3 RD INTERNATIONAL CRETACEOUS SYMPOSIUM

Tübingen, 26.8. - 8.9.1987

FIELD-GUIDE EXCURSION D:

GRENOBLE,FRANCE

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THE LOWER CRETACEOUS FROM THE JURA PLATFORM TO THE VOCONTIAN BASIN (SWISS JURA, FRANCE)

ANNIE ARNAUD-VANNEAU * AND HUBERT ARNAUD *

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SUMMARY

THE LOWER CRETACEOUS DEPOSITS IN THE JURA AND THE SUBALPINE CHAINS

THE LOWER CRETACEOUS DEPOSITS IN THE JURA AND THE SUBALPINE CHAINS

A. PROGRAM

First day : Friday, September 4 th.
T. ADATTE and G. RUMLEY
From Tübingen (R.F.A.) to Annecy (France)
Theme : The Lower Cretaceous of the stratotypic area near Neuchâtel (Switzerland)
First stop and lunch : Marnière de Cressier (Lower Hauterivian) near Neuchâtel
Second stop : Juracime quarry (Valanginian), near Neuchâtel
Transit to Annecy (France)

Second day : Saturday, September 5 th.
A. ARNAUD-VANNEAU, H. ARNAUD and T. BOISSEAU
From Annecy to Grenoble
Theme : The Berriasian-Valanginian carbonate platform of the southern Jura and subalpine chains, the Pierre Jaune de Neuchâtel and the Urgonian platform
First stop : La Chambotte section (Upper Berriasian-Barremian) near Aix-les-Bains
Second stop : The Gorges du Guiers Mort section (Upper Berriasian-Lower Valanginian) near St. Laurent-du-Pont (Chartreuse, subalpine chains)
Transit to Grenoble (St. Pierre-de-Chartreuse, Col de Porte)

Third day : Sunday, September 6 yh.
A. ARNAUD-VANNEAU and H. ARNAUD
From Grenoble to Die
Theme : The Urgonian platform and the Aptian transgression in the subalpine chains
First stop : The Gorges du Nant section (The Barremian-Lower Aptian Urgonian platform) near Cognin (Vercors, subalpine chains)
Second stop : Les Rimets area and the Marnes supérieures à Orbitolines (Lower Aptian) in the Rencurel syncline (Vercors)
Transit to Die (Vernaison valley, Col de Rousset)

Fourth day : Monday, September 7 th.
A. ARNAUD-VANNEAU, H. ARNAUD and J.-P. THIEULOY
The Die area
Theme : The Pelagic sedimentation of the Vocontian basin
First stop : The Marignac-Serre de Jayon section (the Upper Berriasian reworking sedimentation)
Second stop : The Col de Romeyer section (the Valanginian-Lower Hauterivian pelagic sedimentation)
Third stop : The Chamaloc section (the Hauterivian-Lower Barremian pelagic sedimentation)
Return to Die

Fifth day : Tuesday, September 8 th
Return from Die to Tübingen.
(Die, Grenoble, Genève, Lausanne, Berne, Tübingen)

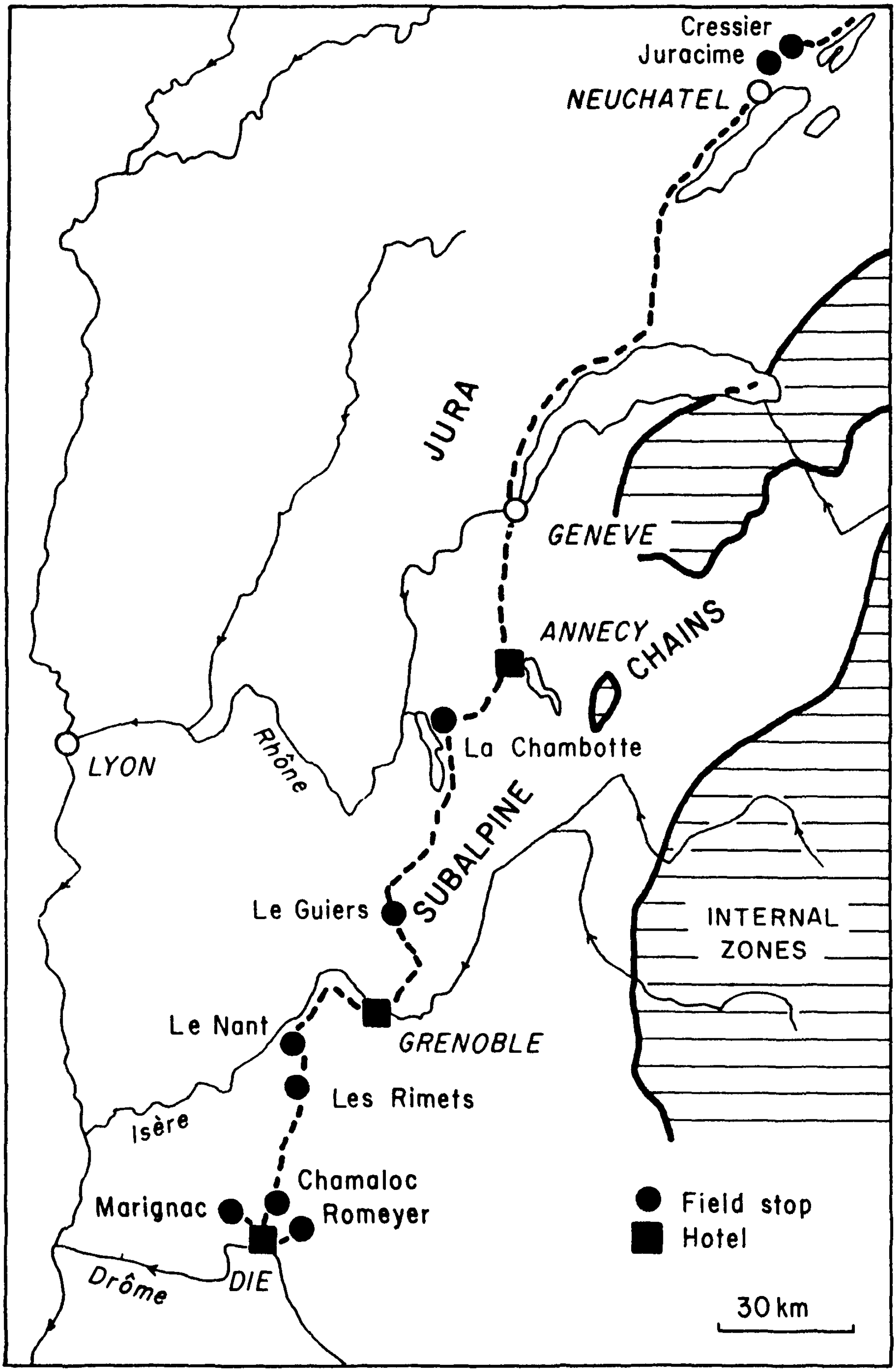


Fig. A1 : Schematic map showing the itinerary of the excursion from Neuchâtel (Switzerland) to Die (France) and the localization of the main stops.

section. It would also appear that these transgressions are not only due to an eustatic cause, but also to hyperactivity all along the oceanic dorsals.

In the Jura and the subalpine massifs, the beginning of the jerky process of platform submersion always begins by a tectonic crisis: the Berriasian crisis, responsible for a substantial paleogeographical modification, for the Hauterivian transgression; the Upper Barremian crisis, with acceleration of subsidence, preceding the Apto-Albian transgression.

G. Stratigraphy and Paleogeography

1. AMMONITES ZONES (H. ARNAUD)

All stages of the Early Cretaceous, from the Berriasian to the Aptian inclusively, have been created in the South-East of France and the Swiss Jura, that is to say in the same paleogeographical region. However, the historical choice of stratotypes in regions characterized either by basin facies (Berrias, Barrême, Apt) or by platform facies (Valangin, Hauterive) has made it very difficult to establish continuous zoning for the stages as a whole.

The zone definitions presently proposed (Fig. A 22) are of differing value and do not all comply with the two fundamental recommendations of the Copenhagen symposium (BIRKELUND *et al*, 1984):
1) The stratigraphic scale contiguity requirement can best be met by defining only the lower boundary of each unit. The upper boundary is then formed by the lower boundary of the next succeeding unit.
2) The base of the zone should preferably be defined according to the first appearance of a new taxon.

The following unit boundaries may be adopted according to BIRKELUND *et al* (1984).
The lower boundary of the Valanginian can be set at the base of the *otopeta* zone. The final decision depends however on the outcome of discussions over the Jurassic-Cretaceous boundary.

The lower boundary of the Hauterivian is defined on the basis of the first appearance of the genus *Acanthodiscus*. This boundary is well-set at La Charce (THIEULOY, 1977).

The lower boundary of the Barremian can be set 1) at the base of the *Pseudothurmannia* beds or 2) at the top of the *Pseudothurmannia* beds (i.e. base of the *Holcodiscus* beds).

Two lower boundaries of the Barremian at Angles have been successively proposed, the first by IMMEL (1978) at the base of the *Pseudothurmannia* beds (bed 42), the second by BUSNARDO & VERMEULEN (1986) at the top of the *Pseudothurmannia* beds (bed 65). This last boundary is debatable for at least two reasons:
1) the *angulicostata* zone of the Upper Hauterivian is defined at the base by the appearance of this taxon and at the top, by its disappearance.
2) the *hugii* zone of the Lower Barremenian is defined at its base, not by the appearance of the index species (which appears only 4 m. above the lower boundary of the *hugii* zone *sensu* BUSNARDO), but rather by the disappearance of *P.angulicostata*, the index species of the underlying zone.

The lower boundary of the Aptian should continue to be set according to the first appearance of *Prodeshayesites*.

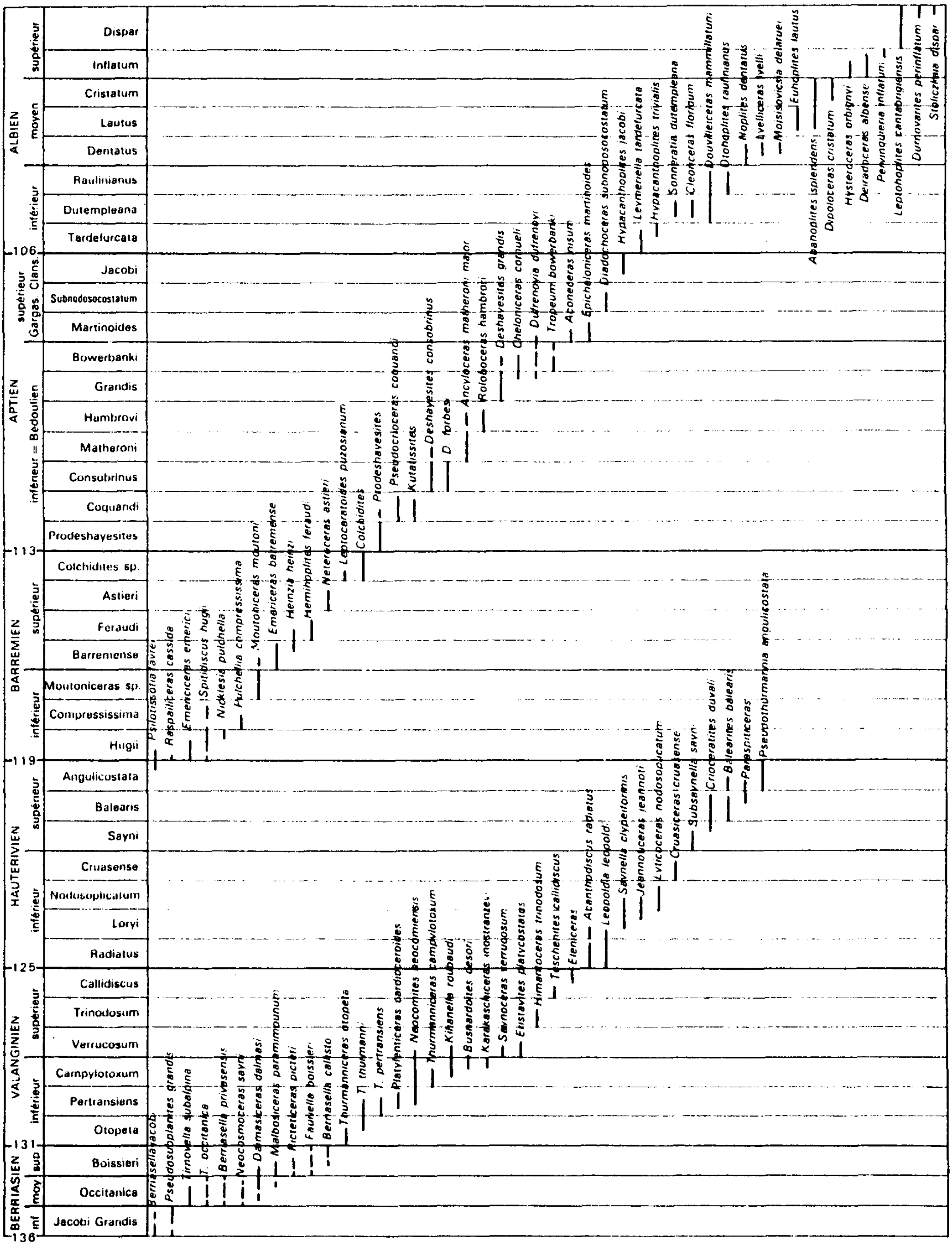


Fig. A 22 : Zonation and distribution of the ammonites (BUSNARDO, 1984)

Zone boundaries and zones themselves are not, on the whole, any better known than stage boundaries.

