Geology of the Bath area: Jurassic

> **This topic provides a summary of the geology of the Bath area – covered by the British Geological Survey**
> **1:50k geological map sheet 265.**
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Marine transgression continued into the Jurassic, and the uplands of the Triassic landscape became distinct landmasses: Cornubia to the south and west of the Bath district, the Anglo-Brabant landmass to the east and the Welsh Landmass to the north-west. Throughout the Jurassic, the Bath district occupied part of a shallow marine platform on the northern margin of the deeper waters of the Bristol Channel, Wessex and Weald basins. Rocks of Jurassic age crop out across most of the district and a relatively complete succession is present, with strata ranging from Hettangian to Oxfordian in age.

Lower Jurassic

Largely argillaceous rocks comprise the Lower Jurassic (Hettangian to Toarcian) Lias Group. This includes much limestone in the lower part with sand and sandy silt towards the top. The lowest unit of the group is the Blue Lias Formation (BLi) of latest Rhaetian to Sinemurian age, which is between 18 and 39 m thick, and is a rhythmic succession of interbedded limestone and mudstone **(P239116)**. The formation is considered to represent hemipelagic shelf sedimentation in relatively quiescent, variably agitated waters. The relative proportions of limestone and mudstone vary through the succession, leading to the recognition of a tripartite subdivision in much of the district, with an upper and lower carbonate-rich unit, separated by a carbonate-poor silicate mudstone division. For the English Midlands, Ambrose (2001) defined these divisions as the lower Wilmcote Limestone Member (Wct), middle Saltford Shale Member (SaSh), and upper Rugby Limestone Member (RLs). They cannot be recognised south of the Newton Fault, where the formation is undivided. Further expansion of the Early Jurassic marine transgression led to the deposition of the grey, variably fossiliferous mudstone, known as the Charmouth Mudstone Formation (ChM). The formation thickens from typically 100 m at outcrop (although locally as little as 35 m) to about 160 m at depth in the north-east (Green, 1992)[1].

In most of the district, the Charmouth Mudstone is overlain by the Dyrham Formation (DyS), a succession of poorly-indurated interbedded mudstone, siltstone and sandy siltstone up to 27 m thick. Above this, the Beacon Limestone Formation (BnL; formerly known as the 'Junction Bed') forms a discontinuous outcrop of up to 3 m of ferruginous and ooidal limestone. The sand and silt content of the Dyrham Formation is thought to indicate an increase in clastic sediment flux during a minor regression, whereas the thin and very condensed succession of the Beacon Limestone Formation may be the result of prolonged deposition in sediment-starved deeper water (Hesselbo, 2008)[2]. In the south and east the Dyrham and Beacon Limestone formations are overstepped by younger Lias Group strata. Above the Beacon Limestone, the Bridport Sand Formation (BdS) is a succession of poorly indurated, bioturbated sand and silty sand, with a few carbonate-cemented masses of sandstone ('doggers'), which thickens north from 20 to 45 m and east to perhaps 60 m.

Middle Jurassic

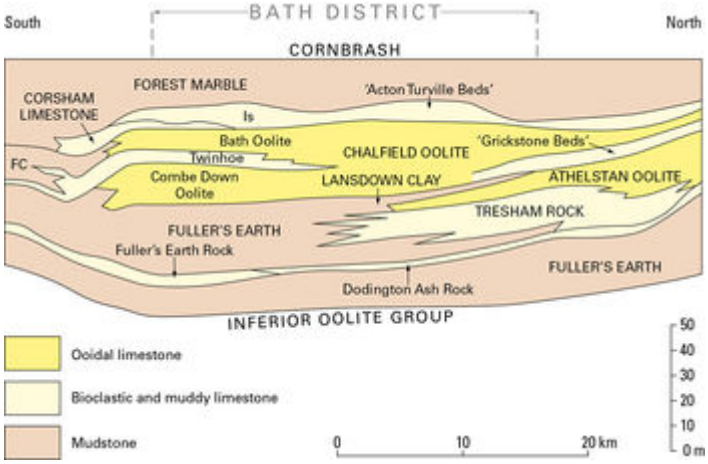
Rocks of Middle Jurassic age extend from the Cotswold escarpment eastward forming the broad dip

slope of the Cotswold Hills. Toarcian regression, accompanied by crustal upwarp and volcanism in the North Sea, led to radical palaeogeographical changes in southern Britain by the onset of the Aalenian. Much of the Midlands became emergent, and the Aalenian to Bathonian rocks of the Bath district represent relatively condensed carbonate deposition on a shallow marine shelf, interrupted at times by the influx of considerable volumes of mud.

