PREMILINARY RESEARCH ON ARSENIC POLLUTION OF SURFACE AND GROUND WATER IN TRA NANG GOLD EXPLOITATION REGION- LAM DONG PROVINCE AND CAO LANH TOWN - DONG THAP PROVINCE

Vu Chi Hieu, Le Tu Thanh, To Thi Hien

Department of Environmental Science, University of Natural Sciences, Vietnam National University Hochiminh City, Vietnam

Abstract

In recent years, heavy metal pollution, especially Arsenic, has become a public concern about environmental problem. Several researches on arsenic pollution in surface and ground water in North of Vietnam have been addressed. These studies showed that the total arsenic concentrations in ground water in many places in North of Vietnam were many times higher than level allowed in drinking water. This paper shows the results of our research on arsenic pollution in surface and ground water conducted at gold mine of Tra Nang - Lam Dong province and Cao Lanh Town – Dong Thap Province.

The samples were taken according to procedures defined in Vietnamese Standards (TCVN 5993 – 1995). They were analyzed by using stripping voltammetry with the rotating gold electrode. The concentrations of arsenic in surface and ground water in gold mine of Tra Nang - Lam Dong were from 2 to 432 higher than the level allowed in Vietnamese Standards (TCVN 5944 – 1995). Arsenic concentrations of groundwater at Cao Lanh Town – Dong Thap Province were from 2 to 14 times higher than the level allowed in (TCVN 5944 – 1995).

Keywords: Arsenic, surface and ground water, anodic stripping voltammetry, gold-mine

Introduction

Arsenic (As) is a naturally occurring element in the earth's crust and is found throughout the environment. In the environment, Arsenic is combined with one or more than elements such as oxygen, chlorine and sulfur to form inorganic arsenic compounds. Arsenic in animal and plants combines with carbon and hydrogen to form organic arsenic compounds. Organic arsenic compounds are less toxic than inorganic arsenic compounds. Exposure to high levels of some organic arsenic compounds may cause similar effects as inorganic arsenic. The effects of exposure to any hazardous substances depend on the dose. Most arsenic that is absorbed into the body is converted by the liver to a less toxic form that is efficiently excreted in the urine. Consequently, arsenic does not have a strong tendency to accumulate in the body, except at high exposure [1].

Inorganic arsenic has been recognized as a human poison and large doses can result in death. Lower levels of exposure may produce injury in a number of different body tissue or systems. Long-term exposure to arsenic via drinking- water causes cancer of lungs, skin, urinary bladder and kidney, as well as other skin changes such as pigmentation changes and thickening. Increased risks of lung and bladder cancer and of arsenic-associated skin lesions have been observed at drinking-water arsenic concentrations of less than 0.05 mg/L. Inorganic arsenic can occur in the environment in several forms but in natural waters, and thus in drinking-water, it is mostly found as trivalent arsenite (As(III)) or pentavalent arsenate (As (V)). Organic arsenic species, abundant in seafood, are very much less harmful to health, and are readily eliminated by the body.

Arsenic may be found in water through the dissolution of arsenic-rich minerals and ores in the earth's crust, and concentrations in groundwater in some areas are elevated as a result of erosion from local rocks. Arsenic is highly toxic and carcinogenic. Groundwater is particularly vulnerable to contamination with arsenic as a result of natural geochemical processes and problems can be exacerbated by mining activity. Even natural concentrations of arsenic in groundwater can limit its suitability for drinking [2].

Method

To solve practical demand about arsenic, in this publication we show results of the determination of arsenic contamination in surface and ground water in many areas of South of Vietnam, initiative in Tra Nang gold exploitation area in Lam Dong Province. The aim of work is to give general assessment about groundwater contamination posture in these areas.

