
Brathay Quarries

[NY 356 010], [NY 359 010], [NY 357 016] and [NY 358 017]

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Introduction

This site comprises four disused quarries between Hawkshead and Ambleside in the western part of the Lake District (Figure 3.49). The Brathay Quarries *sensu stricto* lie on the east side of Great Brathay [NY 357 016] and in Renny Park Coppice [NY 358 017]. High Crag Quarry [NY 356 010] and Cold Well Quarry [NY 359 010] lie about 0.5 km farther south, along the ridge between High Crag and Randy Pike. The two sets of quarries were the original type locations for two of the three major lithostratigraphical units of the Lake District Wenlock Series: the Brathay Flags (Marr, 1878) and the Coldwell Beds (Aveline and Hughes, 1872). Subsequently, Kneller *et al.* (1994) have formalized the Brathay and Coldwell formations, and also established the intervening Birk Riggs Formation.

The Brathay Flagstone was nailed after this locality by Sedgwick (e.g. 1845). However, Sedgwick (1846) came to prefer the term Coniston Flagstone, and it was Marr (1878) who reverted to the original name, but for the lower part only of Sedgwick's Coniston Flags. Moseley (1984) used the term Brathay Flags Formation. In formalizing the Brathay Formation, Kneller *et al.* (1994), following Kneller (1990), offered an alternative type section for the formation in Ashgill Beck [SD 2711 9525], within the nearby Torver–Ashgill GCR site. The latter site, incidentally, also contains the type section for the Birk Riggs Formation, a unit that corresponds in large part to the Grit Band 1 of Aveline and Hughes (1872) and the Lower Coldwell Beds of Marr (1878).

The Coldwell Formation is characterized by calcareous siltstone units, the presence in this area of such relatively lime-rich beds having been noted by Sedgwick (1845). These units, together with an intervening laminated siltstone unit, constitute the Coldwell Beds of Aveline & Hughes (1872). Marr (1878) expanded the term Coldwell Beds and divided it into three divisions, and included within it both the underlying sandstone-rich unit — the present Birk Riggs Formation — and the overlying unit dominated by laminated siltstone — the present Wray Castle Formation (of Kneller *et al.*, 1994) which is of early Ludlow age. This illogical grouping of the Lower, Middle and Upper Coldwell Beds, all of contrasting lithology, persisted for a century (e.g. Moseley, 1984; Lawrence *et al.*, 1986). Kneller *et al.* (1994), wisely, reverted to the original sense for their formalized Coldwell Formation, although they based it on a type section east of Birk Riggs ([SD 2808 9536]–[SD 2814 9529]), again within the Torver–Ashgill GCR site. The constituent lower and upper calcareous siltstone units have been distinguished as the Randy Pike Member and High Cross Member respectively (Kneller, 1990; Kneller *et al.*, 1994). The type section for the Randy Pike Member is near the Brathay Quarries site at Randy Pike Quarry [NY 3622 0097], 250 m east of Cold Well Quarry; that for the High Cross Member is some 3 km to the south-west of Cold Well near High Cross [SD 329 984].

The Brathay Quarries site remains a historically important reference area for the lithostratigraphical divisions of the Wenlock Series of the Lake District. The quarries, additionally, provide valuable confirmatory sections within the region for the graptolite biozonation of the Wenlock sequence, important for correlation of the western and eastern Lake District sections, and for international correlation (Rickards, 1969, 1989a).

Description

The Wenlock rocks in this area of the Lake District dip south-south-eastward at 30° to 40°. They form part of the continuous, tilted succession here of Windermere Supergroup rocks which range from late Ordovician (Ashgill Series) to late Silurian (Ludlow Series) in age (British Geological Survey, 1998). Minor north-verging anticline–syncline pairs affect the contact between the Coldwell Formation and overlying Wray Castle Formation south-east of Cold Well Quarry, and the area is cut by steep NNE-striking sinistral faults and NW-striking dextral faults.

The Brathay Quarries *sensu stricto* (Figure 4.61) expose the bluish-grey laminated siltstone that characterizes the Brathay Formation throughout the region. The lamination comprises couplets of muddy quartzose silt overlain by carbonaceous mudstone, on a scale of about 3 couplets to a millimetre. This facies also contains common carbonate nodules, rare massive grey mudstone beds a few centimetres thick, and beds of bentonitic clay up to 15 cm thick. The quarried units mostly lie within the *rigidus* or the *linnarssoni* Biozone of the middle Wenlock.

The ground between the Brathay Quarries *sensu stricto* and the High Crag and Cold Well quarries is only intermittently exposed. It contains the upper part of the Brathay Formation and the whole of the Birk Riggs Formation. The latter, sandstone-rich unit comprises thin to very thick, fine- to medium-grained sandstone–mudstone couplets, together with interbedded siltstone–mudstone couplets, intercalated with laminated siltstone typical of the Brathay Formation. The Birk Riggs Formation is of late Wenlock, *lundgreni* Biozone age (Rickards, 1969).

