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Correlation of the Kimmeridgian-Tithonian (Jurassic) boundary beds exposed in the Boulonnais, France with those at Kimmeridge, Dorset, UK.

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ABSTRACT

Sediments of Kimmeridgian and Tithonian age are well exposed on the Boulonnais coast of northern France between Equihen and Cap Gris Nez and on the south coast of England at and adjacent to Kimmeridge Bay. Both successions were deposited on a marine shelf and lie within the Subboreal faunal province which enables detailed correlations to be made between them based on ammonite assemblages. They are, however, lithologically markedly different due to their environmental settings: close to a land area in the case of the Boulonnais and within a depositional basin in the case of Kimmeridge. The succession adjacent to the Kimmeridgian-Tithonian boundary exposed in the Boulonnais is highly condensed and laterally variable with more attenuated successions occurring close to the former Anglo-Brabant Massif land area. The boundary occurs at the end of a succession of up to six regressive-transgressive events that onlap the land area. This is in contrast to that at outcrop at Kimmeridge, where the Kimmeridgian-Tithonian boundary is marked by a correlative conformity in an unbroken basinal succession. The cliff and foreshore exposures in the Kimmeridge area provide the only unbroken succession in the Subboreal faunal province of the beds adjacent to the Kimmeridgian-Tithonian boundary.

Key words: Kimmeridgian, Tithonian, Dorset, Boulonnais, Kimmeridge Clay, Argiles de Châtillon, stratigraphy, ammonites

1. Introduction

The late Jurassic Kimmeridge Clay Formation was deposited in fully marine environments in a shelf sea that probably mostly ranged from 50 to 150m depth with shallower environments present close to the Anglo-Brabant land area (Fig.1). Rocks of a similar age exposed on the Boulonnais coast in northern France (Deconinck et al., 1996) were also deposited close to this land area. Kimmeridgian and Tithonian sediments are well exposed in extensive cliff and foreshore outcrops on the Boulonnais coast on either side of Boulogne between Cap Gris Nez and Equihen (Fig. 2).

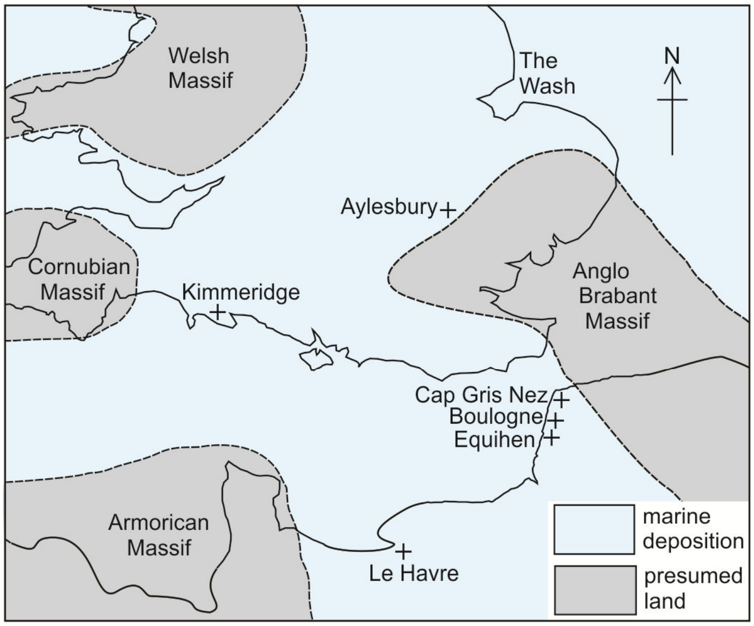

Fig. 1. Palaeogeographical sketch map of the Kimmeridgian Stage showing the positions of localities referred to in the text (after Cox and Gallois, 1981).

The succession is repeated in part by faulting (Fig. 3); this allows lateral variations in some of the formations to be studied over distances of up to 25 km. There are access points at each of the localities shown in Figures 2 and 3, but few in the intervening areas. The Boulonnais succession comprises alternating sandstone and mudstone formations that range in age from early Kimmeridgian to late Tithonian (Fig. 4). Much of the succession was deposited in shallower water, more current-swept environments than those of the Kimmeridge Clay of the Dorset type area (Ager and Wallace, 1970; Fürsich and Oschmann, 1986; Wignall and Newton, 2001). The argillaceous parts of the Boulonnais succession are lithologically and faunally similar to parts of the Kimmeridge Clay which enabled Pruvost and Pringle (1924) to use the ammonite faunas to make broad correlations between the French and English successions. The Kimmeridgian-Tithonian boundary falls within the Argiles de Châtillon Formation. The middle and upper parts of this formation are well exposed in all the coastal sections shown in Figure 2, but the lower part is locally concealed beneath landslide or beach deposits. The formation exhibits marked lateral variations when traced from south to north over a distance of *c*. 23 km due to the increasing proximity of the Anglo-Brabant land area, and locally over as little as a few hundred metres due to penecontemporaneous faulting.

