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The Aptian Stage: Back to fundamentals

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The original definitions of the Aptian, Albian and Urgonian stages by d'Orbigny (1840, 1842, 1847, respectively) on the basis of lithological and paleontological criteria were sufficiently clear and should not have generated the misinterpretations and confusion that began at the end of the 19th century and continue today. The purpose of this paper is thus to clarify the succession of stages within this period of the Cretaceous as well as their relationships, by a better respect for the thought of their creator and also in light of recent work on the historical stratotypes. This return to fundamentals leads us to propose the insertion of a Bedoulian stage between the Barremian (ex Urgonian) and the Aptian s.s. Our proposal includes also recommendations for the definition of the Barremian, Bedoulian (sensu novo), Aptian (s. s.) and Albian boundaries and the corresponding Global Boundary Stratotype Sections and Points (GSSP).

Introduction

Instead of trying to save and restore our ancestor's intentions when subdividing the Lower Cretaceous - particularly the critical 130-100 Myr period - into geological stages, we could elect to erase and delete everything heretofore created, somehow "initialize" the geological time scale by using new criteria and new tools. Gale et al. (2009) publication puts it succinctly: "Defining Cretaceous Stage Boundaries - time for a new approach".

These authors suggest that in defining Global Boundary Stratotype Sections and Points (GSSPs) and timescales the biostratigraphic markers be replaced by geochemical changes and magnetic reversals.

One might go even farther: geological time could be arbitrarily divided into equal astronomically tuned intervals of 4, 5, or whatever Myr, calling these intervals "stages" and giving them new names. At least such an approach should eliminate the morass of inconsistencies and the endless controversies which have wasted so many stratigraphers' time.

Anyway, let's start with some history....

Historical background

If the rule of priority had been applied for stratigraphic nomenclature as strictly as it has been for paleontological denominations, and if the initial intentions of some authors had been better understood and/or respected, the Lower Cretaceous would now comprise the following succession of stages:

Berriasian, Valanginian, Hauterivian, Urgonian, Rhodanian, Aptian, Albian.

Compared to current usage, this original sequence lists two intruders (Urgonian, Rhodanian) and one accepted stage is missing (Barremian). In addition, we will see later that the Aptian is now given a length of time which does not correspond to its original definition.

After having created the Aptian stage (1840), in 1847 d'Orbigny continued his subdivision of the Neocomian of Thurmann (1835) by creating the Urgonian, perfectly defined both by faunas (rudists) of the shallow water "reefy" facies and by faunas (cephalopods) of the deep "muddy" facies. D'Orbigny had thus foreseen the parallelism in age between two discrete facies of the same chronostratigraphic entity. Alas, this brilliant anticipation was not well understood by his contemporaries, more especially as he made the unfortunate choice of Orgon as the type-locality. The rudistid facies of Orgon does not include first rank markers for precise dating, so its chronological equivalence with the muddy facies was not obvious. As a result Coquand (1862) thought that the rudistid Urgonian was not contemporaneous with, but was superimposed on the Urgonian with Cephalopods. Therefore it became advisable to create a new stage for the unnamed space which was thought to be represented by the deeper water strata. Hence the name Barremian, that the dogmatism of Kilian (1910) imposed later to the detriment of the Urgonian, a stage which was perfectly valid.

In 1854 Renevier created the Rhodanian stage for Urgonian-like beds of the Bellegarde area in the Jura which are of the same neritic facies as that of Orgon but with a fauna that the author considered younger. Chronologically this new stage was inserted between the Urgonian s.s. and the Aptian marls (=Aptian *sensu initio*). Not having been defined on the basis of ammonite faunas, the concept of Rhodanian was also misunderstood and was not really successful.

But let us return to the process of creation of the Aptian.

