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A palynological investigation of the offshore Cretaceous sequence on the south-west coast of South Africa

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CHAPTER 7

ASSEMBLAGE STRUCTURE AND PALAEOENVIRONMENT

7.1 INTRODUCTION

Tracing the changing composition and distribution of the palaeoflora through time allows one to draw some conclusions about the environmental conditions and major evolutionary events. The discussion below is a summary of data described in Chapters 4 – 6, while an overview and correlation between the boreholes studied are presented in Chapter 8.

7.2 THE PALAEOENVIRONMENT OF OFFSHORE SITE C-B1

7.2.1 THE PALAEOENVIRONMENT OF THE VERY EARLY RIFT PHASE OF SUBZONE CI - A

- **DEPOSITIONAL ENVIRONMENT:**

  The presence of only land-derived miospores suggests that this zone accumulated during the early rift stages free from marine influence. This subzone is dominated by a thick sequence of claystone and accumulation possibly occurred in the littoral regions (See Chapter 5).

- **SEA LEVEL:**

  Even though a narrow sheltered seaway separated Africa from South America at this time, sea levels were high during the Barremian Stage (Haq *et al*., 1987).

- **DOMINANT FLORA:**

  The Cretaceous vegetation of this zone is well represented by communities that include woodlands of cheirolepidacean conifers (*Classopollis*) that hugged the coastline (Srivastava, 1976 &1978) and higher altitude forests of podocarps (*Zonalapollenites*, *Excessipollenites* and *Blameiopsis*). In both the woodland and forested situations, ferns and mosses probably dominated the ground cover and thrived around river and lake

systems. Columellate semi-tectate pollen typical of flowering plants appears for the first time in the palynofloras of this zone.

Regionalism is evident within both overstorey (high altitude forests) and understorey (woodlands of Cheirolepiaceae, ferns and mosses) vegetation and this is believed to be influenced primarily by climate (Dettmann *et al.*, 1992).

- **FLORA AS CLIMATIC INDICATORS:**

  Classopollis is very abundant in this zone with new *Ephedripites* species just starting to appear. Schrank & Mahmoud (1998) concluded that the appearance of *Ephedripites* and *Classopollis* in their Neocomian – Early Barremian aged assemblages were as xerophytic elements that suggested a climatic shift towards drier conditions. The presence of *Balmeiopsis* is believed to be a warm climate indicator (Kedves, 1986). Fern and moss species are fairly abundant in this zone and may have been confined to the moist, warm habitats near rivers and lakes during the early rift phase (Schrank, 1987). Aboul Ela & Mabrouk (1978) suggested that the presence of *Cyathedites* is an indication that the climate was warm. Sultan's (1986) Neocomian assemblage is very similar to that found in Subzone CI - A i.e. an abundance of gymnosperms, some species diversity in pteridophytic spores, and the complete absence of bisaccate and trisaccate conifer pollens. He suggested that either the prevailing environment was hot and semi-arid or this Neocomian assemblage was reflecting the start of a climatic shift towards drier conditions.

- **PREVAILING PALAEOENVIRONMENT:**

  The environment that prevailed during the accumulation of Subzone CI - A was probably warm and humid as a result of the influence of warm coastal areas and transgressive seas. The forested higher latitudes were cool, moist and temperate.

7.2.2 THE PALAEOENVIRONMENT OF THE EARLY TO LATE RIFT PHASE OF SUBZONE CI - B

- **DEPOSITIONAL ENVIRONMENT:**

  The combination of land derived miospores and scattered occurrences of marine microfossils, strongly suggests that the Early Cretaceous of this part of the South Atlantic, early to late rift region, represents a marginal marine facies, that probably accumulated in the littoral to inner neritic zones (See Chapter 5).

- **SEA LEVEL:**

  Subzone CI - B represents the close of the Barremian to start of the Aptian Stage. Transgressive seas continued to remain high in the seaway separating Africa from South America (Haq *et al*., 1987).

