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A New Ammonite Biostratigraphic Framework for Distal Urgonian Successions of North Provence and a Correlation with Southern Vercors

Camille Frau [1,*], Anthony J.-B. Tendil [2] and Cyprien Lanteaume [3]

[1] Palaeo-Expertise, 8 Rue du Moulin, 65350 Cabanac, France
[2] Badley Ashton & Associates Ltd., Abu Dhabi P.O. Box 108729, United Arab Emirates
[3] TOTAL Energies, Centre Scientifique et Technique Jean Féger, Avenue Larribau, 64018 Pau, France
* Correspondence: camille_frau@hotmail.fr

Abstract

New ammonite discoveries from the south-facing flank of Mont Ventoux (southern France) provide robust and refined age constraints on the maximum northward progradation of Urgonian depositional environments in northern Provence during the late Barremian to early Aptian. The succession records distal Urgonian depositional environments during the late Barremian, spanning from the *Toxancyloceras vandenheckii* to the upper *Gerhardtia sartousiana* Zone, followed by strongly progradational distal Urgonian deposits with an age interval from the terminal Barremian into the early Aptian. These new data permit an updated and simplified regional correlation of Urgonian successions across the Barremian–Aptian boundary in northern Provence and along the northern margin of the Vocontian Basin. Our correlations reveal clear, coeval sedimentary signals across both regions, emphasizing the regional synchronicity of Urgonian platform development at the basin scale.

Keywords: Urgonian platform progradation; ammonite biostratigraphy; Barremian–Aptian boundary

1. Introduction

During the Cretaceous, the Vocontian domain of southeast France developed as a passive marginal basin along the northern palaeomargin of the Pyrenean–Valais oceanic realm, at a palaeolatitude of ~28° N [1] (Figure 1A). This basin was fringed by extensive Urgonian-type shallow-water carbonate platforms, which reached their maximum development during the Barremian in Provence [2,3], in Languedoc [4], and in the southern Vercors [5–10]. During the late Barremian, Urgonian carbonate-producing ecosystems of southern Provence (Marseille), underwent rapid progradation, advancing northwards into the North Provence region (Avignon) and passing into distal outer-platform deposits around the Ventoux–Lure Mountains palaeo-fault system (Figure 1B), which delineated the shelf break adjacent to the Vocontian Basin [3,11]. These ecosystems persisted until the early Aptian, forming the North Provence Platform, while contemporaneous sedimentation in the southern Provence domain was dominated by pronounced subsidence, leading to the establishment of the intra-shelf South Provence Basin [12,13] (Figure 1C).

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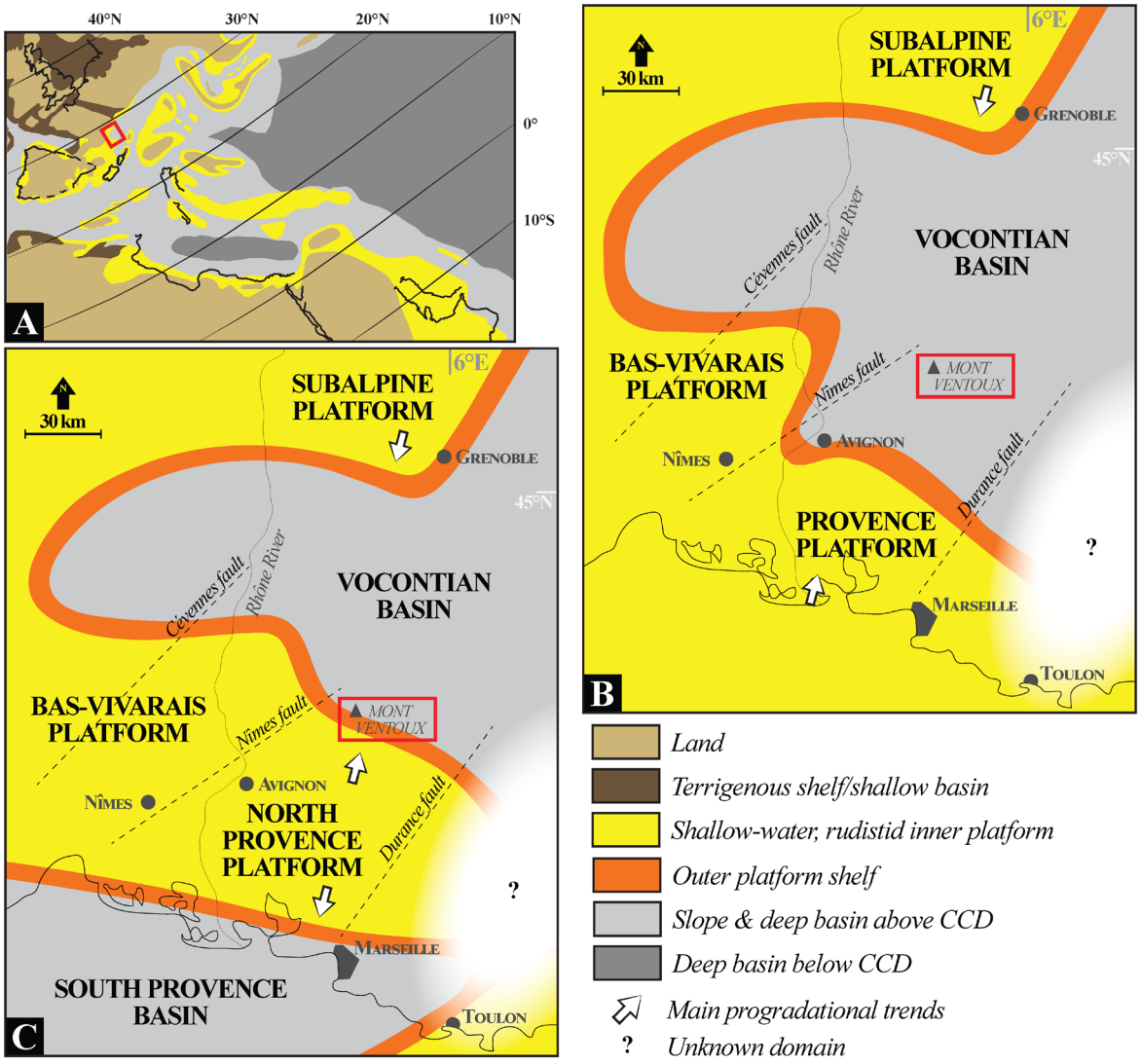


Figure 1. (**A**) Barremian–Aptian palaeogeography of the western Tethys. The red square indicates the location of panels (**B**,**C**). (**B**) Late Barremian palaeogeographic reconstruction of southeastern France showing the coalescent Urgonian platforms surrounding the Vocontian Basin. The red square marks the location of the study area (Mont Ventoux). (**C**) Latest Barremian to early Aptian palaeogeographic reconstruction of southeastern France illustrating the initiation of the intra-shelf South Provence Basin and the differentiation of the North Provence Urgonian platform. The red square marks the location of the study area (Mont Ventoux). All figures are modified after [3].

