



Original Research Article

Detection of heavy metals (Pb, Sb, Al, As) through atomic absorption spectroscopy from drinking water of District Pishin, Balochistan, Pakistan

Afrasiab Khan Tareen^{1*}, Imrana Niaz Sultan¹, Pramuk Parakulsuksatid²,
Mohammad Shafi², Ashraf Khan², Mohammad Waseem Khan² and Sadat Hussain²

¹Balochistan University of Information Technology Engineering and
Management Sciences Balochistan, Pakistan

²Kasetsart University Bangkok, Thailand

*Corresponding author

ABSTRACT

Keywords

Heavy Metal;
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Antimony;
Aluminum.

This study was designed to detect heavy metal traces such as Antimony, Arsenic, Lead, and Aluminum in water samples obtained from tube wells having different depths in district Pishin, Baluchistan, Pakistan. Analysis of 50 fresh water samples was done through Atomic absorption spectroscopy in order to compare various parameters such as age of tube well, EC, Area, pH, depth of tube well, population burden and use of fertilizers in the selected areas. The study revealed that age of tube well had no impact on quantities of studied heavy metals, however, significant impact of tube wells depth was observed in decreasing depth order. Antimony and Aluminum values were found in higher quantities than standard recommended values in tube wells of lower depth. Arsenic and lead were found in below recommended values all tube well water samples. The arsenic presence in the samples may be attributed to the population burden and the use of chemical fertilizers in the surrounding area of tube wells respectively, the quantity of Aluminum and Antimony were found higher than safe levels which is an alarming indication for the drinking water for public use. The conductivity and pH were found higher in shallow depths of tube wells.

Introduction

Area description

District Pishin is situated in the North West Balochistan province (Pakistan) near Afghanistan border. The Surrounding areas of Pishin are Barshore, Milkyar, Nowabad, Saranan and Yaro; this district

lies between 30-04 to 31-17 north latitudes and 66-13 to 67-50 east longitudes. Generally district Pishin is mountainous and its northern half is covered by Toba Plateau. The mountains are fairly uniform,

with long central ridges from which frequent spurs descend. The climate of this region is cold and dry, minimum temperature in winter reaches below freezing point while in summer it can reach as high as 40^oPishin is situated at an elevation of 5104 feet above sea level. Pishin district is famous for its agriculture products, most notably fruit orchards including apples, grapes, some crops and vegetables. The artificial irrigation channels in the area, made by boring holes into rocks to bring water to the surface for agricultural use and human consumption. Karez and modern agricultural methods have done wonders in the area. The ground water resources of district Pishin mostly depends on tube wells, rivers and Karez system.

Water and Heavy metals

Safe and good quality drinking water is the basis for good human health. Water provides some elements, but when polluted it may become the source of undesirable substances, dangerous to human health and cause disease such as, various cancers, adverse reproductive outcomes, cardiovascular disease, teeth decay and neurological diseases. The infants and younger population are more prone to the toxic effects of heavy metals, as the rapidly developing body systems in the fetus, infants and young children are far more sensitive (Johnson and Hallberg, 2005). Childhood exposure to some metals can result in learning difficulties, memory impairment, damage to the nervous system, and behavioral problems such as aggressiveness and hyperactivity (Rajendran *et al.*, 2003). At higher doses, heavy metals can cause irreversible brain damage. Children may receive higher doses of metals from food than adults, since they consume more food for their body weight than adults. The reason for

this hydrological scourge is the presence of alarming levels of heavy metal arsenic in groundwater in several villages of the globe (Dogan *et al.*, 2005).

Heavy metals in the form of arsenic and arsenical compounds are exceptionally toxic and harmful to human health. They are found in effluents and leaches from metallurgic industries, glassware and ceramic industries dye, pesticide and fertilizer manufacturing industries, petroleum refining and other chemical industries. Some part of the world arsenic occurs naturally in the soil from where it reaches to the ground water (Choudhury *et al.*, 2009). Exposure to antimony is associated with damage to the heart, lungs, and other organs. There is limited evidence that chronic exposure can cause developmental and reproductive effects, People can be exposed to antimony by breathing contaminated air, drinking contaminated water, or by eating foods that contain this metal. Lead is a heavy, soft gray metal. The EPA classifies lead as a probable human carcinogen. Exposure to lead results from breathing contaminated air, contacting lead contaminated soils, or drinking contaminated water. Tap water contamination with lead occurs when water passes through older pipes containing lead, lead solder, or brass fixtures that contain lead (ATSDR, 2000), Although aluminum is not a heavy metal (specific gravity of 2.55-2.80), it makes up about 8% of the surface of the earth and is the third most abundant element. When aluminum accumulates acutely in tissues such as the brain, it has the potential to cause serious adverse neurological effects. Dialysis encephalopathy is a form of aluminum neurotoxicity characterized by speech difficulty, dementia and convulsions (Richard, 1993). According to Environmental Protection agency the acceptable amount of heavy metals such as

