Spores, Pollen, and Microplankton from the Horizon Beta Outcrop

Abstract. *Palynology was used for dating a pre-Pleistocene deep-sea organic lutite layer situated stratigraphically near seismic horizon beta, below horizon A. The spores and pollen are closely identified, quantitatively, with nonmarine and marine Middle Cretaceous assemblages (Albian-Cenomanian) on the continents, an age designation that is confirmed by the occurrence of dinoflagellate cysts, acritarchs, foraminifers, and coccoliths in the investigated cores. The abundance of these well-preserved, land-derived assemblages in an area far removed from a source suggests some tectonic displacement since their deposition.*

As part of the study of pre-Pleistocene sediments in the ocean basins being undertaken at Lamont Geological Observatory, five deep-sea cores were investigated for their spore and pollen assemblages. The cores contain rich and very well-preserved assemblages of land-plant spores and pollen, algal microflora (dinoflagellates), and related organisms (acritarchs).

The cores were collected from the area of the seismic horizon β outcrop (*1*), located approximately 265 km east of Cat Island, the Bahamas, and 885 km east-southeast of the coast of Florida, at depths exceeding 5300 m of water (Fig. 1). They are situated stratigraphically below seismic horizon A, which has been dated as Maestrichtian (Upper Cretaceous) (*2*), near horizon β. The various assemblages indicate a Middle Cretaceous age for the investigated cores.

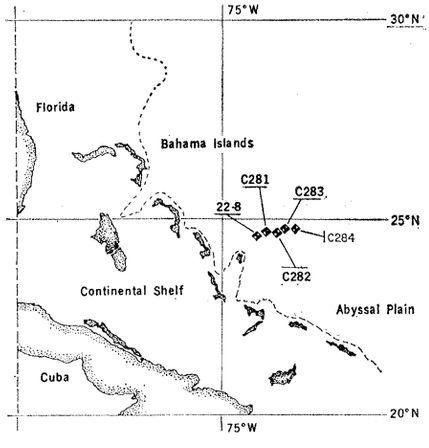

Fig. 1. Location of cores. The cores were collected on cruises 10 of R.V. *Conrad* and 22 of R.V. *Vema*.

These cores are characterized by dark gray to black organic lutites in the lower portions and are overlain by calcareous sediments (Fig. 2). The clays are well compacted to semi-indurated and are separated from the sediment above by a sharp contact. Except for one core, V22-8, in which the clay layers alternate with coccolith-rich layers, the carbonate content of the lower portions is nil.

A sample was taken from the bottom of each core. Two additional samples were taken from RC10-284, at the 205-cm and 235-cm levels, to determine any significant vertical variations. Because of the great abundance of specimens in all samples, conservatively estimated as thousands per gram of sediment, further treatment beyond acid-digestion of the clays was not necessary to concentrate the spore and pollen residue. On the basis of hydrogen peroxide analysis, 40 percent of lutite portions is estimated to be composed of organic material.

Two separate assemblages were identified—a Lower Cretaceous (Albian) assemblage in the bottom of RC10-284, and an Upper Cretaceous (Cenomanian) in the remaining cores. The assemblage in core 284 is distinguished by the predominance of pteridophyte spores and coniferous pollen, which relate it closely to Albian assemblages reported from Maryland (*3*) and Delaware (*4*) in the United States and from Great Britain (*5*). Dicotyledonous angiosperm pollen account for less than 10 percent. They are typically small, smooth, and retipilate prolate forms. In addition, two form species diagnostic of the Aptian-Albian section in the United States and Great Britain, *Spheripollenites psilatus* and *Clavatipollenites hughesii*, occur in appreciable numbers (*6, 7*).

The remaining cores are characterized by the predominance of tricolpate dicotyledonous pollen and addition in appreciable numbers of species typical of the Cenomanian stage (Table 1). The tricolpate types are also larger and have more deeply incised furrows. Tricolporate and triporate grains were not observed. Cenomanian foraminifers have been described from core V22-8 (*2*).

The two other samples from the older 284 core show a similar vertical variation. The predominance of pteridophyte spores and coniferous pollen in the bottom sample gives way to the predominance of tricolpate types at the 205-cm level. Here, for the first time, a few tricolporate grains were observed, types of which have been previously recorded from Cenomanian assemblages (*7*).

The dinoflagellate and acritarch assemblages correlate well with the data concerning spores and pollen. For example, *Palaeohystrichophora infusorioides* occurs in the Cenomanian cores. It has been reported from lower Upper Cretaceous deposits in Great Britain (*8*), Australia (*9*), and the Alabama coastal plain (*10*). A species of *Diplotesta*, an acritarch fossil that appears to be related to the dinoflagellates, is the predominant microfloral type in the bottom of RC10-284. It has a similar worldwide distribution in assemblages

Table 1. Middle Cretaceous palynomorph assemblages. Cretaceous diatoms (*Coscinodiscus marginatus*), Cretaceous coccoliths, and Cenomanian foraminifers also occur.

