

FRactal Analyses of Sedimentary Deep-Sea Record Show Evidence for Non-Linear Behavior of the Earth's Climate System (Leg 104 Site 643, Norwegian Sea)

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A continuous undisturbed Pleistocene sedimentary record of oxygen isotope data, calcium carbonate data and coarse fraction data from ODP Leg 104, Site 643 was investigated in the frequency domain to obtain information about possible fractal distribution of the sedimentary record.

The results of the spectral analyses demonstrate the presence of the orbital frequencies in the Milankovitch band, with mean periods at 100, 41, and 21 kyr.

The fractal dimension D was determined by a power spectral method. All parameters show clear evidence for an underlying fractal Brownian process on a 95% confidence level, i.e., $1 < D < 2$. The CaCO_3 signal shows a persistent behavior ($D = 1.37 \pm 0.10$), whereas the $\delta^{18}\text{O}$ signal seems to be antipersistent ($D = 1.63 \pm 0.09$). The fractal dimension of the terrigenous component ($D = 1.51 \pm 0.09$) is ambiguous in terms of possible underlying persistence.

In addition, we compared the $\delta^{18}\text{O}$ record of the Norwegian Sea with $\delta^{18}\text{O}$ records from the eastern equatorial Pacific (cores RC 13-110 and V 19-27; MIX et al., 1991). The fractal dimensions of these records have been estimated to be $D = 1.63 \pm 0.08$ and $D = 1.45 \pm 0.10$ on a 95% confidence level.

Climatic variability in the late Pleistocene can be regarded as response to periodically changing solar insolation, due to orbital forcing at distinct frequencies in the Milankovitch band. If the coupling between solar insolation and the Earth's climate system were strictly linear, then one would expect only these driving frequencies to occur in the geological record. In addition, resonance frequencies of the climate system would appear. Such a record would not be scale invariant and, hence, the record would not be fractal.

A possible explanation for the observed scale invariance is a non-linear coupling between incoming solar energy and the climate system. Then, the response of the climate system can include harmonic and subharmonic components of the driving frequencies. Beside these harmonic components, combination tones can be produced.

We suppose that the creation of these additional frequencies is responsible for the observed scale invariance of the proxy records in the frequency range between $1/125$ and $1/6 \text{ kyr}^{-1}$. Hence, the fractal property of the sedimentary record might be an expression of the non-linear response of the climate system to driving solar insolation at distinct frequencies.

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HIGH RESOLUTION ANALYSIS OF THE CARBONATE-RICH SEDIMENT CORE 74P FROM THE ONTONG-JAVA PLATEAU (WESTERN EQUATORIAL PACIFIC)

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The concentrations of ^{230}Th , ^{10}Be , Mn and Fe of sediment core 74P (Ontong-Java Plateau, 2500 m water depth, 540 cm length) were measured at high resolution (5 cm/sample). $\delta^{18}\text{O}$ -stratigraphy of the planktonic foraminifer