For the Berriasian, the zoning used is that of LE HEGARAT (1971) defined in several sections and notably in the Berrias stratotype. Zones and sub-zones are defined by species associations; their lower boundaries are not, however, based upon the appearance of index taxons.

For the Valanginian, the zoning used is that of BUSNARDO, THIEULOY & MOULLADE (1979), precisely defined in the Barret-le-Bas section and the Angles hypostratotype. Each of these zones is defined at its base by the appearance of the index species (zoning in accordance with the recommendations of the Copenhagen symposium, 1984).

For the Hauterivian and the Barremian, traditionally-used biozones in the South-east of France have never been as clearly defined as those of the Berriasian and the Valanginian. For the Hauterivian, the first zoning proposed since the Colloque sur le Crétacé inférieur (1963)

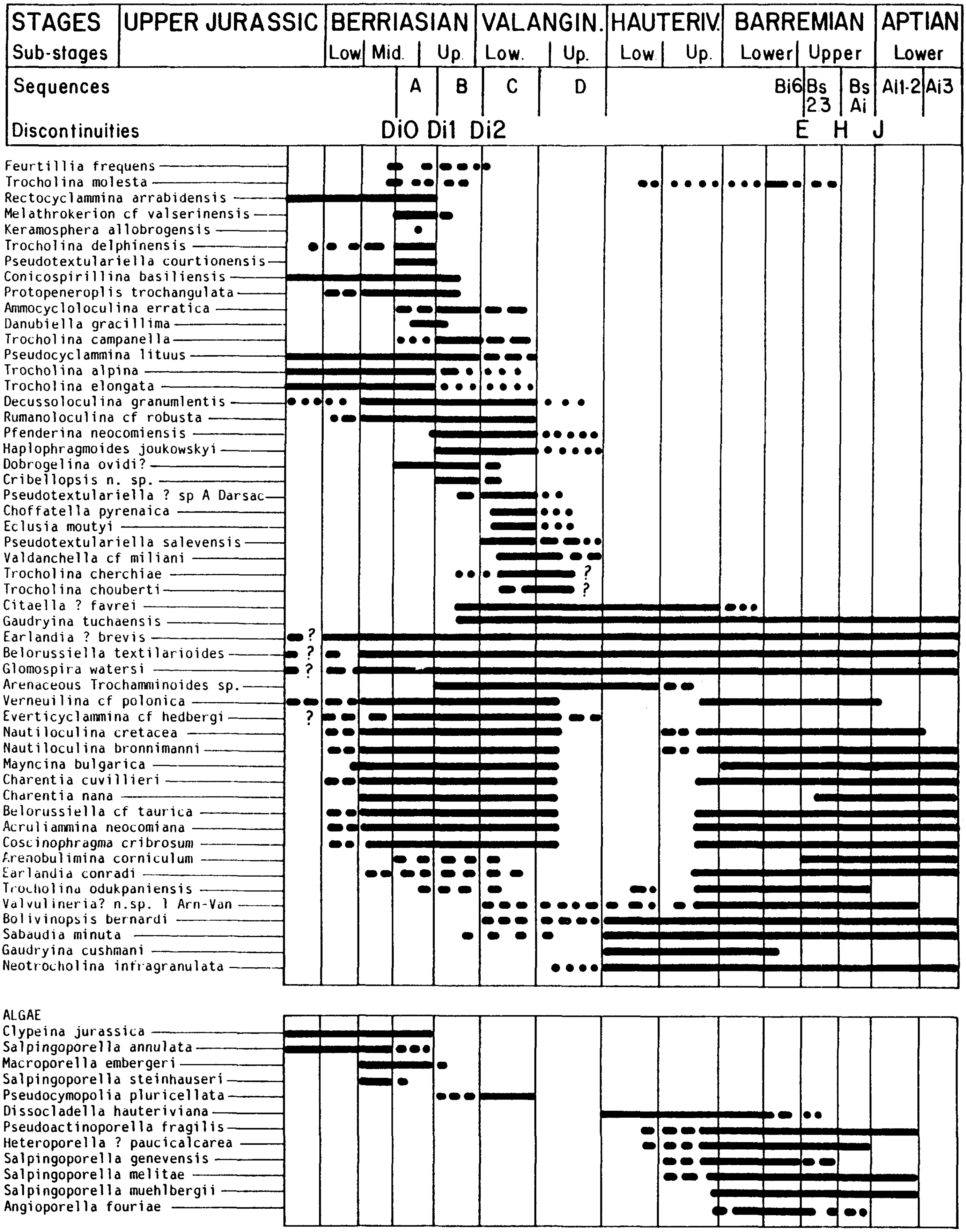


Fig. A 23 : Distribution of the major species of benthic foraminifera

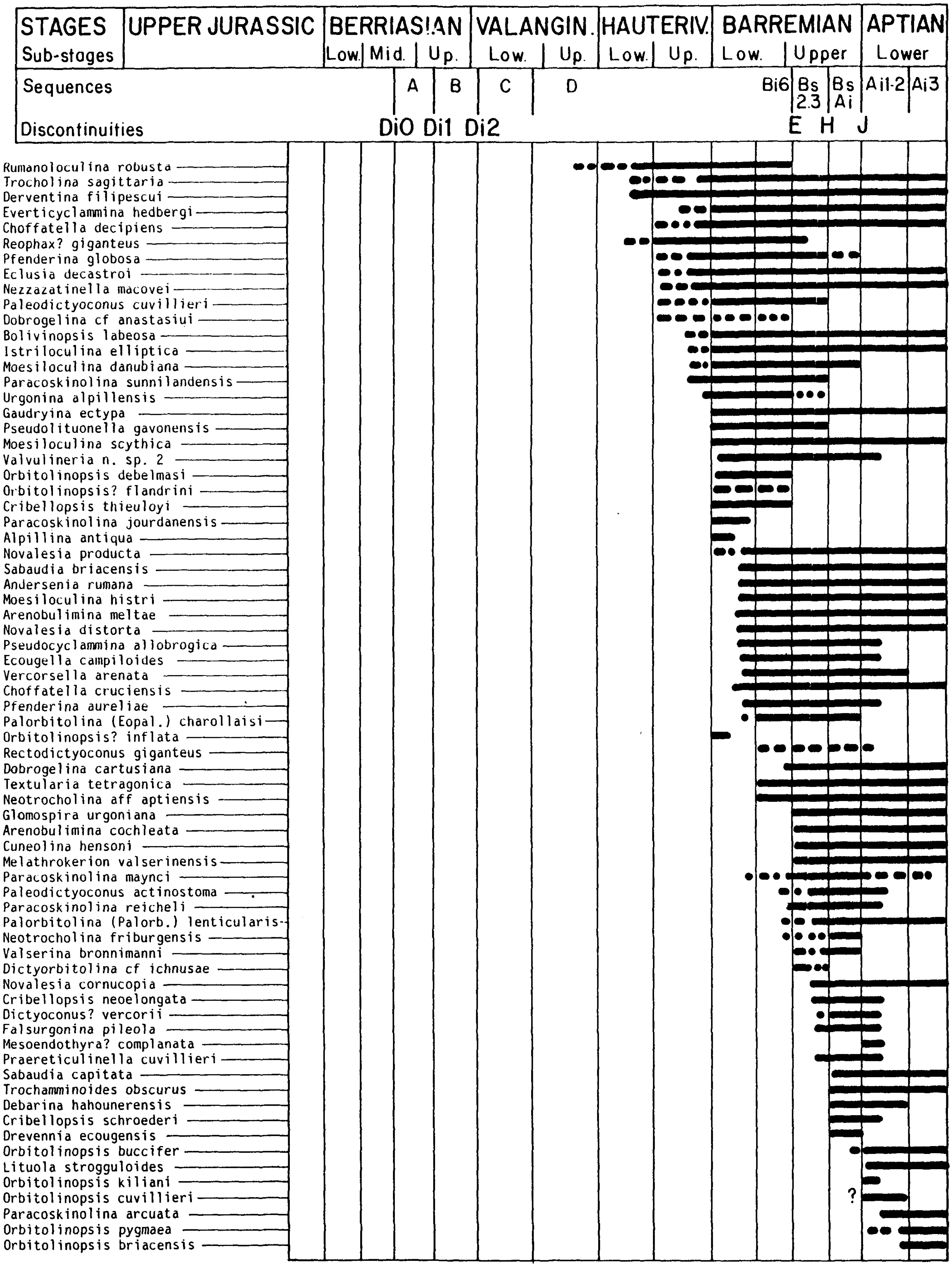
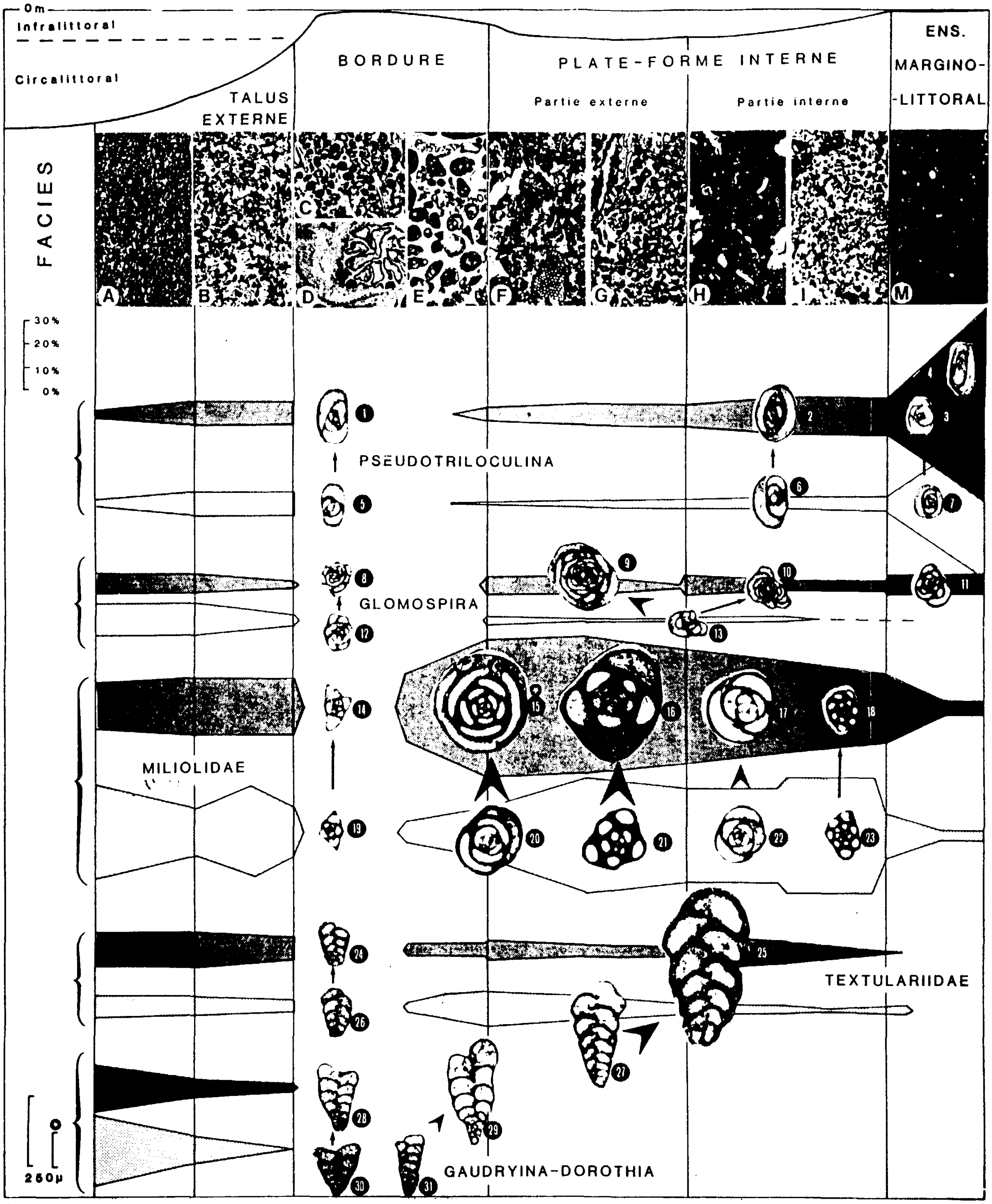


