Jurassic to Cretaceous stratigraphy of shallow cores on the Møre Basin Margin, Mid-Norway

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Four cores drilled by IKU in summer 1988 southwest of Kristiansund at the Møre Basin Margin close to the Gossa High (6206/02) penetrated marginal marine Lower Jurassic coarse clastic and Upper Cretaceous shelf deposits. The lower part of the easternmost core 3 contains Lower Jurassic matrix-supported terrestrial conglomerates rich in mafic clasts deposited in an alluvial fan environment. This is succeeded by a clast-supported, partly marine-influenced very coarse gneiss conglomerate of Pliensbachian–Toarcian age, possibly representing fan-delta deposits. Core 2 penetrated a similar clast-supported conglomerate below a more sandy, partly marine influenced unit of Late Toarcian–Aalenian age. Core 8, further west, and the lower part of core 1 contained similar sandy successions of Late Toarcian–Aalenian age deposited in a distal fan-delta environment. In the latter core there is a major hiatus (some 80 million years) as Upper Toarcian–Aalenian sediments are overlain by Upper Albian Shelf deposits. The Cretaceous succession in the core contained marine mudstones, sandstones and shales/claystones of Late Albian to Turonian/Santonian ages. Distinct seismic reflections are present in the cored succession, but only those in the Cretaceous sequence can confidently be tied directly to the Møre Basin based on the available data. A bedrock map of the Møre Basin Margin is presented.

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Introduction

During the early summer of 1988 IKU drilled eight shallow bedrock cores at seven locations near the coast off Mid-Norway (Fig. 1). A total of 628 m of bedrock was penetrated, and 541 m core was recovered. A high resolution seismic and shallow coring programme was initiated from a regional bedrock mapping project carried out by IKU for the Norwegian Petroleum Directorate (NPD) and Statoil in early 1987. In this paper the Lower Jurassic to Upper Cretaceous stratigraphy of the four southern cores drilled on seismic line IKU-201-88 southwest off Kristiansund (i.e. on the Møre Basin Margin) are described. These cores represent Mesozoic bedrocks outcropping on the Møre Basin Margin east of the Gossen High. The cored Lower Jurassic succession is divided into three informal lithostratigraphic units: A ("Early Jurassic mafic conglomerate"), B ("Early Jurassic gneiss conglomerate") and C ("Early Jurassic sandstone"). The Upper Cretaceous succession can be related to the formal lithostratigraphy of the mid-Norwegian shelf, as described in Dalland et al. (1988). The lithostratigraphic units correspond to the major seismic units identified on line IKU-201-88. The Møre Basin Margin has a complex structure of pre-Cretaceous fault blocks situated within the Møre-Trøndelag Fault Zone. It constitutes the eastern flank of the More Basin between the Sogn Graben and the Trøndelag Platform (Fig. 1). The Møre Basin Margin is narrow and comprises a westward tilted sub-Cretaceous sequence between 0.5 and 5.0 s TWT, onlapped by Cretaceous sediments (Brekke & Riis 1987). The data presented document that at least 700 m of Lower Jurassic strata subcrop west of the present coast in the 6206/02 block. Lower Jurassic sediments were encountered in cores 6206/02-U-03 (the oldest, close to the crystalline basement), 6206/02-U-02, 6206/02-U-08 and 6206/02-U-01 (hereafter cores 3, 2, 8 and 1, respectively). Core 1 shows Upper Albian sediments onlapping Upper Toarcian deposits, with seaward dipping seismic reflectors (Fig. 2).

Core descriptions and interpretations

Three lithostratigraphic units were penetrated in the Jurassic succession, while the cored Cretaceous succession comprises two units (Fig. 2).

Lower Jurassic Unit A

Unit A (174.2–124 m) in core 3 consists mainly of poorly sorted, matrix-supported, polymict conglomerate with bed thickness varying between 0.3 and 3.0 m. The clasts are of subangular, (in situ) strongly weathered, often friable mafic and ultramafic (amphibolite and serpentinite) cobbles and pebbles as well as some scattered, subangular, less weathered granitic gneiss (up to 30 cm). In some beds the clasts display horizontal orientation.

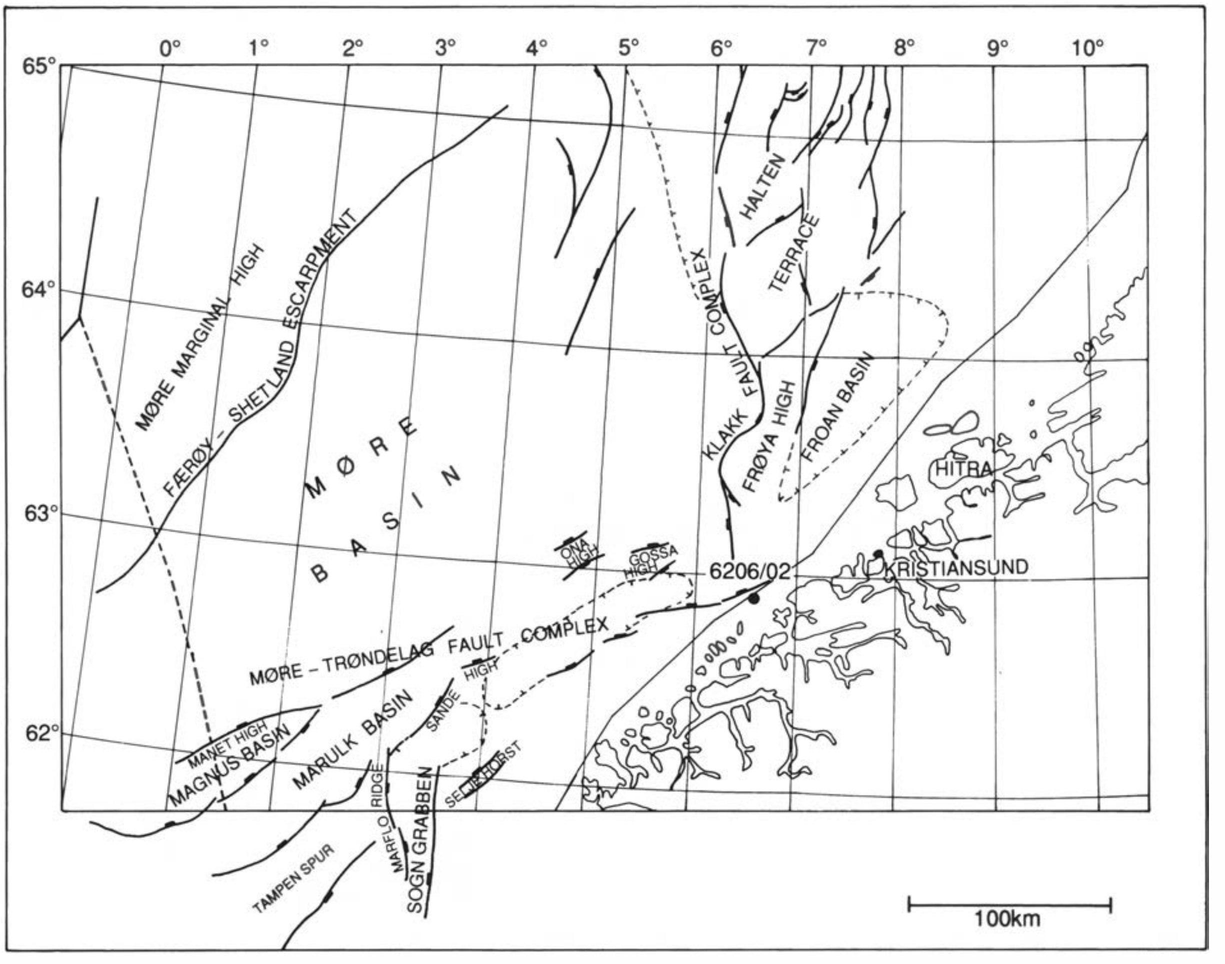


Fig. 1. Main structural elements and location of the stratigraphic cores discussed in this paper.

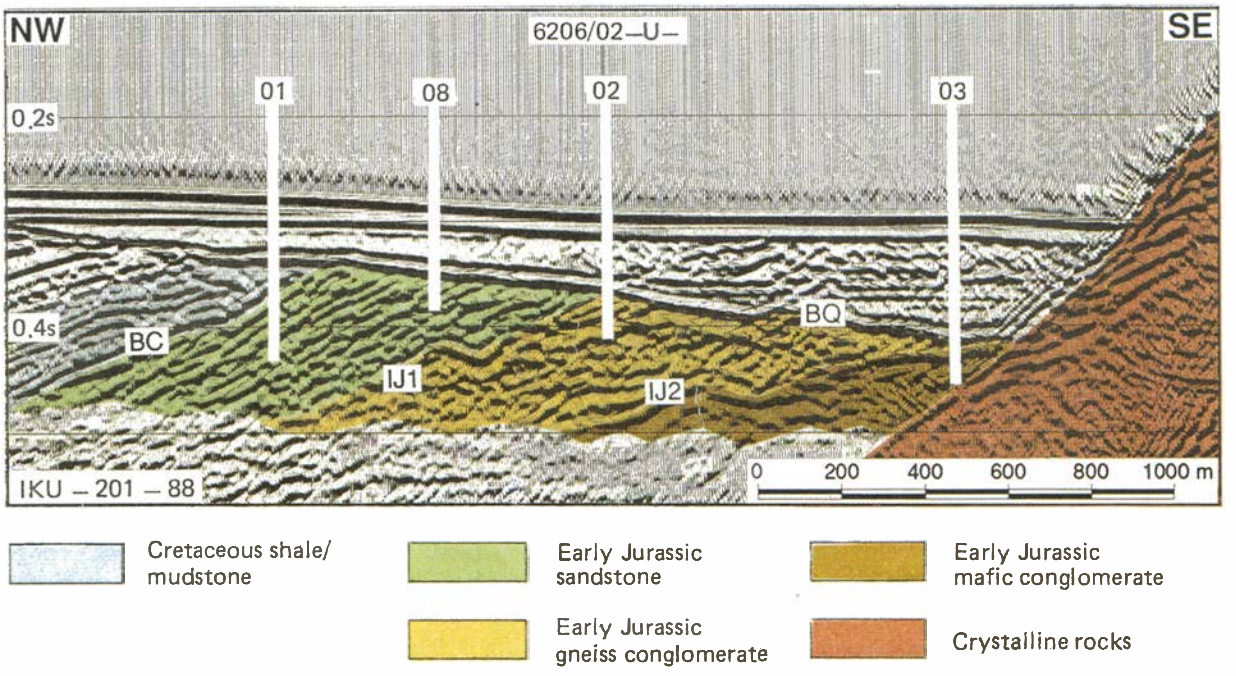


Fig. 2. Shallow seismic line across the core locations (BQ = Base Quaternary reflection, BC = Base Cretaceous reflection, IJ_1 = intra Jurassic reflection 1, IJ_2 = intra Jurassic reflection 2). Colour code: blue = Cretaceous sequence, green = Unit C, light brown = Lower Jurassic, Unit B, dark brown = Lower Jurassic, Unit A = Crystalline basement.

The matrix consists of dark red to red-brown poorly sorted mud that in some beds shows horizontal lamination and cross lamination. Some beds are graded. The upper 10 cm comprises a light grey, muddy, kaolinite weathered horizon with sharp upper and lower boundaries (Fig. 3). The erosional character of the unconformity above the kaolinite horizon is not obvious in the core, but this level displays a sharp colour change. The truncation however, is, clearer in the seismic data (Fig. 2).

The palaeontological analyses give no indication of any marine influence on these deposits. The strong in situ weathering of the mafic clasts and the red-brown colour of the matrix support deposition in fresh water, probably partly under subaerial conditions. The high concentration of expandable clay minerals in the muddy matrix and the absence of kaolinite indicate deposition in a dry and warm climate (Fuchtbauer 1983).

The matrix-supported conglomeratic beds, partly graded, and partly with horizontal and cross lamination, are interpreted as alternating debris flow/mud flow and running water (braided channels or sheet flood) deposits. The first two depositional mechanisms are probably represented by the intervals with no sedimentary structures, while the other two are represented by the horizontal and cross-laminated intervals. An alluvial fan, probably mid-fan position, as the depositional environment is suggested (Fig. 3).

