行政院國家科學委員會專題研究計畫　成果報告

南沖繩海槽中(1)懸浮物中之脂質(2)微量金屬之海氣交換

計畫類別：個別型計畫
計畫編號：NSC91-2611-M-002-008-
執行期間：91 年 08 月 01 日至 92 年 07 月 31 日
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計畫主持人：鄭偉力
共同主持人：林斐然

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行政院國家科學委員會補助專題研究計畫成果報告

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執行單位：國立台灣大學海洋研究所

中　華　民　國 92 年 10 月 22 日

行政院國家科學委員會專題研究計畫成果報告

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一、中文摘要

本計畫採集南沖繩海槽之七個懸浮物與 14 個沈積物標本並分析其所含之脂肪族烴類、肪族醇與固醇，目的為探討懸浮物與沈積物脂質組成之差異。七個由浮游生物所衍生的烴類變化區間是 23%至 62%平均值為 39%，與東海比較該值相對的低很多，可能歸因於南沖繩海槽低生產力因為貧瘠的黑潮水，葉綠素醇(78.6μg/g)與 n-C_{22} 醇(81.2±16.3 μg/g)為懸浮物中最重要成份，n-$C_{20:1}$ 與 n-$C_{22:1}$ 醇濃度分別為 2.54±2.23 與 7.59±5.43μg/g，懸浮物中的四個主要固醇為 cholest-5-en-3β-ol (cholesterol), 27-nor-24-methylcholesta-5,22E-dien-3β-ol, cholesta-5,22E-dien-3β-ol (22-dehydrocholesterol), 24-methylcholesta-5,22E-dien-3β-ol (brassicasterol/diatomsterol)。在沈積物，所含低分子量正烷類(<C_{25})之濃度相對的低並且相似，而高分子量正烷類(≥C_{25})之濃度相對的高並且有顯著奇偶優勢，其 CPI 平均值為 2.82，而 n-$C_{20:1}$ 與 n-$C_{22:1}$ 醇則有相對低濃度分別為 6.78±4.59 與 9.97±4.33 ng/g，顯示此兩個不穩定化合物易受降解作用，沈積固醇與懸浮物固醇顯示相似分佈圖樣。

關鍵詞：脂質、懸浮物、沖繩海槽

Abstract

Seven total suspended matter (TSM) and 14 sediment samples from the southern Okinawa Trough were analyzed for aliphatic hydrocarbons, alkanols and sterols in order to explore the differences between TSM and sediments. The percentages of the 7 planktonically-derived hydrocarbon (PDHC) in TSM ranged from 23% to 62% with an average of 39%. Compared with the East China Sea, these values were comparatively low, probably attributing to the low productivity in the Okinawa Trough because Kuroshio water is oligotrophic. Phytol (78.6 ± 62.1 μg/g) and C_{22} *n*-alkanol (81.2±16.3 μg/g) were the two most significant constituents in the TSM. The concentrations of $C_{20:1}$ and $C_{22:1}$ *n*-alkenols in TSM were 2.54 ± 2.23 μg/g and 7.59 ± 5.43 μg/g, respectively. The sterol composition

of TSM was dominated by 24-methylcholesta-5,22E-dien-3β-ol (brassicasterol/diatomsterol), cholest-5-en-3β-ol (cholesterol), cholesta-5,22E-dien-3β-ol (22-dehydrocholesterol), and 27-nor-24-methylcholesta-5,22E-dien-3β-ol. For sediment samples, lower molecular weight *n*-alkanes ($<C_{25}$) showed relatively low and very similar concentrations, and higher molecular weight *n*-alkanes ($\geq C_{25}$) exhibited comparatively high concentrations and marked odd-even preference with a mean carbon preference index (CPI) value of 2.82. Relatively low concentrations were found for *n*-alkenols: $C_{20:1}$ (average 6.78±4.59 ng/g) and $C_{22:1}$ (average 9.97±4.33 ng/g), reflecting preferential degradation of this labile compound. Sedimentary sterols showed the same pattern as those in TSM.

