Journal of Radiation Research and Applied Sciences 9 (2016) 392–399

HOSTED BY

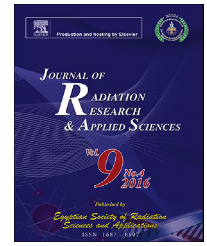
ELSEVIER

Available online at www.sciencedirect.com

ScienceDirect

Journal of Radiation Research and Applied Sciences

journal homepage: http://www.elsevier.com/locate/jrras



Activity of ^{210}Po and ^{210}Pb in the riverine environs of coastal Kerala on the southwest coast of India

CrossMark

N. Venunathan*, Y. Narayana

Department of Studies in Physics, Mangalore University, Mangalagangothri, 574199 Karnataka, India

ARTICLE INFO

Article history:
Received 21 December 2015
Accepted 6 May 2016
Available online 24 May 2016

Keywords:
^{210}Po
^{210}Pb
Sediment
River
Kerala

ABSTRACT

The paper presents the systematic investigations on the activity concentrations of ^{210}Po and ^{210}Pb in the riverine environs of Bharathapuzha, Periyar and Kallada, the three major rivers of coastal Kerala. The radionuclides ^{210}Po and ^{210}Pb in sediment and water samples were separated using radiochemical methods and activity was counted using scintillation based alpha counting system. The mean value of ^{210}Po activity in sediment samples was found to be 3.4 Bq kg^{-1}, 40.0 Bq kg^{-1} and 22.5 Bq kg^{-1} in Bharathapuzha, Periyar and Kallada river respectively. The mean value of ^{210}Pb activity was found to be 13.5 Bq kg^{-1}, 88.7 Bq kg^{-1} and 60.8 Bq kg^{-1} in the sediment samples of Bharathapuzha, Periyar and Kallada river respectively. The activity ratio $^{210}Po/^{210}Pb$ shows that the radionuclides ^{210}Po and ^{210}Pb are not in equilibrium in the riverine environs and the accumulation of ^{210}Pb in sediment is greater than that of ^{210}Po. The disequilibrium between ^{210}Po and ^{210}Pb and the higher activity of ^{210}Pb indicates the presence of unsupported ^{210}Pb in the sediments. A significant correlation was observed between the concentrations of these radionuclides and organic matter content and clay minerals of the sediment samples. The low activity of ^{210}Po and ^{210}Pb was observed in the dissolved phase due to the removal of these particle reactive radionuclides from solution to particle. High K_d value for ^{210}Po and ^{210}Pb in water column indicates that there is a strong adsorption of these radionuclides on to the suspended particles in the aquatic environment, where suspended particulate matter acts as a carrier to transport and removal of ^{210}Po and ^{210}Pb from their site of production.

1. Introduction

Natural radionuclides are present at low concentration in soil, water, air and food. The level of terrestrial environmental radiation depends primarily on the geological and geographical conditions and can be different levels in the soils of each different geological region (Karadeniz, Karakurt, & Akal, 2015). The radionuclides ^{210}Po and ^{210}Pb, widely present in the terrestrial environment, are the final long lived radionuclides in the decay of ^{238}U in the earth's crust. Their presence in the atmosphere is due to the decay of ^{222}Rn diffusing from the ground. These radionuclides return to earth's surface as a result of dry fallout or are washed out in rain (Ozden, Ugur, Esetlili, Esetlili, & Kurucu, 2013). The distribution and behavior of ^{210}Po in the marine environment

* *Corresponding author*. Tel.: +91 9446169002.
E-mail address: venunathan.nittoor@gmail.com (N. Venunathan).
Peer review under responsibility of The Egyptian Society of Radiation Sciences and Applications.
http://dx.doi.org/10.1016/j.jrras.2016.05.002

have been under study for many years, primarily due to its enhanced bio-accumulation, its strong affinity for binding with certain internal tissues, and its importance as a contributor to natural radiation dose received by marine biota as well as humans consuming seafood (Fowler, 2011). Due to its half-life of about 22.3 years, ^{210}Pb has proved to be an important nuclide for studying the sedimentary processes (Mahmood, Ishak, Bakar, Ishak, & Mohamed, 2011). Since ^{210}Pb has a short residence time in atmosphere, it falls into lake or ocean, tends to bury in sediment and over a few months becomes permanently fixed on the sediment particles (Tee, Ahmad, & Mohamed, 2003). In water-marine environment ^{210}Pb is scavenged by suspended particulate matter by several mechanisms and accumulated in the sediments (Aycik, Citaku, Erten, & Salihoglu, 2004). Since ^{210}Po and ^{210}Pb contribute about 8% of the natural radiation exposure to humans (UNSCEAR, 1988), it is important to acquire and analyze base line data about the concentrations of these radionuclides in the terrestrial and aquatic environment.