antimony in one liter of drinking water is 0.006 mg/l, for lead it is 0.015 mg/l, for Arsenic 0.010 mg/l, and for Aluminum 0.05-0.2 mg/l. The heavy metals related most often to human poisoning are lead, mercury, arsenic and cadmium. Other heavy metals, including copper, zinc, and chromium, are actually required by the body in small amounts (Goyer and Clarkson, 2001).

Materials and Methods

The purpose of this study was to evaluate the concentration of heavy metals in ground water from tube wells and to analyze if, parameters such as depth of tube well, location of tube well, age of tube well, sample pH, sample conductivity, population burden and use of fertilizers, pesticides and insecticides has an impact on presence of heavy metal contents and heavy metal concentration.

Sample collection

Fifty (50) water samples from different tube wells of twelve (12) different villages of district Pishin namely (Main Pishin city, Malakyar, ChamanMalakyar, Manzaki, Ismailzai, Bagarzai, Dab khanzai, mianKhanzai, Sir Khanzai, KilliNawabad, Batazai and Tora Shah) were obtained. To avoid possibility of contamination the empty polythene bottles were used for the collection of water samples and were labeled accurately. Two samples were collected from each and every tube well in which one samples of 50 ml was mixed with 4 ml of HNO₃ (Nitric acid) for sample preservation (Michael, 1982; APHA, *et al.*, 1992).

Sample analysis

The pH of all samples was measured by

pH meter (JENWAY MODEL No.3520) and electric conductivity was measured with the help of conductive meter (JENWAY MODEL NO.470). The concentrations of heavy metals were analyzed in all the 50 samples of water using (SOLAAR AA SERIES S4 SYSTEM ATOMIC ABSORPTION SPECTROSCOPY (AAS) by Flame method with the help of nitrous oxide/Acetylene gases as described by (Michael, 1982).

Lamp Current

The operating current in mA for the lamp. It is important that you have verified that the lamp is present before completing this step. A 30 mA current might damage other types of lamps. When the lamp current has been entered, the amplifier gain will be automatically set.

Replicates

Each measurement is repeated 3 times. You may wish to change this number later. The allowed range for the number of replicates is 1-99.

Standard reagents preparation

Three (3) different reagents as standard stock solution of 1000 ppm were prepared for the detection of each and every heavy metal. The reagents prepared were in below concentrations.

Arsenic (As): For the preparation of 1000 ppm stock solution of Arsenic (As) with three different concentrations of 40.00 mg/l, 80.00 mg/l and 120.00 mg/l were prepared. Pure Arsenic (As) was dissolved in de-ionized water in 25ml volumetric flask.

Lead (Pb): For the preparation of 1000 ppm stock solution of Lead (Pb) with three different concentrations of 7.00 mg/l, 14.00 mg/l and 21.00 mg/l were prepared. Pure Lead (Pb) was dissolved in de-ionized water and was made to volume with de-ionized water in 25ml volumetric flask.

Antimony (Sb): For the preparation of 1000 ppm stock solution of antimony (Sb) with three different concentrations of 25.00 mg/l, 50.00 mg/l and 75.00 mg/l were prepared. Pure antimony (Sb) was dissolved in de-ionized water in 25ml volumetric flask.

Aluminum (Al): For the preparation of 1000 ppm stock solution of Aluminum (Al) with three different concentrations of 30.00 mg/l, 60.00 mg/l and 90.00 mg/l were prepared. Pure Aluminum (Al) was dissolved in de-ionized water in 25ml volumetric flask.

