

DETERMINATION AND DISTRIBUTION OF ESSENTIAL ELEMENTS IN MALAYSIAN COASTAL MARINE SEDIMENTS OF THE SOUTH CHINA SEA BY INAA

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ABSTRACT

Ratios of elements in everything from the smallest bacterium to the largest blue whale are regulated by their physiochemical properties and by feedback regulation of the environment. Aquatic organisms accumulate elements from water, sediments and discharge of waste. Inputs of many trace elements to the environment have increased as a result of industrialization and urbanization. Essential element concentrations in coastal marine sediment samples collected from the South China Sea of peninsular Malaysia have been measured using the instrumental neutron activation analysis (INAA) comparative method. The irradiation was carried out using a thermal neutron flux of $\sim 10^{12} \text{ n cm}^{-2} \text{ s}^{-1}$ in TRIGA Mark II at the Malaysia Nuclear Agency (MINT) reactor. Enrichment factor is used to distinguish the natural sediment from the contaminated sediment of element released to the environment due to anthropogenic activities. Accuracy and precision were evaluated by assaying irradiated standard reference material (IAEA-Soil7). The results are found to be in good agreement with certified values. Essential elements have been determined from 30 samples using high resolution gamma spectroscopy.

INTRODUCTION

Marine sediments are a plentiful source of essential elements in coastal area. Therefore, sediment analysis plays an important role in the quality assessment of marine environment [1]. The coastal marine ecosystems of east peninsular Malaysia are basin a lot of small and huge river, which are near the areas of important industrial and agriculture activities [2]. In the north part of the east coast peninsular Malaysia, the Kelantan River discharges and it is one of the influential pollution source in this area. Other important river that discharges to this area is Pahang River. These rivers are more important, because they carry agriculture wastes originating from activities in the big cities, domestic sewage as well as effluents from the industrial estates that are located

along rivers bank. In this study, elements of Ca, Fe, K, Mg and Na are measured. These elements are known as essential elements. They are accompanied by other elements and can become as a toxic material if their concentration are high [3]. The aims of this study are to determine the present essential elements, to distinguish anthropogenic effect and to compare the results from this area with those available from other coast of Malaysia.

MATERIAL AND METHODS

Samples of marine surface sediments were collected from 10 stations of east coast of peninsular Malaysia Figure 1. Sediment samples were collected using standard ponar grab sampler (23Cm×23Cm). Samples were taken from the top 23Cm layer of bottom sediments. The samples were dried in an oven for 10 days at 65 °C then were stored in polyethylene bottles for future analysis. The samples grained until 2 mm size. A triplicate weight ranging from 0.05 to 0.1 g for short irradiation and a triplicate weight ranging 0.15-0.20 g for long irradiation were taken. Standard reference material Soli7-IAEA was prepared in the same condition for each batch.

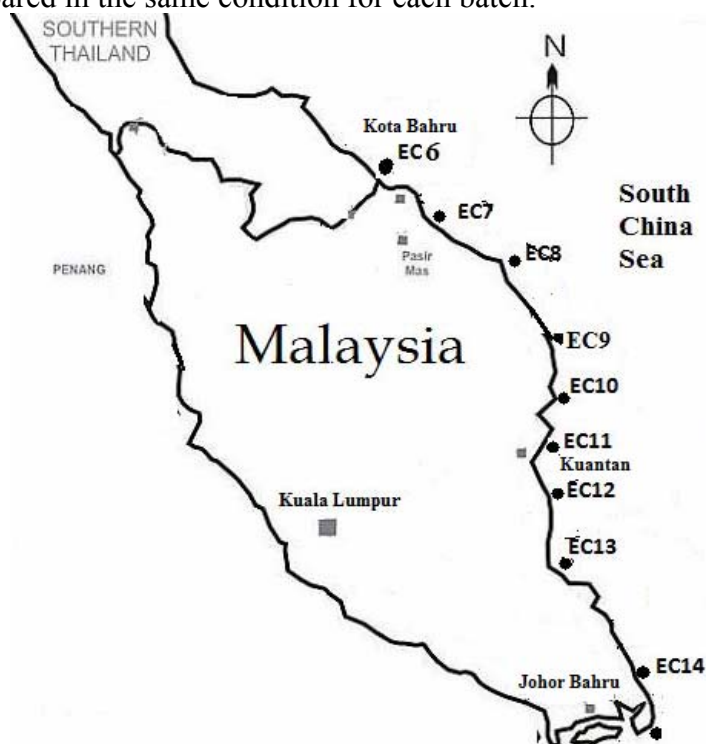


Figure 1: Map of the study area and the sampling sited shown as dark circular

The samples were irradiated by a research reactor with thermal neutron flux of $\sim 10^{12} \text{ n cm}^{-2}\text{s}^{-1}$ in TRIGA Mark II at the Malaysia Nuclear Agency (MINT). Used of a pneumatic transfer system (PTS) in short irradiation (1 minute) for immediate counting of short-lived isotopes Ca, K, Mg and Na. To determine concentration of Fe used long irradiation (6 hours). For the measurement of gamma-rays from the interesting nuclides, an HPGe detector (ORTEC, 20% relative efficiency, FWHM 1.8 keV at 1332 keV of