The High Crag and Cold Well quarries expose a 15 m unit of pale blue-grey calcareous siltstone, typically mottled due to bioturbation, which represents the Randy Pike Member of the Coldwell Formation. *Chondrites* burrows are evident in less bioturbated units, as are thin-graded beds of laminated or cross-laminated coarse siltstone. Dark grey laminated siltstone, similar to that in the Brathay Formation, occurs near the top and bottom of the unit. The Randy Pike Member is overlain by a thicker (about 25 m) unit of laminated siltstone and then by a further band of calcareous siltstone e.g. [NY 3575 0087], the latter representing the High Cross Member.

The Randy Pike Member contains a shelly fauna of trilobites, bivalves, crinoid ossicles, brachiopod fragments and orthoconic nautiloids, and its laminated siltstone intercalations yield graptolites characteristic of the *nassa* Biozone. The Coldwell Formation as a whole, however, ranges through the *ludensis* Biozone of the uppermost Wenlock and, based on the presence of *Monograptus varians* near the top of the High Cross Member, into the *nilssoni* Biozone of the lowest Ludlow (Kneller, 1990; Rickards, 1970b).

Cold Well Quarry is the type locality for the trilobite *Delops obtusicaudatus* (Salter, 1849), and the type material from here has subsequently been used by M'Coy (1851c), Salter (1864), Rickards (1965a) and Morris (1988).

Interpretation

The Brathay Formation and Coldwell Formation represent deposition in, respectively, anaerobic and aerobic marine bottom waters of the Silurian Lake District Basin. During times of anaerobic deposition, fallout of silt and organic carbon produced a laminated deposit that remained undisturbed by any benthic fauna. When the bottom waters were aerated in late Wenlock time, probably by a sea-level fall (Kemp, 1991), a relatively rare shelly benthic fauna became established and the sediments were strongly bioturbated. There has been particular debate over the origin and time-calibration of the lamination of the Brathay facies (see Rickards, 1964; Dimberline *et al.*, 1990; Kemp, 1991). This debate is reviewed in the description of the River Rawthey GCR site.

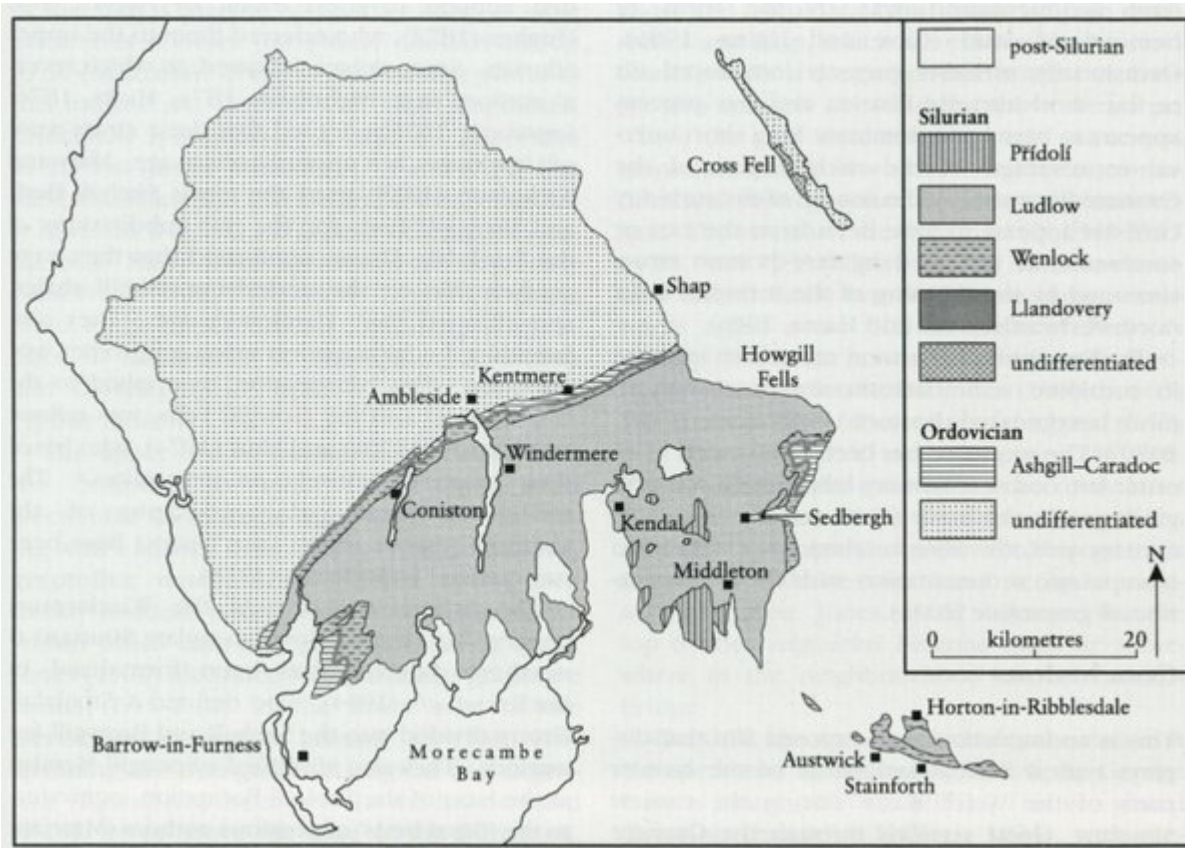
A more complete history of Wenlock deposition can be deduced from the more continuously exposed successions within the very closely linked Torver–Wenlock GCR site, located some 13 km along strike to the south-west. Other complementary GCR sites in northern England include those of the River Rawthey in the Howgill Fells and Arcow Quarry in the Horton-in-Ribblesdale area. All these are relatively offshore sites, and appear to be connected during Wenlock times to similar, deeper water basinal or slope environments in the Welsh Basin, central Ireland, and the East Anglian Basin (see Holland, 1992).

