GY 402 Sedimentary Petrology
Moscow Landing Reference Search
(University Library Assignment)

Preamble: Moscow Landing will be the capstone project in this class. You will be responsible for all aspects of the assignment. You will need to conduct correct field examination of the outcrop, produce a correlated multiple section cross-section and an accompanying report detailing the stratigraphy, sedimentology and at least one geological component that is unique to your study. More on this as the semester progresses. Before you can even get started, you need to know as much background information as possible. Hence today’s assignment.

Your Task and the Rules: Using USA Library resources (including electronic indices), compile a list of at least 5 refereed publications that provide useful background information concerning the Moscow Landing site. I will give you all one additional paper on Moscow Landing stratigraphy by Charlie Smith (see attached file), you find 5 others that are relevant to your research interests. No more than 2 of the 5 can be abstracts (e.g., presentations that were made at conferences). Send this to the GSSA on organization letterhead or if you prefer, add a GSSA coverletter to the page with your 5 references.

Note: Do NOT resort to Google searches to do this assignment. Refereed publications are those that have appeared in legitimate publications. They have been reviewed by geologists. Unless the online publication is associated with a journal (that’s what the Library searches look for), it must be considered non-refereed and as such, is not acceptable as a reference in this (or any other) assignment.

One last thing, in the past I’ve had students work together on this assignment. That is okay, But, turning in an identical list of references is not. If you work together, then find 4 different references each. If I see people with near identical lists (e.g. 3 or more of the same references), your grades for the assignment will be greatly diminished.

I will provide you with help to get started on this assignment. That includes helping you to do electronic searches on the USA Library website and (if necessary), showing you how to use the USA Library. In addition, USA Librarians have offered to show you how to get around their building. Even if you think you know how to use the library, I recommend that you take the tour.

Due Date: See the web site for due dates

Search Strings: When searching for electronic publications, it is helpful to know which terms are most relevant to your study site. Here are a few to search for:

- Moscow Landing
- Prairie Bluff Formation
- David King (Author)
- K-T Boundary
- Porters Creek Formation
- Tsunamiite
- Selma Chalk
- Clayton Sand
- Chixulub
- Extinction of the Dinosaurs

Reference Style: Use a suitable reference style for GY (e.g., Author, date, title, source, pages) See examples below.

Book:


Journal Article:

THE CRETACEOUS-TERTIARY BOUNDARY AT
MOSCOW LANDING, WEST-CENTRAL ALABAMA

GEOLOGICAL SURVEY OF ALABAMA

REPRINT SERIES 112
GEOLOGICAL SURVEY OF ALABAMA

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REPRINT SERIES 112

THE CRETACEOUS-TERTIARY BOUNDARY AT MOSCOW LANDING,
WEST-CENTRAL ALABAMA

By

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The Cretaceous-Tertiary Boundary at Moscow Landing, West-Central Alabama

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ABSTRACT

Cretaceous-Tertiary boundary exposures at Moscow Landing in west-central Alabama represent the most geologically intriguing contact between Mesozoic and Cenozoic strata within the southeastern United States. At this site, about 7 m of bioturbated chalky limestone assignable to the Upper Cretaceous Prairie Bluff Chalk are exposed. The upper surface of the Prairie Bluff is marked by abundant burrows filled with marl from the overlying Paleocene Clayton Formation. Discontinuous, crescentic-shaped wedges of basal Clayton coarse quartzose sand mark channels up to 2.6 m deep scoured into the upper Prairie Bluff surface. About 2 m of interbedded marl and sandy limestone of the upper Clayton conformably overlie the truncated basal Clayton channel fills and adjacent burrowed Prairie Bluff surface.