- **DOMINANT FLORA:**

  Woodlands of cheirolepidacean conifers flourished and the high latitude forests now included *Podocarpidites* and *Microcachryidites* (bi- and trisaccate pollen). Terrestrial ferns and mosses become far more abundant and diverse in composition. Most of the ferns represent extant families of Dicksoniaceae, Gleicheniaceae and Schizeaceae. These ferns probably formed extensive ground covers in the wooded regions.

- **FLORA AS CLIMATIC INDICATORS:**

  Classopollis pollen peaks in this subzone and reflects a species that flourishes in warm coastal areas with transgressive seas (Srivastava, 1976 & 1978). Sultan (1986) found the persistent occurrences of *Classopollis* pollen in his assemblages (Neocomian, Barremian and Aptian stages) suggested drier climatic conditions. From this he concluded that the occurrence of gymnospermous pollen such as *Inaperturopollenites* (*Zonalapollenites* and *Balmeiopsis*) as well as *Classopollis* pointed to the start of a shift towards warmer xeric climatic conditions from the end of the Barremian to early part of the Aptian Stage. This view is further supported by the low diversity of schizaeaceous spores that prefer moist, warm habitats (Aboul Ela & Mabrouk, 1978). The presence of gymnospermous pollens

such as *Podocarpidites* and *Microcachryidites* suggest the presence of subtropical forests. These higher altitude forests were probably cool and more temperate. *Balmeiopsis limbatus* is very abundant in this zone and then disappears altogether in the following zone suggesting that the palaeoclimate that prevailed was steadily changing from tropical and warm (Kedves, 1986) to more xeric and hot.

- **PREVAILING PALAEOENVIRONMENT:**
  These pollens and spores represented plants that thrived in tropical, warm coastal conditions with transgressive seas. Conditions in the uplands were cool and temperate as shown by the presence of podocarp pollen.

7.2.3 THE PALAEOENVIRONMENT OF THE LATE RIFT TO EARLY DRIFT PHASES OF ZONE CII

- **DEPOSTIONAL ENVIRONMENT:**
  This zone represents accumulation during the late rift to early drift phases, with Africa and South America effectively separated from each other by the Cenomanian Stage. This zone accumulated in proximal littoral to shallowest regions of the inner neritic zone (Chapter 5).

- **SEA LEVEL:**
  Regressive seas occurred during the Aptian to the Cenomanian stages. The Aptian regression and the accompanied change in palaeoenvironment saw gymnosperms (*Classopollis*) declining in abundance and in the case of *Balmeiopsis limbatus* may well have contributed to its extinction. The Cenomanian regression that followed was not as severe.

- **DOMINANT FLORA:**
  Coastal-dominated woodlands of cheirolepidacean conifers declined in this zone possibly as a result of the combined effects of the Aptian and Cenomanian regressive episodes and resulting change in climate. Increasing temperatures at the higher latitudes resulted in

forests of podocarps becoming depleted in species such as *Microcachryidites antarcticus.* Terrestrial ferns and mosses however continued to flourish and were becoming increasingly more diverse.

- **FLORA AS CLIMATIC INDICATORS:**

  Classopollis pollen declined in abundance during this period and was probably affected by the regressive seas and increase in temperature and aridity. Four new species of *Ephedripites* pollen appear after the Cenomanian regression in Zone CII. The *Ephedra*-like pollen which entered the geological record in the Late Hauterivian to Early Barremian are morphologically similar to pollen of some recent species of *Ephedra* and furthermore are consistently present in sedimentary successions of post Barremian age in many parts of the world (Couper, 1964). Wood *et al*., (1997) concluded that striate and ephedroid pollen, which are most closely associated with the extant xerophytic gnetalean *Ephedra* and *Welwitschia* pollen, supported the interpretation of a probable arid to semi-arid climate in the rift valleys of the Early Cretaceous of Gabon. *Gleicheniidites senonicus* peaked during the Aptian regression whereas *Balmeiopsis limbatus* disappeared altogether between the Aptian and Cenomanian regressive episodes. Kedves (1986) concluded from his assemblages of Jurassic-Cretaceous age in Egypt, that the palaeoclimate that prevailed was tropical and warm, indicated by the presence of *Gleicheniidites* spores and *Balmeiopsis* pollen. Based on sequences in south-eastern Australia, Dettmann, (1981) found that the increased diversity of schizaeaeous ferns and the gradual decline of *Microcachryidites* during the Albian to Cenomanian stages indicated warmer temperatures than in the Aptian Stage, and a milder climate than in the Albian Stage.