- In 1840 d'Orbigny introduced for the first time this term, used as an adjective: "With regard to the upper beds of the Neocomian

stage... all... prompts me in placing this unit closer to that of the lower Neocomian, although at the same time considering them as constituting a discrete, well-defined period of time. Perhaps one might separate completely this fauna and give the beds that contain it a special name. I shall propose that of Aptian, the surroundings of Apt being its principal location. In any case, they are so different from the gault that under no circumstances can they be compared...”

- In 1841 d’Orbigny defined his stage more precisely but at the same time introduced a certain amount of ambiguity: “Divisions into lower Neocomian and upper Neocomian or Aptian, are taken in the Paris Basin. The concordance of position and the identity of the fossils then enabled me to find them again in Provence. Indeed,..., the clays with *Plicatules* of Mr. CORNUEL, of which I made my upper Neocomian, and later the Aptian, without any doubt are represented in Provence by the marls of Gargas, near Apt...”

It arises clearly from the author’s designation that originally the concept of Aptian was based on a geological formation, the clays with *Plicatules* of the Paris Basin, which d’Orbigny then paralleled with the marls of Gargas. Such a restricted concept of the Aptian was perfectly clear in the middle of the 19th century and thus justified the creation by Renevier (1854) of a stage (the Rhodanian) between the Urgonian and the Aptian.

Useless complications and alterations began in 1887, when Kilian proceeded, in a very informal way, to the subdivision of an Aptian arbitrarily extended downward when compared to the original definition by d’Orbigny. In a table (see Table 1 below) including lists of fossils, without any mention of type-localities, the author introduced the term “Voconcian” for a lower subdivision and that of “Gargasian” for an upper subdivision of the stage. Kilian did not explain why he created the term Voconcian, seemingly equivalent to that of Rhodanian which already existed. Moreover his “upper Aptian” (Gargasian) is useless since it is the chronological equivalent of the original Aptian.

Table 1. First mention (1887) of the terms Voconcian and Gargasian in Kilian’s work

APTIAN	UPPER (GARGASIAN)	Sandy marls with <i>Bel. semicanaliculatus</i>
		Marls with <i>Am. Dufrenoyi</i> , <i>Nisus</i> , <i>Guettardi</i> , <i>Martini</i> , <i>Plicatula radiola...</i>
		Limestone with <i>Am. Martini</i> , <i>A. Dufrenoyi</i> , <i>Plicatula radiola...</i>
	LOWER (RHODANIAN) (VOCONCIAN)	Cherty limestone; <i>Am. consobrinus</i> , <i>Ancyloceras matheroni</i> , <i>Ammonites recticostatus...</i>

The situation worsened a little more the following year, when Toucas (1888) introduced an additional subdivision within the Aptian (*sensu* Kilian): “The richly fossiliferous outcrops of La Bédoule... belong to this zone of the lower Aptian, which could be given the name of Bedoulian...”. Later on Kilian & Reboul (1915), eliminating *de facto* the Rhodanian but also the Voconcian, even though both had been created before it, thus sanctioned the term Bedoulian, and extended the concept by lowering its downward limit. In the conclusions of the Congress of Lyon (1963, publ. 1965) this position

was ratified: “Although A. TOUCAS designated under this name only the upper part of the La Bédoule-Cassis strata..., the unanimity was made to admit the widened meaning given to this term by W. KILIAN and its successors..., i.e. to make the Bedoulian... the equivalent of all the lower Aptian.”

Lastly, completing the imbroglio, on the basis of questionable paleontological arguments, Breistroffer (1947) introduced a new change to the original concept of Aptian, by widening the stage upwards, at the expense of the Albian. The lowermost Albian fauna known as of the “Clansayes horizon” (from the name of a richly fossiliferous outcrop of the Western Drome, SE France) is detached from the Albian and characterizes a “Clansayesian substage... of the Aptian stage”; so the author induces a new mode (ternary) of subdivision of the stage (Table 2).