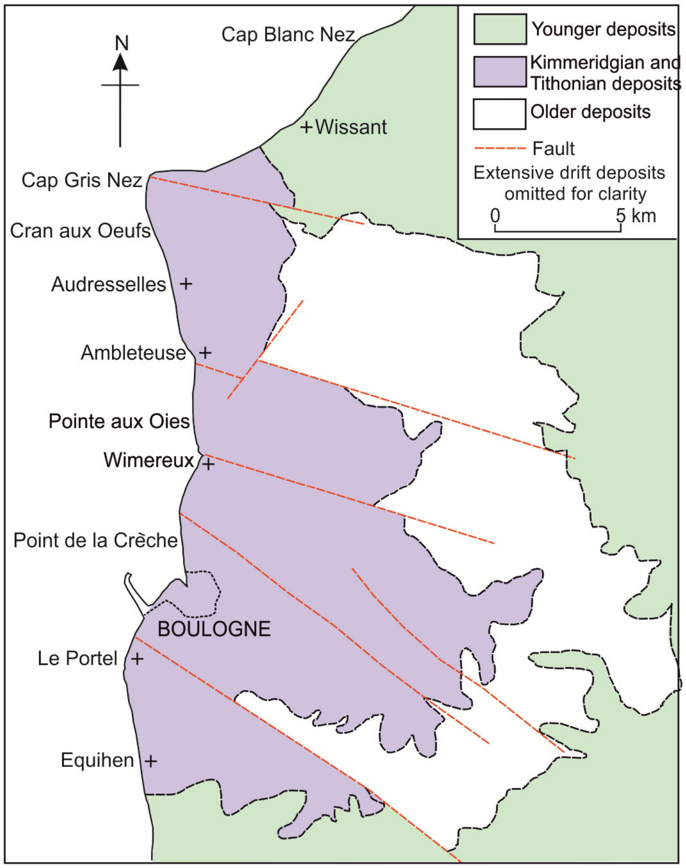

Fig. 2. Geological sketch map of the Boulonnais showing the location of sections referred to in the text (after Pringle and Pruvost, 1924).

In contrast, the Kimmeridge Clay exposed in cliffs and outcrops in the intertidal area adjacent to Kimmeridge Bay, Dorset comprise relatively uniform mudstones that show relatively little lateral lithological variation there or when traced inland over distances of several hundred kilometres (Gallois, 1979). The Kimmeridge Bay sections expose the only complete succession of the beds adjacent to the Kimmeridgian-Tithonian boundary at outcrop in England.

A series of widespread tectonic movements in the late Jurassic resulted in the closure of some ammonite migration pathways and the opening of others with the result that the faunas became progressively more differentiated with time (Énay**,** 1985). In the Kimmeridgian, the Boulonnais and Kimmeridge successions were located on the south side of the Anglo-Norman Depositional Basin of Enay (1980). To the south, a broad positive area, the Western Europe Swell of Hantzpergue (1987), inhibited ammonite migration between the Subboreal and Submediterranean faunal provinces, but at times did not prevent it. As a result, some genera including *Aspidoceras, Crussoliceras, Gravesia* and *Sutneria*, are common to both subprovinces (Callomon and Cope, 1971).

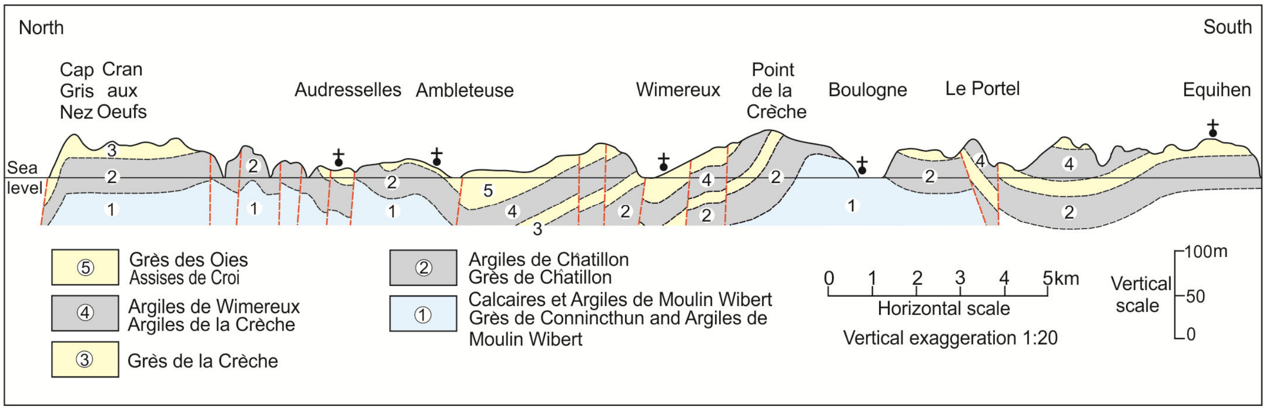

Fig. 3. Geological sketch section of the coastal exposures between Cap Gris Nez and Equihen (after Herbin et al., 1995).

2. Boulonnais succession: Argiles de Châtillon Formation

The Argiles de Châtillon Formation, mostly 25 to 30m thick, can be divided into three members, each of which is separated by an erosion surface and a sedimentary break of unknown duration. At its base, the formation rests with prominent lithological contrast on the Grès de Châtillon which contains the Eudoxus Zone ammonite *Aulacostephanus yo* (d'Orbigny) (Geyssant et al., 1993).

2.1 Argiles de Châtillon infèrieure Member

The Argiles de Châtillon infèrieure comprises thinly- bedded mudstones and calcareous mudstones with beds of laminated bituminous mudstone in the lower part. Comparison of the bituminous mudstones with similar potential hydrocarbon-source rocks in the Kimmeridge Clay and elsewhere led Proust et al. (1995) to conclude that these were deposited in low-energy environments below wave base and are the deepest-water deposits in the formation. The more northerly sections, those more proximal to the land area, contain red-brown mudstones that may indicate deposition in shallow-water, possibly alluvial, environments (Fig. 5). Ammonites are relatively common at a few horizons in the lower and middle parts of the Argiles de Châtillon infèrieure.

