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ScienceDirect
C. R. Geoscience 340 (2008) 390–399
COMPTES RENDUS GEOSCIENCE
http://france.elsevier.com/direct/CRAS2A/

Stratigraphy

Sedimentology and sequence stratigraphy of Aquitanian and Burdigalian stratotypes in the Bordeaux area (southwestern France)

Olivier Parize [a], Thierry Mulder [b,*], Bruno Cahuzac [b], Nicolas Fiet [c], Laurent Londeix [b], Jean-Loup Rubino [d]

[a] *AREVA NC BU Mines, département géosciences, technologies géoscience, sédimentologie, tour AREVA, 1, place de la Coupole, 92084 Paris-la-Défense cedex, France.*
[b] *Université Bordeaux–1, UMR 5805 EPOC, avenue des Facultés, 33405 Talence cedex, France*
[c] *Université Paris–11, UMR 8148 IDES, bât. 504, 91405 Orsay cedex, France*
[d] *TOTAL, CST J-F – GSR/TG/ISS, avenue Larribau, 64018 Pau cedex, France*

Received 3 April 2007; accepted after revision 18 March 2008
Available online 16 May 2008

Presented by Jean Dercourt

Abstract

The historical stratotypes of the Aquitanian and Burdigalian in the Aquitaine Basin are studied here by using the tools of facies sedimentology and the concept of sequence stratigraphy. This analytical method combines recognition and sequential organization of facies, and several types of stratigraphic markers. This method allows identification of at least six depositional sequences within the Miocene of the Saucats area: the four lower ones belong to the Aquitanian, the fifth one to the whole Burdigalian, while the sixth sequence corresponds to the Serravallian. In addition, this method provides evidence of a period of emersion before each transgression, suggesting potential fluvial erosion. Nevertheless, these phases are of lower amplitude than those observed in the Rhodano-Provençal Basin. ***To cite this article: O. Parize et al., C. R. Geoscience 340 (2008).***

Résumé

Première analyse sédimentologique et séquentielle des stratotypes de l'Aquitanien et du Burdigalien de la région de Bordeaux (Sud-Ouest de la France). Les stratotypes historiques de l'Aquitanien et du Burdigalien, en Aquitaine, sont étudiés ici en termes de sédimentologie de faciès et de stratigraphie séquentielle. Cette méthode d'analyse combine la reconnaissance et l'organisation séquentielle des faciès à plusieurs types de repères stratigraphiques. Elle permet d'identifier au moins six séquences de dépôt dans le Miocène de la région de Saucats : les quatre premières dans l'Aquitanien, la cinquième pour le Burdigalien et la dernière pour le Serravallien. Elle a également permis de mettre en évidence des phases d'émersion anté-transgression, suggérant de possibles érosions fluviatiles, mais d'ampleurs inférieures à celles reconnues dans le Bassin miocène rhodano-provençal. ***Pour citer cet article : O. Parize et al., C. R. Geoscience 340 (2008).***

Keywords: Stratotypes; Aquitanian; Burdigalian; Sedimentology; Facies; Sequence stratigraphy; Southwestern France

Mots clés : Stratotypes ; Aquitanien ; Burdigalien ; Sédimentologie ; Faciès ; Stratigraphie séquentielle ; Sud-Ouest de la France

* Corresponding author.
E-mail address: t.mulder@epoc.u-bordeaux1.fr (T. Mulder).

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doi:10.1016/j.crte.2008.03.004

Version française abrégée

Les stratotypes historiques de l'Aquitanien [28] et du Burdigalien [14] en Aquitaine n'ont encore jamais été étudiés en termes de sédimentologie de faciès et de stratigraphie séquentielle, à la différence du stratotype rhodanien de la partie supérieure du Burdigalien [14] et des autres dépôts stratigraphiquement corrélables du bassin molassique rhodano-provençal (BMRP) [23,32,33,40]. Cette méthode d'analyse combine la reconnaissance et l'organisation séquentielle des faciès à plusieurs types de repères stratigraphiques. En outre, elle permet de prendre en compte l'influence relative de la tectonique et de l'eustatisme, de mettre en évidence d'éventuelles érosions fluviatiles et d'identifier les discontinuités stratigraphiques. Dans le Miocène de la région de Saucats, elle permet de reconnaître au moins six séquences de dépôt, dont cinq pour la série stratotypique, quatre au moins pour l'Aquitanien et une cinquième pour le Burdigalien. Une sixième séquence est observée dans le Serravallien.

La discordance à la base du Burdigalien est très nettement érosive, aussi bien régionalement [15,42] qu'à une échelle plus locale (Figs. 2 et 3). L'organisation des divers faciès transgressifs burdigaliens, en contact avec la surface d'érosion fini-aquitanienne, dénote une paléomorphologie associée à une érosion fluviatile antérieure.

