

# Arsenic Contamination in Groundwaters of Village Koudikasa in Rajnandgaon District (Chhattisgarh)

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## Abstract

*Excessive intake of arsenic can lead to health problems. More than 800 water samples collected from hand pumps and dug wells from Chowki block were analyzed for arsenic and some other physico-chemical parameters. Out of the total samples analyzed the highest concentration of 1890  $\mu\text{gAs/L}$  was found in one of the hand pumps at the Koudikasa village. The paper presents results of groundwater samples with special reference to arsenic contamination in village Koudikasa. Short term and long term technological options for providing arsenic free water and recommendations for future course of action have also been delineated in the present paper.*

## Key Words

*Koudikasa Village, arsenic contamination, groundwater*

## Introduction

High concentrations of arsenic in groundwaters of West Bengal, India and Bangladesh have become a major cause of concern in recent years as arsenic has acquired an unparalleled reputation as a poison with arsenic trioxide contributing a convenient agent for homicide. In addition to its publicized role as a poison, arsenic finds its applications in, medicine and dyes. In modern days besides this it is used in pesticides, additives to animal feed, wood preservatives, glasses, semiconducting devices, etc (Webster, 2000). Possibility of arsenic in higher concentrations has never been considered seriously in the past. The ubiquity of arsenic in the environment originates from natural enrichments and is intensified by anthropogenic activities. The most common sources of arsenic in the natural environment are volcanic rocks specially acid volcanic rock, volcanic ash and specifically their weathering products, marine sedimentary rocks, coal, coal ash, petroleum, hydrothermal ore deposits and associated geothermal waters (Korte and Fernando, 1991; Smedley and Kinniburgh, 2002). Arsenic associated with sediment particles can be a major source of arsenic contamination. Major ore minerals of arsenic are

Arsenopyrite ( $\text{FeAsS}$ ), Orpiment ( $\text{As}_2\text{S}_3$ ), Realgar ( $\text{AsS}$ ) and Lollingite ( $\text{FeAs}_2$ ). It is often associated with Au, Ag, Cu forming their arsenite. It is found that geochemical mobility of arsenic in nature depends on oxidation state of arsenic and associated element (Masson and Moore 1982). Arsenic is known as the king of poisons and has plagued human being since the days of antiquity. Arsenic is not a physico-chemical constituent of the body. The toxicity of arsenic species differ with their chemical forms and oxidation states (NRC, 1999; Thomas et al., 2001). The arsenic (III) in the body combines with sulphhydryl containing substances and inhibits the activity of many enzymes of the group. Arsenic can give rise to acute and chronic toxicity in the body. It is suggested that the intake of significant amounts of inorganic arsenic can intensify the chances of cancer development, especially skin, lung, liver and lymphatic cancer. Manifestations due to arsenic poisoning on human body are shown in the Figure 1.

The paper presents results of groundwater contamination with special reference to arsenic in Koudikasa village of Chowki block in district Rajnandgaon, Chhattisgarh. Short term and long term

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technological options for providing arsenic free water and recommendations of future course of action have also been delineated in the this paper.

### Study Area

Koudikasa Village is situated in Chowki block of Rajnandgaon district of Chhattisgarh state. It is 40 Km SW of Rajnandgaon city. The Chowki block has dense forest in some places. Chowki Block is a part of the Mahanadi river basin. The river Shivnath, one of the tributaries of the Mahanadi River, passes near from the village. The major source of water, used for domestic purposes is groundwater. Arsenic affected areas of Rajnandgaon district and Chowki block showing Koudikasa village are depicted in Figure 2.

### Geological Setup of the Study area

Koudikasa Village is covered by rocky rhyolitic rock formation with thin alluvium, colluvium and soil cover. It is a part of Bastar Craton of Central Indian Province. A major liniment (also called rift) trending North- South, passes through this village. Also NE – SW trending major fault passes near from village (Figure 3). The N-S trending early Proterozoic Dongargaon rift zone exposes acid and basic meta-volcanic rocks, meta-volcanic sediments and co-magmatic and contemporaneous Dongargarh Granite. The rift zone is dissected by several N-S and NW-SE trending silicified fault, fracture and shear zones. Quartz veins and reefs emplaced along these faults, fractures and shear zones often carry sulphides. Sulphides also occur sporadically within the metavolcanics. The arsenic contaminated villages are preferentially located within areas exposing acid volcanics, often located close to shear zones and rarely on granite (Figure 3). However, there are several villages located on such settings but are free of arsenic contamination. Arsenic is inferred to be enriched locally in the acid magmatic rocks by hydrothermal solutions that preferentially permeated conductive host rocks along structurally prepared fracture, shear zones and quartz reefs. Severe arsenic pollution in tube-well water is recorded from Koudikasa, Sonsayatola, Joratarai and Jadutola (Figure 3). Country rocks are better exposed around Koudikasa and Sonsayatola areas. The Koudikasa village further, is located over a prominent quartz reef, which also mark tectonic contact between the rhyolites and mafic-volcanics. (Acharyya S. K. et. al 2005)

