ESTIMATION OF GROSS ALPHA ACTIVITY IN SOIL AND PLANT SAMPLES IN UDAIPUR, RAJASTHAN

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Abstract
The concentration of the Naturally Occurring Radioactive material (Norm) of soil and plant samples collected from nearby villages to udaipur and their host communities was measured by determining the gross alpha activity concentration. Determination of the gross alpha radioactivity of soil, field soil and plant samples were obtained by using Alpha Counting System, Nucleonix, Hyderabad. Background measurement test was done to determine the background radioactivity. A number of soil, plant and water samples were collected (between November 2002 to November, 2005) in the environs of radioactive deposits at the two sites. Gross alpha activity were estimated. The gross alpha activity for soil and plant samples are in the range of 175-2260 and 48-477 Bq kg^{-1}, respectively on dry weight basis. In plant samples, maximum gross alpha activity (477Bq kg^{-1}) was observed in *Coriandrum sativum*. In soil samples, maximum gross alpha activity (821 Bq kg^{-1}) was observed in sample no. US VI-6S (*Jatropha curcus)* and minimum (303 Bq kg^{-1}) in *Diospyros cordifolia* at US VI-2S site. The mean alpha activityconcentration for the control soil sample was 22.78.0±1.02Bqkg-1which is low compared with the observed alpha activity values in community's soil, field soil and plant samples respectively. The result indicates an elevation of Norm content due to mineral exploration and production in the area. This could be detrimental to health of individuals exposed to these radiations.
Keywords: Gross alpha, Norm, Natural radioactivity, Plant, Soil

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 Suman 2003; 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: U^{238} (99.27% by mass), U^{235} (0.72%) and U^{234} (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.

Under oxidizing conditions uranium occurs in the soil solution at low pH as the uranyl ion, UO_2^{+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

The Study Area

Udaipur, the `abode of udai', meaning `City of Sunrise' is situated at 24^0 35' N latitudes and 73^0 41' E longitudes at a height of 582 meters above M.S.L. The eastern and north eastern portion of the district is hilly with long continuous ridges, as well as many detached hills, the whole physiography presenting a tangled wilderness of shallow valleys with an immense network of narrow `nallas' and fairly deep gorges. Geographically, the area deserves to be a basin, being girdled by low hills with few natural gaps along its borders. The basin is dominated by Aravali geological formation combined with rocks in its northern and southern parts. There are series of lakes along the western frontage.

Sample Collection and Preparation

A survey of the known Uranium deposits where exploration and exploitation for Uranium has earlier been carried out during sixties was done. The areas are Bhoion Ki Pancholi near Udaisagar, Udaipur and Umra, Udaipur.

Sampling for the following was carried out:

- **a. Soil** – Soil samples have been collected from the areas near and far off from the place where mining activity was carried out. The areas were marked with the help of a portable GM counter. Samples from nearby farmer's fields have also been collected. Soil sampling was carried out for surface as well as sub surface (10-15 cm depth).
- **b. Plants** – Following types of plants have been collected:
  - i. Crop plants growing in the nearby and far off areas
  - ii. Vegetables growing in the nearby and far off areas
  - iii. Wild plants growing in the nearby and far off areas

Preparation of samples for analysis:

The plant samples were dried at 80^oC for 48 hours and powdered in a grinder, numbered and analysed for Gross alpha activity.

Water samples were reduced by evaporation to a definite volume, preserved in plastic bottles and analysed for uranium.

Estimation of Gross alpha activity

Alpha counts:

The plant material was pulverized in a mixer grinder. 25 mg of the pulverized sample was taken in a planchet. A solution of ethyl acetate and colloidin was prepared in the ratio of 1:1. The plant sample kept in a planchet was fixed with the help of 4-5 drops of the mixture of the above solution. It was kept for a period of 20-30 minutes till completely dry. The planchet was kept in the alpha counter for a period of 9000 seconds and counts were noted. Each sample was replicated thrice and their counts were noted 3 times each for 9000 seconds.

The instrument was standardized daily with the help of a standard and background counts were also noted. The results have been calculated in Bq Kg^{-1} on dry weight basis.

RESULTS

Gross alpha activity in soil and plant samples:

The sampling sites are BS 0, BS I, BS II, BS III, BS IV, BS V, BS VI, BS VII and US 0, USI, US II, US III, USIV, US V and US VI. A number of soil, plant samples were collected (between November 2002 to November, 2005) in the environs of radioactive deposits at the two sites. Gross alpha activity were estimated. These are the average of three samples, each further replicated thrice for gross alpha activity taken for 9000 seconds. The results show the presence of high gross alpha activity in various plant species and soil samples.

Bhoion Ki Pancholi Site (BS):

The gross alpha activity for soil and plant samples are in the range of 175-2260 and 48-477 Bq kg^{-1}, respectively on dry weight basis. In soil, maximum alpha activity was observed in sample no. BS I 8S. This soil sample was collected underneath *Lantana camara*. However, sample no. BS V-12S collected underneath *Azadirachta indica* showed an alpha activity of 181 Bq kg^{-1} only.

In plant samples, maximum gross alpha activity (477Bq kg^{-1}) was observed in sample no. BS II-2P (*Coriandrum sativum*) and minimum in BSI-6P (*Diospyros cordifolia*).

Umra Site (US):

The gross alpha activities for plant samples are in the range of 128-421 Bq kg^{-1} on dry weight basis. In plant samples maximum gross alpha activity was in sample no. US VI-4P. However, sample no. US VI- 7P showed only 128 Bq kg^{-1} alpha activity

In soil samples, maximum gross alpha activity (821 Bq kg^{-1}) was observed in sample no. US VI-6S (*Jatropha curcus)* and minimum (303 Bq kg^{-1}) in *Diospyros cordifolia* at US VI-2S site.

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 medium 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

Conclusion

The main target of this work was to assess the naturally occurring radioactive material (Norm) content of a mineral exploration and production by determining gross alpha radioactivity concentrations. In the host community soil, field soil and plant samples, the concentration of the gross alpha were higher than that of the control samples. Natural radioactivity is directly related to the kind of geological layers and of their physico-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

ISSN 2229-5518

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.

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