



## Sources of Arsenic in Groundwater and its Health Significance - A Review

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### ABSTRACT

Arsenic is present in earth's crust and occurs in more than 200 natural minerals. Under favourable environmental conditions, arsenic enters into the groundwater. Groundwater has been the major source of arsenic exposure to human population around the world. The incidence of arsenic in drinking water, above the standard limit (0.05mg/L as per IS: 10500) has emerged as a major public health problem. Water constituting arsenic above 10µg/L is a major concern. Arsenic has reference dose or reference value of 3E-4 mg.kg<sup>-1</sup>.d<sup>-1</sup> as an estimate of a daily exposure to the human population that is likely to be without an appreciable risk of deleterious effects during a lifetime. Lesions manifest at exposure levels of about 0.002-0.02 mg As kg<sup>-1</sup>.d<sup>-1</sup>. The trivalent form of arsenic is considered to be 60 times more toxic than pentavalent form. This communication contemplates on presenting the sources of arsenic, and the influencing factors that facilitate arsenic to groundwater, health implications and present regulation on drinking water standards. From the review, it is clear that the consumption of arsenic contaminated water can cause a wide range of acute and chronic diseases in humans. The source of arsenic for groundwater is mainly geogenic in nature. Therefore, if the groundwater is selected as the source of water, routine monitoring for arsenic becomes a vital step before it is conveyed to the end users for drinking or irrigation or industrial purposes.

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### INTRODUCTION

Arsenic is a well known ubiquitous metalloid which is widely dispersed in the Earth's crust. It has properties of a metal as well as a non-metal and occurs in the elemental state for a smaller extent (Nriagu 2002). It is recognized as a toxic and carcinogenic substance which is present within organic and inorganic compounds. High concentrations of arsenic occur in mineral complexes with metals and other elements. Arsenic exists in the average concentration of approximately 5mg/kg of soil (Garelick et al. 2008). In the aqueous environment, the +3 and +5 oxidation states are most prevalent, as the oxyanions arsenite (pH~9-11) and arsenate (pH~4-10) (Smedley & Kinniburgh 2002). Microbial actions on soil also generate arsine gases, which may eventually dissolve in water. Humans are commonly exposed to arsenic mostly through groundwater utilization and marginally through the food chain (Huq et al. 2006). People consuming water with arsenic concentration exceeding 10µg/L (according to WHO Guidelines) are of greater concern, in view of the fact that, it has the potential to cause a wide range of chronic and acute illness.

Arsenic contamination of groundwater has been identified in different parts of the world. Regardless of localized inputs of arsenic, from human activities, much of the contamination of groundwater with arsenic was shown to arise from geogenic sources and the affected groundwater was

found in countries on nearly every continent or major land mass (Barringer & Reilly 2013).

Hence, this review mainly concentrates on the geogenic sources of arsenic into the groundwater. The anthropogenic sources are also been highlighted wherever it is necessary. The influencing factors which help in mobilizing the arsenic in the groundwater is provided as a basic information. The health significance and present drinking water regulations with oral slope factors are also enumerated.

### SOURCES

Natural sources of arsenic are related to types of rocks with associated geological and geothermal activity. More than 200 minerals contain arsenic, which occur in crustal materials and among them the major contributors for groundwater contamination are Realgar (As<sub>4</sub>S<sub>4</sub>), Arsenopyrite (FeAsS), Anargite (Cu<sub>3</sub>AsS<sub>4</sub>), Arsenolite, and Orpiment. Other mineral are Loellingite, Saffrolite, Niccolite, Rammelsbergite, Cobaltite, Enargite, Gerdorfite, Glaucodot etc. Occurrence of some of the arsenic bearing crustal materials and their background concentrations are summarized in Tables 1 and 2. Anthropogenic activities also directly or indirectly aid in introducing arsenic to groundwater (Smedley & Kinniburgh 2002). Sources of As, that arise from human activities include mining and processing of ores and manufacturing using As-bearing sulfides. Activities like alteration of topog-

raphy and rigidity of soil, thereby facilitating for easy dissolution of soil constituents during natural formation of groundwater. Contamination can occur by natural runoff and subsequent seepage of arsenical compounds applied to the farm lands, atmospheric deposition, or improperly disposed chemicals.