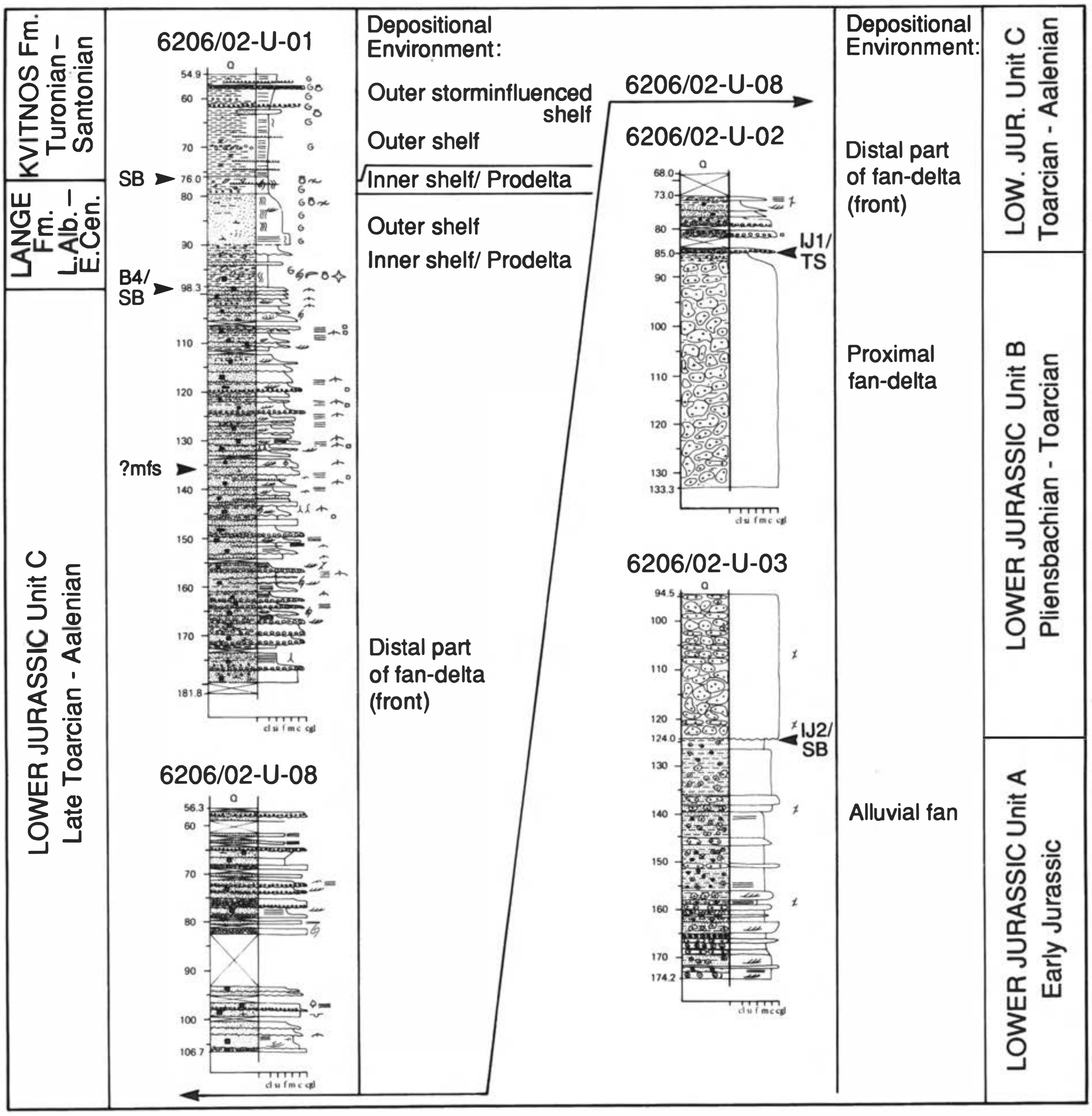


Fig. 3. Stratigraphy of the cored sequences below the base quaternary (see Fig. 2). BC = Base Cretaceous reflection, IJ_1 = intra Jurassic reflection 1, IJ_2 = intra Jurassic reflection 2, SB = sequence boundary, TS = transgressive surface, mfs = maximum flooding surface.

Lower Jurassic Unit B

Unit B in core 3 (124–94.5 m) and core 2 (133.3–85.05 m) represents the same seismic unit and comprises similar lithologies. In core 3, Unit B rests with a sharp boundary on 124.0 m on Unit A. It consists of poorly consolidated, clast-supported conglomerates where the clasts comprise weathered friable, subangular granitic gneiss cobbles/boulders (max. 70 cm) and subangular quartzic cobbles. The matrix is dark red to red-brown mud.

There are no indications of marine influence in the lower part of this conglomerate. Palaeontological data indicate marine influence in the uppermost metres of the cored unit and can be interpreted as evidence of a gradually approaching shoreline. No break or lithological changes were observed that could represent a transition from non-marine to marine environments.

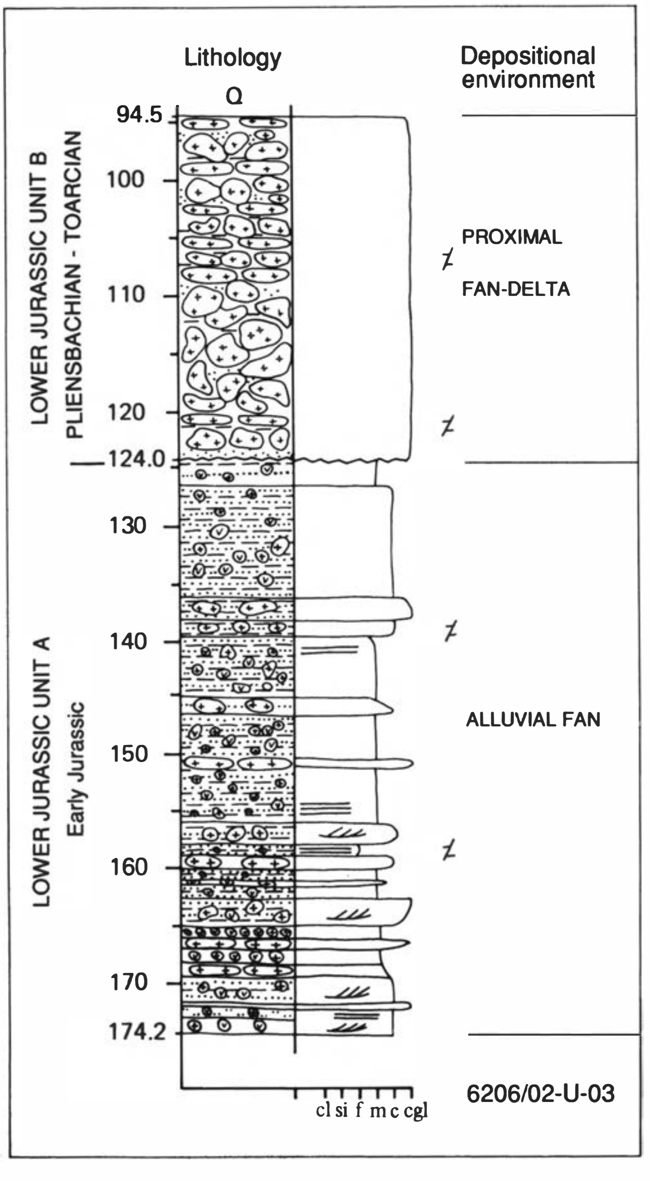


Fig. 4. Sedimentological core log and interpreted depositional environment of core 6206/02-U-03. Legend to the sedimentological log is shown in Fig. 5.

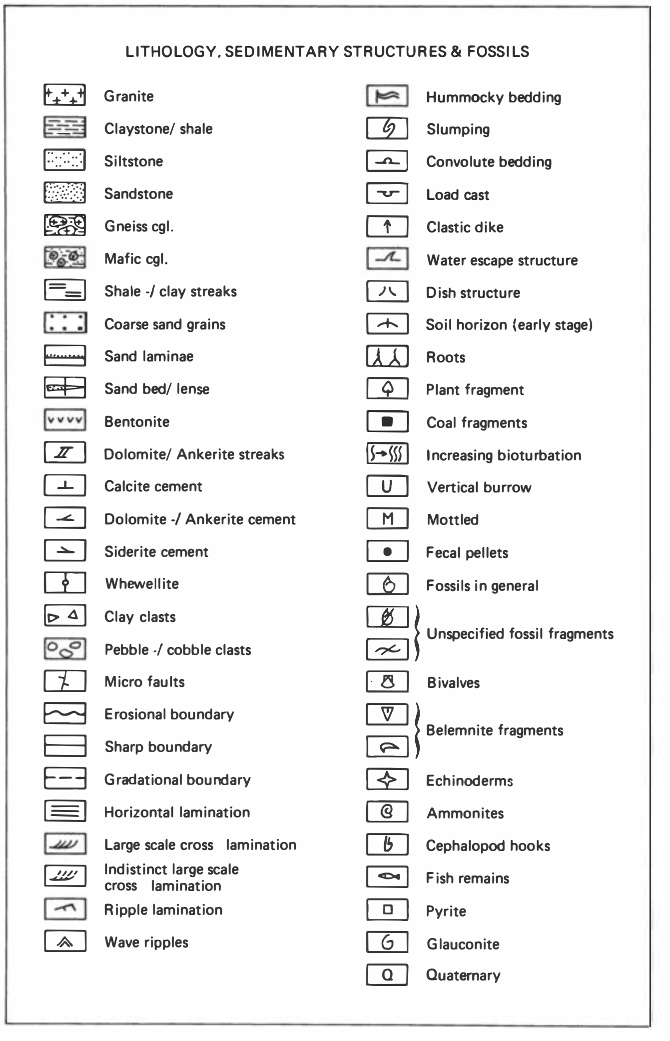


Fig. 5. Legend to the sedimentological logs in Figs. 4, 7, 10 and 12.

The clast-supported conglomerate is interpreted as representing a debris flow and/or rock fall depositional mechanism. The dark red to red-brown colour of the muddy matrix and partly of the clasts indicates deposition under good oxidizing conditions. The granitic gneiss clasts have suffered from much stronger weathering in Unit B than in Unit A. In Unit B there are also considerable amounts of kaolinite (Fig. 3). Unit B was probably deposited in a proximal position on an alluvial fan/fan delta under warm and humid climatic conditions.

In core 2, Unit B (133.3–85 m) comprises a similar clast-supported massive conglomerate as that penetrated by upper core 3. The matric in the lower part (133–94 m) is composed of a dark reddish brown mudstone. In the upper part (94–85 m) the matrix is a dusky yellow green to olive green mudstone. Over the interval 112 to 94 m (Fig. 6) there is a gradual transition from the dark reddish brown matrix to the yellow-green coloured matrix.

The upper 2.5 m of the unit displays a gradual change from a clast-supported texture to a matrix-supported texture, and the uppermost metre consists of a dusky yellow green mudstone with some scattered gravel frag-

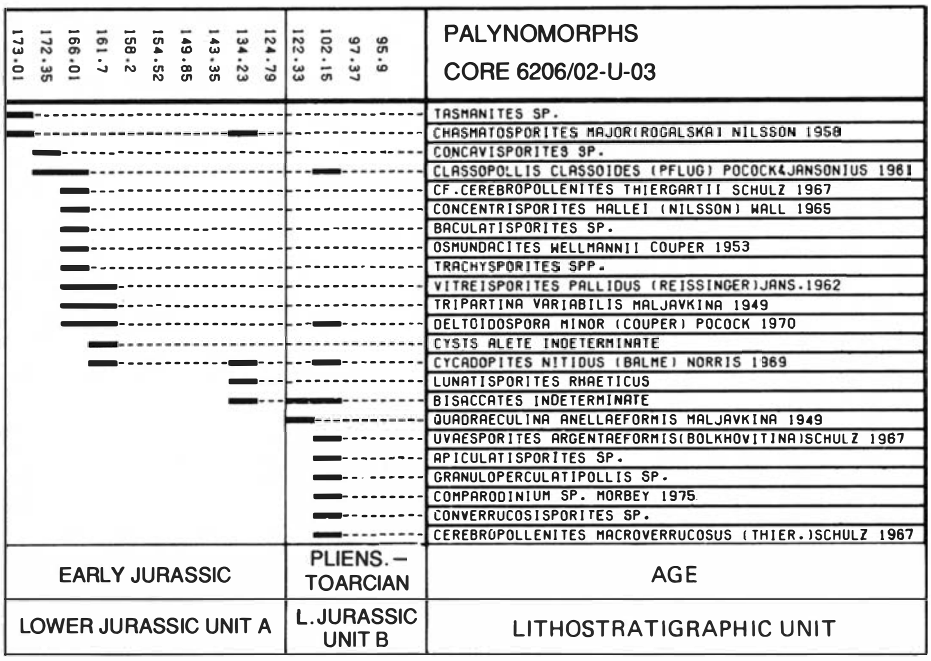


Fig. 6. Range chart of palynomorphs in core 6206/02-U-03.

ments. The palaeontological analyses show no indication of marine influence in Unit B in core 2 (133.3–85 m). The non-graded mudstone in the uppermost two metres was probably deposited by a mud flow. The depositional environment is intepreted as the proximal part of an alluvial fan (Fig. 6).

Lower Jurassic Unit C

Unit C comprises Lower Jurassic strata, mainly sandstones represented in the upper part of core 2 (85.0–73.0 m), the entire core 8 and the lower half of core 1(181.8–98.3 m).

The base of Unit C in core 2 is a 10 to 15 cm thick coal-rich, muddy horizon with some subangular quartzitic cobbles. Above, there are poorly sorted sandstones and mudstones with coal fragments, and fining upward cycles capped by silty claystones. These graded units have thicknesses from 0.3 to 1.5 m. Between 81.5–81 m and 80.7–80.5 m there is a clast-supported conglomerate. The clasts are subangular granitic gneiss and quartzitic cobbles, and the gneiss clasts have suffered from in situ weathering. No structures or preferred clast orientation were seen. Between 78.7 and 77.6 m the cored unit consists of a mudstone with gravel fragments, and displays the same facies as in the interval 133.3–85 m. Between 74.2 and 73.9 m there is a mudstone with angular clasts of cobble size that makes up the lower part of a graded interval. Most of Unit C has an olive grey colour. Some horizontal lamination and large-scale cross lamination can be seen in the sandstones in the upper two metres.

