RATIO OF ^{210}Po AND ^{210}Pb IN FRESH, BRACKISH AND SALINE WATER IN KUALA SELANGOR RIVER

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Abstract

Sediment cores were carried out from Kuala Selangor river to marine sea water via coastal and brackish water ambient. Sample size fraction with saiz less than 125 µm was spiked with tracer ^{209}Po (Polonium-209) and leached with mix concentrated nitric acid (HNO_3), perchloric acid ($HClO_4$), hydrogen peroxide (H_2O_2), hydrochloric acid (HCl), and mineralized with 50 ml of 0.5M HCl. The sample solution was used for spontaneously deposit polonium on a silver disk at 80 – 85 ºC and measured with the Alpha Spectrometry. The distribution of two radionuclides especially ^{210}Po, ^{210}Pb and ^{210}Po/^{210}Pb were useful in identifying the origin of ^{210}Po. Ratio values of ^{210}Po/^{210}Pb in the freshwater, brackish water and saline water were 3.3459, 5.8385 2.9831, respectively. From the high ratio of ^{210}Po/^{210}Pb, the widespread occurrence of excess ^{210}Po in Kuala Selangor river water may came from the atmosphere sources such as stratospheric aerosols, sea spray of the surface micro- layer and bio-volatile ^{210}Po organism from productive species.

Abstrak

Teras sedimen diperolehi dari sungai Kuala Selangor ke laut menerusi pinggir pantai dan muara sungai. Saiz butiran sampel kurang dari 125 µm dimasukkan penyurih ^{209}Po (Polonium-209) dan dicerna dengan campuran asid nitrik (HNO_3), asid perklorid ($HClO_4$), hidrogen peroxida (H_2O_2), asid hidroklorid (HCl), dan dimineralisasi dengan 50 ml 0.5M HCl. Larutan sampel diguna untuk auto-pemendapan polonium atas kepingan silver pada suhu 80-80ºC dan diukur dengan mengguna Spektrometri Alfa. Taburan kedua-dua nuklid terutama ^{210}Po, ^{210}Pb dan ^{210}Po/^{210}Pb adalah bermakna untuk mengenalpasti asal usul ^{210}Po. Nilai nisbah ^{210}Po/^{210}Pb dalam air tawar, air payau dan airlaut adalah 3.3459, 5.8385 2.9831, masing-masing. Daripada nisbah ^{210}Po/^{210}Pb, didapati penyebaran lebihan ^{210}Po telah ujud di sungai Kuala Selangor yang berasal dari sumber atmosfera iaitu aerosol atmosfera, peruwapan lapisan nipis lautan dan hasilan ^{210}Po dari organisma bio-ruwapan.

Introduction

^{210}Po and ^{210}Pb are non-consevative radionuclides in ^{238}U (Uranium-238) decay series products through the disintegration of ^{222}Rn (Radon-222). The main source of this both nuclides in environment which is comes from the earth's crust in ^{238}U decay series. These radionuclides are also intermediate members of the naturally occuring ^{238}U decay series and are recognized as tracers for naturally processes in the atmosphere. The physical half life of ^{210}Po is 138.4 days; ^{210}Pb is 22.3 years, have a potential utility as tracer for biogeochemical processes such as primary production, geochronology, environmental science and degradation of particles. There are also particle-reactive with varying affinities both in terms of efficiency and type of matter to which they associate. ^{210}Pb in surface water are coming from the atmospheric deposition and in situ production by decay of ^{226}Ra, whereas the main source of ^{210}Po is in situ production by ^{210}Pb decay. These nuclides are deposit into the bottom sediment of river bed or sea bed and ^{210}Po is more associated with biogenic particles than is ^{210}Pb [1].

^{222}Rn is a chemically inert noble gas in periodic table with a half life of only 3.8 days, formed through disintegration of ^{226}Ra (Radium-226). Once in the atmosphere, after exhalation from soil, ^{222}Rn decays through a series of short-lived products to ^{210}Pb, which is particularly particle-reactive and largely associates with aerosols. In coastal areas (up to several hundreds of km offshore), residence times of ^{210}Pb in the atmosphere are only of about 7–15 days [2, 3, 4]. Due to these short residence times, ^{210}Po (produced by ^{210}Pb disintegration via ^{210}Bi) concentrations in aerosols, and thus fluxes to the surface, are only about 10–20% that of ^{210}Pb [5].