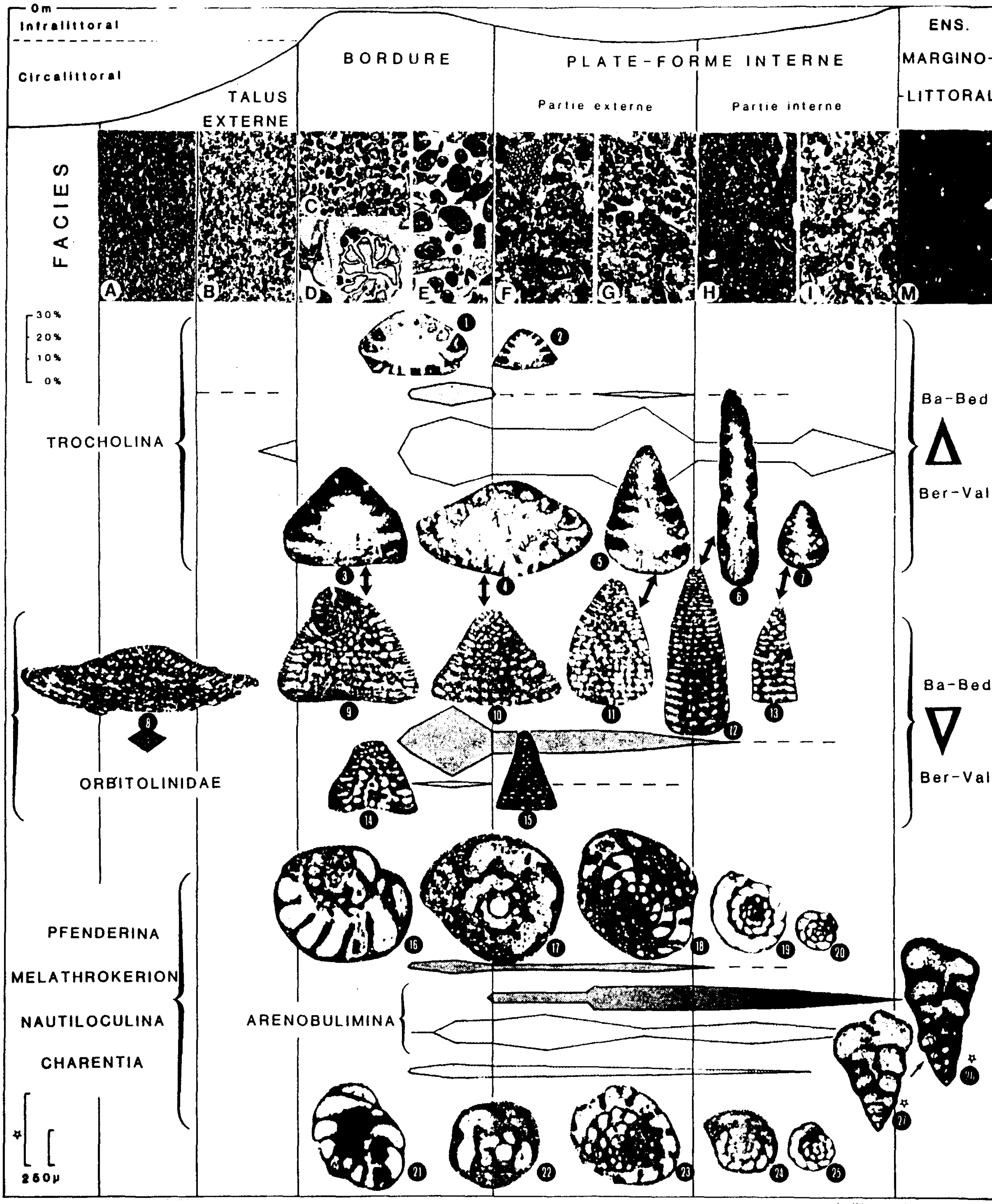
Fig. A 24 : Distribution of the major species of benthic foraminifera



Légende des espèces. List of species.

1.*Pseudotriloculina* n. sp. 2 ARNAUD-VANNEAU ; 2. *Pseudotriloculina* n. sp. 1 ARNAUD-VANNEAU ; 3-4, *Pseudotriloculina* n.sp. ARNAUD-VANNEAU ; 5 à 7, *Pseudotriloculina* sp. ; 8, 12, *Glomospira glomerosa* EICHER ; 9, *Glomospira urgoniana*, ARNAUD-VANNEAU ; 10, 11, 13, *Glomospira* sp. ; 14, 19, *Quinqueloculina* aff. *danubiana* NEAGU ; 15, *Nummoloculina* sp. ; 16, *Quinqueloculina robusta* NEAGU ; 17, 22 *Triloculina* sp. ; 18, 23, *Sigmoilina* sp. ; 20, *Nummoloculina* ? ; 21, *Quinqueloculina* sp. ; 24, *Bolivinopsis rhopaloides* ARNAUD-VANNEAU ; 15, *Textularia tetragonica* ARNAUD-VANNEAU ; 26, *Textularia* ? sp. ; 27, *Textularia* cf. *tetragonica* ARNAUD-VANNEAU ; 28, 30, *Gaudryina tuchaensis* ANTONOVA ; 29, *Dorothia* cf. *praeoxycona* MOULLADE ; 31, *Dorothia* cf. *hauteriviana* MOULLADE.

Fig. A 25 : Distribution of larger benthic foraminifera in the main biotopes of the Berriasian-Valanginian (light grey) and Barremian-Bedoulian (dark grey) shelves (ARNAUD-VANNEAU & DARSAC (1984). List of facies : see p. 44.



. Légende des espèces. List of species.

1,2, *Trocholina* sp. ; 3,4, *Trocholina* cf. *alpina* (LEUPOLD & BIGLER) ; 5, *Trocholina* sp. A3 DARSAC ; 6, *Trocholina elongata* (LEUPOLD & BIGLER) ; 7, *Trocholina* sp. 1 DARSAC ; 8, *Palorbitolina* sp. ; 9, *Paleodictyoconus cuvillieri* (FOURY) ; 10, *Alpillina antiqua* FOURY ; 11, *Paracoskinolina sunnilandensis* (MAYNC) ; 12, *Paracoskinolina maynci* (CHEVALIER) ; 13, *Paracoskinolina* cf. *hispanica* (PEYBERNÈS) ; 14, *Valdanchella* cf. *miliani* (SCHROEDER) ; 15, *Cribellopsis* sp. ; 16, *Pfenderina globosa* FOURY ; 17, *Melathrokerion valserinensis* BRÖNNIMANN & CONRAD ; 18, 23, *Nautiloculina cretacea* PEYBERNÈS ; 19, 24, *Charentia cuvillieri* NEUMANN ; 20-25, *Charentia nana* ARNAUD-VANNEAU ; 26-27, *Arenobulimina corniculum* ARNAUD-VANNEAU ; 21, *Pfenderina neocomiensis* (PFENDER).

Fig. A 26 : Distribution of large benthic foraminifera in the main biotopes of the Berriasian-Valanginian (light grey) and Barremian-Bedoulian (dark grey) shelves (ARNAUD-VANNEAU & DARSAC, 1984). List of facies : see p. 44.

Fig. A 25 et A 26 : list of facies. ***Basin*** *: A, biomicrite with sponge spicules.* ***Outer shelf (slope and shelf edge)*** *: B, biosparite with small foraminifera ;* ***C****, oosparite ; D, Coral reefs ; E, biosparite with large rounded debris.* ***Inner shelf*** *: F, muddy facies ; G, biomicrite to biosparite with large foraminifera and Rudists ; H, muddy facies ; I, biomicrite to biosparite with small Rudists and oncolites.* ***Marginolittoral domain*** *: M, micrite with Pseudotriloculina.*

was published by MOULLADE & THIEULOY (1967): the stage was then subdivided into 7 zones and 2 undifferentiated intervals. Two successive modifications were made to this plan. The first (BUSNARDO & THIEULOY, 1976) consisted of the disappearance of the two undifferentiated intervals and the distinction of a Cruasiceras cruasense horizon at the top of the nodosoplicatum zone (upper part of the Lower Hauterivian). The second set of modifications (BUSNARDO, 1984) was the most substantial, although the reasons for these modifications are unknown (Fig. A22): the disappearance of the jeannoti zone at the Lower Hauterivian, the creation of the cruasense zone at the top of the Lower Hauterivian, the replacement of the ligatus zone by a new balearis zone at the Upper Hauterivian.

For the Barremian, a very incomplete initial zonation of the Angles stratotype section was published by BUSNARDO (1965). It has just been replaced recently (BUSNARDO, 1984) by a new zonation based on the same section. It is just as imprecise as the previous one since the exact distribution of Cephalopods is still unknown. Only the base of the hugii zone, base of the Barremian stage, has been clearly defined (BUSNARDO & VERMEULEN, 1986), even though it still presents a problem since, as it was mentioned earlier, the index species only appears 4 m. above the base of the zone.

To summarize, the distribution of ammonites in the Berriasian-Valanginian is well-known in the South-east of France. On the other hand, Ammonite distribution in a part of the Hauterivian and especially in the Barremian has only been published in a very partial manner. At the present state of knowledge, the proposed zonation cannot be viewed as indisputable stratigraphic tools, but only as a framework subject to fairly large modifications (Fig. A22).

2. FORAMINIFERA DISTRIBUTION (A. ARNAUD-VANNEAU)

Because of their abundance and the diversity of the facies in which they are found, foraminifera are of particular interest not only from a stratigraphic point of view, but also in terms of the characterization of depositional environments.

The stratigraphic distribution of foraminifers is the result of complete inventories of microfauna and their localization in relation to the major discontinuity horizons dated by pelagic organisms (Calpionellids for the Berriasian-Early-Valanginian, ammonites for all levels). For the Berriasian-Hauterivian, scales have been established in the Jura and completed in the Chartreuse subalpine massif. For the Barremian and the Lower Aptian, they have been established in the Vercors where, particularly in the South, several Cephalopod intercalations exist at the Lower Barremian, the Upper Barremian (Matheronites limentinus level, Colchidites level) and the Bedoulian (Couches inférieures à Orbitolines, couche supérieure à Orbitolines). The distribution of the major species of stratigraphic value is presented in Figures A23 and A24.

FOURTH DAY : MONDAY, DEPTEMBER 7 TH

PELAGIC SEDIMENTATION OF THE VOCONTIAN BASIN

A. ARNAUD-VANNEAU, H. ARNAUD, J.-P. THIEULOY, M. ARGOT

with the collaboration of
H.J. OERTLI and J. REMANE for the determination of Ostracods and Calpionellids
T. BAS and C. LEREUS for the field work.

THEME

This day is devoted to the examination of: 1) the pelagic sedimentation of the Valanginian-Hauterivian series and the distribution of ammonites which were numerous in this domain, 2) the reworked sedimentation of the Late Berriasian (with inner platform bioclasts) and of the Valanginian (with only outer shelf sediments or hemipelagic bioclasts), 3) the marl-limestone alternations and cycles which were the most conspicuous features of the Vocontian basin sedimentation.

FIRST STOP : THE REWORKED SEDIMENTATION OF THE LATE BERRIASIAN NEAR MARIGNAC-EN-DIOIS (Fig. E1)

Location: Die 3-4 (1/25000)
This section is located along the road between Die and St. Julien-en-Quint, on the southern side of the small Serre du Jayon hill.

1. DESCRIPTION

This section, described by ALLIOT, FLANDRIN and MOULLADE (1964) and then by LE HEGARAT (1971), is made up of 6 superposed levels among which only Levels 1 to 3 may be observed. It has not been the subject of recent studies except for the microfauna which was reviewed by A. ARNAUD-VANNEAU.

1.1. Level 1

The level 1 corresponds to a mud-flow, several meters thick, made up of a mixture of a matrix of hemipelagic ooze with sponge spicules and two different types of allochem : 1) coarse bioclasts derived from the margin and inner domain of the Jurassian platform (numerous foraminifera, bivalvia, bryozoans, gastropods,...), 2) mud-pebbles ("phacoïds") composed of fine micrite with Calpionellids, Radiolaria, Stomiosphera (facies FO). These mud-pebbles, centimeter- to pluridecimeter-sized, are more or less well-shaped, conveying their transport in a compacted state within the mud-flow.

Among the reworked bioclastic sand foraminifera, one finds Trocholina alpina (Leupold), Trocholina delphinensis Arn-Van., Boisseau, Darsac, Trocholina elongata (Leupold), Trocholina molesta Gorbatchik, Pseudotextulariella courtoniensis Brönnimann, Nautiloculina bronnimanni Arn.-Van. & Peybernes. There are also two Calpionellid associations, the first in the phacoïds : Tintinopsella carpathica (Murg. & Fil.) and Calpionella alpina Lorenz of the C zone (Lower-Middle Berriasian), the second in a massive bank : Calpionellopsis simplex (Col.), Tintinopsella carpathica (Murg. & Fil.) and Calpionellopsis oblonga of the D1-D2 zone (Upper Berriasian).

