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Determination of Antimony in Zahedan Drinking Water

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This article explains the status of antimony in Zahedan aquifer that lies in south east of Iran. We have measured the antimony concentration of 10 wells randomly by flame atomic absorption spectroscopy method. The minimum and maximum concentration of this element was 5.41 and 6.04 ppb in these samples, respectively. These amounts were much more than the standard limit (0.005 ppm). Isoconcentration contours were drawning on geological map of the area to determine the origins of antimony contamination. We have defined the origin of ground water pollution by obtaining information about industrial, agricultural and animal husbandry activities and geology and geochemistry of the region.

Key Words: Zahedan, Contamination, Antimony, Groundwater.

INTRODUCTION

One of the main goals of every government is to prepare and improve water quality for drinking. Water is contaminated by several sources such as heavy metals[1-3]. Ground water is the sole source of drinking water for Zahedan city. Zahedan, in south east of Iran, is characterized with high population growth, limited local fresh water resources and is located in semi-arid region.

A very small amount of antimony is found in the earth's crust in pure form. This element is found in valence state of 3 and 5 and present as pollutant in water. Antimony can enter in our body through ingestion and inhalation[4]. It could be dangerous for human health. Toxic doses of antimony cause either acute or chronic health effect[5]. The acute effect of antimony is rare because exposure of human to a large dose of antimony through groundwater is infrequent, so chronic effect is considerable. When small amount of antimony enter body in long period of time, chronic health effect can occur[6].

Antimony is hard and fragile so it forms alloys with other metals to improve its physical properties such as corrosion resistance and mechanical strength. Today this metal is used in lead storage batteries, solder, sheet, pipe metal, casting ammunition, fire retardation and stabilizers in plastic and additive in glass[7]. Tartar emetic (antimony

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potassium tartrate) is a compound of antimony that is used as a drug against bilharzia disease[8]. The other uses of antimony include manufacture of white metal, bullets, fireworks coating metals, semiconductor and thermoelectric piles[9].

The maximum contaminant level (MCL) and maximum contaminant level goal (MCLG) of antimony is 0.006[10]. There are several methods to determine antimony quantity such as atomic absorption spectrometry (AAS)[11] and inductive coupled plasma mass spectrometry[12]. The detection limits of these methods are 0.8 and 0.1 µg/L, respectively.

Exposure of antimony through food is negligible because this element can not be bio-accumulated but it is a considerable risk through water. Average concentration of antimony is in the range of 0.1-0.2 µg/L in ground water. This element is distributed in some organs such as spleen, liver, bone, skin and hair through red blood cells[13]. Ingestion of antimony compounds has bad effects on the heart, the respiratory system and gastrointestinal tracts with symptoms such as stomachache, vomiting, diarrhea and stomach ulcers[14-16].

EXPERIMENTAL

Water samples have been collected randomly from 10 wells in different places of Zahedan. These samplings were conducted for 10 times. Map of the area (Zahedan aquifer) and locations of the wells are shown in Fig. 1. This figure has been drawn by use of surfer software.

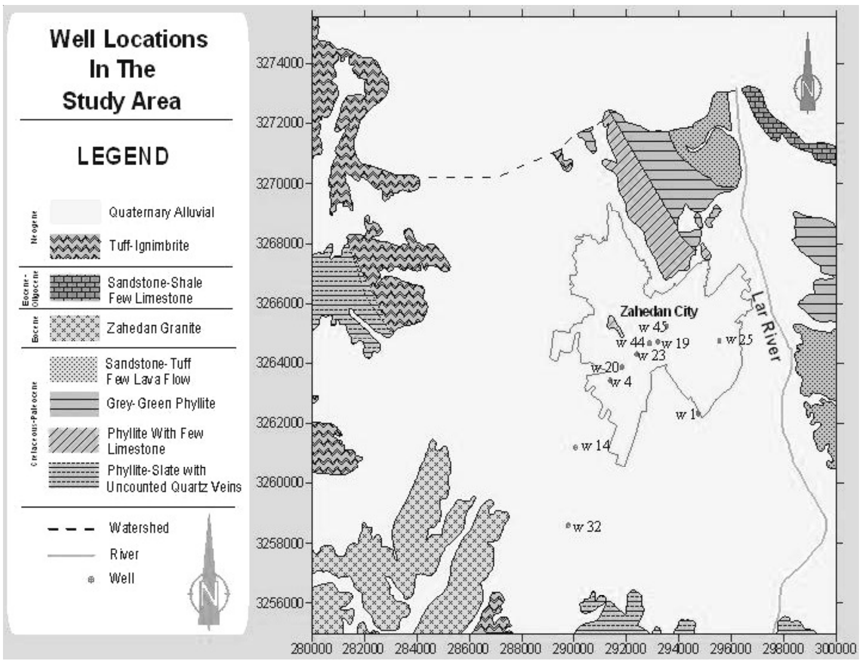

Fig. 1. Zahedan and well locations in the area study

All samplings are based on "standard methods for the examination water and wastewater" book (1999)[17]. The plastic bottles were used for sampling (1.5 L). Before sampling, the bottles washed carefully. The pH-2 was maintained for each sample by adding the concentrated nitric acid to stable the samples immediately[18]. The analysis of the metal elements in the samples has been carried out in the laboratory of Geological and Mining Exploration Organization in Sistan and Baluchistan province. This experiment has been carried out by different methods, including the flame atomic absorption spectrometry for measuring antimony concentrations. The atomic absorption spectrometer, SpectrAA-220 which has been used for the analysis of the samples, was made in Varian Australia[19].

