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6.4 Appendix 9.5 Geodiversity at Crickley Hill and Barrow Wake SSSI

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Appendix 9.5 Geodiversity at Crickley Hill and Barrow Wake SSSI

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Appendix 9.5 Geodiversity at Crickley Hill and Barrow Wake SSSI

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Highways England approval (refer to cover sheet)

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1 Introduction

1.1 Purpose

1.1.1 Crickley Hill and Barrow Wake is a biological and geological Site of Special Scientific Interest (SSSI) due to the nationally important rock exposures and the range of habitats characteristic of the Cotswold limestone that are represented, including species-rich grassland, scrub and semi-natural woodland.

1.1.2 This note describes the findings of a site walkover that was carried out with Natural England to better understand the importance of the geodiversity at Crickley Hill and Barrow Wake SSSI.

2 Geology

2.1 Regional geology

2.1.1 The Cotswolds Hills are underlain by an outcrop of Jurassic rocks that run south-west to north-east across 60 miles of south west and central England. The rolling hills rise from the upper Thames to an escarpment above the Severn Valley. The line of the escarpment is punctuated by valleys and embayments. The A417 traverses the edge of the Cotswold escarpment.

2.1.2 The Cotswolds are famous for the variety and abundance of fossils that can be found. The types of fossils and the ways in which they are preserved can tell us a great deal about the environments in which they lived and died. The changes in the types of sediment seen in the Cotswolds can also give us a wealth of information about the environment in which these sediments were deposited and close examination can provide a very clear picture of the palaeogeography of the area (i.e. the geography of the area at the time).

2.1.3 The rocks that form the Cotswolds date from three different geological stages of the Jurassic period, from 210-140 million years ago. The steep western slope of the Cotswolds Escarpment exposes sections through Lower and Middle Jurassic rocks that dip gently eastwards towards Oxford and London. These rocks are almost exclusively marine and were formed mainly in warm tropical seas.

2.1.4 The Inferior Oolite Group of the Middle Jurassic comprise the characteristic 'Cotswold Limestones'. The base of the Inferior Oolite Group consists of yellow, sandy limestones. Overlying units comprising thick beds of the Birdlip Limestone. These fine-grained oolitic limestones have been widely used as building stone in the region. Towards the top of the Inferior Oolite the limestones become more fossiliferous and are widely referred to as ‘grits’ due to their coarser texture.

2.1.5 At the base of these Jurassic rocks, making up the lower slopes of the Cotswold Escarpment and the level areas of the Severn Vale, are the clayey siltstones, mudstones, thin limestones and sandstones of the Lias Group. These were deposited in a deep marine environment that occasionally shallowed to allow the formation of some limestones, such as the Marlstone Rock Formation.

2.1.6 Geological mapping indicates that the whole of the Cotswold escarpment, including Crickley Hill, is covered in ‘mass movement deposits, comprising a random mixture of the underlying lithologies. The upper slopes are expected to comprise coarser material derived from the Inferior Oolite Group, while the lower slopes may be composed of reworked cohesive material from the Lias Group.

2.2 Local geology

2.2.1 The bedrock and superficial stratigraphy at the Crickley Hill and Barrow Wake SSSI is illustrated in Figure 1 and outlined in Table 1 using information from published resources supplemented by a site walkover with geologists from Natural England completed on 7th November 2019.

Table 1 Crickley Hill stratigraphy using information sourced from the BGS Lexicon, Tucker (2003), Cox & Sumbler (2002) and Barron et al. (1997).