Exceptional exposures occur along the south-facing slopes of Mont Ventoux (Figure 2A–C), the highest summit in Provence (1910 m). In this work, we present a detailed analysis of the Mont Ventoux crest succession, accompanied by an updated ammonite-based age calibration that refines the framework of [2]. In addition, we compiled a virtual composite section of the entire Mont Ventoux Urgonian succession by integrating observations from [3] that encompass the Pié Gros and Petit Fribouquet sections located at the foot of the mountain (Figure 2C). This allows us to propose improved correlations with neighbouring Urgonian successions across the Barremian–Aptian boundary in North Provence and along the northern Vocontian margin (Figure 2D), where distal Urgonian deposits have recently been re-evaluated in southern Vercors.

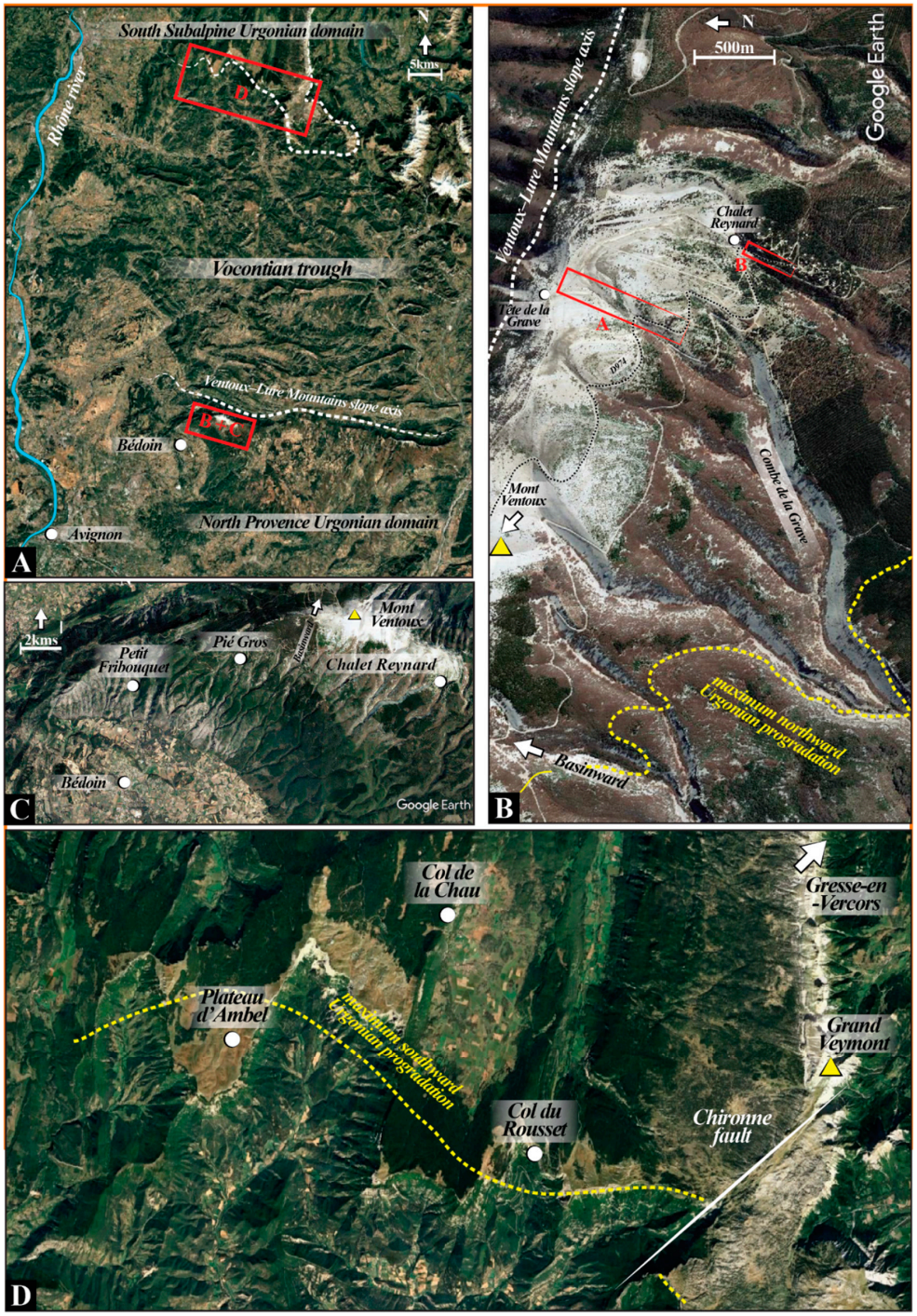


Figure 2. (**A**) Google Earth aerial view of southeastern France, east of the Rhône River, highlighting the North Provence and South Vercors Urgonian domains, separated by the basinal deposits of the Vocontian Trough. Red squares indicate the locations of the study areas (Mont Ventoux to the south; South Vercors to the north). (**B**) Aerial view of the Mont Ventoux crest showing the two sections (red squares) studied in this work, located between Tête de la Grave and Chalet Reynard. (**C**) Enlarged Google Earth aerial view of Mont Ventoux showing the position of the Pié Gros and Petit Fribouquet sections, located at the foot of the mountain and allowing the construction of a virtual composite section encompassing the entire Mont Ventoux Urgonian succession. (**D**) Google Earth aerial view of the southern Vercors showing the main localities cited in the text for discussion of Urgonian correlations.

2. Methods and Convention

This paper presents a coupled sedimentological–palaeontological study based on detailed field observations and ammonite sampling from the Mont Ventoux succession, building on the preliminary results of [2,3]. A precise taxonomic description of the studied ammonite taxa is provided in [2], which has been followed for all identifications. Information on the examined specimens can be found in [2] or obtained directly from the first author (C.F.) upon request. As many of these ammonite specimens were previously described by [2], we provide here descriptions only for the new discoveries, which are included in the Supplementary Data. The direct recognition of ammonite bioevents within the marlstones allows calibration of the Standard Mediterranean Ammonite Zonation established by the IUGS Lower Cretaceous Ammonite Working Group. It also enables regional stratigraphic correlations with the outer Urgonian platform settings of North Provence and the southern Vercors, where ammonite occurrences have been documented in the literature.

3. Geological Settings

The outcrops exposed along the D974 road between Chalet Reynard and the Mont Ventoux summit station, on the southwestern slopes of Mont Ventoux, form the core of this investigation. In this study, we re-examine the two overlapping stratigraphic profiles previously documented by [2,3].

