

The Bolonian Stage: an old answer to an old problem

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with 1 figure

Abstract. Confusion in the use of the Upper Jurassic Stage names Kimmeridgian and Portlandian has persisted for more than a century and is a constant source of irritation for all those having to interpret their use. Such confusion is obviated by the re-introduction of the Bolonian Stage of BLAKE (1881) the base of which is here formally defined at Kimmeridge, Dorset. The Tithonian is now internationally accepted as the primary standard terminal Jurassic Stage, but at present cannot be used outside of the Tethyan area; Bolonian, Portlandian and Volgian are secondary standard stages.

Résumé. Une confusion existe en ce qui concerne l'usage des termes Kimméridgien et Portlandien du Jurassique supérieur; celle-ci persiste depuis plus d'un siècle et c'est une source perpétuelle d'irritation à tous ceux qui doivent interpréter l'usage de ces termes. Cette confusion sera obviée à la réintroduction de l'étage Bolonien de BLAKE (1881), le bas duquel est délimité formellement dans cet article à Kimmeridge, Dorset. On accepte maintenant dans le monde entier que le Tithonien est l'étage type principal du Jurassique terminal, mais on ne peut pas utiliser ce terme actuellement au dehors de la région Téthysienne. Bolonien, Portlandien et Volgien restent comme étages type secondaires.

Introduction

The naming of stages in the Upper Jurassic started with ALCIDE D'ORBIGNY in the middle of the last century. His stages for the latest Jurassic (Kimmeridgian, Portlandian and Purbeckian) have formed the basis of our modern stage nomenclature. The plethora of new and local stage names which were subsequently applied to the Jurassic System during the latter half of the last century and the early years of this century were listed by ARKELL (1933, pp. 617-622) with a supplementary list published later (1956, p. 8). Included in this list of over one hundred and twenty names were many synonyms of the Upper Jurassic stages for North-west Europe proposed by D'ORBIGNY. ARKELL (1946) was a strong proponent of the use of D'ORBIGNY's stages, and discussed problems with the interpretation of some of them. Of the D'ORBIGNY stages, the Purbeckian has been dropped because it is merely a local facies term for the latest Jurassic to earliest Cretaceous rocks of North-West Europe. Following this decision, the Portlandian Stage becomes the D'ORBIGNY Stage for the terminal Jurassic and thus continues upwards to the base of the Cretaceous.

Two other names have also survived for the terminal Jurassic stage, however, the Tithonian (OPPEL 1865) used in Tethyan areas, and the Volgian, (NIKITIN, 1881) used primarily in Russia

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and Poland; both of these are still in regular use. There has been much debate amongst the international community of Jurassic workers about the various merits of the Portlandian, Tithonian and Volgian as candidates for the primary standard terminal Jurassic stage. A series of International Symposia on the Jurassic System (Luxembourg 1962, 1967, Erlangen 1984 and Lisbon 1987) did not resolve the issue. The whole matter became clouded with nationalist feelings colouring the scientific debate.

A further problem exists over the dual meanings of the words Kimmeridgian and Portlandian. This arises from ambiguity in D'ORBIGNY's original definition of the two stages. British geologists have averred that since D'ORBIGNY stated that the Kimmeridgian was the Weymouth Beds and Kimmeridge Clay of FITTON (1836) and that the Portlandian was the Portland Sand and Stone of FITTON (1836) there was no ambiguity (e.g. ARKELL 1946, p. 6). However D'ORBIGNY, a Frenchman who never visited England, defined his stages by three criteria. The first was merely a positional placing of the stage and of little help in its recognition; the second was a list of characteristic fossils, including particularly ammonites, for each stage. The third was a list of formations in various parts of North-west Europe which typified the stage. For the Portlandian, D'ORBIGNY listed *Ammonites gravesiana*, *A. gigas* and *A. irius* as characteristic of the Portlandian Stage. These ammonite species are now included in the genus *Gravesia* SALFELD, 1913. SALFELD showed (1913) that *Gravesia* occurred in the middle of the Kimmeridge Clay of the Dorset coast and thus that the beds containing the genus should, under the second of D'ORBIGNY's criteria, be already Portlandian. This boundary was already long recognised in France (DE LORIOU & PÉLLAT, 1866) and the facies change at the top of the Kimmeridge Clay in the Boulonnais sections introduced the Portlandian there at a level equivalent to the base of the Upper Kimmeridge Clay (*sensu* COPE 1967) and the base of the Upper Kimmeridgian Stage in Britain. Thus there has been recognised Kimmeridgian- and Portlandian Stages *sensu anglico* and *sensu gallico*.