Paleontological investigations indicate that the uppermost Prairie Bluff Chalk is assignable to the planktonic foraminiferal Racinematubulina fructicosoid Zone and to the nanofossil Nephrolithus frequens Zone (CC26) of late middle Maastrichtian age. The overlying Clayton Formation is assignable to the planktonic foraminiferal Morozovella pseudobulloides Zone (Zone P1b) and to the Cruciplacolithus tenuis Zone (NP2) of middle early Paleocene age. Microfossil biostratigraphy, the truncation of high-angle normal faults at the Prairie Bluff-Clayton contact, and the burrowed and channelled upper Prairie Bluff surface all document nondeposition or erosional removal of late Maastrichtian and early Danian sediments along the conformable Prairie Bluff-Clayton contact at Moscow Landing.

INTRODUCTION

Within the Gulf and Atlantic Coastal Plain areas, no stage boundary has received quite as much attention as the contact between the Maastrichtian and Danian. Understanding the nature of the boundary is critical in reconstructing geologic history, in the interpretation of the event(s) responsible for the physical and biological changes documented at the boundary, and in local, regional, and indeed, world-wide correlation of the boundary and adjacent sediments.

The Cretaceous-Tertiary boundary exposures at Moscow Landing offer a unique opportunity to study this contact. These spectacular exposures represent the most laterally extensive and geologically intriguing contact between the Mesozoic and Cenozoic within the southeastern United States. The gentle dip and resulting extensive horizontal length of the exposed units, the 25 m of vertical

Figure 1. Map of a portion of southeastern Sumter County, Alabama, showing the location of the Moscow Landing exposures.
exposure in the steep bluffs, the faulted and gently folded beds, and the fresh unweathered sediments containing a wealth of megafossils and microfossils are unequalled by any other known Gulf or Atlantic Coastal Plain boundary exposure.

Although many geologists have visited this site, confusion exists regarding the geological components that make up the section, their physical nature and relationship to one another, and perhaps most importantly, the age and age relationships of the observed components. This discussion is intended to provide a summary of observations and a geological scenario which will hopefully resolve much of this confusion.

**LOCATION**

The series of Cretaceous-Tertiary boundary exposures at Moscow Landing is located along the western and northwestern bank of the Tombigbee River extending from the now demolished old U.S. Highway 80 bridge (Rooster Bridge; see Smith, 1989, p. 38) about 1.6 km southward to the confluence of the Sacaronochee River (Fig. 1). This site is about 4.5 km by air southwest of the new U.S. Highway 80 bridge and is located in sections 24 and 25, Township 17 North, Range 1 West, Coatopa 7.5-minute quadrangle, Sumter County, west-central Alabama.

**STRATIGRAPHY**

**Prairie Bluff Chalk**

The lowermost unit exposed at Moscow Landing is the Prairie Bluff Chalk. This chalky unit represents the uppermost formation in the Cretaceous System in central and western Alabama and eastern Mississippi and is unconformably overlain by basal Tertiary strata assigned to the Clayton Formation. At its type locality in Wilcox County, Alabama, the Prairie Bluff Chalk is about 3.5 m thick, although at other sites in Wilcox County, as well as in northern Marengo County toward the west and in southern Dallas County toward the east, the unit is locally absent due to post-Cretaceous erosion. At these sites, Tertiary Clayton strata rest unconformably on marly sands and sandstones of the underlying Ripley Formation.

At Moscow Landing, the Prairie Bluff consist of about 7 m of chalky marl (Fig. 2). This unit is white to light-gray, massive bedded, burrowed and bioturbated, somewhat indurated and brittle, very slightly and finely phosphatic and mascovitic, slightly quartzose silty to very fine quartzose sandy, sparsely megafossiliferous, and abundantly microfossiliferous. The upper surface of the Prairie Bluff Chalk is marked by abundant *Thalassinites* burrows 1.5 to 2.0 cm in diameter which extend downward as far as 0.8 m into the underlying chalky marl. These burrows are filled with early Tertiary olive-gray marl and contrast strikingly with the surrounding white chalk. A thin and discontinuous horizon of *Cliona* sponge-bored, calcitic, or partially phosphatized shells of *Exogyra costata* Say occurs about 1.7 m below the top of the Prairie Bluff. A far more distinctive and continuous thin zone of water-worn, abraded and fragmented, predominantly phosphatized internal molds of mollusks occurs in the upper Prairie Bluff exposures about 1 m below the top of the unit (Figs. 2, 3a). More than 45 taxa have been identified from this thin horizon, including *Pycnodonte vesiculata* Lamarck, *Exogyra costata* Say, *Pterotragnia* spp., *Protocardiida* spp., *Turritella* spp., *Gyroides* spp., *Baculites* spp., and *Discocapitites* spp., among many others (Sohl and Koch, 1983). This fauna is assigned to the *Haustrator bilata* Assemblage Zone of Sohl (1977) and has been traced in Upper Cretaceous sediments extending from New Jersey through Texas (Sohl and Smith, 1980).

