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RESEARCH ARTICLE

GEOCHEMISTRY OF ELEMENTS IN SEDIMENTS FROM SADONG RIVER, SARAWAK, MALAYSIA

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ABSTRACT

This work was carried out to assess the spatial distribution of Magnesium, Potassium and Sodium in sediments from Sadong River in Malaysia. These elements are fractionated by grain size due to suspended particulate matter and river bank deposits. The aim of the study includes the determination of the concentration of Mg, Na and K in sediments from Sadong River, investigation of the effects of grain size on the elements and elucidate the origin of these elements. Bedrock lithology had a major influence on the geochemistry of the river sediments. The levels of Mg, K and Na in Sadong River was influenced by natural factors and minimal impact of anthropogenic activities.

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INTRODUCTION

Weathering and erosion of rocks and soils release chemical elements in river catchments. The elements are distributed as river solutes, colloidal phases, suspended materials and bed sediments based on their physicochemical characteristics and the prevailing geological, hydrological, chemical and climatic conditions (Chen *et al*., 2014). About 90% of the flux of material delivered to the oceans are caused by river transport and the suspended particulate phase being higher compared to the dissolved load (Martin and Meybeck, 1979). This indicates the importance of river sediments when studying the biogeochemical cycles of the earth surface. Some studies have investigated the chemistry of sediments in rivers worldwide (Nargis *et al*., 2019; Omorinoye *et al*., 2019a; Chetelat *et al*., 2013; Bouchez *et al*., 2011). Other studies have shown the potential of sediment chemistry for determination of weathering intensities and rates, modelling the composition and history of the upper continental crust; (Dhivert *et al*., 2016; Babek *et al*., 2015) and estimation of the continental material transported to the oceans (Martin and Meybeck, 1979). Recently, studies on large rivers have highlighted the importance of grain size and hydrodynamic parameters on the chemistry of elements in river sediment (Lupker *et al*., 2012). However, Mg, Na and K in river sediments are mostly derived natural origins with the exception of rivers flowing through densely populated and industrialized zones. The river chemistry is affected by human activities released to the environment through waste water discharge, mining, use of fertilizer and pesticides on farmlands and others (Patel *et al*., 2018; Cengiz *et al*., 2017). The study aimed at determining the concentration of Mg, Na and K in sediments from Sadong River, investigation of the effects of grain size on the elements and predict the origin of Mg, Na and K.

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MATERIALS AND METHODS

The Sadong River drains a large area in the western part of Sarawak, Malaysia. Forty-two surface samples were collected in March 2018 from the Sadong River, Sarawak, Malaysia. Surface samples were collected with Wildco grab sampler. The environs of Sadong River are composed of basement rocks and sedimentary rocks. The study area falls in the Kuching zone in the structural development as shown in Figure 1. The sedimentary rocks comprise of siltstone, sandstone and shale (Nagarajan *et al*., 2014). Extraction of elements was carried out according to procedure described by Machado *et al*., (2016). All samples were digested in triplicate and analysed in Atomic Absorption Spectrometry laboratory at Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, Malaysia.

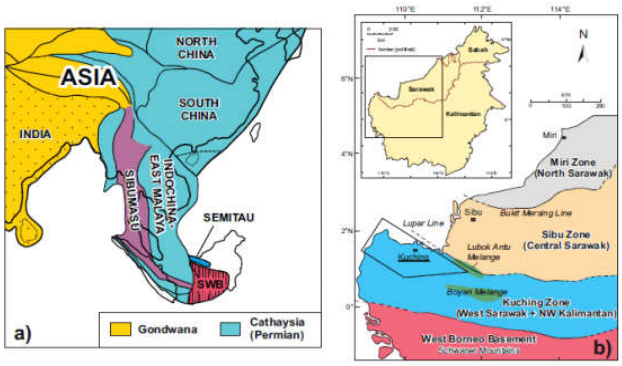

Figure 1: a) Principal continental blocks of SE Asia and SW Borneo blocks (Modified after Metcalfe, 2013). b) Tectonic provinces of NW Borneo (modified after Haile, 1974). The black box shows the study area in the West Sarawak of Kuching zone (Breitfeld *et al*., 2017)