The palaeontological analyses indicate marginal marine environments just above the lag that marks the boundary between Unit B and Unit C. This lag consists of a coaly horizon, including some quartzitic cobbles, and is interpreted to be a transgressive erosional lag.

Unit C in core 2 (85–73 m) includes erosive, graded and non-graded beds (conglomerate to silty clay) with few primary sedimentary structures (horizontal lamination, cross lamination, and a few slumping phenomena in the upper part), interpreted as debris flow/mud flow and stream channel deposits. Sorting is poor, especially in the conglomerates. Marine influence is documented also by the microplankton *Phallocysta eumekes* at the 76.67 m level. The presence of *Botryococcus* suggests an influx of fresh water. The foraminifera *Haplophragmoides* cf. *kingakensis* at 76.67 m and some echinodermal debris at 74.62 m (Fig. 7) also suggest marine influence. These observations suggest a depositional environment in a submarine delta front position within a fan delta. The whole succession (133.3–73 m in core 2) is thus interpreted to reflect a development from proximal parts of an alluvial fan/fan delta to submarine delta front deposits within a fan delta (Fig. 6). No signs of subaerial exposure were observed above 85 m. The palaeontology does not indicate any major break at the boundary to this transgressive unit.

Core 8 penetrated the same sedimentary sequence as Unit C in core 6. Core 8 comprises poorly sorted, weakly cemented sandstones/conglomerates that mainly show fining upward cycles capped by silty claystones (Fig. 9) varying from 0.2 m to 2.5 m in thickness. Most of the core has a greenish grey to light greenish grey colour, but also contains a few thin (3–5 cm) light brownish grey layers. These intervals are composed of clayey silt with coal fragments.

Between 57 m and 98.5 m some 0.5–1.5 m thick are completely calcite cemented horizons mostly associated with zones of coarse and conglomeratic material. The conglomeratic beds are mainly clast-supported, have well

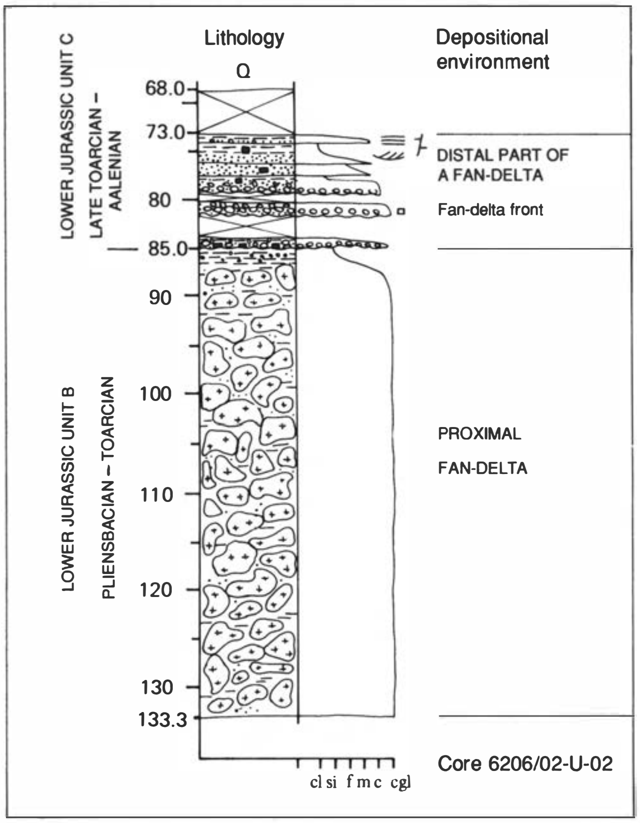


Fig. 7. Sedimentological core log and interpreted depositional environment of core 6206/02-U-02. Legend to sedimentological log is shown in Fig. 5.

rounded clasts of cobble to gravel size, and are 0.2 to about 2 m thick. The clasts consist of granitic gneiss, quartzdiorite as well as some mafic and ultramafic clasts which are restricted to the calcite cemented beds.

Sedimentary structures are rare, but horizontal lamination, large-scale cross lamination, some ripple lamination and slumping structures occur. Some calcite cemented intervals have large-scale, low-angle cross lamination. The graded units in the sandy parts display a development from large-scale cross lamination and horizontal lamination in the coarser parts to ripple lamination and horizontal lamination in the finer grained upper parts.

The few red-brown fine graine horizons, mainly associated with coal fragments, are interpreted as an early stage of soil development, suggesting that the sediments have periodically been subaerially exposed.

The sedimentary facies mainly consist of stacked, erosive, graded units with varying amounts of primary sedimentary structures and are interpreted as representing deposition in running water, where the water path is switching backwards and forwards over a braided plain. It is difficult to judge whether the flow was confined to channels or reflects sheet floods.

The sedimentary observations suggest a depositional environment of a braided river system with shallow poorly confined channels, e.g. distal parts of an alluvial fan/fan delta. Palaeontological analyses indicate some marine influence through parts of the succession, and thus a delta plain/delta front of a fan delta is suggested (Fig. 9).

This model can also explain the calcite cemented gravel/conglomeratic horizons, which may have formed in a mixing zone of fresh and marine water in a beach/foreshore position: a beach rock. Low angle, large-scale cross lamination in some of these coarse grained horizons supports this interpretation, as do the well-rounded clasts.

The Lower Jurassic sequence recovered in core 1 (179.8–98.3 m) is coeval and represents the same seismic unit, and the lithology has much in common with Unit C in cores 2 and 8. The Lower Jurassic sequence of core 1 is consequently given the same informal unit name as the upper unit in core 2 (Unit C).

In core 1, Unit C (179.8–98.3 m) displays one facies association: erosive cycles of graded, poorly sorted, medium-grained, micaceous sandstones (0.2–1.5 m) interbedded with silty claystones and gravel containing a few rootlets and abundant coal fragments. Apart from a few darker clayey intervals, and numerous thinner (5–15 cm) light brownish grey intervals, most of the unit displays a greenish grey to light greenish grey colour. The light brownish grey intervals contain some coaly material (plant debris).

The whole unit shows an overall upward fining trend. There is a dominance of gravel and conglomeratic material in the lower part, and medium and finer-grained sandstones in the upper part (Fig. 11). Sedimentary structures comprise horizontal lamination, large-scale cross lamination, some ripple lamination and slumping structures. The graded units generally have large-scale cross lamination in the coarse-grained parts, and horizontal lamination and ripples in the finer parts.

Most of the unit is poorly cemented, but some intervals are completely calcite cemented. These intervals are generally associated with zones of coarse sand, gravel or conglomeratic material, and they vary in thickness between 0.5 m and 1.5 m. They are homogeneous except for a few intervals with low angle, large-scale cross lamination.

The palaeontological analyses indicate marine influence throughout the whole succession. The light brownish-grey fine-grained horizons, with coal fragments and rootlets, suggest soil development and frequent subaerial exposure during deposition.

The sedimentary facies, which consists of stacked, erosive, graded beds (conglomeratic to silty clay) with varying amounts of primary sedimentary structures (cross lamination, horizontal lamination, a few slumping phenomena and current ripples) is interpreted to reflect deposition in flowing water, where the main water path switched backward and forward over a braided plain. It is difficult to judge whether the water was confined to channels or was a sheetflood.

Because of the marine influence, we infer delta-front/lower delta plain of a braided delta or fan delta as the depositional site for these sediments.

The calcite cemented gravel/conglomeratic horizons are probably caused by marine reworking in a beach/

foreshore setting and may represent beach rock. The upward decrease in beach rock horizons and an increase in signs of subaerial exposure (soil horizons) indicate a regression. Very few palynomorphs have been observed in the uppermost part, implying better oxidizing conditions.

The boundary at 98.3 m between Unit C and the overlying Lange Formation (98.3–76.0 m) is sharp and defines a major hiatus.

The Lower Cretaceous Lange Formation

The Lange Formation in core 1 is subdivided into three sub-units (displaying two types of lithofacies).

Sub-unit 1 (98.3–90 m) shows a disorganized, heterogeneous facies of clasts containing, greyish black mudstone. The clasts are of both intra- and extra-formational origin, and comprise claystone, carbonate, quartz and glauconitic sandstone/clay clasts. They are subangular and from 0.5 to 10 cm (mainly 1–3 cm) in diameter (carbonate clasts are the largest ones). Two medium-graded sandstone units (10–15 cm thick) capped by claystones are observed between 94 m and 90 m. The uppermost is calcite cemented. The whole sub-unit displays numerous slump structures and strong bioturbation. There are fossil fragments of bivalves and belemnites.

Sub-unit 2 (90–79.5 m) consists of a glauconite-rich, fine to medium-grained sandstone that is calcite cemented. The lowermost 3 m of this sub-unit is well sorted, and shows horizontal lamination and some burrowing. From 87.5 m and upwards there is a gradual increase in the silt/clay content. This part shows occasional horizontal lamination and large-scale cross lamination, but is mainly strongly bioturbated.

Sub-unit 3 (79.5–76 m) shows the same type of lithofacies as sub-unit 1, i.e. a rather heterogeneous mudstone with abundant clasts.

Depositional mechanisms for the clast containing mudstone in sub-units 1 and 3 (98.3–90 m; 79.5–76 m) (Fig. 11) are interpreted to comprise partly mass-gravity flows (debris flow, turbidite currents), and partly sedimentation from suspension. An inner shelf/prodelta depositional environment is suggested.

The bioturbated, upward fining, glauconitic sandstone of sub-unit 2 (90–79.5 m) is interpreted as transgressive deposits. The marine coastal sand at the base gradually evolved into a shelf deposit during the transgressive event. This transgression led to a decrease in sedimentation rate, strong bioturbation and glauconitization. The inner shelf/prodelta setting was re-established during deposition of sub-unit 3.

The boundary between the Lange Formation and the Kvitnos Formation (76–54.9 m) is sharp.

The Upper Cretaceous Kvitnos Formation

The Kvitnos Formation is subdivided into two different sub-units (Fig. 11). Sub-unit 1 (76–63 m) consists mainly of calcareous, greyish black, horizontally laminated shale with monor amounts of silt and dolomite/ankerite laminations as well as bioturbated intervals with some glauconite. Around 71 m there are two thin intervals: a medium-grained, bioturbated glauconitic sandstone and a conglomerate with clasts of pebble size. The clasts mainly comprise quartz, carbonate and glauconite. Sub-unit 1 is interpreted as representing an outer shelf environment.

There is a gradual change in lithology from sub-unit 1 to sub-unit 2. Sub-unit 2 (63–54.9 m) displays an overall upward coarsening development resulting in a sandy, calcareous, laminated shale. Most of the sand grains seem to be biogenic silica. The sub-unit contains some erosive, graded, partly laminated, coarse-grained and pebbly glauconitic beds (5–15 cm thick). One of these also contains carbonate clasts. Throughout the unit there are shell fragments, mainly bivalves, which are highly concentrated in silica rich, pebbly horizons.

Sub-unit 2 is interpreted as representing and open marine, outer shelf environment with gradually decreasing sedimentation rates. The erosive, coarse-grained, strongly glauconitized, graded beds in the uppermost part of he sub-unit imply an environment with variable energy conditions. These beds are interpreted as reflecting storm or other current generating events in a sediment-starved shelf area, resulting in condensed sections. The glauconite was eroded from the seabed and redeposited again in the same area.

In terms of organic geochemistry, the shales of the Kvitnos Formation are homogeneous with poor source rock properties suggestive of a low-energy setting with moderate ventilation. This could imply a deeper water environment relative to that of the upper Albian to lower Cenomanian Lange Formation (Fig. 16).

Biostratigraphy

Lower Jurassic Unit A

The poor residues of degraded terrestrial material recovered from Unit A in core 3 contain sporadic palynomorphs that indicate an Early Jurassic, possibly Hettangian age. A Late Triassic age cannot be excluded, but restricted Triassic taxa are missing. The assemblage includes *Classopollis* spp., *Chasmatosporites* spp., *Trachysporites* sp. and a poorly preserved specimen identified as cf. *Cerebropollenites thiergartii* at the 166.01 m level. The presence of *Lunatisporites rhaeticus* at 134.23 m is attributed to reworking from Triassic beds (Fig. 4). The palynomorphs characterizing Unit A resemble those recorded in the Pinuspollenites–Trachysporites Zone (Lund 1977) of Hettangian age. No microfaunal elements were recorded in the core.

Lower Jurassic Unit B

Unit B in core 3 yielded only poor residues of degraded terrestrial material and rare palynomorphs. No microfaunas were recovered. The presence of *Cerebropollenites macroverrucosus* at 102.15 m points to and age not older than earliest Sinemurian at this level. Besides the bisaccate pollen grains, the palynomorph assemblages yielded stratigraphically long-ranging forms such as *Quadraeculina anellaeformis*, *Deltoidospora minor* and *Classopollis* spp. The dinoflagellate cyst referred to as *Comparodinium* sp. of Morbey 1975 is present at 102.15 m. This indicates limited marine influence. The presence of *Granuloperculatipollis* sp. at 102.15 m is interpreted as being reworked from Triassic beds. The oldest occurrence of *C. macroverrucosus* in the Sinemurian of the North Sea (Lund 1977; Morbey 1978; Dybkjær 1991) limits the maximum age for the assemblage.

