Physio-Chemical & EDXRF Analysis of Groundwater of Ambala, Haryana, India

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Abstract: Characterization of the physiochemical parameters of groundwater from fifteen different locations in Ambala, Haryana (India) was carried out. To assess the quality of ground water each parameter was compared with the standard desirable limits prescribed by World health organization (WHO), Bureau of Indian Standard (BIS) and Indian council of medical research (ICMR). Systematic calculation was made to determine the correlation coefficient 'r' amongst the parameters. Significant value of the observed correlation coefficients between the parameters was also worked out. Elemental analysis of three samples was carried out using the EDXRF technique. It is concluded that the water quality of water supply systems in different locations of Ambala is of medium quality and can be used for domestic use after suitable treatment. Suitable suggestions were made to improve the quality of water. [Researcher. 2010;2(1):68-75] (ISSN:1553-9865)

Keywords: Ambala, ground water, water quality parameter, physiochemical parameter, pollution and EDXRF.

1. Introduction

Water is the precious gift of nature to the human being. It is essential for the growth and maintenance of our bodies, as it is involved in a number of biological processes. The quality of water is of vital concern for mankind since it is directly linked with human health, protection of the environment and sustainable development. Increasing population and its necessities have led to the deterioration of surface and sub surface water. Ground water is the major source of drinking water in both urban and rural areas. The domestic sewage and industrial waste are the leading causes of ground water pollution [1, 2]. Quality of ground water is the resultant of all processes and reactions that act on the water from the moment it is condensed in the atmosphere to the time it is discharged by a well or a spring and varies from place to place and with the depth of the water table [3]. Many diseases are caused by the inability of the environment to supply the mineral needs of man and animals in adequate. Sometimes these nutritional abnormalities occur as simple deficiencies or excesses. Many investigations have found a correlation between cardiovascular deaths and water composition [4, 5]. The disorder of teeth and bones is due to consumption of fluoride-rich water [6].

Ambala is located at 30°23′ North 76°47′ East and has an average elevation of 264 meters. It is one of the fastest growing city of Haryana, India. It is a city of scientific instruments and is famous for manufacturing of the scientific research, laboratory and market development equipments. Industries in the nearby areas of city are deteriorating the quality of ground water of Ambala and nearby areas. The sewerage system of the city is also very poor. Most of the domestic waste water seep down into the ground water sources. In Ambala, the water for drinking purpose was sourced from ground water without biochemical treatment. The level of pollution has also become a cause for major concern. Moreover, the water is rendered non-portable for drinking purpose due to presence of high concentration of one or the other constituents. Physical parameters affect the aesthetics and taste of the drinking water and may complicate the removal of microbial pathogens. The objective of the current study is to present the quality of the drinking water supply sources in Ambala, Haryana. The social relevance of the problem has encouraged us in carrying out this work.

2. Review of Literature

R.K.Tatawati and C.P.S. Chandel [7] have studied the ground water quality of Jaipur City, Rajasthan. An extensive study of the modelling of Buckinggham Canal Water Quality is available in literature [8]. The study by J. Jyashri et al., [9] was also carried out on the water quality assessment of the Purna River in Buldana District, Maharastra. M. Jha and S. Tignath [10] have studied the assessment and impacts of surface water environment in and around Jabalpur city, Madhya Pradesh. Studies on Ground Water Quality were done in Hyderabad [11]. The physico–chemical properties of drinking water in town Area of Godda District, Bihar were reported by [12]. K.N. Patnaik et al., [13] reported water pollution in industrial area. N. Ravisankar and S. Poongothai [14] have studied the ground water quality of Tsunami affected areas Sirkazhi Taluk, Nagapattinam, Tamil Nadu. Some studies [12, 13, 15] are available on the assessment of Fluoride level and trace metals in drinking water from various sources in and around Jaipur and in many villages. Recently, Sharma et al., [16] have studied the industrial wastewater and ground water, and pollution problem in ground water. V. Singh and C.P. S. Chandel [17] have analyzed the wastewater of Jaipur City, which is used for agricultural purpose.