Une autre exondation a également été mise en évidence entre les deux séquences supérieures aquitaniennes décrites ici, permettant même le développement d'un karst par une chute du niveau de base (puits de dissolution de L'Ariey à l'Aquitanien, Fig. 3C). D'ampleur certes bien moindre que dans le BMRP, où ils ont été amplifiés par la tectonique, des réseaux de drainage fluviatile ont pu ici se développer lors de phases d'émersion [7]. Ainsi, comme dans le BMRP et conformément au principe de partitionnement spatial des dépôts, les séquences du Miocène inférieur apparaissent amputées, d'une part, des cortèges de bas niveau marin et, d'autre part, d'une partie des termes continentaux des cortèges régressifs. Cette érosion se produit, soit lors de la chute du niveau de base par ravinement, soit lors de la transgression par abrasion par les vagues ou par effets des courants tidaux. Les cortèges de bas niveau marin seraient, quant à eux, à rechercher dans des environnements de dépôt plus profonds, sur la plate-forme aquitaine actuelle ou sur la pente continentale.

L'analyse permet également de rattacher la série stratotypique aux grands cycles eustatiques globaux. Les séquences identifiées peuvent être rattachées aux séquences de troisième ordre du grand cycle transgressif-régressif du Néogène [3]. La séquence burdigalienne de Saucats peut être corrélée avec la première séquence S1 burdigalienne du BMRP [4,32,33,40]. La seconde séquence burdigalienne rhodanienne est absente dans la région de Saucats : cela justifie le choix de Depéret [14] de retenir la suite du stratotype burdigalien dans la vallée du Rhône. Enfin, le découpage que nous proposons de la partie supérieure de l'Aquitanien type en deux séquences est compatible avec l'analyse du parastratotype de Carry-le-Rouet [13,41] ou des dépôts du secteur de Fos-sur-Mer [4,33].

L'identification des séquences est déduite de l'évolution des environnements de dépôt, résultant de l'interprétation des données de sédimentologie de faciès. Les faciès sont précisés et les paramètres environnementaux caractérisés par l'analyse du contenu paléontologique. Ce dernier ainsi que quelques datations par isotopes permettent de positionner précisément le cadre stratigraphique.

Ce travail montre l'intérêt d'une étude intégrée multidisciplinaire. Le découpage séquentiel (Fig. 2) est basé sur les caractéristiques des surfaces interprétées selon les concepts de la stratigraphie séquentielle.

L'application combinée des concepts modernes de la stratigraphie séquentielle et des outils plus classiques de la sédimentologie de faciès est particulièrement efficace au niveau des stratotypes historiques, où des inventaires paléontologiques détaillés avaient été préalablement réalisés. Enfin, le stratotype bordelais de l'Aquitanien, tel qu'il a été défini par Mayer [28], apparaît plus complet que son parastratotype provençal par quatre séquences représentées, même si l'environnement sédimentaire était margino-littoral. Il a été préservé des éventuelles érosions par sa situation dans un contexte géodynamique plus calme.

1. Introduction

Historical stratotypes of the Aquitanian [28] and Burdigalian [14] in Aquitaine (southwestern France) were never studied in terms of facies sedimentology or sequence stratigraphy. This makes a difference with the Burdigalian stratotype [14] and other formations of a similar age in the Rhodano-Provençal Molassic Basin (RPMB), at the front of the Alps [23,32,33,40]. The Miocene series of the RPMB was studied by a multidisciplinary approach to understand the filling of a foreland basin, to revise its stratigraphic architecture [32,40] and to emphasize the importance of river incision in time–space distribution of sediments [4]. It finally allowed us to propose a sequence organization of the basin *sensu* Posamentier and Allen [37].

In this paper, we present the facies organization and the identification of unconformities and other stratigraphic surfaces in the Aquitanian and Burdigalian stratotypes in the Bordeaux area, according to the concepts of sequence stratigraphy. We propose a preliminary comparison between the Miocene series of the Aquitaine Basin stratotypes and those of the RPMB to discuss the facies succession and the importance of river incision at sequence boundaries.

1.1. The historical stratotypes of Aquitanian and Burdigalian in Aquitaine

The Aquitanian stratotype was defined by Mayer [15,28] between the villages of La Brède and Saucats to the south of Bordeaux (southwestern France). Outcrops are mainly located along the Saint-Jean-d'Étampes (Saucats) stream (Fig. 1). According to Mayer, the stratotype extends upstream from the first marine deposits above the Oligocene continental clays and marls at the La Mole watermill (La Brède) [6,8] to the top of the Late Aquitanian lacustrine limestone at L'Ariey (Saucats). Its straightline extent is 2.8 km. The complete outcropping series from Augey to Bernachon and L'Ariey sections [10,25,35] forms a cumulated thickness of approximately 30 m [8,25,35]. They represent a time period extending from −22.5 to −20.5 Ma according to $^{87}Sr/^{86}Sr$ dating measurements [8].

