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Estimation of Uranium Concentration in Water Samples in Bathinda and Suratgarh Thermal Power Stations, India

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Abstract

The concentration of the Naturally Occurring Radioactive material (Norm) mainly uranium is analyzed in water samples collected from Guru Nanak Dev Thermal Plant, Bathinda and Suratgarh Super Thermal Power Station, Suratgarh. Analysis of uranium concentration is done by ICP-MS (Inductively coupled plasma – mass spectrometry) in IIT-Rurkee with multielement standards. Background measurement test was done to determine the background radioactivity. A number of water samples were collected (between July, 2010 to May, 2012) in the two thermal plants. Uranium concentrations in water were analyzed in two thermal plants. The Uranium concentration was in the range of 0.769ppb to 76.499ppb. It is relevant to indicate that the World Health Organization prescribes 30 ppb as a standard for uranium in drinking water. Computing to this prescribed level, 20% samples exceeded the permissible limits. If comparison is made in Bathinda thermal plant and Suratgarh Super Thermal Power Station. Sewerage water of Guru Nanak Dev Thermal Plant, Bathinda has maximum uranium that is 76.499 ppb or 0.076mg/l and minimum uranium in Drinking water 0.769ppb. This water sample was collected in Guru Nanak Dev Thermal Plant, Bathinda. The mean Uranium concentration for the control water sample was negligible. Which is low compared with the observed uranium concentration in water samples collected both thermal plants. The result indicates an elevation of Norm content due to Thermal plant establishment or any other reasons in that area. This could be detrimental to health of individuals exposed to these radiations.

Keywords: Uranium, Norm, Natural radioactivity, water

I. Introduction

Naturally occurring radioactive materials (NORM) are found almost everywhere. NORM is inherent in many geologic materials and consequently encountered during geological related activities. NORM encountered in hydrocarbon exploration and production operations originate in subsurface formations that may contain radioactive materials such as Uranium and thorium and their daughter products, 226Ra and 228Ra. In gas processing activities, NORM generally occurs as radon gas in the natural gasstream (Ajayi et al, 2009; Mokobia et al 2006).

Radioactive tracers are also used in evaluating the effective of well cementing and under ground water and crudeoil flow direction for the purpose of correlation (Ajayi et al ,2009). In some cases, various amounts of radioisotopes are injected with the secondary recovery flooding fluids to facilitate flow. In Nigeria and other countries, many studies have been carried out on the radioactivity matrices (Tchokossa, 2006, Ajayi et al,2009, Diad et al, 2008, Al-Masri and Suman2003; Isinkaye andShitta,2010 and Fatima et al,2008). It has been noted that radiation is part of the natural environment and it is estimated that approximately 80% of all human exposure comes from naturally occurring radioactive materials. Mineral exploration and production activities have the potential to increase the risk of radiation exposure to the environment and humans by concentrating the quantities of naturally occurring radiation beyond normal background levels. EPA(2005) on environments, health and safety online stated that the more radiation dose a person receives, the greater the chance of developing cancer, leukemia, eye cataracts, Erithemia, hematological depression and incidence of chromosome aberrations. This may not appear until many years after the radiation dose is received (typically, 10-40 years). This study therefore, seeks to assess the Norm content of mineral exploration and production activities and to estimate the radiological health implication to the general public.

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 drinking water and food. Natural uranium consists of a mixture of three different isotopes: U238 (99.27% by mass), U235 (0.72%) and U234 (0.0054%).On average, about 90 µg exists in the human body from the normal intake of water, food and air; of which 66% is found in the skeleton, 16% in the liver, 8% in the kidneys and 10% in other tissues (Priest, 1990).