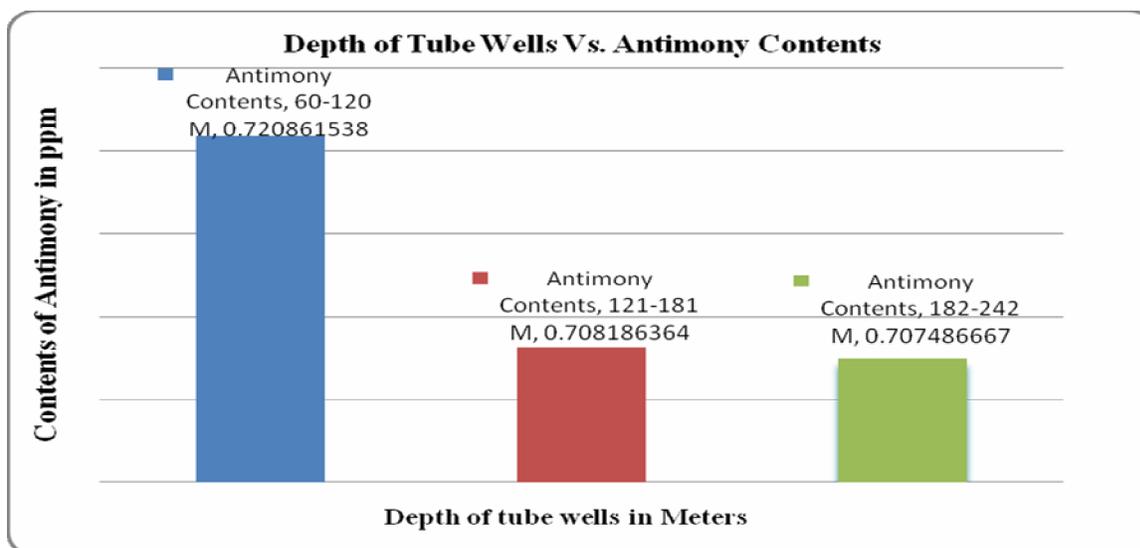
Results and Discussion

Water samples collected from different areas of district Pishin were analyzed for presence of heavy metal contents. The presence of heavy metals such as arsenic (As), lead (Pb), antimony (Sb), aluminum (Al), were analyzed for their presence and compared with different parameters such depth of tube well, age of tube well, location of tube well, sample pH, sample conductivity, population burden, use of insecticides, pesticides and The aesthetic and physical parameters were determined which provided general information about water quality in qualitative terms and include water quality parameters like color, physical appearance, transparency,

Electrical conductivity, odors, pH, taste and turbidity. The overall average pH of all the collected samples were 8.38 with the minimum and maximum values of 7.9 - 8.86 respectively. Most of the sampling areas were having the normal pH value except Nawabad having the average pH of 8.69. The electrical conductivity (EC) provides a rapid and convenient means for estimating the concentration of electrolytes and gives quick information about all minerals. The EC values of all the water samples were in the normal range of 50-500 $\mu\text{S}/\text{cm}$. The age of tube wells were also assessed with the presence of heavy metals in water. The average ages of all the tube wells were approximately 04 years. While the average depth of the wells were recorded as 157 meters (509 feet). Arsenic and lead were found in all samples but they were quite below then the recommended values given by WHO.

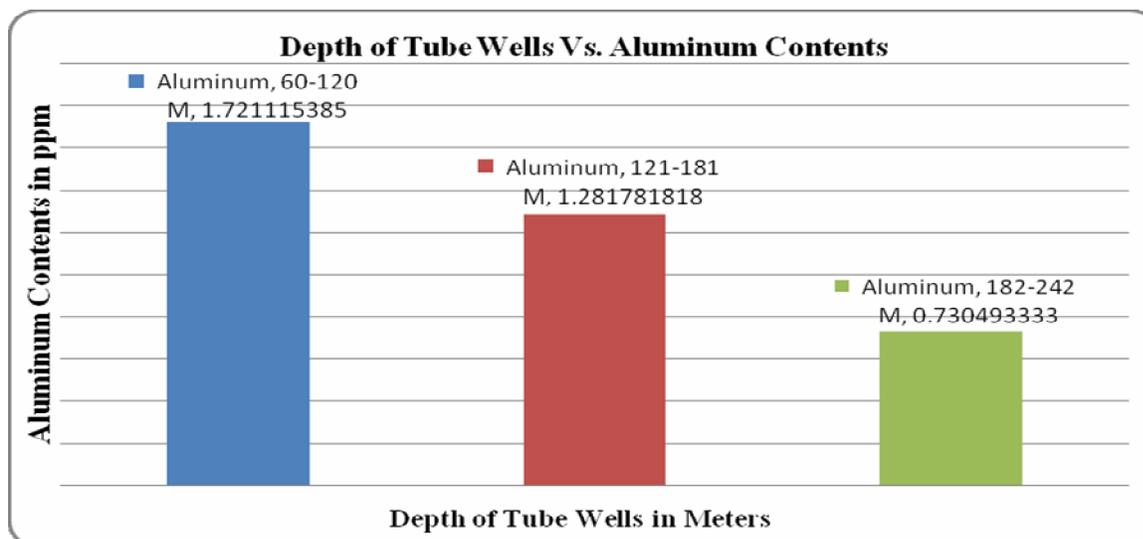
Water samples collected from different areas of district Pishin were analyzed for presence of heavy metal contents. The presence of heavy metals such as arsenic (As), antimony (Sb), aluminum (Al), and Lead (pb) were analyzed for their presence and compared with different parameters such as depth of tube well, age of tube well, location of tube well, sample pH, sample conductivity, population burden, use of insecticides, pesticides and fertilizers. Arsenic and lead Were present in all samples collected from areas of heavy population but on average its concentration was lower than standard recommended values which depicts that population has positive impact on presence of heavy metals. The study findings shows that the depth of tube wells have positive