The Burdigalian was named by Depéret [14] with reference to the Bordeaux area. However, the stratotype

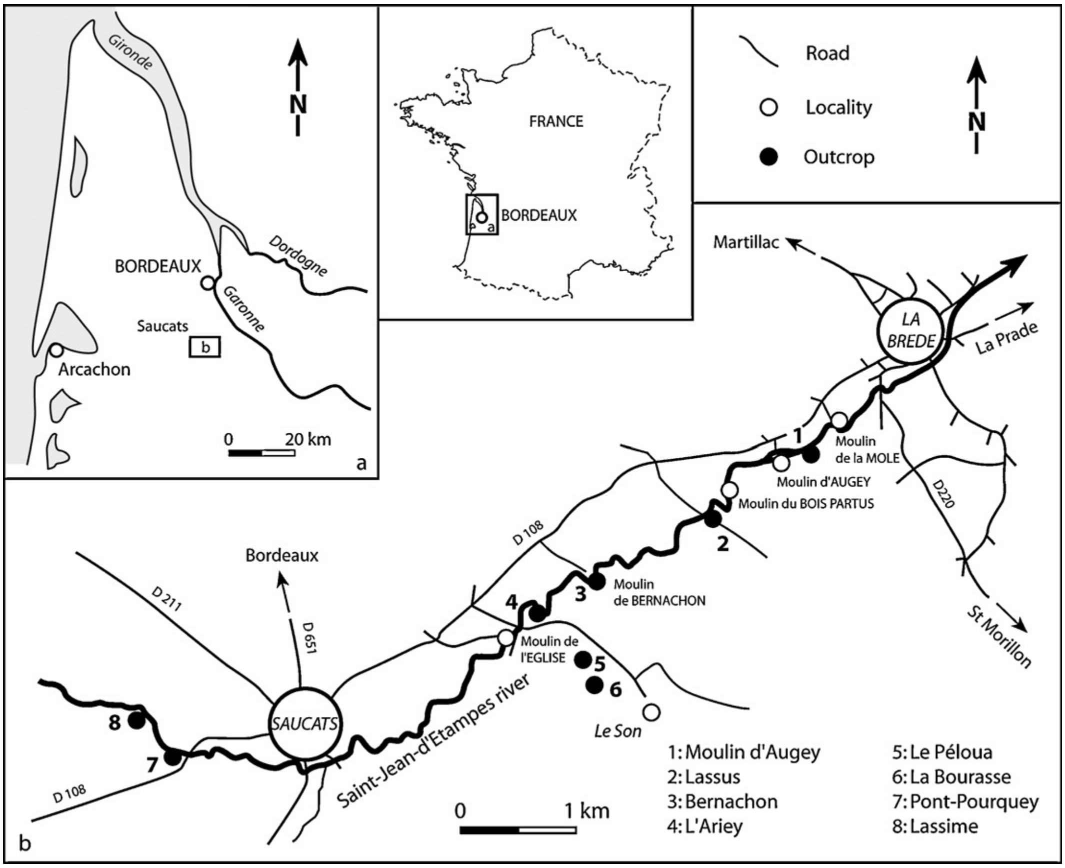

Fig. 1. Outcrops of the historical stratotypes of the Early Miocene of the 'Bordelais', Saucats area. The successions of stratotypic Aquitanian and Burdigalian [14,28] outcrop along the Saint-Jean-d'Étampes (or Saucats) stream, between the La Brède (downstream) and Saucats (upstream) villages. The outcrops are mainly located near watermills (*e.g.*, la Mole, Augey, Bois Pertus ['Partus' *in litteris*], Bernachon, L'Église mills), or bridges (Lassus, Pont-Pourquey), or are preserved by the 'Réserve naturelle géologique de Saucats–La Brède' such as L'Ariey, La Bourasse, Lassime, Le Péloua.

Fig. 1. Les affleurements des stratotypes historiques du Miocène inférieur bordelais, région de Saucats. Les successions de l'Aquitanien et du Burdigalien stratotypiques [14,28] affleurent le long du ruisseau de Saint-Jean-d'Étampes (ou du Saucats) entre les villages de La Brède (en aval) et de Saucats (en amont). Les affleurements sont localisés principalement au voisinage de moulins comme ceux de la Mole, d'Augey, de Bois Pertus [« Partus » *in litteris*], de Bernachon, de L'Église, de ponts à Lassus ou à Pont-Pourquey, ou enfin d'affleurements mis en valeur par la Réserve naturelle géologique de Saucats–La Brède, comme L'Ariey, La Bourasse, Lassime, Le Péloua.

begins in Aquitaine and ends in the Rhone valley. It includes the 'faluns' (shelly sands or crags) of Saucats and Léognan [8,14,15,34,36], stratigraphically overlying the Aquitanian stratotype. The top of the stratotype is constituted by the bioclastic molasse of Saint-Paul-Trois-Châteaux in the Saint-Restitut massif in the RPMB [14,38]. In Aquitaine, the lower part of the historical Burdigalian stratotype includes, among others, the Saucats outcrops of Le Péloua, La Bourasse, Pont-Pourquey, and Lassime [10,36]. This set represents an approximate age ranging between −20.5 and −19.0 Ma according to $^{87}Sr/^{86}Sr$ dating measurements [8].