Table 2. Ternary subdivision of the Aptian stage by Breistroffer (1947)

Aptian	Upper = Clansayesian
	Middle = Gargasian
	Lower = Bedoulian

This subdivision of such an extended Aptian was somewhat ratified in the general conclusions of the Congress of Lyon (1963), but in a rather strange way (binary with three named substages!):

“the Aptian comprises, on the basis of the stratotypes:

a) lower Aptian (Bedoulian)

b) upper Aptian (Gargasian + Clansayesian)”

From this historical summary it appears that the original thought of d’Orbigny was denatured several times, for both the Urgonian and Aptian, as well as that of Renevier for the Rhodanian.

Taking into account the practice which has prevailed, although deploring that it resulted from misinterpretations, disrespect of the rules of priority and/or the dogmatism of certain great figures in geology, it does not appear realistic to return to the origins in regard to the Urgonian or the Rhodanian.

But for the Aptian, on the basis of d’Orbigny’s (1840, 1841) original designations and also our recent work on the stratotype (see below), we suggest a redefinition of this stage which returns to the fundamentals and should simplify a resolution of the imbroglio due to erroneous interpretations and unfortunate decisions by some of his successors.

Recent data

Micropaleontologic work (foraminifera, ostracodes) on the Aptian stratotype (Moullade et al., 2009) shows that the marls from the sector of the hill of Gargas, 2 km NW of Apt (SE France) (Fig.1), near the richly fossiliferous outcrops (Les Billiards, Salignan) mentioned by many authors as typifying the Aptian, in fact represent only a medial fraction (from the middle of the lower Gargasian to the base of the upper Gargasian) of the Aptian as it is currently defined.

In the stratotype of Gargas the fossiliferous Aptian marls are overlain by a series (historically thought to be continuous) of barren clayey sands and sandstones (Moullade, 1965). In the literature these beds have been generally assigned an uppermost Aptian (more particularly Clansayesian) and Albian age. On the basis of our work

Figure 1. Location of the Aptian historical stratotypic localities.

quoted above (Moullade et al., 2009) and a comparison with data from Friès (1987) in the neighbouring sector of Banon, it appears that these detrital levels which directly overly a Gargasian truncated at its top, would be ascribable to the upper Albian, with an important erosional gap between them.

In other words, the spot of the stratotype locality of Gargas does not include strata of Bedoulian nor Clansayesian age.

What to do?

Not wanting to be revolutionists that call everything into question, as our preamble suggests, or to demand a strict application of priority at the expense of well-established usage—even though this usage is founded on erroneous bases—we propose a scheme which appears to us to clarify the current situation. This situation, too strongly

influenced by “Breistroffer’s and Kilian’s heritage”, is unsatisfactory for several reasons, among them the following:

- No respect for the initial concept of d’Orbigny,
- Stage and substage boundaries that have fluctuated without cease,
- Since 1947, use of an impractical ternary or, worse, a “hybrid binary” terminology for the subdivisions of the Aptian, rather than the simple binary mode employed for most of the other stages of the Lower Cretaceous.

Thus we suggest that the “ad hoc” Committees consider the merits of the following proposal.

Proposal

Stratigraphic nomenclature

- 1) Restrain the concept of Aptian to that of the «Aptian marls», as originally defined by d’Orbigny (1840-1841) and reiterated by Renevier (1854).
- 2) Consequently, Gargasian is a junior synonym of Aptian and must be abandoned.
- 3) As there are no Clansayesian beds in the Aptian historical stratotype, whether or not the level is ranked as a substage, the “Clansayesian horizon” must be returned to the Albian, its location before Breistroffer’s (1947) revision.
- 4) The interval of time left between the Aptian *s.s.* as defined above and the Barremian (or Urgonian *sensu initio*), corresponds to the concept of Rhodanian by Renevier. To name it now, there are two possibilities (Fig.2):
 - to follow priority and restore the Rhodanian,
 - to follow usage: taking into account that Rhodanian and Vocontian were abandoned for more than a century, we do not recommend their restoration.