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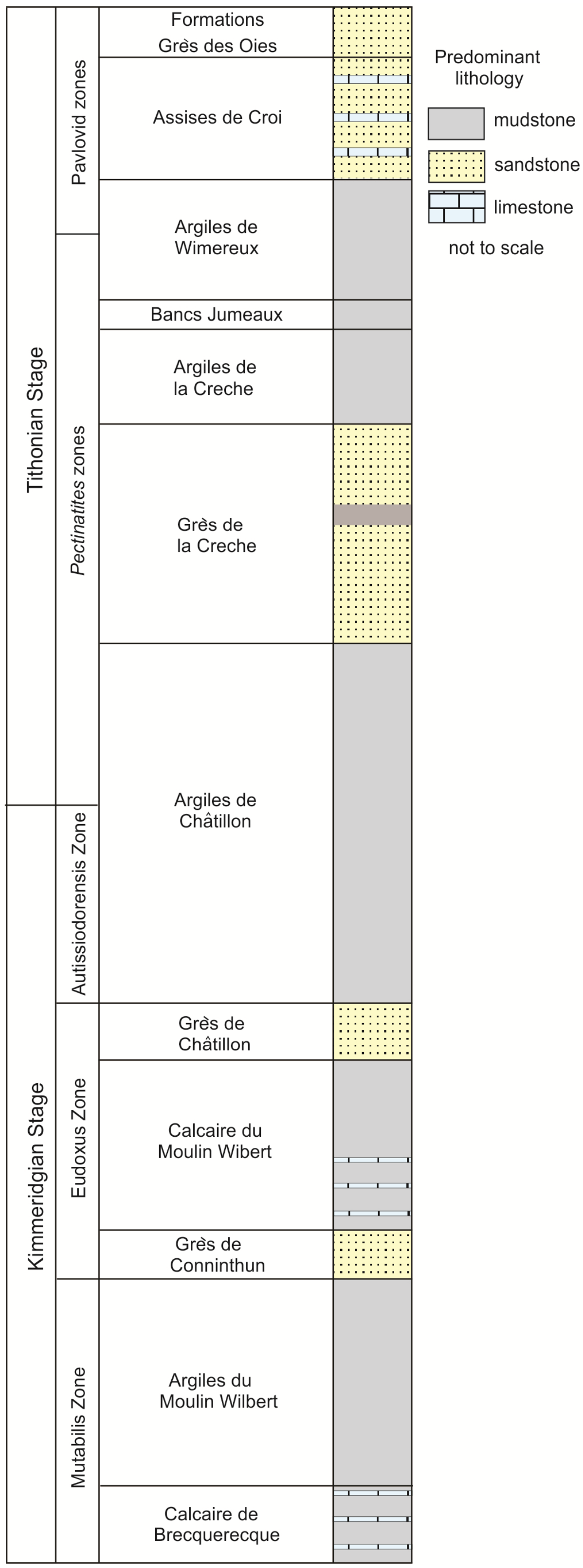

Fig. 4. Generalised stratigraphy of the Kimmeridgian-Tithonian succession exposed on the Boulonnais coast. Nomenclature after Bonte (1969) and Ager and Wallace (1966).

Geyssant et al. (1993) recorded *Aspidoceras catalaunicum* (Loriol), *Aulacostephanus autissiodorensis* (Cotteau), *Aul. volgensis* Vischniakoff and *Propectinatites* Cope (= *Subdichotomoceras* Spath) indicative of the Autissiodorensis Zone at Point de la Crèche and near Audresselles and Cap Gris Nez. A "sandy limestone" at the top of the member with *Aul. autissiodorensis* and *Gravesia lafauriana* Hantzpergue described by Geyssant et al. (1993) is included here in the overlying member (see below).

2.2 Argiles de Châtillon moyenne Member

The Argiles de Châtillon infèrieure and supèrieure members are separated in the more southerly sections by a condensed shallow-water mudstone succession characterised by erosion surfaces overlain by winnowed lag deposits with shell debris, phosphatic pebbles and derived faunas. This is named here the Argiles de Châtillon moyenne Member with the type section the intertidal zone exposures adjacent to Point de Nid du Corbet, Audresselles. Supplementary sections are present in the cliffs and foreshores between Cap Gris Nez and Equihen (Fig. 3). The base of the member is taken at an erosion surface overlain by a prominent phosphatic nodule bed and/ or a *Nanogyra* lumachelle. The succession is laterally variable due to the irregularly downcutting nature of the erosion surfaces (Fig. 5), and shows variations over distances as little as a few tens of metres in the vicinity of major faults. The thickest complete succession recorded, that at Equihen, comprises four upward-fining rhythms in which current-agitated relatively coarse accumulations of shells, shell debris, silt, very fine-grained sand and, locally, phosphatic pebbles and phosphatised derived ammonites and bivalves, pass up into pale grey calcareous mudstones. Each rhythm is separated by an erosion surface that represents a regressive erosional phase of unknown duration followed by a rapid transgression. They are similar to the regression-transgression Type A rhythms of Cox and Gallois (1981) that are confined to the lower part (Baylei to Mutabilis Zones) in the Kimmeridge Clay (Gallois, 2000). The following sections, which were measured at four of the key localities, illustrate some of the variations in the succession.

Equihen: exposures on the beach and in the higher part of the intertidal area.

