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Marine Chemistry 102 (2006) 242–251
MARINE CHEMISTRY
www.elsevier.com/locate/marchem

Higher plant *n*-alkane average chain length as an indicator of petrogenic hydrocarbon contamination in marine sediments

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Received 10 January 2006; accepted 2 May 2006
Available online 9 June 2006

Abstract

The *n*-alkane average chain length (ACL) is the weight-averaged number of carbon atoms of the higher plant C_{25}–C_{33} *n*-alkanes. The abundance of individual *n*-alkanes from higher plant sources generally increases with increasing carbon number in coastal marine sediments around Taiwan, but this trend is reversed for petrogenic hydrocarbons. The ACL would potentially be lowered if petrogenic hydrocarbons were added to sediments containing biogenic hydrocarbons alone. To test this idea, a marine environment off southwestern Taiwan known to contain both biogenic and petrogenic hydrocarbons and two nearby rivers were selected for investigating possible difference in ACL values between their sediments. The average CPI of C_{25}–C_{33} *n*-alkanes was 4.08±2.04 (range 1.90–8.96, $n=15$) for the river sediments and 1.70±0.16 (range 1.43–1.97, $n=15$) for the marine sediments. The ACL of C_{25}–C_{33} *n*-alkanes for river sediments ranged from 29.2 to 30.5 (average 29.9±0.4), and for marine sediments from 28.4 to 29.3 (average 28.9±0.3). The ACL difference between marine and river sediments was significant (Student's *t* test at 99% confidence) although it appeared small. It is suggested that the ACL can be an additional indicator for detection of petrogenic hydrocarbons in coastal marine sediments.

Keywords: *n*-Alkanes; Average chain length; Higher plant; Biogenic; Petrogenic; Sediment

1. Introduction

In the coastal marine environment, hydrocarbons are generally dominated by inputs from terrigenous sources. For instance, the *n*-alkane distribution exhibits high odd-to-even predominance of long-chain (C_{25}–C_{35}) *n*-alkanes, which characterizes hydrocarbons from vascular land plants versus those in petroleum and bacteria (Gearing et al., 1976; Farrington, 1980; Cranwell, 1982). One common parameter derived from this predominance is the carbon preference index (CPI). The CPI is an indication of *n*-alkane source. Hydrocarbons composed of a mixture of compounds originating from land plant material show a predominance of odd-numbered carbon chains with CPI ~ 5–10 (Rieley et al., 1991; Hedges and Prahl, 1993), whereas petrogenic inputs have a CPI approximating 1.0 (Farrington and Tripp, 1977; Eganhouse and Kaplan, 1982; Nishimura and Baker, 1986; Saliot et al., 1988; Pendoley, 1992). CPI values close to one also are thought to indicate greater input from marine microorganisms and/or recycled organic matter (Kennicutt et al., 1987). In organic geochemistry, CPI is used to indicate the degree of diagenesis of straight-chain geolipids, and is

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doi:10.1016/j.marchem.2006.05.001

a numerical representation of how much of the original biological chain length specificity is preserved in geological lipids (Meyers and Ishiwatari, 1995).

Another parameter is the higher plant *n*-alkane average chain length (ACL), which describes the average number of carbon atoms per molecule based on the abundance of the odd-carbon-numbered higher plant *n*-alkanes (Poynter and Eglinton, 1990). Vegetation types are the main influence on chain length of terrigenous leaf lipids. Leaf lipids derived from grasslands may on average have longer chain lengths than do leaf lipids from plants in forests (Cranwell, 1973). It has been suggested that plants produce longer-chain compounds in warmer climates (Poynter et al., 1989). Simoneit et al. (1991) have analyzed continental aerosols from China and reported that higher molecular weight *n*-alkanes (C_{31}) of the aerosols predominate in the warmer climate of southern China. Distributional variations in plant biomarker homologs

