

## Quasi-monochromatic 0.05 Hz Waves in Cape Waters

REGULAR monitoring of ocean gravity waves just north of Cape Town reveals the predominant frequency range as 0.07–0.10 Hz. These waves generally exhibit narrow swell type energy spectra but nonetheless have a small range of frequencies present. The case history described here is interesting because of the low frequency (0.05 Hz) and because it is monochromatic.

On June 26, 1972, a record of a remarkably regular 0.05 Hz swell of height about 1 m was registered by a Wemelsfelder wave recorder situated on a tower in 13 m of water 15 miles north of Cape Town, South Africa. Figure 1a is a sample from the 30 min recording, at 1200 h. Figures 1b and c are respectively the autocovariance curve (which is only slowly damped) and the spectrum (which is sharply peaked).

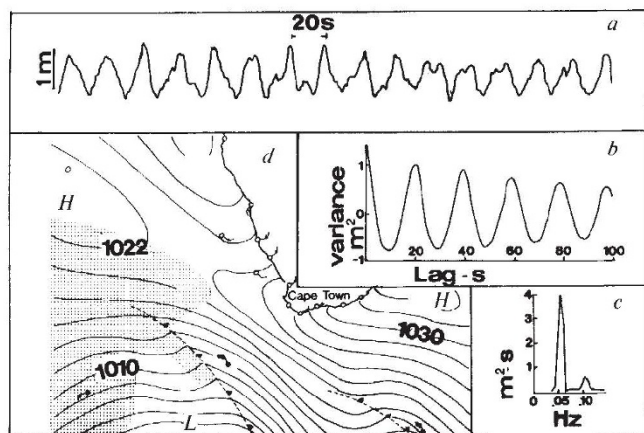


Fig. 1 a, Tracing of wave record, b, autocovariance curve; c, spectrum of record, digitized at intervals of 1 s; d, synoptic chart for 1400 h on June 26, 1972.

Consideration of energy distribution in frequency-time space suggests the swell originated some 1,000 nautical miles away. Figure 1d is the relevant part of the synoptic weather chart published by the South African Weather Bureau for 1400 h on June 26, 1972. On it the area from which waves could be generated towards Cape Town has been shaded. (It was assumed that waves are generated  $\pm 20^\circ$  to the wind direction.) The deduced geostrophic wind velocities in the shaded area are rather lower than are usually associated with 0.05 Hz waves<sup>1</sup>, though they may be in error. The isobars are notably straight and slope from north of west as they did in the previous and following days. In our experience this is not a common condition. The front shown on the synoptic chart passed over Cape Town on the afternoon of June 27, 1972. Presumably the surf swell was the forerunner of this front.

The interception of the swell was made possible by frequent monitoring (every 2 h) of the sea state. The monochromatic nature of the record is in part due to the unusually low level of background noise. The arrival of the swell increased the variance by an order of magnitude.

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<sup>1</sup> Moskowitz, L., *J. geophys. Res.*, **69**, 24 (1964).

## C<sub>18</sub>-Isoprenoid Ketone in Recent Marine Sediment

ISOPRENOID hydrocarbons, fatty acids and alcohols occur in ancient rocks, oil shales, young sediments and living organisms<sup>1,2</sup>. During thermal alteration experiments on a recent marine sediment from Tanner Basin, Southern California continental shelf, we isolated a C<sub>18</sub>-isoprenoid ketone, namely 6,10,14-trimethylpentadecan-2-one. Samples of sediment from the Tanner Basin were sealed in glass bombs and exposed to temperatures from 60° to 150° C for 7 d, 30 d and 60 d. The sediment was then extracted with benzene-methanol and the extract chromatographed on a silicic acid column. The ketone was found in both the heat-treated and untreated sediment. It was extracted with the fatty acid fraction which had been converted to methyl esters, and was separated with the other branched components by the urea adduction method. For comparative purposes, the C<sub>18</sub>-isoprenoid ketone was also synthesized<sup>3</sup>. Analytical comparisons by gas-liquid chromatography, using two 5 foot  $\times \frac{1}{8}$  inch columns (3% OV 101 on 100/120 mesh 'Gas Chrom' Q and 3% DEGS on 100/120 mesh 'Gas Chrom' Z), showed the synthetic product to be identical to the sedimental ketone.

We obtained a mass spectrum of the ketone using a gas chromatograph coupled with a CEC-21-491 mass spectrometer. The spectrum showed a molecular ion peak at  $m/e$  268 with fragmentation peaks at  $m/e$  250 (M-18); 235 (M-33); 225 (M-43) and 210 (M-58). Loss of  $[\text{CH}_3\text{-CO}]^+$  and  $[\text{CH}_3\text{-CO-CH}_2]^+$  gave abundant fragments at  $m/e$  43 and 58, respectively (Fig. 1). This pattern is compatible with synthetic C<sub>18</sub>-isoprenoid ketone reported by Cox *et al.*<sup>4</sup>. Further evidence for ketone structure was also gained from infrared spectroscopic measurements. A weak absorption band (due to small sample size) was observed at  $1,714 \text{ cm}^{-1}$  (in  $\text{CCl}_4$ ), which is characteristic of a saturated methyl ketone. The NMR spectrum (in  $\text{CCl}_4$ ) showed the expected signals for  $\text{CH}_3\text{CO}$  protons ( $\delta$  2.03 p.p.m.),  $\text{CH}_2$  protons adjacent to the  $\text{CH}_3\text{CO}$  group (triplet  $\delta$  2.25, 2.3, 2.35 p.p.m.), other  $\text{CH}_2$  protons as well as  $\text{CH}$  protons (multiplet centred at  $\delta$  1.25 p.p.m.) and  $(\text{CH}_3)_2\text{CH}$  protons ( $\delta$  0.82 and 0.9 p.p.m.). The identity of the ketone was further substantiated by *in situ* formation of a yellow 2,4-dinitrophenylhydrazone on thin-layer plates (silica gel GF-254). The measured  $R_F$  of 0.66 (triple developed with chloroform-hexane, 3:1) was the same as for the synthetic ketone.

The data (Table 1) show the influence of temperature and time of heating upon ketone generation. The ketone

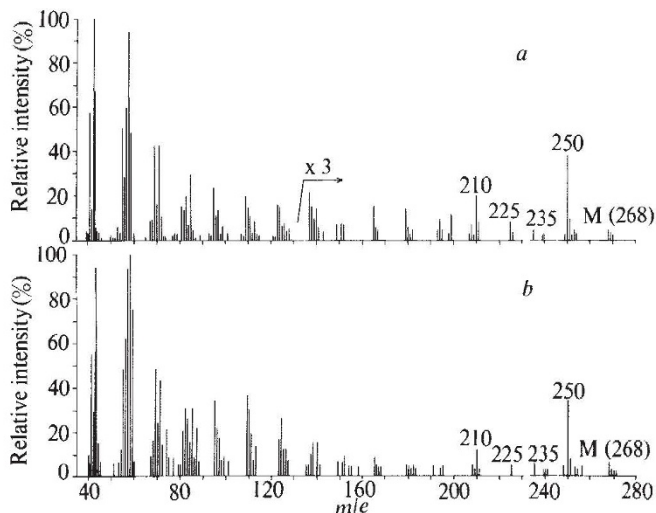


Fig. 1 Mass spectra of, a, synthetic C<sub>18</sub>-isoprenoid ketone; b, ketone isolated from sediment.