REPORT

Research in progress: Tithonian (Late Jurassic) non-marine carbonates in the South Midlands

Published records spanning nearly 200 years document a thin (up to around 7.5 m) succession of latest Jurassic (Tithonian) carbonate-dominated non-marine strata from outliers to the west, north and north-east of Aylesbury, the county town of Buckinghamshire in the South Midlands (Arkell 1947; Bristow 1968; Horton *et al* 1995 and references therein). This succession, the Purbeck Formation, marks the culmination of Late Jurassic regression on the London Platform. Following the cut-off of a narrow seaway skirting the western margin of the Anglo-Brabant Massif, the Purbeck appears to have been deposited in an increasingly isolated microtidal or even atidal embayment, as the Portland sea retreated to the south (Cope *et al* 1992).

English Tithonian strata were deposited close to the northern margin of a circum-equatorial arid belt, at a latitude of around 35 degrees north. The Portland Formation of Buckinghamshire, immediately beneath the Purbeck, includes well-developed shallow-water marine carbonates featuring a rich invertebrate macro-fauna of warm-water aspect (Townson 1971; Radley 2006). Further south in the Wessex Basin, widespread replaced evaporites in the basal Purbeck confirm hot, semi-arid conditions (West 1975; Gallois *et al* 2018).

The Purbeck Formation in Buckinghamshire is broadly divisible into two units at most localities. Basal, tabular to laminated fine-grained limestones and mudstones ('pendle' lithologies of older accounts) are overlain by relatively massive micritic limestones with calcareous mudstones and some arenaceous units, featuring erosion surfaces (Horton *et al* 1995). Ostracod microfaunas and low-diversity molluscan assemblages throughout the formation confirm an overall up-section transition from brackish-marine to low-salinity or freshwater conditions (Barker 1966; Radley 2006).

When I started investigating the Buckinghamshire Purbeck strata in the late 1970s, the only substantial exposure was the disused quarry at Warren Farm, Stewkley, a Site of Special Scientific Interest (SSSI) and Geological Conservation Review (GCR) site, 12 km north of Aylesbury. This revealed just over a metre of calcareous mudstones and limestones above the Portland Formation (Bristow 1968) but is now largely grassed over (Fig. 1). In June 1984, Dr W. A. Wimbledon of the Nature Conservancy Council's Geological Conservation Review Unit oversaw excavation of an additional GCR site in the Purbeck Formation, close to the site of the Bugle Pit, Hartwell, 3 km south-west of Aylesbury (Fig. 2). The Bugle Pit was well known to Victorian geologists for discoveries of fossil insects and dinosaur remains, as well as rich ostracod microfaunas. Typical fossiliferous laminites were evident in the lower part of the newly dug section, overlain erosively by relatively massive micritic limestone beds and thin calcareous mudstones featuring freshwater gastropods, 'vuggy' (probably desiccated) fabrics and a layer of stromatolites. In an account of this section (Radley 1991) I modelled the laminated basal beds as brackish lagoon sediments, and the limestones above as lacustrine. Chief lines of evidence for the lacustrine setting were the abundant freshwater gastropods (chiefly the valvatoidean *Provalvata sabaudiensis*) indicative of shallow water, vegetated environments, and the stromatolites, suggesting lake margin settings. Cavernous/iron-enriched micrites were taken to signify fluctuating water tables and intermittent emergence. The nearby Hartwell borehole (drilled by the British Geological Survey in 1976: Cox *et al* 1994) revealed a closely comparable succession.

The British Geological Survey's Memoir for the 1:50 000 scale Thame sheet was published in 1995 (Horton *et al* 1995). This account confirmed that the carbonate lithologies encountered in the higher part of the Bugle Pit sequence and nearby borehole were widely distributed, recording other features such as ferruginous mottling, putative borings, mudcracks and occasional casts of halite crystals. Additional to these,

***Figure 1**. Disused quarry at Warren Farm, Stewkley, Buckinghamshire, formerly exposing Portland–Purbeck beds. (Adapted from a photograph taken in 2016 by Dudley Miles, licensed under the Creative Commons Attribution Share-Alike 4.0 International License)*

***Figure 2**. Purbeck limestones and calcareous mudstones at the Bugle Pit, Hartwell, Buckinghamshire. The lower, slightly overhanging bed marks an erosion surface and the appearance of carbonates yielding lacustrine gastropods and stromatolites. Photograph taken in 1912. (Source: Geologists' Association Carreck Archive, BGS Geoscenic photograph P805583)*