Epoch	Group	Formation	Member	Description
Pleistocene and Holocene	-	-	-	Tufa. Deposits of calcium carbonate formed at the emergence of springs at the ground surface. Alluvium and Colluvium. Locally derived clayey, silty, sandy soils with some gravel and peat. Fluvial and aeolian deposits generally associated with the deposition during the Holocene. 'Mass movement deposits', synonymous with Pleistocene landslide deposits including rotational, translational and solifluction mass movement deposits. Bluish or pale grey or yellow very stiff slightly sandy silt or clay, with some bioclastic or ooilitic limestone cobble content and gravel. Organic deposits may be also be present.
Middle Jurassic	Inferior Oolite Group	Salperton Limestone	Clypeus Grit	Pale grey to brown rubbly, fine to coarse-grained ooidal, peloidal and finely shell-detrital packstone to grainstone.
			Upper Trigonia Grit	Very competent / hard, poorly (but thickly) bedded, very shelly and coarse shell-detrital ooidal grainstone and packstone. Characteristic fauna includes trigoniid bivalves and brachiopods.
		Aston Limestone	Lower Trigonia	Grey, speckled, orange-brown, very shelly, moderately sandy, peloids wackestones, packstone and grainstones with thin marl and sand beds which are occasionally shelly. Ferruginous peloids are often present and commonly pebbly at its base.
		Birdlip Limestone	Scottsquar	Pale grey and brown, medium to coarse-grained, poorly sorted peloidal and ooidal packstone and grainstone, interbedded with shelly limestone dominated by calcitic mud.
			Cleeve Cloud	Un-fossiliferous and cross bedded, massive ooidal limestone.
			Crickley	Pale grey to yellowish brown pisoidal and shelly peloidal Limestone with thin marl beds. Includes the Pea Grit – a very distinctive rock unique to the Cotswolds consisting of flattened, disc shaped grains of algal limestone which have accumulated around a nucleus, such as a shell fragment or sand grain. The grains have often been encrusted by small marine worms (annelids) and minute marine animals such as bryozoa and foraminifera.
			Leckhampton	Grey, highly bioturbated, finely shell-detrital, medium-grained, peloidal and ooidal sandy, muddy limestone. Thin marl beds are common. Ooids and peloids are commonly ferruginous. Basal bed conglomerate in places. Belemnites, oysters, bivalves and trigoniads identified in the field. 1.5m-2.0m thick.

Epoch	Group	Formation	Member	Description
Lower Jurassic	Lias Group	Bridport Sand		Grey, weathering to orange or brown, micaceous silt, very fine-grained sand and fine-grained sand, locally with calcite-cemented sandstone beds and lenses, variably sandy clay / mudstone at base. Presence of cemented elongate concretions. Very weak. Upper boundary on base of lowest limestone (commonly sandy) of Inferior Oolite or on the “Cotswold Cephalopod Bed” (sandy and argillaceous, ‘ironshot’ commonly fossiliferous limestone).
		Whitby Mudstone		Medium and dark grey fossiliferous mudstone and siltstone with thin nodular and fossiliferous limestone beds at the base in some locations. Laminated and bituminous with rare fine-grained calcareous sandstone beds.
		Marlstone Rock		Sandy, shell-fragmental and ooidal ironshot limestone interbedded with ironshot calcareous sandstone and ironshot mudstone beds. Fossil content variable throughout but locally abundant especially in limestone beds.