Prairie Bluff sediments both below and within the upper phosphatic macrofossil horizon contain an abundant, diverse, and well-preserved planktonic foraminiferal fauna consisting of more than 30 taxa. Included are abundant *Guembelitria cretae* Cushman, *Heterohelix navaroensis* Loeblich, *Planoglobulina carseya* (Plummer), *Pseudotextularia deformis* (Kioike), *Racemigumbelina powelli* Smith and Pessagno, *Globigerinelloides praehilleanus* Pessagno, *Globotruncanella aegyptiaca* Nakkady, G. arca (Cushman), G. dwi Nakkady, *Gansserina gansseri* (Bolli), *Rugoglobigerina hexacamerata* Brönnimann, *Rugoglobigerina rugosa* (Plummer), and *Globotruncanella petaloides* (Gardoll), among many others (Mancini, Tew, and Smith, 1989). This fauna is assignable to the early middle Maastrichtian *Globotruncanella aegyptiaca* Zone of Smith and Pessagno (1973) and is equivalent to the lower unzoned portion of the *Gansserina gansseri* Zone of Caron (1985).

The uppermost approximately 1 m of Prairie Bluff Chalk, extending from the top of the phosphatic macrofossil zone to the overlying Clayton Formation (Figs. 2, 3a), contains a similarly rich planktonic fauna that includes additional taxa such as *Planoglobulina brazoensis* Martin, *Pseudoguembelina cornuta* Seigle, *Racemigumbelina fructicosa* (Egger), *Globigerinelloides rosebudenensis* Smith and Pessagno, *Globotruncanina conica* (White), and *Rotula contusa* (Cushman) (Mancini, Tew, and Smith, 1989). This fauna is readily assignable to the late middle Maastrichtian *Racemigumbelina fructicosa* Zone of Smith and Pessagno (1973) and is equal to the upper unzoned part of the *Gansserina gansseri* Zone of Caron (1985). Based on these data, late Maastrichtian sediments are not present in the uppermost Prairie Bluff at the Moscow Landing exposures.

Unfortunately, debate and disagreement continues as to the biostratigraphic assignment of the upper Prairie Bluff fauna, thus having significance in its chronostratigraphic placement within the Maastrichtian and related discussions regarding the nature of this and many other Cretaceous-Tertiary boundary exposures. Most debate centers around the taxon *Abathomphalus mayaroensis* (Bolli), the name bearer for the *A. mayaroensis* Zone. Most authors agree that the *A. mayaroensis* Zone, defined by the total range of the taxon, defines latest Maastrichtian sediments. This species has never
been reported from the Moscow Landing site, nor from any uppermost Cretaceous sediments in Alabama. Furthermore, this species has never been reported in outcrop anywhere within the Gulf and Atlantic Coastal Plain area (exclusive of Mexico). Most agree that its absence in otherwise richly fossiliferous marine sediments is indicative of older, pre-<i>A. mayaroensis</i> sediments. Others suggest that environmental influences, such as water temperature, turbidity, depth of the water column, salinity, or other arcane effects, must have resulted in the exclusion of <i>A. mayaroensis</i> from the fauna.

