

The Albian stage and substage boundaries

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Abstract

Following discussions at the Second International Symposium on Cretaceous Stage Boundaries, held in Brussels, 8-16 September 1995, the Working Group has identified two possible GSSP's (Global Boundary Stratotype Sections and Points) for the base of the Albian Stage. One of these, located at Vohrum (North Germany), was fully discussed at the Copenhagen Symposium in 1983 and, if selected, would use the appearance of *Leymeriella schrammeni* for the definition of the base of the Albian Stage. Unfortunately, apart from the ammonite information, there appears to be few other biostratigraphic data available for that succession. An alternative stratotype section, in the Vocontian Trough of S.E. France, offers a wider range of descriptors, including ammonites, calcareous nannofossils, planktonic foraminifera, dinoflagellate cysts and oceanic anoxic events [e.g., the Paquier Event]. Once data for both sections are fully compiled a boundary is clearly definable.

The bases of the Middle Albian and Upper Albian were also discussed, the decision having been taken to retain the tripartite subdivision of the Albian Stage. A possible GSSP for the base of the Middle Albian is the Côtes Noires succession on the River Marne near St-Dizier [Haute-Marne, France]. While the boundary may be identified by the appearance of *Lyelliceras lyelli* further work on the proposed GSSP needs to be done [possibly by the GFC]. The base of the Upper Albian is probably best defined by the appearance of *Dipoloceras cristatum*. There are two potential GSSP's; Wissant [Pas-de-Calais, France] and Folkestone [Kent, England] — both listed by d'ORBIGNY in the initial definition of the Stage. Either of these sections could act as the GSSP, although it is recognised that the succession at Folkestone is very condensed. An alternative locality, in the Vocontian Trough [S.E. France] may prove more suitable and information on all three locations will be gathered before a final decision is taken.

Key words: Albian, Lower Cretaceous, biostratigraphy, ammonites, inoceramids, foraminiferids, nannofossils, stratotypes, oceanic anoxic events, GSSP.

Résumé

À la suite des discussions du "Second International Symposium on Cretaceous Stage Boundaries" tenu à Bruxelles (8-16 Septembre 1995), le Groupe de Travail a identifié deux GSSP (Global Boundary Stratotype Sections and Points) possibles. L'une des deux sections, située à Vohrum (Allemagne du Nord) a été discutée en détail au symposium de Copenhague (1983); si elle était choisie, l'apparition de *Leymeriella schrammeni* définirait la base de l'Albien. Malheureusement, peu de données biostratigraphiques, à part celles fournies des ammonites, existent pour cette section. L'autre section considérée se trouve dans la fosse vocontienne (S.-E. de la France); elle offre une série plus étendue de fossiles étudiés tels que les ammonites, les nannofossiles calcaires, les foraminifères planctoniques, les cystes de dinoflagellés, et des niveaux anoxiques océaniques (comme par exemple le niveau Paquier). Après compilation des données pour les deux sections, une limite sera clairement définissable.

Les bases de l'Albien Moyen et de l'Albien Supérieur ont aussi été discutées, la décision ayant été prise de garder une subdivision tripartite pour l'étage Albien. Un GSSP possible pour la base de l'Albien Moyen est la section des Côtes-Noires sur la Marne, près de Saint-Dizier (Haute-Marne, France). La limite peut-être placée à l'apparition de *Lyelliceras lyelli*, mais des recherches supplémentaires sont nécessaires sur ce GSSP proposé (peut-être par le GFC).

La base de l'Albien Supérieur est probablement le mieux définie par l'apparition de *Dipoloceras cristatum*. Il y a deux GSSP possibles: Wissant (Pas-de-Calais, France) et Folkestone (Kent, Angleterre), tous deux mentionnés par d'ORBIGNY dans la définition de l'étage Albien. L'une et l'autre de ces sections pourraient être choisies comme GSSP, bien qu'il soit admis que la section à Folkestone est très condensée. Une localité alternative, dans la fosse vocontienne (S.-E. France) pourrait être plus indiquée. Ces trois localités seront étudiées avant de prendre une décision finale.

Mots-clés: Albien, Crétacé inférieur, biostratigraphie, ammonites, inocérames, foraminifères, nannofossiles, stratotypes, événements océaniques anoxiques, "GSSP".

Альбский ярус и границы подъярусов: предложения Рабочей Группы Альбского Яруса Субкомиссии Меловой Стратиграфии.

Резюме.

В результате обсуждений, прошедших в течение «Второго Международного Симпозиума по вопросам Границ Мелового Яруса» в Брюсселе (8-16 сентября 1995 года), Рабочая Группа определила два возможных GSSP «Global boundary Stratotype Sections and Points» для основания Альбского яруса. Один из них, расположенный в Vohrum, (северная Германия), стал объектом горячих обсуждений на копенгагском Симпозиуме 1983 года; в случае его выбора в качестве стратотипа, основание Альбского яруса будет определяться по появлению *Leymeriella schrammeni*. К сожалению, за исключением аммонитовых данных, существует лишь незначительное количество информации биостратиграфического характера, необходимой для такого выбора. Альтернативный разрез для стратотипа, расположенный в Воконтской впадине, на юго-востоке Франции, предлагает более широкий выбор изученных ископаемых, таких как аммониты, известковые нанофоссилии, планктонические фораминиферы, цисты динофлагеллат, а также океанические бескислородные уровни (как например уровень Paquier). После того как информация по каждой из двух секций будет собрана полностью, возможно будет чётко определить границу. Обсуждения коснулись также Среднего и Верхнего Альба; было принято решение сохранить разделение Альбского яруса на 3 части. Возможным GSSP для Среднего Альба представляется разрез Les Côtes-Noires, на реке Marne недалеко от Saint-Dizier (Haute Marne, Франция).

Границу можно определить при появлении *Lyelliceras lyelli*; тем не менее, необходимо провести дополнительные исследования по данному GSSP (вероятно GFC, Groupe Français du Crétacé). Основание Верхнего Альба вероятно определено наилучшим образом при появлении *Dipoloceras cristatum*. Здесь также возможны 2 GSSP, Wissant (Па-де-Кале, Франция) и Folkestone (Кент, Англия); оба указаны d'ORBIGNY при определении Альбского яруса. В качестве GSSP может быть выбран любой из этих разрезов, хотя допускается, что разрез в Folkestone очень сильно сконденсирован. Воконтская впадина является третьей, наиболее подходящей альтернативой.

Ключевые слова: Альбский ярус, нижний мел, биостратиграфия, аммониты, иноцерамы, фораминиферы, нанофоссилии, стратотипы, бескислородные океанические события, GSSP.

Introduction

The Albian Stage was proposed by d'ORBIGNY (1842-1843) for the interval between the Aptian and what is now called the Cenomanian. The name was originally derived from the Roman name for the Aube (Alba). The localities (Figure 1) initially cited by d'ORBIGNY include Wissant (Pas-de-Calais), Côtes-Noires (Haute-Marne), Gaty, Maurepaire, Dienville, Ervy (Aube), Saint-Florentin (Yonne), Perte-du-Rhône (Ain), Machéroménil (Ardennes) and Varennes (Meuse) in France and Folkestone (Kent) in England.

