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Distribution of ^{210}Po in soils of Virajpet taluk, Coorg District, Karnataka

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ABSTRACT

The present investigation involves the distribution of ^{210}Po in the soils of Virajpet taluk, in Coorg District. The soil samples were collected along a vertical profile at various locations. The samples were analyzed for determination of ^{210}Po activity using standard radiochemical analytical method. The distribution of ^{210}Po along vertical profile was found. The dependence of ^{210}Po activity on organic matter and clay in a vertical profile were analysed. The texture of soil shows that soil is sandy loam or loamy sand, in which illuviation takes place easily. The ^{210}Po activity varies from 1.59 Bqkg^{-1} to 13.95 Bqkg^{-1} in first layer, 0.49 Bqkg^{-1} to 9.79 Bqkg^{-1} in second layer and 0.58 Bqkg^{-1} to 6.14 Bqkg^{-1} in third layer. A negative correlation between organic matter percentage and ^{210}Po activity was found in all the three layers with correlation coefficient −0.872, −0.643 and −0.505. A negative correlation was observed between clay percentage and ^{210}Po activity, in all the three layers with correlation coefficient −0.749, −0.512 and −0.402. The organic matter leaches vertically downwards, due to flow of rainwater.

1. Introduction

A worldwide study on environmental radioactivity has led to a number of surveys in many regions of the world (UNSCEAR, 2000). Such surveys have led to the assessment of dose rates received by the public and the study of nuclear epidemiology. Natural environmental radioactivity arises mainly from the primordial radionuclides, such as ^{40}K and the nuclides from the ^{232}Th and ^{238}U decay chain, which depends on the geological formation of the region. The radionuclides ^{210}Po ($T_{1/2}$: 138 days) and ^{210}Pb ($T_{1/2}$: 22.3 years) are the final radioactive members of ^{238}U series and are widely present in the environment, contributing about 8% of the natural radiation exposure to humans (UNSCEAR, 2000). The presence of ^{210}Po and ^{210}Pb, in the soil may be due to the decay product of radionuclides of ^{238}U chain or due to the precipitation of ^{222}Rn ($T_{1/2}$: 3.84 days) decay products, attached to micro aerosols, in atmosphere (Avadhani et al., 2005). The radionuclide enters to the food chain through their presence in soil (Eisenbud, 1987). ^{210}Po in higher concentration can effect soft tissue organs of human body as ^{210}Po are toxic substances (Matthews, Kim, & Martin, 2007). The characteristic oxidation states of ^{210}Po are −2, +2, +4, +6. In oxidising conditions, the most stable oxidation state is Po(IV) (Mitchell, Perez-Sancez, & Thorne, 2013). ^{210}Po and ^{210}Pb are strongly adsorbed by the organic colloids and clay, on the surface soil (Parfenov, 1974). ^{210}Pb (β-emitter) is a parent nuclei of ^{210}Po. The migration of ^{210}Po and ^{210}Pb radionuclides in soil depends on physico−chemical parameters such as soil texture, organic matter, pH of the soil (Ozden, Ugur, Esetlili, Esetlili, & Kurucu, 2013).

In soil, ^{210}Po radionuclides migrate downward both in soluble and colloidal forms within the soil profile and adsorb on to organic matter, clay minerals, and metal oxides (Vaaramaa, Lasse, Dina, & Jukka, 2010). However, no research work has been carried out on distribution of ^{210}Po and ^{210}Pb radionuclides in illuviated soils. Organic acids dissolve Iron oxide and Aluminum oxides which percolate down in lower horizons of the soil in the process of leaching (Patil & Anil Kumar, 2014). The soil profile of undisturbed illuviated soil is a four characteristic layered profile. The topmost (O-horizon) is the vegetation layer, which contains partially decomposed organic matter. The second layer (A-horizon) is the topsoil, which contains decomposed dark coloured humus of plants and insects, along with inorganic minerals. The third layer is a base cation leached elluvial layer (E-horizon) formed due to elluviation, which is above an enriched illuvial horizon (B-horizon). The illuviated layer has subsoil which contains accumulated clay along

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with Iron oxides, Alumunium oxides and humic compounds. C horizon which lies below B-horizon, comprises of the parent material (Brady & Well, 2008; Wild, 1993, pp. 45–47). Clay illuviation is dominant pedogenic process present in soils of Coorg (Kharche, Sehgal, & Challa, 2000). In this view, an attempt has been made to study the distribution of ^{210}Po in the undisturbed soils of Virajpet taluk, in Coorg District.