Figure.1.0 Depth of Tube Wells vs. Antimony Contents



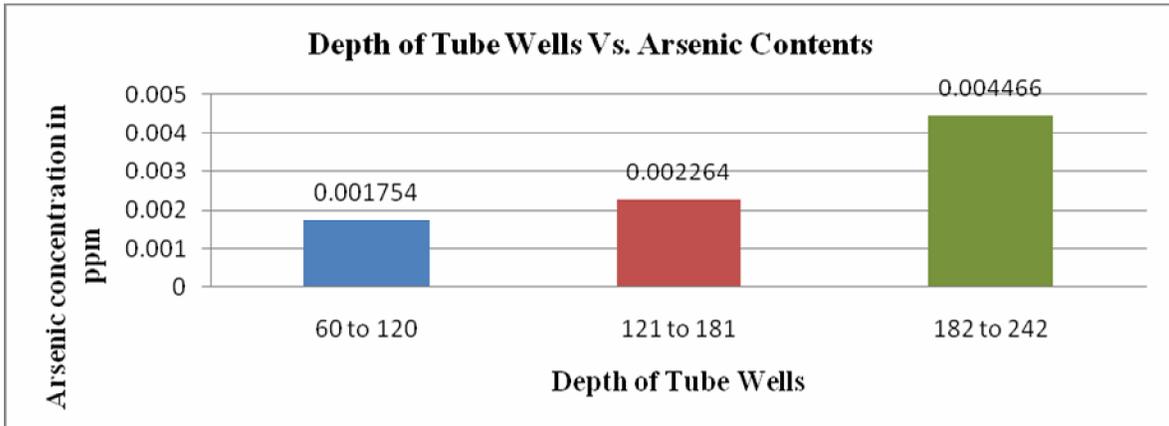
Antimony contents were compared with the depth of the tube wells and it was found that in every sample antimony contents were present and they were significantly above the recommended value. The antimony contents of collected water samples were ranged from 0.2774 mg/l to 1.0214 mg/l. Antimony contents were found in higher amount in tube wells of lower depth and the value of antimony contents was significantly lower in tube wells of higher depth. It was found that as the depth of tube well increased the amount of antimony decreased significantly.