Arsenic is acutely toxic so allowable concentration is low in surface and ground water. Therefore, it is essential to use the analytical techniques with high sensitivity and precision for analyzing arsenic. There are several methods have been applied for determine arsenic concentration such as hydride generation atomic absorption spectrometry (HG – AAS), induced couple plasma atomic emission spectrometry (ICP – AES), stripping voltammetry,.... .In this review, we use the method anodic stripping voltammetry (ASV) at the rotating gold electrode for the determination of arsenic. The determination limit of the method is 0.5μg/L. Vietnamese standard for total arsenic concentrations is 0.05mg/L so ASV method is reliability to detect arsenic [3,4,5,6].

Results and discussion

Tra Nang Gold Deposit consist of many ore Veins belonged to Gold – quarts – sulphide formation. Mineral composition: quarts, native gold, pyrite (FeS_2), arsenopyrit (FeAsS), Galen (PbS), Sfalerit (ZnS), chancopyrit ($CuFeS_2$).

Ore bodies are opened in the Northern and the Southern slope of Daqyun river valley and developed until 200m deeply.

Mining operations : open pits, underground working, mill, ore enriching, and concentrate loading facility. Water sampling network is distributed along the runoff. The samples are taken according to procedures defined in Vietnamese Standards (TCVN 5993 – 1995) and analyzed by using stripping voltammetry with the rotating gold electrode.

FINGURE 1 **WATER SAMPLING POINTS AND TOTAL ARSENIC CONCENTRATIONS**

TRA NANG GOLD MINING REGION - LAM DONG PROVINCE

SCALE: 1/50.000

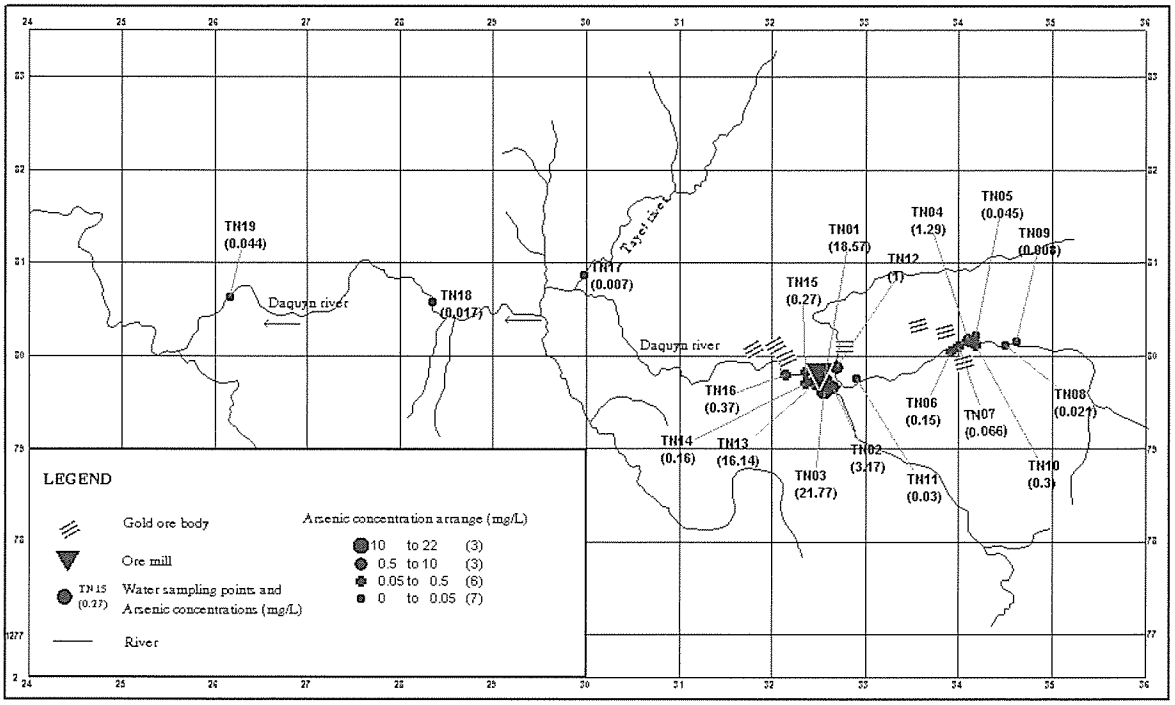

Table 1: Arsenic concentrations in surface and ground water from Tranang Gold mining region – Lam Dong province