Figure 2. Map showing the sampling locations

RESULTS AND DISCUSSION

The physical characteristics of sediments are shown in Tables 1 and 2. The sediments are fine grained. The major metals occurred as particulates, colloids and dissolved phases which can be easily absorbed to silica, clay and organic material. The adsorption process removes these metals from the river water and stored them in the sediment (Nduka and Orisakwe, 2011). Mg, Na and K are important dissolved constituents of natural river water and can be derived from terrestial sources (Kara *et al*., 2015). Mg is a natural component of surface water, their concentration was controlled by various factors, mostly geological feature of the catchment area, soil type, vegetation, weather conditions, topography, type and volume of water supply from surface run-offs and inflows of groundwater (Dalu *et al*., 2018; Potasznik *et al*., 2015). Figure 3 shows the spatial distribution of Mg in surface sediments from Sadong River. Mg is often associated with the weathering of carbonates and carbonate minerals. Lithology, climate, temperature, run off, relief and physical erosion have contributed the presence of Mg in all the sampling stations. The highest concentration of Mg was detected in sediment from the midstream of the river at SR2 with concentration 1860.15±3.26 mg/kg. There was an enrichment of Mg in the surface sediments at the midstream at SR2 and SR3. Lowest concentration was detected in sediments from the upstream at SR7 with concentration 383.23±29.71 mg/kg. The occurrence of Mg is closely related with the type of land use in the study area which is mostly agriculture around the banks and fishing activities.

Table 1: The physical characteristics of surface sediments from Sadong River, Sarawak

Stations	Location	Colour of sediment
SR1	Sebangan	Grey to dark grey
SR2	Sadong Jaya	Dark grey
SR3	Sungai Buloh	Dark grey
SR4	Simunjan	Grey to dark grey
SR5	Gedong	Grey to dark grey
SR6	Sebemban	Dark grey to black
SR7	Serian	Dark grey

Table 2: Moisture content and organic matter from surface sediments of Sadong River

Stations	Moisture Content (%)	Organic Matter (%)
SR1	46±1.00	7.72±1.29
SR2	42±2.18	8.01±1.61
SR3	33±1.43	8.47±0.72
SR4	36±1.04	5.43±0.69
SR5	34±1.04	4.31±0.49
SR6	31±1.00	5.29±1.89
SR7	28±2.60	3.69±0.96