Figure.1.1 Depth of Tube Wells vs. Aluminum Contents



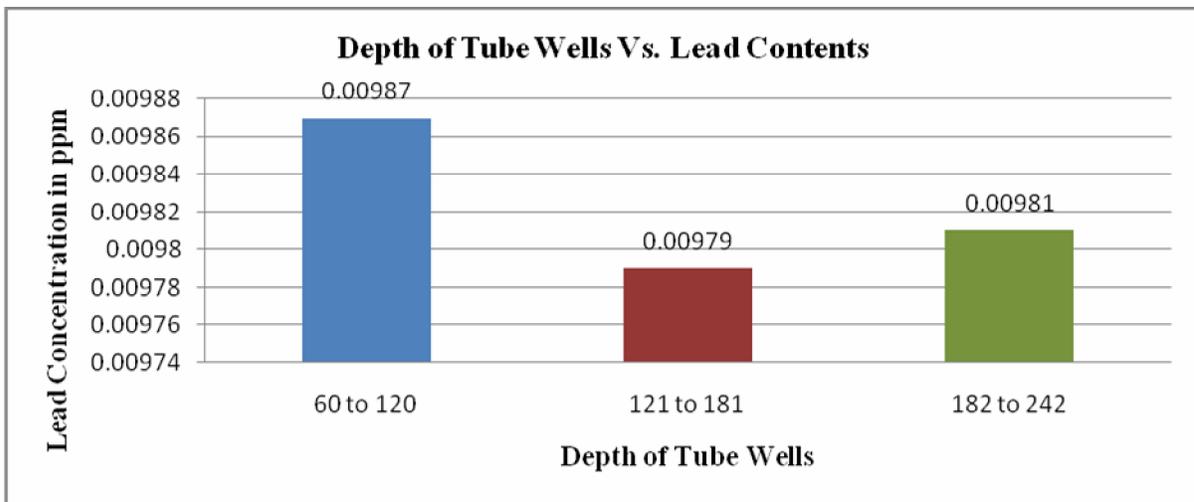
Comparing Aluminum Contents with the depth of the tube wells and it was found that in every sample aluminum contents were present and they were significantly above then the recommended value. Aluminum contents were found in higher amount in tube wells of lower depth and the value of aluminum contents was significantly lower in tube wells of higher depth. It was found that as the depth of tube well increases the amount of aluminum decreased significantly.

Figure.1.2 Depth of Tube Wells vs. Arsenic Contents



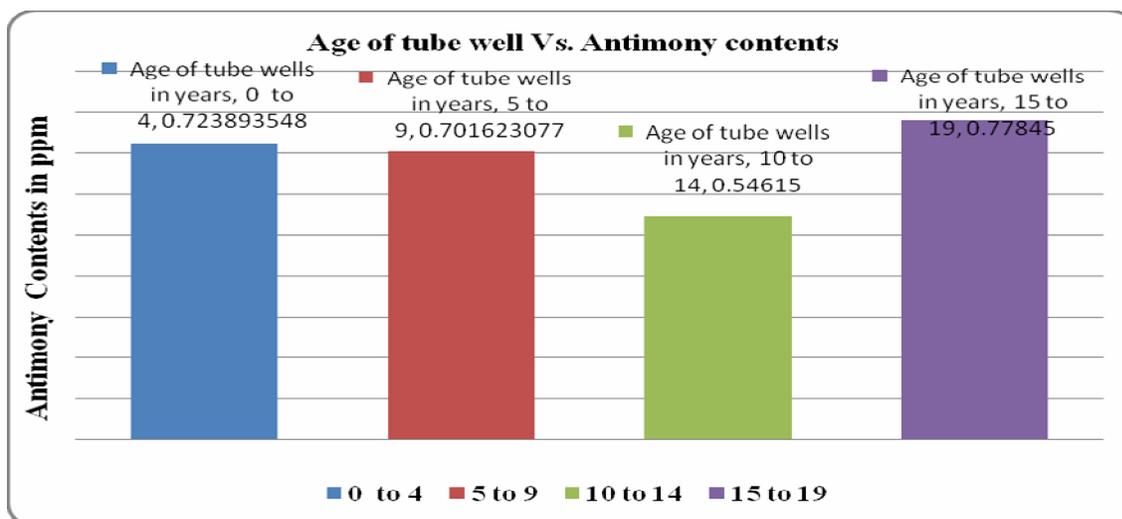
The Depth of tube wells were compared with Arsenic contents in which it was found that in every sample arsenic contents were present but they were below the recommended value. Arsenic contents were found in higher amount in tube wells of lower depth and the value of arsenic contents was significantly lower in tube wells of higher depth but all of them were below the recommended value. It was found that as the depth of tube well increased the amount of arsenic decreased significantly.