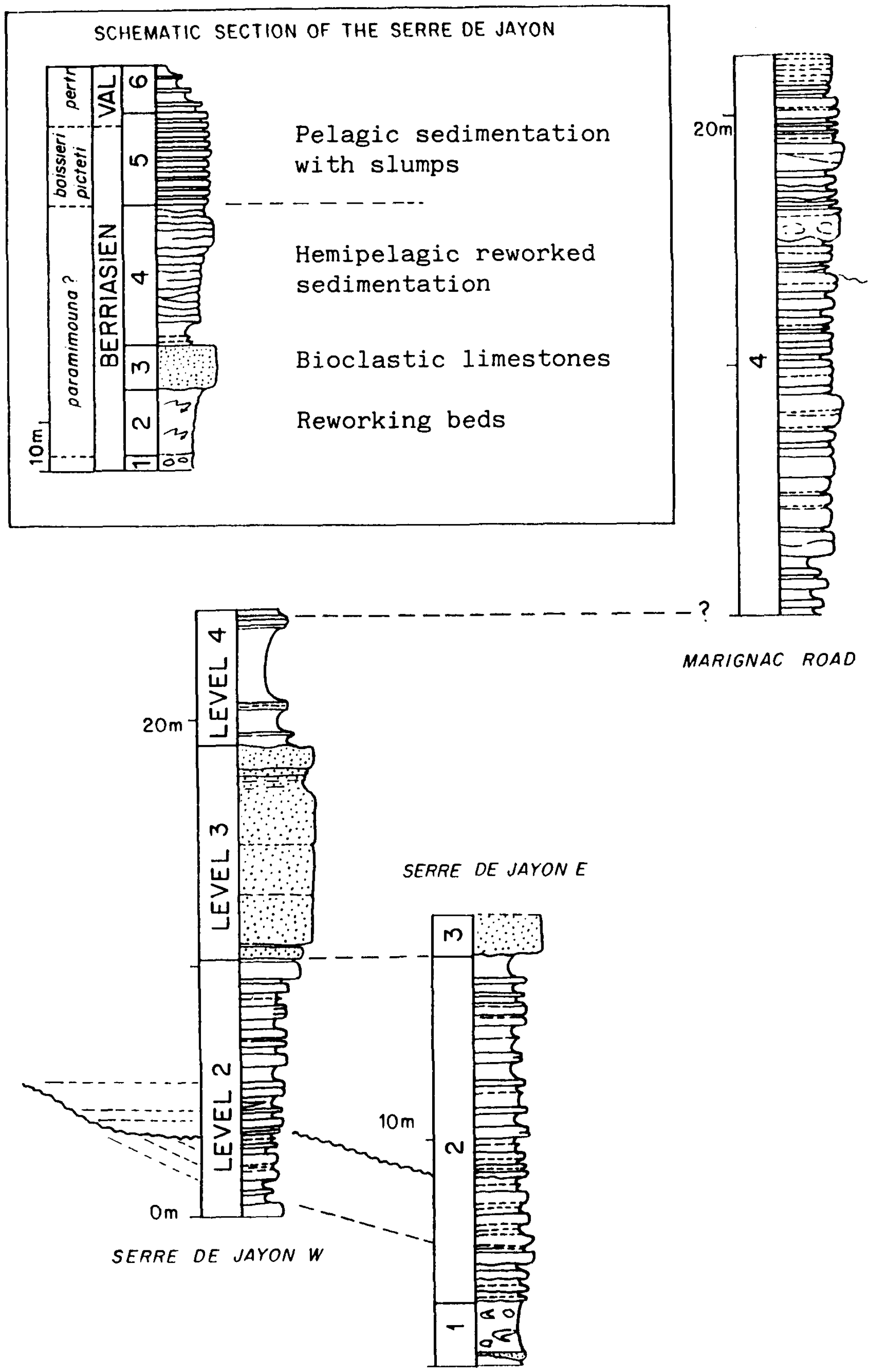


Fig. E 1 : The Serre de Jayon sections (near Marignac-en-Diois). 1 to 6 : level 1 to 6 according to LE HEGARAT, 1971).

At the botton of the Vocontian basin, this outcrop displays the deposit of sediments which were subject to dual transport through the force of gravity: 1) the transport of infralittoral bioclastic sands from the inner domain of the Jurassian platform to the outer slope and the mixing with hemipelagic ooze, 2) the transport "en masse" of the previous mixture to which are added fragments of compacted ooze pulled away from the pelagic domain during the passage of the mud flow.

This level cannot be dated because of the mannerin which it was deposited. In LE HEGARAT's view (1971), it may be assigned to the privasensis (?) sub-zone or to the dalmasi sub-zone (upper part of the Middle Berriasian). The two Calpionellids associations may indicate that all the sediments are reworked, without stratigraphical succession. However, the Calpionellids and the benthic foraminifera indicate for the younger deposits an early Upper Berriasian age, probably just below the

Dil discontinuity.

1.2. Level 2 (variable thickness, 15 to 20 m.)

This level is made up of a pile of hemipelagic marly limestone slumped beds with sponge spicules, Radiolaria, Globochaetae. Many of the beds also contain a more or less large proportion of bioclasts from the Jurassic platform. Several truncature surfaces highlight the existence of a piling-up of slumped levels.

According to LE HEGARAT (1971), this level corresponds to the lower part of the paramimounum sub-zone (lower part of the Upper Berriasian).

1.3. Level 3 (locally about 9 m.)

This level is represented by a small cliff made of massive bioclastic limestones which disappears towards the East. Here again, we have a mud flow made up of a mixture of infralittoral bioclastic sands originating from the inner domain of the Jura platform and hemipelagic ooze with sponge spicules. This mixture is however heterogeneous and, on the outcrop, all the intermediate facies from biosparites with large bioclasts to micrites with sponge spicules may be observed. Contrary to Level 1, there are however no pelagic ooze mud pebbles.

Among the foraminifers, one notes: the same association as that in the first level, but with Everticyclammina cf hedbergi (Maync), Trocholina cf odukpaniensis Dessauvagie, Coscinophragma cribosum (Reuss), Pseudocyclammina lituus (Yoko.), Charentia cuvillieri Neumann and Clypeina jurassica Favre. We may note that ALLIOT et al (1964) had identified Pfenderina globosa (Pfender). This reworking association, especially the youngest forms, seems to indicate the neighbourhood of the Dil discontinuity (Upper Berriasian, picteti sub-zone) or the levels which are immediatly above.

1.4. Level 4 (about 25-30 m.)

This level begins by about 4 meters of marls over-topped by grey, slumped argillaceous limestones similar to those of Level 2 (hemipelagic micrites with sponge spicules and quartz). A good? outcrop is visible on the northeastern slope of the Serre de Jayon, along the road to Marignac (Fig. E1).

1.5. Level 5 (about 20 m.)

This level is represented by marl-limestone alternations (fine micrites with Calpionellids and Radiolaria, facies FO) characteristic of pelagic deposits. Synsedimentary reworking still exists in this series (presence of slumped beds) but the sediments here are autochtonous or only slightly displaced, to the contrary of what is observed in the underlying levels. Berriasella (Picteticeras) picteti, B(P)evoluta, Fauriella rarefurcata at the base, Calpionellopsis oblonga, Berriasella calypso, Fauriella montelsi, F.boissieri have permitted the datation of this level of the picteti and callisto sub-zones (LE HEGARAT, 1971). At the top, we have found Thurmanniceras cf. thurmanni of the Basal Valanginian.

1.6. Level 6

This level, very poorly outcropping to the North of the Serre de Jayon crest, corresponds to yellowish argillaceous limestones and thick, marly intercalations with pyritaceous ammonites. A transition to Lower Valanginian marls (pertransiens zone) is observed to the North of the Serre de Jayon. This level, mainly marly intercalations with pyritaceous ammonites, corresponds precisely to the **Chamaloc fossiliferous level.**

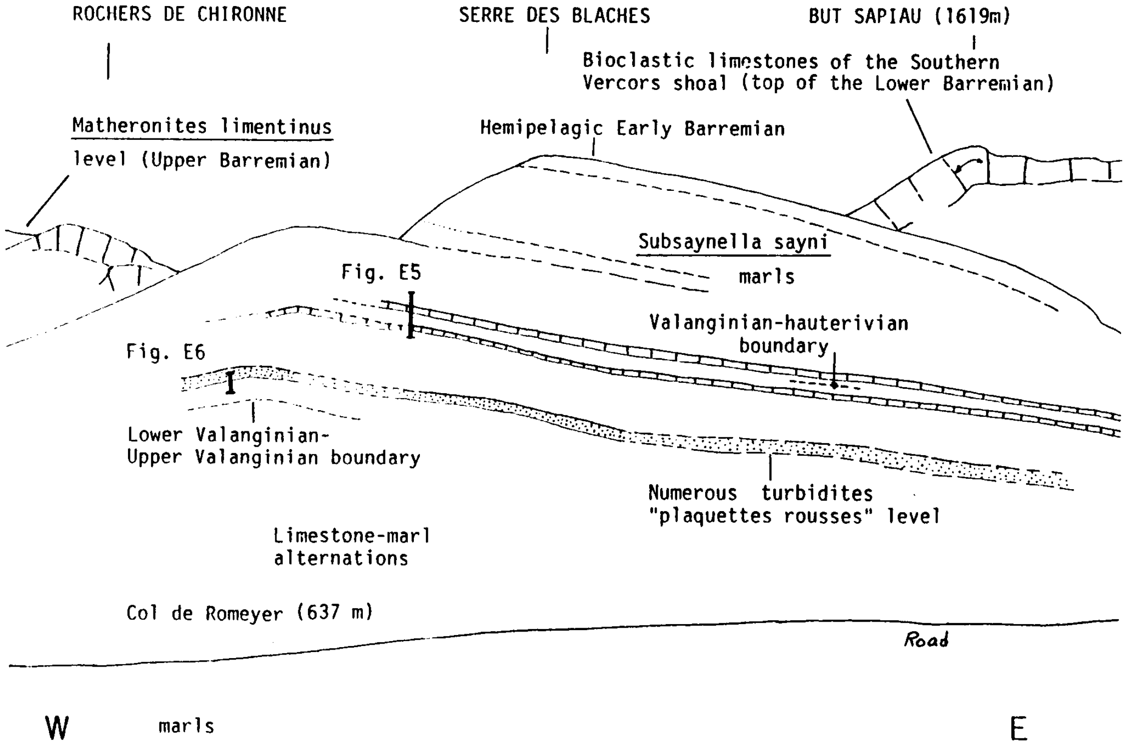


Fig. E 2 : General view of the Col de Romeyer-Serre des Blaches section

2. CONCLUSIONS

1) The Berriasian in the region visited between Marignac and Romeyer is made up of two superposed sedimentological entities : at the base, deposits reworked by the force of gravity, at the top, autochtonous or slightly displaced sediments. The particularly distinct boundary between the two is situated in the Picteti sub-zone, that is to say **in the neighborhood of the Dil discontinuity** (probably above) of the Jura platform.

2) The reworked sediments correspond to a variably-proportioned mixture of elements of various origins : inner platform, outer platform, hemipelagic basin, pelagic basin. They are deposited at the bottom of a very large submarine canyon, several tens of kilometers long, which already existed at the Tithonic, across the Vocontian basin to the North-east of Sisteron, and was named "**Canyon de Céüse**" by BEAUDOIN.

3) Among the bioclasts found in the mud-flows, one finds numerous large-sized foraminifera reworked from the F5 and F8 facies of the Jura platform. **Up until the beginning of the Upper Berriasian, the reworked sediments of the Vocontian basin therefore contained elements originating from the inner domain and margin of the Jura platform.**

4) The ages assigned to the different reworked levels are only of comparative interest. It is not possible to know, in particular, whether the filling up of the Céüse canyon occurred throughout all the Middle Berriasian or whether it was very rapid, in the picteti zone.