I have recently noted brecciated layers and possible rootlet traces in micrite blocks collected from ploughed fields on the Purbeck outcrop to the west of Aylesbury (selected lithologies are illustrated in Figs. 3–4). Such fabrics typify palustrine carbonates: normally fine-grained biogenic freshwater carbonates that have been physically and chemically modified during subaerial exposure. Recent occurrences are documented from low-energy coastal and continental lacustrine/wetland environments, characterised by low topographic relief, minimal clastic input and fluctuating water tables (e.g. see Alonso-Zarza and Wright 2010). The strongly regressive marine to non-marine Portland–Purbeck lithofacies and faunas of the Buckinghamshire Tithonian invite comparison with Recent subtropical/tropical coastal environments documented for example by Platt and Wright (1992, 2022), where marshes and lakes function as palustrine carbonate 'factories', juxtaposed with brackish-water lagoons that pass seaward into barrier systems and marine carbonate shelves.

***Figure 3**. Mottled biomicrite, suggesting remobilisation of iron due to an oscillating water table. Small cavities represent external moulds of small gastropods (*Provalvata*) and probable desiccation fenestrae. Thin, sinuous vertical to subvertical cavities are burrows or rootlet moulds. Specimen is 110 mm in length. West of Barrack Hill, Nether Winchendon.*

To further investigate these carbonate lithologies I have been awarded financial support from the Geologists' Association's Palaeontology Fund. Additional material will be collected from Buckinghamshire localities and previously collected material will be reappraised. Palustrine fabrics have also been recognised among freshwater carbonates of the Purbeck Limestone Group in the Wessex Basin. These will be studied in the field, in the hope of shedding further light on non-marine environments and climatic control on southern English Purbeck deposition.

***Figure 4**. Brecciated micrite: vertical and sheet-like concentrations of micrite grains and clasts interspersed with mudcracked, brecciated micrite. Specimen is 160 mm in length. West of Barrack Hill, Nether Winchendon.*

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EXCURSION

The Roaches, Staffordshire

5 July 2022

Leader: Martin Whiteley

Ten EMGS members and four from the North Staffordshire Group of the Geologists' Association joined our leader, Martin Whiteley, for a visit to the southern end of The Roaches in Staffordshire. After a misty and damp start the weather improved and we finished in sunshine with a stiff breeze. Martin gave an overview of the day, explaining that we were going to walk up through the Namurian 'Millstone Grit' sequence and examine the sedimentary features, fold structures and landforms of the area. He outlined the general setting of the Millstone Grit times with large amounts of coarse and finer sediment being transported from distant (perhaps up to 1000 km) sources in the north by a succession of enormous braided river systems. Three major sand-dominated sequences are exposed at The Roaches – these are the Five Clouds, Roaches and Chatsworth Grits.

At the first stop on the outcrop of the Five Clouds Grit, Martin invited us to examine the mineral content of the rock, which consists of relatively coarse-grained rock fragments with angular milky quartz and creamy feldspar crystals. No significant pebbles were seen. The quartz and feldspar are thought to indicate a granitic or gneissic source, implying the exhumation of a mountain range to expose the previously deeply buried foundations. We then climbed up over unexposed shales to the Roaches Grit outcrops where Martin pointed out the vertical 20 to 30 m high scarps, much loved by climbers. Having reached the top of the grit we could then see the extensive dip slope at about 20° inclining to the north-east. We then walked along the crest of the Roaches Grit escarpment, past Doxey Pool, with fine westerly views to the prominent Cloud hill near Congleton and as far as the Peckforton Hills in Cheshire.

Beyond the viewpoint we examined a large, isolated gritstone tor exhibiting various sedimentary features (see photo), including cross-bedding, which Martin used to explain how the direction of river flow can be determined. Whilst the general direction of flow of the Namurian rivers was from the north and east, this outcrop indicated local variations that were likely caused by pre-existing structural features in the delta plain. The variety of structures seen provoked a lively question and answer session.

We then retraced our steps before heading north-east from the ridge on a footpath down the dip-slope of the Roaches Grit on grass-covered slopes concealing the underlying unexposed shales above the grit. Martin pointed out low outcrops of another grit, the overlying Chatsworth Grit, which forms a subtle feature in the landscape, before reaching a road near Shaw House.