The incidence of arsenic in groundwater is attributed to several geochemical processes, including oxidation of arsenic bearing sulfides, desorption of arsenic from oxide and hydroxides, reductive dissolution of arsenic bearing oxides and hydroxides, release of arsenic from geothermal water, and evaporative concentration, as well as leaching of arsenic from sulfides by carbonate (Nickson et al. 2000).

The concentration of arsenic is found in groundwater due to the strong influence of the water rock interactions along with favorable physical and geochemical conditions of aquifers for the mobilization and accumulation of arsenic in water. Aqueous forms of arsenic are taken up from As-bearing sulfides, arsenides, sulfosalts, oxides, oxy hydroxides, Fe-oxides, -hydroxides, -sulfates, Fe-, Ca-Fe- and other arsenates. The dissolution of arsenic mineral in groundwater was observed to be in the order of native-arsenics > arsenolite > orpiment > realgar > arsenopyrite > tennantite (Islama et al. 2013).

A major inorganic form of soluble arsenic in natural waters usually occurs as oxy anions of trivalent arsenite (arsenous acid, As(III),  $H_3AsO_3$ ) or pentavalent arsenate (arsenic acid, As(V),  $H_3AsO_4$ ). Minor forms of arsenic species found in water are mono-methyl-arsonic acid ( $CH_3AsO(OH)_2$ ); mono-methyl-arsinous acid ( $CH_3AsO(OH)_2[CH_3AsO]_n$ ); di-methyl-arsinic acid [ $(CH_3)_2AsO(OH)$ ]; di-methyl-arsinous acid ( $(CH_3)_2AsOH[(CH_3)_2As_2O]$ ); tri-methyl-arsine [ $(CH_3)_3As$ ] and tri-methyl-arsine oxide [ $(CH_3)_3AsO$ ] (National Research Council 1999; Le 2002). Table 3 is the list of different forms of trivalent and pentavalent arsenic present in the environment.

Sea food, fish and algae are the richest organic sources of arsenic. Ratnaike (2003) reviews that arsenic intake is higher from solid foods than from liquids including drinking water. Organic and inorganic arsenic compounds may enter the plant food chain from agricultural products or from soil irrigated with arsenic contaminated water (Rossman 2007).

Mukherjee et al. (2006) reviewed the arsenic contamination in groundwater on a global scale. In the review, it is mentioned that the majority of the groundwater around the world, the arsenic source of contamination is mainly through geogenic sources (Afghanistan, Argentina, Bangladesh, Canada, Cambodia, Chile, China, Egypt, Finland, Ghana, Hungary, India, Iran, Japan, Mexico, Myanmar, Nepal, New

Zealand, Pakistan, Romania Sri Lanka, Switzerland, USA and Vietnam). Table 4 provides the list of countries in which high level of arsenic concentration is found in groundwater.

## INFLUENCING FACTORS

Many factors control arsenic concentrations and transport in groundwater, which include: Redox potential (Eh), adsorption/desorption, precipitation/dissolution, Arsenic speciation, pH, metal sulfide and sulfide ion concentrations, iron concentrations, biological transformation, etc. Further, these factors may vary from aquifer to aquifer that depend upon the geological settings, geo-chemistry and geo-environmental conditions of an aquifer. Under anaerobic conditions, groundwater normally contains arsenite. Arsenic is particularly mobile at pH values typically found in groundwater (pH, 6.5-8.5) under both oxidizing and reducing conditions. Arsenite is readily oxidized to arsenate in aerobic water at pH values above 7.0. Conversely, arsenate can be reduced to arsenite at low pH values. Under oxidizing conditions, arsenate is dominant, as the  $H_2AsO_4^-$  form at low pH (less than approximately 6.9), or as the  $HAsO_4^{2-}$  form at the higher pH. Under reducing conditions, at pH approximately near to 9.2, the uncharged arsenite species  $H_3AsO_3$  predominates. That is, the pentavalent species are predominant and stable in the oxygen rich aerobic environment, whereas the trivalent species are predominant in a moderately reducing environment. Redox potential (Eh), pH and DO are all important factors controlling As speciation and chemistry in the groundwater.

There are three major types of natural geological conditions giving rise to high levels of arsenic in groundwater (IARC Monograph 2004).