Figure.1.3 Depth of Tube Wells vs. Lead Contents



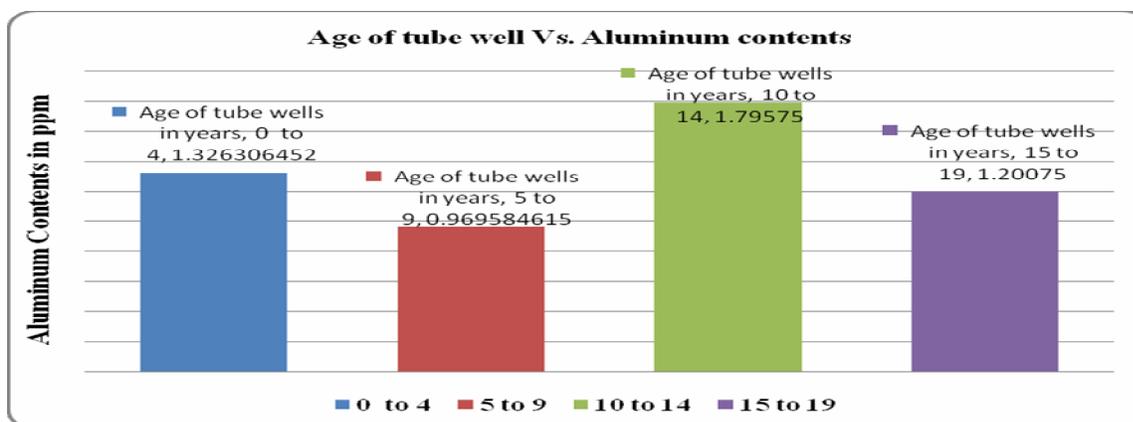
Lead contents were compared with the depth of the tube wells and it was found that in every sample Lead contents were present but they were significantly below the recommended value. The lead contents of collected water samples were ranged from 0.001 mg/l to 0.0078 mg/l. literally lead contents were found almost equal in all depths of tube wells which show that there is no significance of depth on lead contents.

Figure.1.4 Age of Tube Wells Vs. Antimony Contents



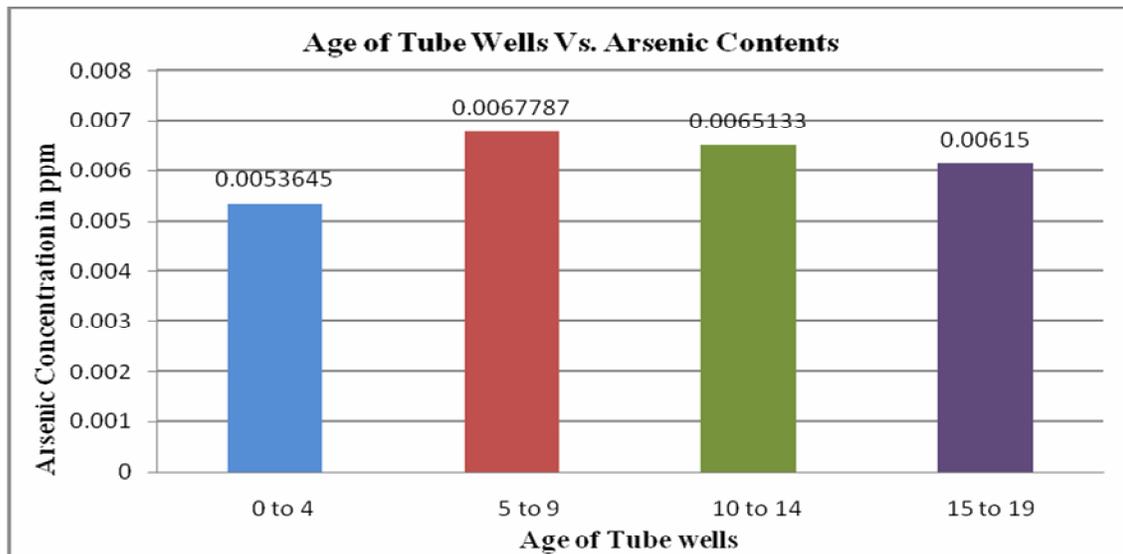
The age of tube wells were studied and its impact was compared on Antimony contents. The study found that antimony was present in almost all water samples collected from different tube wells. The antimony contents were present in significant proportion. When studied for its comparison with age of tube wells it was seen that antimony contents were present in equal proportion regardless of tube well age and there were no significant change regarding age of tube well. The graph shows that tube wells of long and short age have antimony contents in mix proportion. Some tube wells of short age have higher antimony contents while some tube wells of long age have higher antimony contents vice versa. Literally it depicts true picture that age has no impact on proportion of antimony contents in studied water samples.