SECOND STOP : COL DE ROMEYER VALANGINIAN SECTION (Fig. E2 To E6)

Location: Mens 1-2 (1/25000).
This section is situated in the ravines of the eastern slope of the ridge joining the Col de Romeyer (637 m) to the Serre de la Blache (953

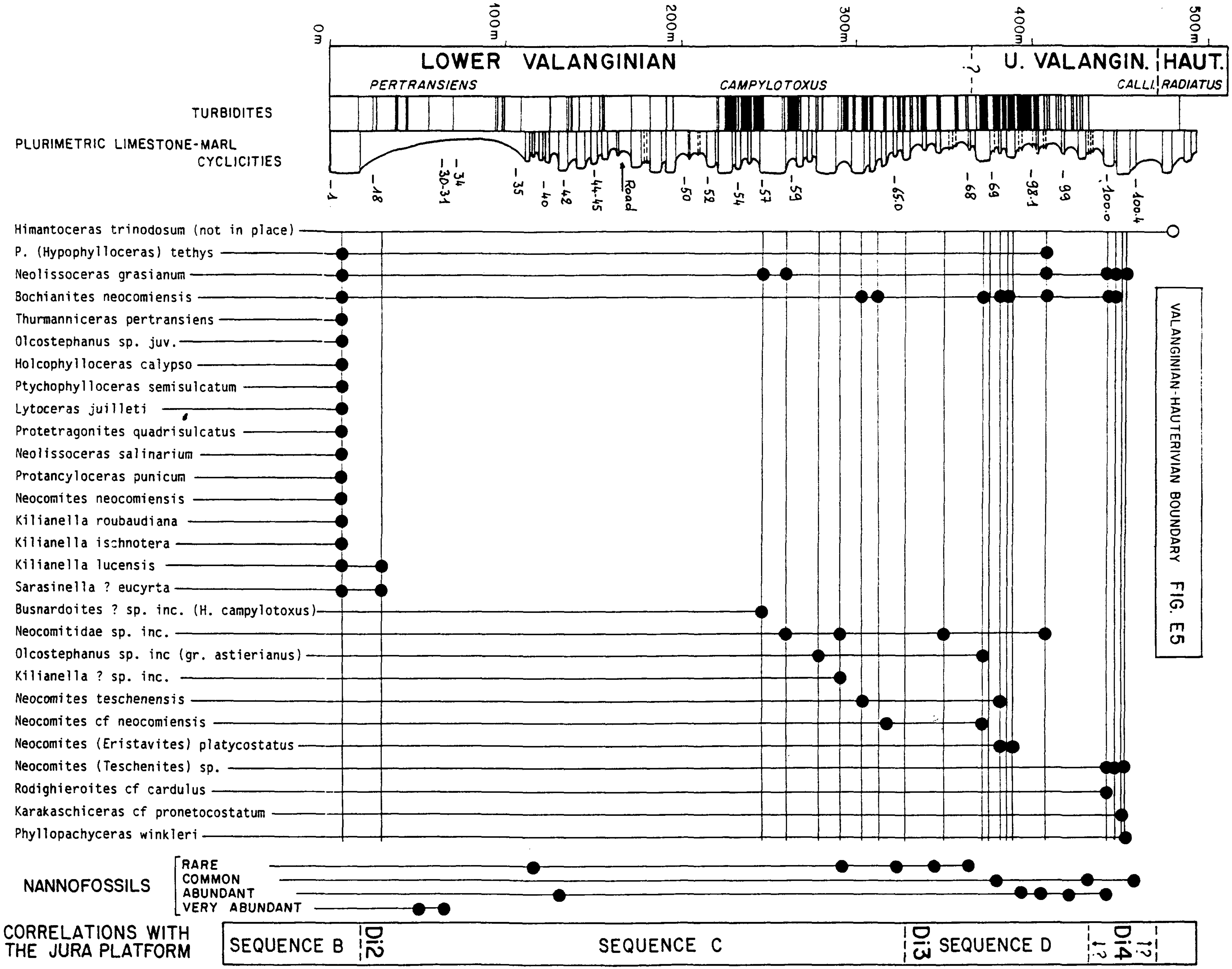


Fig. E3 : Very schematic representation of the Col de Romeyer section (Diois), repartition of Ammonites, abundance of Nannoconus, correlations with the Jura platform.

m). Only the lower part of the section will be observed up to the Valanginian-Hauterivian boundary located at an altitude of about 800 m.

1. DESCRIPTION

This section, almost 500 m thick, is the most beautiful Valanginian section of the Diois. It has been measured in detail for this excursion, but all the results of analyses are not yet known. Because of the length of the section, only certain particular points will be described in detail.

1.1. Early Valanginian with pyritaceous ammonites (Bank 1 to 15)

Above the Upper Berriasian, which closely resembles that of Marignac, the section begins by marl-limestone alternations which correspond precisely to Level 6 of the Serre de Jayon. Pyritaceous ammonites are found as of the base. They are very abundant in a 6 to 8 m. thick level which corresponds regionally to the **Chamaloc level**, of which the type locality situated 1,5 km from the Col de Romeyer, presently covered by vegetation, was discovered by Ch. LORY (1860) and described by PAQUIER (1900).

At the Col de Romeyer, only some specimens have been collected so as not to devastate the outcrop before the excursion. The list of species collected, probably incomplete, is given in Figure E4. This association is typical of the basal part of the Early Valanginian pertransiens zone: Thurmanniceras pertransiens is, in fact, accompanied by T.cf.thurmanni (Pict. & Camp.), by numerous Kilianella (Kilianella roubaudiana d'Orb. especially frequent) and by Protancyloceras punicum (Arn.-Saget).

The pelagic marly-limestones correspond to radiolaria, Globochatae and Calpionellid biomicrite with a rich Calpionellid fauna. J. REMANE has recognized two associations of the Early Valanginian :
- The first , at the base (1-3, fig. E4), with Tintinopsella carpathica Murg. & Fil. and T. longa (Col.), characteristic of Upper D3-E zones,
- the second, above (8-9, fig. E4) with the same and Remaniella cadischiana (Col.), Calpionellites darderi (Col.) characteristic of the E zone.

More generally speaking, two facts may be established:
1) The fauna is very unevenly distributed : certain beds contain very few individuals or species (Phylloceratidae are dominant), whereas others are very rich. This diversity does not appear to be due here to varying fossilisation conditions but rather to variations in population composition.
2) In the pyritaceous ammonite level, the number of individuals and species progressively increases up to a maximum which appears to be reached at bed 5 (Fig E4) and then progressively decreases. If one assumes that a marl-limestone alternation represents sediment deposited over a period of about 20000 years (§ F.2.2, p. 35), maximum ammonite concentration corresponds to an interval of about 100000 years. These particular intervals, regularly observed in the Vocontian basin series, could correspond to **biological crises** during which fauna renewal took place through the appearance and subsequent disappearance of species.

1.2. The Lower Valanginian (level 16 to 68 probably)

Above the marl-limestone alternations at the base of the section, one observes marls over-topped by argillaceous limestones

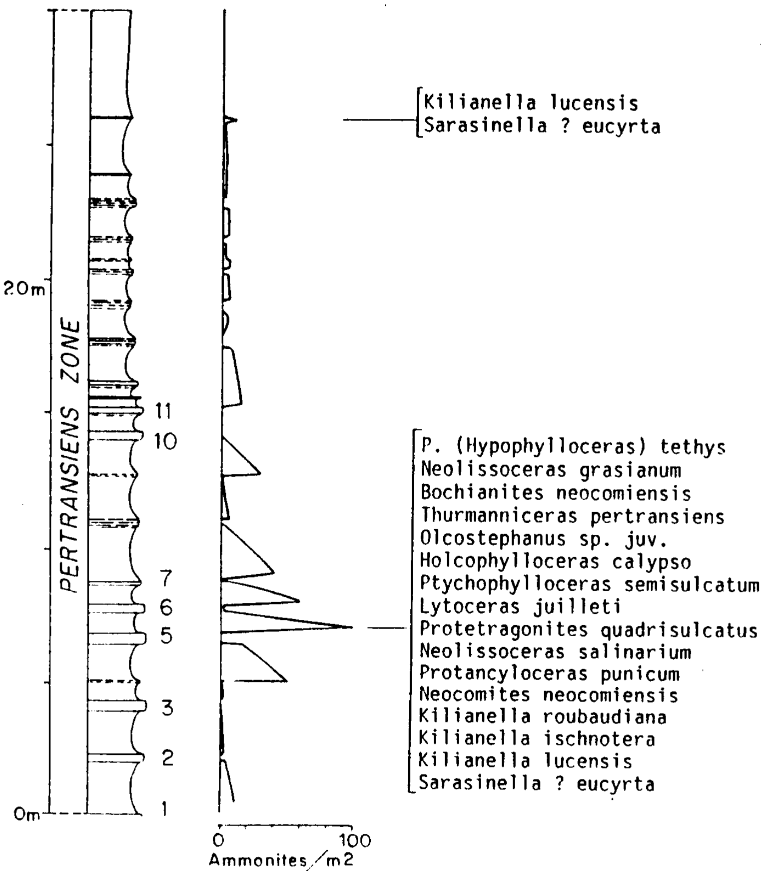


Fig. E 4 : The Early Valanginian of the Col de Romeyer section. Level with pyritaceous ammonites of the pertransiens *zone.*

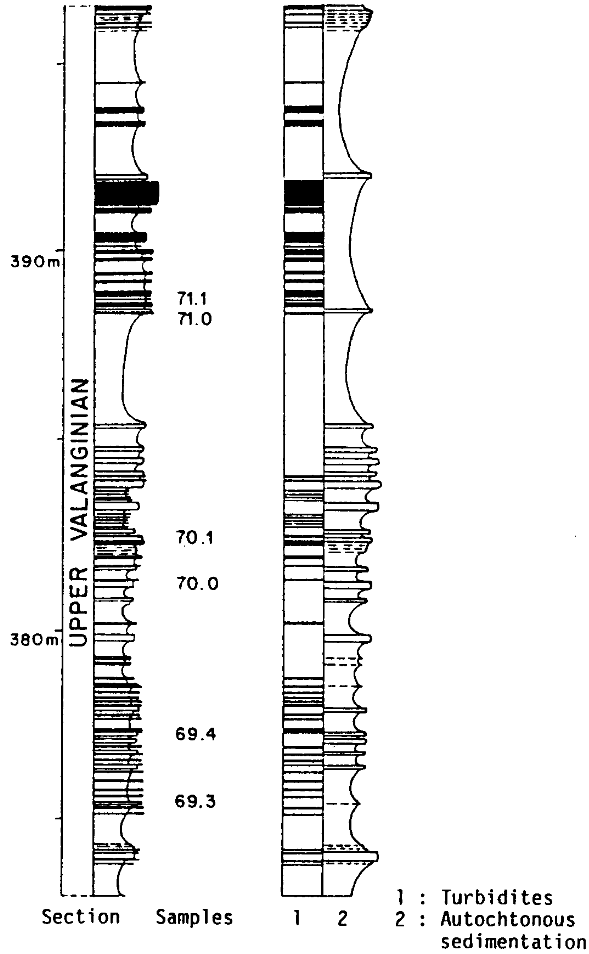


Fig. E 6 : Col de Romeyer section. detail of the section showing the turbidites inserted in the autochtonous deposits. on the right : turbidites and autochtonous banks are separated.

(about 355 m in all).

The marls (about 95 m) contain, at their base, a final pyritaceous ammonite level which has given forth Sarasinella ? eucyrta (Sayn) and several Kilianella lucensis (Sayn) characteristic of an already fairly high part of the pertransiens zone. Above this basal level, the ammonites disapear. The microfauna is poorly preserved, except for at the base, the sample 30-31 which contains : Reophax stellatus Neagu, Gaudryina praedividens Neagu, Gaudryina tuchaensis Antonova, Dorothia kummi Zedler, Lenticulina muensteri (Roemer), Frondicularia Verneuilina acutimarginata Neagu and Spirillina minima Schacko. In this level, the Ostracods are frequent : Parexophthalmocythere berriasensis Donze, Protocythere paquieri Donze and Protocythere entremontensis Donze. At the top (sample 65.0) the microfauna is also abundant : Lenticulina muensteri (Roemer), L. nodosa (Reuss), L. ouachensis multicella Bart., Bett. & Bolli, Gaudryina tuchaensis Antonova, Dorothia kummi Zedler and D. praehauteriviana Dieni & Massari.

The Nannoconus are frequently abundant (24-25, 30-31): Nannoconus cornuta, N. steinmanni, N. globulus, Conusphera mexicana, Cruciellipsis cuvillieri, Calcicalatina oblongata, Parhabdolithus embergeri, Micrantolithus holschulzii, M. obtusus, Braarudosphaera sp gr africana.

The marls display 3 features: 1) marl-limestone alternations subsist in this very argillaceous environment (alternations of dark and light marls are highly visible on the outcrop); 2) the existence of slumped levels in the marls; 3) the appearance of very fine reddish turbidites ("**plaquettes rousses**"), containing bioclasts from circalittoral outer platform environments (Pseudotextulariella salevensis Char., Brön., & Zanin., Citaella ? favrei Char., Brön. & Zanin.).

The argillaceous limestones (about 260 m.) are represented by thin limestone-marl alternations which may be grouped together in cycles which are several meters to ten meters thick.

The reddish turbidites, centimeter- to decimeter-sized, are fairly rare at the base but become so numerous at the top that they sometimes make up small scarps which are apparent in the topography. Some of them also contain foraminifera from circalittoral outer platform environments but most of them are made up of sponge spicules. In most cases, no graded bedding is visible, however, at times, in the thickest turbidites, graded bedding is observed between the large spicules at the base and the small spicules at the top.

Over the first 135 m, the argillaceous limestones and marls are themselves reworked by gravity (arrangement in fine millimeter-sized laminae). This is probably the reason for the fact that no well-preserved ammonites have been encountered.

Over the top 120 m , the reworking of argillaceous limestones appears to be less substantial. Ammonites are more frequent (Fig. E3) and the series becomes more marly.

The Early Valanginian-Upper Valanginian boundary has not been precisely determined. It has been located thanks to the appearance of Neocomites (Eristavites) platycostatus (SAYN) but could be situated a bit lower.