In core 6206/02-U-02 most samples from Unit B (85.07–122.29 m) proved to be barren of palynonmorphs. The enrichment of resinous matter has been interpreted as evidence of oxidative conditions acting in an environment formerly rich in leaf remains. The regular presence of *Cerebropollenites macroverrucosus*, *Chasmatosporites major* and *Concentrisporites hallei* (= *Perinopollenites elatoides* in Dybkjær 1991), in this assemblage (Fig. 8) suggest a Pliensbachian to Toarcian age according to the North Sea ranges (Berthelsen 1974; Lund 1977; Hoelstad 1985; Dybkjær 1988, 1991).

Lower Jurassic Unit C

The microfloras found in Unit C (74.51–84.97 m) of core 2 are characterized by fairly rich spore-dominated assemblages with common *Chomotriletes minor* and dominant *Deltoidospora minor*, *Lycopodiumsporites* spp. and *Retitriletes* spp. other forms include *Acanthotriletes varius*, *Apiculatisporites ovalis*, *Cerebropollenites macroverrucosus* and *Trachysporites* spp. The occurrence of *Cerebropllenites thiergartii* and *Callialasporites trilobatus* suggests a Late Toarcian to Aalenian age (Fig. 8). This is supported by the presence of the dinoflagellate *Phallocysta eumekes* (76.67 m), which is restricted to the *bifrons–opalinun* Zones (Powell 1992).

Core 8 was analysed for palynomorphs and microfaunas. The few single occurrences of agglutinated foraminifera provide little stratigraphic information. The palynological records (Fig. 10) include *Cerebropollenites macroverrucosus* and *C. thiergartii*, and at 105.77 m abundant *Apiculatisporites ovalis* and *Baculatisporites* spp., *Chasmatosporites major*, *Ischyosporites variegatus*, and the dinoflagellate cyst *Phallocysta eumekes*, which confirms a Late Toarcian to Early Aalenian age (Powell 1992). *Callialasporites trilobatus* is rare, being recorded only from the 61.56 m level.

Deltoidospora minor and other smooth forms dominate the spore assemblages, which also include *Apiculatisporites* sp., *Ischysporites variegatus*, *Leptolepidites* sp., *Lycopodiumsporites* spp., *Retitriletes semimurus*, *Stereisporites* spp. and *Chomotriletes minor*. Pollens include *Araucariacites australis*, *Cerebropollenites macroverrucosus*, *C. thiergartii*, *Classopollis classoides* and *Quadraculina anellaeformis*. The palynomorph assemblages characteristic of this unit resemble those of the *Spheripollenites–Leptolepidites* Zone (Dybkjaer 1991).

The abundance of spores in parts of the core, which are rich in degraded and structured wood remains, suggests proximity to a vegetation of ferns and mosses. Single specimens of *Haplophragmoides* and *Ammobaculites* demonstrate marine influence in samples from 105.78 m and 103.0 m (Fig. 7), while *Botryococcus* spp. at 101.29 m and 65.01–61.56 m indicate freshwater influx.

Rich assemblages of spores in core 1 (Fig. 12) include *Corrugatisporites amplectiformis*, *Deltoidospora australis*, *D. minor*, *Ischyosporites variegatus*, *Leptolepidites* spp., *Marttiasporites scabratus*, *Stereisporites* spp., *Retitriletes* (*Lycopodiumsporites*) spp., *S. aulosenensis*, *Striatella seebergensis* (*Asseretospora gyrata*), *Trachysporites* spp., *T. fuscus*, *Tripartina variabilis* and *Chomotriletes minor* (Fig.

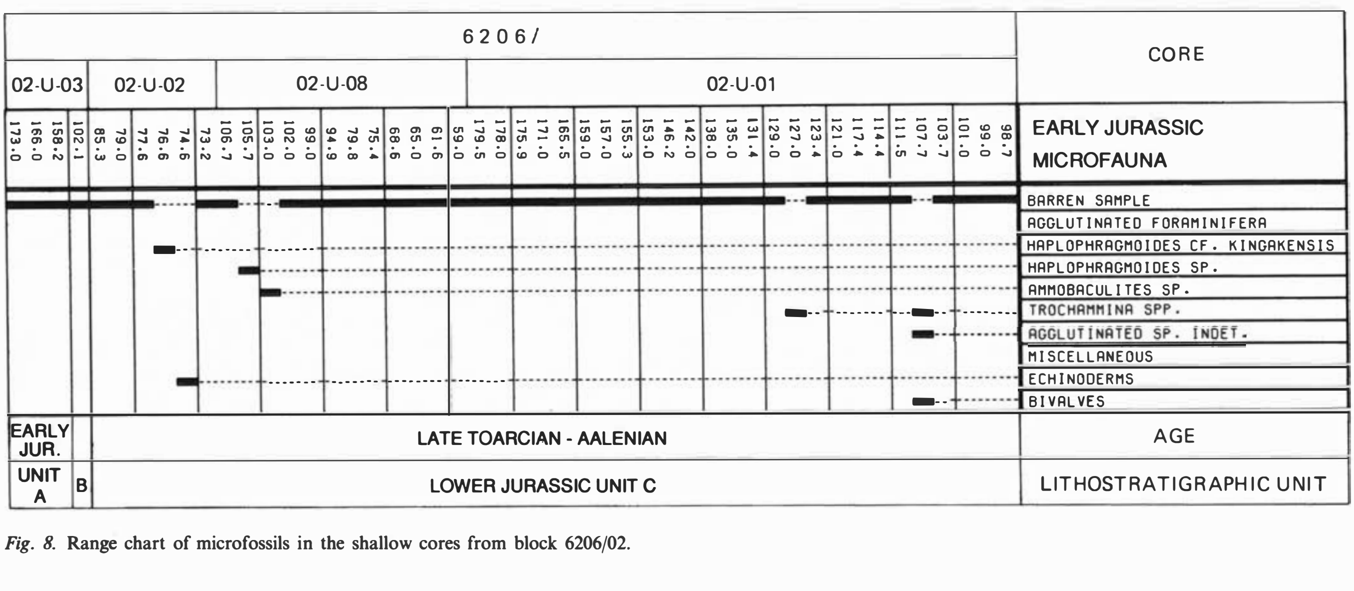


Fig. 8. Range chart of microfossils in the shallow cores from block 6206/02.

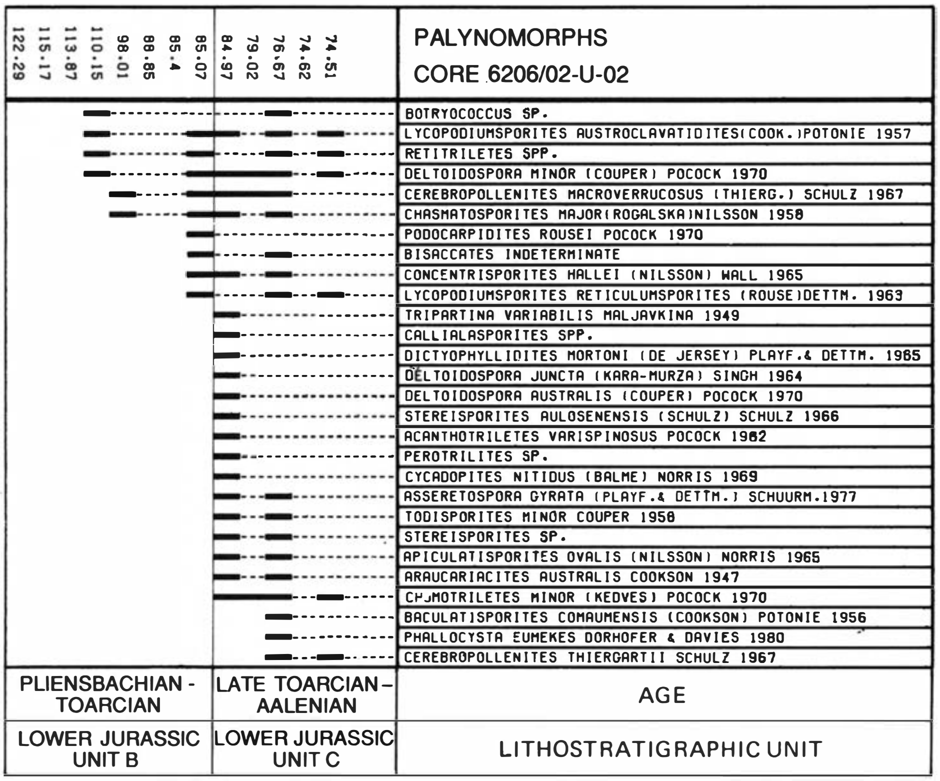


Fig. 9. Range chart of palynomorphs in core 6206/02-U-02.

12). Pollen grains are represented by *Araucariacites australis*, *Cerebropollenites macroverrucosus*, *C. thiergartii*, *Concentrisporites hallei*, *Cycadopites nitidus*, and *Quadraeculina anellaeformis*. The bisaccates generally occur in very low numbers.

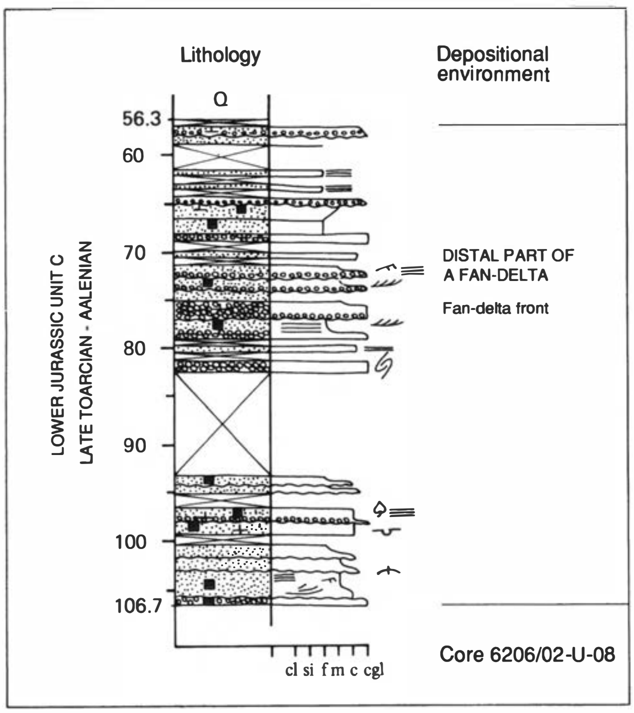


Fig. 10. Sedimentological core log and interpreted depositional environment of core 6206/02-U-08. Legend to sedimentological log is shown in Fig. 5.

There are marked variations in the relative composition of the organic residues and the palynological assemblages, particularly in the content of *Corrugatisporites amplectiformis*, *Striatella seebergensis*, *Ischyosporites variegatus*, *Manumia irregularis*, and *Marattiasporites scabratus*, which have been interpreted as due to the rapidly changing land flora. The abundant and varied pollen and spore assemblage and the presence of megaspores at about 136.21 m, 135.0 m, 131.49 m, 129.0 m and 114.44–107.76 m are interpreted as reflecting proximity to a rich vegetation growing under more humid conditions. The enrichment of cuticles and resinous matter reflect a large input of leaves from this environment. The microflora resembles that of core 8 and of the *Spheripollenites–Leptolepidites* Zone (Dybkjær 1991).

The dinoflagellate cyst *Nannoceratopis ambonis* and indeterminate microplankton (144.71 m) are evidence of restricted marine influence in a generally terrestrial domain.

The age diagnostic taxa, including *Callialasporites dampieri*, *Cerebropollenites thiergartii* and *Nannoceratopis ambonis*, suggest a Late Toarcian to Aalenian age for the entire unit. Though confident data are missing above the 107.76 m level, *Chomotriletes minor* is used to extend this age to the top of the core. In western Canada, *C. minor* is restricted to Jl_1, the lowest Middle Jurassic 'Lower Bajocian' (corresponding to the Aalenian) (Pocock 1970) which would favour an Aalenian age for Unit C.