- i. Aquifers composed of rocks or sediments enriched with arsenic-containing minerals of geogenic origin, such as sulfide mineralization.
- ii. Aquifers containing sediments coated with iron oxy-hydroxide (FeOOH) phases enriched in arsenic through hydrological action, where arsenic is mobilized into the pore water by reducing conditions.
- iii. Aquifers enriched in arsenic through high rates of evaporation in arid areas, leading to increased mineral concentration in groundwater; the arsenic is mobile in such aquifers because of the high pH (> 8.5) caused by concentrations of alkali and alkali earth metals in the solution.

The geo environmental conditions contributing for arsenic are alluvial sediments (Bangladesh, Vietnam, China, Spain, USA, Canada) with high phosphate and organics (India, Hungary and Romania), or lake sediments, high alkalinity (Mongolia and Argentina). Natural coastal zones and black shale (Taiwan, USA, Canada), loess, volcanic rock/

Table 1: Arsenic present in natural minerals.

Mineral	Formula	Occurrence	References
Native Arsenic	As	Hydrothermal Veins	Ko et al. 2012
Arsenopyrite	FeAsS	Lode Gold, Cu Sulfide, Sn, the most abundant As mineral, dominantly mineral veins	Meunier et al. 2010
Cobaltite	CoAsS	Cu, Zn ores, high temperature deposits, metamorphic rocks	Kwong et al. 2007
Gersdorffite	NiAsS	high temperature deposits, metamorphic rocks	Senior et al. 2009,
Enargite	Cu <sub>3</sub> AsS <sub>4</sub>	Hydrothermal Veins and Replacement	Lattanzi et al. 2008,
Niccolite	NiAs	hydrothermal modification of ultramafic rocks	
		Vein deposits and norties	Anita 2011
Orpiment	As <sub>2</sub> S <sub>3</sub>	Hydrothermal Veins, hot springs, volcanic sublimation product	Zhu et al. 2011
Realgar	AsS	Vein deposits, Clay, Lime stone and Hot springs	Jin et al. 2000
Tennantite	(Cu,Fe) <sub>12</sub> As <sub>4</sub> S <sub>13</sub>	Hydrothermal Veins	Bruckard et al. 2010
Arsenolite	As <sub>2</sub> O <sub>3</sub>	Secondary mineral formed by oxidation of arsenopyrite	
		Native As & other As minerals	Islama et al. 2013
Claudetite	As <sub>2</sub> O <sub>3</sub>	Secondary mineral formed by oxidation of realgar, arsenopyrite	
		Native As & other As minerals	Pichler et al. 1999
Scorodite	FeAsO <sub>4</sub> ·2H <sub>2</sub> O	Secondary Mineral	Kossoff et al. 2012
Annabergite	(Ni, Co) <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub> ·8H <sub>2</sub> O	Secondary Mineral	Cook 2010
Hoernesite	Mg <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub> ·8H <sub>2</sub> O	Secondary Mineral	Voigt 1999
Conichalcite	CaCu(AsO <sub>4</sub> )(OH)	Secondary Mineral	Henderson 2008
Pharmacosiderite	Fe <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub> (OH) <sub>3</sub> ·5H <sub>2</sub> O	Oxidation product of arsenopyrite and other As minerals	Tutor et al. 2013
Kankite	Fe <sup>3+</sup> As <sup>5+</sup> O <sub>4</sub> ·3.5H <sub>2</sub> O	-	Walker et al. 2009
Loellingite	Fe <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub> (OH) <sub>3</sub> ·5H <sub>2</sub> O	Mesothermal vein deposits	Borba et al. 2000
Adamite	Zn <sub>2</sub> (OH)(AsO <sub>4</sub> )	Secondary Mineral	Armienta et al. 2000, 2005
Seligmannite	PbCuAsS <sub>3</sub>	Hydrothermal vein	Mandal & Suzuki 2002
Safflorite	(Co,Fe)As <sub>2</sub>	Mesothermal vein, Hornfels	Senior & Sloto 2006, Murcott 2012
Rammelsbergite	NiAs <sub>2</sub>	Mesothermal vein	Nriagu et al. 2007

sediments (Mexico and Chile) thermal spring (Greece, Argentina, USA, Canada), mineralized sandstones (Germany) and closed basin lakes (USA, Canada and Chile) are the different environmental conditions contributing for arsenic to groundwater (Nordstrom 2002)