G.C. Joshi et al., [18] have used EDXRF technique to determine the concentrations of different elements in water samples collected from different locations of famous Nainital Lake including tap water and spring water sample from Nainital (Uttaranchal). H.K. Bandhu et al., [19] have studied the elemental concentration of the aerosol samples collected from industrial, commercial and relatively cleaner zones from the city of Chandigarh using EDXRF and Proton Induced X-ray Emission (PIXE) techniques. B.S. Negi et al., [20] have reported the urban aerosol composition for both major and trace elements, determined using EDXRF technique, in four major cities of India, namely, Bombay, Banglore, Nagpur, and Jaipur. The EDXRF technique has been used for a long time for the elemental analysis of the specimen from biological sciences [21], archaeology [22], environmental science [23] and earth science [24]. The objective of the scientific investigations is to determine the hydrochemistry of the ground water and to classify the water in order to evaluate the water suitability for drinking, domestic and irrigation uses and its suitability for municipal, agricultural and industrial use.

3. Sampling

Ground water samples of different hand pumps and municipal tube wells from fifteen sampling points were analyzed during February 2009 to April 2009. The different sampling locations are given in Table 1. Samples were collected in good quality polythene bottles of one–liter capacity. Sampling of water is truly representative of any aquatic environment. Once a sample has been taken it should have no possibility of transporting trace elements either to or from the sampling container walls. Natural water in its different forms has been interesting material of study. Sampling was carried out without adding any preservative. For the energy dispersive x-ray fluorescence (EDXRF) study, the samples were collected in clean polyethylene bottles five–liter capacity without any air bubbles. The bottles were well rinsed before sampling and tightly sealed after collection and labeled in the field. Three water samples, one from municipal tube well of Ganesh Vihar, Ambala Cantt., one from municipal tube well of Baldev Nagar, Ambala city and one of hand pump water from Mullana, Ambala have been analyzed for their elemental concentrations using the EDXRF technique. For EDXRF analysis, each sample was passed through a coarse 2 mm screen to remove the organic debris and then through a 250 lm nylon screen into a pre-cleaned plastic container. Each sample was dried in the oven at constant temperature of 150˚C. After drying, each sample was ground using a freezer-mill. The thin samples were prepared in pellet form by mixing and pressing the powder. To be sure that the sample holder was not going to introduce analytical errors, blanks were previously checked. The samples were scanned thoroughly to reduce the risk of analytical error and non-uniformity of the samples.

4. Methods of Analysis

4.1 Physio-Chemical Method of Analysis

Analysis was carried out for various water quality parameters such pH , Total dissolved solids (TDS) , Total Hardness , Total alkalinity , Calcium, Magnesium , Chloride , fluoride, Dissolve oxygen, Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) as per standard procedure described "Standard methods for the examination of water and waste water American public Health Association (APHA)" [25]. The physical parameter pH was determined using the digital pH meter (LT-10, Labtronics, Panchkula, India) and EC was determined using the digital conductivity meter (LT-16, Labtronics, Panchkula, India). Total Dissolved Solids (TDS), Dissolved Oxygen (DO), BOD and COD were determined using the digital portable analyzer kit (HACH 40d, USA) at PWD Research Laboratory, Ambala Cantt. COD for a few samples was also done by titration with an excess of $K_2Cr_2O_7$ solution. Calcium (Ca^{2+}), Magnesium (Mg^{2+}) and total hardness (TH) were determined by the Ethylene Diamine Tetra Acetic Acid (EDTA) titration method, Chloride (Cl^-) by Argentometric titration method. The total alkalinity (TA) was determined using the titration method. Fluoride (F^-) was determined using Alizarin spectrophotometer.