Since the pioneering works by Mayer [28] and Dépéret [14], a significant effort has been made to develop the palaeontological inventory of the stratotype deposits. There, marine macrofaunas are usually rich and diversified. They belong to shallow-water environments (internal infralittoral or margino-littoral). Numerous species are thermophilous, suggesting that surface waters were at least subtropical in this neritic environment of the North-East Atlantic domain during the Lower Miocene. In some falun beds, the mollusc association (bivalves, gastropods, scaphopods) [11,12,15,27], scleractinian corals, bryozoans..., are particularly abundant. They are associated with echinoderms and vertebrates. Microfauna includes several hundreds species of ostracods, benthic or planktonic foraminifers [9,16,29,34], nannoplankton, and dinoflagellates [26,30].

These palaeontological inventories allow the reconstruction of the palaeoenvironments (confinement, bathymetry, water salinity, temperature, turbulence and turbidity) and the development of a stratigraphic framework for the whole Miocene series. This framework is based on classical planktonic biozones (foraminifers and nannofossils) and on large benthic foraminifers [5]. It was recently strengthened by measurement of $^{87}Sr/^{86}Sr$ ratios on bivalves [6,8]. Some grade-dating measurements on miogypsinids and globigerinids [19,20] are also documented.

1.2. Sequence analysis of stratotypes: the method

The intercalation of carbonated continental (lacustrine or palustrine) beds in the marine deposits and the presence of perforated surfaces provide the first evidence of a stratigraphic organization depending on relative sea-level changes. In this paper, we assumed the stratigraphic continuity between marine highstand system tracks and the continental limestones to be consistent with the original definition of stratotypes. Facies analysis and palaeoenvironment reconstruction are based on the recognition of deposits affected by tide or swell action together with the faunal content of the sediment. Methodology and identification criteria are those defined in the RPMB [4,32,33,40]. This analysis makes possible the identification of transgressive and regressive trends [37], separated by a level of maximum bathymetry corresponding to the Maximum Flooding Surface (MFS).

In coastal environments, the MFS is certainly the most regular palaeosurface and can be assimilated to a local horizontal plane and be used as a datum plane to provide evidence of river erosion previous to the transgression. Incisions are similar to those observed in the RPMB [4], but with a lesser amplitude. In addition, field data show that local folded tectonics impacted upon the Miocene deposits and must not be neglected.

2. Sequence organization in the Lower Miocene stratotypes and the Middle Miocene in northern Aquitaine

The method of sequence analysis combines recognition of the sequence boundaries, the sequence organization of facies and of several types of stratigraphic surfaces (Fig. 2). This analysis allows the identification of at least six depositional sequences *sensu* Posamentier and Allen [37]. The first four sequences belong to the Aquitanian stratotype; the fifth one corresponds to the whole Burdigalian stratotype in Saucats. The last sequence belongs to the Serravallian.

2.1. The Aquitanian A_BM sequence at Augey

Between Augey and downstream Bernachon watermills, we recognized at least two complete sequences. The first one (A_BM in Fig. 2) lies above Chattian continental claystone with carbonated nodules. It begins with grey–beige marls with bivalves and bioclastic fine sands. $^{87}Sr/^{86}Sr$ dating provides an age between 22.7 and 22.1 ± 0.4 Ma in the basal falun [6,8]. These levels represent the first deposits of the Aquitanian transgression in the Saucats area. They could locally consist in an oyster falun. They are covered by clays in which few thin bioclastic levels are intercalated. Above, close to the Lassus bridge, the deposits pass to clayey and sandy marls with numerous miliolids and bivalves. $^{87}Sr/^{86}Sr$ dating provides an age of about 21.6 ± 0.3 Ma [8]. This series ends with a 40–50-cm-thick nodulous or discontinuous massive sandstone beds topped by an irregular 'nodular' surface. These irregularities can be

