

21. LIPID GEOCHEMISTRY OF SEDIMENTS FROM SITE 462 IN THE NAURU BASIN^{1,2}

Bernd R. T. Simoneit, Institute of Geophysics and Planetary Physics, University of California, Los Angeles, California

ABSTRACT

The lipids of a Pliocene and a Cretaceous sample from Site 462 were analyzed to assess their source and diagenetic history. Judging from the distributions of the *n*-alkanes, *n*-fatty acids, *n*-alkylcyclohexanes and molecular markers, they are autochthonous, of marine origin, and deposited under oxic paleoenvironmental conditions of sedimentation. The stereochemistry of the various molecular markers (e.g., triterpanes and steranes) of the Pliocene sample indicates that the lipids are geologically mature. This supports the hypothesis of sediment recycling from older formations by turbidite redistribution into the Nauru Basin.

INTRODUCTION

The Nauru Basin, in the west-central Pacific, is remote from terrigenous influences, but receives much of its sedimentary detritus by turbidite deposition (Larson et al., 1978). It is of interest to determine the nature and source of the organic matter brought into this pelagic basin.

Samples 462-3-4, 100–150 cm and 462-59-1, 100–125 cm were analyzed. The upper sample consists of calcareous and radiolarian ooze of Pliocene age, derived from 25.25 meters sub-bottom, and the lower sample is a zeolitic claystone of Campanian to Santonian age, from 550.6 meters sub-bottom. Site 462 is in the central Nauru Basin, at 07°14.25'N, 165°01.83'E, in 5189 meters of water.

EXPERIMENTAL PROCEDURES

The core samples were freeze-dried, then extracted with chloroform and methanol (1:1), using ultrasonication. The extracts were derivatized and separated by thin-layer chromatography, as described by Simoneit (1979). The fractions were analyzed by gas chromatography and by gas chromatography/mass spectrometry, using the conditions described by Simoneit (1979).

RESULTS

The results of the carbon and lipid analyses are summarized in Table 1. The organic-carbon content of the Pliocene sample is low, and the lipid yield, especially of the hydrocarbons, is high. The total lipid and organic-carbon content of the Cretaceous sample is very low.

The distribution diagrams for the various homologous series are shown in Figure 1. The *n*-alkanes of sample 462-3-4, 100–150 cm (Fig. 1A) exhibit an essentially unimodal distribution, with a maximum at C₂₂, and only a minor odd-to-even carbon number predominance. The homologs <C₂₅ are probably indicative of an origin from both degraded algae and bacteria (Simoneit, 1979). Only traces of *n*-alkanes (>*n*-C₂₇, odd-

carbon-number predominance) derived from higher-plant wax are present (Simoneit, 1978). The pristane-to-phytane ratio is 0.95, which coupled with the lithologic data indicates a low-oxygen sedimentary paleoenvironment, but not completely anoxic (Didyk et al., 1978). The *n*-fatty acids of this sample (Fig. 1B) range from C₁₀ to C₃₂, with a strong even-to-odd carbon-number predominance (CPI > 7.6), and maxima at C₁₆ (major) and C₂₈ (minor). The homologs <C₂₀ indicate a primarily microbial origin, and those >C₂₂ are derived from vascular-plant wax (Simoneit, 1978, 1979). A trace of dehydroabietic acid is found in the acid fraction, indicating a very minor influx of detritus from resinous higher plants (Simoneit, 1977). Perylene was not detectable.

Because of the low extract yield from Sample 462-59-1, 100–125 cm, only the total fraction could be analyzed. The dominant homologous compounds in the lipids were *n*-alkanes and *n*-fatty acids (Fig. 1C,D). The *n*-alkanes exhibit a trimodal distribution, ranging from C₁₁ to C₃₁, with a low CPI of 1.2 and maxima at C₁₇, C₁₉, and C₂₂. This distribution is characteristic of degraded autochthonous microbial lipids of a marine origin. Perylene was not detectable. The *n*-fatty acids exhibit a bimodal distribution, ranging from C₁₀ to C₂₆, with a CPI of 6.2 and maxima at C₁₆ and C₂₂. This distribution is also characteristic of primarily autochthonous microbial detritus of a marine origin. Dehydroabietic acid was not detectable.