Table 1. Sampling Locations of Ambala

S.No.	Sampling Locations	Code	Sources
1.	D.A.V. School	C1	Tube well
2.	Ram Krishna Colony	C2	Tube well
3.	Civil Hospital	C3	Tube well
4.	Khojkipur	C4	Hand pump
5.	Ganesh Vihar	C5	Hand pump
6.	Government School, Sarsedi	C6	Tube well
7.	Prabhu prem Asharam	C7	Hand pump
8.	Kardhan	C8	Tube well

9.	Housing Board Colony	C9	Hand pump
10.	Bangali Mohalla	C10	Tube well
11.	Bus Stand	C11	Hand pump
12.	Gawal mandi	C12	Hand pump
13.	PWD Office	C13	Tube well
14.	Hathikhana Mandir	C14	Tube well
15.	Ram Nagar	C15	Hand pump

4.2 EDXRF Technique of Analysis

The water samples have been analyzed using the energy dispersive x-ray fluorescence (EDXRF) setup available at Physics Department, Panjab University, Chandigarh. This technique uses proportional characteristics of the multichannel semi-conductor detectors, to produce a distribution of voltage pulses proportional to the spectrum of photon energies from the target. Interactions of photons with matter permit analysis of the sample constituents using excited x-rays. Water samples were analyzed at EDXRF Laboratory, Physics Department, Panjab University, Chandigarh. These samples were analyzed without any chemical pre-treatment. In the EDXRF method, the ionization cross-section for an atomic level is greatest when the exciting x-ray energy just exceeds the binding energy of the electron in that level, and falls off drastically with an increasing difference between the excitation energy and the electron binding energy. The pellets were mounted into a target holder specially made for irradiation of thin target. The energies of the characteristic x-rays were used to identify the elements present in the water samples.

All the calculations were done using $_{42}$Mo $K_{\alpha\beta}$ incident photon energy from intense Mo anode x-ray tube (Panalytical x-ray generator, model PW 3830 4kW). The tube voltage was kept at 29 kV and current 12 mA. The spectra were recorded using a Le(Ge) detector coupled to a PC based multichannel analyzer (MCA) through a spectroscopy amplifier. The resolution of the Le(Ge) detector is about 143 eV at 5.89 keV. Measurements were carried out in vacuum of 10^{-2} Torr for optimum detection of elements. β_i is the self absorption correction factor that accounts for the absorption of the incident and the emitted x-rays in the sample. Since thin samples are used, therefore β_i is 1. The standard samples of the elements present in the samples were also run to compare and to find the concentration.

5. Results & Discussions

Characterization of the physiochemical parameters of groundwater from fifteen different locations in Ambala, Haryana (India) are reported in Table 2. The experimental results are compared with the standard limits recommended by the World Health Organization (WHO), Indian Council of Medical Research (ICMR) and Bureau of Indian Standards (BIS). Considerable deviations are observed in the water quality parameters from the standard limits.

5.1 pH

It is an important ecological factor and provides an important piece of information in many types of geo-chemical equilibrium or solidity calculations. Generally, pH of the water is influenced by geology of catchment areas and buffering capacity of water [26]. The limit of pH value for drinking water is specified [27] as 6.5 to 8.5. Measured pH value of the water samples under study fluctuates between 7.4 to 11.4. The value of pH in C8 area is above the desirable limit. pH value shows a slightly alkaline trend.

5.2 Total Alkalinity

The standard desirable limit [28] of alkalinity in portable water is 120 ppm and the maximum permissible level is 600 ppm. The values of alkalinity in the water samples of Ambala are in between 255 ppm to 980 ppm. The value of alkalinity of water provides an idea of natural salts present in water. Main cause of alkalinity is the mineral which dissolves in water from the soil. Various ionic species that contribute to the alkalinity include hydroxide, carbonates and bicarbonates, and organic acids. These factors are characteristic sources of water and many natural processes take place at any place [29]. Alkalinity in itself is not only harmful to the human being but is a big problem for industries as the alkaline water if used in the boiler for stream generation may leave to the precipitation of sludge, deposition of scales and cause the caustic embrittlement. This indicates that any industry in this area must have alkalinity treatment plant before using the ground water or should use some alternate water sources.

