pleistocene formations or by landscape modification within the city.

Borehole profiles indicate that the interval between the ground surface and the top of the metamorphic rocks comprises alternate layers of volcanic rocks and lake sediments. The volcanism took place over a long period of time with intermediate periods of no activity such that old land surfaces can be recognized (Saggerson, 1991). The thickness of the volcanic rocks and lake sediments was established from a 472 m deep borehole at the Railway Station (BH C-756) within the Nairobi City Centre. Here, metamorphic rocks that are predominantly biotite gneisses, frequently migmatitic and rich in hornblende were encountered (Gevaerts, 1964).

Groundwater abstracted within Nairobi City is encountered within the fractured/weathered volcanic rocks and in the intervening sediments. Figure 1 is a digitized geological map showing thirteen different geologic materials exposed at the surface or encountered in boreholes as well as the sampling sites for this study. The youngest rocks are exposed to the west and the oldest rocks are concealed by Pleistocene and Quaternary deposits to the east.

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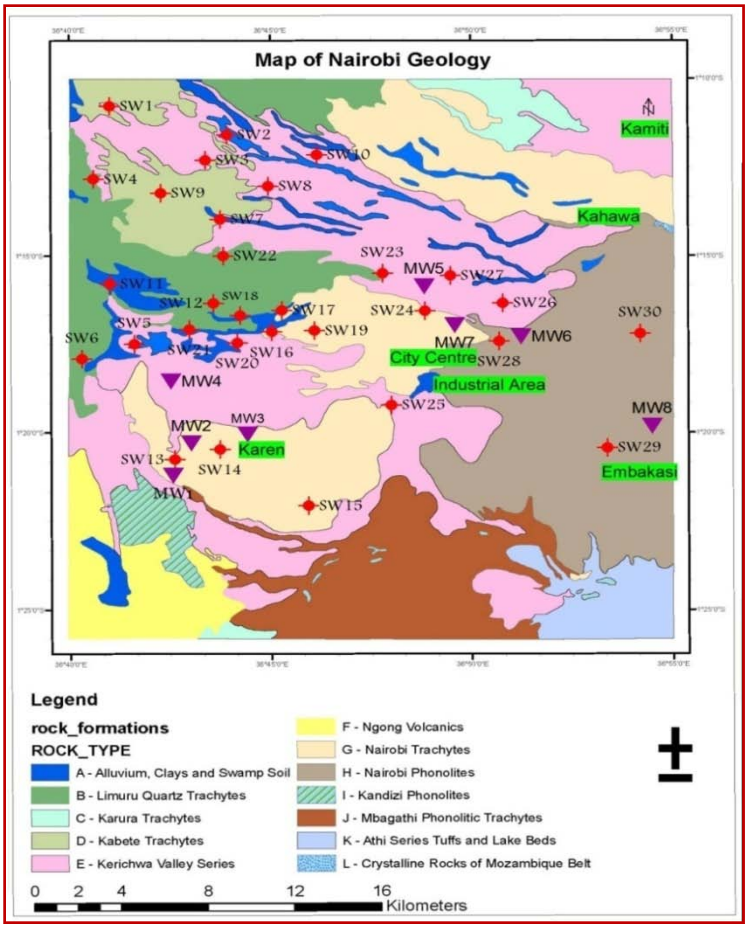

Figure 1 : Digitized geological map of Nairobi City (After Saggerson, 1991) showing study wells (SW) and monitoring wells (MW)

Table 1 presents a geologic profile and summary of thickness ranges of the geological units. The depth of encounter of the geological units varies depending on the shape of the eroded surface at the time of deposition.

Table 1 : Geologic profile and summary of thickness ranges of geological units in Nairobi City

Age	Geologic unit	Thickness range (m)	Total thickness range (m)
Quaternary	Alluvium, clays and swamp soils	1.5-22	50-430
Pleistocene	Limuru Quartz Trachytes	0-25	
Tertiary	Karura Trachytes	0-40	
	Kabete Trachytes	0-32	
	Kerichwa Valley Series	8-45	
	Nairobi Trachytes	0-91	
	Ngong Volcanics	0-58	
	Nairobi Phonolites	0-110	
	Kandizi Phonolites	0-60	
	Mbagathi Phonolitic Trachyte	0-100	
	Athi Series Tuffs and Lake Beds	16-305	
	Kapiti Phonolite	0-53	
Precambrian	Crystalline Rocks of Mozambique Belt	Extending beyond drilled depths	

The role of groundwater in the overall water supply of Nairobi City was discussed by Foster and Tuinhof (2005). They state that surface water supply for Nairobi is undertaken by Nairobi Water and Sewerage Services Company. Most of the water is conveyed by gravity from Ndakaini and Sasumua Dams located more

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than 50 kilometres away. The bulk water supply is not reliable during periods of drought, and is also endangered by reservoir siltation associated with catchment deforestation. The supply problem is further aggravated by the inadequate distribution system, which results in about 50% losses due to leakage and illegal connection. Groundwater is thus an important element of the overall city water supply through a large number of publicly and privately-operated boreholes.

Sikes (1934) found out that Nairobi boreholes abstracted water from unconfined, confined and perched aquifers with variable chemical quality. The difference in geochemistry of the groundwater relates not only to the localized geochemical processes but also to compartmentalization due to faulting (Mohamed and Worden (2006). Gevaerts (1964) investigated among other things, the relationship between the chemistry of the rocks and the geochemistry of groundwater. After it was found that the major problem of the groundwater was its characteristic high fluoride content, the World Health Organisation (WHO) carried out a feasibility study on the possibility of augmenting the Nairobi surface water supply with groundwater (Hove, 1973). It was recommended that the groundwater be mixed with surface water in a ratio of 1:1 to make it suitable for drinking purposes. Mailu (1987) related the high fluoride content in the groundwater to the geothermal gases transported through the faults connecting the study area and the rift valley as well as the feldspathoids within the Nairobi volcanic rocks.

In the former and the current Government of Kenya Water Acts, submission of chemical analysis report is a requirement for commissioning a production well. Bacteriological analysis is not mandatory despite the existence of open sewers, unlined septic tanks, waste disposal sites and pit latrines in the vicinity of many of the producing wells. Foster &Tuinhof (2005) recommended the determination of trace elements (arsenic and selenium) in the Nairobi Groundwater in addition to the major and minor element analysis. Onyancha (2012) discusses groundwater head variation that is partly controlled by the N-S trending faults in study area. She states that the faults are deeply buried in the east. Onyancha et al. (2012) modelled spatial and temporal variation of groundwater rest levels in Nairobi City using Geographic Information System and Produced maps and schematic cross-sections. Groundwater level contours were found to correspond to the topography only to change at fault zones or in the vicinity of rivers. Rest level drops and structural control on rest levels were also clearly visualized. The objective of this study was to analyse the geochemistry of groundwater from various aquifers for major and minor elements, heavy metals as well as the presence of pollutants.

II. Materials and Methods

In this study, 30 groundwater samples were collected at the wellhead for chemical and bacteriological analysis. The sampling locations are shown in Figure 1. For chemical analysis, previously cleaned sample bottles were rinsed with groundwater and then filled to the top. Airtight caps were fitted to each bottle prior to transportation to the laboratory. Dissolved oxygen, alkalinity, carbon dioxide, pH, electrical conductivity and temperature were measured immediately upon sample delivery. The samples for chemical analysis were preserved and analysed within the holding period (wood, 1981). Ion chromatography was used for major anions and atomic absorption and inductively coupled plasma (ICP) techniques were used major cations. Samples for bacteriological analysis were collected in sterilized bottles and tightly sealed. Bacteriological tests were carried out within 6 hours of sample collection. For this reason most samples were delivered in the laboratory before 10 am. The bacteriological quality involved assessment of non-pathogenic bacteria of faecal origin i.e. the *E.colli* and *Enterococcus spp.* All the samples were examined using Membrane Filter Technique according to APHA (1998) and United States Pharmacopeia (1995).

Atomic Absorption Spectrometry (AAS) is based on the phenomenon that an atom in the ground state absorbs light of wavelengths that are characteristic of each element when light is passed through the atoms in vapour state. Because this absorption of light depends on the concentration of atoms in the vapour, the concentration of the target element in the water sample is determined from the measured absorbance (L'vov, 2005). In flame atomic absorption spectrometry (FAAS), a sample is aspirated into a flame and atomized. A light beam from a hollow cathode lamp of the same element as the target metal is radiated through the flame and the amount of absorbed light is measured by a detector. This method is much more sensitive than other methods and free from spectral or radiation interference by co-existing elements. Pre-treatment is either unnecessary or straightforward. However, it is not suitable for simultaneous analysis of many elements because the light source is different for each target element (Becker-Ross, 1996).

Inductively coupled plasma (ICP) method for determination of metals is as follows: an ICP source consists of a flowing stream of argon gas ionized by an applied radio frequency. A sample aerosol is generated in a nebulizer and spray chamber and then carried into the plasma through an injector tube. The sample is heated and excited in the high-temperature plasma (Broekaert, 1998). The high temperature of the plasma causes the atoms to become excited. On returning to ground state, the excited atoms produce ionic emission spectra. A monochromator is used to separate specific wavelengths corresponding to different elements, and a detector measures the intensity of radiation of each wavelength.

III. Results and Discussion

The physical and chemical content of water samples taken from 30 sampling points including results for some heavy metals were summarised; Table 2 presents the physical parameters and bacteriological content at selected sites while Table 3 present major anions and cations content at some selected sites. The samples in Table 2 and 3 were for testing of major and minor elements as well as bacteria and were selected from areas where contamination in water has been reported in monitoring boreholes in the past. In the tables are also given the WHO limits and the ranges of values obtained in past reports submitted after well completion.

Table 2 : Physical parameters and bacteriological content at selected sites

Site	TDS	pH	Turbidity (NTU)	Elec cond	Mn^{-4}	Total hardness	Total alkalinity	*E.coli*	General *coli*
SW16	163.7	7.64	4	264	4.7	12	100	0	31
SW17	544	7.42	2	879	<0.4	214	174	649	>2420
SW18	163.7	7.82	2	264	<0.4	50	118	0	1
SW18	156.9	7.21	1.o	253	<0.4	18	29	0	2
SW15	200.8	7.65	3	324	3.16	38	126	0	2
SW27	60.64	7.18	1	97.8	3.16	34	30	0	0
Sw26	181.7	8.5	1	293	<0.4	10	108	0	9
SW21	511.2	8.0	2	9.22	6.32	16	223	26	>2420
SW25	398.7	8.48	2	643	3.16	14	220	0	11
SW24	180	8.38	1	290	3.9	6	94	0	0
WHO limit	**600**	**6.5-8.5**	**4**		**0.4**	**200**		**0**	**0**
Previous ranges	**59-679**	**7.2-9.5**	**0 -148**	**274-1095**		**6 - 140**	**52- 354**	**0-501**	**0-1300**

Table 3 : Major anions and cations content at some selected sites

Site	Fe	Mn	Ca	Mg	Na	K	NO_3^-	SO_4^-	Cl	F
SW16	0.14	0.06	3.2	0.97	54	1.8	2.1	2.5	14	4.8
SW17	0.07	0.03	39.2	28.2	99	7	27	5.7	114	0.64
SW18	0.07	<0.01	11.2	5.32	35.8	3	1.5	1.7	3	0.9
SW18	<0.01	<0.01	3.2	2.4	47.6	4	<0.01	3.4	11	6.2
SW15	0.05	<0.01	9.6	3.4	55	3.2	2.3	8.86	11	1.4
SW27	<0.01	<0.01	6.4	4.4	6.5	0.4	1.35	3.2	8	0.14
Sw26	0.06	<0.01	3.2	0.5	62	1.6	1.5	2.6	3	7.2
SW21	0.06	0.12	3.2	2.0	203.4	3.4	0.25	1.4	167	0.13
SW25	<0.01	<0.01	2.4	2	140	3	2	5.14		20
SW24	<0.01	<0.01	1.6	0.44	63.5	1.2	1.8	3.14	8	11.5
WHO limit	**0.3**	**0.4**	**300**		**200**		**50**	**250**	**250**	**1.5**
Previous ranges	**0.01-2.87**	**0- 2.0**	**1.6-38.4**	**0.5-18**	**15.1-222**	**1.0-58**	**0.1- 41.7**	**0-4.7**	**2-99**	**0.5-11**

Physical parameters such as TDS, pH and conductivity have a major influence on bacterial population growth (WHO, 2011). TDS represents the amount of inorganic substances (salts and minerals) in the water. High TDS is commonly objectionable or offensive to taste. Except for one sample taken from a borehole next to Karen College (SW13), all the samples had TDS values below WHO recommended limit of 600 mg/l for domestic use. Hove (1973) also observed that the TDS in Nairobi were within the limits stipulated in the international standards for portable water. Data obtained from monitoring wells between January 2006 and January 2009 indicates higher values of TDS in boreholes drilled in Karen area.

Electrical conductivity measures the ability of water to conduct electrical current and is directly related to TDS. Elevated levels indicate higher probability for bacterial contamination. For instance, the water from Kanungaga borehole (SW17) in Table 2 may be contaminated because the shallow borehole is in the vicinity of a leaking sewer line. Higher values of electrical conductivity were also obtained at the Unilever (MW7) and Trufoods (MW6) boreholes in Industrial Area and Kabansora (MW8) borehole in Embakasi during monitoring signalling the presence of pollutants.

