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Distribution of black carbon and PAHs in sediments of Peninsular Malaysia

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ABSTRACT

Concentrations, sources and interactions between black carbon (BC) and polycyclic aromatic hydrocarbons (PAHs) were investigated in 42 sediment samples collected from riverine, coastal and shelf areas in Peninsular Malaysia. The concentrations of BC measured by benzene polycarboxylic acid (BPCA) method and PAHs showed broad spatial variations between the relatively pristine environment of the East coast and developed environment of the West and South coast ranging from 0.02 to 0.36% dw and 57.7 ng g^{-1} dw to 19,300 ng g^{-1} dw, respectively. Among diagnostic ratios of PAHs, the ratios of Ant/(Ant+Phe) and LMW/HMW drew the clearest distinctions between the East coast versus the West and South coast sediments indicating the predominance of petrogenic sources in the former versus pyrogenic sources in the latter. PAHs significantly correlated with BC and total organic carbon (TOC) in the sediments ($p < 0.05$) having similar correlation coefficients. BC accounted for 6.06 to 30.6% of TOC in sediments.

1. Introduction

Rapid industrialization, urbanization and economic growth during recent decades have led to a boost in production and usage of petroleum and its products in Malaysia (Zakaria et al., 2018). Peninsular Malaysia is situated in the middle of the Strait of Malacca in the west and South China Sea in the east; both are congested with oil tankers and contain numerous oil refineries. Petroleum is comprised of many types of hydrocarbons among them are polycyclic aromatic hydrocarbons (PAHs). PAHs are known to be carcinogenic, mutagenic and disruptor of endocrine system (Varanasi, 1989). PAHs are released into the environment through natural and anthropogenic oil spills (petrogenic source) and incomplete combustion of fossil fuels and biomass (pyrogenic source). Black carbon (BC) shares the combustion sources with PAHs, thus the relationship between BC and PAHs and their fate in the environment have attracted a great deal of attention recently (e.g. Bucheli et al., 2004; Li et al., 2016; Lubecki et al., 2019).

PAHs are known to be the molecular precursors of BC which at higher temperature transform into polycondensed benzene rings (Lima et al., 2005). BC is ubiquitous in different environmental matrices and has a significant impact on global warming and biogeochemical carbon cycle (Bond et al., 2013). In addition to combustion origin BC (from char to soot), another condensed form of polyaromatic carbon is petrogenic BC such as coal and graphite formed through metamorphism at high temperature and pressure or precipitation from carbon-bearing fluids (Veilleux et al., 2009; Luque et al., 2012). Different methods using thermal, optical and chemical techniques have been applied to measure BC in various environmental matrices, all founded on a single premise that BC is more recalcitrant than other types of organic matters. Among the available methods, benzenecarboxylic acid (BPCA) method has gained a lot of attention lately since it can provide useful information on the composition and origin of BC (Kappenberg et al., 2016).

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