Argiles de Châtillon supèrieure (pars)

Mudstone, medium and dark brownish grey, bituminous in part; laminated and thinly bedded, splitting into thin sheets; bivalves including *Astarte* and *Lucina* common at some levels with fragments of pectinatitid ammonites	1.60 m

Argiles de Châtillon moyenne	
Muddy lumachelle crowded with whole and broken *Nanogyra virgula* Defrance; strongly cemented in part; *Gravesia* sp.; capped by a bioturbated and shell-encrusted, mineralised hardground surface; erosion surface at base	0.70m
Mudstone, pale grey passing down into medium grey	0.60m
Mudstone, silty, highly bioturbated to give nodular texture; strongly calcareously cemented in part; erosion surface at base	0.20m
Mudstone, very pale grey	0.12m
Lumachelle crowded with whole and broken *N. virgula* and other shell debris; strongly cemented in part; serpulids and *Gervillella* common at some levels; erosion surface at base	0.90m
Mudstone, pale grey, weathering to very pale grey soft clay	1.10m
Mudstone, medium grey with scattered small bivalves, mostly *N. virgula*	0.50m
Mudstone, dark grey, crowded with small bivalves and angular shell fragments; brown phosphatic pebbles including phosphatised casts of paired *Thracia* and other bivalves; erosion surface at base	0.15m
Argiles de Châtillon infèrieure (pars)	
Mudstones, silty and shelly in part; calcareous and sideritic concretions including burrowfill forms at several levels; bivalves and *Aspidoceras*	1.20m
Obscured by beach deposits	c. 2.00m
Mudstone, silty, dark grey, shelly; elongate cementstone doggers capped by crushed large bivalves and *Aspidoceras*	0.40m

Point de la Crèche: cliff section

Argiles de Châtillon supèrieure (pars)	
Mudstone, medium and dark brownish grey, bituminous in part; laminated and thinly bedded	3.90m
Siltstone and silty mudstone, pyritic: erosion surface at base	0.30m
Argiles de Châtillon moyenne	
Calcareous cementstone, tabular	0.25 to 0.26m
Siltstone and silty mudstone, highly bioturbated, ripple-bedded in part; erosion surface at base	0.30m
Mudstone, pale grey, calcareous	0.35m

Siltstone and silty mudstone with decalcified shells; ripple-bedded with small (1-2mm) black phosphatic pebbles resting on erosion surface at base	0.08m
Mudstone, pale grey, calcareous	0.18m
Siltstone and silty mudstone; ripple-bedded with local concentrations of small round black phosphatic pebbles and larger brown phosphatic pebbles; cemented burrowfills extend down 0.1m from erosion surface at base	0.22m
Argiles de Châtillon infèrieure (pars)	
Mudstone, pale grey, calcareous	0.40m
Mudstone, medium and pale grey, thinly bedded; *Aspidoceras* and *Aulacostephanus*	1.35m

Ambleteuse: exposures in the intertidal area A lithologically similar exposure of the lowest part of the Argiles de Châtillon supèrieure resting directly on the highest part of the Argiles de Châtillon infèrieure is exposed in the higher part of the intertidal area at Cran aux Oeufs.

Argiles de Châtillon supèrieure (pars)	
Mudstone, dark grey, bituminous in part, laminated and thinly bedded; *Pectinatites* at several levels	2.00m
Lumachelle crowded with *Nanogyra virgula,* strongly cemented; rare ammonites include *Gravesia* and *Pectinatites*; highly variable thickness with channelled base	0.25 to 1.00m
Mudstone, dark grey, crowded with whole and broken *Nanogyra* shells and with brown phosphatic pebbles including casts of bivalves and partially phosphatised ammonites including *Aspidoceras longispinum* and *Aul. autissiodorensis* (Figs 7e and 7f); irregular base burrowed down into underlying bed	0.02 to 0.20m
Argiles de Châtillon infèrieure (pars)	
Mudstone, mottled red-brown with pale grey passing down into pale grey; sideritic burrowfill nodules at one level; myid bivalves and wood fragments scattered throughout	1.00
Mudstone, dark grey, cemented; bioturbated with thallasinoid burrows on upper surface; bivalves and *Aspidoceras longispinum*	0.08m
Mudstone, dull red-brown with pale grey mottles; wood fragments common	1.30m
Mudstone, pale grey with line of calcareously cemented burrowfill nodules	

in upper part	2.00m

Audresselles: beach and cliff sections showing rapid lateral variations in the Argiles de Châtillon moyennes.

Argiles de Châtillon supèrieure (pars)	
Mudstone, medium and dark brownish grey, bituminous in part; laminated and thinly bedded	2.00m
Lumachelle with abundant *N. virgula* , cemented; abundant angular and rounded black phosphatic clasts resting on an irregular erosion surface	0.03 to 0.04m
Argiles de Châtillon moyennes	
Siltstone, highly bioturbated with variable cement giving rise to nodular texture; *Trigonia*, *Gervillella* and common crushed whole and fragmentary pectinatitid ammonites; mid- brown phosphatic casts of bivalves resting on a channelled and bioturbated hardground surface at base; laterally variable thickness	0.14 to.0.40m
Siltstone, locally densely cemented; bioturbated with scattered small angular black phosphatic clasts; common *Nanogyra* as shell debris and whole shells	0.12 to 0.40m
Siltstone, highly bioturbated, cemented; small oysters, *Gervillella* and rounded and angular phosphatic clasts; passing down into	0.03 to 0.05m
Mudstone, densely cemented with abundant *Nanogyra* at many levels; common *Gervillella* and *Trigonia*; *Aspidoceras* in lower part; weathers out to form pale slabs up to 2m across on the beach; passing down into	0.30 to 0.58m
Nanogyra lumachelle, weakly cemented; *Aul. autissiodorensis* and *Aspidoceras*; mid brown phosphatic bivalve casts at base resting on an undulose hardgound surface with cemented *Thalassinoides* and other burrows	0.10 to 0.40m
Argiles de Châtillon infèrieure (pars)	
Mudstone, pale grey, calcareous with line of calcareous concretions	1.90m
Mudstone interbedded red-brown and pale grey	0.40m

2.3 Argiles de Châtillon supèrieure Member

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In all the sections recorded by various authors, the lower part of the Argiles de Châtillon supèrieure Member comprises thinly interbedded mudstones and laminated organic-rich mudstones that have been extensively studied as potential hydrocarbon source rocks (e.g. Herbin et al., 1995; Hatem et al., 2017). They contain the ammonite *Pectinatites* and rest on an erosion surface that marks the upper limit of the ammonite *Aulacostephanus* (Geyssant et al., 1993).