Instead, we recommend retaining the Bedoulian, but **as a stage between the Barremian and the Aptian *s. s.***

Stratigraphic boundaries and GSSP

1. Barremian – Bedoulian (*sensu novo*) boundary (Fig.3) defined by:
 - FAD of the ammonite genus *Deshayesites* [including *Paradeshayesites*] (Fig.4),

Figure 2. Priority vs. usage.

Figure 3. The Barremian-Bedoulian transition and boundary at the Villeneuve Quarry, Cassis, Bouches-du-Rhône, SE France. The star shows the Bedoulian GSSP (base of bed 60) suggested in this paper.

Figure 4. Key ammonite genera: 1. Deshayesites, 2. Dufrenoyia, and 3a-b. Hypacanthophiles, whose FAD are used in this paper for defining respectively the Barremian-Bedoulian, Bedoulian-Aptian (s. s.), and Aptian (s. s.)-Albian boundaries.

- Proxies (approximates):
 - FAD of the planktonic foraminifer *Praehedbergella primare* (Fig.5), which first occurs in the uppermost Barremian.
 - base of the magnetic reversal M0.

Suggestion for the Bedoulian (*sensu novo*) GSSP (Fig.3)

At Cassis-La Bédoule (SE France) (Figs. 1, 6), in the lowermost

part of the Villeneuve Quarry section, base of bed 60 (cf. Moullade et al., 1998).

2. Bedoulian (*sensu novo*) - Aptian (s.s.) boundary (Fig.7) defined by:

- FAD of the ammonite genus *Dufrenoyia* (Fig.4),
- proxy
 - the triple micropaleontological datum (Moullade et

Figure 5. Micropaleontological markers. 1-3. *Lenticulina* cf. *nodosa*. 4. *Protocythere bedoulensis*. 5-7. *Praehedbergella primare*. 8-13. *Praehedbergella luterbacheri*. 14-16. *Paraticinella eubejaouaensis*.

Figure 6. Location of the Villeneuve and Comte quarries, Cassis-La Bédoule area, respectively suggested as candidates for the Bedoulian and Aptian (s. s.) GSSP.

Figure 7. The Bedoulian-Aptian transition and boundary at the Comte Quarry, Cassis, Bouches-du-Rhône, SE France. The star shows the Aptian (s.s.) GSSP (top of bed 170) suggested in this paper.

al., 2005, 2008), which occurs slightly above the ammonite boundary, and is defined by the following simultaneous bio-events (Figs 5, 8):

- LAD of *Lenticulina* cf. *nodosa* (benthic foraminifer),
- LAD of *Protocythere bedoulensis* (ostracod),
- FAD of *Praehedbergella luterbacheri* (planktonic foraminifer).

Suggestion for the Aptian (*sensu stricto*) GSSP (Fig.3):

Cassis-La Bédoule, in the Comte Quarry section, top of bed 170 (Moullade et al., 1998).

3. Aptian (s.s.) – Albian boundary (Fig.9) defined by:

- FAD of the ammonite genus *Hypacanthoplites* (Fig. 4) (cf. Casey, 1999),
- proxy
 - FAD of the planktonic foraminifer *Paraticinella eubejaouaensis* (Figs. 5, 9).

Albian GSSP

Still to be found: several unfruitful attempts (for instance Kennedy et al., 2000) have been made to define a GSSP for the base of the Albian stage in the Vocontian basin (SE France) (Figs 1, 10), initially thought to be the most suitable area; thus, this GSSP must be also searched for in other areas.

Figure 8. The triple micropaleontological datum suggested as a proxy for defining the Bedoulian- Aptian (s. s.) boundary.

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Figure 9. Variations in the definition of the Aptian-Albian boundary.

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Figure 10. The Aptian-Albian transition in the Vocontian area: example of the Sauzeries-Basses section, near Tartonne (Alpes-de-Haute-Provence, SE France). The Aptian-Albian boundary as suggested in this paper is here underlined in red.

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