AGE OF EARLY CRETACEOUS PALYNOMORPHS IN THE MUIRKIRK CLAY PIT FOSSIL LOCALITY (PRINCE GEORGES COUNTY, MD)

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U.S. Geological Survey
Open-File Report 91-613

December 1991

INTRODUCTION

The Muirkirk clay pit near Laurel, Maryland, is famous for its vertebrate fauna (Kranz, 1989), but the age of its sediments has never been studied in detail. The site in Prince Georges County is also known for the high manganese content of its bog iron ore (Singewald, 1911). The gray clay in the clay pit was correlated with the gray clay of the Lower Cretaceous Arundel Formation of the Potomac Group (Hack, 1977). Revision of the Potomac Group to Potomac Formation changed the status of the Arundel Formation to Arundel Clay (McGee, 1896; Jordan, 1983). Late Aptian and Early Albian palynomorphs in the Arundel Clay define the top of Pollen Zone I (Doyle and Robbins, 1977).

The microflora of the entire Potomac Formation was first zoned into time stratigraphic units by Brenner (1963). The zones were found to have a time transgressive relationship (Doyle and Robbins, 1977), and the floras of the Potomac Group are older to the south in Maryland and younger to the north in New Jersey. Owens and Gohn (1985) showed that time transgression was the result of tectonic movement which created a major delta system that shifted the depositional basins from south to north. Owens (U.S. Geological Survey, oral commun., 1991) considers that shifting deposition should result in stratigraphic hiatus between each palynomorph zone.

Detailed stratigraphic sections of the site have been published in Clark (1911) and Brenner (1963). In general, the stratigraphic section in the clay pit begins with red clays at the base. These are overlain by gray clay units, some of which encase lignitized stems and trunks of trees, as well as sauropod fossils. The gray clay, in turn, is overlain by a brownish gray clay.

Samples were collected from three gray clay units for the purpose of determining the age of the dinosaur-bearing beds. The samples were subjected to palynological processing, the pollen and spore flora were identified using microscope methods, and photomicrographs were taken for display purposes (Robbins, in prep.). The color of the organic tissues, or kerogen, was noted to assess the former depth of burial of sediments in the clay pit.

MATERIALS AND METHODS

The stratigraphic section in the clay pit was not measured in detail by the author. However, lithologies and their approximate thicknesses were estimated from the bottom of the pit to the top of the hillslope (Table 1).

Three samples were collected from this section and subjected to palynological anlaysis. The two lower samples were collected by Robert E. Weems (U.S.G.S.) and the upper sample was collected by the author. For the purpose of palynological and kerogen analysis, 10 gms of clay was subjected to treatment in HCl and HF to liberate pollen and spores. The acid residues were sieved and mounted in glycerin jelly on standard microscope slides. Data were collected on the content of palynomorphs, color of organic tissues, and presence of pyrite. Photomicrographs were taken to help in identifying taxa.

DATA

All three samples contained a rich microflora (Table 2), which is typical of the Lower Cretaceous rocks of Maryland (Table 2). Age diagnostic taxa were present. The flora differed from the basal to the top samples.

The basal sample (1243), collected from a unit that bears turtle remains, contained Cyathidites minor and Deltoidospora hallii. These taxa are characteristic of a Pollen Zone I age. The middle sample (1244) within the lignite contained abundant Cicatricosisporites aralica and Inaperturopollenites dubius. Abundant C. aralica suggests a Pollen Zone I age for this sample. Pilosisporites brevis, Abietineaepollenites minimus, and Tricolpopollenites crassimurus are also present; their presence is more consistent with an Albian or Pollen Zone IIA age. The upper sample (1245), above the lignitic bed, contained abundant Abietineaepollenites microreticulatus and common Podocarpidites potomacensis, but no age diagnostic taxa.