Following the work of BREISTROFFER (1947) the Albian Stage was generally accepted as beginning with the *Leymeriella tardefurcata* Zone, including at the base a level with *Leymeriella schrammeni* (*op. cit.*, p. 38). At the meeting in Copenhagen in 1983 it was agreed that the

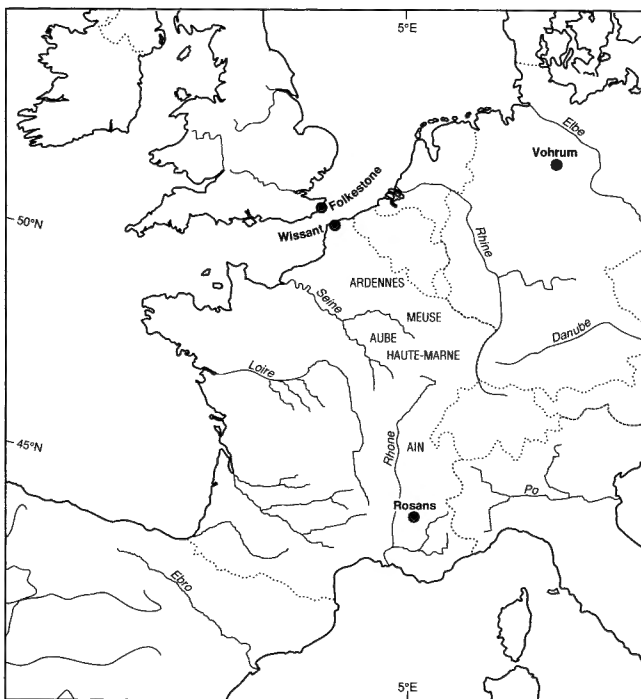


Fig. 1 — Albian localities discussed in the text or mentioned in the initial definition of d'ORBIGNY (1842-43).

base of the Stage would be better drawn at the base of the *Leymeriella schrammeni* Zone (BIRKELUND *et al.*, 1984). Unfortunately this nominate species is restricted to the N. W. European faunal province ("Boreal") and is not known from the classic areas of the Paris Basin.

The internal subdivisions of the Albian Stage are equally problematical, with the base of the Middle Albian and the base of the Upper Albian yet to be agreed. At the present time *Lyelliceras lyelli* can be used to define the base of the Middle Albian and *Dipoloceras cristatum* to define the base of the Upper Albian.

Stratigraphic terms such as the Selbornian (JUKES-BROWNE, 1900) and Vraconian (RENEVIER, 1867) have gained little general acceptance, although the latter is often used in the French literature.

Traditionally the Albian Stage has been subdivided on ammonites and there is established a well-known zonal and subzonal scheme for the European area, although it does have wider application. More recently a number of workers have described the foraminifera, ostracoda, dinoflagellate cysts and calcareous nannofossils (*s.l.*). In many of the areas described as being "typical" of the Stage the lithology is predominantly a dark blue-grey clay, deposited in mid-palaeolatitudes. This rather restricts the faunas and floras and has somewhat limited the international correlation of the Stage.

The Albian Stage occupies a part of the mid-Cretaceous "magnetic quiet zone" and the majority of workers have little magnetostratigraphic data from this interval. Recently E. J. Baraboschkin (Moscow, Russia) has indicated that a magnetic zonation may be possible but this has yet to be tested internationally. While there have been isolated attempts to use stable isotopes there is not yet a generally accepted data base for the Albian Stage that could be used for stratigraphical purposes (unlike for some higher parts of the Cretaceous succession).

The Albian Stage

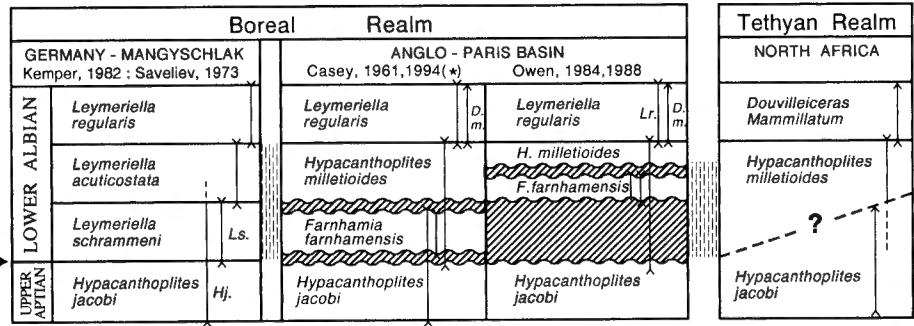
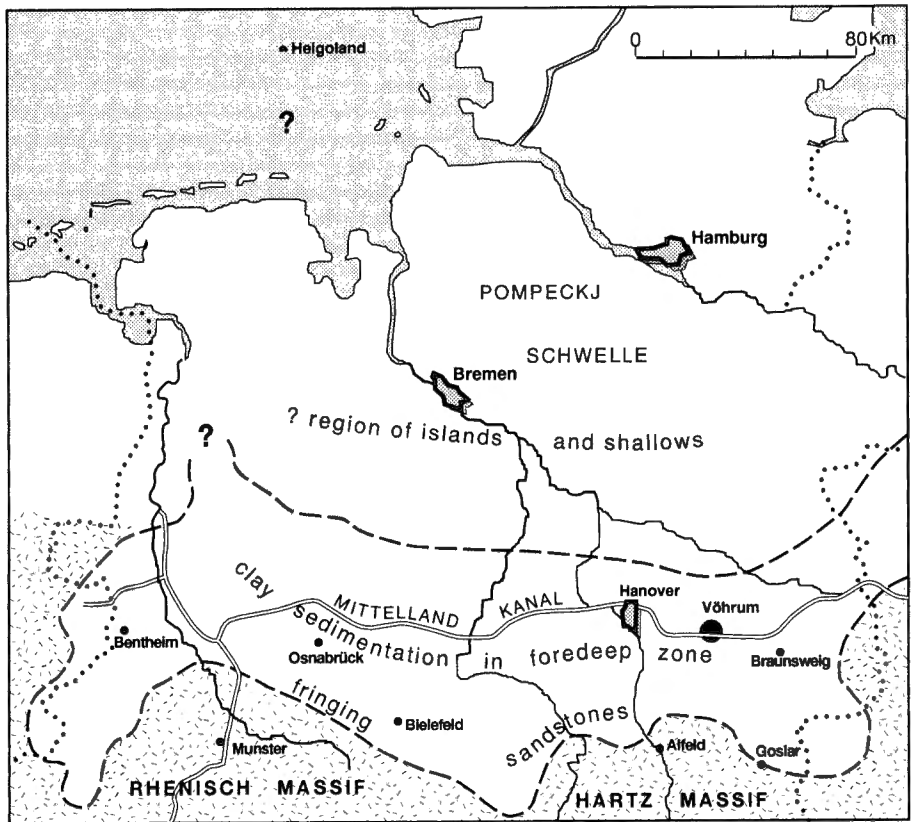
At the Brussels Symposium the Working Group resolved that it would follow the spirit of the initial definition of the base of the Albian and its tripartite division. These decisions reflect both the total duration of the Albian Stage (one of the longest in the Cretaceous) and the well-established ammonite zonation.