The lower section begins at the Mont Ventoux crest, at the locality known as Tête de la Grave, and continues downslope along the D974 road between Chalet Reynard and the Mont Ventoux summit station (Figure 2B). The succession consists of 96.8 m-thick, well-bedded basinal limestones, locally containing chert nodules, and is punctuated by three distinctive marlstone intervals. The bases of these marlstones are typically marked by firmground surfaces, which are locally enriched in ammonites (Figure 3A).

The upper section corresponds to a low-mural, 83 m-thick exposure along the D164 road near Chalet Reynard (Figure 2B). It begins with a distinctive marlstone horizon that correlates with the second marlstone interval of the lower section (Figure 3B). This is followed by 4 m of massive, glauconite-rich limestone beds. These deposits terminate at an irregular, glauconitic surface, which is overlain by a 10 m-thick succession of fine-grained, wavy-bedded calcisiltites with a third marlstone horizon at its base. This interval passes upward into well-bedded basinal limestones enriched in chert nodules. The fourth marlstone horizon occurs in the upper part of the section and underlies the northward-prograding distal Urgonian biocalcarenites, consistent with the observations made by [3] along the Combe de la Grave ravine (Figure 2B).

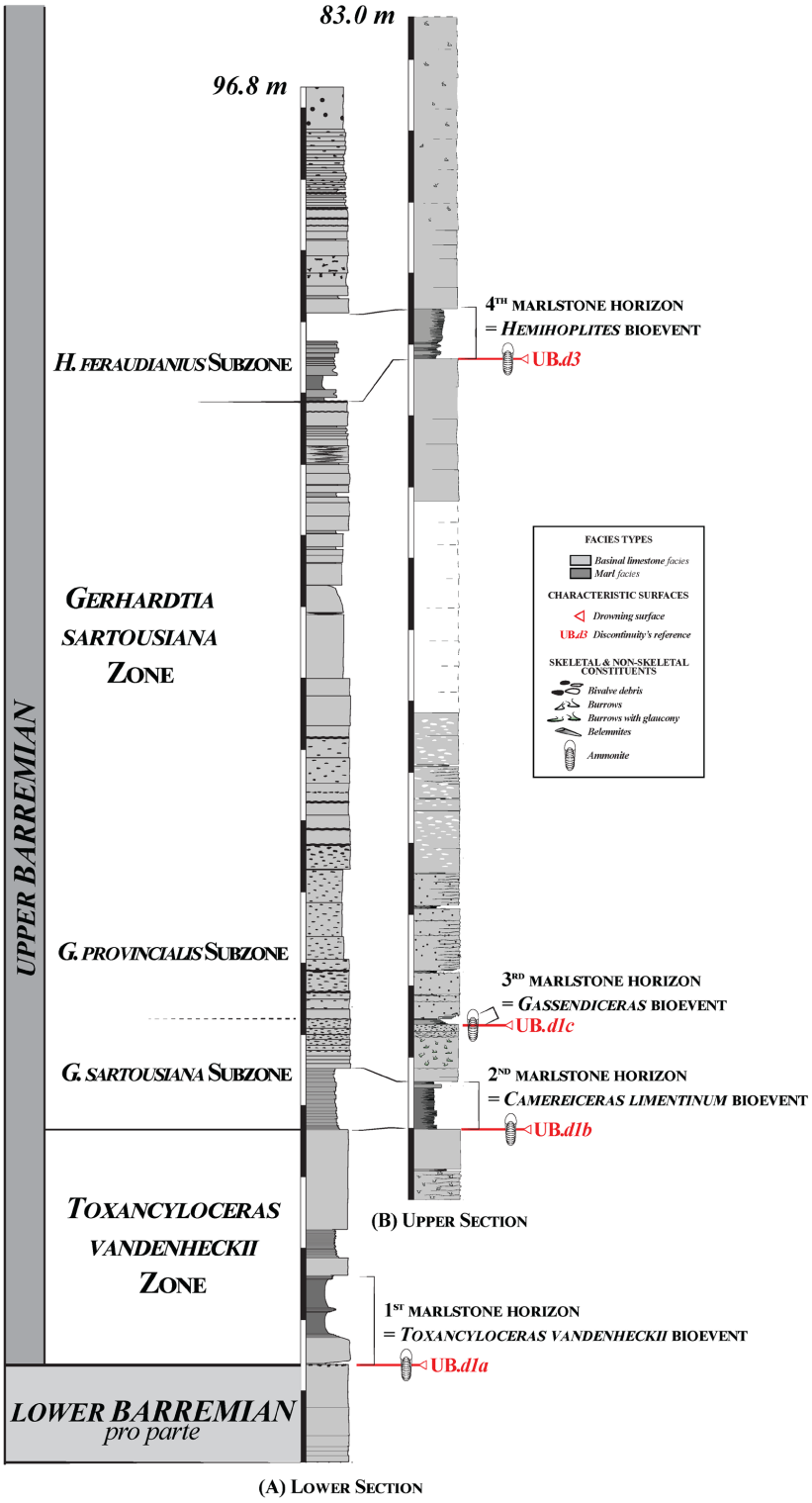


Figure 3. Correlation of the lower and upper sections of the Mont Ventoux crest succession, constrained by revised ammonite age calibration. The figure highlights the position of the fourth main marlstone horizons and the associated basal discontinuities yielding ammonites.

4. New Results on the Chalet Reynard Rock Succession

The Mont Ventoux rock succession is dominated by fine-grained calcisiltites or well-bedded basinal mudstones, interbedded with four main marlstone horizons, forming obvious lithological markers in the landscape. According to the first observations by [2], the ammonite record of these marlstone horizons has allowed the recognition of the two

ammonite zones of the upper Barremian and the first two zones of the lower Aptian. However, the discovery of new ammonites in the upper part of the section allows for a revision of these previous interpretations.

- The first marlstone horizon of the lower section is divided into two marly levels, separated by argillaceous marly limestone beds. The first marly horizon yields at its base the index species *Toxancyloceras vandenheckii* (Figure 4A), the biomarker of the first zone of the upper Barremian (*Toxancyloceras vandenheckii* Zone). This can be tied to the regional drowning discontinuity UB.*d1a* of [3]. This ammonite-constrained timeline can be traced across Mont Ventoux and further south into the Monts de Vaucluse, particularly in the Fontaine-de-Vaucluse section [2]. However, farther south, the continuity of this timeline becomes uncertain and remains a tentative correlation [3].