The samples also contained abundant fungal hyphae and spores, algal cysts in the form of Schizosporis reticulatus, dark yellow thin-walled bisaccate pollen grains, and about 1 percent pyrite crystals. Pyrite took the form of octahedrons enmeshed in the organic tissues and of dispersed framboids. The framboids ranged in size from approximately 4 to 20 um. The enmeshed octahedrons averaged approximately 1 um in length.

INTERPRETATIONS AND DISCUSSION

Gray clays in the Coastal Plain of Maryland are typically correlated with the so-called "Arundel Formation", that contains an upper Pollen Zone I, which is Aptian-Albian in age (Doyle and Robbins, 1977). The taxa in the clay pit samples are consistent with an Upper Zone I age for the basal clay. The middle clay contains some Pollen Zone IIA taxa, which means the upper two clays may be Early Albian in age. A reexamination of new preparations at the top of the section by Brenner (G.J. Brenner, SUNY, oral commun., 1991) indicates a lack of Zone II index pteridophyte spores, suggesting the top of the section is still in Zone I. The single grain of Tricolpopollenites crassimurus may therefore represent an age extension. More samples should be analyzed from the upper clays to remove this age uncertainty.

The palynomorphs in the samples can be used to reconstruct the flora present at the time of deposition of the sediments. The basal clay contained a flora consisting of a diverse mixture of ferns, lycopods, and conifers. Schizaeaceous ferns and taxodiaceous conifers dominated the upper flora. In general, ferns were most plentiful in the basal flora and conifers in the upper flora. Taxodiaceous pollen (Inaperturopollenites dubius) was present in all samples, suggesting that bald cypress-type trees grew in the wetland. Angiosperm pollen was extremely rare. In all, the flora of the Lower Cretaceous at this site consisted primarily of ferns and lycopods, seed ferns, shrubby conifers, and tree conifers.

There is always a problem in trying to determine if the pollen and spores in sediments were indigenous or were transported by wind to the site from outside the local area (Traverse, 1988). The basal and upper clays are not associatied with tree remains that could have formed a closed canopy. Therefore, the flora of these units could be comosed of many extralocal elements which would aid in precise age correlation with other sequences around the world but provide little information about the plants growing there at the time. In contrast, the middle clay, which is composed of a jumble of coalified logs, is underlain by a clay having root casts (table 1). The depositional environment was probably that of a forested wetland. The gray clay substrate of the wetland probably represents deposition in a filled-in oxbow lake (Owens and Gohn, 1985). The canopy of such an environment could have been closed, so that the flora in the unit may have been indigenous. If faster evolution was occurring in taxa outside the wetland, their pollen could have been excluded by the presence of a canopy.

The remains of algae, fungi, and bacteria can be used to understand the microbial component of the depositional environment. The algal spores are thick-walled and distinct. Fungal hyphae, spores, and fungal degradation patterns are present. Micrometer-sized pyrite, considered to be of microbial origin (Altschuler and others, 1983), is not abundant. This suggests that a major sulfate source was not present and that terrestrial deposition is indicated (Williams and Keith, 1962). The pyrite component is composed of two populations, however. The octahedrons enmeshed in the organic tissues could be best analyzed as a result of syndepositional microbial action in the wetland. The larger framboids are more difficult to interpret. One idea is that they may be a post-depositional component added from sulfate-bearing ground water during the Tertiary when the entire region was covered by an ocean (Owens and Gohn, 1985; J.P. Owens, oral commun., 1991).

The color of the thin-walled bisaccate pollen grains can be used to interpret the depth of burial of the sediments (Staplin, 1977). The dark yellow color shows that the sediments have been buried in the past but not deeply.

CONCLUSIONS

1) The palynoflora in Lower Cretaceous samples from the Muirkirk clay pit correlate with Late Aptian-Early Albian taxa in Pollen Zone I; Zone IIA could not be conclusively excluded for the upper samples. More samples need to be studied from the locality to determine the exact age of the dinosaur bearing unit. The analysis from these three samples suggests the unit is of Early Albian age.