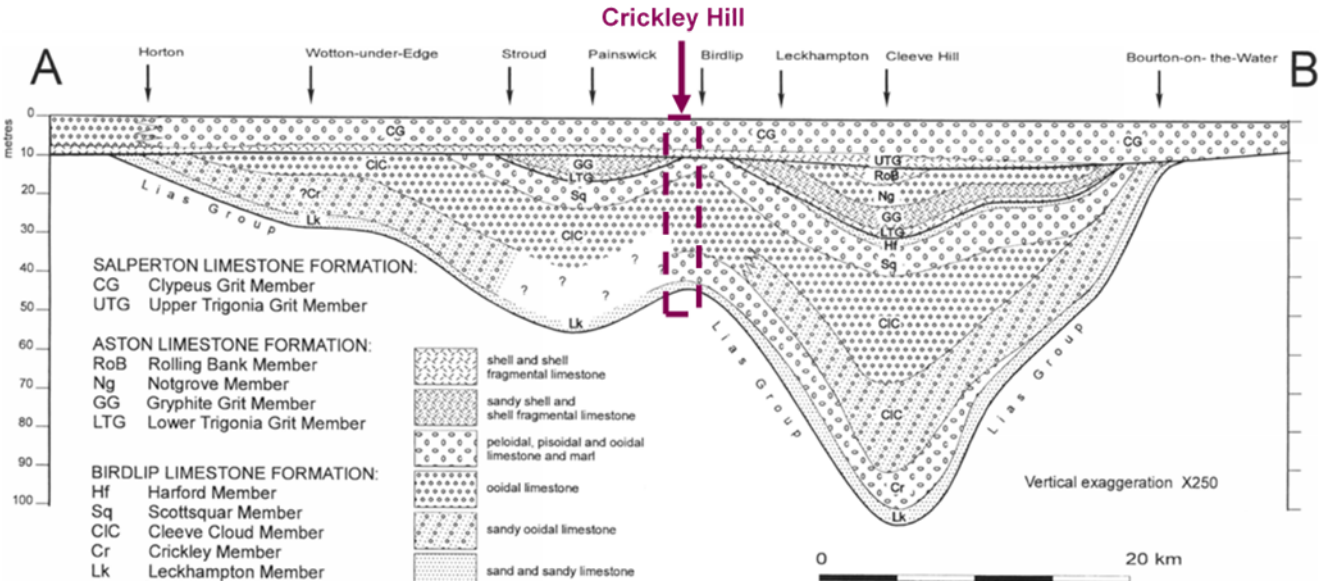

Figure 1 Generalised southwest-northeast section through the Cotswolds showing lithologies and strata relationships, highlighting the stratigraphy at Crickley Hill (Barron et al., 1997)

3 Site walkover

3.1.1 A site walkover was carried out with geologists from Natural England on 7th November 2019 to visit existing locations of the outcrop of the Leckhampton Member.

3.1.2 The presence of the boundary between the Lias Group and the overlying Inferior Oolite Group was identified, which helped to locate the exposures of the Leckhampton Member. The locations of the existing geological exposures of the Leckhampton Member identified with Natural England are shown on Figure 9.5.

3.1.3 The characteristics of the Leckhampton Member identified at outcrop are shown in Figure 2. The Leckhampton Member is shown in multiple locations to overlie the Bridport Sand Formation. There are occasional discontinuities between these two units, which may indicate the slipping or displacement of blocks in the slope. An example of these discontinuities can be seen in Figure 2.

3.1.4 The site observations, combined with structure contour analysis, historic and current available GI data, geophysical testing, and field observations provide comprehensive information on the level of this boundary across the escarpment.

3.1.5 The Leckhampton Member is underlain by a grey mudstone, possibly the upper sections of the Bridport Sand or Whitby Mudstone Formations of the Lias Group. (It is noted that there is commonly a c. 2m thick 'black/dark grey shale' unit at the top of the Bridport Sand Formation just below the Leckhampton Member. Cox and Sumbler, (2002) noted that this can be readily confused with the mudstone of the Whitby Mudstone Formation).

The evidence suggests that the base of the Leckhampton Member lies at approximately the level of the road at the position of the north-eastern most exposure (marked on Figure 9.5). This indicates that there is likely to be a fault with a downthrow to the east between this point and the exposures further west identified on Figure 9.5, as the apparent dip of the exposures to the west would suggest that the Leckhampton member and the Lias Group should intersect at road level further east than this point.

3.1.6 Another minor fault can be seen further upslope, as seen in Figure 3.

3.1.7 The Leckhampton Member is assumed to accommodate the 1.5-2.0m thickness above the observed top of the Lias Group. The depths and thicknesses of these strata will be confirmed by the ongoing ground investigations (GI).

Figure 2 Exposure of Leckhampton Member resting on the Bridport Sand Formation (boundary marked by yellow dashed line). The discontinuity at the eastern end of the section may indicate that this is a slipped/displaced block.

Figure 3 Exposure above the first engineered slope bench. The Bridport Sand Formation is exposed in the lower part of the face, partially covered in talus and vegetation. The base of the Leckhampton Member is clearly visible along the eastern part of the bench, but there is a discontinuity towards the western end (shown above).

4 Geological importance

4.1 National and regional designations

4.1.1 Natural Character Areas are sub-divisions of England defined by Natural England, based on a combination of landscape, biodiversity, geodiversity and economic activity. Geology is a unifying theme across the Cotswolds Natural Character Area, providing much of its character and interest.

4.1.2 Crickley Hill and Barrow Wake is a geological SSSI (Figure 9.5) and is also designated as a Geological Conservation Review (GCR) site and a Regionally Important Geological Site (RIGS). It also falls within the proposed Cotswolds Global Geopark, which will represent an area of diverse and significant geology, containing accessible sites for the community and tourists.

4.1.3 The national and regional geological interest lies primarily in the rock exposures along the southern slopes of Crickley Hill, where extensive exposures of the Upper Lias Group through to the Lower Inferior Oolite Group (Birdlip Limestone Formation) are found. The best sections in the Cotswolds of the 'Pea Grit' (Crickley Member) and overlying Coral Bed are present in this area, and the lowest portion of the sequence is a rare exposure showing the Scissum Beds (Leckhampton Member) overlying the Lias Group.