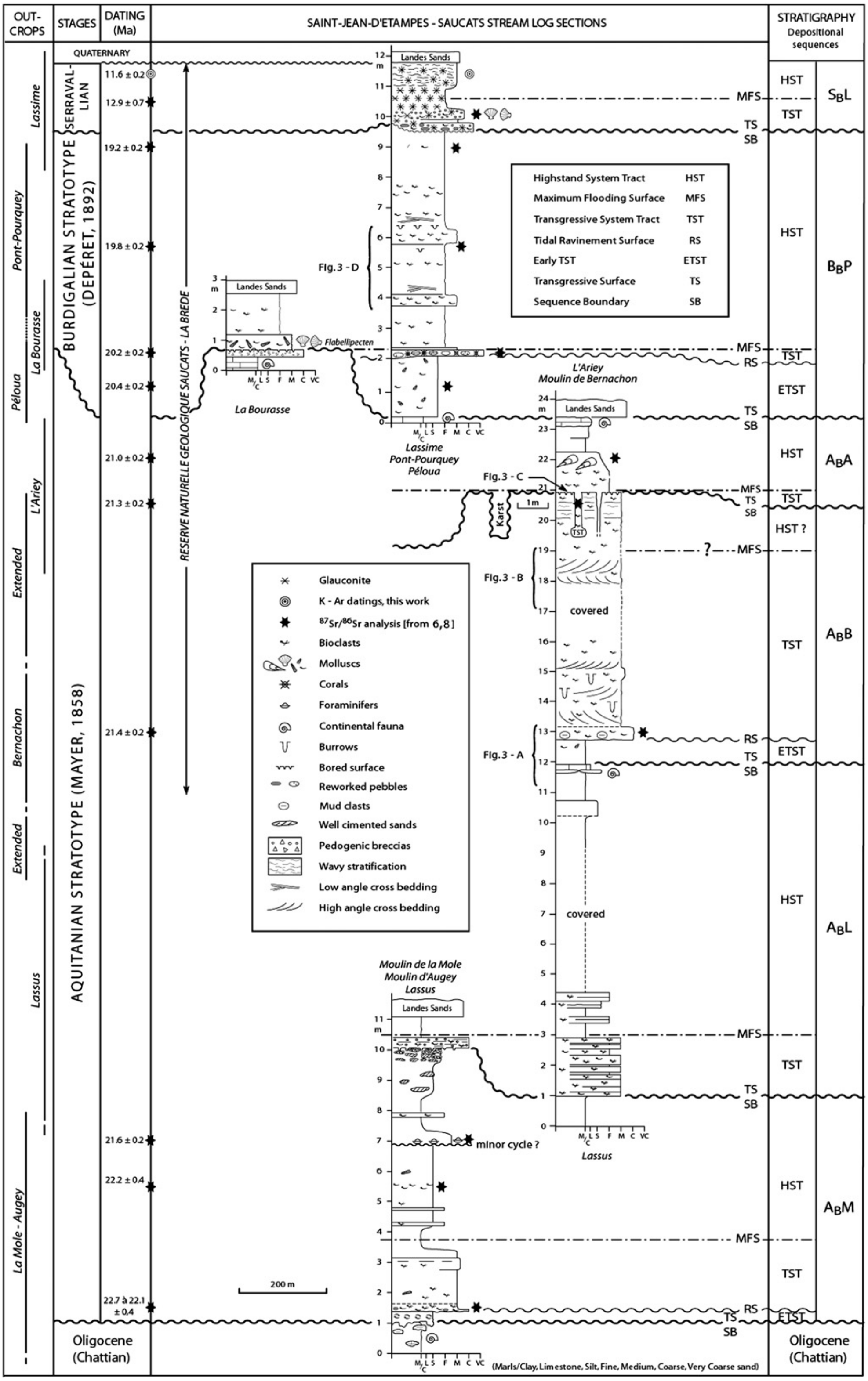

Fig. 2. Sequence organization of the Lower Miocene historical stratotypes, Saucats area. A depositional sequence is bounded by two sequence boundaries (SB). In the study area, the sequence includes only a transgressive system track (TST) and a highstand system track (HST) separated by a

related to weathering linked to sequence boundary. The A_BM sequence is about decametre thick.

2.2. The Aquitanian A_BL sequence at Lassus

The following sequence is decametre thick (A_BL in Fig. 2) and is observed upstream the Lassus bridge. It begins with coarse bioclastic reddish sand forming decimetre- to several decimetre-thick beds. These sediments fill up the small topographic lows at the top of the 'nodular' surface and correspond to the transgressive deposits of the sequence. This formation is covered with marine grey–blue marls, then by greyish–white marls interbedded with more indurated sandy beds. This sequence ends at the Bernachon watermill by blue–green clays and lenses of swamp and lacustrine deposits with carbonate contents lower than 20% (Fig. 3A).