The samples analysed with respect to microfauna were all barren except samples from 127.00 and 107.76 m,

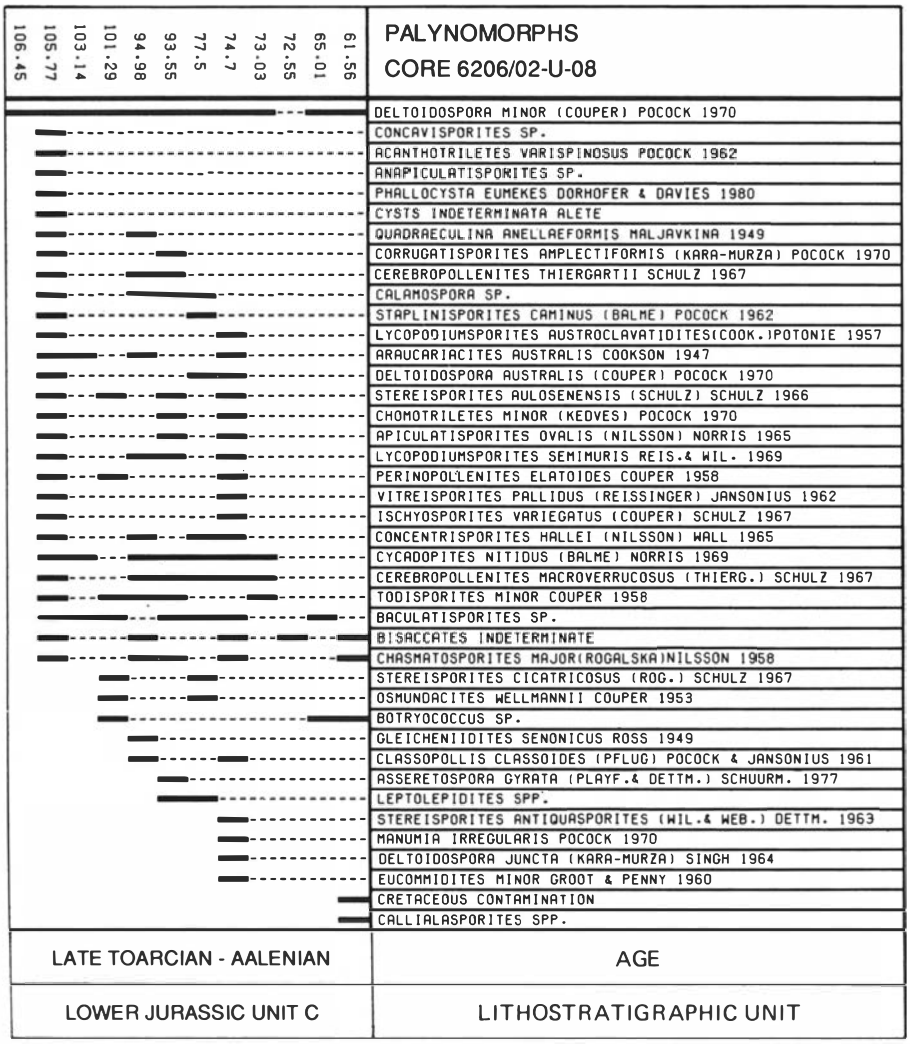


Fig. 11. Range chart of palynomorphs in core 6206/02-U-08.

which contained single occurrences of *Trochammina* spp. and *T.* cf. *squamataformis* respectively (Fig. 7). These observations add little to the stratigraphic information, but demonstrate a marine influence in parts of the succession.

Lower Cretaceous Lange Formation

The Lange Formation (98.3–76.0 m) in core 1 can be divided into two biostratigraphical units, possibly separated by a minor hiatus at approximately 79.5 m. Below this level a Late Albian–Early Cenomanian section is documented based on palynomorphs and foraminifera supported by nannofossil and belemnite records (Figs. 13–15). The 79.5–76 m interval contained different assemblages with respect to palynomorphs, nannofossils and foraminifera, and a general Cenomanian age was concluded separately. A Late Cenomanian age is possible, but not documented.

Following the stratigraphic distribution given by Davy and Costa (1992), the occurrence of the dinoflagellate *Apteodinium grande* between 98.25 and 94.80 m and at 88.00 m suggests a Late Albian age for this interval. This is further supported by the presence of *Litosphaeridium arundum*, *Cauca parva* and *Ovoidinium scabrosum* (Fig. 13). *Litosphaeridium arundum* is normally restricted to the Albian (Heilmann-Clausen 1987), while the latter two species may also range into the Early Cenomanian (Foucher 1981).

Oligosphaeridium complex is common in the lower part of this interval, i.e. from 98.25 to 96.5 m and at 94.8 m. An acme of *Chlamydophorella nyei* is observed at 88 m. *Surculosphaeridium longifurcatum* is common at 97.25 m.

The presence of *Apteodinium maculatum* from 79.71 to 78.00 m suggests an age not younger than Cenomanian. According to Foucher (1981) and Marshall & Batten (1988), *Litosphaeridium siphonophorum* may be used to distinguish Cenomanian and Turonian deposits in Northwest Europe. The presence of this species at 78.00 m is probably indicative of a Cenomanian age. A pre-Turonian age is also suggested by the presence of *Gonyaulacysta helicoidea* at 79.71 m.

The microfaunas recorded vary considerably with respect to both richness and composition (Fig. 14). Below 89.24 m the samples were very poor or barren except those from the lowermost samples at 98.00 and 97.00 m. The latter were composed of both calcareous and agglu-

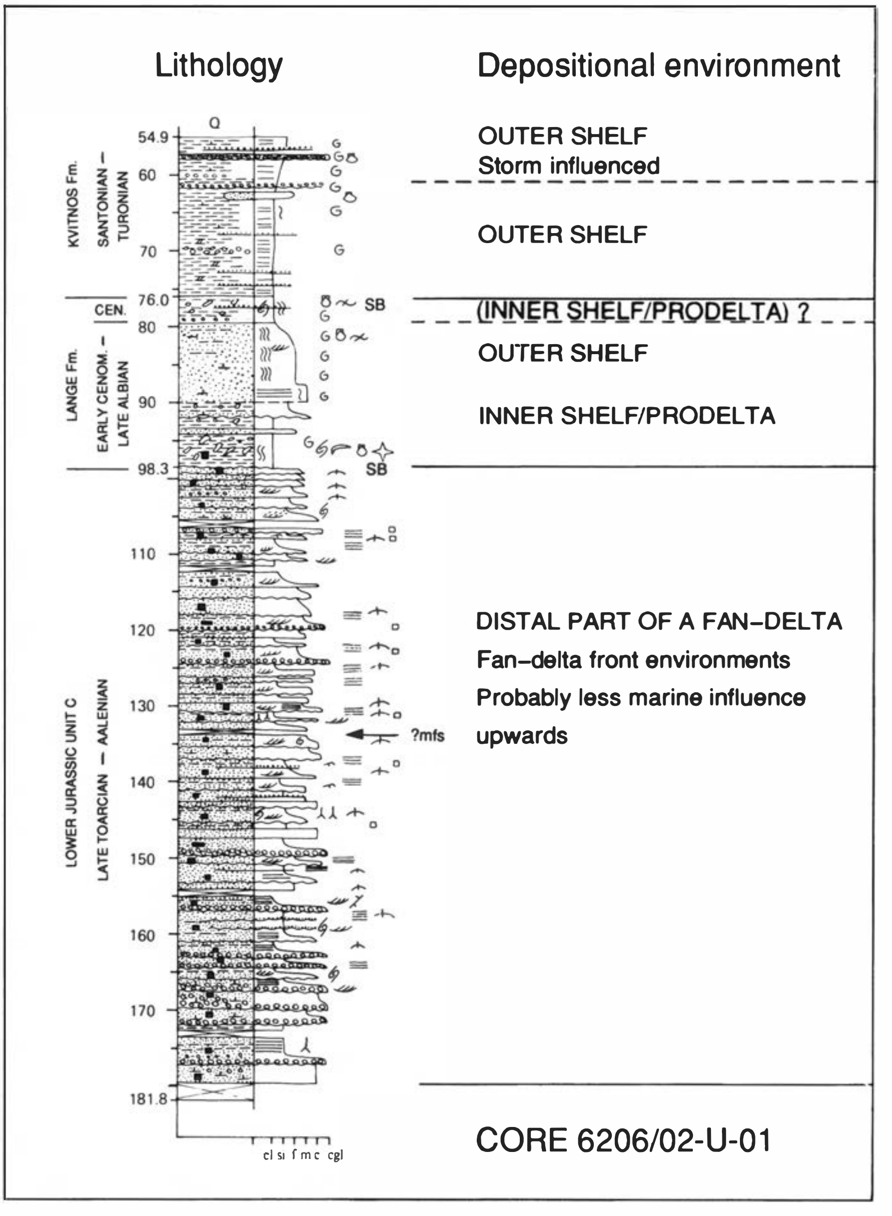


Fig. 12. Sedimentological core log and interpreted depositional environment of core 6206/02-U-01. Legend to sedimentological log is shown in Fig. 5.

tinated elements, and the former of agglutinated elements only, e.g. *Bathysiphon/Rhizammina* spp., *Glomospira charoides*, *Dorothia gradatra*, *Textularia foeda*, *Reophax minuta*, *Psammosphaera* spp. and *Verneuilinoides subfusiliformis*. Sample 97.00 m contained some of these taxa in addition to calcareous element composed of *Hedbergella planispira* (abundant), *Globigerinelloides bentonensis* (common), *Gavelinella schloenbachi*, *Nodosaria humilis* and *Dentalina lorneiana*. The abundant occurrence of the planktonic species *H. planispira* together with *G. bentonensis* support the Late Albian palynological age assignment.

The samples between 86.59 m and 79.71 m all contained the index form *Lingulogavelinella jarzevae* and were dominated by the planktonic *H. delrioensis* and calcareous benthonic species. The more important taxa recorded were *Cibicides gorbenkoi* and *Arenobulimina advena praeadvena* (86.59 m), *H. delrioensis*, *Praebulimina evexa* and *L. kaptarenkae* (85.01 m). The presence of *L. jarzevae* restricts the age of this interval to latest Albian or Early Cenomanian (Hart et al. 1981). Barnard & Banner (1982) report *A. advena praeadvena* from Early Cenomanian in England, with questionable specimens in the very latest Albian, supporting the suggestion of and Early Cenomanian age at the 86.59 m level.

The two uppermost samples in this interval also represent Cenomanian sediments, as shown by the presence of *G. cenomanica* and *G. baltica* (Hart et al. 1981). No forms were found in these samples that could exclude a Late Cenomanian age.

There is no nannofossil evidence below the 90.04 m level of this core. The highest occurrence of *Prediscosphaera columnata* at 83.00 m and *Gartnerago praeobliquum* at 90.04 m (Fig. 15) suggests an Albian age. One sample at 80.16 m could be of Albian to Middle Cenomanian age judged on the presence of *Cribrosphaerella primitiva*, but because of the very poor diversity of the nannoflora the evidence is insufficient to

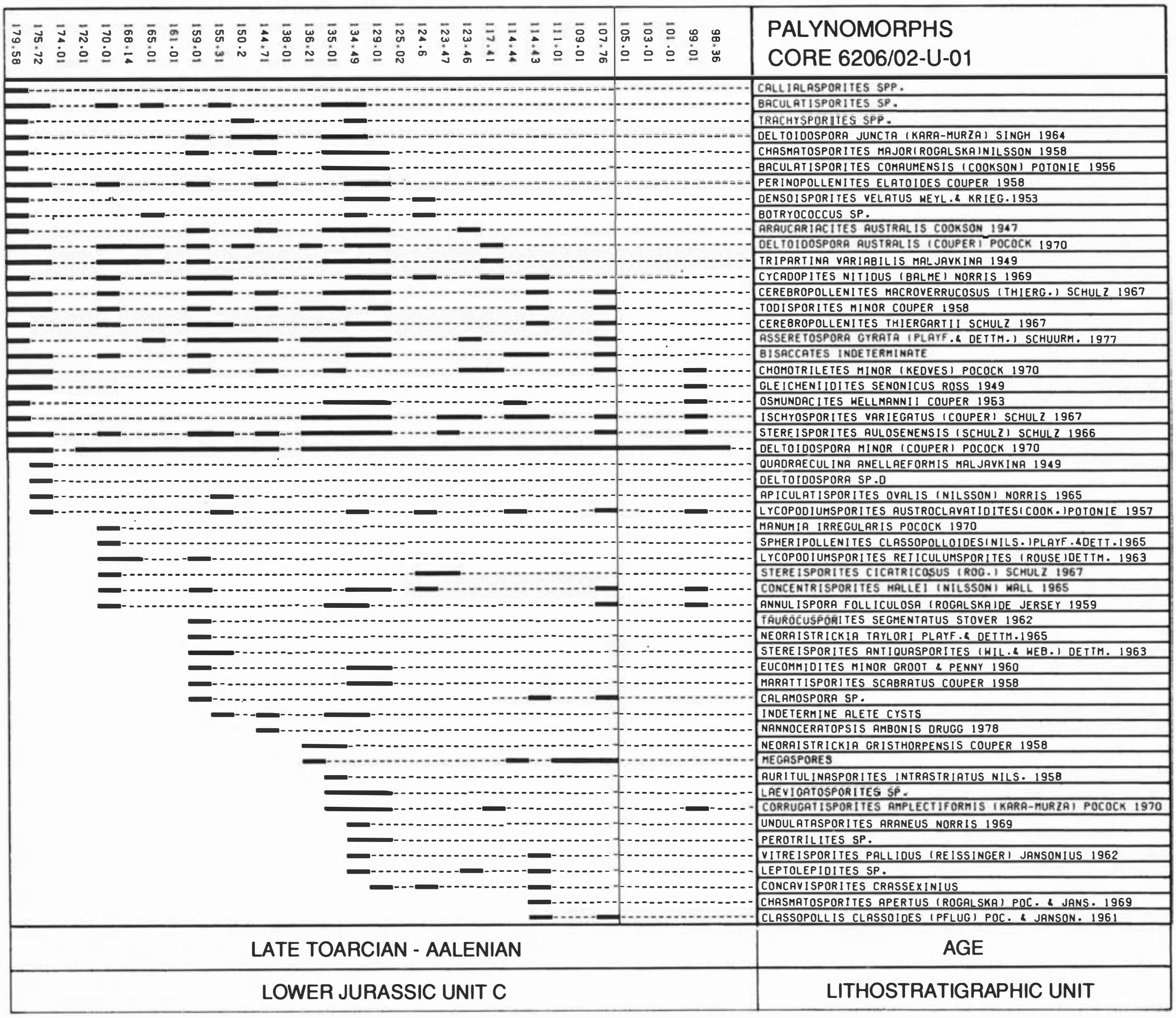


Fig. 13. Range chart of palynomorphs in the Jurassic succession of core 6206/02-U-01.

conclude a Cenomanian age. The occurrence of both *Retecapsa loriei* and *Prediscosphaera cretacea* in a sample at 79.21 m is evidence of a Cenomanian age at this level. The common presence of *Staurolithes matalosus* has also been observed frequently in the Cenomanian.