The pH values for most of the tested water range between 7.18 and 8.5 well within the range of 6.5 and 8.5 recommended for domestic use in the international standards. A pH value range of 8.7-9.5 was obtained in samples collected from Kenya Polytechnic Men's Hostel (MW9) and Unilever Industries (MW7) during monitoring showing that it could favour both indicator and pathogenic microorganism growth (WHO, 1996). The tested turbidity values for majority of the sites are below the 4 NTU recommended by WHO for domestic supplies. Such water can be easily treated with 2 ppm of chlorine to clear and reduce the turbidity to less than 0.3 NTU. High values of turbidity were measured at Boulevard Hotel (MW5) with a range of 20-148 NTU, Jorgen Mbagathi Ridge (MW1) with a range of 18-36 NTU and Trufoods (MW6) with a range of 18 NTU. Records from sites across the city show average turbidity values of 1-12 NTU. Turbidity in water is caused by suspended particles or colloidal matter that obstructs light transmission through the water. It may be caused by inorganic or organic matter or a combination of the two (WHO, 2011). Turbidity therefore acts as an indicator of possible sources of microbial contamination. Boreholes with high turbidity are located either within the Industrial Area or along/nearby faults.

Except for one borehole, the total hardness of the water is below the recommended threshold for domestic use. The study got informed that the SW17 water (with total hardness of 214 ppm) at Kanungaga borehole is not normally used for domestic purposes except for floor cleaning because of the scum that it forms with soap. Hardness is usually indicated by precipitation of soap scum and the need for excess use of soap to achieve cleaning. A total hardness above approximately 200 ppm may cause scale deposition in the treatment works, distribution system and pipe work and tanks within buildings. The taste threshold for the calcium ion is in the range of 100–300 ppm, depending on the associated anion while the taste threshold for magnesium is probably lower than that for calcium (WHO, 2011). Generally, groundwater is harder than surface water and the hardness is mostly due to carbonates of sodium and calcium (Hove, 1973). Alkalinity values mainly indicate the water's aggressiveness to pipes and appliances. Corrosion resulting from attack by alkaline water would affect the taste and appearance of the water. Gevaerts (1964) observed that all water struck in Tertiary formations contains sodium bicarbonate and are usually alkaline. He also observed that high degree of hardness and free CO_2 are introduced into the Kamiti Kahawa area by water of the deeper aquifer near the base of the upper Athi series.

Water in many boreholes is not tested for bacteriological content during well development so no data could be obtained for comparison. Data obtained from the monitoring wells indicate the presence of *General coli* in majority of the monitoring boreholes. The general the coli were also detected in 8 of the 10 samples tested as shown in Table 1. The source of the coli is currently unknown but could be related to contaminated surfaces surrounding the wells. *Escherichia coli (E.coli*) were detected in two samples taken from the two shallow wells at Kanungaga (SW17) and Kabiria (SW21). The source of the coliform could be the nearby pit latrines and unlined septic tanks. In addition, the borehole at Kanungaga was subject to overflowing open sewer line. E.coli is usually present in large numbers in the normal intestinal flora of humans and animals, where it generally causes no harm. However, in other parts of the body, *E. coli* can cause serious disease, such as urinary tract infections, bacteraemia and meningitis (Aydin, 2007).

The heavy metals tested for included lead, zinc and copper. Lead was detected in 16 out of 20 samples, with values ranging between 0.01-0.07 ppm. The action level for lead recommended by EPA (2002) is 15 μg/l. A major source of environmental lead, particularly in urban areas, is due to the combustion of leaded petrol. Lead is discharged by vehicles into air, and then adsorbed from the air by environmental samples such as soil and plants. Lead then enters the waterways from soil, thus affecting the levels of lead in natural waters (Oclay,*et al*., 2011). Concentrations of Zinc were detected in 15 samples with ranges of 0.03-7.41 ppm. WHO provides a safe limit of 4 ppm for drinking water. All the samples tested have values below this limit except the sample collected from a borehole at Kwarara Road in Karen (SW14) that contained 7.41 ppm of lead. Since the sample was collected from the tap at the surface (although the water was allowed to run to 20 minutes before the sample was collected) the elevated zinc could be related to the corrosion in old galvanized materials used in the distribution system (WHO, 2011). Zinc imparts an undesirable stringent taste to water at a threshold concentration of about 4 ppm (as zinc sulphate). Water containing zinc at concentrations in excess of 3–5 ppm may appear opalescent and develop a greasy film on boiling (WHO, 2011). Copper was detected in three samples and contents in the samples were in the range of 0.01-0.02 ppm. These values were considerably lower than 1 ppm permitted by WHO for drinking water. The health- based guideline value for copper is 2 ppm. Therefore no copper contamination is detected in water samples collected across Nairobi City. Staining of sanitary ware and laundry may occur at copper concentrations above 1 ppm. At levels above 5 ppm, copper also imparts a colour and an undesirable bitter taste to water.

The major cation concentrations tested were below the thresholds recommended by the health standards. These cations are not usually related to any health hazards but presence of their salts sometimes imparts bad taste on water. For instance, at levels above 0.3 ppm, iron stains laundry and plumbing fixtures. There is usually no noticeable taste at iron concentrations below 0.3 ppm, although turbidity and colour may develop. The presence of manganese in drinking-water, like that of iron, may lead to the accumulation of deposits in the distribution system. At levels exceeding 0.1 ppm, manganese in water supplies causes an undesirable taste in beverages and stains sanitary ware and laundry. Concentrations below 0.1 ppm of manganese are usually acceptable to consumers. Even at a concentration of 0.2 ppm, manganese will often form a coating on pipes, which may slough off as a black precipitate. The health-based value of 0.4 ppm for manganese is higher than this acceptability threshold of 0.1 ppm (WHO, 2011). Records indicate high values of iron (0.45-2.45 ppm) and manganese (0-2.0 ppm) in the water. The borehole at Boulevard Hotel (MW5) has particularly high values of iron (1.03-2.87 ppm) and manganese (0.06-2.0 ppm).

The anions tested for in the water included nitrates, sulphates and chlorides. Of these anions, nitrates have been found to affect health directly. All the samples collected in the study are had nitrate values below the Who guideline of 50 ppm and are therefore safe for use. However the concentration of 27 ppm in the Kanungaga (SW17) borehole is of concern. The presence of excessive nitrogen in the form of NO3- is an index of pollution (Hove, 1973). Too much nitrate in water has a major effect on infants less than 6 months old and leads to "blue-baby syndrome. It also leads to diuresis, an increase in starchy deposits and haemorrhaging at the spleen (EPA, 2002).

The levels of sulphate and chloride in the water are far below the taste limits. Values from the study and those in records indicate chloride ranges below 99 ppm and therefore not of concern. Taste thresholds for the chloride anion depend on the associated cation and are in the range of 200–300 ppm for sodium, potassium and calcium chloride. Concentrations in excess of 250 ppm are increasingly likely to be detected by taste. However, the samples from the Kanungaga (SW17) and Kabiria (SW21) boreholes had a significant salty taste regardless of the fact that the values are far below the threshold. Gevaerts (1964) notes that high chloride and sulphate content is encountered in water from Kapiti Phonolite series. Since the phonolite itself does not contain remarkable amounts of these ions, it is obvious that it is derived from the intercalated lacustrine sediments. Borehole C-1413 reached basement and struck unportable water with carbonate hardness of 346-357 ppm, Cl of 1220 ppm and SO_4^{2-} of 720 ppm. The presence of sulphate in drinking-water can cause noticeable taste, and very high levels might cause a laxative effect in unaccustomed consumers. Taste impairment varies with the nature of the associated cation; taste thresholds have been found to range from 250 ppm for sodium sulphate to 1000 ppm for calcium sulphate. It is generally considered that taste impairment is minimal at levels below 250 ppm.

The fluoride content measured in many samples is high above the recommended threshold of 1.5 ppm. The area underlain by Tertiary phonolites east of Nairobi City Centre have mean values of fluoride concentration of 7.6 ppm. The possible sources of the concentrations above the recommended limit are thought to be feldspathoids (Mailu, 1987). Fluoride in groundwater can also be derived from CaF_2 or volcanic gases. High fluoride in water is the cause of dental fluorosis and has some toxic effect on the skeleton (Hove, 1973). The presence of hot springs and geysers and fumaroles in the rift valley supports the possibility that the fluoride results from volcanic gases. The highest concentrations are around Nakuru and Naivasha (Hove, 1973).

IV. Conclusions and Recommendations

Results of this study as well as those of past chemical analyses indicate that major anions and cations concentrations are within the limits recommended by WHO. Of the 2000 boreholes drilled in Kenya before 1960, only 20% had available records for chemical analysis. In general bacteriological pollution was considered unimportant in groundwater, except in very shallow, coarse aquifers because percolation through them is an effective means of filtration and purification (Hove, 1973). High nitrate concentrations were detected in the shallow wells. Fluoride content is above internationally recommended limits in majority of the boreholes sampled. Past records indicate fluoride contents in the range of 0.5-13.7 ppm against the WHO recommended threshold value of 1.5 ppm. Gevaerts (1964) also documented high fluoride concentrations in the City Centre and low concentrations in Kahawa and Kamiti. Since most boreholes tap from more than one aquifer, it is recommended that the fluoride content for every aquifer be investigated so as to isolate those with high fluoride content. Faulting conducts the fluoride to areas where it may not be expected (Saggerson, 1991). Defluoridation or mixing with water of low fluoride content is normally recommended. Four trace elements are that known to endanger life if they occur in drinking water above certain limits (selenium 0.05 ppm, arsenic 0.2 ppm, chromium 0.05 ppm and cyanide 0.01 ppm) have not been investigated. The presence of general coli and E. coli in eight out of the ten tested samples underlines the importance of disinfecting the water for domestic use. Shallow wells within the city should be discouraged since the two sampled at Kanungaga and Kabiria indicate chemical and bacteriological contamination. The water is unfit for domestic use. The physical parameters of the groundwater across the study area range from those below the recommended WHO limits, to those that raise concern such as the high turbidity, pH and electrical conductivity values in boreholes in Embakasi, Industrial area, and Karen. Since these parameters signify potential for microbial contamination, a research should be carried out to analyse their variation and the relationship with lithology and structural geology of the area.

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Regression Analysis for Predicting Wood Pulp Demand by PSO Optimization

By V. Anandhi & Dr. R. Manicka Chezian
Tamil Nadu Agricultural University, India

Abstract - In today's world, consumption of paper and paperbased products is increasing in all the fields. Wood pulp which is extracted from the wood chips is the most commonly used raw material to manufacture the papers. Demand and supply of the wood pulp determines the social-economical development of a country. Many forecasting methods are used to predict the future demands of the wood pulp so that the supply chain management can be planned. In this paper, support vector regression analysis methods are used to predict the demands of wood pulp and Particle Swarm Optimization (PSO) algorithm is proposed to optimize the parameters of kernel functions. Regression models were created by using the data collected from TNPL. The parameters such as Mean Magnitude Relative Error (MMRE) and Median Magnitude Relative Error (MdMRE) are used for evaluating the results. Evaluated result shows that proposed SVM regression with PSO approach gave improved accuracy with significant decrease in MMRE and MdMRE.

Keywords : wood pulp, demand supply management, support vector regression analysis, particle swarm optimization, RBF.

GJSFR-H Classification : *FOR Code: 860399*

REGRESSION ANALYSISFOR PREDICTING WOOD PULP DEMAND BY PSO OPTIMIZATION

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Regression Analysis for Predicting Wood Pulp Demand by PSO Optimization

V. Anandhi [α] & Dr. R. Manicka Chezian [σ]

Abstract - In today's world, consumption of paper and paper-based products is increasing in all the fields. Wood pulp which is extracted from the wood chips is the most commonly used raw material to manufacture the papers. Demand and supply of the wood pulp determines the social-economical development of a country. Many forecasting methods are used to predict the future demands of the wood pulp so that the supply chain management can be planned. In this paper, support vector regression analysis methods are used to predict the demands of wood pulp and Particle Swarm Optimization (PSO) algorithm is proposed to optimize the parameters of kernel functions. Regression models were created by using the data collected from TNPL. The parameters such as Mean Magnitude Relative Error (MMRE) and Median Magnitude Relative Error (MdMRE) are used for evaluating the results. Evaluated result shows that proposed SVM regression with PSO approach gave improved accuracy with significant decrease in MMRE and MdMRE.

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I. Introduction

Pulp is a processed material from wood fibers and it can be used for the production of paper and paperboard. Different types of woods such as soft woods and hard woods are available to make the wood pulp in the pulp mills. Usually grounded wood is processed in pulp mills to produce the wood pulp and this wood pulp is used to produce papers in the paper industries. Sometimes waste papers are recycled in the paper mills and combined with wood pulp in the paper industries to produce papers [1]. Some mechanical processes, chemical processes and combined processes are used to create the pulp from the wood fibers. In the chemical process, small pieces of wood are heated with some standard so lutions in the required temperature and pressure. This heating dissolves the glue which combines the fibers and leaves the fibers of the type of cellular and gives paper with high quality. Pulp is retrieved up to 60% of the load used by the pieces of wood taken for heating.