## HEALTH COMPLICATIONS

Water containing arsenic concentrations more than 0.05 mg/L (according to drinking water specifications, Bureau of Indian Standards 10500: 2012), is of major concern when it is used for consumption or cooking purposes (Ground Water Association 2007). The ingested arsenic is transmitted through the blood stream and may get concentrated within the internal organs, skin, hair and nails (Barr et al. 2005). Soluble trivalent arsenic compounds, approximately 95% of the ingested dose is absorbed from the gastrointestinal (GI) tract and are eliminated from the body through urination. The trivalent form, As III is considered to be 60 times more toxic than pentavalent form As V (Ratnaik 2003, Yousef et al. 2008). *In vivo*, both forms of arsenic have similar effects, i.e., the absorbed arsenate is mostly reduced to arsenite in the body (i.e. liver). Methylation of inorganic arsenic in liver executed by the enzyme methyl transferase in the presence of sadenosylmethionine (methyl donor) and glutathione (GSH, essential co-factor), results in the formation of or-

ganic arsenics end metabolites mono-methyl-arsinous and di-methyl-arsinous (Mandal & Suzuki 2002).

Exposure to high levels of arsenic can cause short term or acute symptoms, as well as long-term or chronic health effects. Nausea, vomiting, and diarrhea are very common symptoms in humans following oral exposure to inorganic arsenicals, both after acute high-dose exposure and after repeated exposure to low doses; these effects are likely due to a direct irritation of the gastrointestinal mucosa. Acute, high-dose exposure can lead to encephalopathy, with clinical signs such as confusion, hallucinations, impaired memory, and cerebral infarction (Chin 2008), while long-term exposure to lower levels can lead to the development of peripheral neuropathy characterized by a numbness in the hands and feet that may progress to a painful "pins and needles" sensation. Typical dermal effects include melanosis and keratosis (Jyoti et al. 2012). The long term effect is hyper keratinization of the skin (especially on the palms and soles), formation of multiple hyper keratinized corns or warts, and hyper pigmentation of the skin with interspersed spots of hypopigmentation. Lesions typically begin to manifest at exposure levels of about 0.002-0.02 mg As/kg/day but may appear at even lower levels. At these exposure levels, peripheral vascular effects are also commonly noted, including cyanosis, gangrene and black foot disease (Chin et al. 2007). Cardio-

Table 2: Background concentration of arsenic in crustal materials (Smedley &amp; Kinniburgh 2002, Nriagu et al. 2007, Wang et al. 2009).

Rock Type	Range (mg of As/kg)
<b>Igneous Rock</b>	
Ultra basic	0.3-16
Basalt	0.18-113
Gabbro	0.06-28
Latite, Andesite, trachyte	0.5-5.8
Granites/silicic volcanic	0.2-13.8
Rhyolite	3.2-5.4
Diorite, granodiorite, Syenite	0.09-13.4
<b>Sedimentary Rocks</b>	
Shales and Clays	0.3-490
Phosphorites	0.4-188
Sandstones	0.6-120
Limestones	0.1-20
Coals	0.5-80
Bituminous Shale	100-900
<b>Metamorphic Rocks</b>	
Quartzite	2.2-7.6
Hornfels	0.7-11
Slate	0.5-143
Schist	0.1-19
Amphibolite and Greenstone	0.4-45
<b>Sulphide Minerals</b>	
Pyrite	100-77000
Marcasite	20-12600
Pyrrhotite	5-100
Galena	5-10000
Sphalerite	5-17000
Chalcopyrite	10-5000
<b>Oxide Minerals</b>	
Haematite	Up to 160
Fe(III) oxyhydroxide	Up to 76000
Magnetite	2.7-41
Ilmenite	Less than 1
<b>Silicate Minerals</b>	
Quartz	0.4-1.3
Feldspar	0.1-2.1
Biotite	1.4
Amphibole	1.1-2.4
Olivine	0.08-0.17
Pyroxene	0.05-0.8
<b>Carbonates Minerals</b>	
Calcite	1-8
Dolomite	Less than 3
Siderite	Less than 3
<b>Sulphate Minerals</b>	
Gypsum/ Anhydrite	1-6
Barite	1-12
Jarosite	34-1000
<b>Other Minerals</b>	
Apatite	1-1000
Halite	3-30
Fluorite	Less than 2

vascular effects of oral exposure to inorganic arsenic include increased incidences of high blood pressure-hypertension (Islam et al. 2012), Ischemic heart disease (heart attack) and other circulatory problems (Fen et al. 2012).