2.3. The Aquitanian A_BB sequence at Bernachon

The third sequence (A_BB in Fig. 2) corresponds to the Upper Aquitanian. It outcrops at the Bernachon watermill, where it begins with open lagoon marls (Fig. 3A) and at L'Ariey. The facies passes upward to more oxygenated, carbonate-rich (60–80%) environment. These first marine deposits correspond to lagoon deposits interpreted as Early Transgressive System Track or ETST [37]. They vertically evolve rapidly to open-sea deposits. Firstly a level of coarse sandstone with small gravels (falun) and containing *Lucina* and shark teeth corresponds to outer-beach deposits and fills the tidal ravinement surface *sensu* Allen [1]. It is covered with 6–7-m-thick calcarenites and bioturbated, bioclastic, carbonated sands (containing small gravels), sometimes with a sigmoid shape, indicating alternate opposite migration trends (Fig. 3B). The deposits form decimetre- to several-decimetre-thick beds and correspond to small to medium submarine dunes with tide influence. The top of the carbonated sands and calcarenites can be observed at L'Ariey (Figs. 1 and 2). At this location, they are horizontally stratified over more than 1 m with a wavy structure on the surface. Carbonated bioconstructions similar to stromatoliths, including small quartz grains of aeolian origin, overprint this crude stratification [7]. A freshwater limestone bed that does not outcrop anymore today, but that is well documented [2,15,17,24,42], is at the top of the A_BB sequence. This continental environment could be related to the vertical aggradation of an alluvial plain. This upper deposit forms the regressive deposits of this third Aquitanian sequence which is ca. 9 m thick in total.

2.4. The Aquitanian A_BA sequence at L'Ariey

The whole Last Aquitanian sequence (more than 4 m thick; A_BA in Fig. 2) can be observed in full in L'Ariey (Figs. 1 and 2). Its base appears only in the filling of the dissolution holes (sometimes more than –2.4 m deep) [39] (Fig. 3C). These holes are related to karst formation under a warm tropical continental climate [7]. This suggests a fall of the base level during the Upper Aquitanian. After this emersion and erosion period, the transgression was marked by the truncation of the top of the underlying top-hardened sands and the development of an intense biogenic perforation (bivalves, *e.g.* genus *Gastrochaena*). The fauna filling the holes ('L'Ariey falun', cf. [15,28]) shows a gradual transition from lagoon to infralittoral environment, evidencing the transgression [39]. The maximum water depth corresponds to the top of the hole filling. Then the water depth decreases progressively. A *Perna aquitanica* bed located 1 m above the top of the holes indicates a water depth of ca. 1 m. This bed is covered with lagoonal marls and continental clays. The sequence ends with a 1-m-thick lacustrine limestone corresponding to the Agenais grey limestone [15,24].

2.5. The Burdigalian B_BP sequence at L'Ariey

The Aquitanian–Burdigalian transition can be observed in Le Péloua and La Bourasse (Figs. 1 and

maximum flooding surface (MFS). The sequence boundary is related to the beginning of the relative sea-level fall. After an emersion, the return of the sea corresponds to the transgressive surface (TS). The retrogradation of the river mouth where the tidal bar complex is localised generates a ravinement surface (RS) over embayment or lagoon deposits that form the early transgressive system track (ETST). The ages are obtained by radiometric dating measurements using the K–Ar method or deduced from $^{87}Sr/^{86}Sr$ isotopic ratios.

Fig. 2. Organisation séquentielle des stratotypes historiques du Miocène inférieur du secteur de Saucats. Une séquence de dépôt est limitée par deux limites de séquence (SB). Dans la zone d'étude, du fait du partitionnement des dépôts, elle n'est représentée que par un cortège transgressif (TST) et un cortège de haut niveau (HST), séparés par une surface d'inondation maximale (MFS). La limite de la séquence est associée au début de chute du niveau marin relatif. Après une émersion, le retour de la mer correspond à la surface de transgression (TS). La rétrogradation de l'embouchure où se développe un complexe de barres tidales forme une surface de ravinement (RS) sur des dépôts de baie ou de lagune qui enregistrent une phase précoce du cortège transgressif (ETST). Les âges sont obtenus par datations radiométriques par la méthode K–Ar ou déduits des rapports isotopiques $^{87}Sr/^{86}Sr$.