Natural contents of uranium (U) and thorium (Th) in igneous rocks are in the range 0.1-5 and 1-20 mg/Kg respectively, depending on the type of rock. Felsic rocks, such as granite, usually contain more U and Th than mafic rocks, such as basalt and dunite.Under oxidizing conditions uranium occurs in the soil solution at low pH as the uranyl ion, UO2+2 , or as hydrolysis products of this ion. At higher pH the Uranyl ion may form complexes with carbonate ions. These complexes may be relatively mobile in soils and ground water, because of their negative charge.Organic acids, such as acetic acid and oxalic acid, may form soluble complexes with U and Th, and thus increase the solubility of these elements in soils.Uranium contents in average soils are in the range of 1-4 mg/Kg, and thorium contents in the range of 2-12 mg/kg. Contents of U and Th in mineral soils increase with clay content, due to adsorption at the surface of clay minerals and to the higher U and Th contents of minerals in the clay fraction relative to contents in coarser soil constituents.

Material and Methods

II. The Study Area

Suratgarh Super Thermal Power Station:

It is located 27 km away from Suratgarh town in SriGanganagar district and -15 Km from suratgarh to Biradhwal on NH15, then 12km in east from NH-15 It has having extreme hot and cold climate temp. varies between 50^0c to -1^oc.

III. Guru Nanak Dev Thermal Plant, Bathinda:

Guru Nanak Dev Thermal Plant is situated in Bathinda (Punjab) on Bathinda-Malout Road.The historic town of Bathinda was selected for this first and prestigious thermal power project of the state due to its good railway connections for fast transportation of coal, availability of canal water and proximity of load centre.

IV. Sample Collection and Preparation

Different water samples were collected from Guru Nanak Dev Thermal Plant, Bathinda and Suratgarh Super Thermal Power Station, Suratgarh for analysis of uranium concentration. .Analysis of Uranium was done by ICP-MS (Inductively coupled plasma – mass spectrometry A survey of the known Uranium deposits where exploration and exploitation for Uranium has earlier been carried out during sixties was done.

Sampling for the following was carried out:

Water – Water samples have been collected from the areas near and far off from the Two different thermal plants one is situated Rajasthan(Suratgarh Super Thermal Power Station, Suratgarh) and other in Punjab(Guru Nanak Dev Thermal Plant, Bathinda)place where thermal pollution is found due to thermal plant establishment. Water samples is collected as drinking water, cooling tower water and sewerage water from both plants and uranium concentration were analyzed.

Preparation of samples for analysis:

Liquid samples normally aqueous, acidified (typically 2% HNO3 or equivalent), filtered (removing particles > 0.45 um) and with a total dissolved solids content of less than 1000 ppm. Water samples are acidified with conc. nitric acid before analysis to ensure stability and comparability with calibration standards.

Estimation of Uranium concentration in water ICP-MS technique is used for analysis of uranium in water sample collected from Guru Nanak Dev Thermal Plant, Bathinda and Suratgarh Super Thermal Power Station, Suratgarh. It is a multielement analytic method. It has very low limit of detection that is in ppb (parts per billion) or below for solid and solution samples. Samples are introduced into argon plasma as aerosol droplets. The plasma dries the aerosol, dissociates the molecules, and then removes an electron from the components, thereby forming singly-charged ions, which are directed into a mass filtering device known as the quadrupole mass spectrometer.. At any given time, only one mass-to-charge ratio will be allowed to pass through the mass spectrometer from the entrance to the exit.

Upon exiting the mass spectrometer, ions strike the first dynode of an electron multiplier, which serves as a detector. The impact of the ions releases a cascade of electrons, which are amplified until they become a measurable pulse. The software compares the intensities of the measured pulses to those from standards, which make up the calibration curve, to determine the concentration of the element. For each element measured, it is typically necessary to measure just one isotope, since the ratio of the isotopes, or natural abundance, is fixed in nature.

In this case 10 ml of the acidified water sample was taken. The samples were run on a Argon plasma or aerosol droplets in ICP-MS (Inductively coupled plasma – mass spectrometry) in IIT-Rurkee Background and standards counts were also noted to calculate the efficiency of the instrument. The results have been calculated in ppb unit.

V. RESULTS

Guru Nanak Dev Thermal Plant, Bathinda:

The Uranium concentration in different water samples are in the range of 3.436 - 76.499ppb. In water samples minimum uranium concentration in drinking water (3.436 ppb) and maximum uranium concentration (76.499ppb)were in samples collected from sewerage water from thermal plant area.