Keywords: lipid, suspended matter, Okinawa Trough

二、緣由與目的

Lin et al. (1992) have investigated the organic carbon content in the continental margin sediments off northeastern Taiwan and found that lowest organic carbon concentrations were found in the shelf sediments while high concentrations were observed in the upper continental slope sediments. Chen et al. (1992) studying the composition and texture of surface sediments off northeastern Taiwan have concluded that in the Okinawa Trough the sediments beneath the path of the main Kuroshio flow are composed of non-biogenic, fined-grain mud. The much higher proportion of cholesterol in the sediments of the immediate shelf of SOT is most likely derived from mollusks in the relict sediments (Jeng and Huh, 2001). An additional sterol source for the shelf sediments probably is suspended matter in the water column although the shelf has no apparent sedimentation (ibid). The inputs of terrigenous organic matter to the southern Okinawa Trough (SOT) are rather complex—from the northwest and south together with the runoff of the Lan-yang River. Marine input to SOT sediments is particularly low based on the average *n*-C_{17}/*n*-C_{29} alkane and *n*-C_{16}/*n*-C_{28} fatty alcohol ratios, 0.15±0.13 and 0.13±0.06, respectively; this may be due to the fact that marine lipids are more prone to degradation than terrestrial ones (Jeng et al., 2003). This area has the highest plant wax *n*-alkane contribution (average CPI = 3.9±1.2) among the coastal marine areas surrounding Taiwan. In this proposal, 7 samples of total suspended matter and 14 samples of surface marine sediment from the southern Okinawa Trough were collected; they were analyzed for aliphatic hydrocarbons, alkanols and sterols.

三、結果與討論

1. Total suspended matter

In the East China Sea, seven most predominant components of TSM are *n*-C_{17}, pristane, *n*-C_{18}, *n*-$C_{19:1}$, *n*-C_{19}, *n*-$C_{21:6}$ and squalene; other *n*-alkanes up to C_{35} are minor ones. This pattern is similar to station 1 of DH2 reported by Qiu et al. (1991) with the exception of squalene. The 7 hydrocarbons are produced chiefly from plankton (Winters et al., 1969; Blumer et al., 1971) and are termed planktonically derived hydrocarbons (PDHCs). High percentages (80-94%) of the seven PDHCs have observed at 8 stations, but relatively low percentages (45-61%) have been found at 3 stations (Jeng, 2002). It appears that stations with high percentages of PDHC are located close to the Changjiang. The percentages of the 7 PDHC in the southern Okinawa Trough ranged from 23% to 62% with an average of 39%. These values were comparatively low, probably attributing to the low productivity in the Okinawa Trough because Kuroshio water is oligotrophic. However, Sicre et al. (1993a) have obtained a completely different aliphatic hydrocarbon distribution pattern (during high flow) without the predominance of the 7 PDHCs and with the absence of *n*-$C_{19:1}$, *n*-$C_{21:6}$ and squalene in the Changjiang estuary. Therefore, relatively lower percentages (range 6-27%, average 13%, calculated from their data) of PDHCs have been obtained. As to aliphatic hydrocarbon distribution in the GC range, there are five types recognized in the Changjiang Estuary by Qiu et al. (1991) based on the hydrocarbon distributions obtained by gas chromatography.

Besides the predominant PDHCs, land plant waxes in suspended particles from Taiwan might play a role in TSM distribution. The CPI in the range of C_{25}~C_{33} was used to investigate the possible influence of terrigenous lipids from the Lanyang river. The average CPI for the 7 suspended matter was surprisingly low, 1.01. This is mainly because the Lanyang river exports relatively low CPI in its suspended matter to the adjacent seas (Jeng and Kao, 2002).

The distribution of *n*-alkanols observed in suspended matter was similar among stations, and was dominated by shorter chain ($<C_{22}$) alcohols with phytol (78.6 ± 62.1 μg/g) being the most significant constituents, suggesting that the major contributors were from marine sources. In addition, C_{22} *n*-alkanol had the highest concentration (81.2 ± 16.3 μg/g) and was thought to be from bacterial sources. Further, among the shorter chain alcohols, monounsaturated *n*-alkenols $C_{20:1}$ and $C_{22:1}$ can be derived from marine zooplankton especially calanoid copepods (Sargent

and Lee, 1975; Saito and Kotani, 2000). Their concentration were 2.54 ± 2.23 μg/g and 7.59 ± 5.43 μg/g for $C_{20:1}$ and $C_{22:1}$ *n*-alkenols, respectively. In contrast, saturated alcohols from higher plant waxes (>C_{22}) constituted a minor proportion, indicating that terrigenous alcohols played a minor role.