Pulping by mechanical process separates cellulose fibers either with wet grind stones or using refiners. Wet grind stones are used to press the logs and refiners use metal disks to pass the wood chips in the revolving disks. Large quantity of pulp is yielded in mechanical pulping and sometimes the quality of pulp is low because some wastes cannot be detached. So mechanical pulping is used to produce lower cost grades of paper (used for newsprint). To produce varying quality of paper different combinations of chemical and mechanical processes can be used. The usage of paper and its related products are increasing in every year in exponential way. From the year 1981 to 2000, the consumption of paper in india was increased about 0.83 to 0.88 percentage in every year. But from the year 2000 to 2010 consumption was increased by more than 2%. The increase in the conumption of is caused by the factors such as changing lifestyle, growth in economics, raised rate of literacy, growth of media and the need of paper with high quality [2]. To meet the exponential growing need of the paper pulp, implantation of the trees is the only solution. Many studies about forests and agriculture plans for future suggested the implantation. Therefore, during the year 2004 to 2007 around 91 % of plantations were done in the farmlands of tamilnadu [3]. The papers can be classified into three types. They are cultural paper, industry paper and low cost paper. Cultural papers are used for the purpose of writing, industrial papers are used for packing purposes and low quality paper is used for printing newspapers. Some of the issues addressed in national forest policies [4] are,

1) Competition for land is increased among foresting, residential and other activities of development.
2) Investment by the private bodies to maintain the forest is very low.
3) Most of the industry developed products depend on the forest materials.
4) Some forests are degraded by nature.

In India, totally around 600 paper mills are running and most of the industries use wood as a most significant raw material [5]. Domestic supply of wood per year is about 2.6 million metric cubes and it is around 45 % of the industry consumption. Regression analysis is one of the statistical analysis method used to find the relationship between one dependent variable and many independent variables. There are two types of regression. They are linear regression and polynomial regressions. Linear regression uses one independent

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variable to predict the output variable. But multiple regressions use a series of independent variable to predict one dependent variable [6]. Classification and regression are two important statistics used for prediction. Classification maps an independent set of input values into an output value in a predetermined set of values. But prediction maps an independent set of values into a numeric value based on a predetermined relationship [7]. Support vector machine (SVM) is a classification algorithm used for classifying data into two predetermined classes. The aim of SVM is to maximize the margins between two classes so that the errors in the classification can be reduced. The data instance lies in the margins are called as support vectors. Accuracy achieved in classification inspires, to use this algorithm for regression analysis. Support vector regression (SVR) is based on the development of margin kernel methods. This SVR is used to find a relationship between input independent variables and output dependent variable. This relationship maps the values of variables in the input domain into the real output value [8]. Training sample was selected with possible input and output combinations [9]. Genetic Algorithms (GAs) are stochastic search algorithms used for problems that need optimization. GA takes initial population as a set of possible candidate solutions. Using the steps of selection, cross over and mutation of individual solutions in each iteration GA finds an optimal solution. Every solution is evaluated by the fitness function [10]. To improve the results of any regression model genetic algorithms can be used to tune the parameters used to represent the relationship between the input and output variables. But genetic algorithms do not use past search history and does not guarantee for optimized solutions. So swarm intelligence approaches inspired from the behaviour of some animals or insects can be used instead of GA algorithms for optimization. In this work, support vector regressions are used to forecast the demand supply of wood pulp and particle swarm optimization (PSO) is used for optimizing the parameters used for forming kernel function of SVM.

II. Literature Review

V. Anandhi, Dr. R. Manicka Chezian and Dr. K.T. Parthiban presented Forecast of Demand and Supply of Pulpwood using Artificial Neural Network [11]. To predict the future demand and supply of the wood pulp, a prediction model was developed by using artificial neural networks (ANN). The consumption of paper over last 10 years was collected from the tamilnadu newsprint and papers limited and used for training the ANN. Back propagation network was used for training the data. Every time validation error was checked and whenever the validation error was greater than a limit for 6 iterations, the training was terminated. This made the tuning of ANNs towards the forecasting problem of demand supply of wood pulps. This study created awareness in the need of wood pulp in future similar to other products of agriculture. V. Anandhi and R. Manicka Chezian presented Support Vector Regression to Forecast the Demand and Supply of Pulpwood [12]. To forecast the demand supply of wood pulp, SVM regression analysis was used with kernel functions. SVM was a machine learning method used to project the given data into a higher dimensional space. It maximized the margins between two different classes and minimized the regression error margin. Training data was collected from the demand and supply of paper mills over many years and support vector regression model is created. After training any data irrespective of training data could be given for testing. Training and testing using this method gave improved accuracy. Smruti Rekha Das et al presented an Improving RBF Kernel Function of Support Vector Machine using Particle Swarm Optimization [13]. SVM had been used as the most important and accurate tool for the classification, regression and any detection based algorithms. The main goal of SVM was to find the best margin used to separate the data and the outcome of interest was optional. SVM was used in linearly separable problems. To improve the accuracy of classification and regression using SVM optimization was introduced. In SVM-RBF kernel design Particle swarm optimization (PSO) was used to optimize the selection of parameters. After selection the number of features was reduced by principle Component analysis (PCA). Using the same data set algorithms using linear, polynomial and RBF kernel functions were tested and compared. Results showed that PSO optimization for RBF kernel gave improved accuracy.

Dimitri P. Solomatine and And Michael Baskara L. A. Siek presented Flexible and Optimal M5 Model Trees with Applications to Flow Predictions [14]. Numerical prediction was otherwise called as regression. M5-modelled decision tree was one of the classification methods and the tree was created by portioning the large size input space using the entropy measures and gave unique labels in the leaf nodes. The actual values of input parameters were applied from the root node down to the leaf node and the leaf node gave the classified label. For regression, leaf nodes were assigned the average of the output variable. If the input domain has complex regression relationships among them, the leaf nodes were designed to give the relationship functions rather than average value of the output variable. M5 tree was created progressively by dividing the input domain into many subsets. The division was stopped when the regression error was lesser then some acceptable error level from the training data. Reza Shah Hosseini, Saied Homayouni and Reza Safari presented a Modified algorithm based on Support Vector Machines for classification of hyper spectral images in a similarity space [15]. SVM-based classifier is a more accurate classification method when the size of the sample space is very small. The most important aspect of SVM classifier was the kernel function. The main purpose of kernel function was to minimize the distance between instances inside the cluster and maximize the distance between instances of different clusters. The design of kernel functions was done at the time of training process and then tested with test data. Finding best kernel was the time consuming process.

III. Methodology

The SVM-based regression [16] is a supervised strategy used to tune many number of parameters internally, whose values influence the SVM-generated approximation function and should be priory set by the trainer. SVM uses many number of trial-and-error searches to get the lowest regression error. PSO algorithms use the particle swarm intelligence and have more advantages than GA based algorithms. In GA, each iteration deletes the worst solutions by saving only the good solutions but in PSO, all the particles utilize the good solutions obtained by other particles.

To evaluate the accuracy of the regression methods several measures based on the calculation of error is used. Error is calculated by the difference between the actual and predicted values. Absolute percentage of error is represented by Magnitude Relative Error (*MRE*). MRE is computed by the following formula.

$$MRE_i = \frac{|actual_i - estimated_i|}{actual_i}$$

Mean Magnitude Relative Error (*MMRE*) is calculated by taking the average of *MREs* over all the reference projects. For some input domains the *MMRE* is sensitive to outliers if the number of observations is too large [17]. To reduce this sensitivity Median MREs can be used for n number of projects. Formulas to calculate MMRE and MdMRE are given as follows.

$$MMRE = \frac{1}{n}\sum_{i=1}^{n} MRE_i$$

$$MdMRE = \underset{i}{median}\left(MRE_i\right)$$

IV. Results and Discussion

Sample data is collected from the company Tamilnadu News Print Ltd. Supply demand combinations of wood pulp measured in metric tones are calculated for the past 10 years. Sample data collected is shown in table 1.

Table 1 : Sample Data of The Supply and Demand of Pulp Wood in MT (Metric Tonnes)

Year	Supply (in MT)	Demand (in MT)
2003	125954	133719
2004	123026	147505
2005	162935	164804
2006	210152	166471
2007	222478	180577
2008	347139	383315

Source: TNPL Management Plan

Figure 1 shows the actual and predicted values using algorithms such as M5, SVM kernel, SVM with RBF kernel, and SVM-kernal and PSO optimization method. Result shows that PSO optimization for parameters of kernel function gives minimum variations between the actual and predicted values.

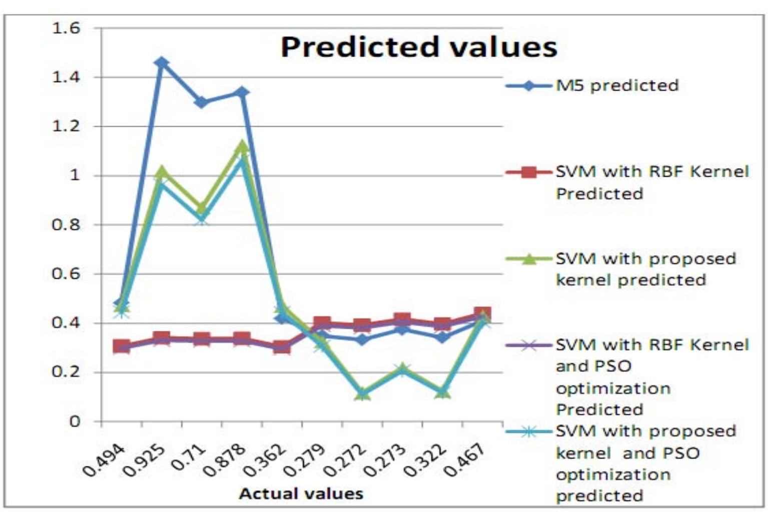

Figure 1 : Actual Vs Predicted Values

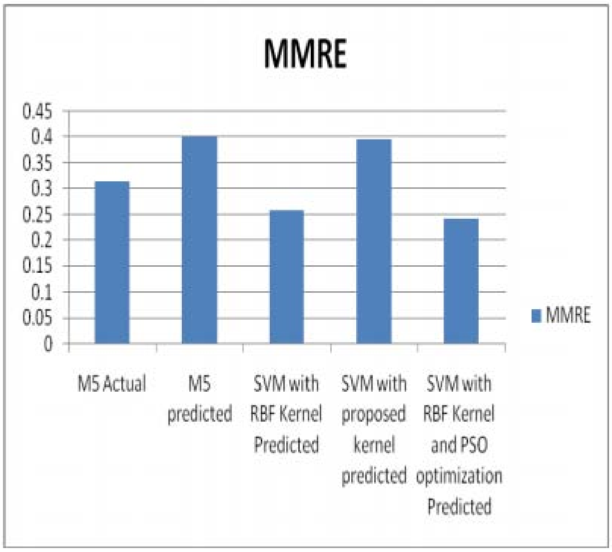

Figure 2 : MMRE

Figure 2 shows the Mean of Magnitude Relative error (MMRE) for the different regression methods using the experimental data. Graphical representation result shows that proposed PSO optimized algorithm with SVM kernel function for regression gives lowest MMRE.

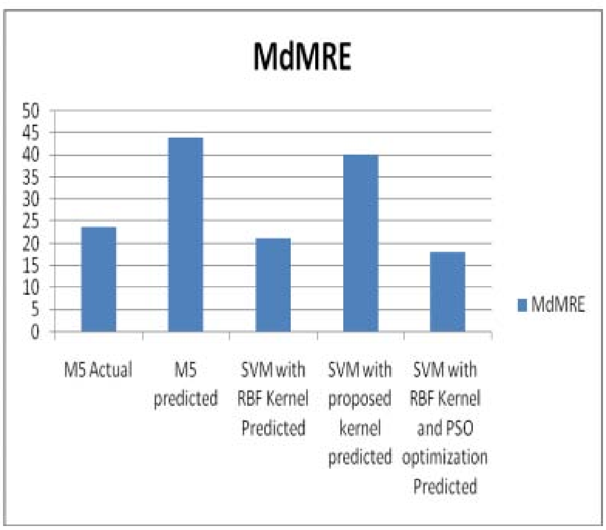

Figure 3 : MdMRE

Figure 3 shows the error measure using Mean of Magnitude Relative error (MMRE) for the different regression methods M5, SVM-kernal, SVM-RBF kernel with PSO optimization using the experimental data. Graphical representation result shows that proposed PSO optimized algorithm with SVM kernel function for regression gives lowest MdMRE.

V. Conclusion

Wood pulp demand and supply chain is an important factor in social and economical development of a country. As the demand is increasing in exponent way, forecasting the need of pulp is useful for the prediction of the market demand, planning alternative sources and planning implantation. In this paper, support vector regression analysis methods are used to predict the demands of wood pulp and Particle Swarm Optimization (PSO) algorithm is used to optimize the parameters of kernel functions to increase the accuracy of prediction. The parameters such as mean magnitude relative error (MMRE) and Median Magnitude Relative Error (MdMRE) are used for evaluating the results. Data is collected from TNPL and various algorithms such as M5, SVM, SVM with RBF kernel and SVM kernel functions with PSO optimization were used. Evaluated results show that proposed SVM regression with PSO approach gave improved accuracy with significant decrease in MMRE and MdMRE.