Earlier studies have concluded that ^{210}Po behaves more like the nutrient elements. Several studies of oceanic ^{210}Pb distribution have shown that scavenging from the water column is enhanced at the continental margins relative to the open ocean [6]. Extensive measurement on ^{210}Po and its parent ^{210}Pb in open-ocean surface waters have shown that the ^{210}Po/^{210}Pb activity ratio, although geographically variable, average about 0.5 in seawater [7]. Through this idea, the objectives of this study was done to investigate ratio ^{210}Po/^{210}Pb in core sediment and water fromstudy location along the river to seawater region via estuary brackish water region.

Sampling and Analytical procedures

This study was carried out at Kuala Selangor River on 22 May 2005. Kuala Selangor river is a fishing village located 67 km southeast fromKuala Lumpur and it is well known with great potential for tourism industry for the firefly habitat, associated with red mangrove system along the river. Kuala Selangor River is one of the major river systems in Selangor state and it drains into Malacca Straits. The river is 500 m wide at the mouth and ~2.5 m deep at low water level. Hightide level may going up to ~10 m high in water level from bottom sea bed and ~2 m high when low tide respectively. The coastal zone is characterized by semi diurnal, macro-tidal regime with the mean spring tidal range of about 4.0 m [8].

Sediment cores were obtained using the gravity sediment corer and the surface water samples were collected using the Van Dorn water sampler at those eight stations along the river to seashore (Fig.1). The in-situ parameters also measured at each sampling station. Sediment core was sliced in 3 cm interval for each segment for all sediment cores. At the laboratory, about 2 g of sediment sample with grain size less than 125 µm were analyzed using the procedure proposed by Flynn [9]. About 15 L of water samples were filtered through the 45 µm of membrane filter for obtain the filtrate samples. Sediment and water samples were spiked with ^{209}Po and plated on the silver disk at 80 – 85 °C in 80 ml of 0.5N HCl. ^{210}Po activity was corrected to the sampling date after analyzed using the Alpha Spectrometry (EG & G, ORTEC). Then the activity of ^{210}Pb was determined after six months due to the in-growth of ^{210}Po.