The lowest division of the Middle Jurassic is the Inferior Oolite Group (InO), which forms a prominent cuesta along the entire Cotswold escarpment. A tripartite division of the succession was recognised in the wider Cotswold region by early workers (Buckman, 1893[3], 1895[4]; Witchell, 1882)[5], and allocated to three formations in the north Cotswolds by Barron et al. (1997). Uplift and erosion in early Bajocian times (Kellaway and Welch, 1993)[6] was most pronounced in the Bath area and probably removed any strata representative of the lower parts of the group (Aalenian and lower Bajocian), forming a significant unconformity. Renewed transgression led to the deposition of the youngest of the three divisions, of late Bajocian to early Bathonian age, comprising a succession of bioclastic, ooidal grainstones 12 to 23 m thick, but these are too dissimilar to the coeval strata of the north Cotswolds to share the same formation name. The rocks represent the deposits of ooid shoals and barriers formed in a shallow, high-energy environment.

Later in the Bathonian there was a considerable influx of clastic sediment, and the clays and limestones deposited at this time form the Great Oolite Group, totalling about 100 m in thickness. The basal unit is the Fuller's Earth Formation (FE), which is approximately 40 m thick, and comprises a series of thick silicate and calcareous mudstone beds interleaved with beds of coarsely bioclastic limestone. Immediately south of the district, the upper part of the formation contains a commercially exploited bed of montmorillonite clay, which may extend into the southern part of the Bath district (see Mineral resources). The presence of abundant montmorillonite indicates contemporaneous volcanic activity. A sequence of shelly limestone 2 to 5 m thick forms a feature between Englishcombe in the south [721 625] and near Dyrham [745 750] in the north, and has been named the Fuller's Earth Rock Member **(FER; P785916)**. North from Dyrham, it passes into the fine-grained Dodington Ash Rock Member (DA), up to 2 m thick. Above it, the Tresham Rock Formation (TR) forms a succession of fine-grained limestone with calcareous mudstone beds that is up to 5 m thick at outcrop, and is overlain by the Lansdown Clay Formation (LC) comprising up to 10 m of calcareous mudstone beds with lenses of limestone. In the outcrop in the extreme north [770 814] and in the subsurface in the eastern part of the district, the Lansdown Clay Formation passes into and is replaced by the Athelstan Oolite Formation (AO).This is a succession of hard, pale grey, fine-grained ooidal limestone with subordinate shell debris, 5.2 m thick in the Lacock No. 2 Borehole (ST96NW 2; [9205 6926]). These rocks represent the development of ooid shoals in higher-energy waters to the east and north of the district.

The Fuller's Earth Formation and its lateral equivalents are disconformably succeeded by the Chalfield Oolite Formation (ChO) of Wyatt and Cave (2002), formerly the 'Great Oolite' of Green and Donovan (1969)[7] **(P785916; P731874)**. The formation is between 15 and 31 m thick, and is a succession of fine to coarse, largely matrix-free ooidal grainstones with, at certain levels, much bioclastic debris. At its greatest development in the south of the district, the formation is divisible into three formal units, in ascending order: the Combe Down Oolite Member, the Twinhoe Member and the Bath Oolite Member **(P785916)**. North of Box, the Twinhoe Member is thought to pass into the lower part of the Bath Oolite, although the subdivision can still be recognised in the north around Castle Combe (Wyatt and Cave, 2002)[8], and in the east, where the Lacock No. 2 Borehole records a 1 m-thick succession of ferruginous peloidal limestone and calcareous mudstone at the Twinhoe horizon. The formation thins northwards as a result of erosion beneath the Forest Marble Formation, resulting in the removal of probably the entire thickness of the Bath Oolite (Wyatt and Cave, 2002, fig. 1)[8].



Simplified cross-section showing lithostratigraphical relationship in the Bathonian strata of the south Cotswolds.