VI. Acknowledgements

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Petrological and Geochemical Characteristics of Pyroclastics Outcropping in Abakaliki Area Lower Benue Trough, Nigeria

By Igwe E. O., Ngwu C. N. & Edene E. N.
Ebonyi State University, Abakaliki, Nigeria

Abstract - Bakaliki pyroclastics are part of the volcanoclastics of the Lower Benue Trough Nigeria. The petrological and geochemical study of the pyroclastics was carried out; to evaluate and re-appraise their petrology, stratigraphic position and origin which have remained subjects of controversy in the Benue Trough Geology. The pyroclastics outcrop as enlongate and domical bodies that are large and massive. Field relationships indicate that the volcanoclastics occur within the Abakaliki Shale of the Asu River Group and in some places they interbed with the shales. They occur mostly as agglomerates and welded tuffs cut by several quartz filled veins and segregations. The agglomerates are porphyritic with angular fragments of shales embedded in them. The tuffs are very fine grained and aphanitic in texture. Petrographic data obtained from this study show plagioclase and augite as the major mineral constituents with quartz, olivine, calcite and iron oxide as the accessories. Devitrified glass shards are common in the rocks. They are of basaltic composition. Geochemical analysis shows that the pyroclastics are subakaline, tholeiitic rocks of thin continental crust origin. They are classified as basalts, basaltic andesites, dacites and rhyolites.

Keywords : abakaliki pyroclastics, benue trough, petrography, geochemistry.

GJSFR-H Classification : *FOR Code: 969999, 040299*

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Keywords : abakaliki pyroclastics, benue trough, petrography, geochemistry.

I. Introduction

The study area is geographically located in the southeastern Nigeria (Fig. 1). Abakaliki Pyroclastics occur as volcanoclastics within the Albian Abakaliki Shale (Asu-River Group) Lower Benue Trough Nigeria (Fig. 2). This study intends to examine the petrology and geochemical characteristics of the pyroclastics and decipher the petrology, origin and stratigraphic position of the pyroclastics which have been subjects of controversy. The occurrence of early Cretaceous volcanic rocks in the Benue Trough was first mentioned by Wilson and Bain (1925). Farrington (1952), Okezie (1957, 1965) and Reyment 1965 described the volcanic rocks which they considered to be in close genetic relationship with lead-zinc mineralization. They however failed to distinguish between these rocks and the more widespread Cretaceous to Tertiary alkaline igneous rocks in the Benue Trough. Okezie (1965) considered them to be andesitic rocks. Two controversial aspects of Nigerian Geology are the petrology and stratigraphic position of the Abakaliki pyroclastics and the origin and evolution of the Benue Trough. The pyroclastics are considered by some workers as lower Benue's oldest volcanic rocks formed during the rifting of the Afro-Brazilian plate in early Cretaceous time that led to the origin of the Benue Trough (Uzuakpunwa, 1974 and Olade, 1975). The Abakaliki Pyroclastics have been variously reported to be Albian or Aptian in age (Uzuakpunwa, 1974). Olade (1979) considered the unit to be older than Asu River Shale and to be overlying the Pre-Cambrian Basement. McConnell (1949) and De Swardt (1950) reported it to be interstratified with Albian Shales. A post-Albian age was advocated by Tattam (1930), Farrington (1952) and Pergeter (1957). The rocks have been variously described as pyroclastic flows, intrusive breccias, submarine spilites, andesitic tuffs, basaltic agglomerates or degraded alkali basalts (McConell, 1949; Tattam, 1930; Okezie, 1957, Olade, 1979). The study has shown that the pyroclastics are subakaline, tholeiitic rocks of thin continental crust origin, classified as basalts, basaltic andesites, dacites and rhyolites.

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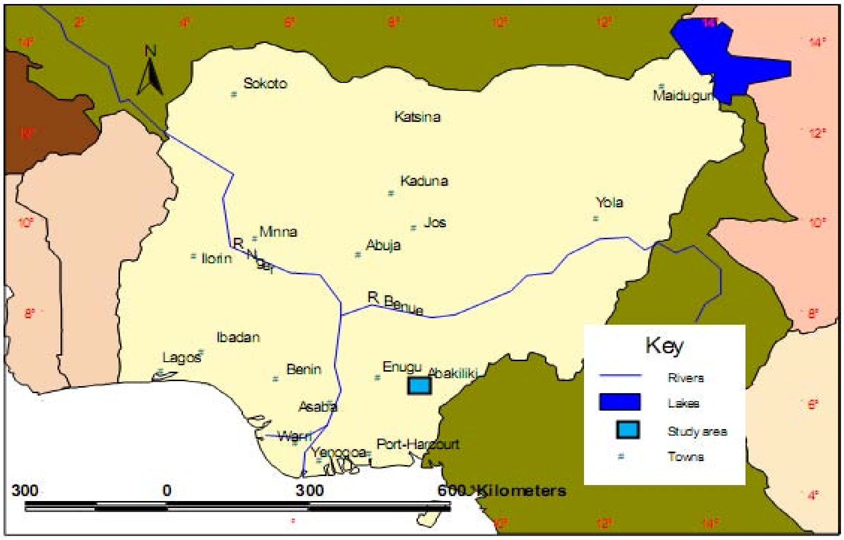

Figure 1 : Map of Nigeria showing the location of the study area and other major cities

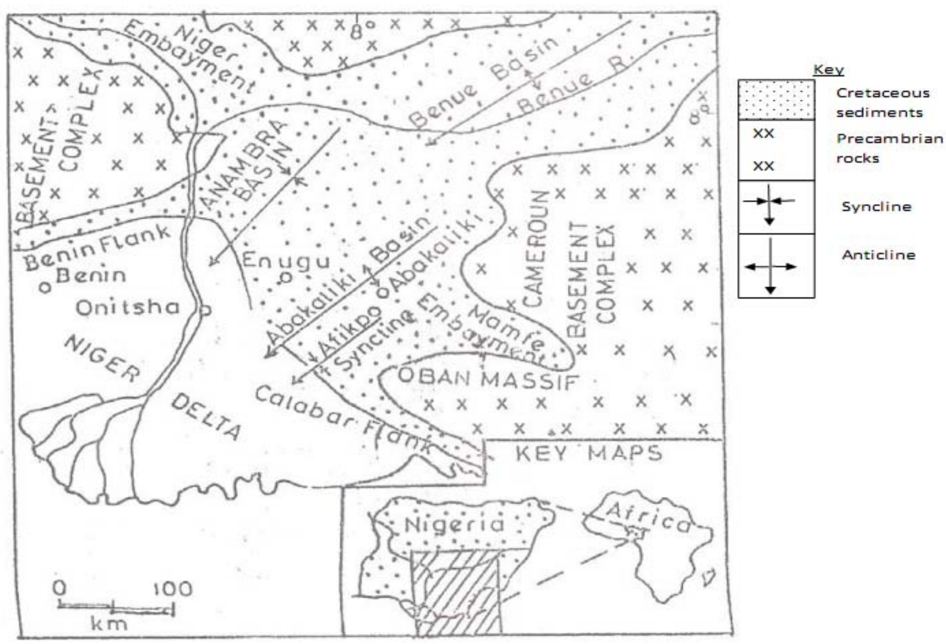

Figure 2 : Generalized map of sedimentary basins in southern Nigeria showing the position of Benue Trough. The Cretaceous basin is stipped (Modified from Hoque 1977)

II. Geologic Setting

In southern Benue Trough, the Albian sediments are the oldest Cretaceous sediment (Table 1) deposited as first marine sediments due to Albian marine transgression in the Abakaliki area. This was followed by the Cenomanian Odukpani Formation in the Calabar Flank (Reyment, 1965). Further transgression and regression took place during Turonian period which deposited Eze-Aku Formation and Awgu Shale (Coniacian) (Murat, 1972). The tectonic event of the Santonian led to uplift, folding and widespread erosion in the sediment fill of the Benue Trough. Another transgression occurred in the Campanian-Maastrichtian resulting in marine sediment. Prior to the marine incursion in the early Campanian, the Abakaliki Basin in the southern sector of the Trough was folded into series of anticlines. Thus the Anambra Basin and Afikpo Synclines became the major depocentres for the Campanian-Maastrichtian sediments (Murat, 1972). The Nkporo/Enugu Shale and Afikpo Sandstone member were deposited in these basins. The Abakaliki Anticlinorium formed the axis of the Santonian uplift and represent stable structural feature, which controlled the development of the associated basins (Anambra Basin and Afikpo Sub-Basin).

Table 1 : Stratigraphic sequence showing the position of Eze-Aku Group relative to other formations in southeastern Niger Hoqueia (Modified from, 1977)

AGE		STRATIGRAPHIC SEQUENCE		BASIN/ CYCLE
EOCENE		AMEKI /NANKA FM		ANAMBRA - AFIKPO BASIN (Second Sedimentary Cycle)
PALEOCENE		IMO SHALE		
UPPER CRETACEOUS	DANIAN	NSUKKA FM		
	MAASTRICHTIAN	AJALI SS		
		MAMU FM		
	CAMPANIAN	NKPORO GROUP/ ENUGU SHALE		
	SANTONIAN			UPLIFT + FOLDING
	CONIACIAN	AWGU FM		ABAKALIKI BASIN (First sedimentary Cycle)
	TURONIAN	EZE-AKU FM	Amasiri Ss / Eze-Aku Sh	
	CENOMANIAN	ODUKPANI FM		
LOWER CRETA.	ALBIAN	ASU RIVER GROUP		
PRE CAMBRIAN		BASEMENT COMPLEX		

III. Method of Study

The field aspect of the work involved description, measurements and sampling of the exposed sections of the Abakaliki Pyroclastics. The pyroclastics outcropping in Onu-ebonyi, Ogbaga, Juju Hill, Strabag quarry, Sharon mines and Azuinyiokwu Rivers were studied. Thin sections were prepared from the representative sandstone samples obtained in the field for thin section petrography which was studied under transmitted light petrographic microscope. Ten samples of the pyroclastic rocks were selected from the Onu-Ebonyi and Strabag quarries for geochemical analysis. The samples were crushed and ground to minus 200 mesh and analyzed using Atomic Absorption Spectrometer (AAS) for Fe, Mg, Ca, Na, K, Mn, P and Al. Mn and Al are analyzed using their respective lamps. Na and K are analyzed using Emission Spectrometry while P was analyzed using the Molybdenum-Blue method. All the elemental compositions were converted to their appropriate oxides and their percentages calculated.

IV. Results

a) Local Stratigraphy and Field relationships

Two most controversial aspects of Nigeria geology are the petrology and stratigraphic position of the Abakaliki Pyroclastics and origin and evolution of the Benue Trough (Hoque, 1984). The pyroclastics are considered by some workers as lower Benue's oldest volcanic rocks formed during the rifting of the Afro-Brazillian Plate in early Cretaceous times that led to the evolution of the Benue Trough. Based on field relationships, the pyroclastics exposed in Abakaliki area are grouped into two pyroclastic masses: the Onu-Ebonyi and Strabag quarry pyroclastic deposit.

The Onu-Ebonyi pyroclastics outcrops an enlongate feature and aligned on a NE-SW direction. The rock has been exposed as a large and massive outcrop due to quarrying. It is composed of agglomerates and tuffs (Fig. 3). The agglomerate is grey to dark in colour and porphritic in texture, comprising of angular to sub-angular fragments in a very fine grained groundmass. The tuffs are fine grained (aphanitic) with the colour ranging from grey to almost white. They show normal and graded bedding, as well as prominent cross-bedding or cross-laminations.

Figure 3 : Abakaliki Pyroclastic outcrop at Onu-Ebonyi showing tuffs (red arrow)

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The Pyroclastic deposit in Strabag quarry is a dome-shaped body that is large and massive. Quarrying activities expose the rock for study (Fig. 4). The lower levels consist of pyroclastic flows and vesicular rocks interbedded with shales. The main pyroclastic body comprises mainly of tuff with a lot of quartz veins/segregations (Fig. 5) and nodules characterized by lieseagang rings but dominantly light grey on weathered surfaces where they appear brownish to reddish. They show normal and graded bedding and are generally fine grained with occasional phenocrysts of olivine. The texture is ophitic with thin plagioclase lathes interwoven with pyroxene crystals. Mudstone and shale xenoliths characterize the rocks.

Figure 4 : Outcrop of Abakaliki Pyroclastics exposed by quarrying at Onu-ebonyi

Figure 5 : Outcrop of Abakaliki Pyroclastics showing quartz vein exposed at Strabag Quarry

b) Petrology

The texture of the rocks generally ranges from porphyrtic through oophitic to aphanitic. The porphyritic rocks have angular to subangular minerals as phenocrysts in groundmass of very fine grained minerals. The oophitic manifests as random orientations of enlongate/prismatic plagioclase laths in a groundmass of dominantly (Fig. 6) very fine grained equigranular matrix of plagioclase and pyroxene.

The thin section study of the rocks shows that the dominant minerals are plagioclase, augite, quartz and accessory iron oxides, olivine and calcite minerals. Vitric fragments showing extensive alteration are common (Fig. 6). The plagioclase crystals are lath-like and wholly and occasionally partially enclose the augite crystals. Quartz is present as randomly arranged subhedral crystals. Olivine is present as phenocrysts. Iron Oxide is also present as matrix/groundmass minerals randomly oriented. Calcite is present as secondary vein and void fillers. The modal composition of the rocks is shown in Table 2.