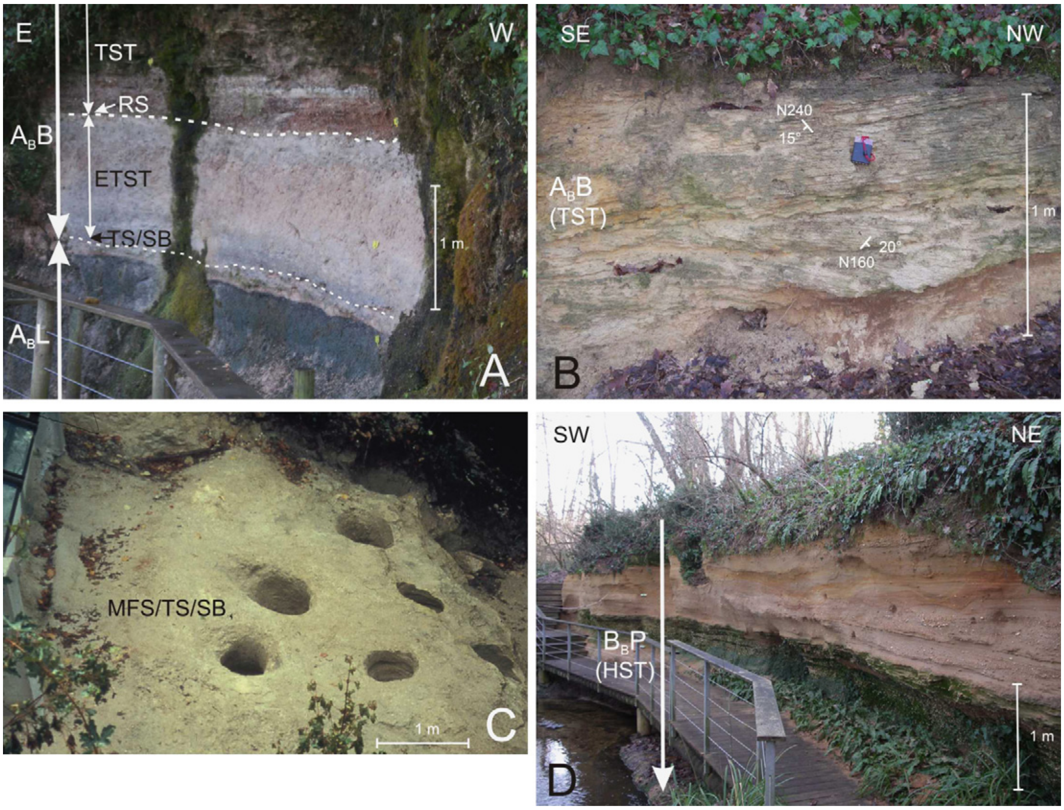

Fig. 3. Photographs of key outcrops at Saucats. (**A**) Bernachon watermill. (**B**) Tidal bar in the Bernachon watermill quarry. (**C**) Dissolution holes in L'Ariey. (**D**) Pont-Pourquey.

Fig. 3. Photographies d'affleurements importants de Saucats. (**A**) Moulin de Bernachon. (**B**) Barre tidale, carrière de Bernachon. (**C**) Puits de dissolution, L'Ariey. (**D**) Pont-Pourquey.

2). The lacustrine limestone ends with pedogenetic calcareous breccia and a perforated surface. At Le Péloua, the Burdigalian series begins with a 1-m-thick bed made of sandy lagoonal marls containing *Granulolabium*. It is overlain by a 'conglomerate' containing decimetre- to several-decimetre-large clasts of rounded coral fragments or reworked blocks of the underlying lacustrine limestone. The blocks are wrapped in shell-rich carbonated sand. This level is topped by a coarse bioclastic and shelly bed (falun); the fauna association suggests a peri-reefal and infralittoral depositional environment. Both levels form the transgressive deposits of the Burdigalian sequence (B_BP in Fig. 2).

In La Bourasse, a sandy horizon containing large Pectinidae lies directly on the Aquitanian limestone. It corresponds to the MFS, but the depositional environment remains infralittoral. Lateral correlation between Le Péloua and La Bourasse (horizontal distance is 80 m) shows that a pre-existing morphology controlled the Early Burdigalian deposits. The marine transgressive deposits outcrop in Le Péloua but lack in La Bourasse. Above the *Pectinidae horizon*, the Burdigalian deposits in La Bourasse show a falun with large *Turritella* and *Cardium* shells corresponding to a bathymetry of about 5 m in the present Mediterranean, and carbonated sands with shelly lenses.

Similar sandy facies can also be observed in Pont-Pourquey over thickness larger than 4 m (Fig. 3D). They show horizontal and cross-stratification with a low dip corresponding to beach deposits. Centimetre- to several-centimetre-thick shelly levels intercalate or fill little gouges. The proportion of lagoonal fauna increases towards the top indicating a prograding trend. The sandstones at the top, of the sequence are truncated by an unconformity that can be observed on the Lassime outcrop.

2.6. *The Serravallian S_BL sequence at Lassime*

The Lassime outcrop (Fig. 1) shows the unconformity of glauconite-rich bioclastic deposits of the Middle Miocene (Serravallian) over the Burdigalian (Fig. 2).