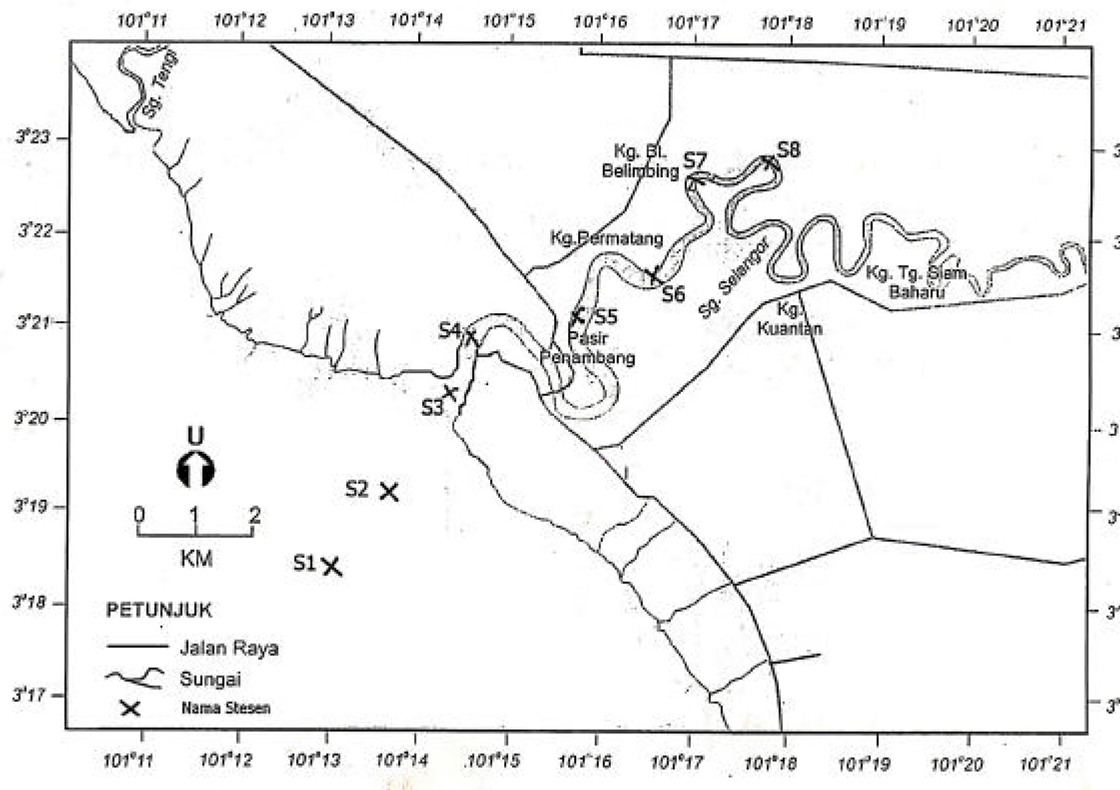

Figure 1: Map showing the sampling stations at Kuala Selangor from sea to the river region.

Results and Discussion

^{210}Po and ^{210}Pb were computed into ratio ^{210}Po/^{210}Pb showed in Figure 2. The water samples were slightly varied from range 4.27 to 4.42 (Fig.2). The minimum activity was in station 1 and maximum activity was in station 8 along to river region from sea region. The unusual 4 times activity of ^{210}Po higher than ^{210}Pb may fallout in particulate source from atmospheric ^{210}Po flux during ra infall event [10].

Southwest monsoon at the west coast of Peninsular Malaysia is usually established in middle of May or early of June and end in September therefore it was affected at the sampling location. The rainwater will flow from upstream of river to estuary and it is maintain constantly in ratio 4 also when low tide. The same ratio value also published by Tee [9] with result above 1 and obtained ratio during this study was varied from 1.19 to 6.84 in surface water sampling in August 2001. The source of excess ^{210}Po in surface air have been suggested to occur through the biomass burning [11], industrial emissions [12] and emission of bio-volatile ^{210}Po from coastal seawater [13]. The relationship between the conductivity value in water was inversely with the ratio value of ^{210}Po/^{210}Pb, where the ratio gradually high with the conductivity values gradually decreased (Table 1) from seawater to the river water. Moreover, the haze problem also affected the air quality in west coast Peninsular Malaysia air environment due to the air pollution forest burning from the Sumatera, Indonesia during August to October every year since year 1997 [14].

The average activity ratio of ^{210}Po/^{210}Pb in sediment core showed in Table 2. Ratio of ^{210}Po/^{210}Pb obviously indicated greatly varied change from seawater to brackish water with the highest value of 5.84 to the lowest value of 2.98. Apart from the ^{210}Po was formed by the decay of ^{210}Pb containing in the atmospheric, additional amounts are emitted directly from the Ea rth as a result of forest burning [15, 16]. It was increased from estuary to inland river stations (Fig. 2)