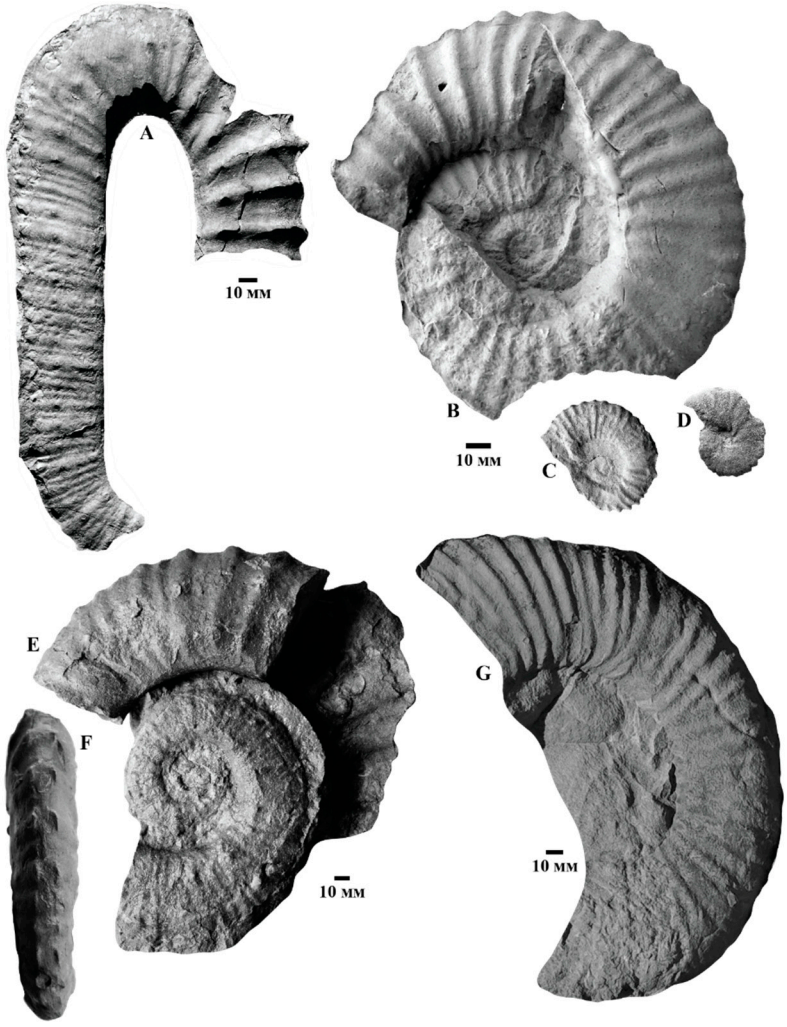


Figure 4. Illustrations of selected ammonites from the fourth main marlstone horizons of the Mont Ventoux crest succession. (**A**) *Toxancyloceras vandenheckii* from the *T. vandenheckii* bioevent. (**B**) *Camereiceras limentinum*. (**C**) *Janusites janus*. (**D**) *Gerhardtia galeatoides* from the *Camereiceras limentinum* bioevent. (**E**,**F**) *Gassendiceras coulletae* from the *Gassendiceras* bioevent. (**G**) *Hemihoplites* gr. *feraudianus* from the *Hemihoplites* bioevent. Scale bar = 10 mm for all figures. (**A**–**D**) modified after [2].

- The second marlstone horizon of the lower section yielded numerous Barremitidae together with the *Hemihoplitidae Camereiceras limentinum* (Figure 4B), *Janusites janus* (Figure 4C), and the *Pulchelliidae Gerhardtia galeatoides* (Figure 4D). This association dates to the lower part of the Gerhardtia sartousiana Zone, and more precisely to the *Gerhardtia* sartousiana Subzone (= Camereiceras limentinum bioevent of [2]). It can be

correlated with the regional drowning surface UB.*d1b* defined by [3], which is best constrained within outer Urgonian platform settings of northern Provence, such as in the Nesque Canyon [2]. Farther south, its correlation within the inner-platform settings of the Urgonian remains uncertain.

- The third marlstone horizon was tentatively dated to the *Imerites giraudi* Zone by [2] and consequently tied to the regional drowning discontinuity UB.*d3* of [3]. A new ammonite collection from this marly horizon has yielded significantly better-preserved material than was available during the preparation of [2]. Notably, we identified the species *Gassendiceras coulletae* (Figure 4E,F), a well-established marker of the topmost part of the lower *Gerhardtia sartousiana* Zone [14]. We therefore propose to designate this occurrence as the *Gassendiceras* bioevent, likely dating the transition between the lower and middle *Gerhardtia sartousiana* Zone. This new ammonite-based age calibration indicates that the basal firmground of this third marlstone horizon closely approximates the UB.*d1c* discontinuity of [3]. This discontinuity is also recognized farther south, where it appears as an orbitolinid-rich marly horizon in the Nesque Canyon, and can be traced landward to the southern Monts de Vaucluse (e.g., Orgon, Fontaine-de-Vaucluse), where its age had previously remained poorly constrained.
- The fourth marlstone horizon directly underlies the first strongly progradational Urgonian deposits on the northern flank of Mont Ventoux. This horizon was tentatively assigned an early Aptian age by [2], based on poorly preserved, putative *Deshayesites* fragments, and correlated with the regional drowning discontinuity LA.*d5* of [3]. However, new sampling from this marlstone has revealed large-sized *Hemihoplitidae* (Figure 4G). Comparison with the specialist literature indicates that these specimens best match adult *Hemihoplites feraudianus* as illustrated by [15]. A *Hemihoplites* bioevent—indicative of the upper *Gerhardtia sartousiana* Zone according to [2]—has already been documented farther south (La Fare), suggesting that this bioevent is supra-regional rather than local, provided that the identification of the Mont Ventoux material is correct.

5. Implications for Regional Correlations and Insights into Distal Urgonian Depositional Environments

5.1. Correlation with Northern Provence Urgonian Domain

The work of [3] was aimed at reconstructing the stratigraphic architecture of the Provençal Urgonian platform and identifying the key mechanisms that governed its evolution. Nearly thirty stratigraphic sections were analysed across the entire Provence domain. The unprecedented identification of eight ammonite "bioevents" associated with drowning phases of the Urgonian platform led to the establishment of regionally correlatable timelines for the late Barremian to early Aptian period [2]. The direct recognition of these ammonite bioevents—or their derived stratigraphic correlations—has allowed the reconstruction of three platform-to-basin transects across the Provence platform domain ([2], Figures 5–7). However, the transect terminating at Mont Ventoux–Chalet Reynard section has long appeared problematic. In particular, the supposedly complete upper Barremian to lower Aptian succession exposed along the Mont Ventoux crest cannot satisfactorily account for the apparent continuity with the upper Barremian–early Aptian platform series of the southern Mont Ventoux slope, unless a post-Cretaceous tectonic overprint resulting in duplication of the succession is invoked.

