Middle Hope, North Somerset

[ST 322 659]–[ST 350 670]

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Introduction

The Middle Hope GCR site, a large coastal site near Weston-super-Mare and about 4 km northeast of the Spring Cove GCR Site, provides a Courceyan to Chadian section extending from the Black Rock Limestone through to the Gully Oolite. The section includes an exceptional development of the Middle Hope Volcanic Beds with undersea lavas and pyroclastic deposits. The section has been described by Geikie and Strahan (1899), Morgan and Reynolds (1904), Sibly (1905), Reynolds (1908, 1917), and more recently by Matthews *et al.* (1973), Speedyman (in Savage, 1977), Jeffreys (1979), Whittaker and Green (1983) and Faulkner (1989b). The following account is based mainly on the work of Faulkner (1989b). Details of the lava geochemistry are to be found in Faulkner (1989a).

Description

The Lower Carboniferous succession on the Middle Hope peninsula (see (Figure 7.16)a) includes 97 m of the Black Rock Limestone, 30 m of the Black Rock Dolomite and 10 m of the Gully Oolite (Faulkner, 1989b). The principal feature of interest is the Tournaisian Middle Hope Volcanic Beds (also known as the Wood-spring Lava and Tuff). These volcanic beds, 4–37 m thick, occur within the Black Rock Limestone, lying entirely within the *Polygnathus communis carinata* biozone of Groessens (1976) and the *Caninophyllum patulum* assemblage biozone of Ramsbottom and Mitchell (1980). Additional biostratigraphical information relating to this part of the succession, including detail of the distribution of conodonts, corals and brachiopods, is given by Whittaker and Green (1983).

The Middle Hope Volcanic Beds crop out at several locations on the northern side of the Middle Hope peninsula (see (Figure 7.16))a. They are best examined in two small bays, one at the eastern end of Swallow Cliff [ST 3245 6605] and the other 700 m WNW of Woodspring Priory [ST 337 664] (localities 1 and 2 in (Figure 7.16)a. Details of the succession are illustrated in (Figure 7.17).

The lower part of the Black Rock Limestone, below the volcanic rocks, consists of decimetre-scale, bioturbated wackestones and packstones, with fissile and manly layers. The fauna consists of crinoids, brachiopods, and rugose and tabulate corals. Trace fossils include *Zoophycos, Chondrites, Planolites* and *Thalassinoides*-likeburrows. This is overlain by a unit of multicoloured tuffs, which coarsens upwards. Lapilli-rich layers, 3–5 cm thick, within this unit also increase in grain size upwards. Bioclastic material of marine origin is present in these tuffs. Associated with the tuffs are thin-bedded limestones, some planar stratified or showing symmetrical ripples. The multi-coloured tuffs are in turn overlain by a unit of green, graded and ungraded lapilli-tuffs, with clasts of devitrified amygdaloidal basalt and unidentified chloritized rock, mixed with marine bioclastic material (Figure 7.18). Calcite vein networks are prominent locally. Within the ungraded lapilli-tuffs there are matrix- and clast-supported conglomerates, with clasts of chert nodules and limestones. Also associated with the lapilli-tuffs are bioclastic limestones and both cross-stratified and laminated sandstones (Figure 7.19). The latter have abundant small vertical burrows (pipe rock') associated with the brachiopod *Lingula mytiloides* (Faulkner, 1989b). Within the lapilli-tuffs is a prominent, laterally impersistent basaltic pillow lava. At Swallow Cliff, the lava ranges in thickness from 3.5 m to 4.3 m. The basalt is very weathered with abundant calcite-filled amygdales up to 10 cm across. The upper surface is very irregular and highly amygdaloidal.