^{60}Co) coupled to a Multichannel Analyzer was used. During the gamma ray measurement, the dead time was kept below 10%. Gamma vision software was used for the γ spectrum processing. The detector has been calibrated by Amersham standard point sources. Essential elements concentrations, in the samples were calculated using:

$$C_{\text{sam}} = \frac{A_{\text{sam}}}{A_{\text{std}}} \cdot \frac{w_{\text{std}}}{w_{\text{sam}}} \cdot C_{\text{std}} \quad (1)$$

where:

A_{sam} and A_{std} : the activity of interested element in the sample and calibration standards, respectively

w_{sam} and w_{std} : the weight of the sample and calibration standards, respectively

In order to evaluate the extent of the anthropogenic effect the coastal marine sediments, an enrichment factor (EF) is calculated as follows:

$$\text{EF} = (\text{Me/Sc})_{\text{sed}} / (\text{Me/Sc})_{\text{ref}} \quad (2)$$

where:

$(\text{Me/Sc})_{\text{sed}}$: the concentration ratio of a given element to Sc in the coastal marine sediment

$(\text{Me/Sc})_{\text{ref}}$: the average ratio of the same element to Sc in the Mean crustal material

The reproducibility of the method was tested by triplicates analysis of the samples, and the errors associated with the data represent one standard deviation.

RESULTS AND DISCUSSION

The thirty surficial sediments considered of east coast peninsular Malaysia came from the South China Sea. Essential elements (Ca, Fe, K, Mg and Na) were measured in this area. Their concentration of each station is shown in Table 1. Distribution of essential elements of the studied area is shown in Figure 2.

The enrichment factor calculation shows a powerful tool to distinguish the natural sediment from the contaminated sediment of elements released to the environment due to anthropogenic activities [4]. If related enrichment factor is equal or less than unity it indicates that the main source is natural and originally came from the crustal or marine. K, Mg, and Na are poorly elements ($\text{EF} < 1$) in the east coast of peninsular Malaysia. Otherwise, if the enrichment factor ranging from 1 to 2 are natural occurring and the main sources is of the earth's crust or marine origin. Ca has enrichment factor between from 1 to 2 and is slightly enriched elements in this area. Enrichment factor for Fe is more than 2 and indicates the significant anthropogenic activity in the east coast of peninsular Malaysia. This elevation is due to the industrial activities namely mining activities.

Ca concentration is ranged from 1.20 mg/gr to 71.64 mg/gr with an average 23.20 mg/gr. The highest concentration average of Ca is 131.28 mg/gr in the EC13 station. This highest concentration is less than the highest concentration of Ca in the Straits of Malacca [4].

Fe concentration is ranged from 9.40 mg/gr to 75.57 mg/gr with an average 28.40 mg/gr. The highest concentration average of Fe is 59.36 mg/gr in the EC14 station. This highest concentration is higher than the highest concentration of Fe in the Straits of Malacca [4], Straits of Johor and Penang Island (Table 2), [5, 6].