Several authors have suggested that the uppermost Prairie Bluff fauna which have direct bearing on its zonal assignment have either been overlooked or blatantly ignored. First, a number of species occur in the uppermost Prairie Bluff which are not known to occur in the Abathomphalus mayaroensis Zone. These include <i>Heteroherelix glabratus</i> (Cushman), <i>Globigerinelloides prairehilliensis</i> Pessagno, <i>Globotruncanina plummerae</i> Gandolfi, and <i>Globotruncanina stephensoni</i> Pessagno. Secondly, <i>Gansserina gansseri</i>, abundant in the uppermost Prairie Bluff, is known to occur only in the middle Maastrichtian <i>G. gansseri</i> Zone and very basal part of the overlying late Maastrichtian <i>A. mayaroensis</i> Zone (Caron, 1985). Its presence is definitive evidence that the Prairie Bluff cannot be of latest Maastrichtian age. Thirdly, the Prairie Bluff faunas do not contain <i>Pseudoxestuarina intermedia</i> de Klasz, <i>Abathomphalus intermedius</i> (Boldi), nor <i>A. mayaroensis</i> which are diagnostic of the late Maastrichtian <i>A. mayaroensis</i> Zone. Lastly, several of the species recorded from the uppermost Prairie Bluff are morphologically immature when compared with individuals from known <i>A. mayaroensis</i> Zone faunas (Smith and Poore, 1984). For example, <i>Racemiguembelina fructicosa</i>, although present, is represented only by morphotypes transitional in the <i>Racemiguembelina powelli-R. fructicosa</i> lineage (Smith and Pessagno, 1973). No advanced <i>R. fructicosa</i>, those having 24 to 30 or more chambers in the multiserial portion of the test, are known from the Prairie Bluff Chalk at Moscow Landing. <i>Rosita contusa</i> (Cushman) is another taxon which occurs in both middle and late Maastrichtian sediments (Pessagno, 1967; Caron, 1985). Advanced morphotypes from the <i>A. mayaroensis</i> Zone are much more strongly spherocurved, have far more intensely plicate chambers, and a more profound undulatory polygonal outline than their earlier predecessors from the <i>G. gansseri</i> Zone. None of these advanced forms of <i>R. contusa</i> are found in Prairie Bluff beds. Yet another example is found in <i>Globotruncanita conica</i> (White). This middle and late Maastrichtian species becomes progressively more spherocurved in younger beds, thus its more biconvex forms are indicative of middle Maastrichtian sediments.

Many uppermost Prairie Bluff exposures in Mississippi and Alabama, including those at Moscow Landing, contain the calcareous nanofossil <i>Nephrolithus frequens</i> Gorka, a taxon whose total range defines the nanofossil highest Maastrichtian <i>Nephrolithus frequens</i> Zone (Zone CC26). Although many workers relate the nanofossil <i>N. frequens</i> Zone to the planktonic foraminiferal
Abathomphalus mayaroensis Zone since both represent uppermost Maastrichtian zones, Smith (1975) documented the range of N. frequens from the upper part of the Gansserina gansseri Zone (late middle Maastrichtian) through the A. mayaroensis Zone (late Maastrichtian). The occurrence of this taxon in Prairie Bluff or other sediments, thus, cannot be used as proof for sediments of late or latest Maastrichtian age.

The faunal and floral evidence seems abundantly clear: the uppermost Prairie Bluff Chalk at Moscow Landing is assignable to the upper portion of the Gansserina gansseri Zone and thus can be no younger than late middle Maastrichtian age. Sediments representing the time interval defined by the A. mayaroensis Zone were either never deposited or erodedly removed, resulting in a significant, well defined, and unambiguous unconformity between the Prairie Bluff and overlying Clayton sediments.