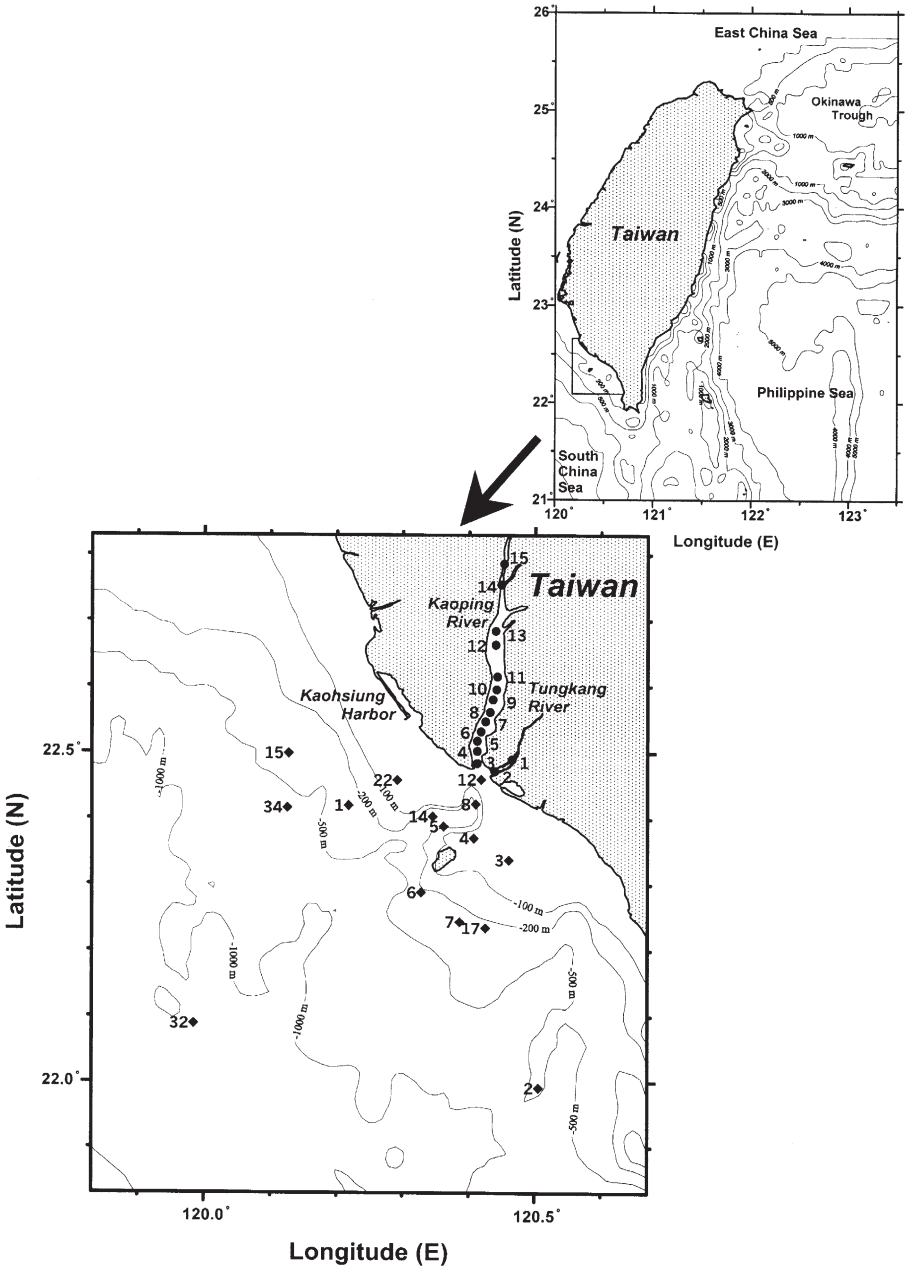

Fig. 1. Sampling locations off southwestern Taiwan and the nearby rivers. Filled diamonds, marine sediments; filled circled, river sediments.