Table 1: Essential elements content of east coast peninsular Malaysia

Element Station	Na(mg/gr)	K%(mg/gr)	Mg%	Ca(mg/gr)	Fe(mg/gr)
EC6-AM	1.44±0.80	18.28±0.61	13.06±0.70	1.2±	29.4±4.81
EC6-BM	15.65±0.80	14.53±1.20	13.86±1.10	5.63±	22.81±1.22
EC6-CM	12.93±1.03	13.24±0.50	12.89±0.60	4.93±	21.33±2.80
EC7-AM	8.28±0.26	10.6±0.60	8.55±0.36	16.26±2.11	9.4±6.38
EC7-BM	10.64±0.12	19.47±0.64	8.74±0.60	19.13±5.40	13.65±1.07
EC7-CM	9.97±0.70	17.14±0.17	7.85±0.95	12.87±2.24	15.22±0.35
EC8-AM	7.36±.76	8.33±1.37	7.24±1.47	39.39±0.62	15.84±0.96
EC8-BM	8.54±0.30	11.81±4.11	6.37±1.10	45.28±2.52	14.52±1.07
EC8-CM	5.45±.60	6.54±1.03	4.26±0.38	42.23±3.39	10.04±1.76
EC9-AM	8.76±.39	12.35±0.94	7.08±0.56	25.93±0.65	16.37±4.48
EC9-BM	16.52±4.80	12.21±2.16	17.97±0.84	21.68±3.24	21.13±0.82
EC9-CM	11.25±1.42	17.08±2.33	18.7±3.60	31.02±0.80	16.92±1.57
EC10-AM	13.51±0.71	13.65±1.51	7.05±0.56	19.84±1.18	19.01±0.81
EC10-BM	10.55±0.46	13.75±0.23	7.34±0.77	15.26±0.78	14.28±0.34
EC10-CM	11.09±0.41	13.46±0.55	6.29±0.29	14.04±0.65	14.46±1.80
EC11-AM	6.7±0.26	8.31±0.39	5.94±0.54	18.59±0.04	15.31±6.71
EC11-BM	9.07±0.22	10.79±1.44	14.19±0.36	16.82±0.29	17.49±1.80
EC11-CM	10.87±1.67	10.47±1.88	15.31±0.92	20.41±0.20	20.41±0.46
EC12-AM	19.5±2.16	13.15±0.92	11.13±0.64	14.18±0.68	39.63±6.93
EC12-BM	19.24±4.01	13.37±1.03	10.32±0.74	10.38±0.43	33.27±11.12
EC12-CM	18.87±0.88	14.23±0.45	9.15±1.40	14.05±0.61	46.52±0.21
EC13-AM	18.73±0.51	14.63±1.41	9.14±0.43	10.96±1.28	25.21±0.42
EC13-BM	17.03±.47	9.94±0.57	10.2±2.58	9.61±1.43	24.05±0.63
EC13-CM	17.31±0.52	- ¹	21.7±1.27	13.51±0.85	22.98±0.05
EC14-AM	10.15±0.72	10.77±0.45	8.25±0.71	71.64±1.28	59.92±10.35
EC14-BM	11.95±2.07	10.44±0.99	7.95±1.31	56.1±5.41	59.62±1.93
EC14-CM	9.14±0.54	9.53±1.27	7.71±0.98	54.58±2.79	58.55±7.31
EC15-AM	17.38±0.75	13.25±0.63	8.63±0.63	25.017±1.00	75.57±2.75
EC15-BM	10.8±0.68	10.83±0.74	8.98±0.74	-	70.86±0.76
EC15-CM	13.89±3.22	12.76±0.49	8.42±0.49	22.22±1.09	28.29±0.39