4.1.4 The wealth of opportunity at Crickley Hill and Barrow Wake SSSI for the study of geology and geomorphology, in particular the stratigraphy, fossils and geological history, provides great educational and scientific value. Geological studies in the area date back to the early 1800s and William Smith, 'The Father of English Geology', who made some if his key observations of stratigraphy in the Cotswolds. Geological research has continued here for 200 years since.

4.1.5 The area is popular for fossil hunters – echinoids, brachiopods and gastropods have all been found in the Pea Grit, and there are significant collections of rocks and fossils found in the area that are now housed in local museums.

5 Summary

5.1.1 It is important to protect the significant geodiversity at Crickley Hill and Barrow Wake SSSI due to the nationally important geological exposures. Some of these exposures are only accessible at this locality, and hence the geological sequence has been invaluable in stratigraphic study. The proposal for the site to become a Global Geopark will ensure the area remains valuable to future study and learning.

Endnotes and References

[1] B. G. Survey, “The BGS Lexicon of Named Rock Units,” Accessed: August 2019.

[2] A. Barron, M. Sumbler and A. Morigi, “A revised lithostratigraphy for the Inferior Oolite Group (Middle Jurassic) of the Cotswolds, England,” 1997.

[3] M. Sumbler, B. Cox, R. Wyatt and K. Page, “The Middle Jurassic stratigraphy of the Cotswolds.,” 2002.