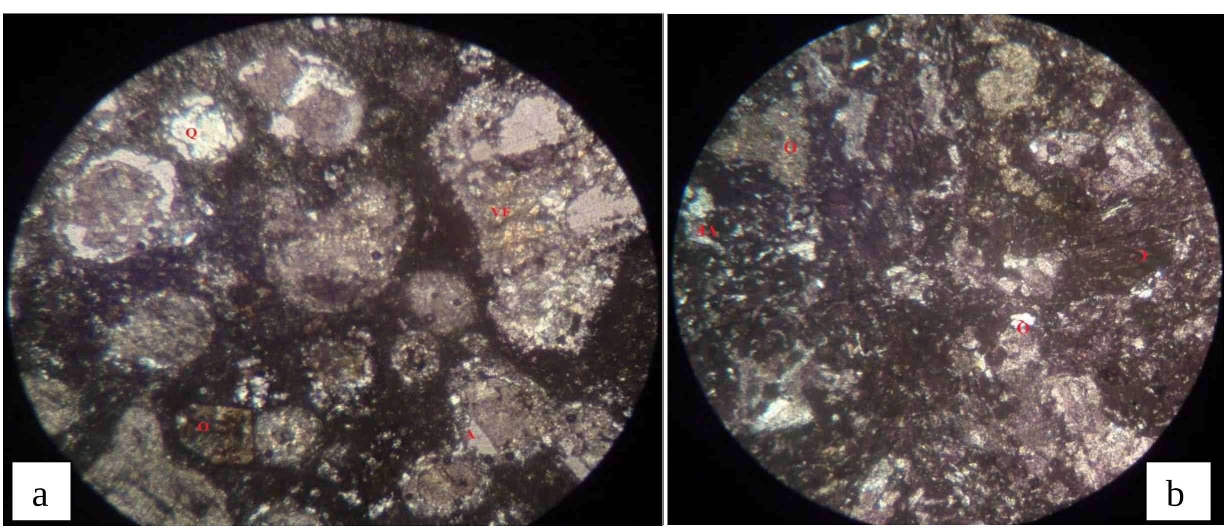

Figure 6 a & b : Photomicrograph of sample E4 and E7 showing Quartz (Q), Vitric fragments (VF), Olivine (O) and Albite

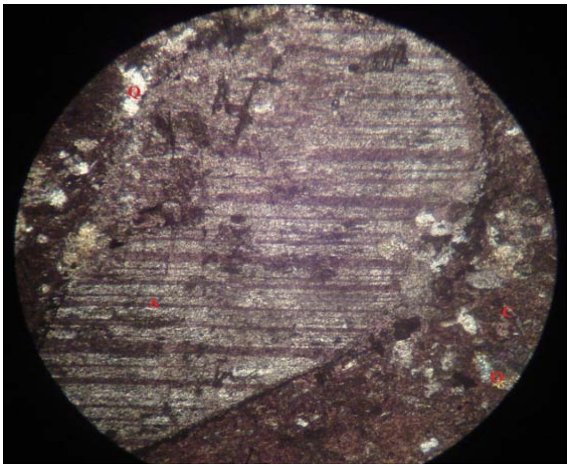

Figure 7 : Photomicrograph of sample E9 showing Albite (A), quartz (Q), Olivine (O) and Calcite (C)

Table 2 : Modal Composition of the Pyroclastic Rocks

Mineral	E1	E2	E3	E4
Quartz	40%	25%	20%	20%
Plagioclase	20%	35%	30%	30%
Augite	10%	15%	15%	10%
Olivine	10%	5%	5%	10%
Iron Oxide	10%	10%	15%	20%
Calcite	5%	10%	15%	10%

c) Geochemistry

The result of the geochemical analysis shows silica content of not less than 53.97% (Table 3). Samples E1, E2, E5, E7 and E8 show highest silica contents ranging from 70.04% to 81.01%. Samples E3, E4,E6, E9 and E10 have lower silica contents ranging from 53.97% to 66.44%. The Fe_2O_3 and MgO contents of the rocks are relatively high with Fe ranging between 7.57% and 20.11% and Mg between 6.14% and 14.24%. CaO content is high for samples E2,E 3, E5, E6 and E10. It varies from 7.09% to 12.5% and low for samples E1, E4, E7, E 8 and E9 varying from 0.73% to 4.71%. The total alkali (Na_2+K_2O) content is low for these rocks. The values range from 0.109% to 0.256%. MnO is low, values range from 0.014 to 0.755%. P_2O_5 and Al_2O_3 are also low though P_2O_5 is much lower. Generally the pyroclastic rocks appear to be higher in SiO_2, Fe_2O_3, MgO contents as compared to the other oxides (Table 3).

Table 3 : Chemical Analyses results for the Pyroclastic Rocks Converted to Percentages (%)

Sample Nos	SiO_2	Fe_2O_3	MgO	CaO	Na_2O	K_2O	MnO	P_2O_5	Al_2O_3	TOTAL	Na_2O + K_2O
E1	81.01	7.69	6.80	2.44	0.14	0.035	0.165	0.00021	1.83	99.90	0.175
E2	70.93	8.37	10.43	7.71	0.15	0.033	0.622	0.00054	1.75	99.99	0.183
E3	58.49	17.6	13.97	7.09	0.204	0.044	0.473	0.00052	2.08	99.95	0.448
E4	59.40	20.11	13.29	0.89	0.149	0.029	0.097	0.003	6.03	99.99	0.178
E5	70.04	10.25	6.14	12.44	0.118	0.106	0.319	0.00019	0.59	100	0.224
E6	66.44	13.81	6.29	11.69	0.153	0.103	0.199	0.00014	1.34	99.30	0.256
E7	79.0	8.09	1.51	4.71	0.143	0.039	0.152	0.00014	1.34	99.98	0.182
E8	72.7	12.25	8.71	2.18	0.122	0.036	0.124	0.00018	3.70	99.91	0.158
E9	61.9	18.28	12.10	0.73	0.089	0.0305	0.014	0.00029	6.70	99.92	0.1195
E10	53.97	12.69	14.24	12.5	0.083	0.026	0.755	0.00021	5.74	100	0.109

The plot of the total alkali against the total silica content of the rocks (Fig.8) shows that all the pyroclastic rock samples from the study area plot within the subalkaline rocks suite. Subalkaline rocks are grouped into the tholeiitic and calc-alkaline suites. The tholeiitic rocks show stronger environment in Fe relative to Mg than calc-alkaline rocks and generally have less variation in silica and alkalines (Best and Christiansen, 2001). The plot of K_2O against Si_2O is represented in Fig. 9; generally, the K_2O content of the rock is very low varying from 0.029% to 0.106% (Table 3). Their Fe content is high relative to the Mg composition of the rocks (Table 3). These however suggest that the rocks are tholeitic. There is variation in composition of the pyroclastics from basaltic andesites through andesites to dacites and rhyolites. They are classified as intermediate and acid rocks. Samples E10, E 3, E 4 and E9 are andesitic rocks with silica percentage of 53.97%, 58.49%, 59.49% and 61.9% respectively (Table 3). Dacites and rhyolites are acidic rocks (silica content > 66%). Rhyolites are less common tholeitic rocks than dacites. Samples E6, E5 and E8 represent dacites and samples E7 and E1 are rhyolitic in composition. The plots of MgO against CaO Fig. 10 demonstrate that the rocks are extruded from a region of thin continental crust. Tholeitic rocks occur where the crust is oceanic and relatively mafic or at the thin continental crust (Best and Christiansen, 2001).

The representations in Fig. 11 distinguishes the tholeitic differentiation trend of Fe enrichment with limited felsic derivatives and the calc-alkaline differentiation trend of limited Fe enrichment and abundant felsic derivatives.

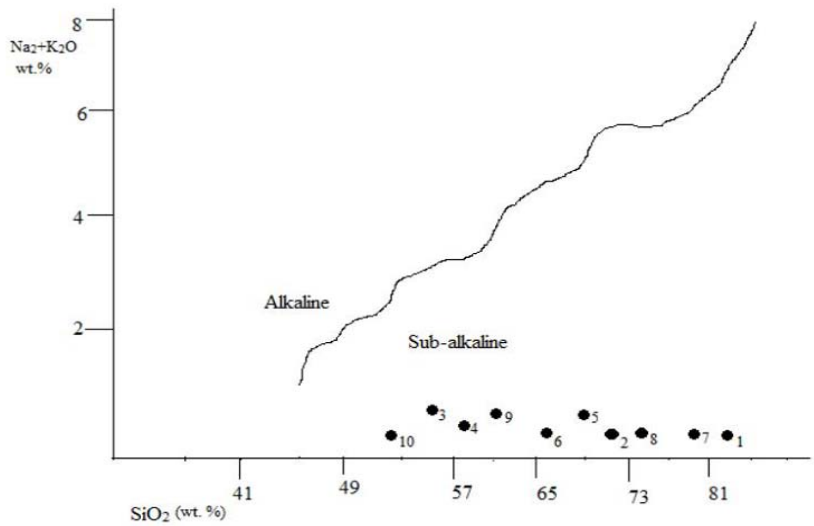

Figure 8 : Plot of total alkali ($Na_2O + K_2O$) against total silica (SiO_2) content of the rocks (method of Le Bas et al 1992)

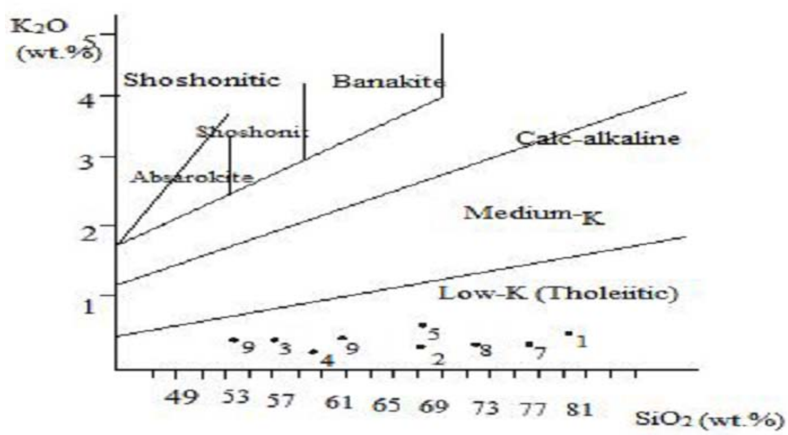

Figure 9 : Plot of K_2O against Si_2O (Method of Ewart, 1982)

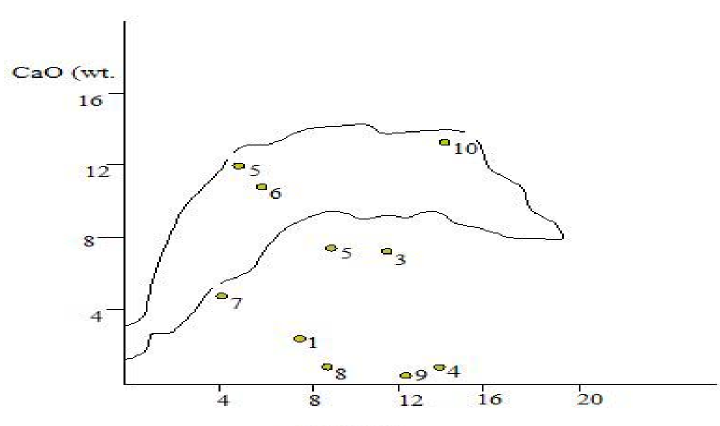

Figure 10 : Plot of CaO against MgO (after Davidson, 1996)

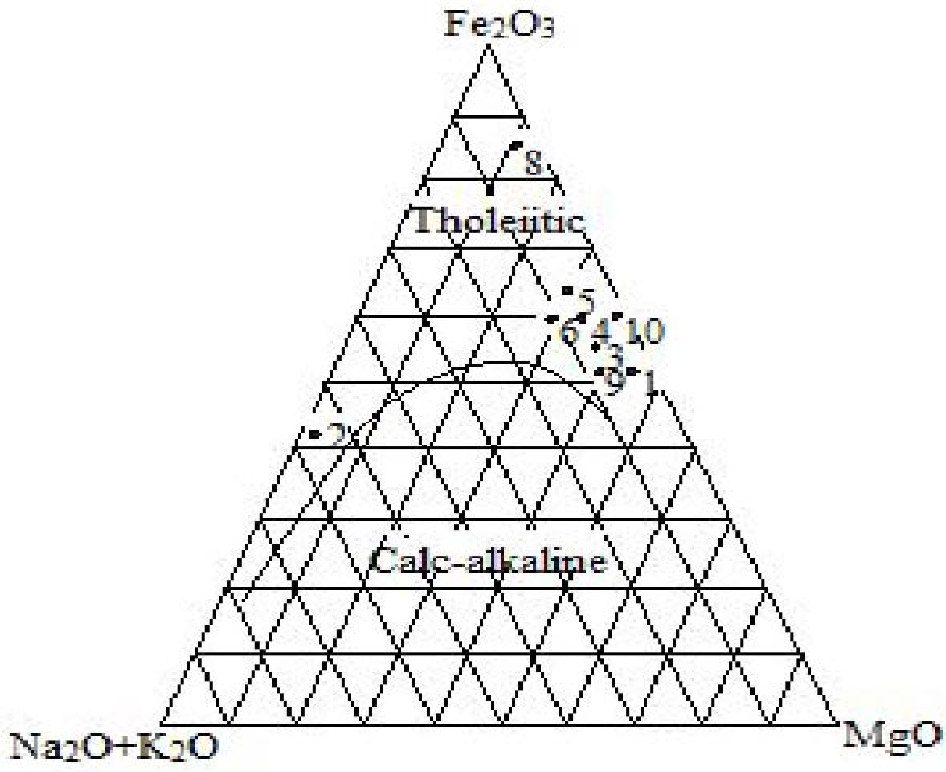

Figure 11 : Variation diagram showing the relationship of Fe_2O_3 with Na_2O_3 + K_2O and MgO (Method of Best and Christiansen, 2001)

V. Discussion

The petrology and geochemistry of the Abakaliki Pyroclastics as presented in this study have implications on earlier thoughts on the origin and evolution of Benue Trough. Most workers associate the origin of the trough to the splitting of the Afro-Brazilian plate in early Cretaceous time (Hoque, 1984). The trough is portrayed as a rifted depression (Kings, 1950; McConnell, 1969) or a failed arm of an RRR triple junction involving the Gulf of Guinea, the South Atlantic and the Benue Trough (Burke et al 1971, 1972; Burke and Dewey, 1973). Within the concept of plate tectonics, Burke et al (1972) postulated an active oceanic spreading along the Benue Trough and formation of about 150-200km wide of oceanic crust beneath the lower trough followed subduction motion along a Benioff zone which gave rise to more than 1300m of andesitic, basaltic and pyroclastic rocks. Olade (1975, 1979) cited Abakaliki Pyroclastics and associated intrusive as an evidence of initial volcanic activity related to a plume generated rifting of the Afro-Brazillian plate and regarded these volcanic forming a substratum of the rifted basin.