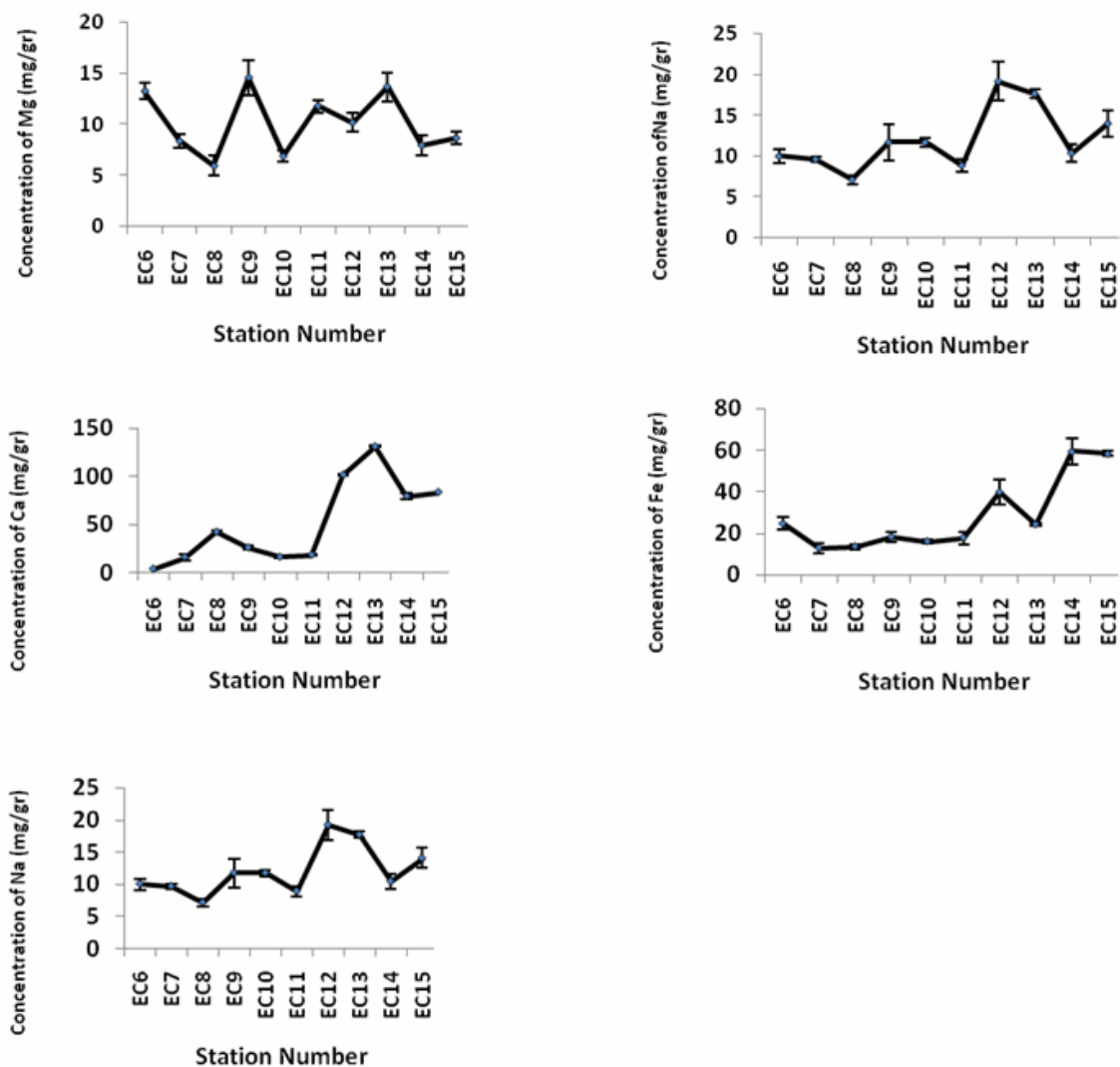


Figure 2: Distribution of essential elements in east coast peninsular Malaysia

K concentration is ranged from 6.54 mg/gr to 19.47 mg/gr with an average 12.58 mg/gr. The highest concentration average of K is 15.738 mg/gr in the EC7 station. This highest concentration is less than the highest concentration of K in the Straits of Malacca (Table 2), [4].

Mg concentration is ranged from 4.26 mg/gr to 21.70 mg/gr with an average 10.14 mg/gr. The highest concentration average of Mg is 14.58 mg/gr in the EC9 station. This highest concentration is less than the highest concentration of Mg in the Straits of Malacca (Table 2), [2].

Na concentration is ranged from 1.44 mg/gr to 19.50 mg/gr with an average 12.08 mg/gr. The highest concentration average of Na is 19.20 mg/gr in the EC12 station.

This highest concentration is less than the highest concentration of Na in the Straits of Malacca (Table 2), [2].

The average concentration totality Fe, K, Mg and in the east coast of peninsular Malaysia is higher than the average their concentration in the Mean Crustal Materials and average shales except Na which its average concentration totality is higher compared with its average shales (Table 2). The average concentration totality of Ca in the east coast peninsular Malaysia is higher than its concentration in the Mean Crustal Materials and average shales.

Table 2: Comparison of essential elements concentration in the studied area with those in other coast of Malaysia, Mean Crust materials and average shales

	Ca(mg/gr)	Fe(mg/gr)	K(mg/gr)	Mg(mg/gr)	Na(mg/gr)
our work	131.28	59.36	15.74	14.58	19.2
melaca	25.9	26.6	14.2	17.7	22.5
johor	-	30.4	-	-	-
pinang	-	21.6	-	-	-
mean	36.3	41.0-50	25.9	20.9	28.3
crustal					
average	16	47-48	24.5	16	5.9
shales					

CONCLUSION

Based on the analytical results of Ca, Fe, K, Mg and Na in this work and reported concentrations in other coastal sites of in the Malaysia region, the following conclusion can be get:

In spite of, east coast peninsular Malaysia is older pathway than the straits of Malacca, concentration of K, Mg and Na in this area is less than their concentration in the straits of Malacca that is more industrial region. The Fe content in studied area has been affected on anthropogenic activities especial in stations EC14 and EC15. Universally, east coast of peninsular Malaysia has reasonable concentration of essential elements. Evaluation and interpretation of this data can be provided new research information on the concentration/effects relationship of essential elements on aquatic organisms.

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