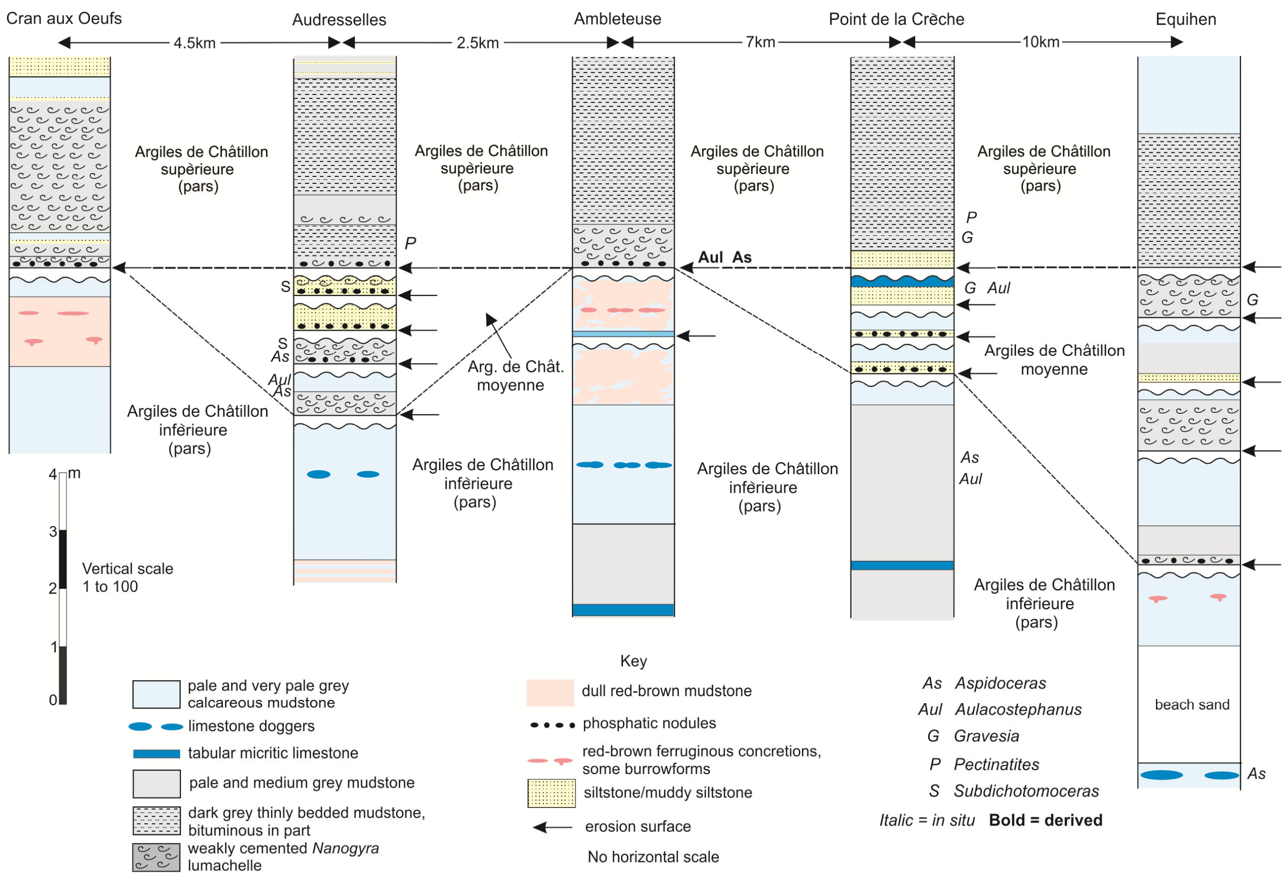

Fig. 5. Correlation of the Kimmeridgian-Tithonian boundary beds exposed in selected sections on the Boulonnais coast.

3. Kimmeridge Bay succession

The beds adjacent to the Kimmeridgian-Tithonian boundary are wholly exposed in the intertidal areas and cliffs on either side of a shallow anticline at and adjacent to Kimmeridge Bay. The succession comprises rhythmic alternations of mudstone, bituminous mudstone (including high total-organic-carbon (TOC) mudstones commonly referred to as oil shales) and calcareous mudstone with a few thin (mostly up to 0.3 m thick) beds of dense tabular dolomitic micrite (Irwin,1980) that form prominent marker beds in the cliffs and intertidal outcrops. The succession is consequently well documented lithologically (Gallois, 2011, 2017) and faunally (Cox and Gallois, 1981; Van der Vyver, 1986). The succession ranges from the upper part of the Eudoxus Zone into the Tithonian Stage (Fig. 6). It is fossiliferous throughout with ammonites and bivalves especially common on many bedding planes. Almost all the ammonites are crushed, but are otherwise well preserved.