- **PREVAILING PALAEOENVIRONMENT:**

  The prevailing environment in the uplands was milder and more temperate resulting in a change in composition of the high latitude forests due to the presence of bisaccate pollen (*Podocarpidites*). In the lower latitudes regressive events had changed the environmental conditions from tropical and warm to hot and semi-arid.

7.2.4 THE PALAEOENVIRONMENT OF THE EARLY DRIFT PHASE OF ZONE CIII

- **DEPOSITIONAL ENVIRONMENT:**
  Zone CIII represents the early drift phase, with Africa and South America slowly drifting further apart from each other. This zone probably accumulated in the shallower regions of the inner neritic zone.

- **SEA LEVEL:**
  Regressive seas returned during the Turonian Stage however unlike the Aptian regressive event, the flora does not appear to be significantly affected by this event.

- **DOMINANT FLORA:**
  The lowland woodlands continued to be dominated by cheirolepidacean conifers. The higher latitudes were covered in dense, evergreen forests of podocarps. Ferns and mosses formed the ground covers in the sheltered understories of the forests and woodland regions.

- **FLORA AS CLIMATIC INDICATORS:**
  Classopollis pollen again declined in abundance during the start of this period and is probably affected by the regressive Turonian seas and increased temperatures. However by the end of this zone transgressive seas had returned and *Classopollis* was flourishing once more. Only one species of *Ephedripites* pollen crossed over into Zone CIII. *Ephedripites* supports the interpretation of a probable arid to semi-arid climate and Sultan (1985) has used the presence of ephedracean pollen in the Aswan region to assume the prevalence of arid climatic conditions during the Coniacian - Santonian stages. *Gleicheniidites senonicus* remains very abundant in this zone along with *Cicatricosisporites* and *Cyathedites.* The diversity of the pteridophyte spores, particularly the presence of *Cyathedites,* suggests that the climate was warm (Aboul Ela & Mabrouk, 1978). The more abundant *Gleichenia*-like spores and more diverse schizaeaceous derivatives would seem to indicate warmer climatic conditions (Dettmann, 1981).

Schizaeaceous and gleicheniaceous ferns would probably have been restricted to sheltered areas of lower altitudes. A variety of podocarps suggest a prevailing climate in the upland areas that has returned to more cool and temperate conditions.

- **PREVAILING PALAEOENVIRONMENT:**
  Conditions in the higher latitudes have been interpreted to be cool, moist and temperate due to the presence of podocarp pollen. The environment in the lower latitudes are becoming hotter and more arid.

7.2.5 THE PALAEOENVIRONMENT OF THE EARLY DRIFT PHASE OF ZONE CIV

- **DEPOSITIONAL ENVIRONMENTS:**
  Zone CIV reflects sedimentary accumulation during the early drift phase, which continued to separate the African and South American continents. This zone gradually accumulated in the shallow to deeper regions of the inner neritic zone (See Chapter 5).

- **SEA LEVEL:**
  The sea level was high (Haq *et al*., 1987) and stable during this period.

- **DOMINANT FLORA:**
  The low latitude woodlands have recovered from their decline in Zones CII and CIII and were once again flourishing. Ferns and mosses remained abundant and diverse through the changing climates. The structure of the high altitude podocarp forests have become much lower in diversity.