The Middle Hope Volcanic Beds thin laterally from 37 mat Swallow Cliff in the west, to 4 m in the east of the site [ST 348 669]. They are overlain erosively by the upper part of the Black Rock Limestone, which comprises a fining-upwards, cross-stratified bioclastic grainstone unit (24 m thick) with a conglomerate at its base and a gradational top contact with the overlying Black Rock Dolomite. Faunal evidence presented by Whittaker and Green (1983) indicates the presence of a significant non-sequence at the top of the Black Rock Dolomite after which the Gully Oolite was deposited. The Gully

Oolite is a massive cross-bedded oolite, fossiliferous and partly dolomitized in its lower part.

Interpretation

The lower matrix-rich limestones at the base of the Black Rock Limestone represent deposits formed in the outer part of a sloping, shallow marine shelf (Figure 7.16)b, below storm-wave base (Faulkner, 1989b). The lower tuff unit records the onset of volcanic activity, which increased in intensity with time, producing the coarsening-up trend. The lapilli-rich layers in this unit indicate periods of more energetic eruptions. Associated limestones were probably deposited by storm currents (Faulkner, 1989b). An upward-shallowing trend recognizable in these lower units is interpreted as a response to local updoming associated with the volcanicity.

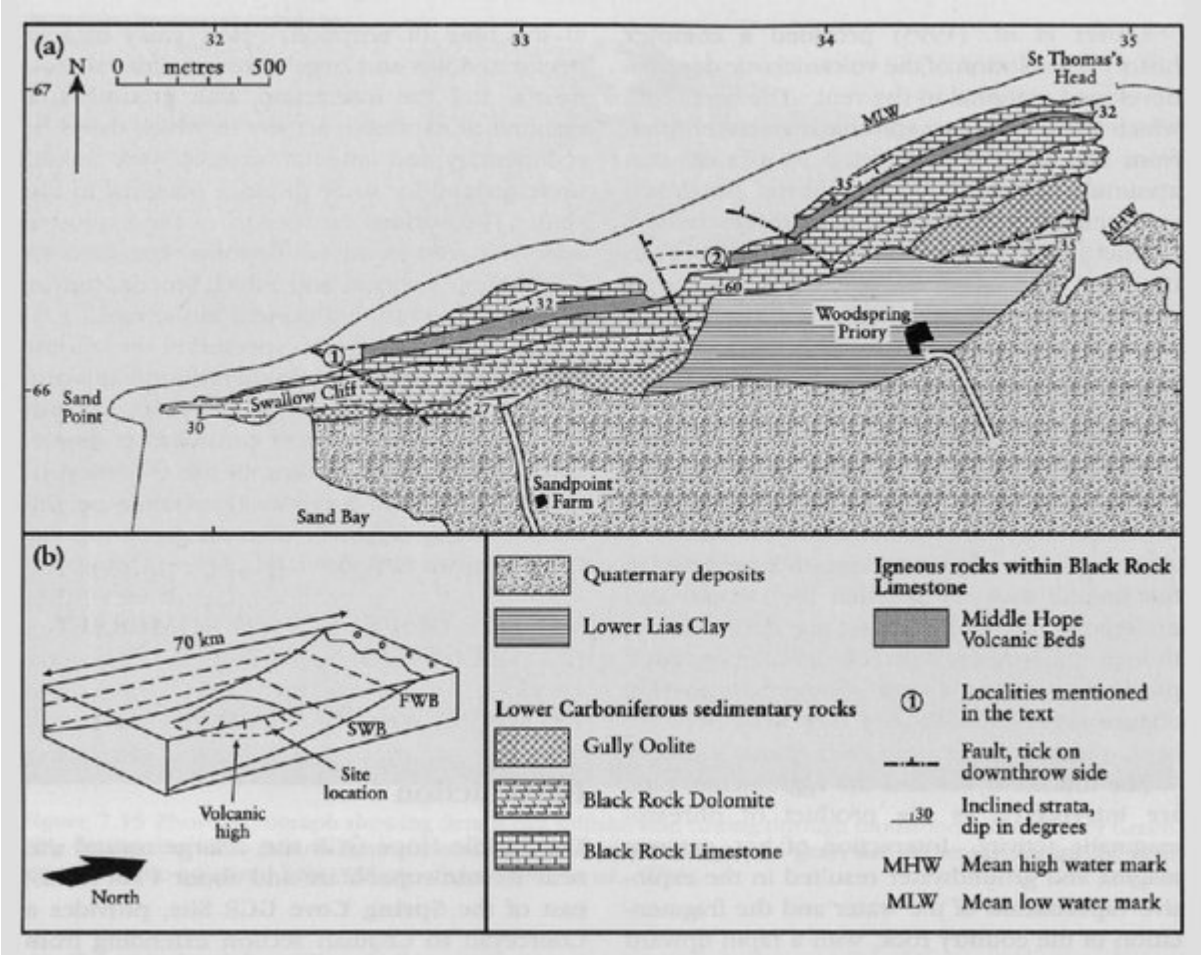
The overlying lapilli-tuffs were also deposited in marine waters, and were emplaced either by sediment gravity flows related to the eruptions, or by marine currents. The pillow basalts indicate subaqueous igneous activity, and show that the site was close to the volcanic centre. The marine limestones associated with the lapilli-tuffs were current reworked. The style of the vertical burrows in the sandstones suggests rapid sedimentation and the cyclic repetition of thin rippled layers with drapes of fine tuff indicates fair-weather deposition above wave base (Faulkner, 1989b). This sequence is interpreted as representing deposition of the lapilli-tuffs in relatively shallow water as the volcanic cone built up to its maximum height. Progressive eastward thinning of the volcanic beds suggests that the source of this volcanic material lay to the west of the site.