Suratgarh Super Thermal Power Station, Suratgarh.
The Uranium concentration in different water samples are in the range of between 0.769 to 2.144ppb. In water samples minimum uranium concentration in waterworks water (0.769 ppb) and maximum uranium concentration (2.144ppb) were in samples collected from drinking water of thermal plant area.

Discussion

Uranium in local soil mainly arises as a result of weathering of rocks, mining activities and use of phosphatic fertilizers in agriculture. In turn, it leaches out and mixes with water and get distributed in the local environment (Eisenbud, 1987).

Among the parameters involved in the probable contamination of human food chain by uranium tailings pile, migration of radionuclides and conventional toxins through subsoil seepage assumes significance. Processing of uranium ore leaves behind a large volume of low specific activity waste which is retained in the tailings pond. The chemical additives in the milling process account for the contribution of conventional toxins such as manganese, sulphate, chloride, etc.

Uranium content in average soils is in the range of 1-4 mg kg-1 and thorium contents in the range of 2-12 mg kg-1. Contents of U and Th in minerals soils increase with clay content, due to adsorption at the surface of clay minerals and to the higher U and thorium contents of minerals in the clay fraction relative to contents in coarser soil constituents.

Rumble and Bjugstad (1986) determined uranium and radium concentration in plants growing on uranium mill tailings in South Dakota. The U concentrations in mill tailings averaged 13.3µg g-1 compared to 5.1µg g-1 in soils from control sites. U concentration in plants from tailings averaged 3.6 µg g-1, but only 3.4 µg g-1 from control sites.

Lakshmanan and Venkateswarlu (1988) studied uptake of U by potatoes, Raphanus sativus, Lagenaria leucantha, Solanum melongena and Abelmoschus esculentus in pots by spiking soil and irrigation water with uranium. Increase in U was observed with increased U in water but not soil. However, the concentration factor for uptake of U by vegetables decreased with increase of U in the water. In rice, concentration in the grain was significantly less than in the husk, which was significantly less than in straw.

Koul et al. (1983) while studying the uptake of uranium in the plant Cyclanthera pedata also found uranium accumulation in the order of root, stem, leaf and flower.

Tutin et al. (1980) studied the vegetation covering the Crucea mining waste (Romania) which is characterized by coniferous forest species, consisting of Abies alba, Picea exclesa and Larix decidna and deciduous tree such as Carpinus betulus, Acer negundo and Fraxinus excelsior. The undergrowth consists of shrubs, such as Vaccinium myrtillus and Rubus idaeus and different forest species of spontaneous flora, such as Dryopteris filix-mas, Lipidium draba, Holoshoenus vulgaris, Urtica dioica, Xanthium spinosum, Festuca rubra, Agrostis tenuis, Vaccinium myrtillus and Nardus stricta.

Rubus idaeus, Abies alba, Festuca rubra, Agrostis tenuis, Nardus stricta, Lipidium draba, Urtica dioica, Xanthium spinosum showed that different capabilities of uranium assimilation and uranium are not uniformly distributed among plant tissues. The fir A. alba was found to have higher uptake of uranium (1300 ppm) than any other vegetation in the roots and twigs. R. idaeus and V. myrtillus, shrubs with edible fruits, showed meduium to high uranium concentration (60 ppm) while U. dioica, H. vulgaris and X. spinosum have low (10 ppm) or no uranium retaining capacities. The roots of F. rubra, A. tenius and N. stricta and the twigs of V. myrtillus concentrated uranium as much as 3 times, the roots of L. draba concentrated uranium as much as 1.7 times, and roots of V. myrtillus had the highest concentration, as much as 6 times the uranium content in soil. Bramble (X. spinosum) had a poor uranium-retaining capacity, commonly lower than the uranium concentration in soil.