Our new biostratigraphic data demonstrate that the Mont Ventoux crest succession does not extend into the base of the Aptian and it is directly overlain by the progradational Urgonian platform deposits of the latest Barremian to earliest Aptian age, thereby refuting the hypothesis of stratigraphic duplication. The lithological logs of our two Mont Ventoux

sections, together with the southern slope data (based on the Pié Gros–Petit Fribouquet composite sections revised by [3]), enable the reconstruction of a complete virtual profile of the Mont Ventoux outer-platform succession (Figure 5A). The facies exposed at Mont Ventoux record distal outer-platform depositional environments from the *Toxancyloceras vandenheckii* Zone to the upper *Gerhardtia sartousiana* Zone (*H. feraudianus* Subzone pro parte). These deposits are then overlain by evidence of maximum northward Urgonian Provence platform progradation, mainly during the uppermost *H. feraudianus* Subzone to the early Aptian; however, their laterally equivalent outer-platform facies are no longer preserved on Mont Ventoux due to post-Cretaceous erosion. This configuration differs eastward, where the inner-to-outer-platform architecture at the Barremian/Aptian transition remains intact, consistent with the two other transects established by [2] (their Figures 5 and 6).

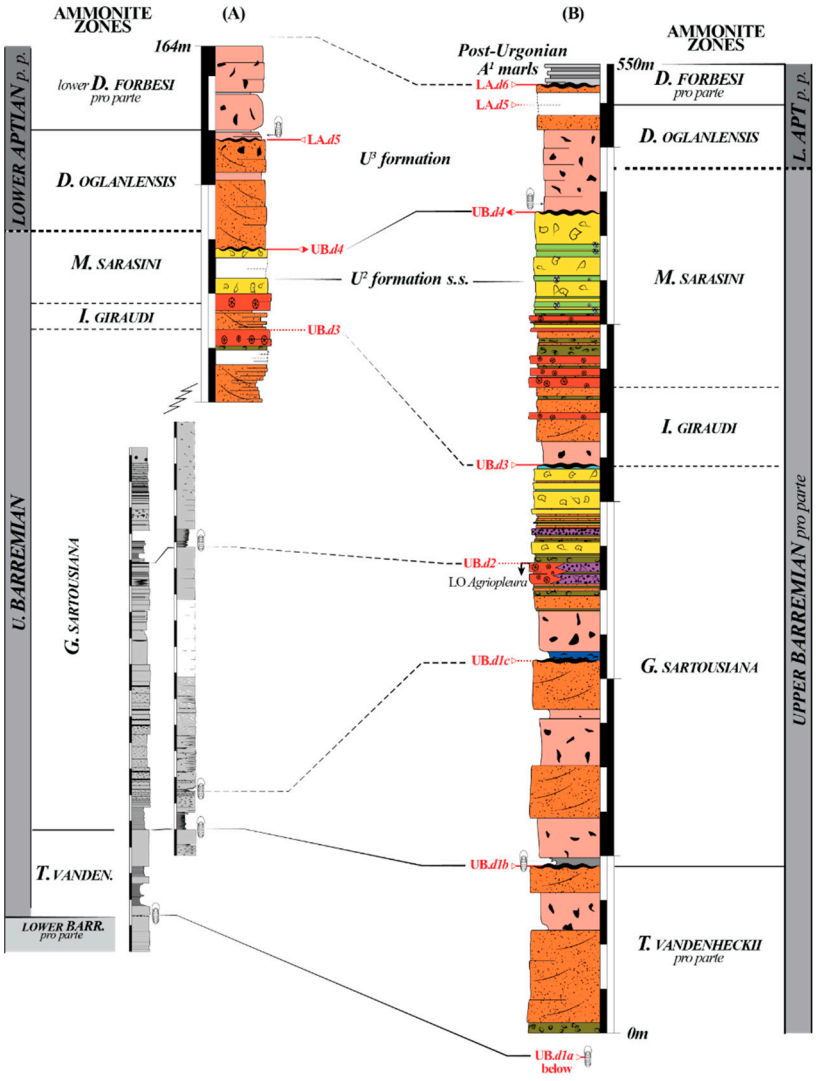


Figure 5. Virtual composite profile and ammonite-based age calibration of the Mont Ventoux Urgonian succession (**A**), with correlation of the main discontinuities (UB.*d*, LA.*d*) to those identified in the Gorges de la Nesque Urgonian succession (**B**) (modified after [3]). The stratigraphic position of the last occurrence (LO) of *Agriopleura* rudists is indicated in the Nesque Urgonian succession.

A striking result of our study is the confirmation that the main drowning episodes of the platform series in northern Provence—particularly in the Gorges de la Nesque—are directly linked to marlstone horizons observed in distal Urgonian depositional settings of Mont Ventoux (Figure 5B). Notably, the three drowning events associated with discontinuities UB.*d1a*, UB.*d1b*, and UB.*d1c* in the Gorges de la Nesque are regarded as direct

equivalents of the first three marlstone horizons at Mont Ventoux, as supported by ammonite evidence from both areas. Of particular interest is the UB.*d1c* drowning, associated with an orbitolinid proliferation underlying the northward extension of Urgonian rudist-bearing deposits.

One apparent contradiction involves the UB.*d2* discontinuity of [3], commonly interpreted in northern Provence as a brief emersive surface associated with the European-wide extinction of *Agriopleura* rudists [2,16], whereas at Mont Ventoux it corresponds to the fourth marlstone horizon, yielding the *Hemihoplites feraudianus* bioevent. However, proximal-to-distal mapping of UB.*d2* in the Nesque Canyon ([17], their Figure 12) reveals an inverted regressive/transgressive to transgressive/regressive trend toward distal settings, consistent with its expression as a marlstone horizon at Mont Ventoux. It should further be noted that the UB.*d2* discontinuity in the Provence and Languedoc Urgonian domains more frequently reflects a drowning rather than exposure [18]. This suggests that the UB.*d2* discontinuity and the associated *Agriopleura* extinction event cannot be interpreted simply as the expression of an emersion surface, but instead reflect a complex interplay between eustatic fluctuations and tectonic overprint [18], consistent with the coeval development of a marlstone horizon in distal outer-platform settings.

5.2. Correlation with Southern Vercors Urgonian Domain

At first glance, the comparison of sedimentary signals between the northern Provence Urgonian domain and the adjacent Subalpine series appears complex when contrasted with the synthesis of [5]. However, over the past two decades, successive re-evaluations by [3,6–9,16,19], subsequently refined by [10], have led to a substantially improved ammonite-based chronostratigraphic calibration. This revised temporal framework allows the identification of coeval sedimentary patterns in distal Urgonian depositional settings across both domains, thereby reconciling their respective stratigraphic records.