The thick, cross-stratified grainstone unit at the top of the Black Rock Limestone represents part of a transgressive, high-energy offshore shoal, influenced by longshore or tidal currents that formed in progressively deeper water as the volcanic cone was eroded or as the regional sea level rose, drowning the shoal (Faulkner, 1989b).

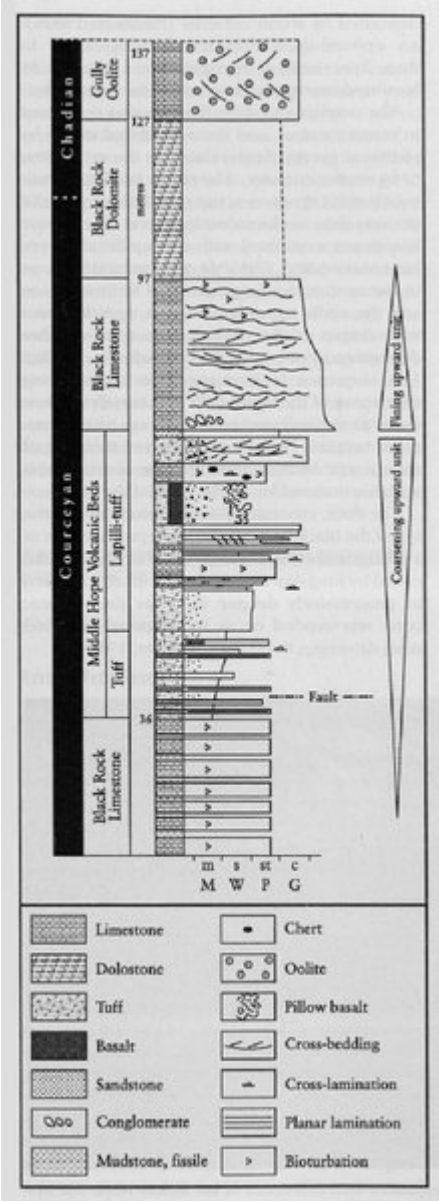
Conclusions

The Middle Hope GCR site provides an exceptional section of Tournaisian (Courceyan) marine limestones and volcanic rocks, representing the growth and subsidence of a volcanic cone on the outer part of an Early Carboniferous shallow-sloping marine shelf. The repeated exposure of the Middle Hope Volcanic Beds along the northern shoreline of the site allows the anatomy of the volcanic pile to be reconstructed in detail. The combined association of sedimentological and palaeontological features indicates that although the volcanic high was initially below storm-wave base, it subsequently developed in progressively shallower water as a result of volcanic updoming and the formation of a volcanic cone, which came close to sea level before finally subsiding. Together these features make Middle Hope one of the most important sites for the understanding of Early Carboniferous volcanic processes in southern England.