The four predominant sterols of marine origin in TSM of the East China Sea have been found to be in general order of decreasing abundance, 24-methylcholesta-5,22E-dien-3β-ol (brassicasterol-diatomsterol), cholest-5-en-3β-ol (cholesterol), cholesta-5,22E-dien-3β-ol (22-dehydrocholesterol), and 27-nor-24-methylcholesta-5,22E-dien-3β-ol (Jeng, 2002). They account for an average of 55% of total sterols in TSM, that is close to a study with an average of 57% (calculated from Sicre et al., 1994), but higher than two other studies with averages of 36 and 44% (calculated from Tian et al., 1992 and Sicre et al., 1993b, respectively). However, in the present study, the most abundant sterol in TSM was cholest-5-en-3β-ol (cholesterol) having an average concentration of 269 ± 157 μg/g, not 24-methylcholesta-5,22E-dien-3β-ol (brassicasterol-diatomsterol) with a mean concentration of 91.2 ± 36.9 μg/g . This may reflect a very different phytoplankton structure between ECS and SOT. The three common phytosterols used as indicators of higher plants were 24-methylcholest-5-en-3β-ol (campesterol), 24-ethylcholesta-5,22E-dien-3β-ol (stigmasterol) and 24-ethylcholest-5-en-3β-ol (sitosterol). They accounted for a substantial proportion of the sterol fraction, 14.8 ± 2.4 %.

2. Sediment

The distribution of *n*-alkanes was quite consistent with lower molecular fraction (<C_{25}) having relatively low and very similar concentration and higher molecular fraction (≥C_{25}) having marked odd-even preference. The CPI values ranged from 2.17 to 5.04 with a mean of 2.82. It is worthwhile to mention that diploptene had an average concentration of 671 ± 450 ng/g, which was considered not to be derived from higher plants alone (Jeng et al., 2003).

The distribution patterns of alkanols in sediment were quite similar, with a general trend of higher molecular weight *n*-alkanols (>C_{22}) outweighing those of lower molecular ones (<C_{22}). This indicates a greater contribution from higher plant lipids because they usually contain predominant C_{24}, C_{26}, and C_{28} *n*-alkanols (Prasad et al., 1990; Rieley et al., 1991; Vioque et al., 1994). Two highest concentrations in this fraction were phytol (average, 731±434

ng/g) and C_{22} *n*-alkanol (average, 776±222 ng/g). The result of C_{22} *n*-alkanol maximum has also been reported in an estuary (Mudge and Norris, 1997). Relatively low concentrations in sediment were found for *n*-alkenols: $C_{20:1}$ (average 6.78±4.59 ng/g) and $C_{22:1}$ (average 9.97±4.33 ng/g), reflecting preferential degradation of this labile compound (Prahl et al., 1980; Meyers et al., 1984).

The distribution pattern of sterols in sediment was similar to that in TSM with cholest-5-en-3β-ol (cholesterol) being the most abundant, 956±583 ng/g. The three common phytosterols used to be indicators of higher plants and accounted for a high proportion, 24.0±2.0%. In addition, diplopterol span a wide range, 536±505 ng/g.

3. Differences between TSM and sediment

The average CPI value of *n*-alkanes for TSM was 1.01 and that for sediment was 2.82, suggesting that high molecular weight *n*-alkanes in the TSM could not be the source to the sediments. The mean $C_{20:1}OH/C_{20}OH$ ratios for TSM and sediment were 0.24 and 0.051, respectively. The average $C_{22:1}OH/C_{22}OH$ ratios for TSM and sediment were 0.091 and 0.012, respectively. These *n*-alkenols decreased by factors of 4.7 and 7.6 from TSM to sediment, reflecting preferential degradation of these labile compounds.

四、計畫成果自評

主持人對本計畫研究成果感到很滿意。

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