Conclusions

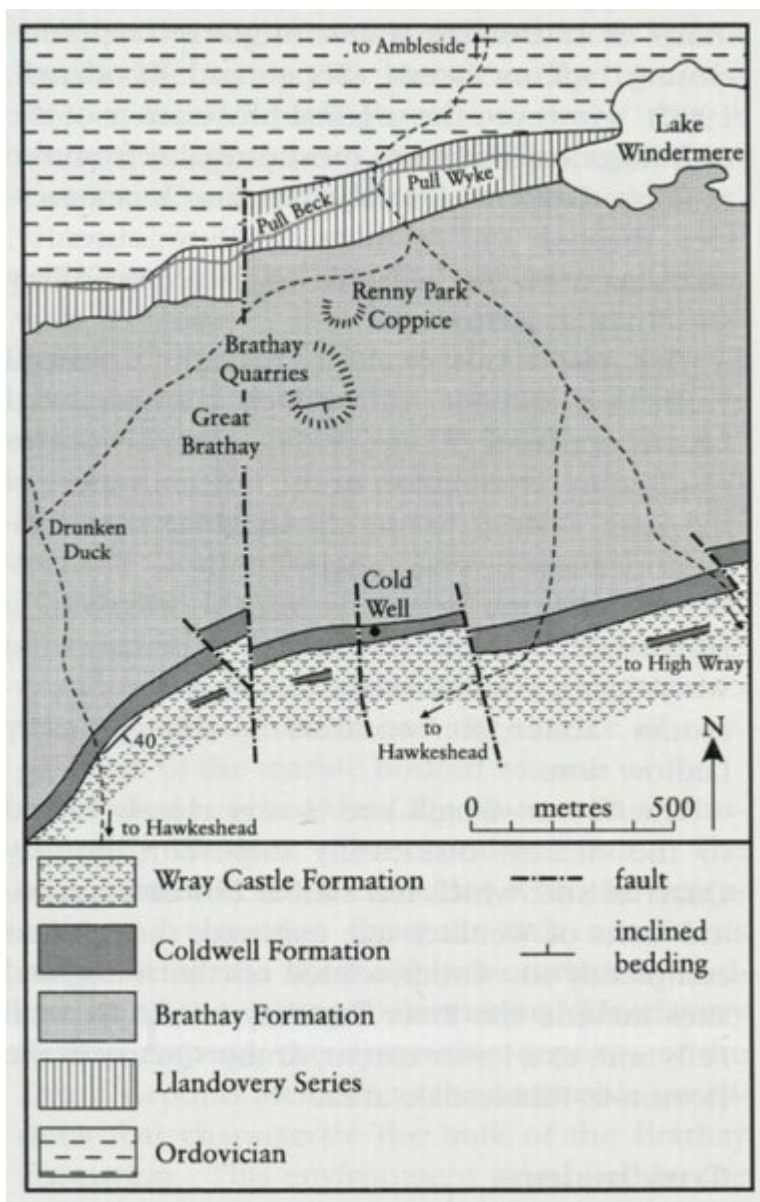
The Brathay Quarries site is historically important in the early development of a lithostratigraphy for the Lake District rocks. Brathay and Cold Well still lend their names to two of the three Wenlock age formations, even though alternative type sections have been proposed within the Torver–Ashgill GCR site. The Brathay and Coldwell formations can be mapped across the Lake District and Howgill Fells, and have direct analogues in other Lower Palaeozoic basins of the old Avalonian continent. The Randy Pike Member of the Coldwell Formation is well displayed within the site, and defined

in adjacent ground.

References



(Figure 3.49) Outline geological map of the Lake District and Howgill Fells (modified after Rickards, 1989a).



(Figure 4.61) Geology of the original type areas of the Brathay and the Coldwell formations, the Lake District (after Rickards, 1989a, with revision of lithostratigraphy after Kneller et al., 1994).