5.3 Total Dissolved Salts (TDS)

BIS prescribed that the desirable limit of TDS is 500 ppm and the maximum permissible level is 2000 ppm. TDS values observed in C3, C4, C6, C8 and C15 areas were found to be high when compared with the desirable limit of 500 ppm. TDS of C8 area is 1840 ppm, which may be due to the ground water pollution by the residential waste. The residential waste is discharged into the pits, ponds due to which the waste migrates down to the water table [30] and moreover there is a possibility of dissolution of rocky materials in the area.

5.4 Total Hardness

Water hardness is a measure of capacity of water to react with soap. Hardness is very important property of ground water from utility point of view for different purposes. Standard permissible limit specified by ICMR and BIS of total hardness is 300 ppm of $CaCO_3$. A fluctuating trend is observed in the measured total hardness values in all the fifteen sites of Ambala. Total hardness of the water samples from C4, C8 and C15 areas is high compared with the tolerance limit of 300 ppm.

5.5 Electrical Conductivity (EC)

Electrical conductivity was positively correlated with total dissolved solids and total hardness. The value of EC was found higher at C8 area, which may be due to the high concentration of dissolved salts and ionic substances in the area. Higher the concentration of electrolyte in water more is its electrical conductivity. Conductivity is proportional to the dissolved solids and both showed analogous trends in seasonal variation.

5.6 Chloride

Chloride is important in detecting the contamination of ground water. Its concentration increase rates of corrosion of metals in the distribution system. The permissible limit [28] of chloride in drinking water is 250 ppm. The chloride concentration in water samples from all the locations ranged from 15.02 ppm to 256.6 ppm. In C4, C7, C8, C12 and C15 areas, it is found to be high. The value of chloride in C8 area was more than the maximum permissible limit, which may be due to the natural process such as passage of water through natural salt formation in the earth or it may be an indication of pollution from industrial use and domestic waste [31].

5.7 Calcium

Calcium concentration is an important factor in determining the quality of drinking water. Calcium concentration in water samples from all the locations was found to vary from 47.8 ppm to 460 ppm. For domestic use, the maximum desirable limit for calcium is 75 ppm whereas in case of non availability of water calcium up to 200 ppm could be accepted. High concentration of Calcium may be attributing to the passage through or deposits of limestone, dolomite and gypsum (APHA 1992) [21].

5.8 Magnesium

Magnesium concentration in water samples from all the locations ranged from 58.6 ppm to 309.9 ppm. Magnesium concentration in all the samples except C11 is above the highest permissible limit of 150 ppm which may be due to the rich rocks and minerals, sand or due to the disruption in internal sources of hardness and alkalinity, climatic factors and industrialization.

5.9 Dissolved Oxygen

Dissolved oxygen present in drinking water adds taste and it is highly fluctuating factor in water. In this study dissolved oxygen content varied in a limited range of 5.31 ppm to 8.2 ppm.

5.10 Chemical Oxygen Demand (COD)

The maximum allowed value of chemical oxygen demand (COD) is 10 ppm in drinking water. The present samples have registered a range of 1.6 ppm to 5.4 ppm. These values are within permissible level which is expected for good quality portable water.

5.11 Fluoride

Abnormal level of fluoride in water is common in fractured hard rock zone with pegmatite veins. The veins are composed of minerals like topaz, fluorite, fluor-apatite, villuamite, cryolite and fluoride-replaceable hydroxyl ions in ferro-magnesium silicates [32]. Fluoride ions from these minerals leach into the groundwater and contribute to high fluoride concentrations [33]. Occasionally, mica group of minerals like muscovite and biotite also contribute to water fluoride content. Fluoride concentration in all the samples ranged from 0.6 ppm to 2 ppm. The C1, C9, C10, C11, C12 and C15 are the areas, which have fluoride concentration higher than the standard permissible limit of 1.5 ppm as per ICMR and BIS standards. High level of fluoride content in the sampling areas of Ambala is a matter of concern. Although fluoride contents beyond the guideline values of WHO have been found in a large number of samples, no report of fluorosis from the area has been known till date. There may be two reasons for this. First, most of the residents of area use shallow dug wells or hand tube wells. The number of users of deep tube well is relatively smaller, and they are economically well-off and healthier.