Figure.1.5 Age of Tube Wells Vs. Aluminum Contents



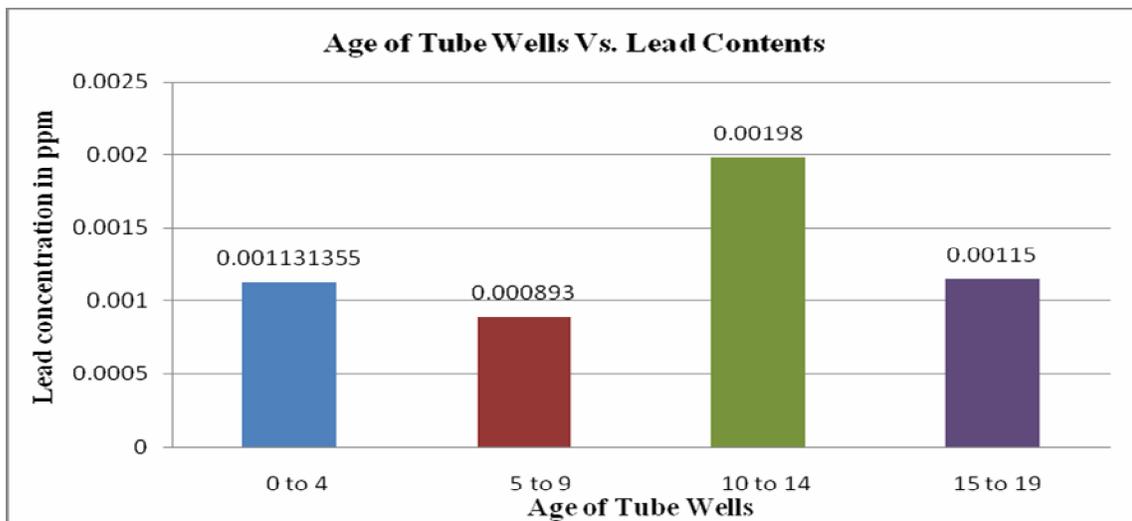
The age of tube wells were calculated and its impact was compared on aluminum contents. It was found that aluminum contents were in equal proportion regardless of tube well age. The graph shows that tube wells of long and short age have aluminum contents in mix proportion. Some tube wells of short age have higher aluminum contents while some tube wells of long age have higher aluminum contents vice versa. Literally it depicts true picture that age has no impact on proportion of aluminum contents.

Figure.1.6 Age of Tube wells Vs. Arsenic Contents



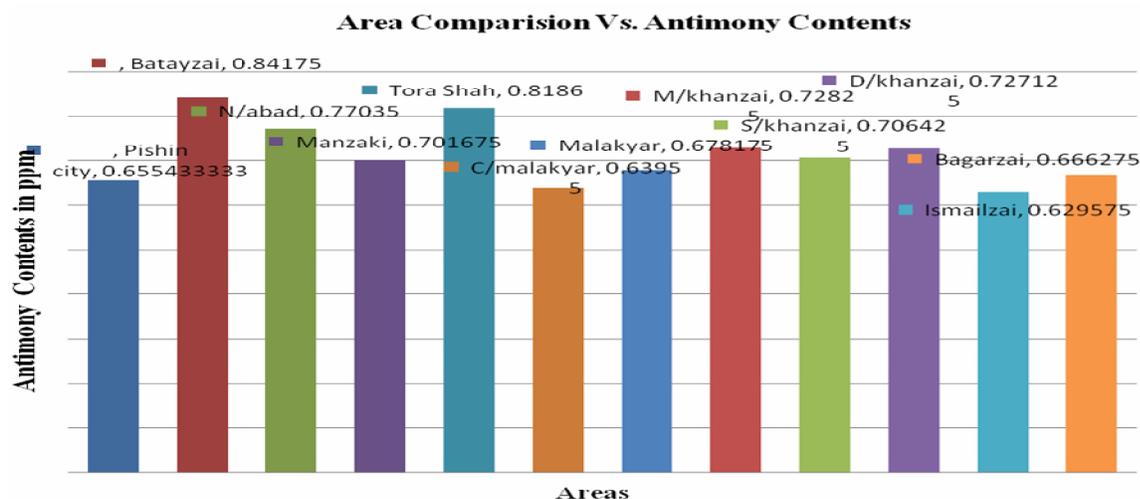
Lead Contents were compared with the age of tube wells. It was found that lead contents were in equal proportion regardless of tube well age. The graph shows that tube wells of long and short age have lead contents in mix proportion. Some tube wells of short age have higher lead contents while some tube wells of long age have higher lead contents vice versa. Literally it depicts true picture that age has no impact on proportion of lead contents.