Current stage nomenclature and use

The base of the Tithonian stage is now internationally accepted as being defined by the base of the *Hybonoticerias hybonotum* Zone, although a boundary stratotype section has yet to be selected. The *hybonotum* Zone yields species of *Gravesia*, thus providing an approximate correlation at about the level of the base of the Portlandian *sensu gallico*.

The Volgian Stage, as originally defined by NIKITIN (1881), included at its base what is now the *Dorsoplanites panderi* Zone, a horizon which correlates approximately with the *Pavlovina pallasioides* Zone in the Northwest European succession (COPE, 1978) or with the *Pseudovirgatites scruposus* Zone in the Tethyan area (ZEISS, 1983). However, GERASSIMOV & MICHAÏLOV (1964) in a move which may have been calculated to seize the initiative in proposing the Volgian as the primary standard terminal Jurassic Stage, moved the base of the stage down to the base of the *Ilovaiskya klimovi* Zone – a level which also yields *Gravesia* and thus produced a Kimmeridgian/Volgian boundary closely coincident with the Kimmeridgian/Tithonian boundary and with the Kimmeridgian/Portlandian boundary (*sensu gallico*).

The type section of the Volgian rocks at Gorodische on the Volga was soon shown, however, to be highly condensed; its many phosphatic nodule beds clearly representing large scale non-sequences, and CASEY (1967) showed that the equivalent of the whole of the Port-

land Beds of Britain, reaching in places a thickness of c. 100 m and containing at least 5 ammonite zones (WIMBLEDON & COPE, 1978) was probably entirely missing. These deficiencies soon led to the abandonment of the Volgian as contender for the primary standard terminal Jurassic Stage.

A major breakthrough came at an informal meeting of members of the Jurassic Subcommittee held when it became clear that a large number of specialists in the problem were gathered at the 3rd international 'Fossili, Evoluzione, Ambiente' meeting at Pergola, Italy in October 1990. Here it was agreed *nem.con.* that the Tithonian should be put forward as the international primary stage for the terminal Jurassic. This decision was endorsed at a formal convention of the Jurassic Subcommittee held during the International Jurassic Symposium at Poitiers, France in September 1991. Even though this matter was agreed, there remains the problem of what terminology to use for other parts of the world. It is at present totally unrealistic to refer to the latest Jurassic 'hot shales' of the northern North Sea as Tithonian, although acceptance of the Tithonian as the primary stage for the terminal Jurassic necessarily implies that this should ultimately be the case. What is accepted is that there is the need, at least for the time being, to also accept some local stages as secondary reference standards. Thus Volgian is the appropriate local stage name for Russia and parts of Poland; Portlandian is the appropriate term, not only for Britain, but for northern France, and it can certainly be applied to Greenland and the whole of the North Sea area (although confusion over stage nomenclature has caused many North Sea workers to prefer Volgian). What has proved a stumbling block, and a cause of confusion over many parts of the world is the dual meaning of the word Kimmeridgian.

ARKELL (1956) overcame this by referring to successions outside of North-west Europe as Lower Kimmeridgian + Tithonian, or Lower Kimmeridgian + Volgian. But this does not solve the problem, for in those areas where the Kimmeridgian is recognised in its shorter sense, the stage is already divided into two parts, thus the terms "Lower Kimmeridgian" and "Upper Kimmeridgian" have different meanings in the Tethyan and North-west European regions, leading to further confusion.