The Base of the [Lower] Albian

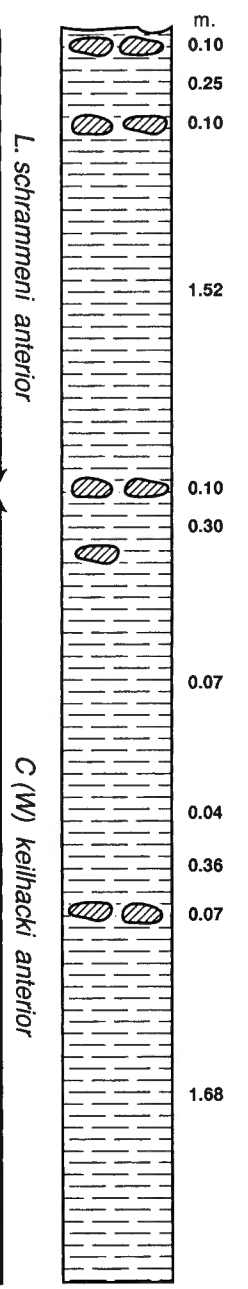
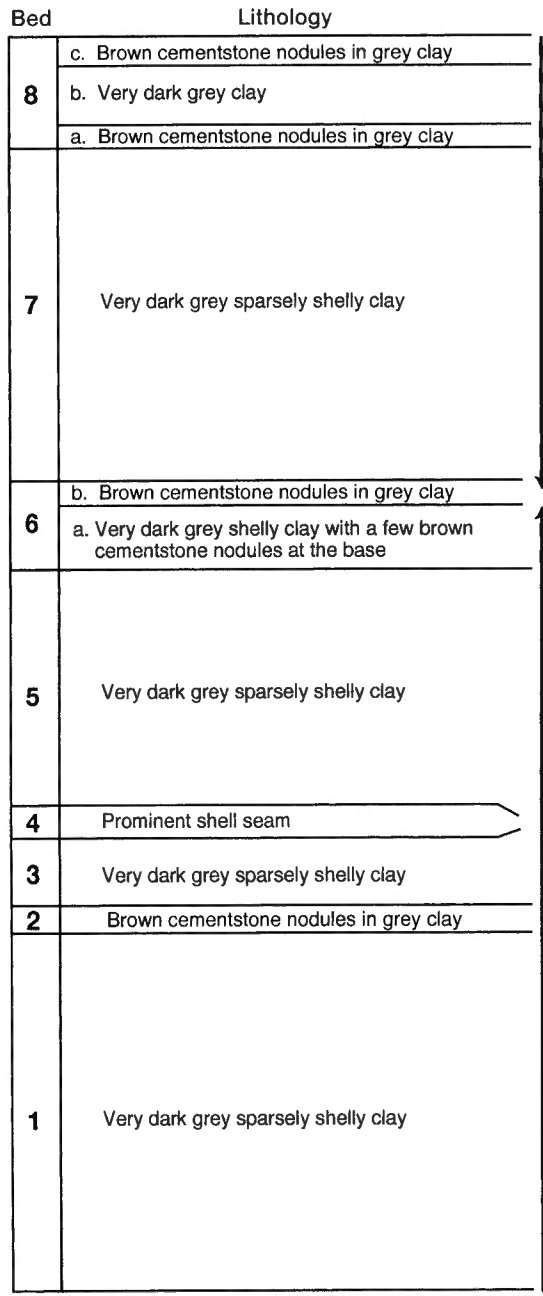
At the Copenhagen Symposium in 1983 (BIRKELUND *et*



Fig. 2 — Locality map for Vohrum and the succession in the section described by OWEN (1979). The correlation diagram is based on unpublished data supplied by F. AMÉDRO.