Various molecular markers that could be correlated with biogenic sources were determined. Sesquiterpenoids and diterpenoids were not detectable in both samples. The following markers could be confirmed in sample 462-3-4, 100–150 cm only. A series of *n*-alkylcyclohexanes, ranging from C₁₄ to C₂₇, with a maximum at C₂₁ was present (Fig. 1E). These compounds are microbial lipid residues (Simoneit, 1978, 1979). Minor amounts of extended diterpanes (I), ranging from C₁₉ to C₂₆ are present (Fig. 1F), also indicating autochthonous material. The steranes were present as trace components only and exhibited complex isomeric distributions where the 5 α (H)-steranes (II) and the 5 α (H),14 β (H)-steranes

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Table 1. Results of carbon and lipid analyses.

| Sample | Carbon ^a | | CaCO ₃ ^a (%) | Total Lipids (μg/g) ^b | <i>n</i> -alkanes | | | Pr/Ph ^e | <i>n</i> -fatty acids | | |
|----------------------|---------------------|----------------|---------------------------------------|-------------------------------------|-------------------|------------------|-------------------|--------------------|-----------------------|------------------|-------------------|
| | Total (%) | Organic (%) | | | μg/g ^b | CPI ^c | Max. ^d | | μg/g ^b | CPI ^c | Max. ^d |
| 462-3-4, 100-150 cm | 0.1 | 0.1 | 0 | 1400 | 460 | 1.2 | 17,22 | 0.95 | 130 | 7.6 | 16,28 |
| 462-59-1, 100-125 cm | 0.0 | 0.0 | 0 | 15 | 5 | 1.2 | 17,19,22 | 1.7 | 3 | 6.2 | 16,22 |

^a Data provided by G. Bode, Deep Sea Drilling Project.

^b Based on dry sediment weight.

^c Carbon-preference index, summed from C₁₀-C₃₅, odd-to-even for *n*-alkanes, even-to-odd for *n*-fatty acids.

^d The dominant homolog is underscored.

^e Pristane-to-phytane ratio.