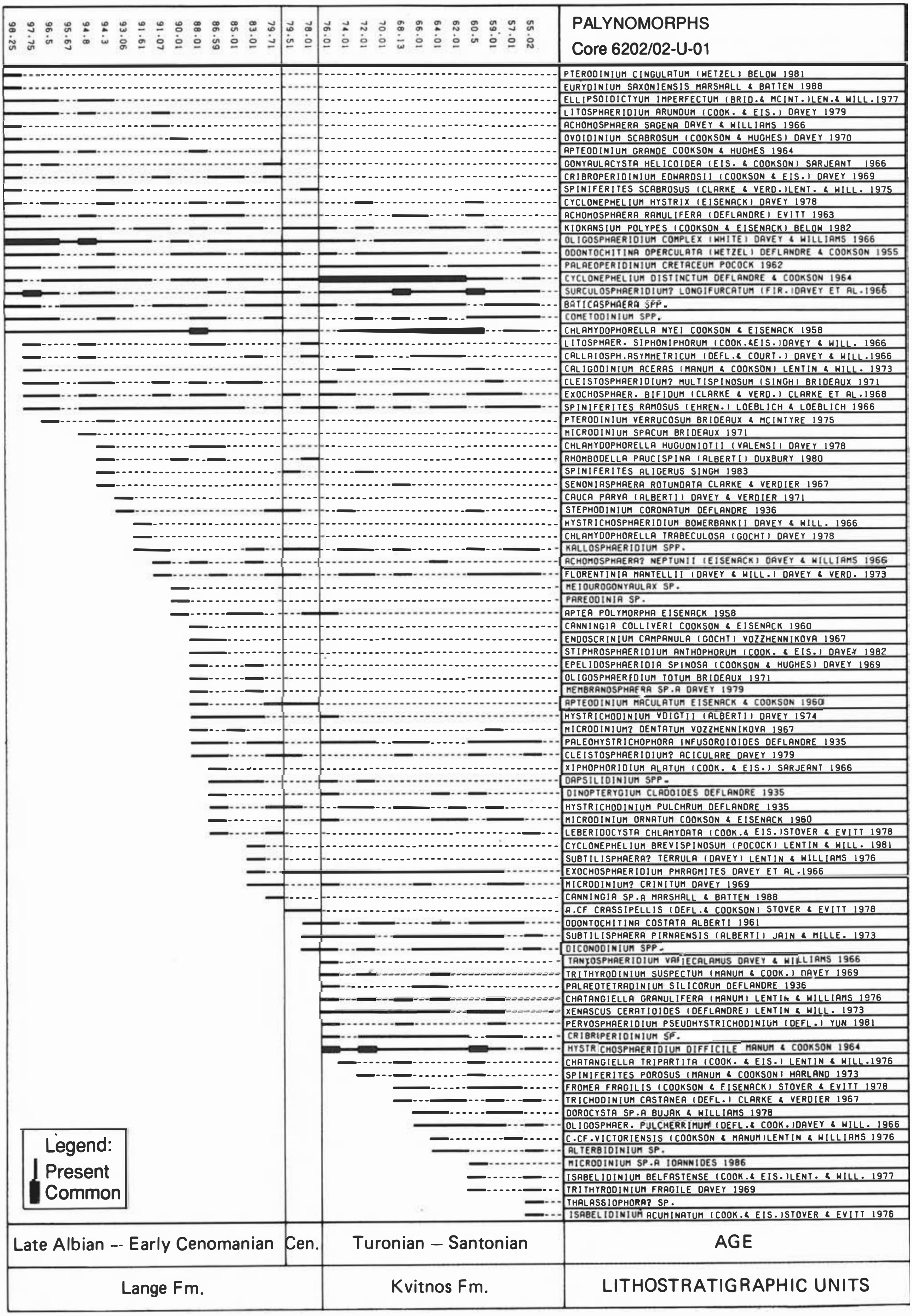
A belemnite epirostrum from 96.50 m has been determined as *Neohibolites minimus* (Lister). This supports a Late Albian age for this level.

Upper Cretaceous Kvitnos Formation

A general Turonian to Santonian age is assigned to the Kvitnos Formation in core 1 based on the overall microfauna and floral content. The biostratigraphic evidence indicates a hiatus of approximately 2 My at the boundary between the Lange and the Kvitnos formations, and that upper Cenomanian and lowermost Turonian deposits are missing at this locality.

The earliest appearance of dinoflagellates *Hystrichosphaeridium difficile* and *Chantangiella granulifera* at 76.00 m immediately above the unconformity show that Turonian or younger Cretaceous deposits are reached. According to the 'Cycle chart' by Haq et al. (1987), *H. difficile* ranges from the Late Turonian to Early Santonian, but according to Jarvis et al. (1988) this species occurs in the Early Turonian in southeast England. The occurrence of *Subtilisphaera pirnaensis* up to 55.02 m

Fig. 14. Range chart of dinoflagellate cysts in the Cretaceous succession of core 6206/02-U-01.


PALYNOMORPHS
Core 6202/02-U-01
98.25
97.75
96.5
95.67
94.8
94.3
93.06
91.61
91.07
90.01
88.01
86.59
85.01
83.01
79.71
79.51
78.01
76.01
74.01
72.01
70.01
68.13
66.01
64.01
62.01
60.5
59.01
57.01
55.02
PTERODINIUM CINGULATUM (WETZEL) BELOW 1981
EURYDINIUM SAXONIENSIS MARSHALL & BATTEN 1988
ELLIPSOIDICTYUM IMPERFECTUM (BRID.& MCINT.)LEN.& WILL.1977
LITOSPHAERIDIUM ARUNDUM (COOK. & EIS.) DAVEY 1979
ACHOMOSPHAERA SAGENA DAVEY & WILLIAMS 1966
OVOIDINIUM SCABROSUM (COOKSON & HUGHES) DAVEY 1970
APTEODINIUM GRANDE COOKSON & HUGHES 1964
GONYAULACYSTA HELICOIDEA (EIS. & COOKSON) SARJEANT 1966
CRIBROPERIDINIUM EDWARDSII (COOKSON & EIS.) DAVEY 1969
SPINIFERITES SCABROSUS (CLARKE & VERD.)LENT. & WILL. 1975
CYCLONEPHELIUM HYSTRIX (EISENACK) DAVEY 1978
ACHOMOSPHAERA RAMULIFERA (DEFLANDRE) EVITT 1963
KIOKANSIUM POLYPES (COOKSON & EISENACK) BELOW 1982
OLIGOSPHAERIDIUM COMPLEX (WHITE) DAVEY & WILLIAMS 1966
ODONTOCHITINA OPERCULATA (WETZEL) DEFLANDRE & COOKSON 1955
PALAEOPERIDINIUM CRETACEUM POCOCK 1962
CYCLONEPHELIUM DISTINCTUM DEFLANDRE & COOKSON 1964
SURCULOSPHAERIDIUM? LONGIFURCATUM (FIR.)DAVEY ET AL.1966
BATICASPHAERA SPP.
COMETODINIUM SPP.
CHLAMYDOPHORELLA NYEI COOKSON & EISENACK 1958
LITOSPHAER. SIPHONIPHORUM (COOK.&EIS.)DAVEY & WILL. 1966
CALLAIOSPH.ASYMMETRICUM (DEFL.& COURT.) DAVEY & WILL.1966
CALIGODINIUM ACERAS (MANUM & COOKSON) LENTIN & WILL. 1973
CLEISTOSPHAERIDIUM? MULTISPINOSUM (SINGH) BRIDEAUX 1971
EXOCHOSPHAER. BIFIDUM (CLARKE & VERD.) CLARKE ET AL.1968
SPINIFERITES RAMOSUS (EHREN.) LOEBLICH & LOEBLICH 1966
PTERODINIUM VERRUCOSUM BRIDEAUX & MCINTYRE 1975
MICRODINIUM SPACUM BRIDEAUX 1971
CHLAMYDOPHORELLA HUGUONIOTII (VALENSI) DAVEY 1978
RHOMBODELLA PAUCISPINA (ALBERTI) DUXBURY 1980
SPINIFERITES ALIGERUS SINGH 1983
SENONIASPHAERA ROTUNDATA CLARKE & VERDIER 1967
CAUCA PARVA (ALBERTI) DAVEY & VERDIER 1971
STEPHODINIUM CORONATUM DEFLANDRE 1936
HYSTRICHOSPHAERIDIUM BOWERBANKII DAVEY & WILL. 1966
CHLAMYDOPHORELLA TRABECULOSA (GOCHT) DAVEY 1978
KALLOSPHAERIDIUM SPP.
ACHOMOSPHAERA? NEPTUNII (EISENACK) DAVEY & WILLIAMS 1966
FLORENTINIA MANTELLII (DAVEY & WILL.) DAVEY & VERD. 1973
MEIOUROGONYAULAX SP.
PAREODINIA SP.
APTEA POLYMORPHA EISENACK 1958
CANNINGIA COLLIVERI COOKSON & EISENACK 1960
ENDOSCRINIUM CAMPANULA (GOCHT) VOZZHENNIKOVA 1967
STIPHROSPHAERIDIUM ANTHOPHORUM (COOK. & EIS.) DAVEY 1982
EPELIDOSPHAERIDIA SPINOSA (COOKSON & HUGHES) DAVEY 1969
OLIGOSPHAERIDIUM TOTUM BRIDEAUX 1971
MEMBRANOSPHAERA SP.A DAVEY 1979
APTEODINIUM MACULATUM EISENACK & COOKSON 1960
HYSTRICHODINIUM VOIGTII (ALBERTI) DAVEY 1974
MICRODINIUM? DENTATUM VOZZHENNIKOVA 1967
PALEOHYSTRICHOPHORA INFUSOROIOIDES DEFLANDRE 1935
CLEISTOSPHAERIDIUM? ACICULARE DAVEY 1979
XIPHOPHORIDIUM ALATUM (COOK. & EIS.) SARJEANT 1966
DAPSILIDINIUM SPP.
DINOPTERYGIUM CLADOIDES DEFLANDRE 1935
HYSTRICHODINIUM PULCHRUM DEFLANDRE 1935
MICRODINIUM ORNATUM COOKSON & EISENACK 1960
LEBERIDOCYSTA CHLAMYDATA (COOK.& EIS.)STOVER & EVITT 1978
CYCLONEPHELIUM BREVISPINOSUM (POCOCK) LENTIN & WILL. 1981
SUBTILISPHAERA? TERRULA (DAVEY) LENTIN & WILLIAMS 1976
EXOCHOSPHAERIDIUM PHRAGMITES DAVEY ET AL.1966
MICRODINIUM? CRINITUM DAVEY 1969
CANNINGIA SP.A MARSHALL & BATTEN 1988
A.CF CRASSIPELLIS (DEFL.& COOKSON) STOVER & EVITT 1978
ODONTOCHITINA COSTATA ALBERTI 1961
SUBTILISPHAERA PIRNAENSIS (ALBERTI) JAIN & MILLE. 1973
DICONODINIUM SPP.
TANYOSPHAERIDIUM VARIECALAMUS DAVEY & WILLIAMS 1966
TRITHYRODINIUM SUSPECTUM (MANUM & COOK.) DAVEY 1969
PALAEOTETRADINIUM SILICORUM DEFLANDRE 1936
CHATANGIELLA GRANULIFERA (MANUM) LENTIN & WILLIAMS 1976
XENASCUS CERATIOIDES (DEFLANDRE) LENTIN & WILL. 1973
PERVOSPHAERIDIUM PSEUDHYSTRICHODINIUM (DEFL.) YUN 1981
CRIBROPERIDINIUM SP.
HYSTRICHOSPHAERIDIUM DIFFICILE MANUM & COOKSON 1964
CHATANGIELLA TRIPARTITA (COOK. & EIS.) LENTIN & WILL.1976
SPINIFERITES POROSUS (MANUM & COOKSON) HARLAND 1973
FROMEA FRAGILIS (COOKSON & EISENACK) STOVER & EVITT 1978
TRICHODINIUM CASTANEA (DEFL.) CLARKE & VERDIER 1967
DOROCYSTA SP.A BUJAK & WILLIAMS 1978
OLIGOSPHAER. PULCHERRIMUM (DEFL.& COOK.)DAVEY & WILL. 1966
C.CF.VICTORIENSIS (COOKSON & MANUM)LENTIN & WILLIAMS 1976
ALTERBIDINIUM SP.
MICRODINIUM SP.A IOANNIDES 1986
ISABELIDINIUM BELFASTENSE (COOK.& EIS.)LENT. & WILL. 1977
TRITHYRODINIUM FRAGILE DAVEY 1969
THALASSIOPHORA? SP.
ISABELIDINIUM ACUMINATUM (COOK.& EIS.)STOVER & EVITT 1976
Legend:
Present
Common
Late Albian -- Early Cenomanian
Cen.
Turonian – Santonian
AGE
Lange Fm.
Kvitnos Fm.
LITHOSTRATIGRAPHIC UNITS