Copenhagen 1983, proposal gap no correlation (*) in litteris



The Albian stage and substage boundaries

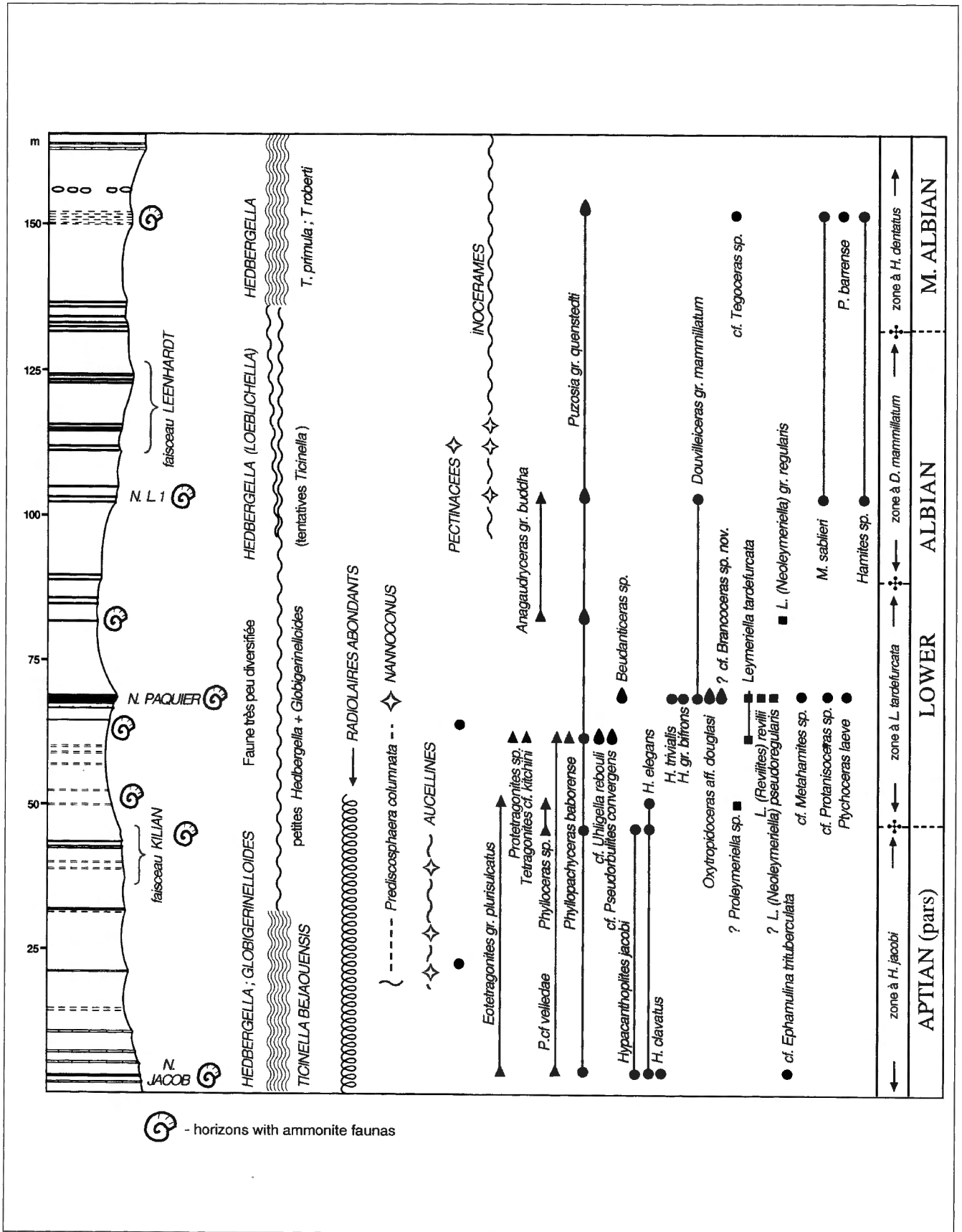


Fig. 3 — The succession of the Col de Pré-Guittard (Drôme); based on data in BRÉHERET *et al.* (1986). N.B. the placing of the Aptian/Albian boundary - as indicated in the text - is not precisely known. [filled triangles = Mediterranean forms; filled circles = cosmopolitan forms; filled squares = European forms; filled droplets = cosmopolitan forms with Mediterranean affinities].

al., 1984) the discussion focused on the ammonite faunas that could be used to identify the base of the Albian. Few data were forthcoming on any other fossil groups, although it was suggested that the calcareous nannofossil, *Prediscosphaera columnata*, might be a possible alternative. It was recommended that the boundary might continue to be placed at the base of the *Leymeriella schrammeni* Subzone which is well-documented in the N. W. European succession. If that subzone is to be used OWEN (1979) has proposed that the best exposed section is that near Vorhurn, in the Hannover-Braunschweig area of North Germany (Figures 1 and 2). Following that decision there has been considerable interest in the Lower Cretaceous successions of the Vocontian Trough (BRÉHERET *et al.*, 1986 and references therein).

Both of the above locations were discussed at the Brussels Symposium and it was resolved that a more complete database for the Vocontian Trough would be obtained prior to making any decision on the GSSP. Information from North America was lacking from the discussions in Brussels and nothing else has come to light since that time. Some information is available from the Cauvery Basin (South India), the Mesozoic Basins of Eastern Brazil and successions in the south of Russia (N. Caucasus), but there appears to be little support for using any of these areas as alternatives.

Vohrum, North Germany

OWEN (1979, 1984), accepting the base of the *Leymeriella schrammeni* Subzone as the base of the Albian stage, recommended that the succession at Vohrum (Figs 1 and 2) be identified as the boundary stratotype. The boundary would, therefore be located (Figure 2) at the level between Beds 6a and 6b, in a succession of clays spanning the Aptian-Albian boundary interval. *L. schrammeni* was assumed to mark the base of the Albian by KEMPER (1973) and the same author (KEMPER, 1982 a, b) has provided further data on the North Germany successions, including information on the ostracod faunas.

There are problems with this definition and the selection of Vohrum as the stratotype section.

1. Interprovincial correlation of the *schrammeni* Subzone is difficult and this is summarised in BIRKELUND *et al.* (1984) and OWEN (1984).

2. CASEY (1961) correlated the subzone of *L. schrammeni* with his subzone of *Farnhamia farnhamensis*, apparently despite that species not having been found outside S. E. England (OWEN, 1984). During the writing of this report CASEY (1996) has highlighted what he considers to be problems over the correlation of the ammonite subzones between S. E. England and N. Germany (OWEN, 1988, 1992). This, CASEY (*op. cit.*) claims, caused AMÉDRO (1992) to postulate a gap in the succession at the base of the Albian. OWEN (1996), in a direct reply to CASEY's comments, attempts to explain his position, outlining the difficulties involved in correlating ammonite data from isolated collections with a well-determined succession where *in-situ* material can be collected.

Clearly there should be a resolution of these difficulties before a decision is taken on the base of the *L. schrammeni* Subzone at Vohrum as the definition of the GSSP for the base of the Albian stage.

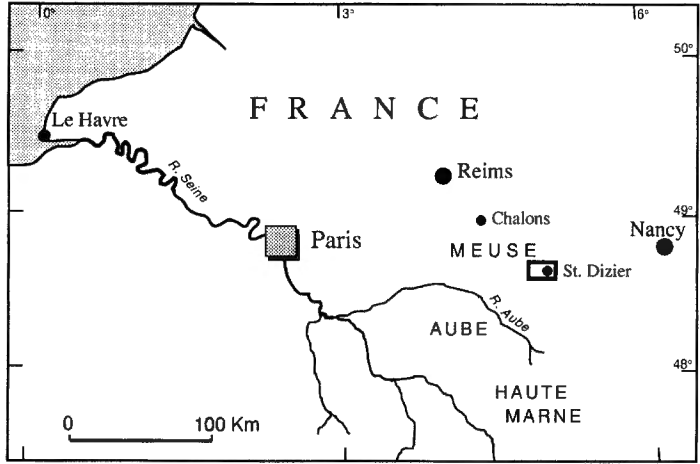
3. As far as can be determined there is relatively little new work on the Vohrum section in terms of belemnites, inoceramids, foraminifera, ostracods, calcareous nannofossils and dinoflagellate cysts. If the Vohrum succession is to be the GSSP for the base of the Albian stage some of this information will be required so that correlations away from the reference section can be performed as accurately as possible. There has been a considerable amount of work on the foraminifera of North Germany (eg. BARTENSTEIN, 1976 a, b, c, 1977; BARTENSTEIN & BETTENSTAEDT, 1962; BARTENSTEIN & BRAND, 1949; GRABERT, 1959) but none of this appears to specifically relate to Vohrum. The published information indicates that several taxa may appear at, or about, the base of the *schrammeni* Subzone. These are *Pleurostomella obtusa*, *Pl. subnodosa*, *Arenobulimina macfadyeni*, members of the *Gaudryina dividens* lineage, *Dorothia filiformis* and *Vaginulina gaultina*. MUTTERLOSE (1992) has indicated that the calcareous nannofossil, *Prediscosphaera columnata* appears within the *tardefurcata* Subzone, but the flora — in general — is rather poor in the N. W. German Basin. The belemnites are very important in N. W. Europe and a considerable amount of work has been done by SPAETH (1973), MUTTERLOSE (1990) and MUTTERLOSE *et al.* (1983). It is generally accepted (MUTTERLOSE, 1992) that the base of the *schrammeni* Subzone equates to the base of the *Neohibolites strombecki* Zone. If this is true, then it should be confirmed with collections made at Vohrum (if it is to be selected as the GSSP). Such collections could also be used to confirm the distributions of other microfossil groups.

