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THE GEOCHEMISTRY OF RARE EARTH ELEMENTS IN BRUNEI BAY, BORNEO

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INTRODUCTION

The chemical properties of rare earth elements (REE) have been shown to change systematically, retaining their relative abundances across processes during their mobilisation from land, river, estuary and to the ocean. As such REE are especially suitable in the study of geochemical processes of trace metals in estuaries and bays. In the context of differentiating between anthropogenic and natural sources of metal contaminants, REE can be used as geochemical tracers to determine the origin of metals that are closely related to water-rock-sediment interaction (Zhu *et al.*, 2006; Verplanck, 2013). Brunei Bay is endowed with a large diversity and abundance of marine life that may be threatened by urbanisation and industrialisation of the coastal zone surrounding the bay. Pulp and paper industries, heavy industries, vast oil palm plantations and maritime transport activities have the potential to contribute to pollution of the bay with organic and inorganic chemicals.

Very little work has been carried out on the abundance of rare earth elements in the coastal marine environment of Malaysia. The distribution of REE in South China Sea sediments off Peninsular (Rezaee *et al.*, 2009) and in the Terengganu River basin, Malaysia (Sultan & Shazili, 2009) indicated LREE enrichment and HREE depletion in chondrite-normalized ratios of REE. However there is no information on REE distribution in Borneo.

As part of a larger study of the geochemistry of metals in Brunei Bay, the REE were measured in water and sediments of Brunei Bay. The main objective of these measurements is to characterise the natural concentrations of rare earth elements in dissolved, particulate and sediment bound phases.

MATERIALS AND METHODS

Water and surface sediment samples were collected at forty nine sites in May 2013, July 2013 and October 2013 representing the Southwest Monsoon period and in January 2014 and April 2014 representing the Northeast Monsoon period. The sampling points were in Malaysian waters and may be divided into 3 sections: coastal, mid-bay transect and Labuan Island stations (Figure 1). The sampling stations (Table 1) were categorised into various aquatic zones to simplify discussion and interpretation of data.

Surface sediment was collected using a Ponar grab whereas water samples from the surface and bottom layers were collected using a Niskin water sampler. Samples were sealed in acid-washed containers, kept on ice and then transported to the field laboratory. Water samples were filtered through 0.45 μm clean PTFE filters under a Class-100 flow hood and the rare earth elements pre-concentrated using Chelex-100 resin (Adiana *et al.*, 2014). Suspended particulate matter caught on the PTFE filters were analysed for particulate REE concentrations. Particulate REE and bulk surface sediment samples were totally digested using Teflon bomb under microwave heating (Bidai, 2012).

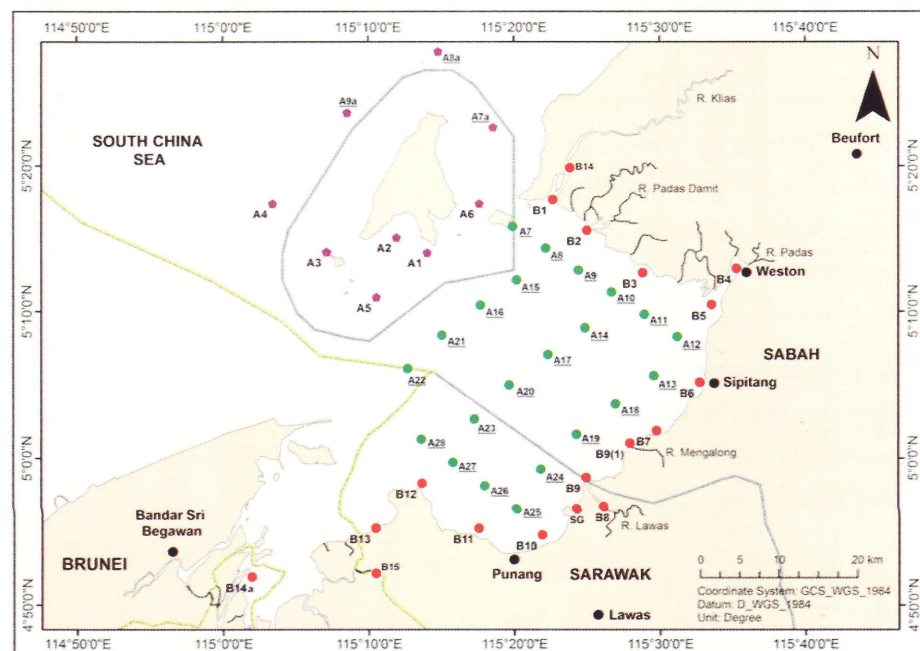


Figure 1: Sampling stations in Brunei Bay, Borneo