Not to scale. Formations in capitals, members in upper and lower case, informal units in inverted commas. ls - Forest Marble Formation basal limestone beds; FC - Frome Clay Formation. Modified after Penn et al (1979)[9], Wyatt (1996)[10] and Hesselbo (2008)[11].

P785916.

The Combe Down Oolite Member (CDO) is a 9 to 18 m-thick unit of creamy-grey to yellowish, medium- to coarse-grained, cross-bedded ooid-grainstone **(P731874)**, interleaved in the lower part with prominent beds of calcareous mudstone. The Twinhoe Member (Tw) comprises a succession of up to 11 m of limestone with ferruginous pisoids and ooids, bioclasts and corals, whilst the succeeding Bath Oolite Member (BO) is a monotonous sequence of up to 15 m of fine- to medium-grained, cross-bedded ooid-grainstone, with very subordinate shell debris and without prominent mudstone interbeds. In the north of the district where the members are not distinguished on the map, a prominent succession of up to 5 m of coarse bioclastic limestone (ls) lies at the base of the Chalfield Oolite Formation, and has been informally named the 'Grickstone Beds' (Cave, 1977[12]; Wyatt and Cave, 2002)[8]. The Chalfield Oolite Formation represents the distal deposits of an extensive carbonate ramp covered by a shallow, subtropical sea, where high-energy, tidally-dominated conditions led to the development of shifting ooid shoals and migratory sand waves. The deposition of such sediments in the Bath district is attributable to an abrupt southward shift of the ooid grainstone facies belts in the late Bathonian, possibly as a result of the reactivation of deep-seated faults along the northern margin of the Wessex Basin (Bradshaw et al., 1992)[13].

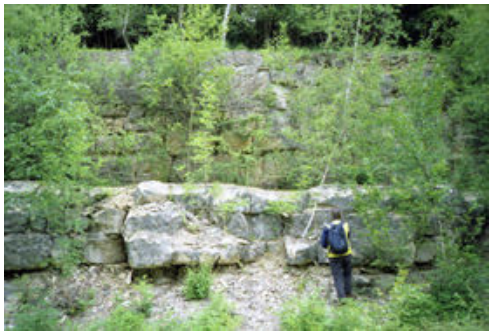
In the south of the district, the uppermost cross-bedded ooid-limestone beds of the Bath Oolite Member are overlain by a succession of white or brown, variously ooidal, shell detrital limestone beds with in places one or more lenticular coralliferous beds **(P210749)**, totalling up to 9 m thick. This unit was termed the 'Upper Rags' by Green and Donovan (1969)[7], but not separated from the Bath Oolite on the maps published at that time. The Upper Rags have been subsequently included either in the Forest Marble Formation (Cave, 1977[12]; Wyatt, 1996[14]; Wyatt and Cave, 2002)[8] or as the Corsham Member in the Chalfield Oolite Formation (Sumbler, 2003)[15]. In the course of the present survey, it has been concluded that the Upper Rags generally show insufficient similarity in lithofacies with either formation and are termed here the Corsham Limestone Formation (Cm), and where possible are distinguished above the Bath Oolite on the map. The coralline units probably represent patch reefs or their remains. The formation overlies the Chalfield Oolite non-sequentially, and the boundary with the overlying Forest Marble Formation is disconformable, and both contacts may be marked by a hardground.

The Forest Marble Formation (FMb) is 24 to 31 m thick, and on the map it is generally divisible into two parts. The basal unit is composed of lenticular, locally channel-form, flaggy or rubbly, coarse, bioclastic limestone and subordinate ooidal grainstone beds, generally not more than 10 m thick. The higher part is mudstone dominated with lenticular or impersistent limestone beds, and is up to 21 m thick. The limestone beds represent the deposits of a shallow, transitory, probably tidally dominated carbonate shelf or inner ramp. In the north between North Wraxall and Badminton (Malmesbury district) the basal limestone beds are represented by a more argillaceous variant, informally named 'Acton Turville Beds' by Cave (1977)[16]. The overlying clay-dominated part of the formation results from an increased fine clastic influx and the occlusion of carbonate production. At one or more levels near the base there is a distinctive brachiopod-dominated benthic assemblage (the 'Bradford Clay Fauna') which flourished at this time.