There is a working group of the Jurassic Subcommittee of the IUGS at present examining possible boundary stratotype sections for the base of the Kimmeridgian Stage. One of the strongest candidates is the section at Ringstead Bay, Dorset, proposed by MORTON et al. (1974) where the base of the Kimmeridge Clay, which is coincident with the base of the *Pictonia baylei* Zone, is well exposed and marks the base of the Kimmeridgian Stage. The Kimmeridgian Stage, as understood in Britain, continues upwards to the base of the Portlandian Stage, the basal boundary stratotype of the latter being the base of the Massive Bed of the Portland Sand on Hounstout Cliff, Dorset, which marks the base of the *Progalbanites albanii* Zone (WIMBLEDON & COPE, 1978).

Thus we have in Britain a stage nomenclature which is at odds with stage nomenclature in virtually all other places in the world. A shortened Kimmeridgian stage is used in Northern France (in conjunction with an enlarged Portlandian Stage) [Kimmeridgian and Portlandian *sensu gallico*]. A shortened Kimmeridgian is used in the Tethyan areas (in conjunction with the Tithonian Stage). A similarly shortened Kimmeridgian is used in Russia and Poland (in conjunction with the Volgian Stage). To obviate the confusion a Kimmeridgian Stage of uniform length seems essential.

The Bolonian Stage

The dual meaning of the word "Kimmeridgian" was already perceived by J. F. BLAKE in 1880 and his views were subsequently developed the following year (BLAKE, 1881). BLAKE clearly understood that beds containing species of the ammonite genus *Gravesia* in the Paris Basin, called in that area Lower Portlandian, correlated with the lower part of the Upper Kimmeridge Clay of England. BLAKE's proposal (1881, p. 581) states "For the series of deposits which overlie the true Kimmeridgian or Virgulinian, and underlie the true Portland Beds the name Bolonian is proposed. The name Portlandian has usually been applied to them [in France], but since it is certain that they do not correspond to our Portland rocks, but to beds below them, this name is to the last degree misleading and the only way out of the confusion is the use of a distinct name".

BLAKE also illustrated that he was aware of approximately where the boundary lay in Dorset, for he stated that the basal boundary of the Bolonian "must be drawn in the midst of clays, where the most marked introduction of new species commences, this . . . may be as low as Bed 40" (BLAKE, 1881, p. 584). In fact, the base of the Upper Kimmeridgian as at present used in Britain is at the base of BLAKE's Bed 42 – some 6 m lower in the section than Bed 40 (it should be noted that BLAKE numbered his beds from the top downwards, but because his beds are readily recognisable they have been followed by subsequent workers). Bed 42 marks the base of the *Pectinatites (Virgatospinctoides) elegans* Zone (COPE, 1967) and marks a major faunal turnover from an aulacostephanid dominated ammonite fauna to a pectinatitid dominated fauna. The fact that the ammonite genus *Gravesia* occurred at Kimmeridge was not known by BLAKE, and it was some years later that SALFELD (1913) established its occurrence in what is now the *elegans* Zone. BLAKE, however, did clearly appreciate that this was the level where *Gravesia* occurred, for he refers to the "Lower Bolonian or zone of *Ammonites gigas*" (BLAKE, 1881, p. 582). These were remarkable observations for the time, observations for which BLAKE has received little credit, most of this going to SALFELD for his subsequent discovery of *Gravesia* in Dorset.

I propose that the term "Bolonian" be re-introduced to end the confusion already in existence over a century ago and which has persisted to the present. Although the nomenclatorial type locality is at Boulogne-sur-Mer, the beds are much more thickly developed in a uniform facies in Dorset, which is therefore selected as the locality where the base is defined. The proposed basal boundary stratotype section for the Bolonian Stage is at Hen Cliff, Kimmeridge, Dorset (Grid Reference SY 908786), the basal boundary being the base of BLAKE's (1875) Bed 42, here marking the base of the *Pectinatites (Virgatospinctoides) elegans* Zone (COPE, 1967). The top of the Bolonian is automatically fixed by the base of the Portlandian, so that the Bolonian Stage embraces the zones up to and including the *Virgatopavlovvia fittoni* Zone, and replaces the term Upper Kimmeridgian *sensu anglico* (see COPE, 1980).