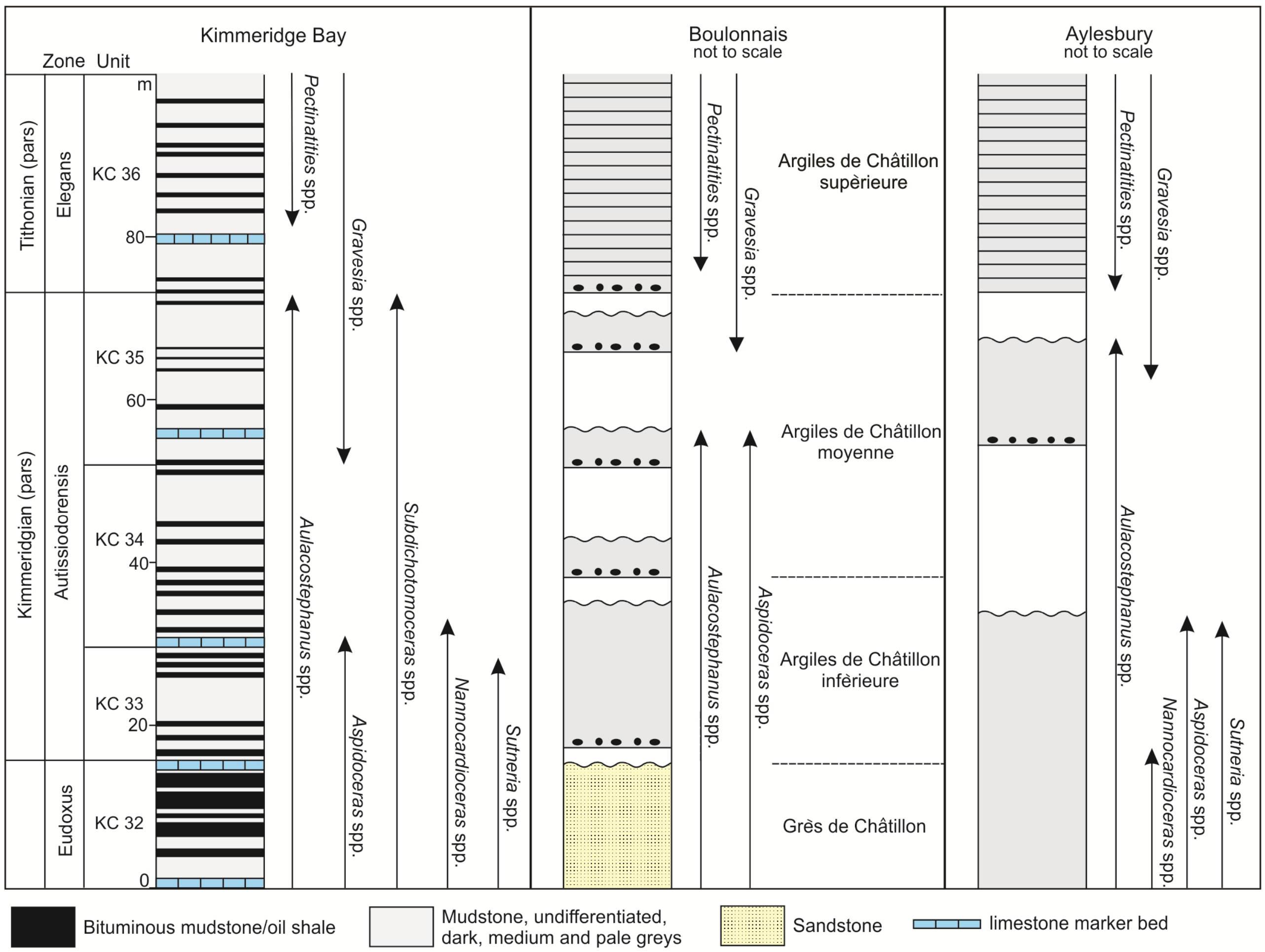

Fig. 6. Comparison of the Kimmeridgian-Tithonian boundary beds succession at Kimmeridge Bay (after Enay et al., 2014), in the Boulonnais, and at Aylesbury (after Oates, 1991).

In addition to the common occurrence of species of *Amoeboceras*, *Aspidoceras*, *Aulacostephanus*, *Subdichotomoceras* and *Sutneria*, the Eudoxus Zone sediments contain several faunal marker beds. These include the *Aulacostephanus yo* Horizon of Hantzpergue (1989), a coccolith-rich marker bed (EU3 of Gallois and Medd, 1979) and the Hoplocardioceras Bed of Van der Vyver (1986). Pyritised *Nannocardioceras* spp. are common in all the oil shales in the Eudoxus Zone and the early part of the Autissiodorensis

Zone. In addition, Van der Vyver (1986) recorded *Amoeboceras (Amoebites)* aff. *quadratolineatum* (Salfeld), *A.* (*Hoplocardioceras) decipiens* Spath, *Nannocardioceras krausei* (Salfeld), *N.* cf. *anglicum* (Salfeld), *Aspidoceras catalaunicum*, *Aulacostephanus* cf. *eudoxus* (d'Orbigny), *Aul. jasonoides* (Pavlow), *Aul. kirghisensis* (d'Orbigny), *Aul. rigidus* Ziegler and *Aul. volgensis.*

The Autissiodorensis Zone contains a similarly diverse ammonite fauna with the same genera as that of the Eudoxus Zone but with the addition of *Pseudogravesia* and *Gravesia* in the higher part of the zone. Species recorded by Cox (*in* Cox and Gallois, 1981) and Van der Vyver (1986) include *A. (N.) krausei*, *A. (N.)* cf. *anglicum*, *Aspidoceras* cf. *longispinum* (J. de C. Sowerby, *A.* (*A.*) *cf. iphicerum* (Oppel), *A. sesquinodosum* (Fontannes), *Aulacostephanus autissiodorensis, Aul. kirghisensis* (d'Orbigny), *Aul. jasonoides*, *Aul. mammatus* Ziegler and *Aul.* aff. *rigidus*. In addition, Enay et al. (2014) recorded *Pseudogravesia*, *Subdichotomoceras lamplughi lamplughi* Spath, *S.* cf. *speetonense* Spath and *S. websteri* (Cope). Hantzpergue (1989) recorded *Gravesia lafauriana* Hantzpergue, and Gallois and Etches (2010) recorded gravesiids attributable to *G. gigas*. (Zieten) and/or *G. gravesiana* (d'Orbigny) in the younger part of the zone. The widespread Rebholzi Marker Bed with abundant *Sutneria rebholzi* (Berckhemer) and the internationally correlated Volgae Marker Bed with abundant *Nannocardioceras volgae* (Pavlow) occur in the older part of the zone.