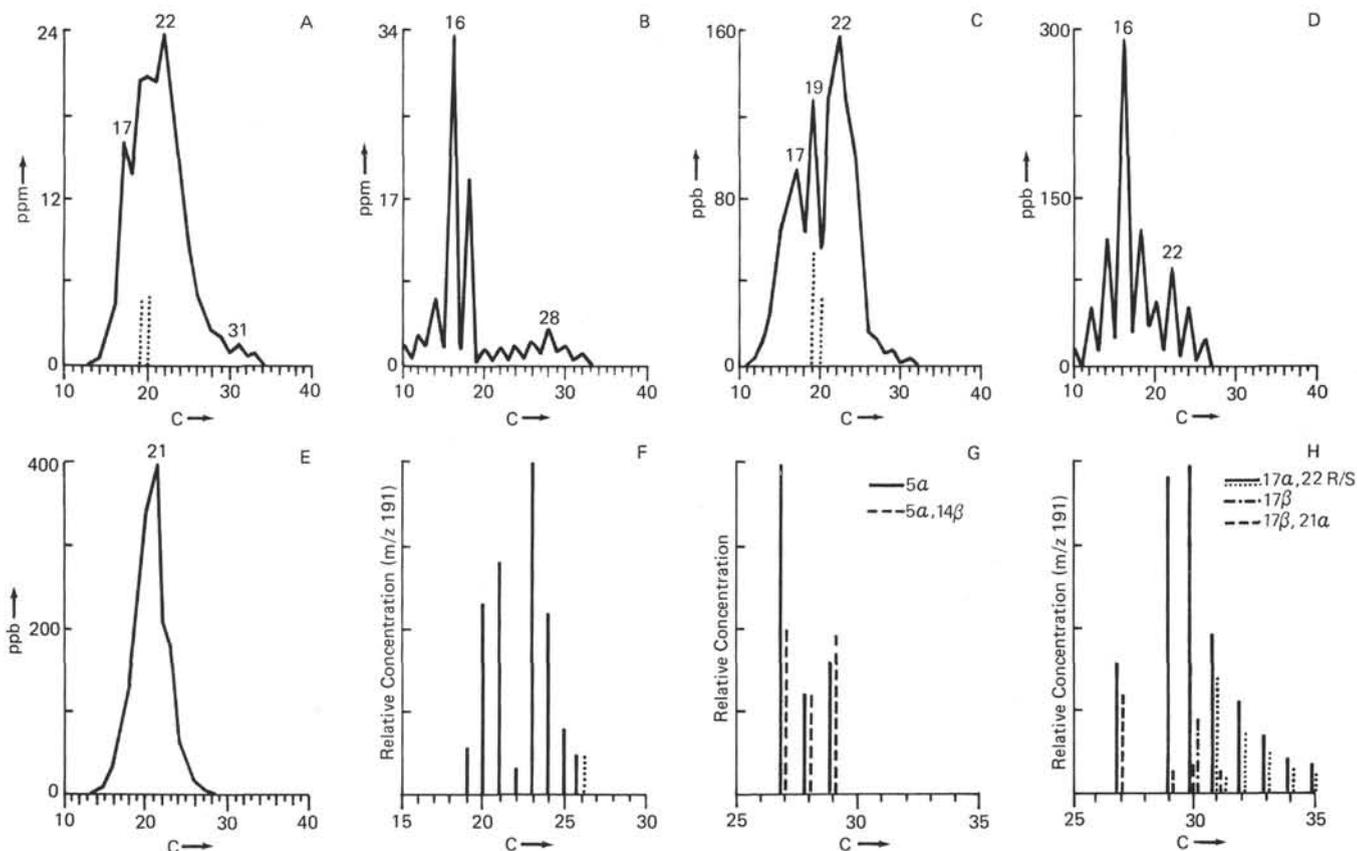


Figure 1. Distribution diagrams for *n*-alkanes, *n*-fatty acids and molecular markers in the lipids of the samples from Site 462. Sample 462-3-4, 100-150 cm: A. *n*-alkanes. B. *n*-fatty acids. E. *n*-alkylcyclohexanes. F. Extended diterpanes (I). G. Steranes. H. Triterpanes. Sample 462-59-1, 100-125 cm: C. *n*-alkanes. D. *n*-fatty acids.

(III) were dominant (Fig. 1G). The 5β(H) stereomers were not detectable. The distribution with cholestane as the dominant homolog indicates autochthonous marine material (Gaskell, 1974; Rubinstein, 1973).

Triterpenoids are present primarily as the 17α(H)-hopane (IV) series, with lesser amounts of the moretanes (V) and trace of 17β(H)-hopanes (Fig. 1H). The homologs range from C₂₇, C₂₉ to C₃₅, where the compounds >C₃₁ are resolved into *R* and *S* diastereomers (VI) at C-22 in the approximate ratio of *S/R* = 1.4. The source of these triterpenoids is marine microbial detritus. The presence of the 17α(H) stereomers and an almost equal proportion of the 22*S* and *R* isomers (Dastillung and Albrecht, 1976), coupled with the

steranes and other markers, indicate that the lipids of this shallow sample are old (mature), and not syngenetic. They probably were introduced from geologically older sediments by erosion and redeposition.

CONCLUSION

The lipids of both samples from the Nauru Basin are primarily autochthonous and marine, with only traces of terrestrial higher-plant wax residues.

The molecular markers in the lipids of Sample 462-3-4, 100-150 cm are diagenetically older than the sediment, i.e., they are quite mature. This indicates and supports the fact of turbidite deposition, in which older material was brought to this pelagic basin.

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APPENDIX