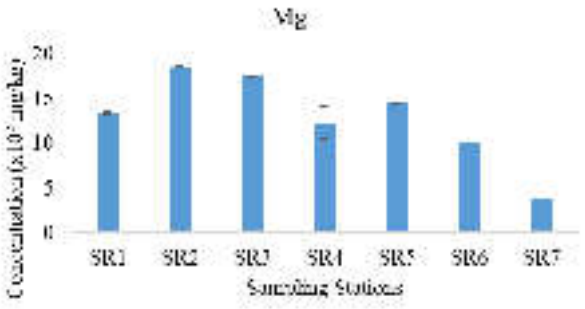

Figure 3. Spatial distribution of Mg in surface sediments from Sadong River

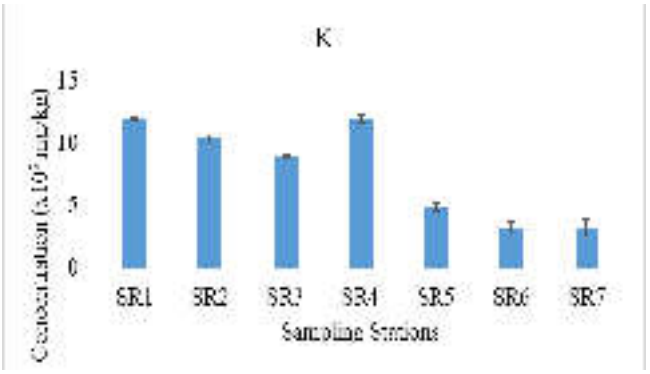

Figure 4. Spatial distribution of K in surface sediments from Sadong River

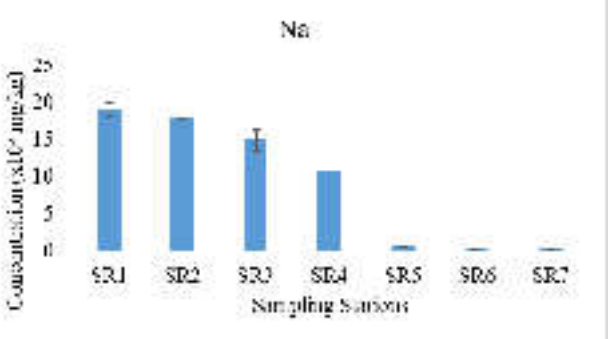

Figure 5. Spatial distribution of Na in surface sediments from Sadong River

Mg is a component of chlorophyll and it is present in enzymatic reactions. Biological activity may have contributed to differences in the Mg composition from the upstream to downstream. Certain factors affect the chemical composition of K such as grain size and sorting of minerals during the transportation of eroded sediments (Ge *et al*., 2019). The extent of the mobility of K is dependent on weathering and adsorption of dissolved K on clay minerals (Nesbitt and Young, 1996). The highest concentration of K as shown in Figure 4 is detected in surface sediments at SR4 with concentration 1193.84±6.06 mg/kg. The surface sediments at the midstream and the downstream of the river have high concentration of K and concentration of K depleted at the upstream ofthe river. While the lowest concentration ofK was detected in surface sediments of SR7 with concentration 318.81±70.09 mg/kg.

The spatial distribution of Na in surface sediments from Sadong River is shown in Figure 5. The contribution of Na from atmosphere is minimal suggested that Na in the river is originated from another source than atmospheric precipitation. Na could be derived from weathering of silicate minerals (Gupta *et al*., 2011). The highest concentration of Na was detected in surface sediment from downstream of Sadong River at SR1 with concentration 1908.88±83.94 mg/kg. Concentration of Na in surface sediment increased gradually from the upstream towards the midstream to the downstream ofSadong River. The lowest concentration ofNa was detected in surface sediments of SR7 with value 35.11 ±7.97 mg/kg. The variation of Na concentration in the sediment at the upstream towards the midstream of the river indicated a depletion of dissolved ions during transportation and/or an addition ofalkali from terrigenous sources. The concentrations of Mg and K in surface sediments were recorded at exceptionally high from all sediments compared with Na with concentration ranged for Mg and K were 380.24±29.72 to 1857.16±3.26 and 319.01 mg/kg 70.10 to 1197.35±32.54 mg/kg, respectively. There was very low concentration of Na in surface sediments ofSR5, SR6 and SR7. The concentration of Mg, Na and K detected in surface sediments of Sadong River is lower compared to concentration of Mg (14,139±14,653 mg/kg), K (3,224±1,426 mg/kg) and Na (14,287±8,774 mg/kg) detected in surface sediments from Aliaga region, Turkey (Kara *et al*., 2015).

Conclusion

Magnesium occur naturally in rivers and it is among the most highly available alkali metals in the environment. The occurrence of Mg, K and Na suggests the dominance of rock forming minerals such as K-feldspar and plagioclase feldspar in the river sediments. The concentration of Na in surface sediments was low at the upstream in SR7 and the midstream at SR5 and SR6. Based on the data, it can be concluded that the average concentration of Mg, K and Na in the surface sediments ofSadong River varied considerably in response to natural factors and minimal anthropogenic factors.

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