3. Discussion and Conclusions.

Much of the Kimmeridgian-Tithonian succession exposed on the Boulonnais coast was deposited in shallow-water, current-dominated, near-shore environments in contrast to the lithologically uniform mudstones of the equivalent succession exposed on the Dorset coast. This contrast is well illustrated by the successions adjacent to the Kimmeridgian-Tithonian boundary. In the Boulonnais, the Argiles de Châtillon, although lithologically similar to parts of the correlative mudstones at Kimmeridge Bay, is a highly condensed succession that contains erosion surfaces, phosphatic pebble beds and *Nanogyra* lumachelles. In the Kimmeridge Clay, such features are confined to the oldest (Baylei and basal Cymodoce Zones) transgressive part of the formation. Other lithological differences include red-brown mudstones in the upper part of the Argiles de Châtillon infèrieure that have not been recorded in the Kimmeridge Clay.

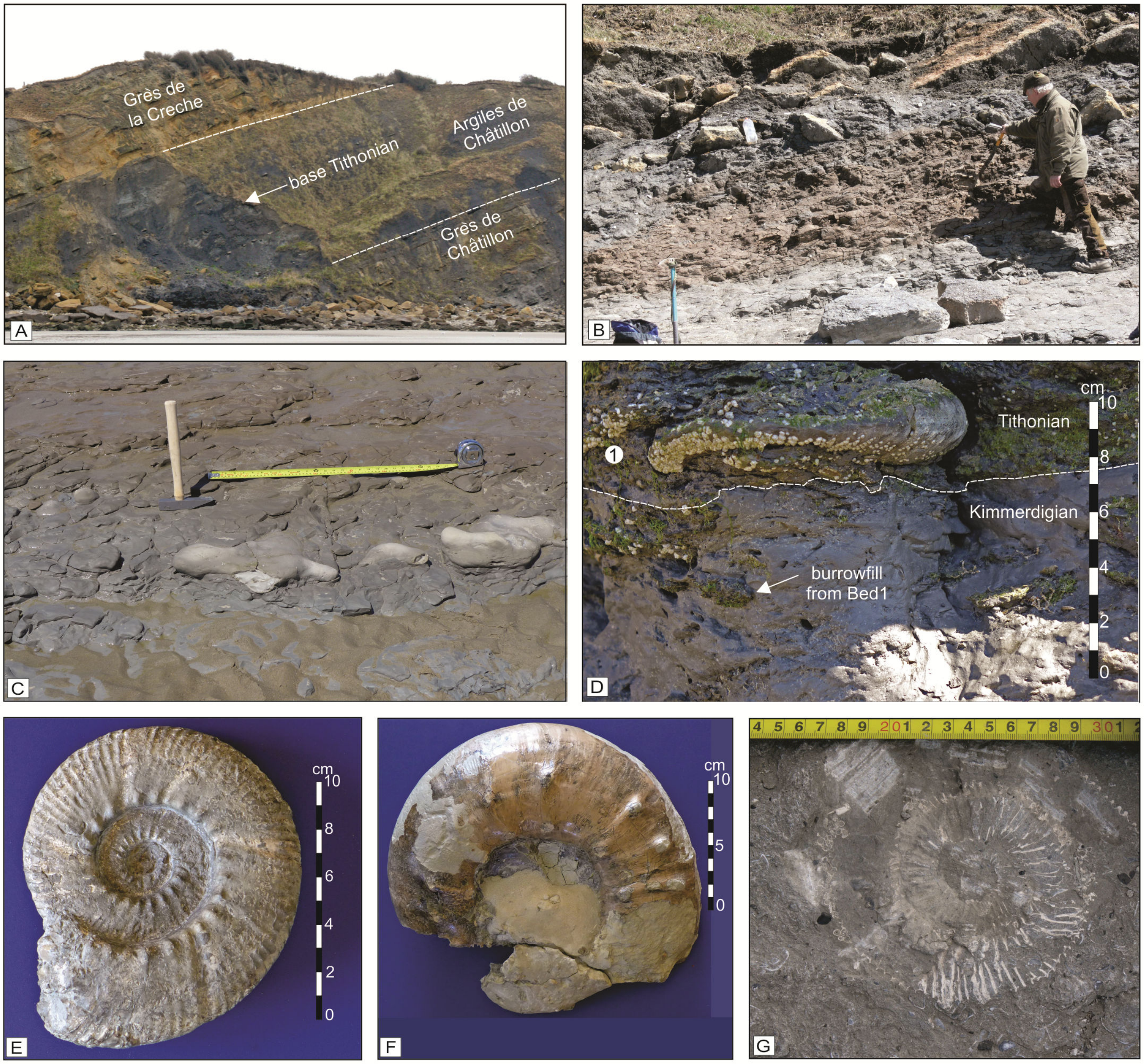

Figure 7. Kimmeridgian-Tithonian boundary beds. a Outcrop of the Argilles de Châtillon Formation, Point de la Crèche. **b** Red-brown mudstones in the highest part of the Argilles de Châtillon infèrieure, Cran aux Oeufs. **c** Pale grey calcareous mudstone with burrowform concretions overlain by red-brown mudstones in the highest part of the Argilles de Châtillon infèrieure, Ambleteuse beach. **d** Dark grey, gritty, shelly basal bed of the Argilles de Châtillon supèrieure resting with irregular burrowed contact on calcareous mudstones at the top of the infèrieure Member, Ambleteuse beach. Partially phosphatised derived *Aulacostephanus autissiodorensis* close above the contact. **e** and **f** Partially phosphatised *Aulacostephanus autissiodorensis* and *Aspidoceras longispinum* collected from the same bed as **d**. Vadet Collection Nos 5464 and 8660. **g** Siltstone, gritty with shell debris and small black phosphatic clasts including casts of small bivalves. Indeterminate partially phosphatised perisphinctid ammonite; probably *Subdichotomoceras* on the basis of stratigraphical position. Argiles de Châtillon moyenne, Audresselles beach.