- **FLORA AS CLIMATIC INDICATORS:**
  Classopollis peaked for one last time during this zone, before declining in successive zones. Three species of *Ephedripites* pollen occur here and their presence supports the interpretation of a probable arid to semi-arid climate (Sultan, 1985). *Gleicheniidites, Cicatricosisporites* and *Cyathedites* species are still abundant in this zone and the presence of *Cyathedities* (Aboul Ela & Mabrouk, 1978), Gleichenia-like spores and more

diverse schizaeaceous spores indicates warm, humid climatic conditions in the lower latitudes (Dettmann, 1981).

- **PREVAILING PALAEOENVIRONMENT:**
  The environment in the lower latitudes of this zone is interpreted by the palynomorphs present as warm to hot, humid and semi-arid. The podocarp forests in the higher latitudes suggest warm and temperate conditions.

7.2.6 THE PALAEOENVIRONMENT OF THE MIDDLE RIFT PHASE OF SUBZONE CV - A

- **DEPOSTIONAL ENVIRONMENT:**
  The Late Cretaceous sedimentary strata of this South Atlantic middle drift region represent a deep marginal marine facies. This sequence was probably deposited in the shallow to deeper regions of the inner neritic zone (See Chapter 5).

- **SEA LEVEL:**
  The sea level was still at a highstand during this subzone. By this stage the South Atlantic had expanded to twice its former size and deepened to more than 4 km in depth (Thierde & van Andel, 1977).

- **DOMINANT FLORA:**
  This zone represents the start of Herngreen & Chlonova's (1981) Palmae Province. This province is characterized by a greater diversity of angiosperm and tropical African pollen. The cheirolepidacean conifer dominated woodlands have now taken a subordinate role in the palaeoflora. Terrestrial ferns and mosses are still diverse and abundant.

- **FLORA AS CLIMATIC INDICATORS:**
  Classopollis pollen is still present but low in abundance. The presence of *Ephedripites* supports the continuation of a probable arid to semi-arid climate. The *Gleicheniidites, Cicatricosisporites* and *Cyathedites* groupings are abundant in this subzone with that the

diversity of the pteridophyte spores, particularly the presence of *Cyathedities* and Gleichenia-like spores indicating warm climatic conditions. Palmae pollen (*Dorreenipites* sp., *Andreisporis mariae* and *Constantisporis jacquei*) appear for the first time at the close of this zone that also represents the start of the Cenomanian Stage. The Cenomanian Stage heralded in wetter climatic conditions.

- **PREVAILING ENVIRONMENT:**
  The introduction of the Palmae Province signaled a climatic shift from hot and semi-arid to a mixed warm, temperate and humid climate.

7.2.7 THE PALAEOENVIRONMENT OF THE DRIFT PHASE OF SUBZONE CV - B

- **DEPOSITIONAL ENVIRONMENT:**
  The Late Cretaceous sediments of this South Atlantic drift phase represen accumulation possibly in the shallow to deeper regions of the inner neritic zone (See Chapter 5).

- **SEA LEVEL:**
  Campanian seas were transgressive and high. Haq *et al*., (1987) estimated these seas to be up to 200 m higher than today.

- **DOMINANT FLORA:**
  The Palmae Province continues into Subzone CV - B. The cheirolepidacean conifer dominated woodlands are now of little significance in the palaeoflora. A sudden decrease in the diversity of ferns and mosses along with a change in the composition of the higher altitude forests suggests that the close of the Cretaceous period is nearing and Teriary floras are taking over.

- **FLORA AS CLIMATIC INDICATORS:**
  Classopollis pollen has dwindled to a point where it was only just present and only one species of *Ephedripites* still occurs in this subzone. The diversity of the pteridophyte spores, particularly the presence of *Cyathedites,* more diverse schizaeaceous spores and

the presence of palmae pollen, a species that by todays standards flourishes in tropical conditions, indicates an adaptation to changing conditions that are wetter and warmer. Only a few podocarp species remain of the original diverse high latitude forest flora.

