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# Use of molecular markers and compound-specific isotopic signatures to trace sources of black carbon in surface sediments of Peninsular Malaysia: Impacts of anthropogenic activities

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ABSTRACT

Black carbon (BC) acts as a reservoir of carbon in sediment due to its high persistency. Southeast Asia (SEA) is a main source region for BC emissions across the globe due to extensive biomass burning and escalating fossil fuel consumption. However, our understanding of the sources and sinks of BC in SEA is limited. Here, we have analysed BC structure using benzene polycarboxylic acid (BPCA) method in combination of stable carbon isotope ($\delta^{13}C$) signatures for B5CA and B6CA using HPLC-IRMS in sediment samples from riverine, coastal and shelf areas in Peninsular Malaysia. BPCA molecular markers indicated higher degree of aromatic condensation and lighter isotopic composition in relatively pristine environment of the East coast compared to developed environment of the West and South coast. n-Alkane biomarkers clearly demonstrated higher anthropogenic impacts on the sediments of the West and South coast compared to the East coast. Biomass burning with the predominance of $C_3$ plants and the large share of natural gas in the energy mix in Malaysia are possibly the main reasons for the isotopically light composition of sedimentary BC (−45.4 to −26.4‰). Atmospheric soot and petrogenic BC are the possible main sources of BC in the East coast sediments, while char residues of low temperature biomass burning likely contribute more to sedimentary BC in the West and South coast. The n-alkane indices implied that the sediments of the Kelantan adjacent shelf area receive great proportion of terrestrial organic matter and the associated BC.

## 1. Introduction

Black carbon (BC) is a highly refractory aromatic form of organic compound generated through incomplete combustion of fossil fuels and biomass (Goldberg, 1985). The chemical structure of BC is recalcitrant to biodegradation making sedimentary BC a stable reservoir of carbon in the aquatic environments (Elmquist et al., 2008). BC plays important roles in various crucial processes on Earth from global carbon cycle to climate change (Bond et al., 2013).

BC is not a singular entity but a continuum mixture of carbon-rich products with solid residues (char) from combustion of cellulose-rich plant tissues at one end-point and combustion condensates of released gas phase particles (soot) mainly from combustion of fossil fuels and biomass burning at flaming stage at the other end-point, the former is the more oxidized residues of low temperature (300–600 °C) combustion of biomass, while the latter is formed by high temperature

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