5.12 Salinity

Salinity is an ecological factor, which influences organisms that live in a water bodies and the growth of plant that will grow either in the water bodies or on the land fed by the ground water. Salinity values observed in all the samples ranged from 0.22% to 0.91%. The values of salinity observed in C7, C8 and C15 area is found to be high.

6. Statistical Analysis

6.1 Correlation Studies

Study of correlation reduces the range of uncertainty associated with decision making. The correlation coefficient ‘r’ was calculated using the equation

$$r = \frac{\sum xy}{\sqrt{\sum x^2 \times \sum y^2}}$$

The correlation matrix for the water quality parameters are given in Table 3.

6.2 Test of significance of the observed correlation coefficients

Significance of the observed correlation coefficient has been tested by using ‘t’ test. A total of 66 correlations were found between the two parameters in which 27 correlations were found to have significance at 5% level, (r > 0.396). Negative correlations were found in 23 cases between the electrical conductance and total alkalinity, between electrical conductance and fluoride, between electrical conductance and DO, between electrical conductance and B.O.D, between total dissolved solids and fluoride, between total dissolved solids and DO, between total dissolved solids and BOD, between total alkalinity and total hardness, between total alkalinity and Calcium, between total alkalinity and Magnesium, between total alkalinity and DO, between total alkalinity and BOD, between total alkalinity and COD, between total hardness and fluoride, total hardness and BOD, between Chloride and Fluoride, between chloride and DO, between chloride and BOD, between Calcium and Fluoride, between Magnesium and Fluoride, between fluoride and DO, between fluoride and BOD, and between fluoride and COD. Some of the highly significant correlations were discernible between the EC and TDS, between EC and total hardness, between calcium and chloride, between total hardness and magnesium, between total alkalinity and BOD, and between chloride and magnesium.

7. EDXRF Analysis

The energies of the characteristic x-rays were used to identify the elements present in the water samples. The concentration of the elements present in the water samples is given in Table 4. Typical x-ray spectrum of one of the water samples from Ganesh Vihar, Ambala Cantt., is shown in Figure 1. Elements such as Ca, Fe, Br and Sr are measured. The peaks of Cu and Zn are from the absorbers used in the geometrical setup. Mo K x-rays are of the anode of the x-ray tube used in the present measurements. It can be seen from the peak heights that there is no variation between the fractions for the calcium. From the quantification of the samples, it is observed that the concentration of calcium is high. Calcium is responsible for hardness of the water. Hardness of water leads to encrustation of water supply structure. In regard to concentration change of the heavy metals in Mullana, Ambala Cantt and Ambala City water samples showed the higher concentrations of Ca. It can be explained that dilution, precipitation, adsorption to sediments and local anthropogenic input probably affect metal concentrations in the ground water of Ambala region. A close look at the elements present in water samples shows variation in concentrations but all elements are within the safe limit. The best thing in the ground water of Ambala is that it is free from the toxic elements, e.g., sulphur, arsenic, selenium, cadmium, lead etc, which may pose hazards to the health. Presence of these elements affects the biotic and abiotic systems. These may interact with antibodies and the auto-immune response system. Also the uptake of these elements onto surfaces during DNA replication and transcription may result in the genetic damage. Iron is an element, which plays a strong role in catalyzing free radicals and fat peroxidation. The free radicals could cause breakage and distortion of DNA in the nucleus of the cell. The excess of Fe in the human body is dangerous and can cause cancer.