- **PREVAILING PALAEOENVIRONMENT:**
  Climatic conditions had changed so much that once again humid, warm, wet conditions prevailed with the global temperature averaging ca. 24 º C and precipitation ca. 1 mm / day wetter than today (De Conto, *et al.,* 1999). A change in composition in the high latitude forests suggests much warmer wetter conditions had manifested themselves.

7.3 PALAEOENVIRONMENTAL OVERVIEW FOR OFFSHORE SITE C-B1

Conditions during the Early Cretaceous Zone CI (Subzones CI - A and CI – B) were probably humid and tropically warm with climatic conditions starting to shift as shown by the presence of *Classopollis* and *Ephedripites*, towards being semi-arid and warm to hot. The environment of Zone CII, the Early / Late Cretaceous crossover was becoming less tropical and more one reflecting hot and semi-arid conditions. Zone's CIII and CIV, the Late Cretaceous accumulated in warm, semi-arid and humid conditions. Zone CV (Subzone's CV - A and CV – B), the close of the Late Cretaceous saw climatic conditions change so much that once again humid, warm, wet conditions prevailed. The microflora adapted and flourished to all the conditions that prevailed but the most noticeable change in the flora was the slow replacement of the gymnosperms with the more adaptable angiosperms. By the start of Subzone CV - B the flora of the Tertiary was well established.

7.4 THE PALAEOENVIRONMENT OF OFFSHORE SITE O- A1

7.4.1 THE PALAEOENVIRONMENHT OF THE EARLY RIFT PHASE OF ZONE OI

- **DEPOSITIONAL ENVIRONMENT:**
  This zone consists of land-derived palynomorphs as well as marine microfossils suggesting that the Early Cretaceous of this South Atlantic rift region possibly accumulated in the proximal littoral to marginal marine regions of the inner neritic zone (See Chapter 5).

- **SEA LEVEL:**

  Transgressive seas (Haq *et al*., 1987) occurred in the narrow, elongated ocean that formed between Africa and South America.

- **DOMINANT FLORA:**

  This zone represents pre-angiospermous palaeoflora. The gymnosperm communities are abundant and diverse and dominate both the woodland and upland forest communities. Pteridophytes and bryophytes are conspicuous by their low abundance and diversity in this zone, however they may have been confined to the moist, warm habitats near rivers and lakes (Schrank, 1987).

- **FLORA AS CLIMATIC INDICATORS:**

  Classopollis and *Balmeiopsis* are far more abundant in this zone than Subzone CI-A and Subzone CI -B of Offshore Site C-B1 combined. No species of *Ephedripites* occur here supporting an interpretation of warm, mild and moist climatic conditions. The diversity of pteridophyte and bryophte spores are very low in this zone in comparison to the other zones. The presence of two species of *Cyathedites* and *Gleicheniidites* however respectively suggest that the prevailing climate was warm (Aboul Ela & Mabrouk, 1978). The presence of podocarps such as *Microcachryidites antarcticus* (trisaccate) and *Podocapidites* pollen (bisaccate) lend support to cool, moist, temperate conditions in the higher latitudes.

- **PREVAILING PALAEOENVIRONMENT:**

  The palaeoenvironment of Zone OI was moist, humid and warm. Upland regions were cool and temperate.

7.4.2 THE PALAEOENVIRONMENT OF THE EARLY RIFT PHASE OF ZONE OII

- **DEPOSITIONAL ENVIRONMENT:**

  The Early Cretaceous of this South Atlantic region represents an early rift environment. Zone OII probably accumulated in the proximal littoral to shallow regions of the inner

neritic zone (See Chapter 5).

- **SEA LEVEL:**

  This zone is characterized by the Aptian regressive event. This regression is a worldwide event and can be found in Zone CII & OII of both Offshore Sites.