The Forest Marble Formation is conformably overlain by the Cornbrash Formation (Cb), which is 4 to 6 m thick (Cave, 1977[16], fig. 20)[12] and consists of poorly bedded, non-ooidal argillaceous bioclastic limestone with partings of mudstone. The Cornbrash represents renewed carbonate deposition following the onset of a major transgression which began during the latest Bathonian. Previous workers have recognised a lower and upper division at outcrop (e.g. Cave, R. 1977[12]; Douglas and Arkell, 1932[17]), with a non-sequence between them approximating to the Bathonian–Callovian stage boundary and representing a minor marine regression. However, this distinction has not been made during the present survey.

The Kellaways Formation (Kys) represents relatively deeper water sedimentation following continued Callovian transgression. The district includes the type section (Tytherton No. 3 Borehole, ST97SW 2 [9440 7445]) and type area of the formation at Kellaways [947 758], which is also the origin in latinised form of the stage name Callovian (Cox and Sumbler, 2002)[18]. The formation is 21 to 25 m thick, and north of Chippenham is divisible into two members, the Kellaways Clay and Kellaways Sand, but these cannot be distinguished in the south. The Kellaways Clay Member (KlC) is dark grey mudstone with thin and lenticular beds of fine sand or sandstone. The Kellaways Sand Member (KlS) forms a relatively thin development of sand and calcareous sandstone above the Kellaways Clay, perhaps related to a brief marine regression in the mid Callovian. It is well exposed in the banks of the River Avon at Kellaways [9466 7577] **(P692881)**, first recognised here by William Smith around 1800.

The top of the Middle Jurassic succession occurs within the mudstone-dominated Oxford Clay Formation (OxC). Its thickness is uncertain but from regional considerations it is estimated to be about 150 m. Where better exposed elsewhere in southern England, the formation is divided into three members, but they cannot be distinguished on the map in this district. The lower part (Peterborough Member) is olive-grey, thinly laminated organic-rich mudstone, which is highly fossiliferous at some levels. This unit represents sedimentation in association with poor bottom-current circulation, resulting in sea-floor anoxia and the widespread preservation of organic matter. Improved circulation occurred in the later Callovian and early Oxfordian, and the upper part of the formation (Stewartby and Weymouth members) is blocky grey mudstone with some shell debris-rich beds and calcareous siltstone horizons.



The Chalfield Oolite Formation near Ford. Roadside cutting [8510 7468] in the Combe Down Oolite Member. In the upper part, a prominent cross-bed set can be seen dipping to the left (west) (Photographer A J M Barron) P731874.

Corsham railway cutting (as seen in 1967). The uppermost beds of the Bath Oolite Member, forming the ledge upon which the hammer rests, are overlain by the Corsham Limestone Formation, including its basal coralliferous limestone lens (the Corsham Coral Bed) succeeded by flaggy bioclastic limestone with mudstone beds [8602 6947] (Photographer C A F Friend) P210749.

The Kellaways Sand exposed in the bank of the River Avon at Kellaways [9465 7577] (Photographer A J M Barron) P692881.

Upper Jurassic

Upper Jurassic rocks are found only in the extreme south-east of the district. The transgression which characterised the latest part of the Mid Jurassic continued during the Late Jurassic, but tectonic movements in the Celtic Sea area led to the emergence of an enlarged landmass to the west of the district. By the mid Oxfordian, calcareous and sandy sediments spread over extensive areas of southern Britain, forming the rocks of the Corallian Group, which pass laterally south and east into more argillaceous rocks in the Weald and Wessex basins.

The basal unit of the Corallian Group is the Hazelbury Bryan Formation (Hz), a 15 to 30 m-thick unit of yellow, brown and grey very fine- to medium-grained quartzose sandstone, with thin sandy siltstone and sandy mudstone beds in parts. The sediments represent deposition on a quiescent, low-energy clastic shelf. Above this, the Kingston Formation (Ki) is a 5 to 20 m- thick succession of calcareous mudstone and medium-grained quartzose sand, with carbonate-cemented beds and masses of calcareous sandstone or sandy limestone (ls). On the eastern edge of the district, it is overlain by shell detrital limestone, ooidal limestone and calcareous mudstone of the Stanford Formation (St), of which not more than 5 m is present. Sea level fall in the very latest Jurassic led to the removal from the district of all Jurassic strata younger than the mid Oxfordian.

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