The last sequence (Serravallian; S_BL on Fig. 2) begins with a transgressive conglomerate containing calcareous indurated pebbles similar to the underlying Burdigalian sands, shells and fish teeth over a sandy bioturbated surface. Dating using strontium isotopes on *Glycymeris* shell provided an age of 12.9 ± 0.7 Ma [8]. The transgressive interval is constituted of a 0.6-m-thick clay and glauconite-rich falun containing large bivalves. It is capped with a more clayey bed containing partially dissolved bivalve shells and interpreted as the MFS. At the top of this outcrop, occurs a glauconite-rich marly level [25], with wavy stratification, possibly indicating swell action.

A sample was collected in this level for K–Ar dating. The selected non-reworked glauconite-grains according to [4,18,31] provided an age of 11.6 ± 0.2 Ma. It is consistent with the biostratigraphic framework provided by planktonic foraminifers (N13–14) and calcareous nannoplankton (NN6–7 to NN7).

The sedimentary hiatus *sensu* Posamentier and Allen [37] above the Burdigalian can be appraised by the dating of the Burdigalian upper level of Lassime at 19.2 Ma using $^{87}Sr/^{86}Sr$ measurements [8].

3. Stratigraphic implications

The sedimentology analysis and the sequence and facies interpretation in Aquitaine stratotypes evidence the existence of at least six depositional sequences: at least four in the Aquitanian, a fifth one for the Burdigalian, and a sixth one for the Serravallian. This paper focuses on the four upper ones. The Aquitanian stratotype lower series is currently under more detailed study.

Along the Saucats stream, the observed sequences can be related to third-order cycles *sensu* [21,22] within the large transgression–regression cycle of the Neogene [3]. This new proposition based on facies and ecological analysis differs from a previous tentative correlation based on grade-datings on this same stratotype section [19,20].

The unconformity at the base of Burdigalian is clearly erosive (Fig. 1), whatever the scale of observation [15,42]. The organization of the observed transgressive Burdigalian facies and their contact with the Uppermost Aquitanian unconformity suggest the existence of a palaeomorphology related to river incision.

Another exundation phase allowing karst development is evidenced between the two Aquitanian upper sequences (dissolution holes of L'Ariey) and suggests again a drop of the base-level. Similarly to what happened in the RPMB and according to spatial partitioning concept, ravinement and fluvial systems could develop during emersion phases. However, the erosion is of lesser amplitude in Aquitaine than in the RPMB, where erosion was amplified by tectonics. Like in the RPMB, the depositional sequences in Aquitaine are not complete both at their top, with the ravinement of the continental and/or proximal marine parts of the highstand system tracts, and at their base, with the lack of the lowstand system tract, probably preserved in deeper depositional environments, more distally on the Aquitaine continental shelf or slope.

The Burdigalian sequence in Saucats can be correlated with the isochronous sequence S1 in the RPMB [4,32,33,40]. The second Burdigalian sequence of the RPMB is not present in this northern part of Aquitaine, due to an important lacuna anterior to the Serravallian deposits. This strengthens the choice of Depéret [14] to use the Rhone valley to complete the upper part of the stratotype. The splitting of the Upper Aquitanian in two sequences is consistent with the analysis of the parastratotype of Carry-le-Rouet (S0 and S1 of [13,41]) or in the Fos-sur-Mer area [4,33]. Next studies will allow us to correlate these two sedimentary basins and to bring evidence for tectonic or eustatic forcings in order to explain their differences.

4. Conclusions

This study shows the stratigraphic improvements related to the use of a multidisciplinary approach combining facies sedimentology and palaeontology. The sequence organization (Fig. 2) is based on the characteristics of sedimentary surfaces interpreted using the sequence stratigraphy concept. The evolution of each sequence is deduced from the evolution of depositional environments using facies analysis. Facies interpretation is deduced from environmental parameters and quantified by palaeontology. The stratigraphic framework is provided by the palaeontological studies and is quantified using numerical dating measurements. This approach, combining sequence stratigraphy analysis and palaeontology, is particularly efficient when applied on historical stratotypes where palaeontological inventories exist.

Finally, the Aquitanian stratotype in Saucats includes at least four sequences and is more complete than the parastratotype in Provence, despite it shows a proximal, margino-littoral setting. Although fluvial ravinement is not deep, the deposits have been preserved from shallow marine or continental erosion because of the mainly sheltered environments, and of their location in a rather quiet geodynamic regional context.

Acknowledgements

The logs of Aquitanian and Burdigalian stratotypes in the Saucats area are in part located in the 'Réserve naturelle géologique de Saucats – La Brède'. We thank Y. Gilly and M. Lo Cascio for the help and facilities provided during our visits on the field, and Mr. and Mrs Mercier for the authorization given to access the Moulin d'Augey outcrops. We also thank D. Besson and P. Razin for the scientific discussions on the outcrops during fieldwork and the two anonymous reviewers for their constructive comments on the manuscript.

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