Within the southern Vercors transects, six main distal progradational Urgonian units (U01–U06) have been partly identified along the Gresse-en-Vercors cliff outcrops [6,8,9], and followed southward along the Grand-Veymont–Col de Rousset and Col de Lachau–Plateau d'Ambel transects ([9]; revised by [10]). These units are each separated by distinctive intra-Urgonian marlstone horizons. A discussion of the age and its coevality with the distal Urgonian successions of northern Provence is presented below and summarised in Figure 6.

The stratigraphic profile established along the Gresse-en-Vercors cliff outcrops documents the development of outer-platform Urgonian bioclastic clinoforms prograding across the Hauterivian–Barremian transition (Hs1–2 of [9] and U01 of [6]). These clinoforms are truncated at their top by the D1 drowning event, corresponding to the Pas de la Balme marls, as suggested by [8], and subsequently confirmed by [9]. The marls are overlain by the development of two major, flat-topped, rudist-dominated inner-platform stages (units U02 and U03.1b–2/3), which grade southward into a gently dipping ramp composed of outer-platform to slope deposits. Both rudist-bearing inner-platform stages represent overall shallowing-upward sequences, interrupted by two major drowning events (D2 and D3); Richet's D3 discontinuity is termed the Pas de Berrièves Marls in [9].

The Pas de Berrièves marlstone horizon has yielded an unfigured hemihoplitid specimen tentatively assigned to *Camereiceras limentinum* (in [6]), an attribution subsequently repeated by [8], despite extensive efforts to relocate the specimen, which ultimately proved unsuccessful. [9] correlated these marls with an intra-*Toxancyloceras vandenheckii* marly horizon of the Vocontian Basin, whereas [10] reassigned them to a latest early and/or basal late Barremian age, despite the absence of direct ammonite evidence, relying instead on the occurrence of dinoflagellate cysts reported by [20]. If a basal late Barremian age is accepted, this marlstone interval would be nearly coeval with the lower marly episode at the crest of

Mont Ventoux, where the basal late Barremian index species *Toxancyloceras vandenheckii* has been documented, and thus marks the onset of the upper Barremian.

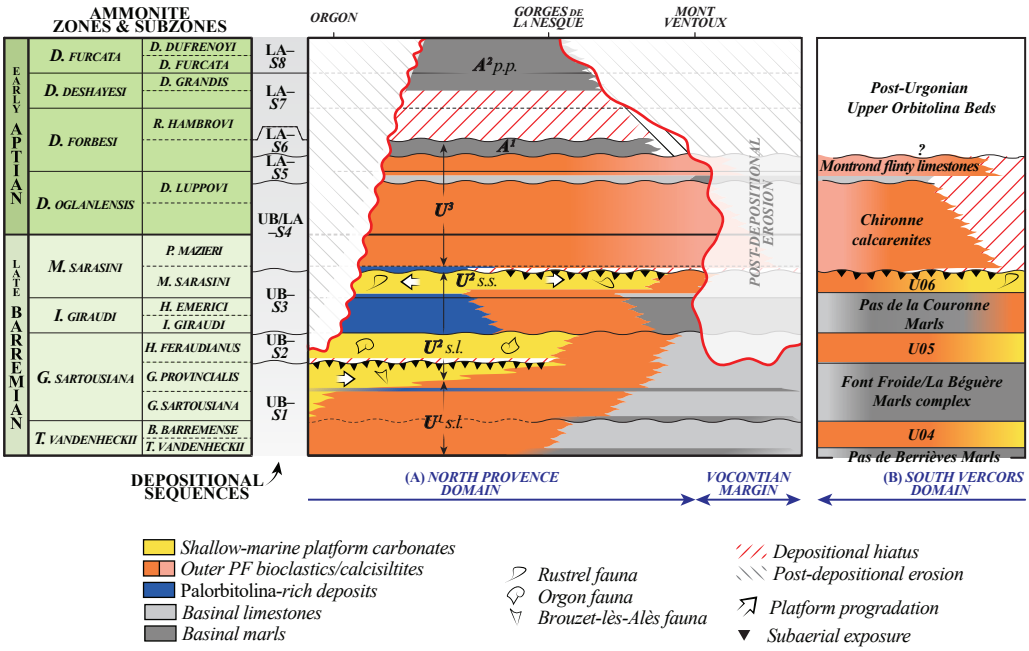


Figure 6. Lithostratigraphic framework of the upper Barremian–lower Aptian sedimentary succession across (**A**) the North Provence domain, from Orgon—the Urgonian unit stratotype—to Mont Ventoux (modified from [3]). Ammonite-based age calibration follows [2] and this work, and the distribution of rudist assemblages (Brouzet-lès-Alès, Orgon, and Rustrel faunas) follows [16]. (**B**) Correlation with the main Urgonian lithostratigraphic units of the southern Vercors sensu [9], recalibrated by [10]. Note that only the Rustrel fauna is currently well calibrated in Vercors, whereas the transition from the Brouzet-lès-Alès to the Orgon rudist fauna remains undocumented in southern Vercors ([16]).

The overlying U04 Urgonian unit exhibits more pronounced southward progradation and is similarly capped by a thick marl interval, the Font Froide–La Béguère Marls complex along the Grand-Veymont–Col de Rousset transect [5]. Ref. [9] interpreted this marl complex as encompassing the entire *Gerhardtia sartousiana* Zone based on ammonite evidence. A glauconitic horizon atop this complex was interpreted by [9] as either an emersive hiatus or a condensed interval corresponding to the so-called *Heteroceras* marls of the nearby Vocontian Basin (assigned to the *Imerites giraudi* Zone and basal *Martelites sarasini* Zone), based on the report of an unfigured specimen of *Martelites* sp. (Pictet in [9]). This interpretation was later revised by [10], who placed the Font Froide–La Béguère Marls complex as encompassing the lower and middle parts of the *G. sartousiana* Zone, in agreement with ammonite-based arguments previously discussed by [8]. This corresponds to the same ammonite assemblage observed in the second and third marlstone horizons at Mont Ventoux, marking the transition between the *G. sartousiana* and *G. provincialis* subzones.

The overlying U05 Urgonian unit records further southward-prograding sequences. Rudist facies are absent along the Grand-Veymont–Col de Rousset transect but are preserved westward at Col de Lachau–Plateau d'Ambel transect, where U05 is capped by the Pas de la Couronne marlstone horizon. [9] assigned the Pas de la Couronne Marls to the latest Barremian, corresponding to the upper *Martelites sarasini* Zone, in apparent contradiction with the ammonite record, which yields large-sized *Heteroceras emerici* and *Martelites* spp., typical of the *Heteroceras* Marls elsewhere in Vocontian Basin (e.g., [19]) and its margins [2]. Following observations made here by [16] and refs. [10,19] revised this interpretation, placing the Pas de la Couronne Marls within the *Imerites giraudi* Zone and the basal *Martelites sarasini* Zone. This marlstone horizon is absent at Mont Ventoux due

to shallower depositional conditions but is widely recognised throughout the northern Provence distal Urgonian domain [2].