The relative abundance of ammonites, the decrease in reworkings and the stratigraphic level allow correlation of the Jurassic platform Di3 discontinuity with the base of the more marly level (near the altitude 320 m, Fig. E3).

1.3. The Upper Valanginian (level 69 to few meters above 100.4)

It displays 4 main features.

a) Marly sedimentation is preponderant;
b) The facies progressively become more pelagic and synsedimentary reworking on the slopes appears to progressively disappear. Throughout this series, the autochtonous marl-limestone alternations become very regular and typical of Vocontian basin pelagic facies.
c) Ammonites become very frequent at the top of the series where they are represented by a rapid multiplication of Bochianites in almost all of the beds and by the great abundance of Neocomitidae (notably Teschenites) in certain beds.
d) Nannofauna are the same as in the Lower Valanginian, but we constate the disappearance of Nannoconus cornuta.
d) Turbidites are very numerous and fairly thick (up to several decimeters thick at the base of the Upper Valanginian). They make up a scarp which is highly visible in the topography (Fig. E2). They consist exclusively of sponge spicules **reworked from hemipelagic facies.**

Above this level, the turbidites become very rare and then **disappear entirely 40 m below the Valanginian-Hauterivian boundary** (they are lacking in most of, if not all of the callidiscus zone).

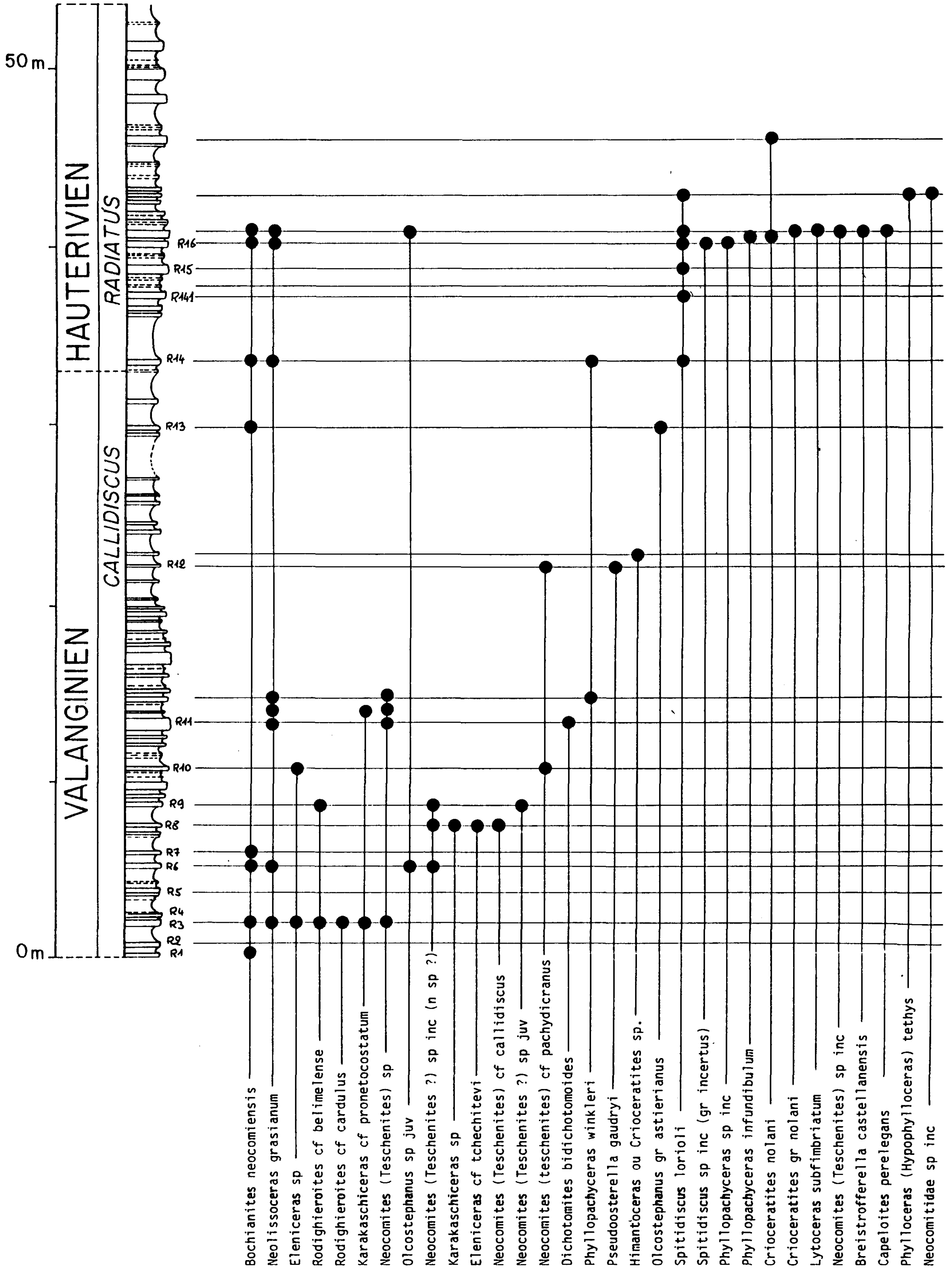


Fig. E 5 : The Valanginian-Hauterivian boundary of the Col de Romeyer section. Distribution of the ammonites.

1.4. The Valanginian-Hauterivian boundary (Fig. E5)

It is found in a small marly flat located between two small calcareous scarps highly visible in the topography (Fig. E2). Ammonites are very numerous, especially in the two calcareous scarps.

- The callidiscus zone of the Upper Valanginian is characterized by an association of which the most characteristic species are Eleniceras cf tchechitevi Breskovski, Rodighieroites cf cardulus Company, R. cf belimense Mandov, Karakaschiceras cf pronetocostatum (Felix), Neocomites (Teschenites) cf callidiscus, N. (T.) cf pachydicranus Thieuloy, Pseudoosterella gaudryi Nickles. The boreal migrant Dichotomites bidichotomis (Kemper) has been found in this association.

- The radiatus zone of the Basal Hauterivian is characterized by the disappearance of Valanginian species and by the appearance of numerous new species including Spitidiscus lorioli (Kil.), S. sp gr incertus (d'Orb.), Crioceratites nolani (Kil.), Breistrofferalla castellanensis (d'Orb.).Spitidiscus and Crioceratites are found in abundance at the base. Capeloites perelegans (Matheron), exceptionally rare in the Vocontian basin, is represented here by a typical sample.

This first group of Basal Hauterivian calcareous beds is over-topped by more marly levels covered by vegetation. These more marly levels (cf. the section on the road from Col de Rousset to Chamaloc, Fig. E7) represent the Vocontian domain lateral equivalent of the **Marnes Bleues d'Hauterive.** It therefore clearly appears that the hardground observed at the base of the latter in the Gorges du Nant region and in Neuchâtel represent a sedimentary hiatus which corresponds to the deposit of the first Hauterivian calcareous cycle of beds of the Chamaloc-Col de Rousset section.

2. CONCLUSION

1) The Col de Romeyer Valanginian corresponds to an autochtonous or slightly displaced marly or argillaceous carbonate sedimentation. The reworking observed can be explained by a deposit on a slightly-inclined slope.

2) Turbidites are present almost throughout the series except in the callidiscus zone. They are especially abundant in the campylotoxus zone and at the base of the Upper Valanginian.

At the base of the series, they contain circalittoral foraminifera from the outer platform. At the top, only sponge spicules are found. This variation in the composition of the constituent elements of the turbidites illustrates the progressive submersion of contemporary platforms and the retrograding of facies on their margins (a fact already established in the Jurassic platform sections). There are never any **inner platform facies reworked in the Valanginian of the Vocontian basin.**

3) Considering the C sequence and its equivalent in the Col de Romeyer series, turbidites are especially rare at the base and numerous at the top. A correlation would therefore appear to exist between the maximum progradation of platform facies and the turbidite maximum in the bassin.

THIRD STOP : HAUTERIVIAN SECTION ON THE ROAD TO COL DE ROUSSET (CHAMALOC) (Fig. E7 and E8)

Location: Die 3-4 (1/25000)

This section, situated along the road to Col de Rousset, corresponds to the extension of the Col de Romeyer to the Serre des Blaches section. The lower and upper parts of the section have been the subject of detailed research in regards to fauna. The central part has been the subject of only a fairly rapid exploration.

1. DESCRIPTION :

This section is about 300 m. thick. It begins in the Upper Valanginian, below the last small scarp of the callidiscus zone, and ends in the Early Barremian at the base of very thick hemipelagic facies. It is represented by a succession of limestone-marl alternations with pelagic facies. There is no transition between the pelagic Hauterivian limestones (radiolaria limestones) and the reworked hemipelagic Barremian limestones (fine-grained biosparite mixed with biomicrite with Sponge spicules).

1.1. The Lower Hauterivian (level 140 to 227)

The Valanginian-Hauterivian boundary has not been precisely set ; only the framework has been set thanks to bed-to-bed correlations with the Col de Romeyer section.

Above the first group of Hauterivian calcareous beds, two lithologic entities are observed:

- **at the base**, a marly entity which corresponds to a large part of the loryi zone and probably to a part of the radiatus zone (by comparison with Col de Romeyer). It is a lateral equivalent of the **Marnes Bleues d'Hauterive.**

- **at the top**, a more calcareous entity which begins in the loryi zone, continues in the nodosroplicatum zone and ends at the top, which becomes more marly again, in the cruasense zone. All of the index species i.e. Crioceratites loryi (Sarkar), Lyticoceras gr nodosoplicatum (Kil. & Reb.) and Cruasiceras cruasense (Torcapel), having been found in this section. However, we note the enormous development of the loryi zone compared to the nodosoplicatum and cruasense zones. Because of the previously presented correlation between limestone-marl alternations and astronomical 20000-year cycles, it would appear that we have here a substantial disparity in the lifespan of each of these zones. The Nannofauna is sometimes abundant : Nannoconus steinmanni, Conusphaera mexicana, Cruciellipsis cuvillieri, Calcicalatina oblongata, Parhabdolithus embergeri, Micrantolithus holschulzii, M. obtusus. Lithraphidites bollii appears between the banks 230 and 330.

This calcareous entity corresponds to a lateral equivalent of the "**Pierre Jaune de Neuchâtel**".

1.2. The Upper Hauterivian (Bank 227 to 332)

It is made up of three lithologic levels.

- **At the base** (sayni zone), an entity in which marly beds and limestone beds are of about the same thickness. Grioceratites duvali (Lev.) and Subsaynella sayni (Paq.) appears in this level.

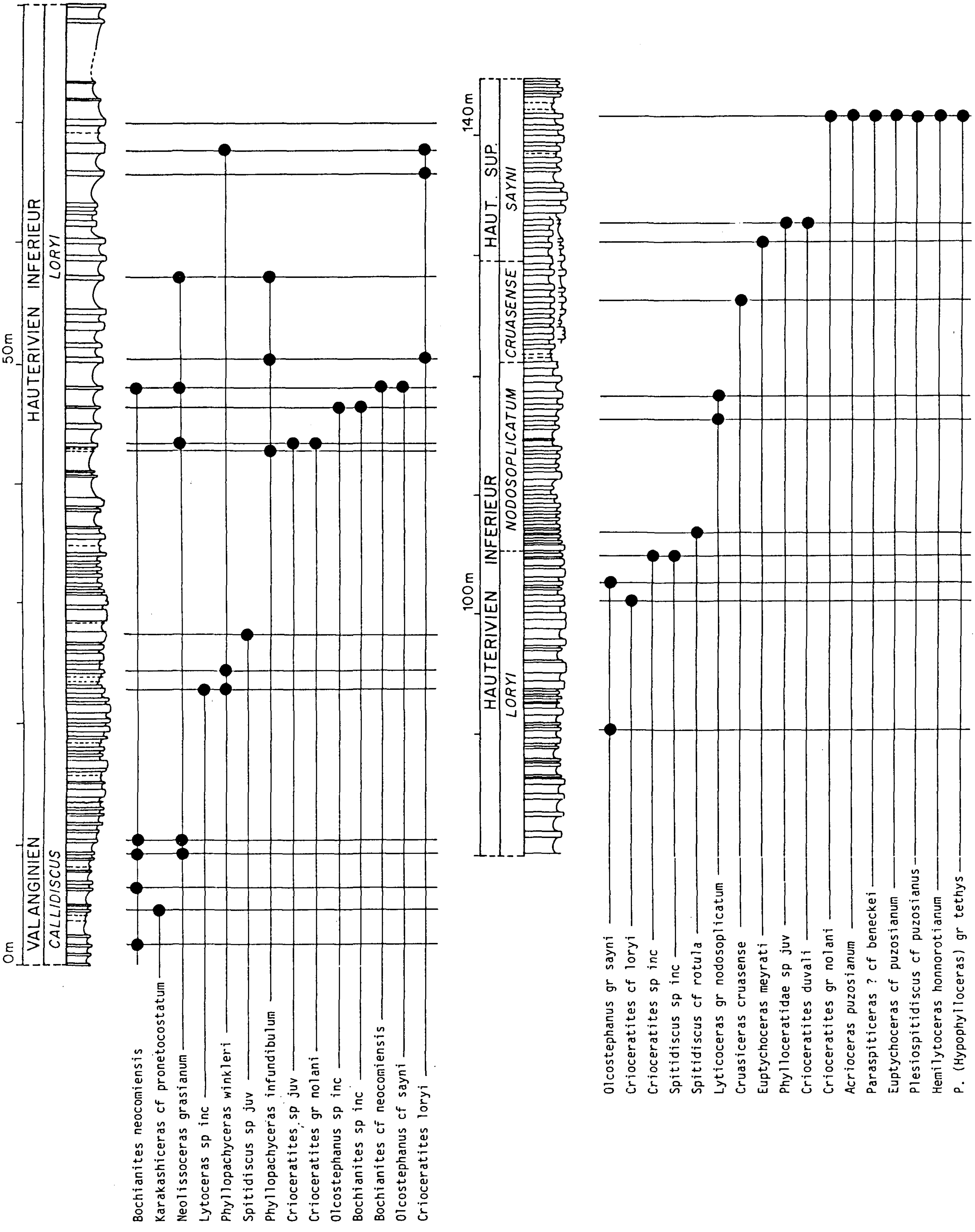


Fig. E 7 : The Hauterivian section along the Chamaloc-Col de Rousset road (first part). Distribution of the ammonites.