There are significant problems over the use of the first appearance of *L. schrammeni* as the marker for the base of the Albian. As indicated in Figure 2 there are problems of inter-regional correlation, especially in parts of Southern Europe and North Africa. In the Kuma section of the North Caucasus DRUSHCHITS & MIKHAILOVA (1966) have described the biostratigraphy, although Baraboschkin (*pers. comm.*) has been unable to find the index fossil either in the field or in museum collections. In every section in the area there is a hiatus/phosphorite horizon. The situation is the same in Turkmenia, Crimea, Mangyshlak and the whole of the Russian Platform (SAVELIEV, 1973; BARABOSCHKIN, *in press*).

The Vocontian Trough

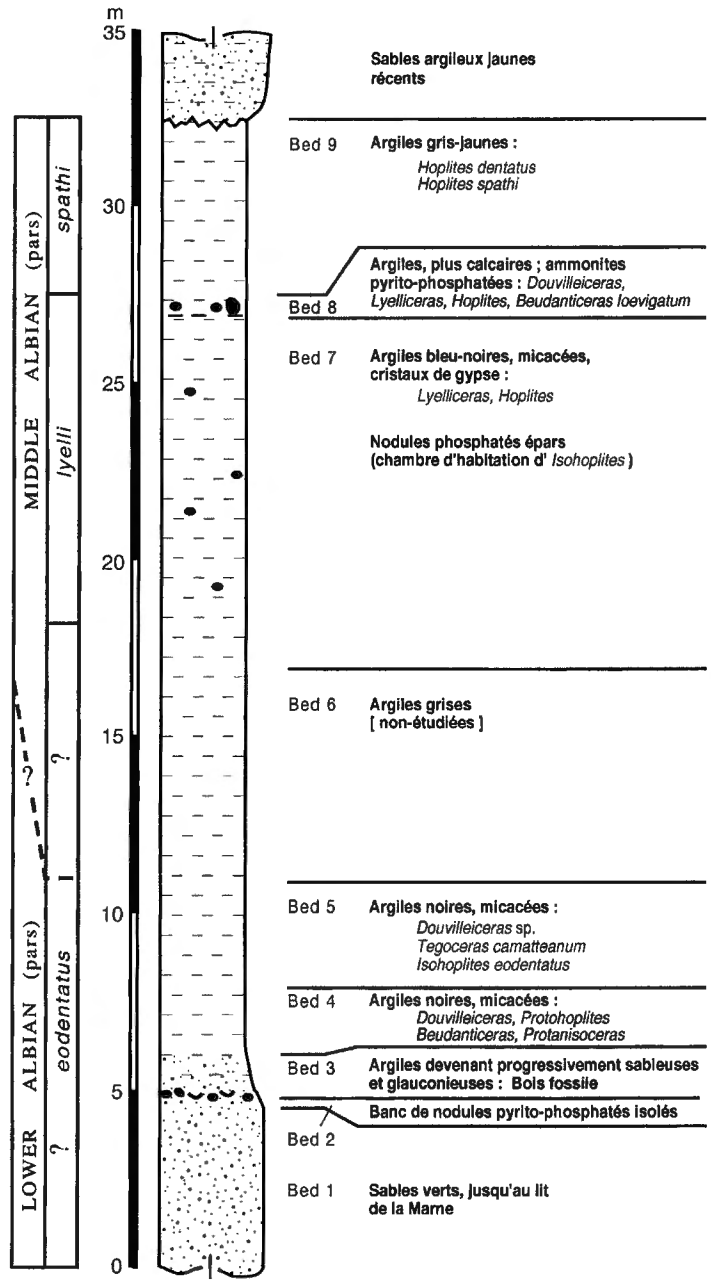
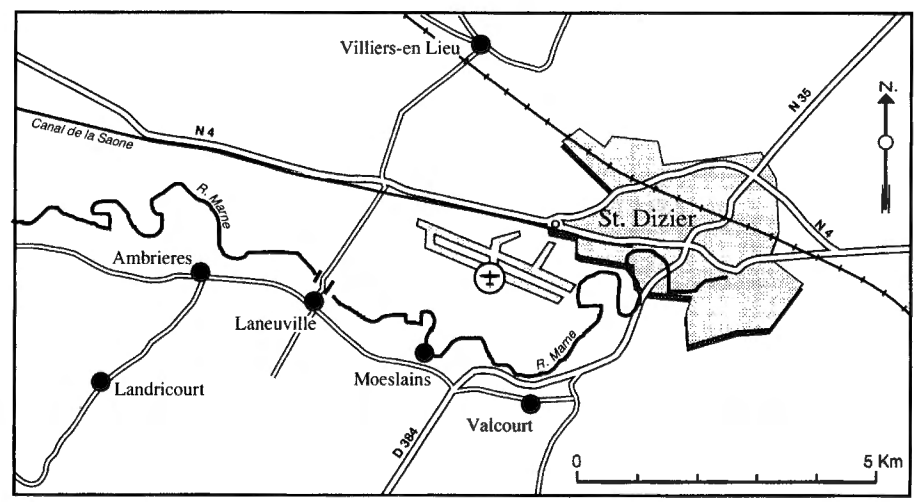
BRÉHERET *et al.* (1986) have described an integrated sedimentological, geochemical and palaeontological study of the Aptian-Albian succession in the Vocontian Trough. In particular, the succession on the Col de Pré-Guittard (Drôme) may be:

- the most complete succession across the boundary;
- one of the best studied sections currently available;
- well-exposed and unlikely to disappear over time;
- readily accessible;



Legend

- Dark Clays
- Sands
- Exogyra*
- pyrite - phosphate nodules
- pyrite - phosphate ammonites



It contains a range of faunal and floral groups together with the Paquier and Jacob "oceanic anoxic events". Using data from BRÉHERET *et al.* (1986) it has been possible to construct a summary chart (Figure 3) which shows a range of geological, sedimentological and palaeontological features that could be used to define the boundary. Options appear to be:

- FO of *Leymeriella tardefurcata*
- FO of *Douvilleiceras* ex. gp. *mammillatum*
- FO of *Prediscosphaera columnata*
- LO of *Hypacanthoplites jacobi*
- the Paquier "oceanic anoxic event" [top or bottom]
- the topmost organic-rich bed of the "faisceau Kilian".
- any other datum

While there are a number of gaps in our knowledge, the dinoflagellate cysts have recently been described by VINK (1995). These data show a number of possible datums between 50 m. and 80 m. (Figure 3), with the most suitable horizon being located slightly above the boundary indicated in the figure. Bréheret (*pers. comm.* to Han Leereveld) has indicated that the full data on the ammonite succession has yet to be published and that the boundary should be taken as lying between 42 m. and 54 m. Bréheret and Delamette have also suggested that there may even be an hiatus at, or about, the potential boundary. Important extinctions of dinoflagellate cysts at, or about, the boundary include *Hystrichosphaerina schindewolfii* and *Cerbia tabulata* while *N. singularis*, *P. securigerum*, *Systematophora penicillata*, *Litosphaeridium arundum* and *P. eisenackii* have their first appearance within the same interval. The planktonic foraminifera are very abundant in this succession but, unfortunately, cannot offer a suitable LAD or FAD at this level. CARON (as a co-author in BRÉHERET *et al.*, 1986) has shown that the planktonic foraminifera responded to the Paquier (and other) oceanic anoxic events in by adjusting their position in the water column and often excluding those that lived in deeper-water environments. Ticinellids, and other stratigraphically important taxa, disappear at the critical level (Figure 3), being replaced by a population of small, shallow-water, hedbergellids (BRÉHERET *et al.*, 1986, figs 3, 11, 13, 14).