Coccolith-rich limestones that form laterally persistent marker beds at several levels in the Kimmeridge Clay (Gallois and Medd, 1979) have not been recorded in the Argiles de Châtillon possibly because the finely particulate, low-density, coccolithic debris was largely dispersed by storm and tidal currents in the Boulonnais. Bituminous mudstones with total organic contents (TOCs) of mostly < 5wt% have been recorded in the Argiles de Châtillon (Herbin et al., 1995), but combustible oil shales with TOC mostly > 20wt% that are common in the Kimmeridge Clay have not. Here too, this may be because of the dispersion of some of the particulate organic matter by currents in the Boulonnais. The ammonite *Nannocardioceras*, which occurs in abundance in association with the oil shales in the Kimmeridge Clay, has not been recorded in the Boulonnais. In addition, the climatically controlled Milankovitch rhythms that are such a prominent feature of the succession at Kimmeridge Bay (House, 1995; Weedon et al., 2004) are only weakly developed in the more distal Boulonnais successions and appear to be absent in the more proximal areas. Herbin et al. (1995) recorded up to four rhythms in the organic-rich beds at the base of the Argiles de Châtillon supèrieure based on total organic carbon contents in addition to which Waterhouse (1995) recoded palynological rhythms that do not have any obvious lithological expression. These are similar to the organic-rich rhythms Type B stillstand rhythms of Cox and Gallois (1981).

Throughout NW Europe, the upper recorded limit (Last Appearance Datum) of *Aulacostephanus* is taken as a proxy for the Kimmeridgian-Tithonian (Hantzpergue, 1989) and Kimmeridgian-Volgian (Scherzinger and Mitta, 2006) stage boundaries pending a decision on the Global Boundary Stratotype Sections and Point (GSSPs) for these boundaries. In the Kimmeridge Clay, the boundary falls within an unbroken sedimentary succession in which the LAD of *Aulacostephanus* is a sharp boundary, both at outcrop at Kimmeridge and in continuously-cored boreholes inland (Gallois, 1979). The LAD of *Subdichotomoceras* at Kimmeridge Bay occurs at a closely similar level (Enay et al., 2014).

In the Boulonnais, the Kimmeridgian-Tithonian boundary occurs at the top of the Argiles de Châtillon moyenne at the last of up to six regressive-transgressive cycles that are represented by erosion surfaces overlain by phosphatic nodule beds (Fig. 5). At Equihen, Audresselles and Point de la Crèche, there are locally up to three erosion surfaces in the Autissiodorensis Zone which are overstepped by a transgressive erosion surface overlain by deeper-water mudstones with *Pectinatites* spp. (Fig. 5). At Ambleteuse and Cran aux Oeufs, only the last of these transgressive events is now preserved. The lateral variations in the

Argiles de Châtillon moyenne succession, both regional and locally over distances as little as 10 m as at Audresselles and Ambleteuse, suggest that sedimentation was affected by penecontemporaneous movements on local faults.

The best documented example of a nearshore succession in England, and one that is comparable with that of the Boulonnias, was recorded by Oates (1991) in temporary excavations at Aylesbury, Buckinghamshire. There, the Kimmeridgian-Tithonian boundary lies above a condensed succession that contains two principal sedimentary breaks (Fig. 6). The older of these separates an early Autissiodorensis Zone assemblage with *Aspidoceras*, *Aulacostephanus*, *Nannocardioceras* and *Sutneria* from a later Autissiodorensis Zone fauna with *Aulacostephanus* and *Gravesia*. This is separated from deeper-water mudstones with *Pectinatites* spp. by the second unconformity. The highly condensed nature of the Aylesbury succession is illustrated by the position of the widespead Rebholzi Marker Bed in the early part of the Autissiodorensis Zone which was recorded 1 m below the Kimmeridgian-Tithonian boundary. The same stratigraphical interval is represented by over of 75 m of mudstones at Kimmeridge Bay.

The long-term Jurassic sea-level curve shows a steady rise in global sea level in the Kimmeridgian and Tithonian with a high point in the early Tithonian at an estimated 150 m above present-day mean sea level (Haq, 2017). Superimposed on this Second Order curve are six Third Order Pulses (eustatic changes in sea level referred to as sequence boundaries, lowstand events by some authors) in the Kimmeridgian (JKm1 to JKm 7) and six in the Tithonian (KTi1 to KTi 7) (Haq, 2017). Taylor (2000) and Taylor and Sellwood (2002) recognised thirteen Third Order regression-transgression cycles in the Kimmeridge Clay in boreholes in southern England, but concluded that few of these can be correlated with eustatic changes in sea level because of local factors such as the difficulty of making chronostratigraphical correlations and tectonic overprinting. They noted that these events were only recognisable in the successions close to the London-Brabant landmass, and that several were are represented by a correlative conformity at Kimmeridge Bay and in other basinal areas where sedimentation was influenced by tectonically enhanced deepening of the sea (Taylor and Sellwood, 2002). The presence of deeper-water sediments including organic-rich mudstone close below the first occurrence of Tithonian pectinatitid ammonites in the successions proximal to the Anglo-Brabant Massif in the Boulonnais and at Aylesbury suggests that the erosion surface at their base is such a widespread event that it probably in

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part reflects a eustatic rise in sea level. It falls within a period of rising sea level between the JKm7 and JKTi1 events in the Haq (2107) chart.

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