2) The organic tissues are dark yellow in color, which suggests the rocks have never been buried deeply in the past.

3) The samples contain two populations of pyrite, octahedrons about 1 um in size, and framboids ranging from 4 to 20 um. The two populations may be the result of two different events, one syndepositional and the other postdepositional.

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Table 1. Approximate stratigraphic section of Muirkirk clay pit, Laurel 7 1/2' Quadrangle. Sample locations are indicated by #.

Top of hill	Estimated Thickness (ft)
10. brownish gray clay, mottled (#1245)	
9. grey clay, some charcoal and iron zones	40
8. log unit, top - dark gray clay with logs having bark; ironstone root casts (#1244)	
middle - dark gray clay with needles and twigs; pyrite	
bottom - dark gray clay with sediment filled roots, non-calcareous; sauropod femur discovered May,1991 (A. Norden, Maryland Dept. Nat. Res., oral commun., 1991)	15
7. rooted underclay	
6. grey clay in ironstone unit	
------------------unconformity-----	
5. orange sand with gray clay balls	
4. darker gray clay with twigs	25
3. 6" gray clay having turtle scutes (#1243)	
2. mottled red clay	30
1. red clay	
Floor of pit	

Table 2. Taxa in clay samples from the Muirkirk site and their botanical affinity (from Brenner, 1963, and Traverse, 1988). See text for details on age determination and zonal definitions.

Taxon	Sample Number 1243	1244	1245	Affinity
Cirratriradites spinulosus	x	-	-	*Selaginella*-type
Cyathidites minor	x	-	-	Dicksoniaceae fern
Deltoidospora hallii	x	-	-	Dicksoniaceae fern
Ischyosporites crateris	x	-	-	Schizaeaceae fern
Lycopodiacidites cristatus	?	-	-	lycopsid
Sulcatisporites sp.	x	-	-	pteridosperm (seed fern)
Vitreisporites pallidus	x	-	-	Caytoniales
Cicatricosisporites hallei	x	x	-	Schizaeaceae fern
Concavissimisporites punctatus	x	x	-	not known
Araucariacites sp.	x	x	-	conifer
Perinopollenites elatoides	x	x	-	conifer (Taxodiaceae)
Parvisaccites radiatus	x	x	-	cf. *Dachrydium*
Platysaccus megasaccus	x	x	-	Corystospermaceae
Apiculatisporis asymmetricus	x	x	x	fern
Cicatricosisporites aralica	x	A	x	Schizaeaceae fern
Concavissimisporites variverrucatus	x	-	x	not known
Densoisporites microrugulatus	x	x	x	lycopsid
Inaperturopollenites dubius	x	A	x	conifer (Taxodiaceae)
Abietineaepollenites sp.	x	C	x	conifer
Cingulatisporites distaverrucosus	-	x	-	not known
Pilosporites brevipapillosus	-	x	-	not known
Cingulatisporites distaverrucosus	-	x	-	not known
Entylissa nitidus	-	x	-	Gingko/Cycad
Abietineaepollenites minimus	-	x	-	conifer
Podocarpidites potomacensis	-	x	C	conifier or cordaite
Tricolpopollenites crassimurus	-	x	-	angiosperm
Schizosporis reticulatus	-	x	-	alga
Laricoidites magnus	-	?	?	conifer
Classopollis torosus	-	A	x	conifer
Abietineaepollenites microreticulatus	-	x	A	conifer
Aliporites cf. *bilateralis*	-	x	x	pteridosperm or conifer
Pinuspollenites spherisaccus	-	x	x	conifer
Appendicisporites potomacensis	-	-	x	Schizaeaceae fern
Cicatricosisporites australiensis	-	-	x	Schizaeaceae fern
Cingulatisporites sp.	-	-	x	not known
Foveotriletes subtriangularis	-	-	x	not known
Parvisaccites amplus	-	-	x	cf. *Dacrydium*

Abbreviations: A=abundant, C=common, x=present, -=absent