Substage Boundaries

The Base of the Middle Albian

At the Copenhagen Symposium it was agreed (BIRKELUND *et al.*, 1984) that the base of the Middle Albian

should be drawn at the base of the *Lyelliceras lyelli* Subzone. It was noted that the best sequences across the boundary are located in the Aube (see Figure 1) and it was recommended that, following the work of OWEN (1971) and DESTOMBES (1979), a suitable GSSP might be identified.

OWEN (1971, 1984) has given detailed accounts of the possible definitions for the base of the Middle Albian, together with a resume of previous work. After a full discussion of the ammonite faunas from many localities in the Anglo-Paris Basin, OWEN (1984, p. 186) concluded that the base of the *L. lyelli* Subzone be regarded as the base of the Middle Albian. This largely follows the revisions of the stratigraphy proposed by DESTOMBES & DESTOMBES (1965, pp. 265-267). Both DESTOMBES & DESTOMBES (1965) and OWEN (1971) regard the section at Les-Côtes-Noires-de-Moëslains near St-Dizier (Haute-Marne) as being a potential stratotype (Figure 4). Sedimentologically it is relatively complete and there are good ammonite faunas. It has the advantage of being a natural exposure; a riverbank on a meander of the River Marne that is accessible from a minor road that runs parallel to the river on the southern bank.

There are, unfortunately, two problems with this otherwise straightforward solution.

1. Despite a quite exhaustive search it has been impossible to track down any other detailed palaeontological work on the Côtes-Noires succession. This means that data on the foraminifera, ostracods, calcareous nannofossils, etc., is lacking. DESTOMBES & DESTOMBES' (1963) description of the lithology of Bed 7 (the critical level) as "argiles bleu-noires, micacées, cristaux de gypse" is very worrying. Gypsum (or selenite) crystals are a product of modern weathering that usually indicate that the carbonate microfauna may have been leached out of the sediments. Clearly work needs to be done on the succession if it is to be proposed as a GSSP in order that the other fossil groups can be investigated. HART (1973) has shown that the *eodontatus-spathi* interval is represented by his Zone 3(i) with, appearing at — or about — the base of the *lyelli* Subzone, the distinctive foraminiferal species *Epistomina spinulifera*. Associated with this taxon in UK successions (HART, 1973; PRICE, 1977; HART *et al.*, 1989) are *Conorboides lamplughii* and *Gavelinella tormarpensis*. MAGNIEZ-JANNIN (1983), working on the successions of the Aube has compared her micropalaeontological zonation with that of the ammonite faunas and located the base of the Middle Albian (AMÉDRO *et al.*, 1995, fig. 6) in the middle of her Zone 2 (based on the appearance of *Valvulineria parva rotunda*). Using material from the same localities as HART in S. E. England, TAYLOR (1982) has identified a number of calcareous nannofossils (*Prediscosphaera cretacea*, *Dictyococcites parvidentatus*, *Gaarderella granulifera* and *Braarudosphera regularis*) that appear at, or about, the boundary. HART (1973) also described the ostracod fauna and while a number of taxa are present (especially *Schuleridea brevis* and *S. jonesiana*) the fauna is relatively poor in comparison to the remainder of the Gault Clay succes-



Fig. 4 — Locality map for the section at Les Côtes-Noires-de-Moëslains near St-Dizier, France. The succession shown is based on the work of DESTOMBES & DESTOMBES (1965) and OWEN (1971). N.B. the lack of specific information in Beds 6 and 7 and the report of gypsum crystals (see text for significance) in the latter.

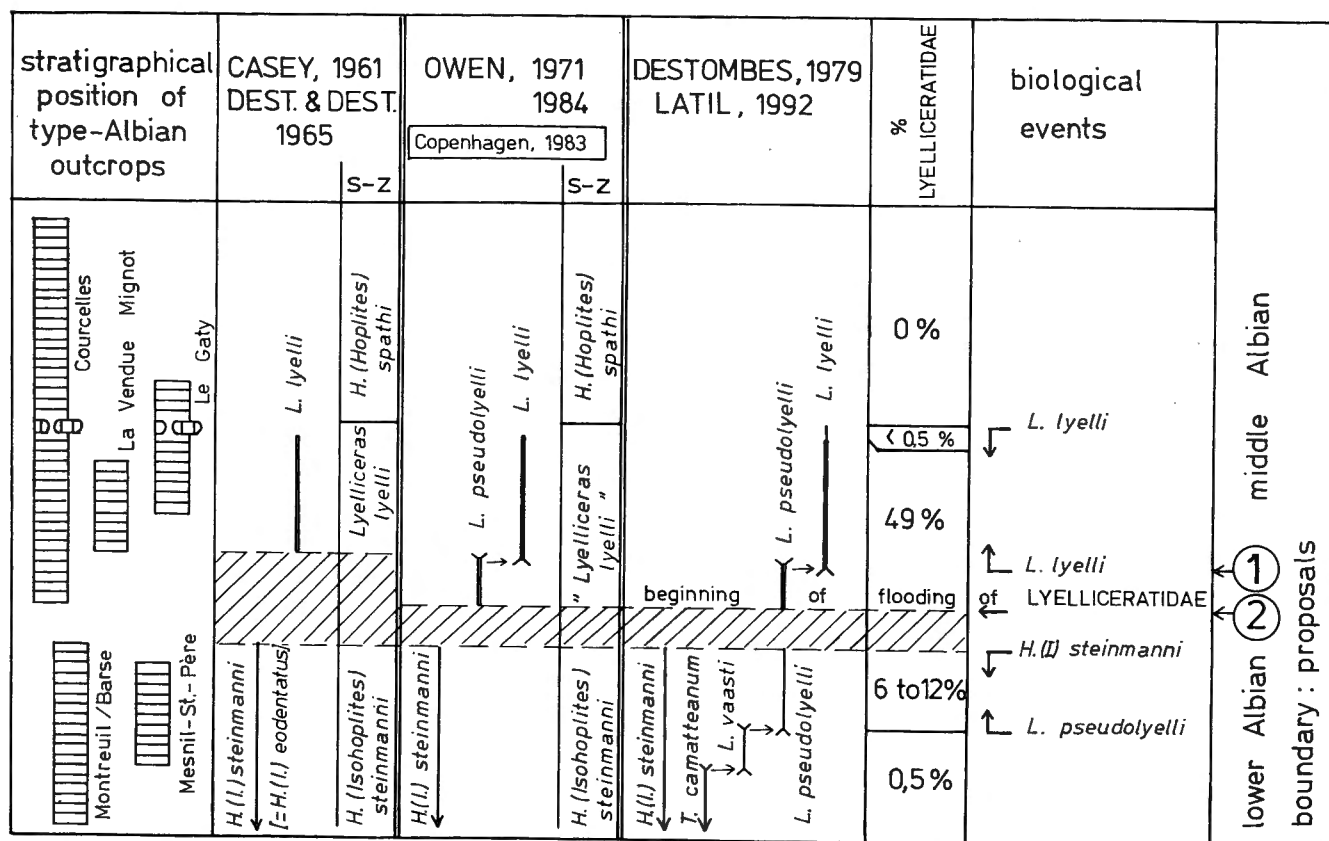


Fig. 5 — Stratigraphical details of the Lower-Middle Albian boundary provided by F. AMÉDRO.