Clayton Formation

Channel Fill Sand

Discontinuously exposed along the Moscow Landing outcrop are lenticular- to crescentic-shaped wedges of coarse quartzose sand and granular gravel restricted to broad channels on the upper Prairie Bluff surface (Figs. 2, 3b). These sands, which have a maximum observed thickness of 2.6 m, are ferruginous-stained shades of yellowish to orange-brown and consist of thin bedded to massive or cross-bedded, firm yet friable, poorly sorted, argillaceous, medium to coarse quartzose sand and granular quartzose gravel containing common reworked Cretaceous microfossils, Euxyrca costata and other reworked Cretaceous megafossils, shark teeth, and phosphate pebbles. Although rare, the distinctive guide fossil Ostrea pulakensis Harris is present in these sands. This species occurs throughout the Gulf Coast where it is restricted to sediments of early Paleocene age (Toulmin, 1977), thus establishing an early Paleocene, Danian age for emplacement of the sands. In association with the abundant reworked Upper Cretaceous microfossil taxa, the presence of the planktonic foraminifera Globorotalia daubjergensis (Brönnimann), Morozovella pseudobulloides (Plummer), and Globigerina triloculinoidea Plummer indicate these sands are assignable to the Morozovella pseudobulloides Interval Zone (Zone 1P1b) of middle early Paleocene, early Danian, age (Mancini, Tew, and Smith, 1989).

No species characteristic of the earliest Danian Globigerina eugubina Zone are known from these coarse channel-fill sands. Thus, the hiatus marked by the unconformity between the Prairie Bluff Chalk and the Clayton channel-fill sand encompasses the interval from early or late middle Maastrichtian to middle early Paleocene time, a period of perhaps as much as 3 to 3.5 my duration.

Many of the channel fill sand wedges also contain irregularly shaped chalk clasts and rounded pebbles, cobbles, and boulders of reworked chalk, the largest measuring one meter in diameter (Fig. 3c). Chalk blocks are especially common in the lower parts of many of the sand bodies. These blocks are interpreted as boulders of Prairie Bluff Chalk that were ripped from the bottom or sides of the channel depressions during emplacement of the channel fill sand and incorporated into the sand bodies. This implies an extraordinarily high energy regime and accumulation of the channel fill in a very short period of time. However, other channel fill sands are distinctly thick bedded and contain thin horizontal box-work systems of the burrow Thalassinoides suercias (Savrda, 1991). The bedding and burrowing characteristics suggest short periods of relative quiescence in an overall high energy regime. The large Prairie Bluff clasts may have been emplaced during early-stage high-energy scour of the channel floor or caving from undercut portions of the channel walls, with later more quiescent deposition of the bedded and burrowed sand. These sand bodies are further intriguing in that most appear to represent sedimentation in faulted depressions.

Faulting of the Moscow Landing exposures was noted by Smith and Johnson (1887), with sketches of the exposures and observations that in rare instances the sand bodies were cut by the faults. Brett and Jones (1967) suggested that the local sandstone masses resting at the top of the Prairie Bluff represented accumulation of sand in faulted depressions in the chalk. More intensive study of the faulting at Moscow Landing was conducted by Self (1975, 1976) who documented at least two stages of structural deformation. The oldest series of faults, often characterized by zones of plastic flow (Fig. 3b), formed prior to lithification of the Prairie Bluff, are truncated by the Cretaceous-Lower Tertiary contact, and thus displace only the Prairie Bluff Chalk. It is this stage of faulting, which must have occurred shortly after deposition of the chalk, that largely controls the occurrence and distribution of the early Paleocene channel fill sands. A younger series of faults characterized by slickensided calcite-filled fractures in the Prairie Bluff and overlying Clayton Formation and producing fault planes lined with limonite or selenite in the overlying Porters Creek Formation, frequently result in horsts and grabens, displace all exposed units at Moscow Landing, and thus must be of post-Porters Creek (late Danian) age.