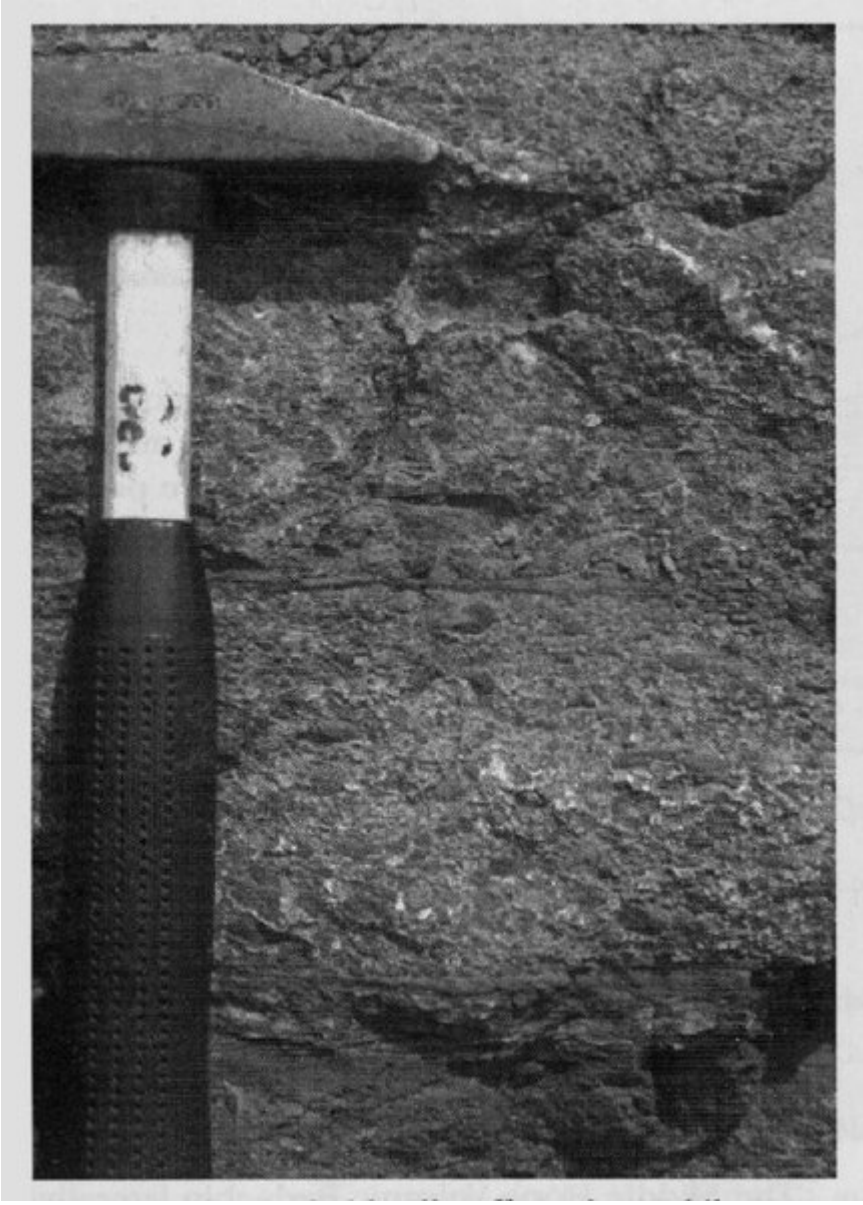
References



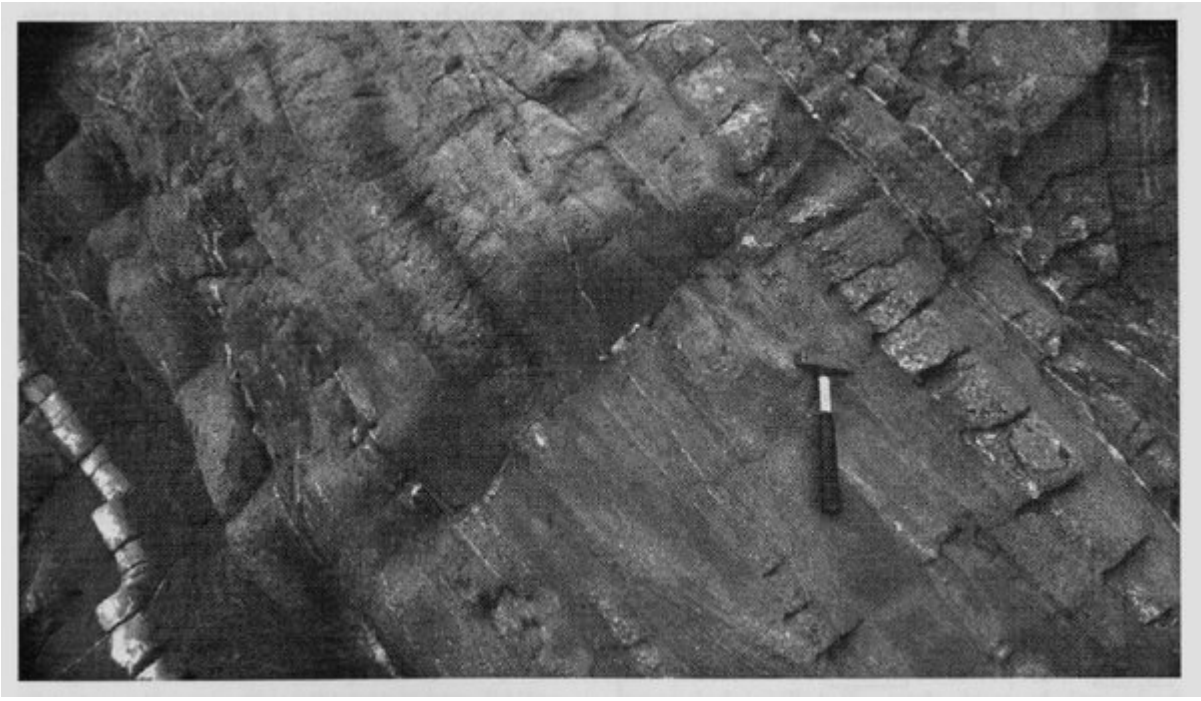
(Figure 7.16) (a) Map of the Middle Hope peninsula illustrating the position of localities referred to in the text (1 = Swallow Cliff [ST 3245 6605]; 2 = 700 m WNW of Woodspring Priory [ST 337 664]). (b) Schematic model of the volcanic high responsible for the formation of the Middle Hope Volcanic Beds (FWB = fair-weather wave base; SWB = storm-wave base). Modified after Faulkner (1989b).



(Figure 7.17) Generalized sedimentary log of the Lower Carboniferous succession at the Middle Hope GCR site. The vertical scale is non-linear; figures are metres above base of section. Horizontal scale indicates grain size: (m = mudstone; s = siltstone; st = sandstone; c = conglomerate; M = mudstone (calcareous); W = wackestone; P = packstone; G = grainstone). After Faulkner (1989b).



(Figure 7.18) Graded lapilli-tuffs in the Middle Hope Volcanic Beds. The hammer shaft is about 35 cm long. (Photo: P.J. Cossey.)



(Figure 7.19) Graded and cross-bedded lapilli-tuffs, interbedded with limestones in the Middle Hope Volcanic Beds. The hammer shaft is about 35 cm long. (Photo: P.J. Cossey.)