Annex A Photographs from Arup (2019) Site Walkover

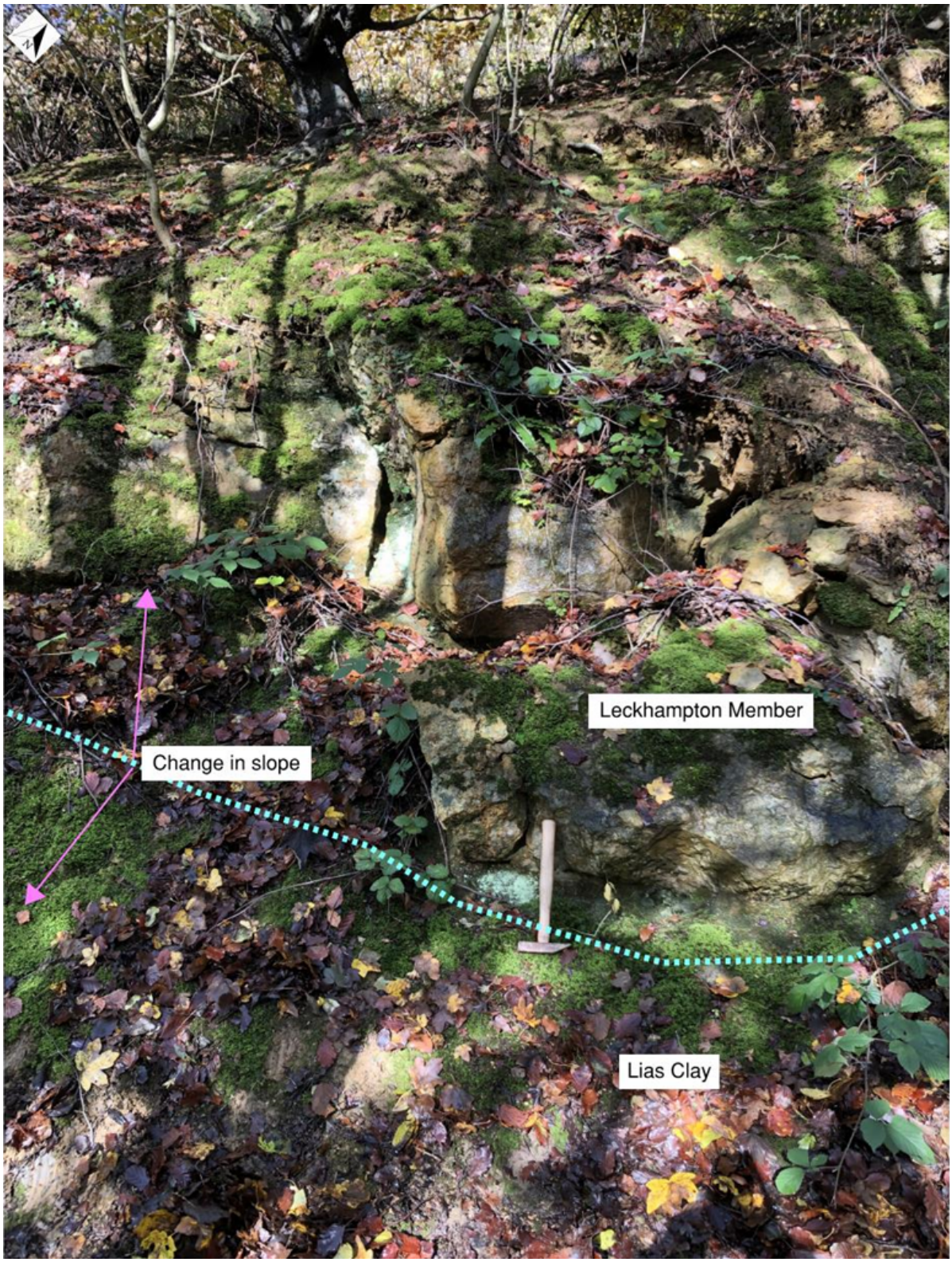

Figure 4 Boundary between Leckhampton Member and Bridport Sand showing a change in slope.

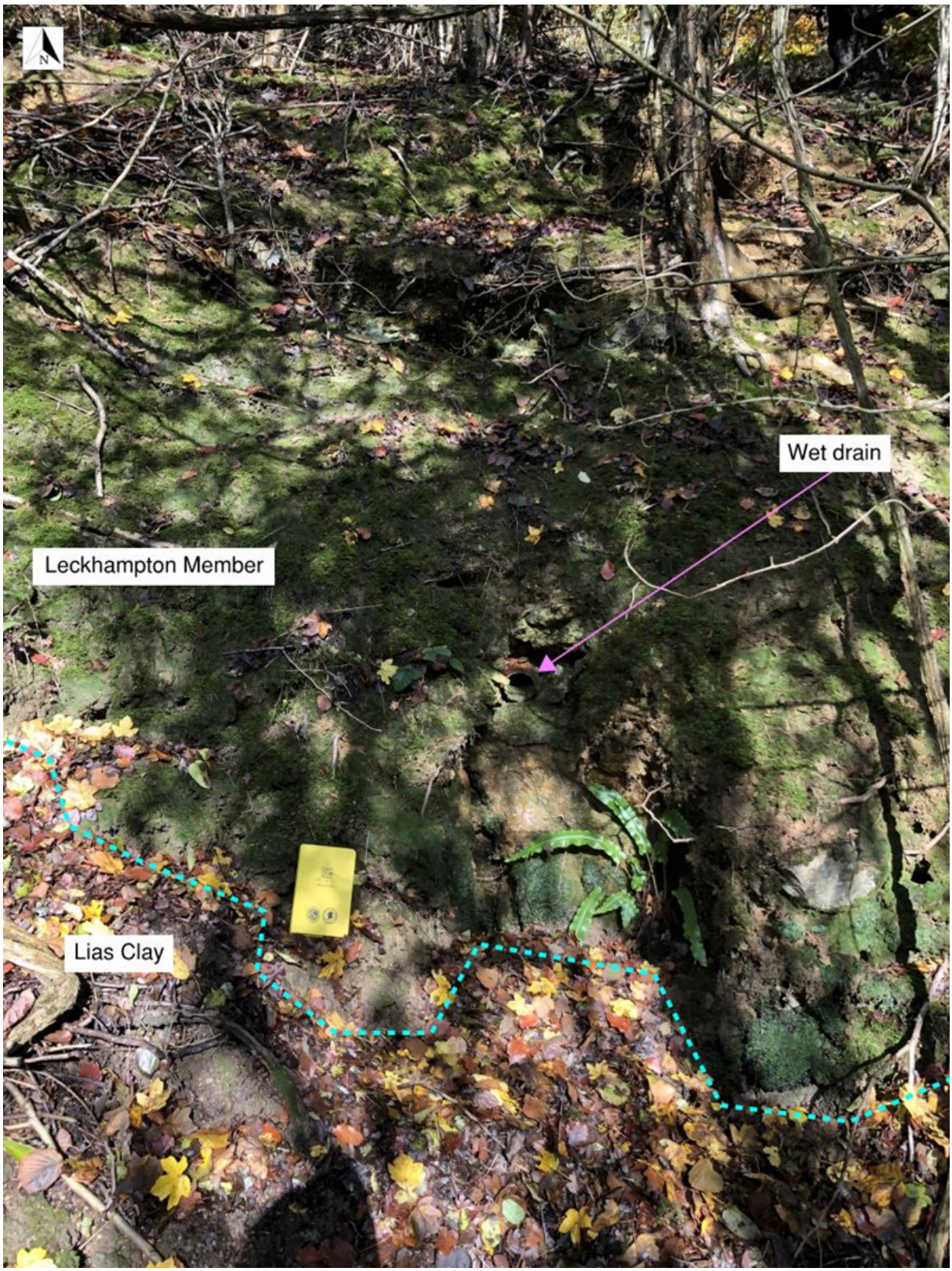

Figure 5 Boundary between Leckhampton Member and Bridport Sand showing a change in slope