8. Conclusions

Groundwater from the Ambala Haryana, India was analyzed to study the status of different elements, some quality parameters and interim correlations. Water in the entire area shows alkaline trend, which is indicated by pH values. The average of alkalinity has exceeded the desirable limits which are due to improper drainage system and due to domestic and agricultural activity in the villages. Water quality with respect to alkalinity and fluoride level is cause of concern. The extent of fluoride in the groundwater was found high with respect to the WHO standard. The high level of fluoride contents is responsible for dental and skeletal fluorosis, which is a serious health problem in many areas of world. Groundwater is the only portable source in the localities of Ambala. It may be said that water in Ambala is though fit for domestic and drinking purposes but need treatment to minimize the contamination especially alkalinity and fluoride. Although we could not conclude that the reason for the high incidence of cancer is due to the high concentrations of Fe and Cu in the drinking water, perhaps this is an important factor. The EDXRF method has proven to be a useful tool for elemental analysis of water samples. The strength of the technique relies on simple preparation of the samples, a reasonable time of measurement, and a non-complicated data analysis.

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Table 2. Physiochemical parameters of groundwater from fifteen different locations in Ambala, Haryana (India)

Parameters → / Sample Site ↓	Area Code	Source	Colour	pH	EC (µs/cm)	TDS (ppm)	(Ppm)	(ppm)	Chloride (ppm)	Calcium (ppm)	(ppm)	Flouride (ppm)	D.O. (ppm)	B.O.D. ppm	C.O.D .(ppm)	Salinity (%)
WHO Standards				7-0 - 8.5	-	500 - 1,500	-	100 - 500	200 - 600	75 - 200	30 - 150		-	>5	>5	-
ICMR Standards			**25 Hazen**	6.5 - 9.2	-	500 - 3000	-	300 - 600	200 - 1000	75 - 200	30 - 150		-			-
BIS (IS 10500-91)			**5 Hazen**	6.5 - 8.5	-	500 - 2000	200 - 600	300 - 600	250 - 1000	75 - 200	30 - 150		-			-
DAV School	C1	T	Colourless	7.9	470	344	225	392	15.02	153.1	167	1	7.6	3.6	4	0.27
RamKrishan Colony	C2	T	Colourless	8.6	440	323	300	396	28.5	160	173	0.6	8.2	4.4	5.4	0.49
Civil hospital	C3	T	Colourless	7.4	850	700	400	532	47.8	265.4	266.4	0.9	7.4	3.4	5	0.77
Khojkipur	C4	H	Paleyellow	8.6	930	590	500	613	210	291	322	0.7	6.92	2.9	4.3	0.67
Ganesh Vihar	C5	H	Paleyellow	8.2	440	317	320	333.3	145	83.3	250	0.7	7.01	3	4.9	0.54
Govt. School	C6	T	Colourless	8.1	450	680	380	300	77.8	175	125	0.8	7.71	3.1	5.6	0.32
Prabhu Prem Ashram	C7	H	Paleyellow	7.5	760	510	375	466	122	108	158	0.9	7.66	2.3	4.3	0.88
Kardhan	C8	T	Colourless	11	1320	1840	206	766	256.6	460	306	0.8	7.96	3.6	5	0.90
Housing Board Colony	C9	H	Paleyellow	8.04	470	340	275	250	98.2	86.6	200	1.8	7.45	2.6	3.1	0.33
Bangali Mohalla	C10	T	Colourless	8.13	550	350	300	240	78.3	90	170	1.2	7.31	3.2	3.6	0.22
Bus Stand	C11	H	Paleyellow	8.24	591	608	775	145	34.9	48.3	58.6	1.4	5.31	1.3	2.6	0.49
Gawalmandi	C12	H	Paleyellow	9.21	723	569	565	308	80.7	123.7	206.7	2	6.21	3.4	4.9	0.89
PWD Office	C13	T	Colourless	7.2	288	204	350	500	208	187.6	210.9	0.8	7.08	2	5.6	0.36
HathikhanaMandir	C14	T	Colourless	9.2	204.8	358	980	190	76.9	47.8	158.8	0.9	6.66	3	4.5	0.40
RamNagar	C15	H	Paleyellow	8.5	1100	1285	800	750	244.5	105.8	309.9	1	5.44	1	1.6	0.91
			Mean=	8.3	639.1	601.2	450.1	412.1	114.9	159.04	205.4	1.03	7.06	2.85	4.29	0.56
			S.D. =	0.9	307.1	430.9	231.5	191.1	79.9	109.3	73.9	0.4	0.84	0.90	1.15	0.25
			CV % =	11	48.1	71.6	51.4	46.3	69.5	68.7	36	39.3	12.03	31.45	26.80	0.4

T → Tube well, H → Hand pump

Table 3. Correlation matrix for the water quality parameters.