- **DOMINANT FLORA:**

  No comment may be made as to the behavior and response of the palaeoflora during the Aptian regressive episode as very little palynodebris was preserved over this interval (3800 m – 3750 m). The first angiosperm pollen appears at the end of this zone signaling the end of the pre-angiosperm palaeoflora. Gymnosperms continue to dominate the palaeoflora with flourishing cheiroledipacean woodlands at the lower latitudes. The higher altitudes continue to be covered in dense forests of podocarps. Ferns and mosses flourished and diversified in this zone resulting in dense understorey ground covers.

- **FLORA AS CLIMATIC INDICATORS:**

  Two new species of *Ephedripites* pollen appeared towards the end of this zone for the first time. Wood *et al*., (1997) concluded that striate and ephedroid pollen supported the interpretation of a probable arid to semi-arid climate in his region of study that was in the rift valleys of the Early Cretaceous of Gabon. The occurrence of a number of species of ephedralean pollen along with other gymnosperms such as *Zonalapollenites* and *Classopollis,* which flourished in this zone, all suggest prevailing hotter xeric climatic conditions during the Barremian to Aptian stages (Sultan, 1986). An increased diversity in schizaeaceous ferns coupled with a decline in *Microcachryidites* indicates much warmer temperatures especially in the higher latitudes (Dettmann, 1981). Zone OII of Offshore Site C-B1 experienced the same palaeofloral trends.

- **PREVAILING PALAEOENVIRONMENT:**

  The environment of this zone was probably humid, moist and tropically warm with climatic conditions shifting towards becoming more semi-arid and warm to hot. The upland regions were warm and temperate.

7.4.3 THE PALAEOENVIRONMENT OF THE EARLY DRIFT PHASE OF ZONE OIII

- **DEPOSITIONAL ENVIRONMENT:**

  The Cenomanian Stage was not preserved at this Offshore Site, however this zone does represent the start of the drift phase. Zone OIII probably accumulated in the shallower regions of the inner neritic zone (See Chapter 5).

- **SEA LEVEL:**

  Regressive seas occurred during the Turonian Stage.

- **DOMINANT FLORA:**

  Angiosperms that are native to the Tertiary Period appear with a flourish for the first time in this zone however as none of them are palm pollen, the start of the Palmae Province (Herngreen & Chlonova, 1981) cannot be concluded. Gymnosperms continue to dominate the palaeoflora with flourishing cheiroledipacean woodlands at the lower latitudes and dense forests of podocarp at the higher latitudes. Ferns and mosses continue to flourish and diversify and by this stage most of the extant fern families are established.

- **FLORA AS CLIMATIC INDICATORS:**

  Classopollis flourished throughout this zone indicating ideal dry and hot climatic conditions probably fueled by the Turonian regression. The last appearance of *Balmeiopsis limbatus* was at the end of the Late Turonian and the major drop in sea level seems to be responsible for its exclusion at this site. A similar set of circumstances occurred in Offshore Site C-B1 except the Aptian regression appears to be responsible for its demise.

  Microcachryidities antarcticus (trisaccate) and *Podocapidites* pollen (bisaccate) flourished during this zone, once again supporting an interpretation of cool, stable temperate upland conditions. Seven new species of angiosperm appeared at intervals throughout this zone and one of them, *Buttinia andreevii,* is a K / T boundary indicator (Oboh Ikuenobe, 1999 *pers. comm.)*. The *Cyathedites, Gleicheniidites* and

Cicatricosisporites groupings flourished during and after the transgressive event suggesting highly adaptable species.

- **PREVAILING PALAEOENVIRONMENT:**
  The climate that prevailed during the accumulation of these early rift sediments was humid and warm with climatic conditions changing to more hot and semi-arid. The higher latitudes had returned to cool, moist and temperate.

7.4.4 THE PALAEOENVIRONMENT OF THE LATE DRIFT PHASE OF ZONE OIV

- **DEPOSITIONAL ENVIRONMENT:**
  These late drift sediments of the Late Cretaceous accumulated on the border between the shallow and deeper regions of the inner neritic region (See Chapter 5).