Although exceptions exist, the southern or downstream end of each sand body is generally bounded by the upthrown block of a normal fault. The channel fill sands are invariably thickest adjacent to the fault plane. As they are traced northward, or upstream, the sands thin and eventually pinch out at the Prairie Bluff-Clayton contact. In all cases, the upper surfaces of the sand bodies are eroded, beveled, and Thalassinoides-burrowed (Savrda, 1991), and do not rise appreciably above the “normal” burrowed Prairie Bluff-Clayton contact adjacent to the sands. It is believed that the faulted depressions in the upper Prairie Bluff surface served, at least in part, as conduits for high-energy coarse clastic deposition of the basal Clayton sands during early Paleocene sea level rise.

Sandy Marl

Sediments overlying the coarse channel fill sands consist of as much as 0.5 m of medium-gray to medium-greenish-gray, massive bedded, sparingly muscovite, phosphatic and glauconitic, fossiliferous, very fine to fine quartzose sandy marl containing abundant quartz and phosphate granules and pebbles and abundant reworked Cretaceous macrofossils. This bed, which is interpreted as a transgressive lag deposit, disconformably overlies the channel fill sands and extends laterally to disconformably rest upon the buried upper surface of the Prairie Bluff Chalk (Fig. 3a). This marl contains common Ostrea pulakensis and rare individuals of the nautiloid Hercoglossa ulrichi, and a common to abundant microfauna assignable to the middle early Paleocene, early Danian, M. pseudobulloides Interval Zone, and thus lies within the same biostratigraphic interval as the underlying high-energy channel fill sands.

Sandy Limestone and Marl

The most persistent and uniform beds to occur along the Moscow Landing boundary exposures are a series of two thin somewhat indurated sandy limestone beds separated by a thin intervening marl (Figs. 2, 3a). The two limestone beds are more resistive than the underlying sandy marl or overlying clays of the Porters Creek Formation and thus form distinctive ledges that can be traced laterally along the exposure. The lower sandy limestone varies in thickness from 13 to 33 cm and consists of light-olive-gray, massive, indurated, burrowed and bioturbated, medium to coarse quartzose sandy limestone containing abundant medium- to coarse-sand sized black phosphatic grains, amber-colored fecal pellets, and dark-green glauconite. This lower sandy limestone is further distinguished by being literally packed with the small shells of Ostrea pulakensis (Fig. 4). Although dominated by reworked Cretaceous microfossil taxa, this lower indurated bed contains rare Globorotalia daubjaergensis, Morozovella pseudobulloides, and Globigerina triloculinoidea.
noides, and like the underlying coarse channel fill sands and transgressive sandy marls, is assignable to the Morozovella pseudobulloides Interval Zone of middle early Paleocene age.

The lower indurated sandy limestone bed is conformably overlain by a thin, fine quartzose sandy marl about 20 cm in thickness. This marl is predominantly dark-greenish-gray, massive, burrowed and bioturbated, fossiforous, very fine to fine quartzose sandy, and contains abundant fine dark-green glauconite and black phosphatic grains. Like the underlying more indurated limestone bed, this thin marl contains similarly large numbers of Ostrea pulaskensis and a common to abundant microfauna assignable to the middle early Paleocene M. pseudobulloides Interval Zone.

The upper indurated sandy limestone bed of the Clayton Formation is usually 25 to 28 cm in thickness and is lithologically similar to the lower limestone bed. It typically contains 20 to 25 percent very fine to fine quartzose sand, perhaps 8 to 10 percent fine dark-green glauconite, and an abundance of Ostrea pulaskensis. Microfossils recovered from this bed include the same taxa as the underlying Clayton sediments in addition to the distinctive species Morozovella inconstans (Subbotina) and Morozovella trinitidens (Bolli) and is thus indicative of the Morozovella trinitidens Interval Zone (Zone P1e) of late early Paleocene, middle Danian, age (Mancini, Tew, and Smith, 1989).