Figure 6 Index fossil in the Leckhampton Member

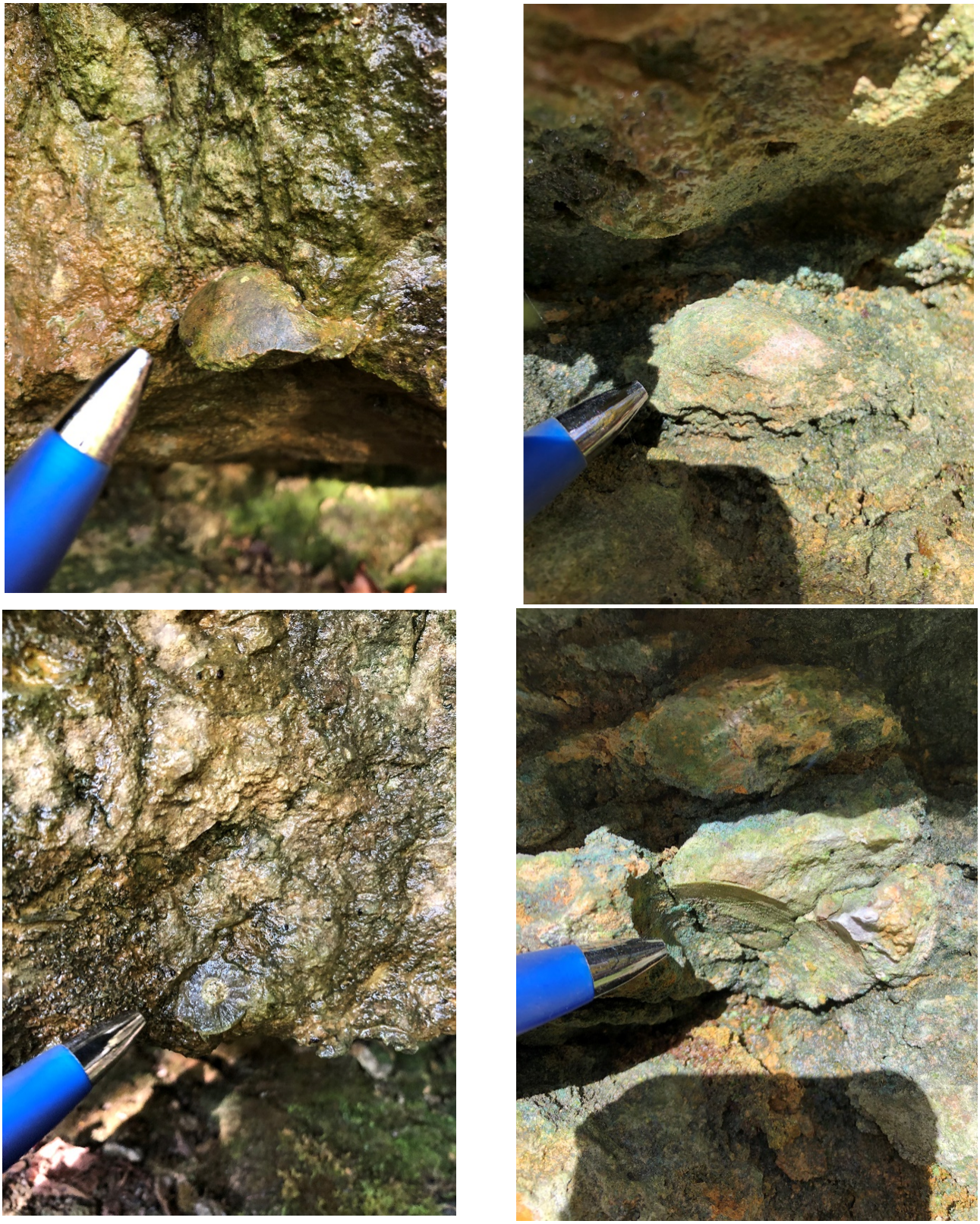

Figure 7 Fossils in the Leckhampton Member

Figure 8 Spring emerging flowing over Lias Clay