The final Urgonian sequence of the southern Vercors, the U06 unit, was assigned to the earliest Aptian by [9], despite lacking direct ammonite evidence. This age has been changed to latest Barremian by [10], with the unit considered to largely fall within the *M. sarasini* Subzone according to ammonite evidence found in distal equivalent deposits. Ref. [10] overlooked the mention of a Rustrel-type caprinid rudist fauna in U06, as evidenced at Col de Lachau, first reported by [16]. This fauna indeed confirms the latest (but non-terminal) Barremian age for the U06 unit as the fauna is known elsewhere in southeastern France Urgonian domains to span the lower *Martelites sarasini* Zone [2,16,21]).

To summarise, the U03 to U06 units of the southern Vercors Urgonian domain broadly span the entire late Barremian, consistent with the main U1 and U2 Urgonian formations (sensu [22]) of northern Provence (Figure 6). To date, there is no evidence for early Aptian Urgonian-type, rudist-bearing units in the southern Vercors, except for the post-Urgonian deposits known as the Upper Orbitolina Beds. Their regional correlation remains unclear, as they occur as infills within pre-existing incised valleys atop the Urgonian formation.

Nevertheless, detailed mapping and biostratigraphic calibration by [10] indicate that post-Urgonian deposits are also represented by the Chironne calcarenites, interpreted as a marginal prism succession in southwestern Vercors. These deposits are assumed to have accumulated during "a prolonged phase of platform emersion in the latest Barremian and possibly the earliest Aptian", coinciding with the formation of the aforementioned incised valleys [10]. The calcarenites are capped by an ammonite-rich firmground yielding small-sized *Deshayesites* and *Barremites*, indicating an earliest Aptian age. They are then overlain by the Monrond flinty limestones, which extend further north than the underlying calcarenites but thin rapidly in that direction. These limestones, topping onto the U06 Urgonian unit, may be interpreted as transgressive deposits following deposition of the Chironne lowstand wedge, but preceding the deposition of the Upper Orbitolina Beds in the early late Aptian [10]. Altogether, this pattern aligns closely with the final Urgonian depositional stages at Mont Ventoux (Figure 6), corresponding elsewhere in northern Provence to the U3 Formation (sensu [22]), for which a latest Barremian to earliest Aptian age has been established based on ammonites [2]. In North Provence, a comparable firmground horizon separates the lower calcarenites from the overlying cherty limestones within the U3 Formation [2]. These consistent sedimentary signals strongly support the interpretation of [23], demonstrating that the latest Barremian–earliest Aptian transition was marked by widespread platform exposure in southeastern France, and more broadly across the Tethys, reflecting a general basinward shift in Urgonian facies throughout SE France. We are currently reconstructing the palaeogeographic extent of this platform in the study area, which appears to have been largely overlooked until now, and which is shown to be characterised by distinctive rudist and algal assemblages in locations where inner-platform depositional environments are preserved, as observed in the southern part of North Provence ([24], their Figure 12) and in northeastern Languedoc [21]. However, it should be noted that mapping of this mainly early Aptian platform is strongly influenced by syn- and post-Cretaceous erosion, which complicates both the delineation and correlation of this platform stage at the basin scale.

6. Conclusions

In this study, the ammonite-based biostratigraphy of the Mont Ventoux area was refined and updated. The succession records distal Urgonian depositional environments during the late Barremian, spanning from the *Toxancyloceras vandenheckii* to the upper *Gerhardtia sartousiana* Zone, followed by strongly progradational distal Urgonian deposits

with an age interval from the terminal Barremian into the early Aptian. Intra-Urgonian, ammonite-bearing horizons prove to be of primary importance for dating and correlating Urgonian units and support a supra-regional evolutionary scenario linking the northern Provence and southern Vercors Urgonian domains. Recent revisions in this region reveal consistent sedimentary patterns, most notably the recognition of widespread platform exposure across the Barremian–Aptian boundary. This platform exposure is coeval to a general basinward shift in Urgonian facies in southeastern France, a feature that has largely been overlooked until now.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/d18030162/s1. References [25–29] are cited in the supplementary materials.

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References

1. Dercourt, J.; Ricou, L.E.; Vrielynck, B. (Eds.) *Atlas Tethys Palaeoenvironmental Maps*; 14 maps; Gauthier-Villars: Paris, France, 1993; 307p.
2. Frau, C.; Tendil, A.J.-B.; Lanteaume, C.; Masse, J.-P.; Pictet, A.; Bulot, L.G.; Luber, T.; Redfern, J.; Borgomano, J.; Léonide, P.; et al. Late Barremian–early Aptian ammonite bio-events from the Urgonian-type series of Provence (Southeast France): Regional stratigraphic correlations and implications for the peri-Vocontian carbonate platforms. *Cretac. Res.* **2018**, *90*, 222–253. [CrossRef]
3. Tendil, A.J.-B.; Frau, C.; Léonide, P.; Fournier, F.; Borgomano, J.R.; Lanteaume, C.; Masse, J.-P.; Massonnat, G.; Rolando, J.-R. Platform-to-basin transition of the Urgonian carbonate platform in Provence (Barremian–Aptian, SE France): New insights into the regional to global factors controlling the local stratigraphic architecture. *Cretac. Res.* **2018**, *91*, 382–411. [CrossRef]
4. Frau, C.; Tendil, A.J.; Lanteaume, C. New insights into the platform-to-basin anatomy of the Urgonian Bas-Vivarais Domain (Lower Cretaceous; SE France). *J. Geogr. Environ. Earth Sci. Int.* **2023**, *27*, 19–47. [CrossRef]
5. Arnaud, H.; Arnaud-Vanneau, A.; Blanc-Alétru, M.-C.; Adatte, T.; Argot, M.; Delanoy, G.; Thieuloy, J.-P.; Vermeulen, J.; Virgone, A.; Virlouvet, B.; et al. Répartition stratigraphique des orbitolinidés de la plate-forme urgonienne subalpine et jurassienne (SE de la France). *Géologie Alp.* **1998**, *74*, 3–89.
6. Richet, R. High Resolution 3D Stratigraphic Modeling of the Gresse-en-Vercors Lower Cretaceous Carbonate Platform (SE France): From Digital Outcrop Modeling to Carbonate Sedimentary System Characterization. Ph.D. Thesis, Université d'Aix-Marseille II, Marseille, France, 2011.
7. Clavel, B.; Charollais, J.; Busnardo, R.; Granier, B.; Conrad, M.; Desjaques, P.; Metzger, J. La plate-forme carbonatée urgonienne (Hauterivien supérieur–Aptien inférieur) dans le Sud-Est de la France et en Suisse: Synthèse. *Arch. Sci.* **2014**, *67*, 1–97.
8. Frau, C.; Tendil, A.J.-B.; Masse, J.-P.; Richet, R.; Borgomano, J.R.; Lanteaume, C. Revisited biostratigraphy and regional correlations of the Urgonian southern Vercors carbonate platform, southeast France. *Cretac. Res.* **2021**, *124*, 104773. [CrossRef]