**Porters Creek Formation**

The upper indurated sandy limestone bed of the upper Clayton Formation is conformably overlain by lower beds of the Porters Creek Formation. In the Moscow Landing area, the Porters Creek exceeds 15 m in total thickness. The lower 5 m of the unit consists of dark-gray, blocky-fracturing, calcareous and fossiforous silty clay containing an abundant microfauna assignable to the Morozovella trinitidens Interval Zone. A quartzose sandy and glauconitic marl about 45 cm in thickness and containing small phosphatic nodules and granular quartz gravel disconformably overlies the lower calcareous clays. This marl is overlain by about 60 cm of calcareous clay, which is in turn conformably overlain by a fossiforous limestone bed about 30 cm in thickness. Overlying Porters Creek clays become progressively less and less calcareous and fissiforous, such that about 5 m above the thin fissiforous limestone, the blocky clays become olive-black to black, noncalcareous, carbonaceous, and contain only small arenaceous foraminifera.

Porters Creek sediments immediately below the limestone bed and continuing through the Porters Creek to near the top of the exposure contain abundant microscopics, or microscelers, of the demosponge Geodia Lamarck, 1815. Although their significance is unknown, the presence of these small 180 to 200 micron diameter spherical spherasters is important in that it represents their only known occurrence in Mesozoic or Cenozoic strata of either the Gulf or Atlantic Coastal Plain areas of North America (Rigby and Smith, 1992).

**SEQUENCE STRATIGRAPHY**

Interpretations of the sequence stratigraphy at Moscow Landing have been presented by Mancini, Tew, and Smith (1989) and Mancini and Tew (1993a, b). The following discussion is based largely on these earlier studies with slight modification or reinterpretation resulting from the current investigation.

Within central and western Alabama and eastern Mississippi, the Prairie Bluff Chalk represents part of a Type 1 unconformity-bounded depositional sequence (Fig. 4). The Prairie Bluff depositional sequence consists of sandy fossiforous chalks in the lower Prairie Bluff interpreted as transgressive systems tract deposits. Lower Prairie Bluff beds at Moscow Landing, that is, those chalks below the phosphatic macrofossil horizon (Figs. 2, 3a), are assignable to the upper part of this transgressive systems tract. The phosphatic macrofossil horizon located about 1 m below the top of the Prairie Bluff and consisting of burrowed glauconitic chalk containing water-worn and often phosphatized, chlino-bored and serpulid-encrusted mollusks and phosphate pebbles, indicative of long exposure on the sea floor and low sedimentation rates, is representative of the condensed section. This macrofossil horizon represents the surface of maximum sediment starvation, or point of maximum transgression within the Prairie Bluff depositional sequence. Overlying upper Prairie Bluff chalks at Moscow Landing, extending from the macrofossil horizon to the Prairie Bluff-Clayton contact and assignable to the Racemiguembelina fruticosa Zonale (Fig. 4), represent the highstand regressive systems tract. No evidence for a decrease in water depth is evident, but rather the richly microfossil-
iferous chalks are interpreted to represent a continuation of slow rates of sediment accumulation.

The Clayton Formation and lower portions of the overlying Porters Creek Formation also represent a Type 1 unconformity-
bounded depositional sequence (Fig. 4), designated the TAGC-1.1
(Texas A; Gulf Coast) sequence by Mancini and Tew (1993b). Where
present, the basal Clayton channel fill sands (Figs. 3b, c) represent
early Paleocene deposition in topography developed in the underly-
ing Prairie Bluff chalk during sea-level fall. The channel fill sands
are sharply overlain by lower Clayton marl (Fig. 2) containing abun-
dant quartz and phosphate granules and pebbles interpreted as a
transgressive lag deposit associated with sea-level rise during the
early Paleocene. Where channel fill sands are present, the sharp yet
burrowed contact between the sand and overlying phosphatic marl
represents the transgressive surface of the depositional sequence
(Fig. 4). Where the sands are absent, the transgressive surface
merges with the lower unconformity of the sequence. In this case,
the early Paleocene phosphatic marl rests disconformably on the
upper burrowed surface of the middle Maastrichtian Prairie Bluff
Chalk (Fig. 3a). The lower Clayton marl, which represents the lower
transgressive systems tract, is overlain by the upper Clayton sandy
limestone and marl, representing the upper transgressive systems
tract and condensed section (Fig. 4). The highstand regressive sys-
tems tract is made up of the overlying 5 m of calcareous and fossil-
iferous clays in the lower part of the Porters Creek Formation.