Ham et al. (1998) showed that soil adhesion made only a small contribution to the activity concentrations observed in the edible parts of crops. Sheppard et al. (1989) studied the effects of soil type on crops grown in lysimeters artificially contaminated with naturally-occurring radionuclides. This study demonstrated that soil type could have an effect on observed CRs. The study showed that values for sands were higher than those for finer textured soils, for which sorption of radionuclides would be greater

VI. Conclusion

The main target of this work was to assess the naturally occurring radioactive material (Norm) content in Guru Nanak Dev Thermal Plant, Bathinda and Suratgarh Super Thermal Power Station. In this study different water samples are found where uranium concentration is high for public use as compared to control. The World Health Organization prescribes 30 ppb as a standard for uranium in drinking water. Computing to this prescribed level, **20%** samples exceeded the permissible limits. Natural radioactivity is directly related to the kind of geological layers and of their physio-chemical conditions. The overall result shows a gross radiological pollution of the area which could be detrimental to the health of the general public as continuous exposure can lead to build up of radionuclide in the body which could lead to cancer and other related sicknesses. Therefore we recommend further studies on radiological burden of the various resources of the area and ascertain safety measure to limit exposure to these ionizing radiations.

References

1. Ajayi,T.R,Torto,N.,Tchokossa,P.&Akinlua,A.(2009). Natural radioactivity and trace metals in
2. Crude oils: Implication for health. Environ Geochem Health. 31:61-69.
3. Al-masri and Siman (2003). NORM waste management in the oil and gas industry: the Syrian
4. Experience. Journal of Radioanalytical and Nuclear chemistry. 256 (1):159-162.
5. Diab,H.M,Nouh,s.a.,Hamdy,A.,&El-fiti,S.A.(2008). Evaluation of Natural radioactivity in a
6. Cultivated area around a fertilizer factory. Journal of Nuclear and Radiation physics.3 (1)
7. 53-62.
8. Eisenbud, M. 1987 Environmental Radioactivity from Natural, Industrial and military sources; 3rd edition, Academic press, Inc. New york.
9. Fatima et al,(2008). Measurement of Natural Radioactivity and Dose rate gamma radiation of the
10. Soil of Southern Punjab, Pakistan. Radiation Protection Dosimetry.128 (2):206-212.
11. Ham, G. J., Ewers, L. W., and Wilkins, B. T. 1998 Variations in concentrations of naturally occurring Radionuclides in foodstuffs. Chilton, NRPBM 892.
12. Isinkaye M.O and Shitta,M.B.O.(2010). Natural Radionuclide Content and Radiological
13. Assessment of clay soil collected from different sites in Ekiti state, Southwestern Nigeria.
14. Radiation Protection Dosimetry.139 (4):590-596.
15. Koul, S., Kaul, V. and Chadderton, T. L. 1983. Uranium uptake and the cytology of Cyclanthera Pedata: A Fission Track Study. Environmental and Experimental Botany, 4, 379-392.
16. Lakshmann, A.R. and Venkateswarlu, K.S. 1988. Uptake of uranium by vegetables and rice. Water, Air and Soil Pollution, 38: 151-156.
17. Mokobia et al,(2006).Radioassay of Prominent Nigerian Fossil Fuels using Gamma and TXRF
18. Spectoscopy: Fuel 85:1811-1814.
19. Rumble, M. A. and Bjugstad, A. J. 1986 Uranium and radium concentrations in plants growing on uranium mill tailings in South Dakota. Reclamation and Revegetation Res., 4, 271-277.
20. Sheppard, S.C., Evenden, W.G., Pollock, R. J. 1989. Uptake of Natural Radionuclides by Field and Garden crops. Can. J. Soil. Sci., 69.
21. Tchokossa, P. (2006). Radiological study of oil and gas producing areas in Delta state, Nigeria.
22. Unpbl. Ph.D thesis , Obafemi Awolowo University, Nigeria.
23. Tutin, T.G., Heywood, V.H., Burges, N.A., Moore, D.M., Valentine, D.H., Walters, S.M. and Webb, D.A. 1980. Flora Europea: Cambridge, Cambridge University Press.