CONCENTRATION OF ARSENIC IN UNDERGROUND AND DRINKING WATER IN KOSTOLAC COAL BASIN (NORTHERN-EAST SERBIA, YUGOSLAVIA)

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ABSTRACT

Arsenic is a widespread element in nature. Increased amouns of arsenic in drinking water are appearing in regins and areas whith intensive exploatation of coal ant it's combustion in termoelectrical power plants (China, Taiwan). That is why we studied containment of arsenic in flood, dreniged and undergroung waters from ash deposits of Kostolac termoelectrical power plants, wells and local water system in Kotolac and four sorrounding villages. Increased amounts of arsenic in ash (19-33 mg/kg), which is hydraulicly transported from termoelectrical power plants are causing contamination of undergroung waters under and near ash deposits (0.1-0.08 mg/l). However, increased amount of arenic in those underground waters don't polute wells for watersupplying population whith drinking water, because in thease causes, amount's of arsenic found in exzamined areas are under 0.05 mg/l. We have concluded that despite increased amounts of arsenic in the ashes of termo-electrical power plants, contamination of residents water supplying wells has not occured for the last few decades, but the risk of that still exists. Tharefore we suggest regular controls of arsenic containment in drinking water and further construction of regional water supply system.

Key words: drinking water, pollution, arsenic, thermoelctrical PP, ashes

INTRODUCTION

Arsenic is a ubiquitous element with metalloid properties. In its elemental form, arsenic is a grayish metal; it has atomic number 33 and is found next to selenium in the periodic table, in the same group as phosphorus. Arsenic is a constituent of more than 200 different minerals. The name arsenic, usually refers to, arsenic trioxide, As_2O_3, rather than to arsenic, As, as an element. In many parts of the world, arsenic is present in drinking water from

wells drilled in ground strata containing the element[1, 2]. Arsenic is commonly found in association with coal, gold, nickel, cobalt, antimony, and iron ores, in concentrations ranging from parts per million to around 15 per cent. Arsenic in ground water usually derives from various terrestrial sources, although arsenic pollution can also originate from human activities. Naturally occurring arsenic is found almost exclusively in the form of arsenite or arsenate, even in ground water, and methylated arsenic compounds, such as methyl- and dimethylarsenic acid, are generated in the environment as a result of biological activity. Arsenic of anthropogenic origin can exist in any form, for example, as organic arsenic species. Ground water in acidic to neutral volcanic rock, or sediments derived from such rock, often have arsenic concentrations exceeding 0.050 mg/l, and that level is the current drinking water standard in many countries and was previously the maximum allowable amount recommended by the World Health Organization. During coal combustion As in the coal is volatized and may condense on the surface of the fly ash particles that enter the atmosphere and are subsequently deposited on terrestrial and aquatic system[3]. Fly ash contain variable amounts of As[4,5], mean concentrations in coal ashes have been reported vary from 56[4] to 156 mg/kg[5] , to values >200 mg/kg[6]. Water–soluble As in fly ashes ranged from 4 to 17% of total As concentration, which open deposition, can leach into ground water and reservoirs[6]. In the system arsenic-food chain, inorganic As is most toxically than organic form of As. High concentration of As detected in drinking water in Argentina, Bangladesh, Chile, China, Hungary, Finland, India, Japan, Mexico, Taiwan, and Thailand[7]. Concentration ranges from 0.8 in Argentina to 3.4 mg/l Bangladesh, retrospectively. Arsenic via drinking water can result in skin cancer and cancer of internal organs[8], whereas exposure via inhalation can lead to cancer of the lung[9]. Arsenic in the drinking water from deep artesian wells of Southwest Taiwan has been indicated in the etiology of Blackfoot disease, a vascular disease, which can result in spontaneous or surgical amputation of limbs[10]. So, the aim of this work is research As concentration in flood and underground water leached from deposits of coal ash in Kostolac coal basin and in artesian, shallow and local water supply system in town Kostolac and near four villages.