Table 3: Different forms of arsenic concerning human exposure (Hughes et al. 2011).

Trivalent oxidation state	Pentavalent oxidation state
Arsenite	Arsenate
Arsenic trioxide	Arsenic pentoxide
Monomethylarsonous acid	Monomethylarsonic acid
Dimethylarsinous acid	Dimethylarsinic acid
	Trimethylarsine oxide
	Arsanic acid
	Arsenobetaine

Neurobehavioral alterations are observed more in arsenic exposed children, as they tend to drink more water per unit of body weight than adults. Chronic exposure of humans to inorganic arsenic in the drinking water has been associated with an excess incidence of miscarriages, stillbirths (Richard et al. 2006, Abul et al. 2005), preterm births, and infants with low birth weights. Animal data suggest that arsenic may cause changes to reproductive organs of both sexes, including decreased organ weight and increased inflammation of reproductive tissues, although these changes may be secondary effects. However, these changes do not result in a significant impact on reproductive ability. Long-term (years to decades) exposure to even relatively low concentrations of arsenic in drinking water can increase the risk of developing cancers in skin, lung (pulmonary), kidney and bladder (Guo et al. 2001, Ismail et al. 2008, Mazumder 2008, Claudia et al. 1998, Ferreccio et al. 2013). Some of the diseases aggravated by consuming arsenic contaminated water are furnished in the Table 5.

Arsenic is also suspected to contribute immunological, neurological, and endocrine diseases, but as with the above symptoms, the epidemiological study of diseases caused by arsenic poisoning is only in its infancy. Gandhi & Rakesh (2013) concluded that exposure of arsenic in gestational stage causes developmental and behavioral toxicity. Further, it is a potent carcinogen and toxicant, which easily passes the placenta. Studies have also shown the possibility of causing DNA damage due to oral exposure to arsenic (Feng et al. 2001, Yolanda et al. 2012).

## REGULATIONS OR GUIDELINES

The limits for certain contaminant or pollutant are set for safe consumption of the water by different regulatory bodies across the world. Generally, WHO guidelines are followed to set the standard limits. Table 6 provides the information on limits set by Indian Standards (IS10500:2012), World Health Organization (WHO), United States Environment Protection Agency (USEPA), Central Public Health and Environmental Engineering Organization (CPHEEO) and Indian Council of Medical Research (ICMR).

Table 4: Arsenic contamination in different parts of the world.

Continent	Country	References
Asia	China, Taiwan, India, Bangladesh, Thailand, Japan, Vietnam Nepal, Pakistan, Myanmar, Cambodia, Sri Lanka, Philippines, Iran Laos, Korea	Chen et al. 1994, Mandal et al. 1996, Chatterjee et al. 1993, Dhar et al. 1997, Nickson et al. 2000 & 2005 Williams et al. 1996, Kondo et al. 1999, Berg et al. 2001, Agusa et al. 2006, Hoang et al. 2010, Luu et al. 2009, Wijesekara & Marambe 2011, Fonseca et al. 2012
Europe	Romania, Hungary, England, Germany, Greece, Spain, Poland, Sweden, Finland, Bulgaria, Greece, Switzerland	Gurzau & Pop 2012, Nordstrom 2002, Ravenscroft et al. 2009, Sanchez 2005, Mayorga et al. 2013, Niedzielski et al. 2001, Siepak et al. 2004, Svensson et al. 2010, Kouras et al. 2007, Meladiotis et al. 2002
North America	Canada, USA, Mexico, Alaska	Katsoyiannis & Katsoyiannis 2006, Pfeifer et al. 2002 Robinson Jr & Ayotte 2006, Normandin et al. 2014 Armienta & Segovia 2008, Camacho et al. 2011 Verplanck et al. 2008, Munk et al. 2011
South America	Brazil, Argentina, Chile, al. 2004	Mirlean et al. 2014, Bhattacharya et al. 2005, Richtera et
Australasia & Oceania	Australia, New Zealand,	Appleyard et al. 2006
Africa	Egypt, Ghana,	Nariman et al. 2011

Table 5: Effect of arsenic exposure on human health.