Olade (1979) proposed that the pyroclastics are not andesitic lavas and tuffs as opined by Burke et al, 1971) but rather are altered alkali basalts, pyroclastic flows and tuffs. He interpreted the pyroclastics as product of hotspot activity associated with initial continental rifting during Aptian-Albian times. Hoque (1984) said that the generating magma of the pyroclastics was dominantly alkaline and silica under-saturated and had no affinity with magma characteristic of andesitic volcanism at a convergent plate boundary or with a tholeitic and silica-oversaturated magama typical of a zone of oceanic spreading (Bailey, 1974, 1977).

The compositions of the pyroclastics as shown in the variation diagrams suggest that the parent magma of these rocks was subalkaline and silica saturated. The rocks include basalts, basaltic andesite, dacite and rhyolites of thin continental crust. From the field relationships, the pyroclastics are found interbedded with shales in some places and outcropping as enlongate and domical bodies. The interbedded nature invalidates Uzuankpunwa (1974) and Olade's (1979) ideas that the pyroclastics form the initial substratum for the Trough. The interbedding of the pyroclastics with the country rocks indicates both long age range and multiplicity of extrusive volcanic episodes interspersed with marine sedimentation for these sedimentary rocks of igneous origin.

VI. Conclusions

The Abakaliki pyroclastics are rocks of intermediate to acid composition. They are mainly basalts, basaltic andesites and dacites. Basaltic andesites and dacites are the dominant rock types suggesting silica-rich parent magma. This fact is collaborated by the presence of quartz enclaves and segregations in the field. This agrees with Okezie (1965) and Burke et al (1972) who suggested that the pyroclastic rocks are andesitic lavas and tuffs and had affinity with a magma characteristic of andesitic volcanism and silica over saturated magma (Bailey, 1974, 1977).

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Statistical Assesment of Ground Water Quality using Physico-Chemical Parameters in Bassi Tehsil of Jaipur District, Rajasthan, India

By Umesh Saxena & Swati Saxena
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Abstract - Water is an essential natural resource for sustaining life and environment but over the last few decades the water quality has been deteriorated due to its over exploitation. Water quality is essential parameter to be studied when the overall focus is sustainable development keeping mankind at focal point. Groundwater is the major source of drinking water in rural as well as in urban areas and over 94% of the drinking water demand is met by groundwater. The study has been carried out to assess the ground water quality and its suitability for drinking purpose in most rural habitations of Bassi tehsil of Jaipur district, Rajasthan, India. For this purpose, 50 water samples being collected from hand pumps, open wells and bore wells of villages of study area were analysed for different physicochemical parameters such as pH, electrical conductivity, total alkalinity, total hardness, calcium hardness, magnesium hardness, chloride, nitrate, fluoride and total dissolved solids.

Keywords : groundwater quality, physico-chemical parameters, statistical parameters, ph, electrical conductivity, total alkalinity, total hardness, calcium hardness, magnesium hardness, chloride, nitrate, fluoride and tds, bassi tehsil, and rajasthan.

GJSFR-H Classification : *FOR Code: 880206, 960608*

STATISTICAL ASSESMENT OF GROUND WATER QUALITY USING PHYSICO-CHEMICAL PARAMETERS IN BASSI TEHSIL OF JAIPUR DISTRICT, RAJASTHAN, INDIA

Strictly as per the compliance and regulations of :

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Umesh Saxena [α] & Swati Saxena [σ]

Abstract - Water is an essential natural resource for sustaining life and environment but over the last few decades the water quality has been deteriorated due to its over exploitation. Water quality is essential parameter to be studied when the overall focus is sustainable development keeping mankind at focal point. Groundwater is the major source of drinking water in rural as well as in urban areas and over 94% of the drinking water demand is met by groundwater. The study has been carried out to assess the ground water quality and its suitability for drinking purpose in most rural habitations of Bassi tehsil of Jaipur district, Rajasthan, India. For this purpose, 50 water samples being collected from hand pumps, open wells and bore wells of villages of study area were analysed for different physico-chemical parameters such as pH, electrical conductivity, total alkalinity, total hardness, calcium hardness, magnesium hardness, chloride, nitrate, fluoride and total dissolved solids.

pH value in the study area found from 6.3 to 8.7. EC ranges from 1100-16000 μmhos/cm and total alkalinity between 70 to 990 mg/L. Total hardness ranged from 30 to 980 mg/L and calcium hardness from 10 to 480 mg/L. Magnesium hardness varied from 20 to 500 mg/L and chloride from 20 to 3620 mg/L. Values of nitrate concentration varied from 9 to 224 mg/L and fluoride from 0.28 to 11.5 mg/L while value of TDS ranges from 770 to 11200 mg/L. The study reveals that almost all parameters were exceeding the permissible limits. As per the desirable and maximum permissible limit for fluoride and nitrate in drinking water, determined by WHO, BIS and ICMR standards, 64% and 42% of groundwater sources are unfit for drinking purposes respectively. Due to the higher fluoride level in drinking water, the several cases of dental and skeletal fluorosis have appeared at alarming rate in this region. After evaluating the data of this study, it is concluded that drinking water of Bassi tehsil is not potable and there is an instant need to take ameliorative steps in this region to prevent the population from adverse health effects.

Keywords : groundwater quality, physico-chemical parameters, statistical parameters, ph, electrical conductivity, total alkalinity, total hardness, calcium hardness, magnesium hardness, chloride, nitrate, fluoride and tds, bassi tehsil, and rajasthan.

I. Introduction

"Water is life's matter and matrix, mother and medium. There is no life without water." In now a days, the modern civilization, urbanization and expanded population resulting with industrial operation has intensified the old problem of polluting our life, mother and medium. At present our life, mother and medium is being polluted and even worse situation is that we encounter with scarcity of this degraded quality of water too. It has raised certain basic challenges in our environment and we have been suffering both the problems of quality and quantity of water. In India groundwater is the major source of drinking water and over 94% of the drinking water demand is met by groundwater. Water quality is essential parameter to be studied when the overall focus is sustainable development keeping mankind at focal point, since it is directly linked with human welfare.

Statistical investigation offers more attractive options in environment science, though the results may deviate more from real situations (Nemade and Shrivastava, 1997). The correlation provides an excellent tool for the prediction of parametric values within a reasonable degree of accuracy (Venkatachalam and Jabenesan, 1998). The quality of water is described by its physical, chemical and microbial characteristics. But, if some correlations are possible among these parameters, then the more significant ones would be useful to indicate fairly the quality of water (Dhembare and Pondhe, 1997). A systematic study of correlation of the water quality parameters not only helps to assess the overall water quality but also to quantify relative concentration of various pollutants in water and provides necessary clue for implementation of rapid water quality management programmes (Dash et al, 2006).

Rajasthan is the largest state in the country in terms of geographic spread. It has an area of 342,239 lakh Sq kms being largest state of the country having 10.41 % of the country's area and 5.5% of nation's population but has low water resources i.e. 1% of the country's resources. The state has extreme climatic and geographical condition and it suffers both the problems of quantity and quality of water.

Review on the literature showed that no studies have been undertaken in the study area in regard to physico-chemical characteristics of water yet. So the objective of this study is to investigate the quality of drinking water (underground water) in most rural habitations of Bassi Tehsil of Jaipur, Rajasthan, India.

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II. Materials and Methods

a) Study Area

Jaipur district with geographical area of 11,151 sq. km forms the East-central part of Rajasthan (INDIA) which is administered by 13 tehsils and 13 blocks. The district covers about 3.3% of total area of the State. Jaipur, the capital city is also popularly known as Pink city and is situated towards central part of the district. The semi-arid district receives normal annual rainfall of 527mm (1901-71) while average annual rainfall for the last 30 years (1977-2006) is 565mm. Over 90% of total annual rainfall is received during monsoon. (CGWB, 2007; JDA, 2012)

Bassi Tehsil of Jaipur district is almost 29 KM far away from the main city having the area of 654.69 sq. km. It is located at $26^0 96'$ N latitude and $75^0 62'$E longitude. In Bassi Tehsil there are 210 villages (famous for their leather footwear and Embroidery beading). There are no major surface water sources in the study area however, main sources of drinking water are open wells, hand pumps and bore wells.

b) Water Sampling

Ground water samples of a total of 50 villages in Bassi Tehsil of Jaipur district were collected in pre-cleaned and rinsed polythene bottles of two litres capacity with necessary precautions (Brown et al. 1974). The samples were collected, during April 2012 to March 2013 from manually operated hand pumps, open wells and bore wells.

c) Physico-chemical Analysis

All the samples were analyzed under the following Physico-chemical parameters; pH, Electrical Conductivity (EC), Total Alkalinity (TA), Total Hardness (TH), Calcium hardness (Ca H), Magnesium hardness (Mg H), Chloride, Nitrate, Fluoride and Total Dissolved Solid (TDS). The analysis of water samples were carried out in accordance to the standard analytical methods (APHA, 2005). All the chemicals used were of AR grade and double distilled water used for preparation of solutions. Details of the analysis methods are summarized in Table-1.

Table 1 : Parameters and methods employed in the physicochemical examination of water samples

S.No.	Parameters	Unit	Method Employed
1.	pH	-	Digital pH-meter
2.	Electrical Conductivity	µmhos/cm	Digital Conductivity-meter
3.	Total Alkalinity	mg/l	Titrimetric method (With HCl)
4.	Total Hardness (as $CaCO_3$)	mg/l	Titrimetric method (with EDTA)
5.	Calcium Hardness (as $CaCO_3$)	mg/l	Titrimetric method
6.	Magnesium Hardness (as $CaCO_3$)	mg/l	Titrimetric method
7.	Chloride (as Cl^-)	mg/l	Titrimetric method (With $AgNO_3$)
8.	Nitrate (as NO_3^-)	mg/l	Spectrophotometric method
9.	Fluoride (as F^-)	mg/l	Ion Selective Electrode
10.	Total Dissolved Solids	mg/l	Digital Conductivity-meter

d) Statistical Analysis

In the present study Minimum, Maximum, Average, Standard Deviation and Correlation coefficient (r) have been calculated for each pair of water quality parameters by using Excel spreadsheet for the experimental data.

The standard formulae were used in the calculation for statistical parameters are as follows (S.P. Gupta, 1999):

$$Mean\ (\mu) = \frac{\sum x}{N}$$

x = Value of Observation

N = Number of Observation

$$\text{Standard Deviation } (\sigma) = \sqrt{\frac{n\sum x^2 - (\sum x)^2}{n(n-1)}}$$

x = Values of Parameter

n = Number of Observations

$$\text{Karl Pearson's Coefficient of Correlation } r = \frac{n\sum xy - \sum x \sum y}{\sqrt{n\sum x^2 - (\sum x)^2}\sqrt{n\sum y^2 - (\sum y)^2}}$$

x, y = Values of array 1 and array 2 respectively.

n = Number of Observations

III. Result and Discussion

The respective values of all water quality parameters in the groundwater samples are illustrated in Table-2. All the results are compared with standard permissible limit recommended by the Bureau of Indian Standards (BIS), Indian Council of Medical Research (ICMR) and World Health Organization (WHO), depicted in Table-3. Statistical Parameters of groundwater samples of study area are summarized in Table-4.

a) pH

pH is measure of intensity of acidity or alkalinity of water. All chemical and biological reactions are

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directly dependent upon the pH of water system (Rao, 2006). In our findings pH varied between 6.3-8.7. Maximum pH was recorded at S41 in village *Dhani Baba Ki* and minimum pH was recorded at S20 in village *Ateri*, which are not within the permissible limit prescribed by BIS, ICMR and WHO. The variation of pH in ground water samples of study area has been depicted in Figure – 1, which shows that most of the samples are alkaline in nature. The pH of water is very important indication of its quality and provides information in many types of geochemical equilibrium or solubility calculations (Mitharwal et al., 2009).

b) *Electrical Conductivity*

The electrical conductivity of water depends on the concentration of ions and its nutrient status. Based on electrical conductivity values, the water quality can be classified as poor, medium or good (Gulta, Sunita, & Saharan, 2009). In the present investigation maximum conductivity 16000 μmhos/cm was observed at S20 in village *Ateri* and minimum 1100 μmhos/cm at S30 in village *Todabhata.* The maximum limit of EC in drinking water has been prescribed as 1400 μmhos/cm (WHO: 2006), Samples are exceeding the permissible limit extremely as shown in Figure- 2.