sion. Unfortunately, the major facies change at the base of the Gault Clay does not allow the documentation of a full Lower - Middle Albian transition in any work based on the succession at Folkestone. In the successions in North Germany *Neohoplites minimus* appears just before the base of the Middle Albian (as defined in that area; base of the Zone of *H. dentatus*). As this belemnite is well-known right across Europe and into Russia it is important that its precise appearance in relation to the sub-stage boundary is determined.

2. The second problem concerns the *precise* definition of the base of the *lyelli* Subzone. AMÉDRO (manuscript) has shown that *L. lyelli s. s.* appears slightly above the influx of *Lyelliceras* in the succession (Figure 5) and that one has to decide whether to use:-

- the appearance of a flood of *Lyelliceras*, including *L. pseudolyelli*; or
- the appearance of *L. lyelli s. s.*

The Working Group in Brussels suggested that all the above issues should be investigated, especially as they apply to the succession of the Côtes-Noires. It was suggested that an international group, possibly co-ordinated by the GFC, might take this on board and that, until that work is completed, we adhere to the decisions of the Copenhagen Symposium and record that the appearance of *Lyelliceras lyelli* should be used to define the base of the Middle Albian.

In Russia (MIKHAILOVA & SAVELIEV, 1989) the base of

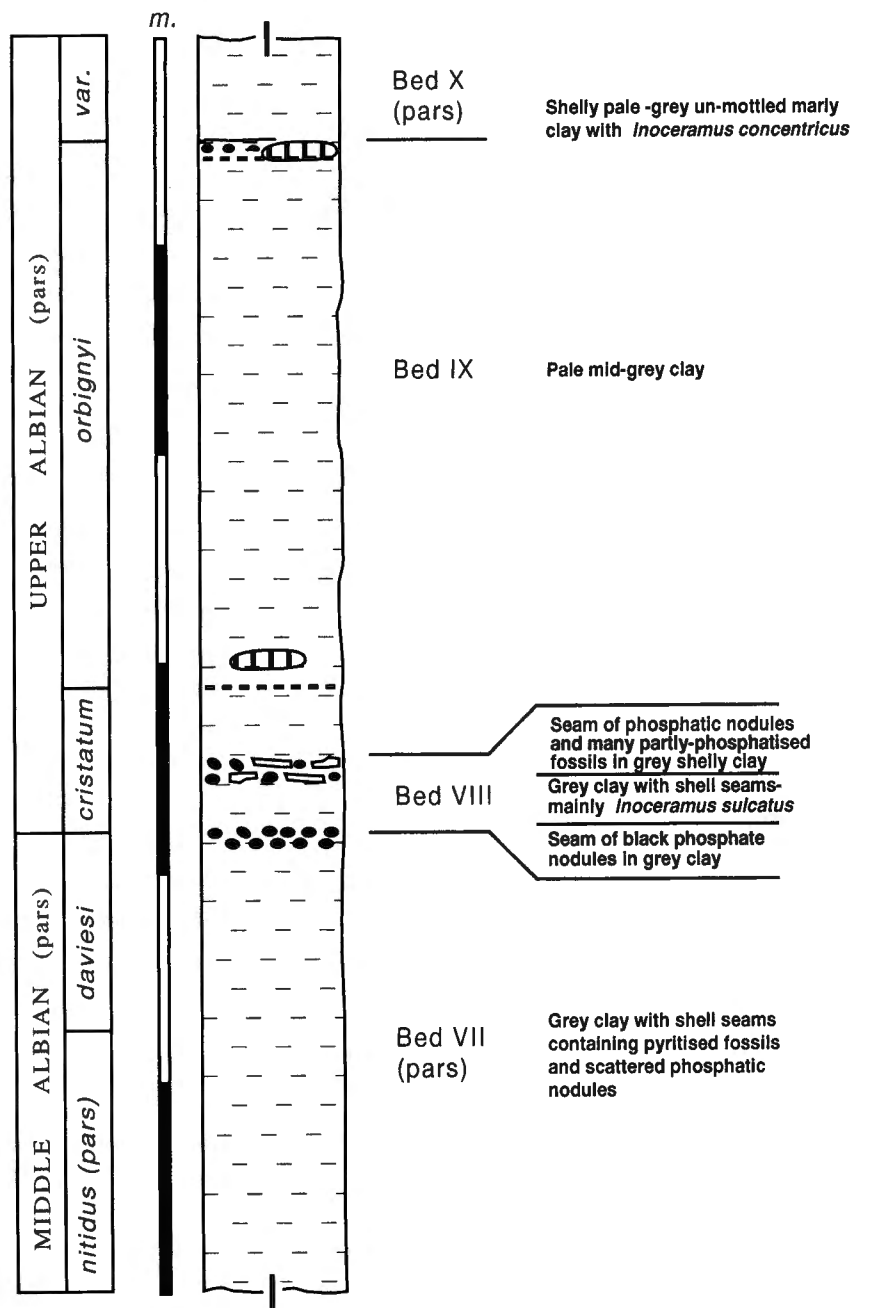
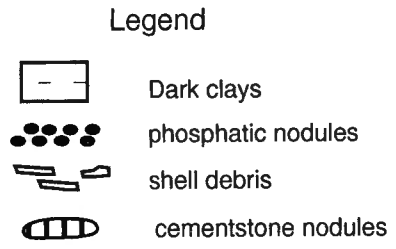
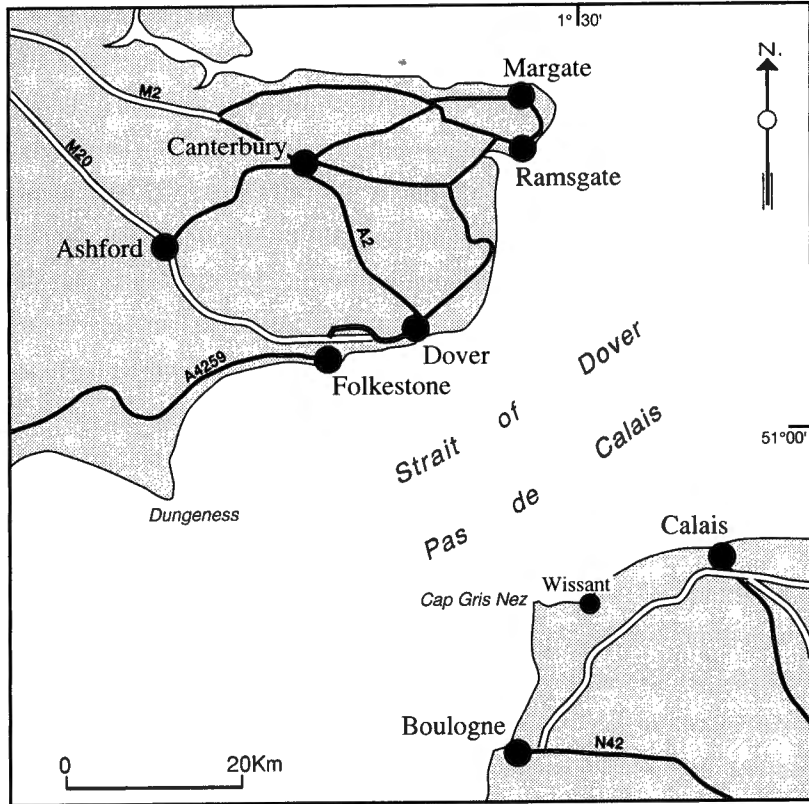
the Middle Albian is taken at the base of the *Isohoplites eodentatus* Zone. This is based on a view of *Isohoplites/Hoplites* evolution, the "European" nature of the taxon, a basin-wide sea level rise in the *eodentatus* Zone and a significant change in the inoceramid fauna immediately below the base of the zone (SAVELIEV, 1962; BARABOSCHKIN, *in press*).