- **SEA LEVEL:**
  The sea level of the Late Coniacian Stage had risen once again to that of trangressive seas and the vegetation was flourishing due to the wetter conditions.

- **DOMINANT FLORA:**
  Gymnosperms, specifically the cheiroledipacean woodlands no longer dominate the palaeoflora as in previous zones. Ferns and moss communities however continue to flourish and diversify in the under canopy of the forests and remaining woodland areas. Angiospermous vegetation are all Tertiary representatives.

- **FLORA AS CLIMATIC INDICATORS:**
  Classopollis pollen declined noticeably in this zone and *Ephedripites* pollen does not occur at all in this zone. Their presence in previous zones supports the interpretation of a probable arid to semi-arid climate. *Gleicheniidites senonicus, Cicatricosisporites* and *Cyathedites* still occur in this zone but not in any abundance possibly suggesting poor preservation potential. *Podocarpidites* and *Microcachryidites* continue to flourish thereby supporting a cool and temperate climate in the upland areas.

- **PREVAILING PALAEOENVIRONMENT:**

  The conditions that prevailed in this zone have shifted back to those of warm and moist. The uplands are cool and temperate.

7.4.5 THE PALAEOENVIRONMENT OF THE DRIFT PHASE OF ZONE OV

- **DEPOSITIONAL ENVIRONMENT:**

  This zone represents the middle drift phase and probably accumulated in the border regions between the shallow to deeper regions of the inner neritic zone (Chapter 5).

- **SEA LEVEL:**

  The sea level during this period was transgressive.

- **DOMINANT FLORA:**

  This zone represents the start of Palmae Province (Herngreen & Chlonova, 1981). This province as with Subzone's CV - A and CV - B of Offshore Site C-B1 is characterized by a high diversity of angiosperm as well as tropical African palm pollen. The cheirolepidacean-dominated woodlands have peaked for the last time at the close of this zone. Terrestrial ferns and mosses still flourished and the presence of *Podocarpidites* and *Microcachryidites* reflected cool temperate, moist conditions at the higher latitudes.

- **FLORA AS CLIMATIC INDICATORS:**

  This zone represents the close of the Late Cretaceous Period. Only 5 podocarp species remain of the original diverse low and high latitude flora. *Classopollis* pollen peaks only for a short period at the end of this zone while the last species of *Ephedripites* disappears midway through. The presence of still flourishing fern and moss communities as well as the presence of palmae pollen indicates an adaptation to changing conditions that are wetter and warmer. The continued presence of *Podocarpidites* and *Microcachryidites* support cool and temperate conditions at the higher latitudes.

- **PREVAILING PALAEOENVIRONMENT:**

  The conditions that prevailed during the accumulation of these drift sediments was that of humid, warm and wet. The upland regions however remained cool, moist and temperate.

7.5 PALAEOENVIRONMENTAL OVERVIEW FOR OFFSHORE SITE O-A1

The conditions that prevailed during the accumulation of the early-rift sediments during the Early Cretaceous of Zone OI was humid and warm. By the end of Zone OII, conditions were changing from humid and tropically warm to an environment that was much warmer and dryer (semi-arid). By the Late Cretaceous the accumulation of early-rift sediments in Zone OIII was still humid and warm but becoming steadily hotter and more semi-arid. Zone OIV reflected a hot and semi-arid environment and by the end of Zone OV (the close of the Late Cretaceous Period) climatic conditions had reverted back to humid, warm and wet conditions The microflora adapted and flourished to a greater extent at this site than at Offshore Site C-B1. The most noticeable change in the flora started during the Turonian Stage (Zone OIII) with the slow replacement of the gymnosperms with angiosperms. By the end of Zone OIII the flora of the Tertiary was well established.

Conditions in the upland regions however remained stable, cool and temperate throughout the entire Cretaceous Period.