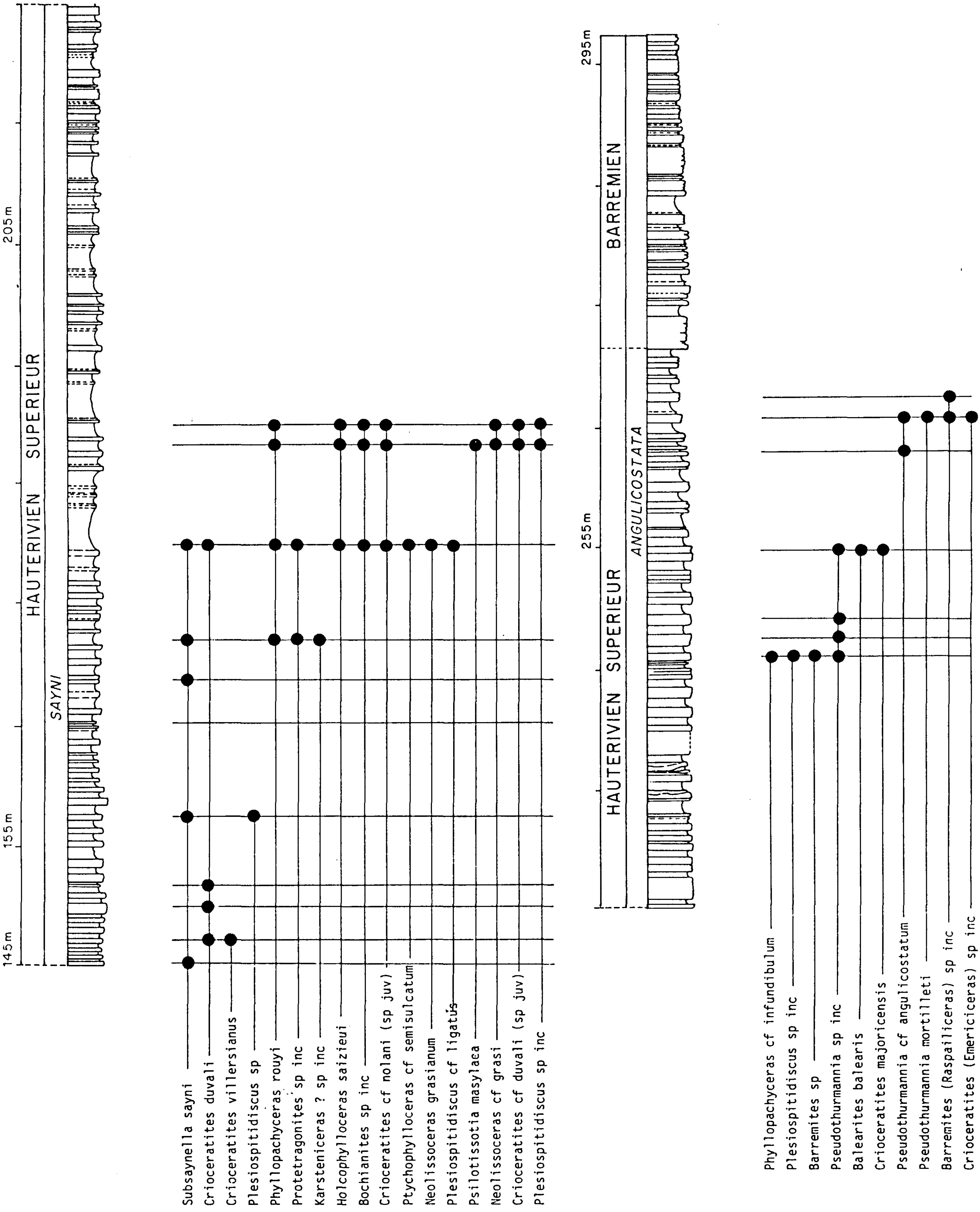


Fig. E 8 : The Hauterivian section along the Chamaloc-Col de Rousset road (second part). Distribution of the ammonites.

- **In the middle** (sayni zone), a thick marly level containing several pyritaceous ammonite levels (**S. sayni marls**) with Crioceratites duvali (Lev.), C. cf nolani (Kil.), Plesiospitidiscus cf ligatus (d'Orb.), Phyllopachyceras rouyi (d'Orb.), Holcophylloceras saizieui (Kil.), Karsteniceras ? sp inc, and Psilotissotia masylaea (Coq.),an conspicuous but extremely rare species.
Subsaynella sayni (Paq.) is abundant in the first meters of the marly level but has not been encountered above.

- **At the top**, a calcareous entity in which only the angulicostata zone has been recognized up to now. Pseudothurmannia are abundant here, but the P.angulicostata species has only been found at the top, in association with Raspailiceras and Emericiceras whose presence conveys the proximity of the Barremian. Balearites balearis has only been found in the lower part of the Pseudothurmannia level (Fig. E8).

The Nannofauna is the same as in the Lower Hauterivian with the exception of disappearance of Lithraphidites bollii and appearance of Nannoconus circularis, both in the bank 330 at the top of the angulicostata zone.

As in the Early Hauterivian, there is a marked disproportion between the relative thickness of the sayni zone and the terminal zones of the Hauterivian (balearis and angulicostata zones).

The pelagic limestone and marls of the Hauterivian are directly over-topped, without any transition, by hemipelagic argillaceous limestones (up to bank 333), undated at this point but which contain, above Serre des Blaches (Romeyer), in the marls equivalent to those of Level 346, Early Barremian fauna.

The Subsaynella sayni marls are the equivalent of the argillaceous limestones and marls, rich in Toxaster, which are situated above the Cruasiceras cruasense calcareous limestones in the Vercors and in Chartreuse. They could also represent the lateral equivalent of the marly levels which over-top the "Pierre Jaune de Neuchâtel" in La Chambotte section and in a large part of the Jura.

2. CONCLUSIONS

1) The cyclical nature of pelagic sedimentation in the Vocontian basin is well-conveyed on all scales: 1st order cycles of marl-limestone alternations, 2nd order cycles on a scale of 4-5 alternations, 3rd order cycles on a scale of twenty alternations, 4th order cycles on a half-stage scale (cycle included between the marls of the base of the Hauterivian and the S.sayni marls).

2) There is a clear relationship between the basin deposits and the deposits on the Jurassic and subalpine platform. The marly levels correspond to drowned platform periods (Chamaloc Early Hauterivian marls and the Marnes Bleues d'Hauterive ; S.sayni marls and the marly levels over-topping the "Pierre Jaune de Neuchâtel" in the Jura). On the other hand, the most calcareous levels in the basin correspond to the periods of lowest sea level (Chamaloc nodosoplicatum and cruasense limestones and "Pierre Jaune de Neuchâtel").

3) At the Hauterivian-Barremian boundary, the transition from pelagic to hemipelagic facies is abrupt. This event is contemporaneous with a very

substantial acceleration of the sedimentation rate: in the Die region 140 m thick for the Upper Hauterivian, 1000 to 2000 m for the Early Barremian.

This event is undoubtedly linked to the major tectono-sedimentary crisis in this region, manifestations of which are perceptible from the top of the Hauterivian to the beginning of the Upper Barremian and notably marked by:

- exceptionally high sedimentation rates and the birth of a shoal in the Southeastern Vercors;
- the drastic decrease or total absence of the Early Barremian and the Upper Hauterivian in the Jura and along the Isère fault.

REFERENCES

ADATTE T. & RUMLEY G. (1984).- Microfacies, minéralogie, stratigraphie et évolution des milieux de dépôt de la plate-forme bérriaso-valanginienn des régions de Sainte-Croix (VD), Cressier et du Landeron (NE) Bull. Soc. neuchâtel. Sci. nat., 107, p. 221-239.

ALLIOT C., FLANDRIN J. & MOULLADE M. (1964).- Les sédiments grossiers du Berriasien de la "fosse vocontienne". Trav. Lab. Géol. Lyon, N.S, 11, p. 161-181.

ARNAUD H. (1981).- De la plate-forme urgonienne au bassin vocontien : le Barrémo-Bédoulien des Alpes occidentales entre Isère et Buëch (Vercors méridional, Diois oriental et Dévoluy). Géologie Alpine, Grenoble, mém. n° 11, 3 vol., 804 p.

ARNAUD H. (1988).- Subsidence in some domains of Southeastern France during the Ligurian Tethys opening and spreading stages. Bull. Soc. géol. France (à paraître).

ARNAUD H., ARNAUD-VANNEAU A., BOURBON M., LEMOINE M., MEGARD-GALLI J. (1986).-Hauts-fonds et seuils dans la paléogéographie mésozoïque des Alpes occidentales : témoins d'une activité tectonique liée à l'ouverture de l'océan téthysien ligure. Bulletin de la section des Sciences, Paris, t. 9, p. 115-128.

ARNAUD-VANNEAU A. (1980).- Micropaléontologie, paléoécologie et sédimentologie d'une plate-forme carbonatée de la marge passive de la Téthys : l'Urgonien du Vercors septentrional et de la Chartreuse (Alpes occidentales). Géologie Alpine, Grenoble, mém. n° 10, 3 vol., 874 p.

ARNAUD-VANNEAU A., ARNAUD H. & THIEULOY J.-P. (1976).- Bases nouvelles pour la stratigraphie des calcaires urgoniens du Vercors. Newsl. Stratig., 5, 2-3, p. 143-149.

ARNAUD-VANNEAU A. (1986)- Episodes transgressifs et renouvellements des Foraminifères benthiques sur les plates-formes du Crétacé inférieur du Sud de la France. Bull. Centres Rech. Explor.-Prod Elf-Aquitaine, Pau, 10, 2, p. 405-420, 6 fig., 4 tab., 1 pl.

ARNAUD-VANNEAU A., ARNAUD H., BOISSEAU T., DARSAC C., THIEULOY J.-P. & VIEBAN F. (1982).- Synchronisme des crises biologiques et paléogéographiques dans le Crétacé inférieur du Sud-Est de la France : un outil pour les corrélations plates-formes-bassin. Géologie Méditerranéenne, Marseille, 9, 3, p. 153-165.

ARNAUD-VANNEAU A., ARNAUD H., COTILLON P., FERRY S., MASSE J.-P. (1982).- Caractères et évolution des plates-formes carbonatées périvocontiennes au Crétacé inférieur (France SE). Cretaceous Research, 3, 1-2, p. 3-18, 9 fig.

ARNAUD-VANNEAU A. &, DARSAC C. (1984).- Caractères et évolution des peuplements de Foraminifères benthiques dans les principaux biotopes des plates-formes carbonatées du Crétacé inférieur des Alpes du Nord (France). Premier congrès international de paléoécologie, Géobios, Mémoire spécial n°8, p. 19-23, 2 pl.

ARNAUD-VANNEAU A., ARNAUD H., MEUNIER A.-R. & SEGUIN J.-C. (1987).- Caractères des transgressions du Crétacé inférieur dans le Sud-Est de la France et les régions voisines (Italie) Mém. Géol. Univ. Dijon (sous presse)

ANNAUD-VANNEAU A., MASSE J.-P..- Les Foraminifères benthiques des formations carbonatées de l'Hauterivien-Barrémien p.p. du Jura vaudois et neuchâtelois (Suisse). Sous presse.

BAUMBERGER E. & MOULIN H. (1899).- La série néocomienne à Valangin. Bull Soc. neuchâtel. Sci. nat., 26, p. 151-210.