Table 2 : Analysis of ground water quality parameters in villages of Bassi Tehsil (Jaipur, Rajasthan, India)

S.No.	Sampling Site	Cod	pH	EC	Alk. mg/l	TH mg/l	Ca H mg/l	Mg H mg/l	Cl^- mg/l	NO_3^- mg/l	F^- mg/l	TDS mg/l
1.	Kanota	S1	7.4	3100	650	100	70	30	280	20	1.78	2170
2.	Dyarampura	S2	8.5	4100	710	250	110	140	540	84	1.2	2870
3.	Bassi	S3	8.5	2100	560	120	40	80	150	109	1.8	1470
4.	Naya Bagrana	S4	8.4	3700	70	590	250	340	470	186	1.02	2590
5.	Moondli	S5	8.4	3400	990	90	30	60	290	10	3.89	2380
6.	Bishanpura	S6	8.0	3100	700	180	70	110	410	15	2.4	2170
7.	Roopura	S7	8.4	3300	80	770	370	400	60	27	11.5	2310
8.	Hardi	S8	8.2	3300	350	970	470	500	110	13	4.6	2310
9.	Ralawata	S9	8.2	3200	80	760	360	400	60	25	11.0	2240
10.	Hardhyanpura	S10	8.0	3200	350	980	480	500	110	11	4.4	2240
11.	Heerawala	S11	8.2	3200	340	960	460	500	100	10	4.2	2240
12.	Ramratanpura	S12	8.4	3300	280	980	480	500	120	10	4.1	2310
13.	Biharipura	S13	8.2	3300	880	100	40	60	300	16	4.0	2310
14.	Handi	S14	8.1	2743	780	150	60	90	210	75	10.0	1920
15.	Akhepura	S15	8.0	3500	520	220	100	120	460	76	0.69	2450
16.	Banskhoh	S16	7.7	1900	400	360	120	240	100	48	2.6	1330
17.	Peipura	S17	7.8	3300	260	950	450	500	400	12	1.7	2310
18.	Jhajhawad	S18	7.2	6000	640	280	130	150	1320	68	0.48	4200
19.	Sankh	S19	6.5	4500	380	870	410	460	720	142	1.1	3150
20.	Ateri	S20	6.3	16000	90	660	280	380	3620	146	0.36	11200
21.	Barala	S21	7.3	5200	480	120	40	80	720	206	4.3	3640
22.	Hanumanpura	S22	6.9	5100	160	80	30	50	880	224	2.1	3570
23.	Peepalabai	S23	7.3	4300	710	60	20	40	560	50	3.1	3010
24.	Basedi	S24	7.2	3000	160	180	80	100	480	48	1.6	2100
25.	Mandurupura	S25	7.7	2600	680	280	120	160	120	202	0.28	1820
26.	Ghasipura	S26	8.3	2300	760	70	30	40	50	26	11.4	1610
27.	Ramsinghpura	S27	8.3	2200	800	70	30	40	70	26	10.9	1540
28.	Baseri	S28	8.3	1600	540	70	30	40	60	9	6.4	1120
29.	Gangarampura	S29	8.2	2200	810	80	30	50	90	29	11.4	1540
30.	Todabhata	S30	7.1	1100	320	70	20	50	30	68	0.4	770
31.	Jagdishpura	S31	8.4	2000	140	50	20	30	50	33	6.2	1400
32.	Ramrakhpura	S32	8.1	1700	520	30	10	20	80	60	0.5	1190
33.	Nangalkarna	S33	8.0	2300	800	70	30	40	80	29	5.9	1610
34.	Danau Khurd	S34	7.2	1300	360	170	60	110	100	106	4.5	910
35.	Sewapura	S35	7.4	1700	560	40	20	20	30	24	0.54	1190
36.	Ramsar	S36	6.8	1700	470	90	30	60	180	68	0.58	1190
37.	Dubali	S37	8.0	1600	520	60	20	40	40	48	0.99	1120
38.	Virajpura	S38	7.6	1400	420	220	90	130	20	22	0.95	980
39.	Kishanpura	S39	8.0	1500	440	160	70	90	20	20	1.9	1050
40.	Tungi	S40	8.1	1200	440	60	20	40	20	12	0.59	840

41.	Dhani Baba ki	S41	8.7	3300	730	150	60	90	350	12	2.15	2310
42.	Bainada Mod	S42	8.5	2300	840	250	110	140	100	59	0.98	1610
43.	Danau Khurd	S43	8.2	2400	450	280	120	160	140	22	2.9	1680
44.	Anantpura	S44	8.3	2100	460	150	60	90	170	18	1.8	1470
45.	Ratanpura	S45	8.4	1500	480	90	30	60	70	24	1.5	1050
46.	Kaneta	S46	8.4	1700	560	70	30	40	40	14	0.7	1190
47.	Nimora	S47	8.2	2700	520	50	20	30	80	11	3.2	1890
48.	Kesopura	S48	8.2	2200	810	50	20	30	80	25	5.8	1540
49.	Kawarpura	S49	7.4	1943	110	210	90	120	340	86	1.1	1360
50.	Madhogarh	S50	8.0	1500	470	80	30	50	50	23	2.2	1050

c) Total Alkalinity

Total Alkalinity ranges from 70 mg/L to 990 mg/L, the maximum value was recorded in village *Moondli* (S5) and minimum in village *Naya Bagrana* (S4). Variation in total alkalinity of ground water samples is represented in Figure- 3 which clearly depicts that these values are more than the permissible limits of BIS, ICMR and WHO. In ground water, most of the alkalinity is caused due to carbonates and bicarbonates.

d) Total Hardness

Hardness is the property of water which prevents lather formation with soap and increases the boiling point of water. Hardness of water mainly depends upon the amount of calcium or magnesium salt or both (Singh et al. 2012). It is an important criterion for determining the usability of water for domestic, drinking and many industrial supplies (Mitharwal et al., 2009). In our findings, the value of hardness fluctuates from 30 mg/L to 980 mg/L (Figure-4), which are beyond the permissible limit as prescribed by BIS, ICMR and WHO. The minimum value was found in S32 (Village- *Ramrakhpura*) and maximum value was found in samples S10 and S12 (village- *Hardhyanpura and Ramratanpura*).

e) Calcium Hardness

Calcium Hardness varies from 10 mg/L to 480 mg/L as illustrated in Figure-5. It may be due to the presence of high amounts of calcium salts in ground water samples.

f) Magnesium Hardness

Magnesium Hardness of groundwater varies from 20 mg/L to 500 mg/L as shown in Figure-6. High values of magnesium hardness can be attributed to the large amounts of magnesium salts in ground water.

g) Chloride

Chloride contents in fresh water are largely influenced by evaporation and precipitation. Chloride ions are generally more toxic than sulphate to most of the plants and are best indicators of pollution (Rao, 2006). Chloride found high during the study ranged from 20 mg/L to 3620 mg/L (Figure-7). Minimum value was observed at samples S38, S39 and S40 and maximum value was observed at S20 in village *Ateri*. These unusual concentrations may indicate pollution by organic waste. Chloride salts in excess of 100 mg/L give salty taste to water and when combined with calcium and magnesium, may increase the corrosive activity of water (Tatawat and Singh- Chandel, 2007).

h) Nitrate

During the study Nitrate fluctuated between 9.0 to 224 mg/l (Figure-8) which is beyond the permissible limit of BIS, ICMR and WHO. In presence of high concentration of nitrate drinking water is toxic (Umavathi et al. 2007). Due to higher concentration (over 100 mg/L) of nitrate in water, infants, less than six months old, have been suffering from methamo-globinemia or blue baby disease.

i) Fluoride

Fluoride is important in human nutrition for the normal development of bones. The required level of fluoride is 1.0 to 1.5 mg/L. Higher concentration of fluoride in ground water appears to create dental, skeletal and non-skeletal fluorosis. Fluoride concentration in sampling sites ranges from 0.28 to 11.5 mg/L in ground water samples, with lowest value 0.28 mg/L (S25) in village *Mandurupura* and highest value 11.5 mg/L (S7) in village *Roopura.* As shown in Figure-9 and Table-2, most of the samples are having fluoride concentration more than the permissible limit and suffering from the acute fluoride problems.

j) Total Dissolved Solids

Total dissolved solid is an important parameter for drinking water and water to be used for other purposes beyond the prescribed limit, it imparts a peculiar taste to water and reduce its potability (Sandeep Mitharwal et al., 2009). Total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of Calcium, Magnesium, Sodium, Potassium, Manganese, organic matter salt and other particles (Siebert et al., 2010). In the present finding TDS value varied from 770 to 11200 mg/L (Figure-10), which is also not within the prescribed permissible limits. Maximum TDS recorded at S20 in village *Ateri* and minimum at S30 in village *Todabhata*.

Table 3 : Standards for drinking water quality

S. No.	Parameter	BIS: 1999	ICMR: 1975	WHO: 2006
1.	pH	6.5-8.5	7.0-8.5	6.5-8.5
2.	EC (µmhos/cm)	-	-	1400
3.	TA	600	600	120
4.	TH	600	600	500
5.	Cl-	1000	200	200
6.	NO_3^-	100	50	45
7.	F^-	1.5	1.5	1.5
8.	TDS	2000	1500	500

Table 4 : Statistical parameters of the different chemical constituents of ground water of the study area

S.No.	Parameter	Minimum	Maximum	Average	Standard Deviation
1.	pH	6.3	8.7	7.89	0.56
2.	EC	1100	16000	2957.72	2178.90
3.	TA	70	990	492.6	238.06
4.	TH	30	980	275	305.58
5.	Ca H	10	480	123	148.38
6.	Mg H	20	500	152	158.02
7.	Cl^-	20	3620	298.6	545.76
8.	NO_3^-	9	224	54.14	56.06
9.	F^-	0.28	11.5	3.39	3.30
10.	TDS	770	11200	2070.4	1525.23

k) *Correlation of water quality parameters*

In the present study, the correlation coefficients (r) among various water quality parameters have been calculated and the numerical values of correlation coefficients (r) are tabulated in Table-5.Correlation coefficient (r) between any two parameters, x & y is calculated for parameter such as water pH, electrical conductivity, total alkalinity, total hardness, calcium hardness, magnesium hardness, chloride, nitrate, fluoride and total dissolved solids of the ground water samples. The degree of line association between any two of the water quality parameters as measured by the simple correlation coefficient (r) is presented as 10 x 10 correlation matrix.

The pH has been found to show positive correlation with total alkalinity and negative correlations with electrical conductivity, total hardness, calcium hardness, magnesium hardness, chloride, nitrate, fluoride and total dissolved solids. EC has been found to show negative correlations with total alkalinity and fluoride while all other parameters are positively correlated with EC. Out of the 55 correlation coefficients, 5 correlation coefficients (r) between the EC and Cl^- (0.9651), TH and Ca H (0.9971), TH and Mg H (0.9974), Ca H and Mg H (0.9892), Cl^- and TDS (0.9651) are found to be with highly significant levels ($0.8< r < 1.0$), and 3 correlation coefficients give the significant ($0.5< r < 0.6$) level of r values. There is not any value of r which belongs to the moderate significant coefficient levels ($0.6< r < 0.8$). 34 cases were calculated out positive correlation while 21 cases were calculated out negative.

Table 5 : Correlation coefficient (r) among water quality parameters

Parameter	pH	EC	TA	TH	Ca H	Mg H	Cl^-	NO_3^-	F^-	TDS
pH	1.0000									
EC	-0.4556	1.0000								
TA	0.3139	-0.2187	1.0000							
TH	-0.0404	0.3328	-0.5067	1.0000						
Ca H	-0.0246	0.3100	-0.4909	0.9971	1.0000					
Mg H	-0.0550	0.3525	-0.5189	0.9974	0.9892	1.0000				
Cl^-	-0.5632	0.9651	-0.2256	0.1908	0.1624	0.2164	1.0000			
NO_3^-	-0.4986	0.4023	-0.2502	-0.0006	-0.0333	0.0299	0.4436	1.0000		
F^-	-0.1436	-0.1058	0.1280	0.0898	0.1054	0.0747	-0.2431	-0.2555	1.0000	
TDS	-0.4556	1.0000	-0.2187	0.3328	0.3100	0.3525	0.9651	0.4023	-0.1058	1.0000