System	Health Effects
Cardiovascular	Acrocyanosis and Raynaud's Phenomenon, Heart attack, cardiac arrhythmias, thickening of blood vessels, loss of circulation leading to gangrene of extremities, hypertension, (Barringer & Reilly 2013)
Dermal	Hyperpigmentation, basal cell carcinoma and squamous cell carcinoma, abnormal skin thickening, Symmetric hyperkeratosis of palms and soles (palmoplantar), melanosis or depigmentation, bowen's disease, facial edema, Desquamation
Gastrointestinal	Esophagitis, Colitis, anorexia, weight loss, Heartburn, nausea, abdominal pain, Liver Cancer (Robert & Anna 2008)
Hematological	Anemia, low white-blood-cell count (leucopenia), Megaloblastosis
Neurological	Brain malfunction, hallucinations, memory loss, seizures, coma, peripheral neuropathy, hearing loss, encephalopathy
Pulmonary, Respiratory	Chronic cough, restrictive lung disease, cancer, Lung Cancer, Laryngitis, tracheal bronchitis, rhinitis, pharyngitis, shortness of breath, perforation of nasal Septum (Abul & Mahfuzar 2002)
Renal	Hematuria, proteinuria, shock, dehydration, cortical necrosis, cancer of kidneys and bladder, Nephrosis and Nephritis (Yu et al. 2009)
Reproductive	Spontaneous abortions, still-births, congenital malformations of fetus, low birth weight, prostate cancer (Yang et al. 2008, Rahman et al. 2013)
Endocrine System, Metabolic	Diabetes mellitus and goiter
Ophthalmic	Lens Opacity
Hepatic	Cirrhosis, hepatomegaly, portal hypertension, fatty degeneration,
Hematological	Bone marrow hypoplasia, aplastic anemia, leucopenia, thrombocytopenia, impaired folate metabolism, karyorrhexis

## REFERENCE DOSE OR ORAL SLOPE FACTOR

Reference dose or reference concentration is defined as an estimate of a daily exposure to the human population that is likely to be without an appreciable risk of deleterious effects during a lifetime. RfD or RfC is based on No Observed Adverse Effect Level (NOAEL) or Lowest Observable Adverse Effect Level (LOAEL), combined with appropriate uncertainty factors to account for interspecies variability in sensitivity, interspecies extrapolation, extrapolation from LOAELs to NOAELs and extrapolation from sub-chronic

to chronic data. Oral cancer Slope Factor is a measure of the incremental lifetime risk of cancer by oral intake of the chemical. Arsenic has RfD value  $3E-4 \text{ mg.kg}^{-1}.\text{d}^{-1}$ . RfD: Reference Dose is computed by multiplying the consumption rate and divide by the mass of a reference person.

## CONCLUSION

An attempt is made to recapitulate on the arsenic sources in groundwater and associated health complications. Arsenic in trivalent form is considered to be more toxic than

Table 6: Drinking water standards.

Parameter	Unit	IS10500:2012		WHO	USEPA		CPHEEO		ICMR	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Arsenic	mg/L	0.01	0.05	0.05	0	0.01	0.01	0.05	-	0.05

(1) Desirable, (2) Permissible, (3) Guideline Value, (4) Maximum Contaminant Level Goal (MCLG) - The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals, (5) Maximum Contaminant Level (MCL) - The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards, (6) Acceptable, (7) Cause for Rejection

pentavalent form. According to the present review, it is evident that major source of arsenic in groundwater is geogenic in nature. Alluvial deposits, volcanic sediments and geothermal water are the main arsenic source of groundwater. Several factors are responsible for concentration and transport of arsenic in groundwater. Arsenic can cause wide range of chronic and acute illness when consumed in varying concentration. Consuming water constituting arsenic above 10µg/L is a major concern. Hence, the source water has to be analyzed for arsenic and all possible actions must be recommended to remediate it as first priority and also, if feasible, alternative sources are to be identified for supplying safe drinking water. Further, treatment methods have to be proposed and the mitigation measures have to be considered as location specific and it cannot be generalized for other regions. Educating the people on potential threat of consuming arsenic contaminated water is also an important step for overcoming arsenic exposure problems through drinking water. When the arsenic contaminated water is used for irrigation purpose the accumulation factor has to be considered as major parameter in order to avoid the unfavorable concentration reaching the consumer through food products.

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