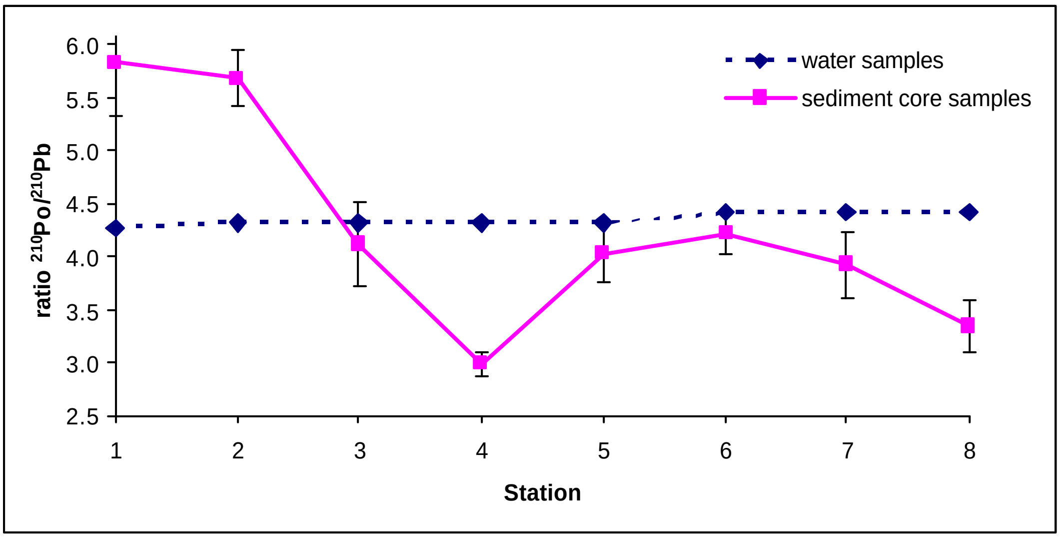

Figure 2: Ratio ^{210}Po/^{210}Pb of water samples and sediment core samples at Kuala Selangor from sea ambient (St 1-St 3) to river ambient (St 5-St 8).

The highest value of ^{210}Pb in the surface sediment found at St 4 about 3.98 ± 0.10 dpm/g was due to the boating activities. Furthermore, in the water column at St 1 has the highest ratio of ^{210}Po/^{210}Pb may correspond to the high contents of total dissolve solid (TDS) which is influenced by particulate tendency bury to the seabed. Dissolved and particulate samples ratio obtained during this study will be figure out the boundary scavenging intersected occur at the St 3 with a ratio 4.40, where the water mass coming in contact with this margin and affected the sediment acted to enhance the ^{210}Pb sinking flux by supplying water with a high ^{210}Pb concentration.

Conclusions

Ratio of ^{210}Po/^{210}Pb in surface water was consistent from seawater amb ient to the inland river with value from 4.27 to 4.42. This related to the contents of suspended particle in the water column. The activity of ^{210}Po was greater than the ^{210}Pb in all the samples obtained during this study.

Table 1: *In situ* water samples parameter and ratio $^{210}Po/^{210}Pb$ in Kuala Selangor River

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8
Coordinate	03° 17' 28 N	03° 18' 31 N	03° 21' 10 N	03° 20' 04 N	03° 21' 09 N	03° 22' 02 N	03° 23' 08 N	03° 23' 16 N
Location	101° 12' 52 E	101° 13' 02 E	101° 14' 10 E	101° 15' 25 E	101° 15' 23 E	101° 15' 47 E	101° 16' 52 E	101° 17' 46 E
Temperature (^{O}C)	29.97	30.11	30.94	30.83	30.82	30.58	30.87	31.20
Conductivity (mSv)	53571	50713	52954	24751	1700	510	178	138
Salinity	31.81	29.83	30.77	13.31	0.76	0.24	0.07	0.06
TDS (ppm)	31.80	30.04	30.91	14.48	0.99	0.34	0.11	0.08
DO (%)	79.70	78.20	92.00	64.20	71.50	63.10	64.40	66.40
pH	7.99	7.77	7.76	7.13	6.40	6.23	6.16	6.14
Turbility (NTU)	124.40	71.20	197.90	74.40	323.30	354.10	471.30	286.30
Ratio $^{210}Po/^{210}Pb$	4.2731	4.3154	4.3154	4.3154	4.3154	4.4229	4.4229	4.4229

Table 2: Average activity ^{210}Po, ^{210}Pb and ratio $^{210}Po/^{210}Pb$ in sediment core at Kuala Selangor River

Station	Average ^{210}Po (dpm/g)		Uncertainty	Average ^{210}Pb (dpm/g)		Uncertainty	Ratio $^{210}Po/^{210}Pb$		Uncertainty
1	7.10	±	0.43	1.22	±	0.07	5.84	±	0.51
2	8.14	±	0.27	1.43	±	0.05	5.69	±	0.27
3	7.98	±	0.54	1.94	±	0.13	4.12	±	0.40
4	11.86	±	0.30	3.98	±	0.10	2.98	±	0.10
5	13.58	±	0.65	3.37	±	0.16	4.03	±	0.28
6	14.32	±	0.47	3.39	±	0.11	4.22	±	0.20
7	11.09	±	0.64	2.83	±	0.16	3.92	±	0.32
8	12.63	±	0.63	3.75	±	0.19	3.35	±	0.25

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