The Base of the Upper Albian

BREISTROFFER (1947) proposed that the base of the Upper Albian should be drawn at the appearance of the ammonite *Dipoloceras cristatum* and related species of *Dipoloceras*. This view was upheld in Copenhagen (BIRKELUND *et al.*, 1984; OWEN, 1984) especially since *D. cristatum* is quite widely known (eg. Texas — see YOUNG, 1966) and, even where it is absent, the horizon can be determined adequately by other faunas (OWEN, 1984).

AMÉDRO (manuscript) has indicated, however, that there are large areas of the world (Western USA and Japan) where the *D. cristatum* fauna is unknown. AMÉDRO

Fig. 6 — Locality map for the sections at Folkestone and Wissant. The succession at Copt Point, Folkestone, is based on the work of OWEN (1976). Information on the Boulonnais successions can be found in ROBASYNSKI *et al.* (1980).



& DESTOMBES (1978) have shown that, even in the North European Province of the Boreal realm, *Dipoloceras* is usually a very minor component of any ammonite fauna. An alternative marker, favoured by AMÉDRO, would be the first appearance of *Mortoniceras (Mortoniceras) pricei* as this taxon appears to be recognised over a much wider geographical area. In two of the key sections (Wissant, Pas-de-Calais, France and Folkestone, Kent, United Kingdom - see Figure 6) the successions are quite condensed and there are disadvantages to both. Micro-palaeontological work (HART, 1973; PRICE, 1977; ROBASZYNSKI *et al.*, 1980; TAYLOR, 1982; HART *et al.*, 1989) has been based largely on a sample interval too crude for these condensed successions (despite being at intervals of 1 m. or even 0.50 m.). In the Aube succession AMÉDRO *et al.* (1995, fig. 6) indicate that *D. cristatum* is not yet known in the area as there are no suitable exposures but, as far as it can be identified, the base of the *cristatum* Subzone is located in the middle of MAGNIEZ-JANNIN's (1983) zone 8, which is based on the appearance of *Citharinella* aff. *pinnaeformis*. The base of her zone 9 (which coincides with the base of the *Mortoniceras (M.) pricei* Zone) is characterised by the appearance of *C. pinnaeformis s. s.* In the succession at Folkestone both HART (1973, fig. 3) and PRICE (1977) indicate that *C. pinnaeformis* appears within the *cristatum* Subzone (middle of Bed VIII) with *Arenobulimina chapmani* appearing a few centimetres above in the base of Bed IX (and probably just below the appearance of *Mortoniceras (M.) pricei*. Just before the appearance of *C. pinnaeformis*, in the Folkestone succession, there is a flood of *Hedbergella washitensis*, a highly distinctive planktonic species which is known from many parts of the world (eg. Brazil - see KOUTSOUKOS *et al.*, 1989).

MUTTERLOSE (1992) indicates that the base of the *D. cristatum* Subzone equates with the base of the *Neohibolites oxycaudatus* Zone in the North German successions and this important correlation requires confirmation. The appearance of *D. cristatum* is used to define the base of the Upper Albian in large areas of the North Caucasus (BARABOSCHKIN, *in press*) and Turkmenia (MIKHAILOVA & SAVELIEV, 1989). In these areas *Actinoceramus sulcatus* appears together with *D. cristatum*.

In order to progress towards a decision, the Working Group suggested that information on as many faunal/floral groups be obtained from:

1. Wissant (Pas-de-Calais, France) where the base of the *D. cristatum* Subzone can be located 0.20 m. below the top of "Bed r" of AMÉDRO & DESTOMBES (1978).

2. Folkestone (Kent, UK) where the base of the *M.*

(*M. pricei* Zone of AMÉDRO (1992), equivalent to the top of the *D. cristatum* Subzone, can be drawn 0.70 m. above the base of "Bed IX" (OWEN, 1976).

3. Dallas (Texas, USA) where successions with *D. cristatum* might prove to be a valuable reference point for correlation into the USA and (perhaps) the Pacific Region.

4. Localities in the area around Rosans (Drôme, France) where, in an expanded succession (Gale, *pers. comm.*), it may be possible to investigate ammonite, inoceramid, calcareous nannofossil, foraminiferal and dinoflagellate cyst distributions. These expanded successions may provide better resolution of the palaeontological data than is possible in the relatively condensed successions of Folkestone and Wissant.

For the present the Working Group recommends that the base of the *D. cristatum* Subzone continues to be used to define the base of the Upper Albian.

Summary

The Working Group has identified two possible stratotype sections for the base of the Albian Stage. These are the sections at Vohrum (North Germany) and the Col de Pré-Guittard (Drôme, France). If the former is used then the appearance of *L. schrammeni* will almost certainly be used as the marker. The succession of the Col de Pré-Guittard offers a range of possibilities and these were not fully discussed in Brussels.

The base of the Middle Albian may be located at the appearance of *Lyelliceras lyelli* in the section at "Les-Côtes-Noires-de-Moëslains" near St-Dizier (Haute-Marne, France) although this remains to be fully investigated.

The base of the Upper Albian may be drawn at the base of the *D. cristatum* Subzone, although a suitable succession is still being sought. A number of possibilities have been identified; Folkestone, Wissant or a locality in the Vcontian Trough.

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