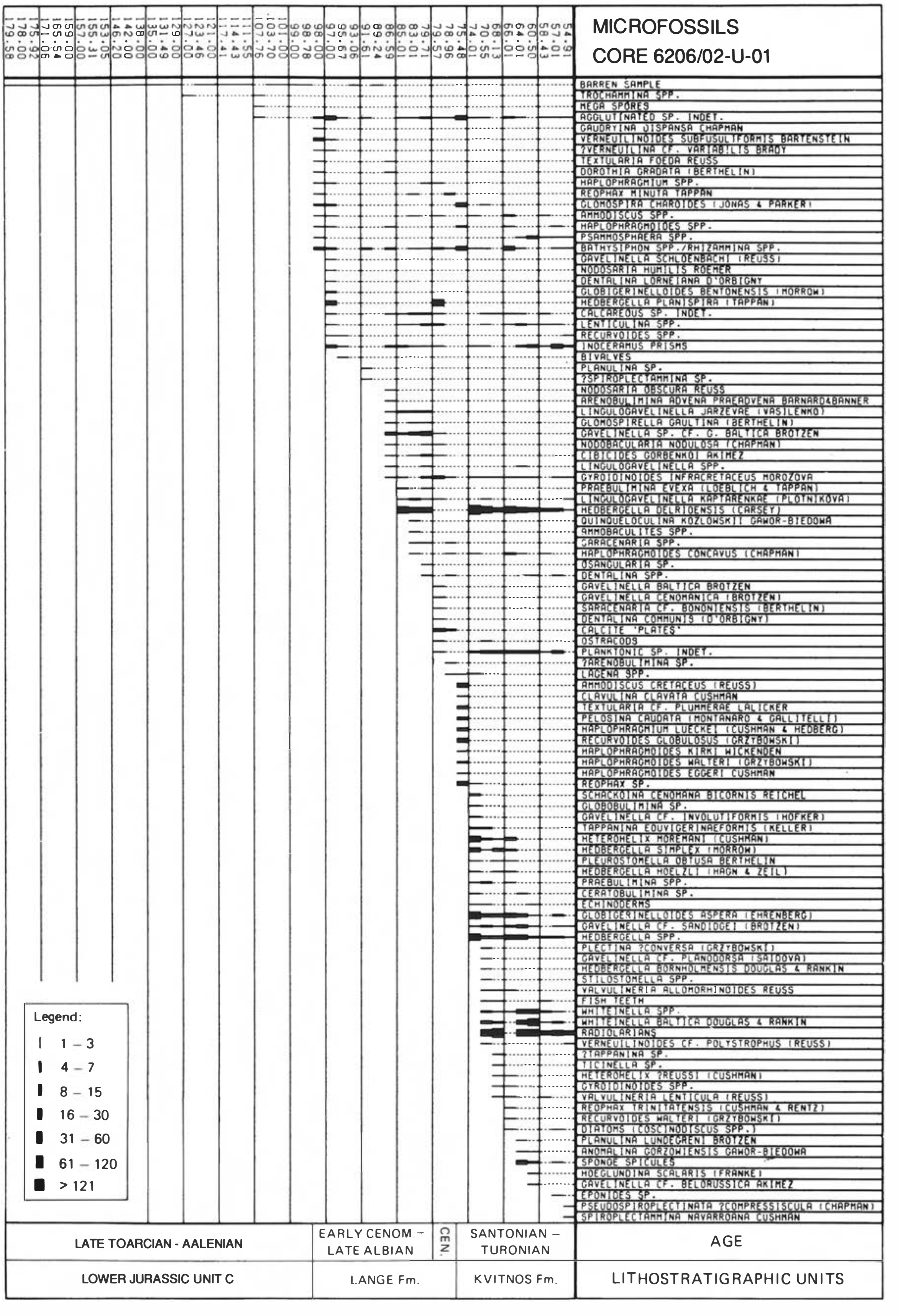


Fig. 15. Range chart of microfossils in core 6206/02-U-01.

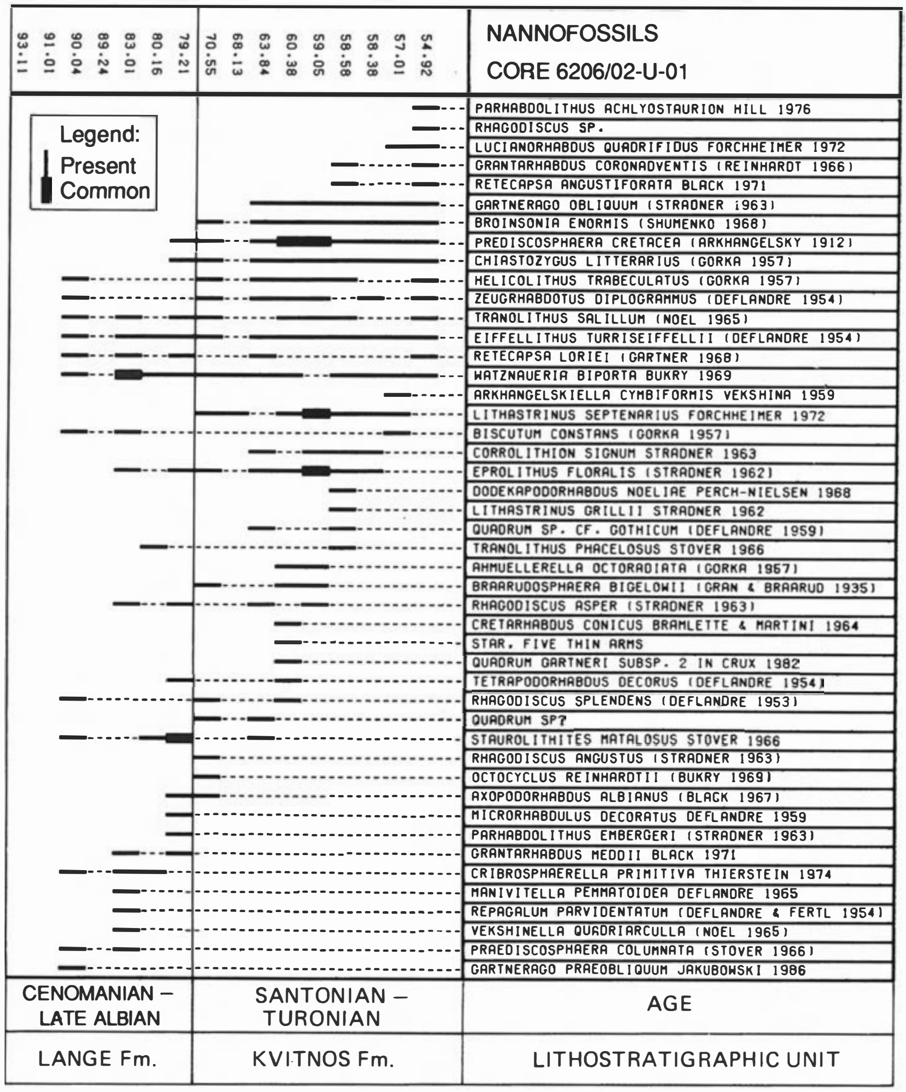


Fig. 16. Range chart of nannofossils in core 6206/02-U-01.

further supports an age not younger than the Santonian for the top of the core.

Other characteristic Late Cretaceous taxa include: *Alterbidinium* sp., *Chatangiella tripartita*, *Diconodinium* spp., *Dorocysta* sp. A of Bujak & Williams 1978, *Fromea fragilis*, *Isabelidinium* spp., *Odontochitina costata* and *Palaeotetradinium silicorum*.

The presence of *Stephodinium coronatum* up to 60.50 m may suggest that the interval 76.00–60.50 m is of Turonian age, as this species is normally restricted to pre-Coniacian strata (Haq et al. 1987).

Cyclonephelium distinctum is the most common species between 76.00 and 62.00 m. *Hystrichosphaeridium difficile* is prominent at 76.00, 72.00 and 60.50 m. *Chlamydophorella nyei* and *Surculosphaeridium longifurcatum* which are also common in some samples from the Late Albian and Cenomanian interval, also have acme occurrences at 60.50 m and at 68.50 m and 60.50 m, respectively.

An agglutinated 'flysch-type' foraminifer fauna at 75.48 m includes *Ammodiscus cretaceus*, *Bathysiphon/Rhizammina* spp., *Clavulina clavata*, *Glomospirella charoides*, *Haplophragmium lueckei*, *Haplophragmoides kirki*, *Pelosina caudata*, *Recurvoides globulosus*, *Textularia* cf. *plummerae* and others. The fauna is entirely different from the fauna following from the 74.01 m level and persisting to the top of the core. The association is dominated by planktonic foraminifera, with calcareous and agglutinated elements as minor, but indigenous elements. The important new occurrences are as follows: *Gavelinella* cf. *sandidgei*, *Globigerinelloides aspera*, *Hedbergella hoelzli*, *H. simplex*, *Heterohelix moremani*, *Pleurostomella reussi*, *Schackoina cenomana bicornis* and *Tappania eouvigerinaeformis* (74.01 m), *H. bornholmensis*, *Valvulineria allomorphinoides Whiteinella baltica*, *Verneuilinoides polystrophus* (70.55 m), *Anomalina gorzowiensis* (64.01 m), *Planulina lundegreni*, *Gavelinella* cf. *belorussica* (60.50 m) and *Valvulineria lenticula* (68.13 m).

H. hoelzli, *P. lundegreni* and *W. baltica* restrict the age to Turonian or younger. *W. baltica* (57.01 m) and *H. delrioensis* (54.91 m) make it likely that the age is not younger than Santonian. The uppermost sample contained few age diagnostic species, though according to Robaszynski et al. (1980) allow a restriction to Santonian age.

The nannoflora assemblage in the Kvitnos Formation represents a stratigraphic mixture of index species. The occurrence of early forms of *Quadrum gartnerii* and the co-occurrence of *Biscutum constans* and *Ahmuellerella octoradiata* and common to abundant *Lithastrinus septenarius* and *Eprolithus floralis* firmly suggests a Turonian age at 59.05 m. *Rhagodiscus asper* at this high level and *Rhagodiscus angustus*, *Octocyclus reinhardtii* and *Axopodorhabdus albianus* at the 70.55 m level, are all considered as Cenomanian or older reworked material. These observations support the sedimentological indications that reworking of older sediments has taken place at this level.

In conclusion, both the microfauna and nannoplankton assemblages support a latest Turonian age below 59 m, and a possible Coniacian–Santonian age above 58.43 m.

Seismic interpretation and sequence stratigraphy

Seismic units and reflections

At site 3 we can define two seismic units within the penetrated section on seismic line IKU-201-88 (Fig. 2). These correspond to lithostratigraphic Units A and B, respectively. Both bedrock units have chaotic acoustic signatures with discontinuous reflections. The frequency of reflections is lower in Unit A, but this might be explained by the processing causing lower energy return from around 0.5 s. The reflection amplitudes are high in Unit B, and low below the strong and nearly continuous reflection separating the two units. This reflection has a large-scale hummocky appearance in the upper part, but is difficult to interpret confidently below 0.5 s.

The reflections in the upper part of Unit B at site 3 are apparently truncated at a nearly horizontal and partly continuous west of the site, approximately 20 ms below the base Quaternary. A possible explanation could be that this represents a weathering boundary within the upper unit, stratigraphically above the cored section.

At site 2, two seismic units corresponding to lithostratigraphic Units B and C are defined (Fig. 2). The lower seismic unit was also defined in the upper part of core 3. The lower unit (B) has a chaotic seismic signature, with discontinuous high amplitude reflections. The upper unit (C) has high amplitude reflections which become more continuous higher up. Also the amplitude and frequency of reflections increase upwards in this unit.

At site 1 three seismic units corresponding to lithostratigraphic Unit C and the Cretaceous Lange and Kvitnos formations are defined (Fig. 2). The oldest comprises partly continuous high amplitude reflections as described above. The onlapping reflectors in the seismic unit above corresponding to the Lange formation have lower amplitude and are truncated by the uppermost sequence boundary, i.e. the boundary between the Lange and Kvitnos formations. The middle seismic unit is probably pinching out immediately eastwards of the coring site. The uppermost seismic unit corresponding to the Kvitnos formation has a chaotic seismic signature at the coring site, but upwards nearly parallel continuous reflections can be seen.

Seismic and depositional sequences

The large-scale hummocky appearance of the reflection at the interface indicates that Unit A has been subject to erosion, and the boundary between Unit A and Unit B represents a major sequence boundary. This corresponds to seismic reflection IJ_1 on Figs. 2 and 3. The poor biostratigraphic resolution makes it difficult to estimate the temporal magnitude of the hiatus separating these two units, but the stratigraphic gap may be in the order of 20 My, implying that at least the Sinemurian and Pliensbachian are missing at this site.

The boundary between Unit B and Unit C in core 2 is defined at 85 m by the transition to a unit comprising poorly sorted sandstones and mudstones with coal fragments. This boundary corresponds to the IJ_1 seismic reflection. The boundary between Units B and C in core 2 is also recognized by a distinct shift in the petrophysical logs, and by the high amplitude seismic reflection, which has a distinctive 'wavy' appearance, possibly representing an inundated topography.

The erosional lag deposits at the base of Unit C are interpreted here as a transgressive surface. Following this interpretation the proximal fan-delta deposits of Unit B would comprise low stand deposits, while Unit C would represent the lower part of a transgressive unit.