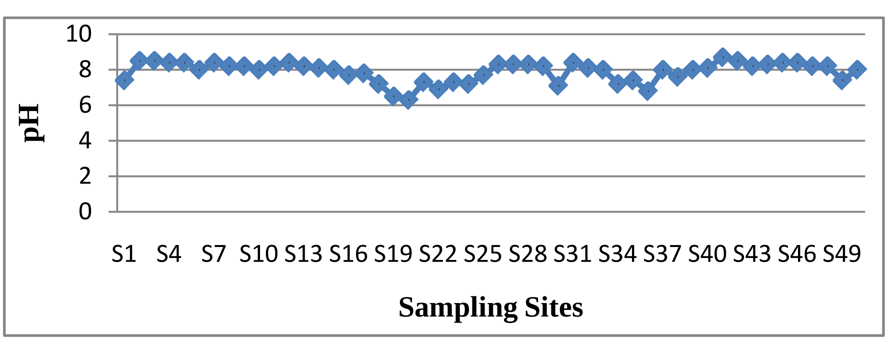

Figure 1 : Variation in pH with sampling sites of Bassi Tehsil

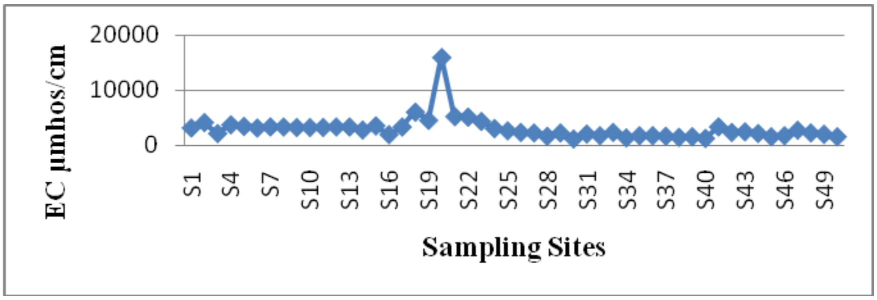

Figure 2 : Variation in EC with sampling sites of Bassi Tehsil

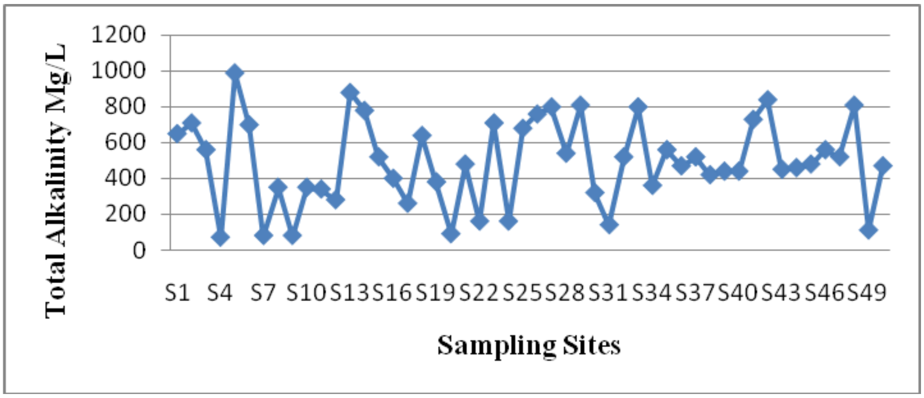

Figure 3 : Variation in Total Alkalinity (mg/L) with sampling sites of Bassi Tehsil

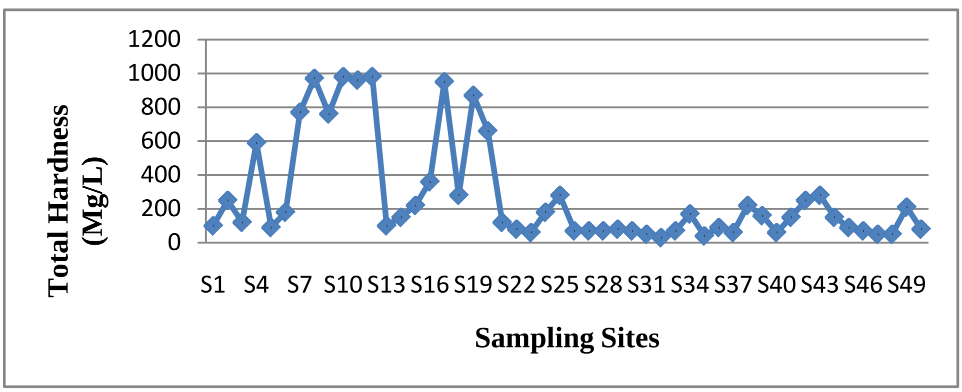

Figure 4 : Variation in Total Hardness (mg/L) with sampling sites of Bassi Tehsil

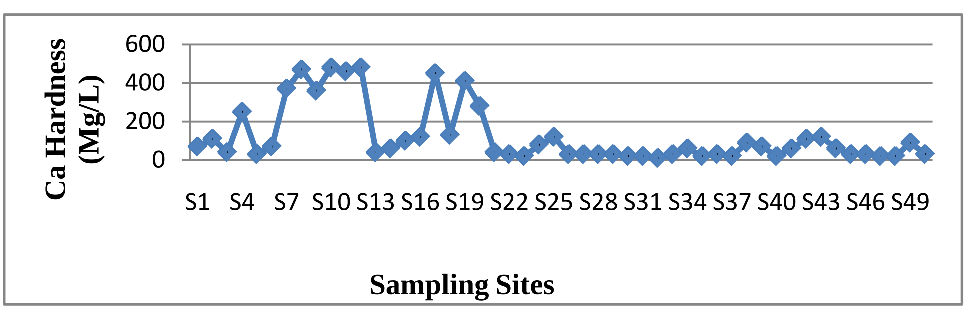

Figure 5 : Variation in Ca Hardness (mg/L) with sampling sites of Bassi Tehsil

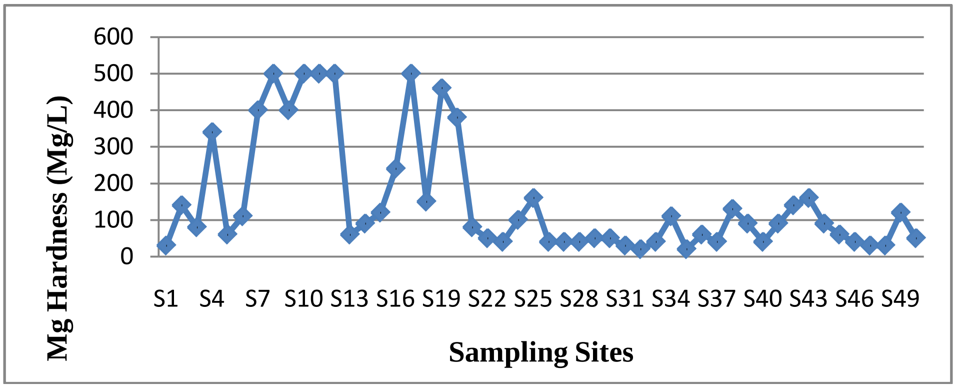

Figure 6 : Variation in Mg Hardness (mg/L) with sampling sites of Bassi Tehsil

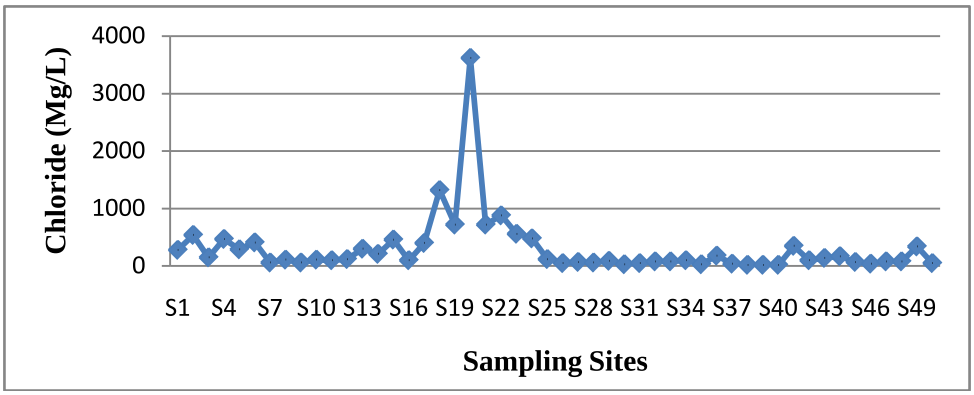

Figure 7 : Variation in Chloride (mg/L) with sampling sites of Bassi Tehsil

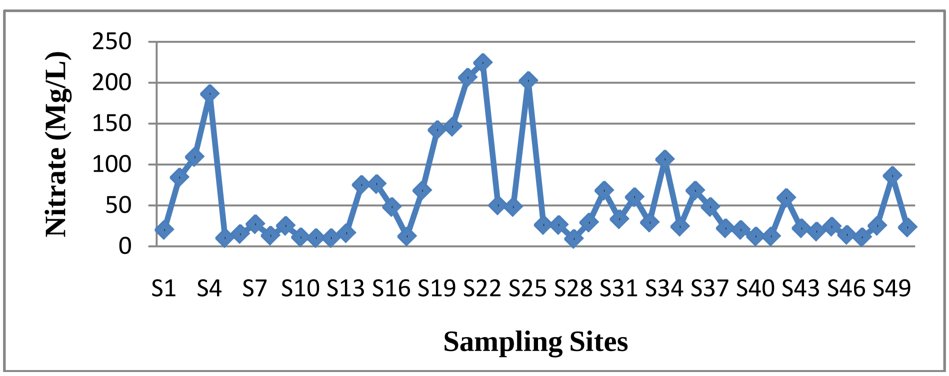

Figure 8 : Variation in Nitrate (mg/L) with sampling sites of Bassi Tehsil

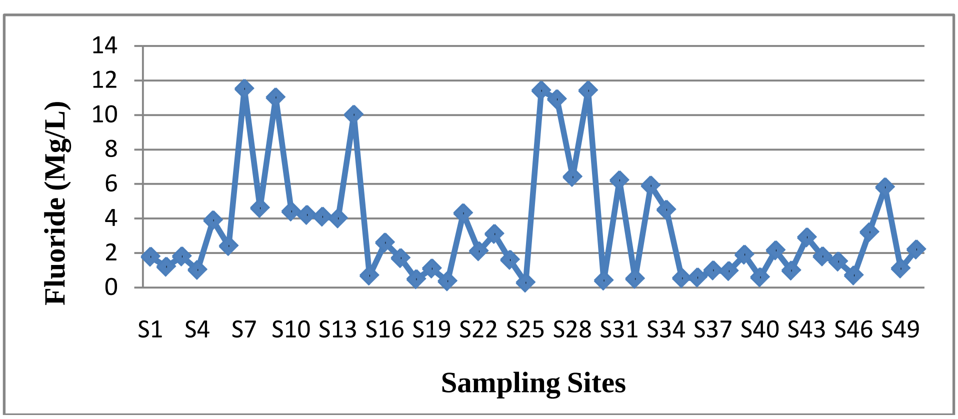

Figure 9 : Variation in Chloride (mg/L) with sampling sites of Bassi Tehsil

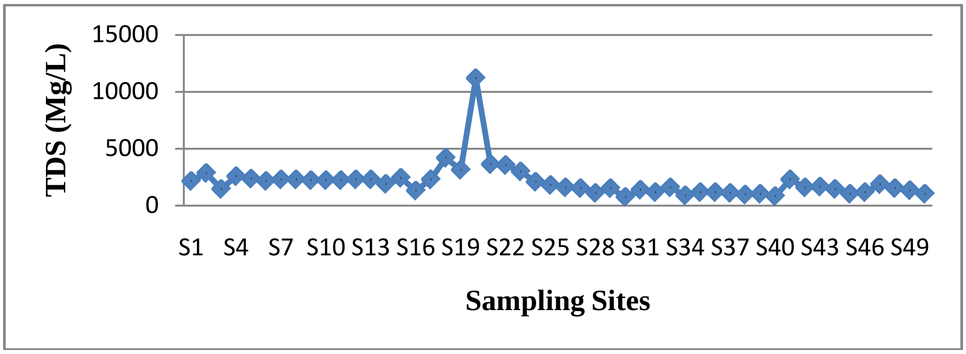

Figure 10 : Variation in TDS (mg/L) with sampling sites of Bassi Tehsil

IV. Conclusion

The analysis of ground water samples being collected from the different villages of Bassi Tehsil in Jaipur district revealed that in samples almost all water quality parameters (pH, electrical conductivity, total alkalinity, total hardness, calcium hardness, magnesium hardness, chloride, nitrate, fluoride and TDS) are beyond the permissible limit as per BIS, ICMR and WHO standards. In comparison to all other parameters, there is an acute problem of extremely high levels of Fluoride, Nitrate, Total Dissolved Solids and Chloride. As only 36% of ground water samples have fluoride content within the permissible limit (> 1.5 mg/L, WHO) and remaining 64% of villages are having very high fluoride concentrations. The favourable factor which contributes to rise of fluoride in ground water is presence of fluoride rich rock salt system.

The nitrate ion concentration of 42% of total samples was more than 45 mg/L. Some samples contai n this concentration up to 224 mg/L. The increased nitrate level in the ground water samples may be due to the consumption of large quantity of nitrogen-nous fertilizers like urea, NPK and cattle shed along with municipal wastes. 44% of ground water samples are having TDS more than 2000 mg/L (relaxed permissible limit as per BIS standards) and 36% ground water samples reported the Chloride level more than 200 mg/L.

The results of current study indicate that the drinking water, used by the people residing in villages of Bassi Tehsil, is not potable. So, the proper environment management plan must be adopted to control drinking water pollution immediately. Based on these results and analysis of water samples, it is also recommended to use water only after boiling and filtering or by Reverse Osmosis treatment for drinking purpose by the individuals to prevent adverse health effects.

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- Font type of all text should be Swis 721 Lt BT.
- Paper Title should be of Font Size 24 with one Column section.
- Author Name in Font Size of 11 with one column as of Title.
- Abstract Font size of 9 Bold, "Abstract" word in Italic Bold.
- Main Text: Font size 10 with justified two columns section
- Two Column with Equal Column with of 3.38 and Gaping of .2
- First Character must be three lines Drop capped.
- Paragraph before Spacing of 1 pt and After of 0 pt.
- Line Spacing of 1 pt
- Large Images must be in One Column
- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
- Numbering of Second Main Headings (Heading 2) must be in Alphabets, Italic, and Font Size of 10.

You can use your own standard format also.
Author Guidelines:

1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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Complete support for both authors and co-author is provided.

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Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

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(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

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(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

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(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

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References

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27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

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30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

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33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

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Key points to remember:

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- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

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· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

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- To the point depiction of the research
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- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
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- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

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Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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