RESULTS AND DISCUSSION

The histogram diagrams (Fig. 2) show the concentration of antimony in the sampling wells. We observe the minimum and maximum concentration in this figure.

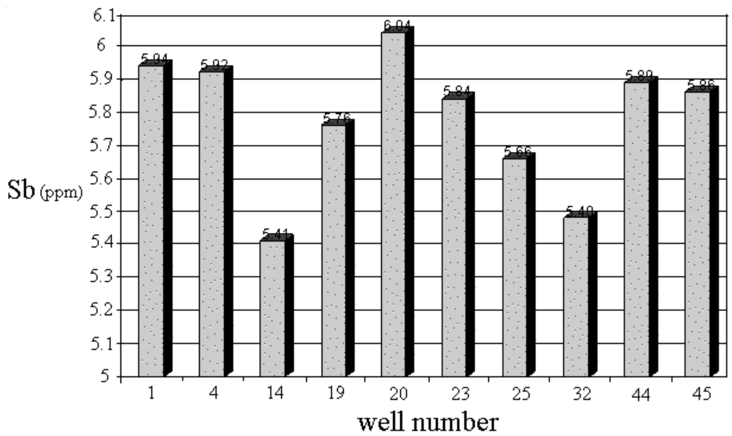

Fig. 2. Comparing the antimony concentration in sampling wells

Pollution distribution and origins of contaminations were studied by use of such information as the concentration of antimony in the water of wells, geographic coordinates of the sampling wells, geological map of the area and the geographical information system (GIS) of the area and sampling wells[20]. Moreover, water contaminations, investigated by use of isoconcentration contours have been drawn by use of Surfer software.

Fig. 2 compares the antimony concentration in the sampling wells and it shows the differences. The minimum amount of the measured concentration was observed in the No. 14 well (5.41ppm) and the maximum concentration was in the No. 20 well (6.04 ppm). The WHO guidelines for drinking-water quality (1993) reported the health-related limit of 0.005 mg/L antimony in natural mineral water (0.005 ppm or 5 ppb)[21].

Fig. 3 shows isoconcentration contours of antimony in aquifer of the studied area. Two positive anomalies have been observed by studying the drawn contours around the wells Nos. 1 and 20. There are an industrial town and a waste burial place around the No. 1 well. However, there are not any pollutant sources like industrial pollution and human factors around the No. 20 well.

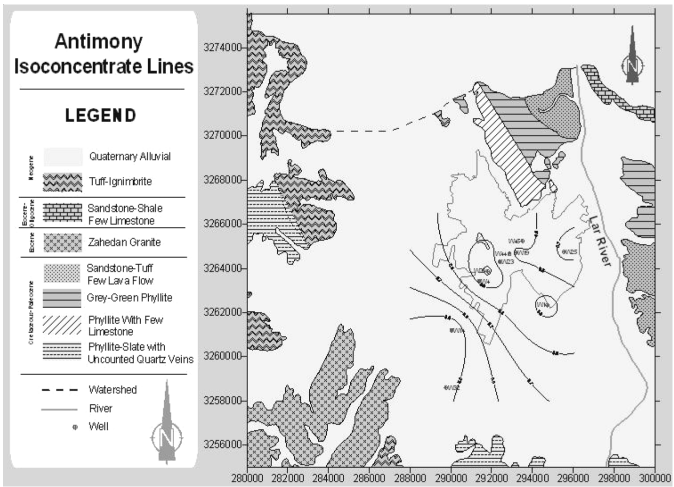

Fig. 3. Antimony isoconcentration contours (ppm) in the groundwater of region

Antimony exists in groundwater veins, lead ores and other metals. With due attention to volcanic activities of Taftan and Bazman, we could say that very high concentration of antimony (about 1000 times more than the allowable limit) in the groundwater of the area is closely related to the geological situation of the area. This area has mines with a high degree of antimony and therefore must be taken into consideration. An existence of antimony and cadmium along with lead causes the concentration curves of these elements to be very much alike in the area. This is the other geological origin of antimony.

Conclusion

Antimony concentrations have higher than WHO guidelines for drinking water at all areas as the antimony concentration is about 1000 times higher than standard quantity. The focus of contamination is around the number 20 well, located at Behdasht Boulevard. Whereas contamination as a result of human and industrial activities has not been observed, this contamination seems to be due to the existence of mines of this element in the soil and stones of this area. Pollutant focuses at the areas may be due to the Mirjaveh industrial town, the workshop industrial town and the waste burial place due to human activities such as industry, agriculture and animal husbandry. However, these industries are few and they cannot put such quantities of contamination into the aquifer. Therefore, the fact that human activities do not have many effects on these contaminations does not imply that the existent industries treat their wastewater. Rather, the wastewater enters the environment. Although these effects are very small, the intensification of pollution could occur so that a little anomaly is created around the No. 1 well. The roles of the Mirjaveh industrial town and the waste burial place are more crucial in the intensification of contamination.

Generally, geological effects of heavy metals in groundwater contamination are observed at all the area. Moreover local human activities (industry, agriculture and animal husbandry) also contaminate aquifer, although to a lesser degree.

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