The result of the use of the Bolonian stage would be that Kimmeridgian would be used in the same sense internationally, and there would be no further ambiguity over the use of the term. The use of Portlandian would then be also restricted to its use in the English sense, obviating any further confusion in the interpretation of that term too. Bolonian + Portlandian would have a similar basal marker and cover much the same time span as the Volgian; it would also have a similar basal marker and cover much of the same time span as the Tithonian, the latter remaining as the primary standard.

1	2	3	BRITAIN	E. GREENLAND	4	VOLGA BASIN	5	S. FRANCE S. SPAIN	S. GERMANY
PORTLANDIAN	PORTLANDIAN	PORTLANDIAN	Lamplughii Preplicomphalus Primitivus Oppressus Anguiformis Kerberus Okusensis Glaucolithus	Groenlandicus Anguinus Pseudapertum Gracilis Liostraca Communis Rugosa Iatrensis Primus Pectinatus	VOLGIAN	Nodiger Subditus Fulgens	BER.	Jacobi	Chaperi
			?Blakei			'Durangites'	Transitorius		
KIMMERIDGIAN	PORTLANDIAN	BOLONIAN	Fittoni	Hudlestoni Wheatleyensis Scitulus Elegans	VOLGIAN	Virgatus		TITHONIAN	Micracanthum
			Rotunda			Panderi	Puschi Bavaricum Palatinum Vimineus Parvinodosum Triplicatus Tagmersheimense Hybonotum		
			Pallasioides Pectinatus			Tenuicostata			Ponti
KIMMERIDGIAN	KIMMERIDGIAN	KIMMERIDGIAN	Hudlestoni	Wheatleyensis Scitulus Elegans	KIMMERIDGIAN	Pseudoscythica	KIMMERIDGIAN	Fallauxi Semiforme	Beckeri Eudoxus Acanthicum
			Wheatleyensis			Sokolovi		Darwini	
			Scitulus Elegans			Klimovi		Hybonotum	
KIMMERIDGIAN	KIMMERIDGIAN	KIMMERIDGIAN	Autissiodorensis	Cymodoce Baylei	KIMMERIDGIAN	Autissiodorensis Eudoxus Acanthicum	KIMMERIDGIAN	Beckeri Eudoxus Acanthicum	Beckeri Eudoxus Acanthicum
			Eudoxus Mutabilis			Kitchini		Divisum Hypselocyclum Platynota	
			Cymodoce					Divisum Hypselocyclum Platynota	
KIMMERIDGIAN	KIMMERIDGIAN	KIMMERIDGIAN	Baylei	Baylei	KIMMERIDGIAN		KIMMERIDGIAN		Divisum Hypselocyclum Platynota

Fig. 1. Stage nomenclature and Standard Zonal schemes in use for the terminal Jurassic. Small ticks within the stage boxes indicate formally recognised subdivisions of the stages. Based on COPE (1985) with modifications. 1 – Present stages and boundaries as used in Britain. 2 – Present stages as used in northern France. 3 – New Secondary Standard Stage scheme for North-West Europe proposed herein. (Note for columns 1–3 that the equivalent of the basal Berriasian has yet to be identified; when this is done, it will automatically fix the top of the Portlandian – presumably lower than is indicated here). 4 – Secondary Standard Stage scheme as used presently in Russia and Poland. 5 – Primary Standard Stage scheme as now accepted by the Jurassic Subcommittee. Ber. = Berriasian Stage of Lower Cretaceous.

Conclusions

The time may well come when it is possible to correlate accurately between the different ammonite faunal provinces of the terminal Jurassic; until that time it will probably prove necessary to use both a primary and secondary standard stages. The Tithonian Stage has now been internationally accepted as the international primary standard stage for this interval. Confusion in dual meanings of the terms Kimmeridgian and Portlandian can be readily overcome by the simple expedient of re-introducing the Bolonian Stage as a secondary standard, with equal status to the other secondary stages currently in use, the Portlandian and the Volgian.

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