BEAUDOIN B. (1980).- Le Bassin subalpin (au Mésozoïque). in A. AUTRAN & J. DERCOURT : Evolutions géologiques de la France. Colloque C7, Géologie de la France. 26è Congr. géol. intern. , Paris 1980. Mém BRGM, Orléans, 107, p. 284-291.

BESSE J., BOISSEAU T., ARNAUD-VANNEAU A., ARNAUD H., MASCLE G. & THIEULOY J.-P. (1986).- Modifications sédimentaires, renouvellements de faunes et inversions magnétiques dans le Valanginien de l'hypostratotype d'Angles. Bull. Centres Rech. Explor.-Prod. Elf-Aquitaine, Pau, 10, 2, p. 365-368.

BIRKELUND T., HANCOCK J.M., HART M.B., RAWSON P.F., REMANE J., ROBASZYNSKI F., SCHMID F & SURLYK F. (1984).- Cretaceous stage boundaries - Proposals. Bull. Geol. Soc. Denmark., 33, 1-2, p. 4-19.

BOILLOT G., RECQ M., WINTERER E., MEYER A.W., APPLEGATE J., BALTUCK M., BERGEN J.A., COMAS M.C., DAVIES T.A., DUNHAM K., EVANS C.A., GIRARDEAU J., GOLBERG D.G., HAGGERTY J., JANSA L.F., JOHNSON J. A., KASAHARA J., LOREAU J.P., LUNA SIERRA E., MOULLADE M., OGG J., SARTI M., THUROW J. & WILLIAMSON M.A. (1986).- Amincissement de la croûte continentale et dénudation tectonique du manteau supérieur sous les marges stables : A la recherche d'un modèle - L'exemple de la marge occidentale de la Galice (Espagne). Bull. Centres Rech. Explor.-Prod. Elf-Aquitaine, Pau, 10, 1, p. 95-104.

BOISSEAU T. (1987).- La plate-forme jurassienne et sa bordure subalpine au Berriasien-Valanginien (Chartreuse-Vercors). Thèse Université Grenoble 1 (à paraître).

BOISSEAU T., THIEULOY J.-P., ARNAUD-VANNEAU A., ARNAUD H. (1982).- Crises biologiques, coupures biostratigraphiques et migrations des faunes : l'exemple du Valanginien dans le SE de la France. 9è Réunion Annuelle des Sciences de la Terre, Paris, p. 64.

BUSNARDO R. (1965).- Le stratotype du Barrémien. Lithologie et macrofaune. Colloque sur le Crétacé inférieur, Lyon 1963. Mém. Bur. Rech. Géol. Min., 34, p. 101-116.

BUSNARDO R. (1984).- Echelles stratigraphiques du Crétacé inférieur, Ammonites, in DEBRAND-PASSARD S. et al., Synthèse géologique du Sud-Est de la France. Mém. Bull.Rech.Géol.Min., n° 125, p. 291-293.

BUSNARDO R., THIEULOY J.-P. & MOULLADE M. (1979).- Hypostratotype mésogéen de l'étage Valanginien (Sud-Est de la France. Editions du C.N.R.S., n° 6, 143 p.

BUSNARDO R. & THIEULOY J.-P. (à paraître).- Les Ammonites de l'Hauterivien du Jura suisse.

BUSNARDO R & VERMEULEN J. (1986).- La limite Hauterivien-Barrémien dans la région stratotypique d'Angles (SE de la France). C. r. Acad. Sci. Paris, 302, 7, p. 457-459.

CLAVEL B., CHAROLLAIS J., BUSNARDO R. & LE HEGARAT G. (1986).- Précisions stratigraphiques sur le Crétacé inférieur basal du Jura méridional. Eclogae geol. Helv., 79, 2, p. 319-341.

CLAVEL B., CHAROLLAIS J. & BUSNARDO R. (1987).- Données biostratigraphiques nouvelles sur l'apparition des faciès urgoniens du Jura au Vercors. Eclogae geol. Helv. , 80, 1, p. 59-68.

COTILLON P. & RIO M. (1984).- Cyclicité comparée du Crétacé inférieur pélagique dans les chaînes subalpines méridionales (France SE) , l'Atlantique central (Site 534 D.S.D.P.) et le Golfe du Mexique (Sites 535 et 540 D.S.D.P.). Implications paléoclimatiques et application aux corrélations stratigraphiques transtéthysiennes. Bull. Soc. géol. France, 7, 26, n°1, p. 47-62.

DARSAC C. (1983).- La plate-forme berriaso-valanginienne du Jura méridional aux massifs subalpins (Ain, Savoie). Thèse 3e cycle, Univ. Grenoble, 319 p.

DESOR E. (1853).- Sur l'étage inférieur du groupe néocomien. Bull. Soc. neuchâtel. Sci. nat., 3, p. 172-180.

DONZE P. & THIEULOY J.-P. (1975).- Sur l'extrême condensation du Valanginien supérieur dans le Jura neuchâtelois, en particulier dans le stratotype de Valangin, et sa signification dans l'ensemble des formations valanginiennes du SE de la France. C. r. Acad. Sci. Paris, 280, p. 1661-1664.

FERRY S (1976).- Cônes d'épandage bioclastique en eau profonde et glissements sous-marins dans le Barrémien et l'Aptien inférieur vocontiens de la Drôme. Implications paléostructurales. Thèse 3e cycle, Univ. Lyon, 144p.

GIDON P. (1952).- Une ammonite de l'Urgonien en Grande Chartreuse. C. r. Soc. géol. France, p. 237-238.

GRACIANSKY P.-C de, BOURBON M., CHENET P.-Y., CHARPAL O. de & LEMOINE M. (1979).- Genèse et évolution comparées de deux marges continentales passives : marge ibérique de l'Océan Atlantique et marge européenne de la Téthys dans les Alpes Occidentales. Bull. Soc. géol. France, 7, 21, p. 663-674.

GRACIANSKY P.-C. de, RUDCKIEWICZ J.-L. & SAMEC P. (1986).- Tectonique salifère d'âge jurassique dans la zone subbriançonnaise (Savoie, Alpes françaises). C. r. Acad. Sci. Paris, 302, Série II, p. 891-896.

IMMEL H. (1978).- Die Ammonitengliederung des mediterranen und borealen Hauterive und Barreme unter besonder Berichtigung heteromorpher Ammoniten der Gattung Crioceratites Leveillé. Newsl. Stratigr., 7, 3, p. 121-141.

LE HEGARAT G. (1971).- Le Berriasien du Sud-Est de la France. Docum. Lab. Géol. Fac. Sci. Lyon, n° 43, 2 vol., 576 p.

LEMOINE M. (1984).- La marge occidentale de la Tethys ligure et les Alpes occidentales. In "les marges continentales actuelles et fossiles autour de la France" (G. BOILLOT, coordin.), Masson ed., Paris, p. 155-248.

LEMOINE M., BAS T., ARNAUD-VANNEAU A., ARNAUD H., DUMONT T., GIDON M., BOURBON M., de GRACIANSKY P.-C., RUDKIEWICZ J.-L., MEGARD-GALLI J. & TRICART P.(1986)- The continental margin of the Mesozoic Tethys in the Western Alps. Marine and Petroleum Geology, Amsterdam, vol. 3, p. 179-199.

LORY C. (1860-1864).- Description géologique du Dauphiné pour servir à l'explication de la carte géologique de cette province. Savy édit., Paris? 1ère partie (1860) p. 1-240 ; 2è partie (1861) p. 241-500 ; 3è partie (1864) p. 501-747.

MASCLE G., ARNAUD H., DARDEAU G., DEBELMAS J., DUBOIS P., GIDON M., GRACIANSKY P.-C. de, KERCKHOVE C. & LEMOINE M. (1986).- Halocinèse précoce sur la marge téthysienne alpine : vers une réinterprétation des zones de gypse des Alpes. C. r. Acad. Sci. Paris, 302, Série II, p. 963-968.

MASSE J.-P. (1976).- Les calcaires urgoniens de Provence. ValanginienAptien inférieur. Stratigraphie, paléontologie, les paléoenvironnements et leur évolution. Thèse Doctorat Etat, Aix-Marseille II, 445 p.

MORET L. & DELEAU P. (1960).- Note de paléontologie savoisienne : Découverte d'Ammonites dans le Berrias et l'Urgonien des environs d'Annecy (Hte-Savoie). Trav. Lab. Géol. Univ. Grenoble, 36, p. 43-44.

MOULLADE & THIEULOY (1967).- Les zones d'Ammonites du Valanginien supérieur et de l'Hauterivien vocontien. C. r. Soc. géol. France, 6, p. 228.

PAQUIER V. (1900).- Recherches géologiques dans le Diois et les Baronnies orientales. Thèse, Imp. Allier Grenoble, 402 p.

PERES J.-M. (1961).- Océanographie biologique et biologie marine. Volume 1. Presses Universitaires de France, Paris, 541 p.

PERES J.-M. & PICARD J.-M.(1959).- On the vertical distribution of benthic communities. First Inter. Oceanogr. Cong. New-York (abstract).

PERNET O. (1983).- La transgression de la base du Crétacé sur la bordure Sud-Est du Bassin de Paris (Valanginien-Hauterivien-Barrémien). Thèse 3e cycle, Dijon, 124 p.

PICARD J.-M. (1980).- Les écosystèmes benthiques des plates-formes carbonatées actuelles : définitions et délimitation, successions et biotopographie. Trav. Lab. Géol. Hist. et Paléont. Marseille, 11, p. 103-111.

REMANE J. (1982).- Die Kreide des Neuenburger Juras. Jber. Mitt. oberrhein. geol. Ver, N.F., 64, p. 47-59.

REMANE J., BUSNARDO R., CHAROLLAIS J., CLAVEL B., THIEULOY J.-P. (à paraître).- Description de profils dans l'Hauterivien de la région neuchâteloise, du Mont de Chamblon et des environs de Sainte-Croix (cantons de Neuchâtel et de Vaud, Suisse).

RENEVIER E. (1874).- Tableau des terrains sédimentaires formés pendant les époques de la phase organique du globe terrestre avec leurs représentants en Suisse et dans les régions classiques, leurs synonymes et les principaux fossiles de chaque étage. Bull. Soc. vaud. Sci. nat, 13, p. 218-252.

RENZ O. (1976).- Ein grosser Pachydesmoceras (Ammonoidea) aus dem Unteren Cénomanien des Schweizer Juras. Eclogae geol. Helv., 69, p. 753-763.

RENZ O., LUTERBACHER H. & SCHNEIDER A. (1963).- Stratigraphischpaläontologische Untersuchungen im Albien und Cénomanien des Neuenburger Jura. Eclogae geol. Helv., 56, p. 1073-116.

REY J. (1973).- Observations sur l'écologie des Orbitolines et des Choffatelles dans le Crétacé inférieur d'Estrémadura (Portugal). C. r. Acad. Sci. Paris, 276, p. 2517-2520.

STEINHAUSER N & CHAROLLAIS J. (1971).- Observations nouvelles et reflexions sur la stratigraphie du "Valanginien" de la région neuchâteloise et ses rapports avec le Jura méridional. Geobios, Lyon, 4, 1, pp. 7-59.

THIEULOY J.-P. (1969).- Sur la présence du genre Capeloites LISSON (Ammonoidea) dans le Néocomien des Basses Alpes et la sugnification des espèces migratrices transatlantiques. C. r. Som. Soc. géol. Fr., 7, p. 256.

THIEULOY J.-P. (1977).- La zone à Callidiscus du Valanginien supérieur vocontien (SE de la France). Lithostratigraphie, ammonitofaune, limite Valanginien-Hauterivien, corrélations. Géologie Alpine, 53, p. 83-143.

THIEULOY J.-P. (1977).- Les Ammonites boréales des formations néocomiennes du SE français (provonce subméditerranéenne). Géobios, 10, 3, p. 395-461.

THIEULOY J.-P. & GIROD J.-P. (1964).- L'Aptien et l'Albien fossilifère du synclinal d'Autrans (Vercors septentrional). Trav. Lab. Géol. Univ. Grenoble, 40, p. 92-111.

THIEULOY J.-P. & GIROD J.-P. (1965).- Nouvelles données sur l'Albien de la Chartreuse et du Vercors. Trav. Lab. Géol. Univ. Grenoble, 41, p. 141-162.

VIALON P. (1974).- Les déformations "synschisteuses" superposées en Dauphiné. Leur place dans le collision des éléments du Socle Préalpin. Conséquences paléostructurales.Schweiz. mineral. petrogr. Mitt. Zürich, 54, 2/3, pp.663-690.

VIEBAN F. (1983).- Installation et évolution de la plate-forme urgonienne (Hauterivien à Bédoulien) du Jura méridional aux chaînes subalpines (Ain, Savoie, Haute-Savoie). Thèse 3e cycle, Grenoble, 291 p.

ZWEIDLER D. (1985).- Genèse des gisements d'asphalte des formations de la Pierre Jaune de Neuchâtel et des calcaires Urgoniens du Jura (Jura neuchâtelois et nord-vaudois, Suisse). Thèse Univ. Neuchâtel, 107 p.