Parameters	pH	EC	TDS	TA	TH	Cl^-	Ca^{2+}	Mg^{2+}	f^-	DO	BOD	COD
pH	1	0.485	0.679	0.115	0.267	0.345	0.471	0.310	0.042	0.008	0.290	0.090
EC		1	0.871	-0.061	0.782	0.572	0.653	0.649	-0.031	-0.101	-0.110	0.022
TDS			1	0.044	0.697	0.581	0.646	0.501	-0.102	-0.090	-0.116	0.139
TA				1	-0.184	0.006	-0.440	-0.145	0.153	-0.789	-0.528	-0.197
TH					1	0.753	0.729	0.822	-0.429	0.114	-0.068	0.428
Cl^-						1	0.483	0.734	-0.263	-0.128	-0.370	0.275
Ca^{2+}							1	0.608	-0.373	0.446	0.373	0.420
Mg^{2+}								1	-0.252	0.055	0.065	0.354
F^-									1	-0.404	-0.181	-0.530
DO										1	0.750	0.389
BOD											1	0.380
COD												1

*Significant at 5% level, r > 0.396

Table 4. Elemental concentration of the elements present in the water samples

Sample	Ca (µg/cm^2)	Fe (µg/cm^2)	Br (µg/cm^2)	Sr (µg/cm^2)
Sample 1	1270	0.002	0.095	18.27
Sample 2	1149	0.015	0.072	17.99
Sample 3	3263	0.022	0.150	27.35

Sample 1→ sample from Mullana, Ambala Sample 2 → sample from Ganesh Vihar, Ambala Cantt., Sample 3 → sample from Baldev Nagar, Ambala City

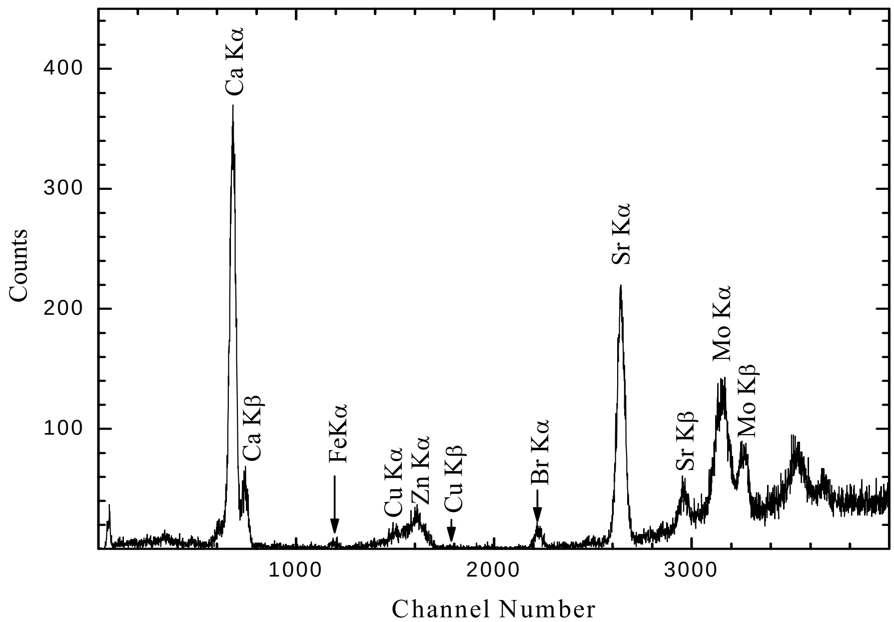

Figure 1. Elemental Analysis of Water Sample from Ganesh Vihar, Ambala Cantt.

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