9. Thomas, A. Géométrie de la Progradation Urgonienne et Propriétés Pétrophysiques des Différents Faciès (Vercors, SE France). Ph.D. Thesis, Université de Lorraine, Nancy, France, 2022.
10. Pictet, A.; Ferry, S.; Pietra, L. Ammonite biostratigraphy on the platform–slope transition between the Vercors Urgonian platform and the Vocontian Trough (SE France). *Swiss J. Palaeontol.* **2026**, *145*, 17–76. [CrossRef]
11. Michel, J.; Lanteaume, C.; Massonnat, G.; Borgomano, J.; Tendil, A.J.-B.; Bastide, F.; Frau, C.; Léonide, P.; Rebelle, M.; Barbier, M.; et al. Questioning carbonate facies model definition with reference to the Lower Cretaceous Urgonian platform (SE France Basin). *BSGF Earth Sci. Bull.* **2023**, *194*, 13. [CrossRef]
12. Frau, C.; Delanoy, G.; Masse, J.-P.; Lanteaume, C.; Tendil, A.J.-B. New Heteroceratidae (Ammonoidea) from the late Barremian deepening succession of Marseille (Bouches-du-Rhône, France). *Acta Geol. Pol.* **2016**, *66*, 205–225. [CrossRef]
13. Frau, C.; Delanoy, G. Taxonomic notes on some Barremian–Aptian cephalopods from the Station de Cassis section and surrounding sites, Bouches-du-Rhône, Southern France. *Strat. Série 2e* **2022**, *58*, 1–45.
14. Bert, D.; Delanoy, G.; Bersac, S. Descriptions de représentants nouveaux ou peu connus de la famille des Hemihoplitidae Spath, 1924 (Barrémien supérieur, Sud-Est de la France): Conséquences taxinomiques et phylogénétiques. *Ann. Muséum d'Hist. Nat. Nice* **2006**, *21*, 179–253.
15. Delanoy, G. Données nouvelles sur l'espèce-index *Hemihoplites feraudianus* (d'Orbigny, 1841) (Ammonoidea, Ancyloceratina). *Comptes Rendus l'Académie Sci. Paris* **1990**, *310*, 661–666.
16. Masse, J.-P.; Frau, C.; Tendil, A.J.-B.; Fenerci-Masse, M. Evidence for three successive upper Barremian–lower Aptian rudist faunas in the Urgonian-type deposits of southeastern France and their stratigraphic value. *Cretac. Res.* **2020**, *115*, 104561. [CrossRef]
17. Léonide, P.; Borgomano, J.; Masse, J.-P.; Doublet, S. Relation between stratigraphic architecture and multi-scale heterogeneities in carbonate platforms: The Barremian–lower Aptian of the Monts de Vaucluse, SE France. *Sediment. Geol.* **2012**, *265*, 87–109. [CrossRef]
18. Masse, J.-P.; Fenerci-Masse, M. Diversity dynamics, trophic, community and environmental changes in early Cretaceous rudist bivalves (Hippuritida): New insights on the late Barremian "*Agriopleura* extinction event" and subsequent recovery. *Palaeogeogr. Palaeoclimatol. Palaeoecol.* **2022**, *601*, 111143. [CrossRef]
19. Delanoy, G. Biostratigraphie des Faunes d'Ammonites à la Limite Barrémien–Aptien dans la Région d'Angles–Barrême–Castellane: Étude Particulière de la Famille des Heteroceratidae Spath, 1922 (Ancyloceratina, Ammonoidea). Ph.D. Thesis, Université de Nice Sophia Antipolis, Nice, France, 1996.
20. Wilpshaar, M. Direct stratigraphic correlation of the Vercors carbonate platform in SE France with the Barremian stratotype by means of dinoflagellate cysts. *Cretac. Res.* **1995**, *16*, 273–281. [CrossRef]
21. Masse, J.-P.; Rineau, V.; Fenerci-Masse, M.; Frau, C. Upper Barremian–lower Aptian rudist faunas of Urgonian-type platform formations from Ardèche (southeastern France). *Carnets Géologie* **2026**, *26*, 51–87. [CrossRef]
22. Leenhardt, F. Étude Géologique de la Région du Mont Ventoux. Ph.D. Thesis, Université de Montpellier, Montpellier, France, 1883; 273p.
23. Frau, C.; Tendil, A.J.-B.; Pohl, A.; Lanteaume, C. Revising the timing and causes of the Urgonian rudistid-platform demise in the Mediterranean Tethys. *Glob. Planet. Change* **2020**, *187*, 103124. [CrossRef]
24. Masse, J.-P.; Fenerci-Masse, M. Stratigraphic updating and correlation of Late Barremian–Early Aptian Urgonian successions and their marly cover, in their type region (Orgon–Apt, SE France). *Cretac. Res.* **2013**, *39*, 17–28. [CrossRef]
25. Haeckel, E. *Allgemeine Entwickelungsgeschichte der Organismen*; Reimer: Berlin, Germany, 1866; 612p.
26. Gill, T. Arrangement of the families of mollusks. In *Smithsonian Miscellaneous Collections*; Smithsonian Institution: Washington, DC, USA, 1871; Volume 227, pp. 1–49.
27. Spath, L.F. On the ammonites of the Speeton Clay and the subdivisions of the Neocomian. *Geol. Mag.* **1924**, *61*, 73–89. [CrossRef]
28. d'Orbigny, A. *Paléontologie Française. Description Zoologique et Géologique de Tous Les Animaux Mollusques et Rayonnés Fossiles de France. Terrains Crétacés, Vol. I: Céphalopodes*; Arthus-Bertrand: Paris, France, 1840–1842; 662p. [1–120 (1840); 121–430 (1841); 431–662 (1842)].
29. Bert, D.; Bersac, S.; Canut, L. Implications of the 'hemihoplitid-like' ammonites iterative morphology in the context of the Late Tethyan Barremian (Early Cretaceous). *Cretac. Res.* **2020**, *106*, 104239. [CrossRef]

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