Figure.1.7 Age of tube wells Vs. Arsenic Lead Contents



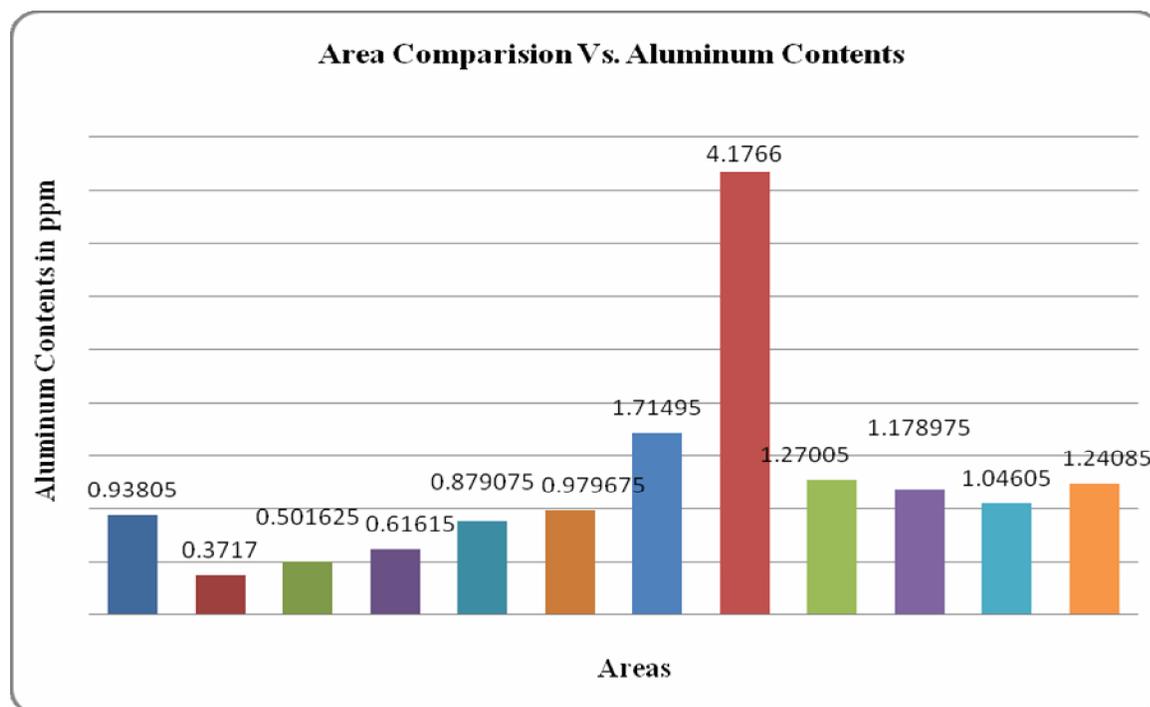
The age of tube wells were calculated and its impact was compared on Arsenic contents. It was found that Arsenic contents were in equal proportion regardless of tube well age. The graph shows that tube wells of long and short age have arsenic contents in mix proportion. Some tube wells of short age have higher arsenic contents while some tube wells of long age have higher arsenic contents vice versa. Literally it depicts true picture that age has no impact on proportion of arsenic contents.

Figure.1.8 Area Comparison Vs. Antimony (Sb) Contents



Antimony contents were compared with different study areas. It was found that antimony contents were found in every area water sample collected from tube wells. Antimony 3contents had almost equal amount in all studied areas and no significant change was found

Figure.1.9 Area Comparison Vs. Aluminum (Al) Contents



Aluminum contents were compared with different study areas. It was found that aluminum contents were found in every area water sample collected from tube wells. However in some areas including (Pishin city, Ismailzai, Nawabad and Bagarzai) the aluminum contents were found significantly higher than other studied areas. It was assumed that the increase in aluminum contents in these areas might be due to water turbidity and muddy soil in nature found in these areas.

impact on concentration of these heavy metals in particular such as Antimony (Sb), Arsenic (As), and Aluminum (Al). The above discussion leads to the conclusion that the geologic condition of the area, use of fertilizers, insect repellants and depth of tube wells may contaminate the underground water.

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