The southwest coast of Kerala is one of the known high background radiation areas of the world. Studies reported in literature suggest that the source of radionuclides in the high background radiation area can be traced to the rocks in the catchment area of the major rivers. The radionuclides released during the weathering of these rocks are transported by rivers to the sea and subsequently deposited on the beach areas. Different geo-chemical processes influence the interaction of dissolved radionuclide with suspended matter and sediments. Sedimentation and resuspension are of importance for controlling the two-way migration of radionuclide from water column to sediments and vice-versa (Monte et al., 2005). So it is important to study the nature and transport of radionuclides in river environment. In view of this, an attempt was made to study the transport and distribution of ^{210}Po and ^{210}Pb in sediment, water and suspended particulate matter of major rivers of coastal Kerala, namely, Bharathapuzha, Periyar and Kallada. To understand the affinities of these radionuclides for particulate matter, the distribution coefficients (K_d) for ^{210}Po and ^{210}Pb were studied and reported. Correlation between the activities of ^{210}Po and ^{210}Pb and the influence of physico-chemical parameters on the speciation of these radionuclides in the riverine environs was analyzed. The results of these investigations are presented and discussed in this paper.

2. Materials and methods

2.1. *Study area*

In the present study sediment samples were collected from three major rivers of coastal Kerala namely, Bharathapuzha, Periyar and Kallada (Fig. 1). Bharathapuzha is the second longest river in Kerala (209 km) with catchment area of 4400 km^2 within Kerala. It originates from Anamalai Hills in Western Ghats and discharges into Arabian Sea along coastal Kerala. It originates in a charnockite territory and flows through mignatite terrain. The hinterland consists of crystalline rocks of Archean age and sediments of Tertiary age. The Crystalline includes charnockite and khondalite, granite gneisses and granite traversed by basic rocks. Charnockite is wide spread in hill ranges of Western Ghats. Hornblende and biotite gneisses occur locally and are derived by retrograde metamorphism and mignatization of biotite gneiss Khondalitic rocks are exposed in south Kerala. Latterite is the product of residual chemical weathering of both crystalline rocks and Tertiary sediments and forms flat topped hills and ridges between the foothills of Western Ghats and Arabian Sea.

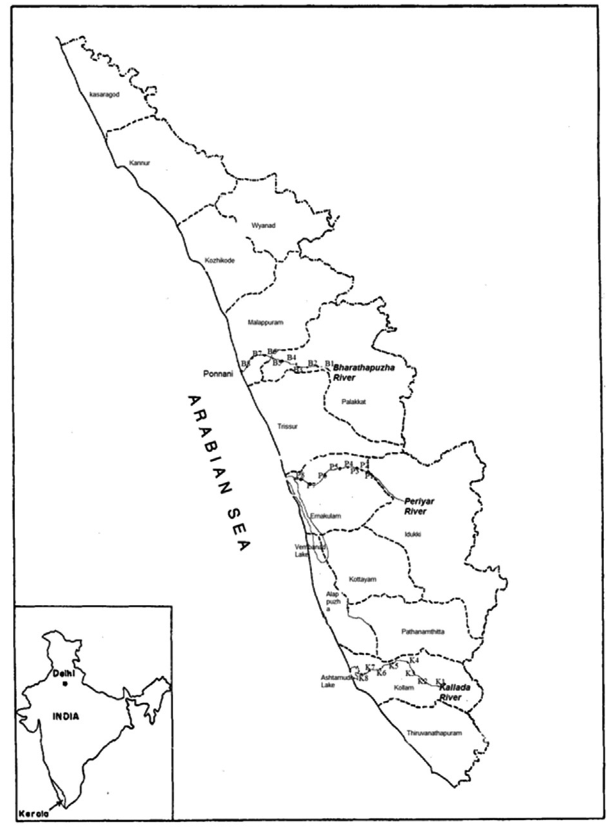


Fig. 1 – Map showing sampling locations.

The Periyar River has a length of 244 km and is the longest river in Kerala, with drainage area 5398 km^2. It is formed by confluence of large number of streams originating from Sivagiri Hills in Western Ghats and discharges into Kodungallur Lake which opens to Arabian Sea. The river originates and follows through a metamorphic terrain consisting of charnockite garnet-sillimanite gneiss, garnet-biotite and hornblende-biotite gneiss besides magnetite and granite. Angamali to Kochi is the most industrialized zone of Periyar river basin. There are over 50 large and medium industries in this region. The industries such as monazite processing plant and fertilizer factory operate in the bank of this river. These industries also discharge waste to this river. The monazite and phosphate rock is known to contain trace levels of Uranium and its decay products.

The Kallada River has a length of 121 km with catchment area about 1699 km^2. The river on its course encounters a number of geological formations, namely charnokiltes and khondalites, joins Astamudi Lake which opens to Arabian Sea. The river Kallada discharges into the Arabian Sea near Chavara, the known high background radiation area. These