Sample	Water Sampling Points	As (mg/L)
TN1	Discharged water from ore mill	**18.57**
TN2	The surface stagnant water	**3.17**
TN3	Discharged water from ore mill	**21.77**
TN4	Water flow from underground working	**1.29**
TN5	Well water at 20 meters in depth	**0.045**
TN6	The surface stagnant water	**0.15**
TN7	Runoff water near the ore deposit	**0.066**
TN8	Runoff water upstream from mine	**0.021**
TN9	Well water at 20 meters in depth	**0.008**
TN10	Fish pond water	**0.30**
TN11	The surface stagnant water	**0.03**
TN12	Runoff water downstream from mining operations	**1.00**
TN13	Discharged water from ore mill	**16.14**
TN14	Runoff water downstream from mining operations	**0.16**
TN15	Water flow through one of the ore bodies	**0.27**
TN16	Runoff water downstream from mining operations	**0.37**
TN17	X Tayet River Water	**0.007**
TN18	Daquyn River Water	**0.017**
TN19	Daquyn River Water	**0.044**

Table 2 : Arsenic concentrations in groundwater of some places from Cao Lanh Town – Dong Thap Province

Sample	Water Sampling Points	As (mg/L)
CL1	Household Well water at 80m in depth	**0.005**
CL2	BinhMinh Station water at 320m in depth	**0.002**
CL3	Water from BinhMinh Station	**0.003**
CL4	UNICEF Household Well water at 40m in depth	**0.003**
CL5	UNICEF Household Well water at 69m in depth	**0.27**
CL6	Drilling well water at 40m in depth	**0.47**
CL7	UNICEF Household Well water at 63m in depth	**0.56**
CL8	UNICEF Household Well water at 82m in depth	**0.12**
CL9	Drilling well water at 35m in depth	**0.15**
CL10	Drilling well water at 25m in depth	**0.71**
CL11	Drilling well water at 50m in depth	**<0.0005**
CL12	Drilling well water at 100m in depth	**0.001**
CL13	Drilling well water at 150m in depth	**<0.0005**

Water contamination is detected at the downstream from mine with the As concentrations from 2 to 432 higher than the level allowed in Vietnamese standards.

Water pollution is created from oxidation process of sulfide minerals caused by the weathering and mining operations.

The most serious problem from mining operation is Acid Mind Drainage (AMD) – oxidation process are complex involving series of chemical reaction. The final solution is in the sulfuric acid form. The Arsenic have been in existence in $Fe[AsO_4].H_2O$ form. At 5 kilometers distance downstream from mine, the arsenic concentration is lower than the Vietnamese standards.

Results of analyzing Arsenic at the wells belong to three groundwater aquifers following:
– The wells from 20 to 70 meters in depth, these wells were supported by UNICEF. The arsenic concentrations are from 3 to 14 times higher than allowable level in Vietnamese standards.
– The wells from 100 to 150 meters in depth are not polluted because the arsenic concentrations are lower than allowable level in Vietnamese standards.
– At the depth of 320 meters, groundwater is used to supply domestic water for citizens in this area. The water quality is good and the arsenic concentrations are much lower than allowable level in Vietnamese standards.

References

1. http://www.atsdr.cdc.gov/tfacts2.html
2. http://www.who.int/inf-fs/en/fact210.html
3. Application bulletin 226/2 e, Determination of arsenic by tripping voltammetry at the rotating gold electrode, Metrohm, 2002.
4. J.W.Kiennuck and S.Ray. Analysis of contaminants in edible aquatic, VCH Publisher, 1994.
5. I. Rodier, L' analyses de l'eau, Dunod Paris, 1984.
6. J.D.Winerfordner, Hydride generation atomic absorption spectrometry, Vol 130, John Wiley & Sons. 1995.