This transgressive unit is also represented by core 8, which penetrated the same seismic unit as the upper part of core 2. The seismic unit recovered in core 8 contains high amplitude reflections which are partly continuous at the coring site and to the west of it. The high frequency of reflections which correlates with the observation of numerous cemented layers in the sandstone sequence encountered at this site.

Within the penetrated bedrock at site 1, three seismic units are defined (Fig. 2). These units correspond to the Lower Jurassic Unit C, and to the Cretaceous Lange Formation and the Kvitnos Formation, respectively.

The lowermost Unit C, below the reflections defining the lowermost sequence boundary at 98.3 m in core 1 (i.e. the Jurassic/Cretaceous boundary), shows partly continuous high amplitude reflections. The lowermost part of this seismic unit represents a further continuation of the transgressive deposits recognized in the upper core 2 and core 8.

The upward decrease in beach rock horizons and an increase in signs of subaerial exposure indicate a regressive development in the upper part of the unit.

The evidence is vague, but, based on the distribution of marine microplankton and the interpretation of the petrophysicial logs, we have interpreted the peak in the gamma readings at ≈135 m, tentatively to coincide with the maximum flooding surface of the sequence comprising lithostratigraphic Units B and C. The transgressive deposits of this sequence would thus comprise the succession covered by the upper part of core 2, core 8 and the lower part of core 1 (i.e. below 135 m), and the high stand system tract of the sequence would comprise the middle part of core 1 (i.e. from 135 m up to the sequence boundary at 98.3 m).

The sequence boundary recognized at 98.3 m in core 1 represents a major hiatus with a temporal magnitude of 80 My (i.e. spanning the earliest Aalenian to the Late Albian time interval). This boundary corresponds to the BC seismic reflection. The overlying 43.4 m thick Cretaceous succession in core 1 can be divided into two sequences by the sequence boundary at 98.3 m and an intra-Cretaceous sequence boundary at 76.0 m. These two sequence boundaries show evidence of both truncation and onlap.

The oldest of the two sequences, which lithostratigraphically can be related to the Lange Formation, has lower amplitude reflections than the underlying Lower–Middle Jurassic sequence. It possibly pinches out immediately east of the coring site. Poor seismic resolution allows no detailed interpretation at the site.

The sequence corresponding to the Lange Formation comprises three sub-units. The lowermost unit (98.3–90 m) is interpreted as representing partly mass-gravity flows, and partly sedimentation from suspension in an inner shelf/prodelta depositional environment. These may represent low-stand deposits.

The overlying sub-unit (90.0–97.5 m) comprises marine coastal sand at the base, gradually evolving into outer shelf deposits during a transgressive event (i.e. representing a transgressive system fract).

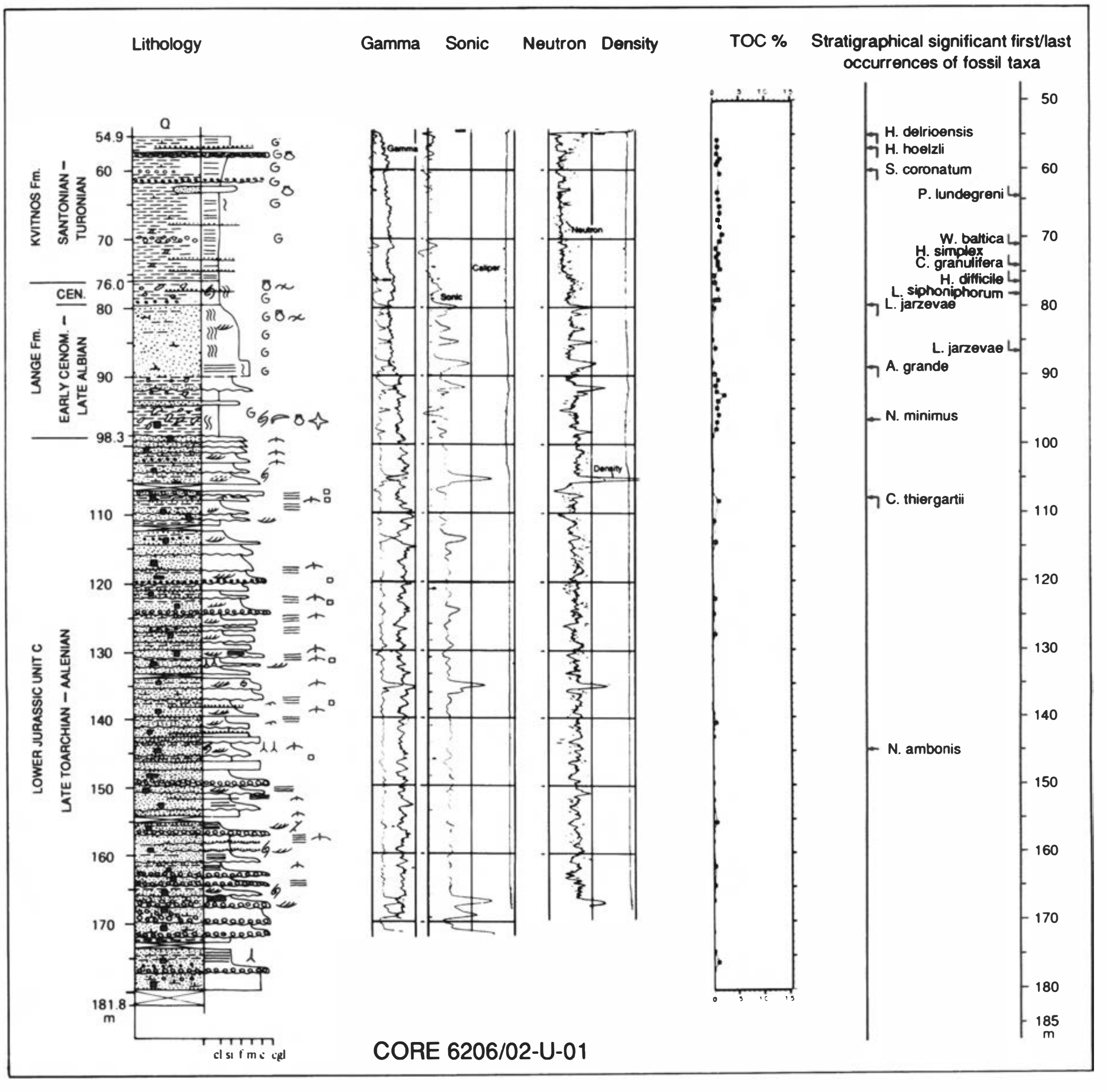


Fig. 17. Lithostratigraphy, petrophysical logs, TOC – data and first/last occurrences of biostratigraphic key fossils in core 6206/02-U-01.

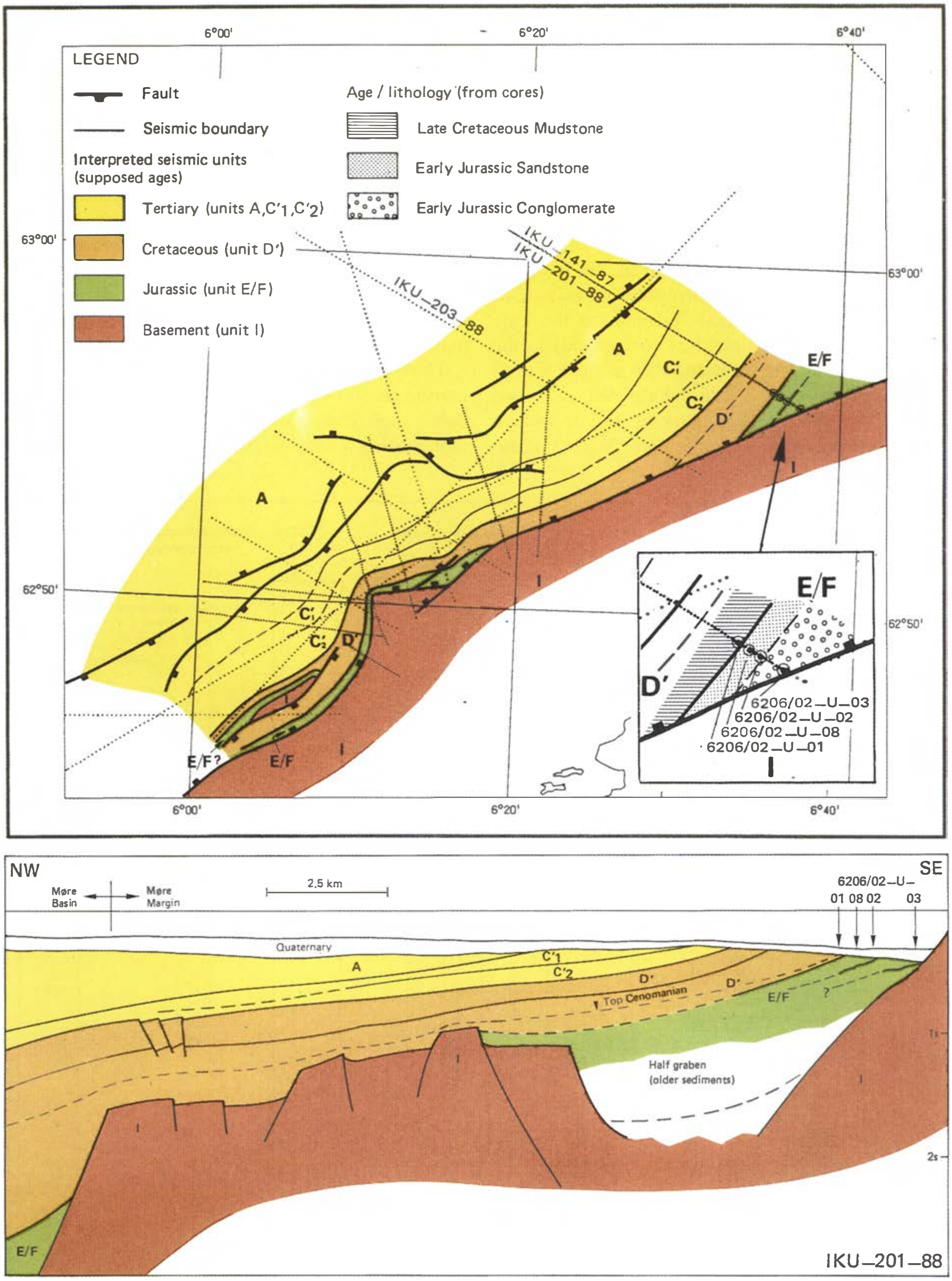


Fig. 18. Seismic interpretation of subcropping units at the Møre Basin Margin. A schematic profile is drawn from seismic line IKU-201-88 (see also Fig. 2).

At 79.5 m there is a marked change in lithofacies, and the sandstone is replaced by heterogeneous mudstone with abundant clasts. This lower Cenomanian unit is. interpreted as inner shelf/prodelta deposits, representing the high stand system tract of the Late Albian–Middle Cenomanian depositional sequence.

The Turonian–Santonian sequence referred to as the Kvitnos Formation is interpreted as representing open marine outer shelf sediments deposited during a relative sea-level high stand period.

The Late Albian to Early Cenomanian sand body within the Lange Formation might possess potential reservoir qualities in marginal positions, and deserves some consideration with respect to its possible areal distribution. The sand may have been deposited in response to a distinct short-term sea level fall close to 97 My. According to Hastings (1987), the (?)Aptian to Cenomanian sands in the northern Haltenbanken area represent regional mappable seismic units, whereas the Turonian and younger sands have the seismic character of a submarine fan with local sand bodies. This may support the assumption that the Late Albian (at base) sand is caused by sea level fluctuations. Our sedimentological model (inner shelf/coastal) is in agreement with the observation by Hastings (1987). Brekke & Riis (1987) indicate that the clastic input is probably derived through erosion from the Trøndelag Platform and Frøya High, which represented stable elements at that time.

Bedrock map of the Møre Basin Margin

A series of westward tilted horst blocks separates the deep Møre Basin from a nearshore basin within the Møre Basin Margin in the southern area. Several subcropping units have been mapped in the nearshore area, but owing to the offshore horst only units of late Cretaceous or younger age can confidently be tied from the nearshore basin into the Møre Basin.

The subcrop map in Fig. 17 is modified from the map presented by Haugane et al. (unpublished), partly based on information from cores. As data from new seismic surveys have not been available, a complete reinterpretation of the subcropping units has not been carried out.

Units C_1' and C_2' (Fig. 17) were previously interpreted to be of Cretaceous age, but Turonian/Santonian age in the uppermost part of core 6206/02-U-01 now indicates that the Cretaceous–Tertiary boundary subcrops further to the east. The reflection between units C_2' and D′ is a possible candidate for this boundary.

Core 1 shows that the Cretaceous–Jurassic boundary subcrops further to the west than previously interpreted. As this boundary does not subcrop on line IKU-203-88, the subcrops of the sequences seen on line IKU-201-88 (IKU-141-87) are cut off by the basement fault to the south somewhere between the two lines.

The seismic tie to the subcropping Jurassic units encountered at the coring sites southwest of the area around 62°50′ is uncertain, and the sedimentary unit subcropping near the basement in this area has a seismic signature different from that seen on line IKU-201-88. Based on the existing data we cannot, however, exclude a possible Jurassic age of the oldest subcropping strata.

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