The middle Porters Creek quartzose sandy and glauconitic marl
containing phosphatic granules and pebbles disconformably over-
lying the lower Porters Creek calcareous clays (Figs. 2, 4) represents
the transgressive systems tract of the overlying Type 2 depositional
sequence, designated the TAGC-1.2 sequence by Mancini and Tew
(1993b). The overlying 60 cm of calcareous clay lie within the upper
part of this transgressive system. The thin fossiliferous limestone in
the upper part of the Moscow Landing exposures represents the con-
densed section, and the overlying calcareous and fossiliferous clays
are assigned to the lower highstand regressive systems tract.
Noncalcareous and carbonaceous Porters Creek clays at the top of
the upper exposure represent the upper part of this highstand regressive
systems tract.

CONCLUSIONS

This study has documented the physical and biological stratig-
raphy of the Cretaceous-Tertiary boundary exposures at Moscow
Landing along the Tombigbee River in Sumter County, Alabama.
The geological scenario presented for the observations will hopefully
resolve existing debate and confusion regarding the relationships
at this important Cretaceous-Tertiary boundary exposure.

Most contentious debate involves the nature of the bound-
ary itself. That is, whether the boundary is conformable and thus
represents a continuum of events, or whether the contact is discon-
formable with either Late Cretaceous and/or early Tertiary time
unrepresented in the geological record. Based on regional stratig-
graphic relationships, local sedimentology, physical lithostratig-
raphy, structural geology, biostratigraphy, age relationships of beds,
and sequence stratigraphic interpretation, the Cretaceous-Tertiary
contact at Moscow Landing is unequivocally disconformable with
an associated hiatus which may encompass as much as 3 to 3.5 my
duration. Evidence for this conclusion includes:

1. The absence of the Prairie Bluff Chalk at many boundary expo-
sures east of Moscow Landing in which the Clayton Formation
disconformably rests upon the much older Ripley Formation;

2. A sharp change in lithology from uppermost Prairie Bluff
open-marine chalks (nannofossil oozes) to lower Clayton shal-
low-neritic phosphatic and glauconitic sandy marl;

3. The presence of a lower Clayton phosphatic lag containing
reworked and often glauconitized Prairie Bluff Chalk clasts,
phosphatic Prairie Bluff megafossils, and reworked microfoss-
ils;

4. Burrowing of the upper Prairie Bluff surface with burrow fills
consisting of lower Clayton sandy marl;

5. Scour and incision of the upper Prairie Bluff surface with chan-
nel fill of high-energy coarse quartzose basal Clayton sands
containing rip-up clasts from the underlying chalk;

6. The presence of high-angle normal faults abruptly truncated at
the Cretaceous-Tertiary contact;

7. Assignment of the uppermost Prairie Bluff Chalk to the plank-
tonic foraminiferal Racosphaerestellina fruticosa Zonule of
late middle Maastrichtian age, while the overlying basal
Clayton sand or lower Clayton sandy marl is of early (but not
earliest) Danian age;

8. The absence of late Maastrichtian and earliest Danian plank-
tonic foraminiferal index taxa as well as the absence of
advance morphotypes of many middle and late Maastrichtian
taxa confirm that late Maastrichtian and earliest Danian strata
are unrepresented at Moscow Landing;

9. Lack of scientific evidence for the exclusion of foraminifera
due to anything other than nondeposition and/or erosional
removal along the contact unconformity; and

10. Calcareous nannofossil biostratigraphy that indicates that the
middle and upper parts of the late Maastrichtian Nephrolithus
frequens Zone (Zone CC26) as well as the earliest Paleocene
Markalius inversus Zone (Zone NP1) are not represented in the
boundary sediments.

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