MATERIAL AND METHODS

Kostolac coal basin is situated in northern-east Serbia (Yugoslavia) on the Right Bank of river Danube. There are three thermoelectrically power plants with the power of 1000 MW. They combust 7 millions t of lignite coal annual and produce about two millions t of ashes. Ash from power plants is transported by hydraulic system to the deposits (on the right side of Danube River and near village Stari Kostolac). These deposits are in the area of 254 ha. Ash belongs to the group of silica ashes, contains mostly ferric oxide, silicate oxide, alumnae, calcium carbonate, and contains 13 trace elements more. Reaction of ash is basal (pH 8.1-9.1). Four villages in the one townships of Kostolac basin include in the present study. These areas included Kostolac, Stari Kostolac, Ostrovo, Petka and Drmno. Residents in Kostolac, Stari Kostolac and Drmno had used shallow well water (40-50 m deep) across local supplying system. Residents in Ostrovo used artesian well (270 m deep) and shallow well waters (13-17 m deep), retrospectively. Residents in Petka used shallow well water (11-13 m deep). A total of 10 well water samples were collected during spring 2001. We collected flood and drainage waters from deposits of coal ashes, too. As content measured after acidified with hydrochloride acid, on AAS[11] (Perkin-Elmer). All samples were measured in three replicates and total concentration of As (mg/l) dated as mean value.

RESULTS AND DISCUSION

Table 1 demonstrates that the average as As in flood and drainage waters on ash deposits is 0.1 mg/l, more than two times higher than the drinking water standard by World Health Organization[1]. Certain amounts of As are reaching the underground waters below ash deposits, and the concentrations of As are increased and they are 0.08 m/l (Table 1)

Table 1 Mean concentration of As (mg/L) in uindreground and drinking waters in Kostolac coal basin

Site location	Descriptions	Distance from deposits of coal ash (km)	Concentration of As (mg/l)*
Stari Kostolac	Flood waters on deposits of coal ash	/	0.1
Stari Kostolac	Underground waters (deep 30-40 m)	/	0.08
Stari Kostolac	Shallow well (deep 50m)	2 km	0.0008
Kostolac	Shallow wells and local water supply system (deep 50 m)	2.5 km	0.0006
Kostolac	Shallow well (deep 7 m)	4 km	0.0005
Drmno	Shallow well (deep 50 m)	1 km	0.0006
Ostrovo	Artesian well (deep 270 m)	8 km	0.0004
Ostrovo	Shallow well (deep 13 m)	8 km	0.0006
Petka	Shallow well (deep 11 m)	6 km	0.0009

*mean value after three replicate ($p>0.05$)

However, increased amounts of As in underground waters of ash deposits are not burdening water supply wells in Kostolac coal basin. One well in Kostolac (depth 50m, capacitate 40 l/s) is being exploited for the last six decades (since 1941), and the rest just for the last few years. Concentration of As in that water is below regulated level (0.05 mg/l) 8 to 10 times. But nothing is known about cumulative As exposure considering history of drinking well water, capacitate, and geochemical relation with underground waters below ash deposits. Deranged and underground waters, as well as wells for residents water supply are located in the same sand-gravel sediment of Danube river alluvial. Those are why it is necessary to do additional measuring of watercourse and with proper models predict further As accumulation in drinking water[12] . On the other sites, the concentration of As in water wells is below regulated drinking water level. Concentration of As in shallow water wells is greater then in deep and artesian water wells. That is pointing to the danger of As contamination of unprotected wells from fly ash. Control of these wells is recommended (season as well as yearly control) and protection of airsediment contamination in water sources. There are dangers from commutative As exposure and such low amounts of As in drinking water. Cumulative As exposure is sum of As concentration and daily water consummation of a resident during a year (mg/l)As/yr[13]. Cumulative As exposure of Kostolac residents is 1.387 – 1.551 (mg/l)As/yr. According to the same author such value

of cumulative exposure can bring to appearance of hypertension to 0.05% of population[13] or the odds for cerebrovascular disease is 1-2.69 on 10000 residents, and cerebral infarction is 1-5.39[14] , retrospectively. Therefore we suggest further research of ash deposits water effect on As concentration in Kostolac coal basin drinking water, further construction of local water supply system with deeper wells that are not geochemicaly connected to mentioned waters or are out of Kostolac region, as well as protection of shallow, open wells in villages.

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