2. Materials and methods

2.1. Study area

Coorg forms typical place in the entire state of Karnataka in terms of its weather conditions. Coorg lies along the eastern slopes of Western Ghats, which is in the south western side of Karnataka state. Coorg has an area of 4102 Km^2 and it is bound between latitudes 11° 57′ N and 12° 48′ and longitudes 74° 55′ E to 76° 00′. Virajpet taluk is bound between latitudes 12° 2′35″ N and 12° 8′ 46″and longitudes 75°39′32″ E and 76° 10′ 37″, with an area of 1605 Km^2. It is surrounded by Kerala on the south western side, Madikeri taluk and Somwarpet taluk on the northern side, and Mysore district on the south eastern side. The geological map of Coorg shows that, the rocks in Coorg are sedimentary rocks with various types of Schist and Gneiss. The soil of Coorg is red soil and Lateritic soil (Kharche et al., 2000). The temperature in Coorg district varies from 10 °C to 28 °C with an average of 15 °C. Coorg has temperate climate with high rainfall. The average annual rainfall of Coorg is around 250 inches. The altitude of Coorg varies from 900 m to 1500 m above sea level.

2.2. Sampling

The sampling locations were identified based on geology and undisturbed soil samples were collected from different locations, following standard procedure (EML, 1983). Soil samples were collected during summer season in April-2015. The sampling locations were on plain lands or gentle slopes. The study area received a short duration, uneven rainfall, during summer season,

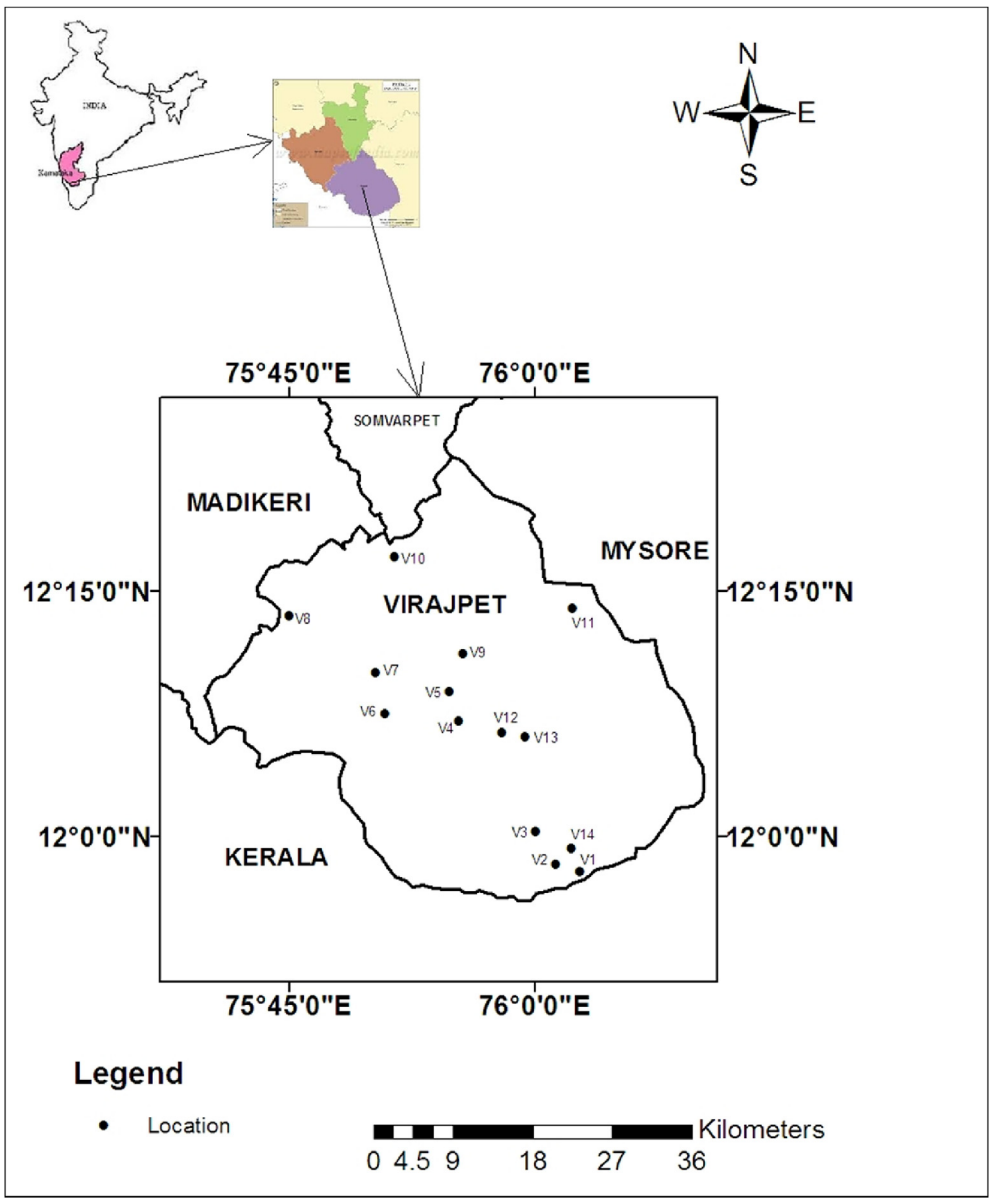

Fig. 1. Sampling stations in Virajpet Taluk, Coorg District.

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