Presence of Uranium in Groundwater in Punjab: An Overview

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ABSTRACT

Uranium is the heaviest naturally occurring element found at an average concentration of 0.0004 % in the earth's crust and in low levels within all rock, soil and water. The estimation of Uranium in water may be significant for the hydro geochemical prospection and for health risk assessments. Uranium contamination can also result from human activities. It can be released into the environment from various activities such as the use of phosphate fertilizers, mining and combustion from coal and other fuels. Being a radioactive mineral, high Uranium concentration can cause impact on water, soil and health. This present work reviews and interprets the prevailing scenario in Punjab region, focusing on Uranium as an important environment contaminant where consumption of fertilizers and pesticides is the highest in the state. The high Uranium concentration observed particularly in certain areas along this track can be attributed due to interaction of groundwater with the soil formation of this region and the local subsurface geology of the region.

Keywords: - Uranium, Groundwater, Geology, Punjab, Fertilizers.

Introduction

Uranium is a naturally occurring, ubiquitous, heavy metal found in various chemical forms in all soils, rocks, seas and oceans. It is also present in air, drinking water and food. Salonen et.al, (2009) reported high concentrations of natural Uranium up to few thousands ppb are found in water from wells drilled in bedrock in certain areas in Finland, Norway, Greece, Canada and the USA. Alrakabi et.al, (2012) and Bhalla et.al, (2011) carried out study on Uranium contamination of ground water in Punjab state in India using X-ray fluorescence technique. These reported Uranium occurrences in different water samples supply sources include handpumps, tube-wells and bore-wells at various depths. It can be released into the environment from various activities such as the use of phosphate fertilizers, mining and combustion from coal and other fuels. In urban areas of India, people consume drinking water, only after proper treatments; therefore the size of the exposed population is very small. But in rural area, people use groundwater more often in the form of communal or individual wells for drinking and agricultural purposes. The natural weathering of rocks such as granite dissolves the natural Uranium, which goes into ground water. Once getting in to water, Uranium does not transfer into the air. Leaching and illuviation are the chemical and physical processes, respectively by which mineral matter and dissolved solutes are moved downward through the soil profile and get concentrated in discrete zones. The contamination of Uranium in ground waters is a matter of great concern because of its chemical toxicity as a dissolved heavy metal. Uranium has both chemical and radiological toxicity with the two important target organs being the kidneys and lungs (WHO, 1998; ATSDR, 1999). Retention of Uranium in the kidney has been attributed to the creation of complexes with proteins and phospholipids in the proximal tubules, considered to be the main site of kidney damage. Water having Uranium concentration above 30 micrograms/l (as prescribed by WHO) and 60 micrograms/l (as prescribed by AERB) is not safe for drinking purposes.

Study Area and Hydrogeology

Punjab state is located in the north western part of India. It lies in the western component of the Great Northern Plains i.e. the Sutlej-Ganga plains of India. Soil of Punjab region is alluvial, composed of sediments of the Shivalik hills and the Himalayas, brought and laid down by the rivers of Indus system. The hills in this area contain rock-phosphate deposits. Such rocks/minerals are known to have high Uranium content, in the range of 300-3900 Bq/kg (Roessler et. al., 1979).

Review of Research

Enhanced level of Uranium has been reported by various agencies and researchers in parts of Southwest Punjab which has been issue of national importance due to its linkage with public health conditions of the study area. The groundwater chemistry could reveal important information on the geological history of the aquifers and the suitability of groundwater for domestic, industrial and agricultural purposes vis-a vis health hazards related to its usage. Gordon (1992) reported the link between ore bodies and biosphere concentrations of Uranium at six locations in Canada. Tripathi et al. (2013) has made an attempt to study the Uranium concentration and activity ratios of Uranium isotopes to present the geochemical conditions of the groundwater in Malwa region of Punjab state, India and the reason for high Uranium levels and variation of activity ratios from secular equilibrium conditions. The study reported Uranium concentration in groundwater samples in the range of 13.9 ± 1.2 to 172.8 ± 12.3 µg/l with an average value of 72.9 µg/l which is higher than the national and international guideline values. Microanalysis of Uranium content employing Solid State Nuclear Track Detectors (SSNTDs) was carried out by Singh et al. (2009) and observed a general trend of growing Uranium content in the water samples, particularly from village Makhu (Ferozpur) to village Budhlada (Bathinda) towards Tusham ring complex, Haryana. Singh et al., further reported higher Uranium content in groundwater samples of Bathinda region which may be attributed to the radioactive rich granitic rock formations of Tusham Hills, Bhiwani district of the neighbouring state of Haryana, India. High Uranium values in drinking water samples may be due to the fact that the Punjab sediments are derived from Shivalik Himalayas, part of which are known for Uranium mineralization. Garg (2010) carried out the study on Uranium, metals make Punjab toxic hotspot in 50 villages in Muktsar, Bathinda and Ludhiana districts and revealed that 20% of the samples showed nitrate levels above the safety limit of 50 mg/L, established by World Health Organization, the study connected it with high use of synthetic nitrogen fertilizers. They revealed that 87% of children below 12 years and 82% beyond that age having Uranium levels high enough to cause diseases. Kochhar et. al. (2006) reported that Uranium, lead, chromium, arsenic and nickel were more than the permissible limits in groundwater of South West Punjab. This might be due to the interaction of groundwater with soils formed from the weathering of Malani granites and the basement rocks (Delhi quartzite) encountered in this region. Singh and Sekhon (1976) studied nitrate pollution of groundwater from Nitrogen in fertilizers and animal wastes in Punjab, India and confirmed that nitrate tend to reach the water table during rainy season and that the concentration was 35.6mg NO3-/l, many times higher than the observed mean of 1.88mg NO_3.

CONCLUSION

The Uranium contamination of groundwater is occurring in many regions of Punjab. The maximum contaminant level for Uranium, recommended by the World Health Organization is 30?g/L and this limit is found to be exceeded in the drinking water of various regions of Punjab. Exposure to Uranium is of serious concern for public health due to its hazardous nature. It is recommended to prefer canal water based drinking supply schemes in southwest Punjab. The government must come out with a legislation to

rationalize the use of chemicals in farming operations. The best suitable remedial method recommended by (USEPA, 2003) is the use of Anion Exchange and Reverse Osmosis to treat contaminated water.

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