Core No.	Spores and pollen	Microflora
	Upper Cretaceous (Cenomanian)	
RC10-282	Dicotyledonous (tricolpate) pollen (> 50%)	*Palaeohystrichophora infusorioides*
RC10-281, V22-8	Minor trilete spores (diverse genera) Minor bisaccates (*Rugubivesiculites*)	*Cleistosphaeridium ancoriferum* *Micrhystridium* sp.
RC10-283	Dicotyledonous pollen and bisaccates	*Palaeohystrichophora infusorioides*
	Appreciable *Classopollis*	*Cleistosphaeridium ancoriferum* *Micrhystridium* sp.
	Lower Cretaceous (Aptian?-Albian)	
RC10-284	Trilete spores (*Gleicheniidites*) and bisaccates (> 50%)	*Diplotesta* sp.
	Appreciable *Spheripollenites psilatus* and *Clavatipollenites hughesii*	*Palaeostomocystis fragilis* *Canningia minor*
	Minor dicotyledonous pollen	*Hystrichosphaeridium arundum*

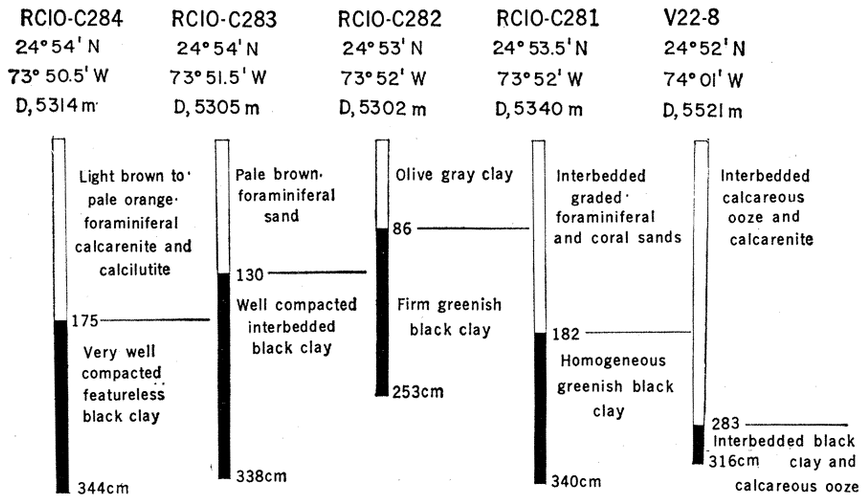

Fig. 2. Lithologic description of cores.

ranging from Upper Jurassic through Lower Cretaceous.

The probability of the assemblages being younger, reworked, marine deposits is small, on the basis of the following evidence: (i) lack of spore and pollen taxa characteristic of younger assemblages, at both the generic and species levels; (ii) occurrence of dinoflagellate and acritarch assemblages that have a closer affinity to older Cretaceous assemblages rather than younger; (iii) close quantitative identity with nonmarine and marine Middle Cretaceous assemblages on the continents; and (iv) evidence from Cretaceous coccoliths and Cenomanian foraminifers.

Study of the distribution of modern land-plant spores and pollen in the ocean basins, especially by Groot (*11*), Stanley (*12*), and Koreneva (*13*), has led to the conclusion that they are deposited relatively close to the continents. Koreneva concluded, moreover, that by 200 to 500 km offshore, the concentration of grains drops sharply from hundreds of specimens per gram to only a few, and that, by sorting or other processes, they lose all quantitative identity with the source area.

On the basis of this and other data obtained thus far from these studies, the assemblages occurring in the five cores suggest deposition in an oceanic environment much nearer a land source than is now indicated, a phenomenon that may be explained by some vertical or lateral tectonic displacement since deposition. The occurrence of thousands of grains per gram of sediment of well-preserved and quantitatively well-defined Middle Cretaceous assemblages, at considerable distance from shore, strongly supports this view. If the continental shelf were submerged through the Middle Cretaceous, the nearest source for these land-derived particles would have been at least 800 km distant.

In conclusion, palynology is held to be a valuable new tool in pre-Pleistocene deep-sea studies.

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Pulsating Radio Sources near the Crab Nebula

Abstract. *Two new pulsating radio sources, designated NP 0527 and NP 0532, were found near the Crab Nebula and could be coincident with it. Both sources are sporadic, and no periodicities are evident. The pulse dispersions indicate that 1.58 ± 0.03 and 1.74 ± 0.02 × 10^{20} electrons per square centimeter lie in the direction of NP 0527 and NP 0532, respectively.*

During a general search for dispersed periodic signals, an unusual pair of pulsating sources was found in the vicinity of the Crab Nebula. They have been tentatively designated NP 0527 and NP 0532, pending more accurate measurements of position. The search was prompted by the discovery of periodic pulsed radio sources by Hewish *et al.* (*1*). The antenna was the 300-foot (90-m) transit telescope of the National Radio Astronomy Observatory (*2*), Green Bank, West Virginia. The receiver monitored the band between 110 and 115 Mhz with 50 channels, each 0.1 Mhz wide. The time constant of the receiver was 0.05 second, and all channels were sampled every 0.6 second. The output was recorded in digital form on magnetic tape.

The sources were observed during normal drift scans on 17, 19, and 21 October 1968. The beam width of the antenna (2.5°) permitted observations for 15 minutes each day. The sources become more evident when displayed in a time-frequency diagram (Fig. 1). A series of four pulses from NP 0532 and a single pulse from NP 0527 are shown; both the linear and second-order terms of the dispersion relation and also some narrow-band interference can be seen.

The apparent variations in pulse duration indicate variations in pulse strength and result primarily from the 50-msec time constant and the threshold method of display. The absence of strong variations with frequency, despite the strong variations with time, is one of the unusual characteristics of these sources, and it suggests that most of the variations may originate in the immediate vicinity of the sources. The illustrated pulses were observed with circular polarization to minimize the effects of Faraday rotation.

The stability of the pulse dispersion