## Methodology

### Sample Collection

Total 813 groundwater samples were collected from the Chowki Block. There were 692 water samples collected from hand pumps, 119 samples collected from dug wells and two water samples were collected from the river Shivnath. Total 25 groundwater samples were collected from the village Koudikasa. The water samples were collected in 500 ml polythene bottles. During sampling at the hand-pump, water was flushed for about 5 minutes before filling it in the polythene bottle. Sampling at the dug well was done with the help of rope & bucket. The polythene bottles were thoroughly rinsed with the water sample before filling. At each source two aliquots were collected. The first aliquot of water sample was collected as such, whereas the second aliquot of the sample was acidified at the spot by adding 10 drops of nitric acid (concentrated). The water samples were brought to the laboratory for further analysis.

### Sample Analysis

The first aliquot of each source was analyzed for pH, alkalinity and conductivity whereas the second aliquot was analyzed for arsenic, iron and manganese levels by the ICP-AES. The standard Methods for the examination of water and wastewater was followed for the analysis of pH, conductivity and alkalinity. Iron and manganese were estimated by the ICP-atomic emission spectroscopic method. Analysis of arsenic was carried out using Hydride Generation-Inductively Coupled Plasma (HG-ICP) spectroscopic method.

### Results and discussion

Results of groundwater samples at Koudikasa village are given in Table 1. Out of 25 samples collected from Koudikasa village 19 samples showed arsenic concentration above the WHO guideline value of 10 µgAs/L. Variation of arsenic levels in the 25 samples is represented graphically in Figure 4.

Out of the total 813 water samples analyzed from Chowki block the Koudikasa village is severely affected and showed highest concentration of 1890 µgAs/L (or 1.89 mg/L). There are 11 villages besides Kodikasa where arsenic levels were above 50µg/L that is the BIS limit for arsenic in drinking water. These 11 villages are Arajkund, Atargaon, Biharikala, Dhadutola, Jadutola, Joratarai, Koudikasa, Mangatola,



Sangli, Sonsaytola, and Telitola shown in (Figure 3). The total population of the Koudikasa village is about 2000. From a preliminary investigations and considering the geological formation of the area, it appears that the source of arsenic in Rajnandgaon district may not be the same as that of West Bengal and Bangladesh. Many villagers from Koudikasa go to nearby streams, small canals (Bhagawantala, Basta), and Shibnath river to collect gold particles; Bodal is about 5 km away from Koudikasa, where the Atomic Energy Commission had set up uranium mines from 1982–1989. Heaps of underground sediments are lying on the surface in Bodal; No information is available about the use of arsenical pesticides or herbicides in the area. Normally, if the dug-well water contains high amounts iron, then arsenic is co-precipitated and goes to sediment where it may reacts with microbes for elimination. Preliminary analysis of Chowki block that only a few villages have contaminated groundwater. The skin lesions in Koudikasa villagers were noticed in the early seventies, they were officially confirmed to be due to arsenic toxicity only few years ago. Most of the villagers of Koudikasa use water from a forest dug-well which now contains about 0.52 µg/L of arsenic.

#### Strategies for Prevention and Control of Arsenic Problem in Chowki Block

Following strategies are suggested to mitigate the prevailing arsenic problem in Koudikasa village.

##### A. Short term Strategies

- Early detection & management of affected population by surveys
- Development alternative water supply options
- Delineation of affected areas for early detection and prevention of further exposure
- Development of education and communication materials
- Strengthening of laboratory facilities
- Conduction training programmes for health personnel
- Establishment of out-patient treatment centre at the

##### Primary health Centre

- Development of collaborative linkages with national and international agencies

##### B. Long term Strategies

- Conduct survey of all groundwater sources in all the blocks of Rajnandgaon district
- Conduction of detailed hydrogeological investigations
- Development of appropriate remedial measures to mitigate the problems
- Development of appropriate measures for supply of arsenic free water
- Establishment of 10 bedded in-patient service centre at Chowki Block
- Watershade management and encouragement of people to use more surface water
- Training of doctors and health personnel to develop skilled manpower and to disseminate knowledge on arsenicosis
- Development of a surveillance team and arsenic network from grass-root level to district level
- Involvement of mass media and development of Information, Education and Communication (IEC) materials

##### Recommendations

- Set-up an arsenic monitoring cell by PHED (Chhattisgarh)
- Monitoring to be headed by an Executive Engineer, supported by two Assistant Engineers and one Chemist
- The PHCs should also have a monitoring wing for recording arsenicosis cases with disease surveillance
- PHED (Chhattisgarh) should seek assistance from International agencies like UNICEF and WHO

- The district laboratory at Rajnandgaon should be upgraded and provided with equipment like spectrophotometer and AAS/CP (with hydride generation attachment)
- Community based simple Yes/No test, which indicate the presence/absence of arsenic concentration more/less than 50µg/L
- The most reliable and user-friendly arsenic test kit should be used
- For safe water sources new hand pumps must be installed on extra deep well and must be tested for arsenic by the PHED immediately after installation

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