Sykes Quarries, Lancashire

[SD 628 519] and [SD 627 519]

Potential GCR site

Introduction

The Sykes Quarries site consists of two disused quarries, the east and west quarries, which lie approximately 4 km north of Dunsop Bridge on the east [SD 6284 5188] and west [SD 6266 5185] sides of the Dunsop Bridge to Lancaster road. They lie in the core of the Sykes Anticline (Figure 6.1) and expose early Viséan limestones of the late Chadian Helton Beck Limestone Member (Hodder Mudstone Formation, Worston Shale Group) (Figure 6.2). The section provides arguably the most spectacular evidence for the formation of tectonically induced gravity slide and slump structures in the Craven Basin. These structures developed on a slope at the southern boundary of a large area of carbonate deposition that extended north to the southern Lake District. A deep fault, which controlled the position of this slope, lies beneath the Sykes Anticline. The anticline was formed by compression of this fault (inversion) during late Carboniferous earth movements (Variscan Orogeny). The anticlinal structure is an ideal analogue for oil and gas traps, although here the trap has been breached and has leaked most of its hydrocarbons due to erosion. The limestones still smell of hydrocarbons when freshly broken. Detailed accounts of the site geology can be found in Gawthorpe and Clemmey (1985) and Aitkenhead *et al.* (1992).

Description

About 85 m of early Viséan limestone and thin mudstones of the Hetton Beck Limestone Member are exposed. These limestones lie in the basal part of the Hodder Mudstone Formation, although their contact with the underlying Clitheroe Limestone Formation is not exposed. Much of the Hetton Beck Limestone Member at this site comprises fine-grained packstones and grainstones with peloidal and carbonate lithoclast textures. Primary sedimentary structures are largely obliterated by bioturbation. In the upper parts of the succession, exposed in both quarries, contorted bedding and cross-cutting bounding surfaces can be seen (Figure 6.13) and (Figure 6.14). These gravity slide and slump features were first described by Gawthorpe and Clemmey (1985). Evidence of both intrafolial soft-sediment slumps and large-scale slide structures can be seen. Some of the features preserved in higher beds in the east quarry are turbidite channels infilled with thin beds of coarse-grained, graded-bedded, crinoidal packstones. Conspicuous in the west quarry, due to differential weathering, are silicified bands of the tabulate coral *Syringopora.* Other macrofauna include bellerophontid gastropods, solitary caniniid corals (e.g. *Siphonophyllia garwoodi,* spiriferoid, productoid and chonetoid brachiopods and a new undescribed species of the trilobite *Cummingella.* Calcareous microfossils are abundant, and include the cyanobacterium *Girvanella,* the dasycladacean alga *Koninckopora* (both mono- and bilaminar-walled forms), and numerous well-preserved foraminifera of the Cf4a2 Subzone including species of *Eoparastaffella* and *Lysella,* indicating a late Chadian age (not Arundian as correlated by Gawthorpe and Clemmey, 1985). Archaediscid foraminifera, diagnostic of a post-Chadian age, have not been found, despite the examination of over 100 thin-sections by one of the present authors (N. Riley).

Interpretation

The Sykes Anticline is a periclinal structure formed by Variscan inversion (with transtensional shear) along a basement fault (Bowland Line; see (Figure 6.1)); it forms the westernmost per-dine (exposing early 'Viséan rocks) of a series of *en échelon* structures extending eastwards to the Eshton–Hetton area (see Haw Crag and Clints Quarry GCR site reports, this chapter). The basement fault, which was active during early Viséan extension, bounds the southern margin of a carbonate ramp attached to the South Lake District High; the Hetton Beck Limestone Member seen at this site being the lateral down-ramp facies equivalent of the Martin Limestone (see Meathop Quarry GCR site report, Chapter 4) farther north. The gravity slides and slumps demonstrate foundering of the southern margin of the ramp due to movement of the

underlying basement fault (interpreted from seismic and gravity data) and the creation of a slope over its footwall. To the south, in the Whitewell and Slaldburn anticlines, coeval turbidites fed from this ramp comprise the Whitemore Limestone Member.

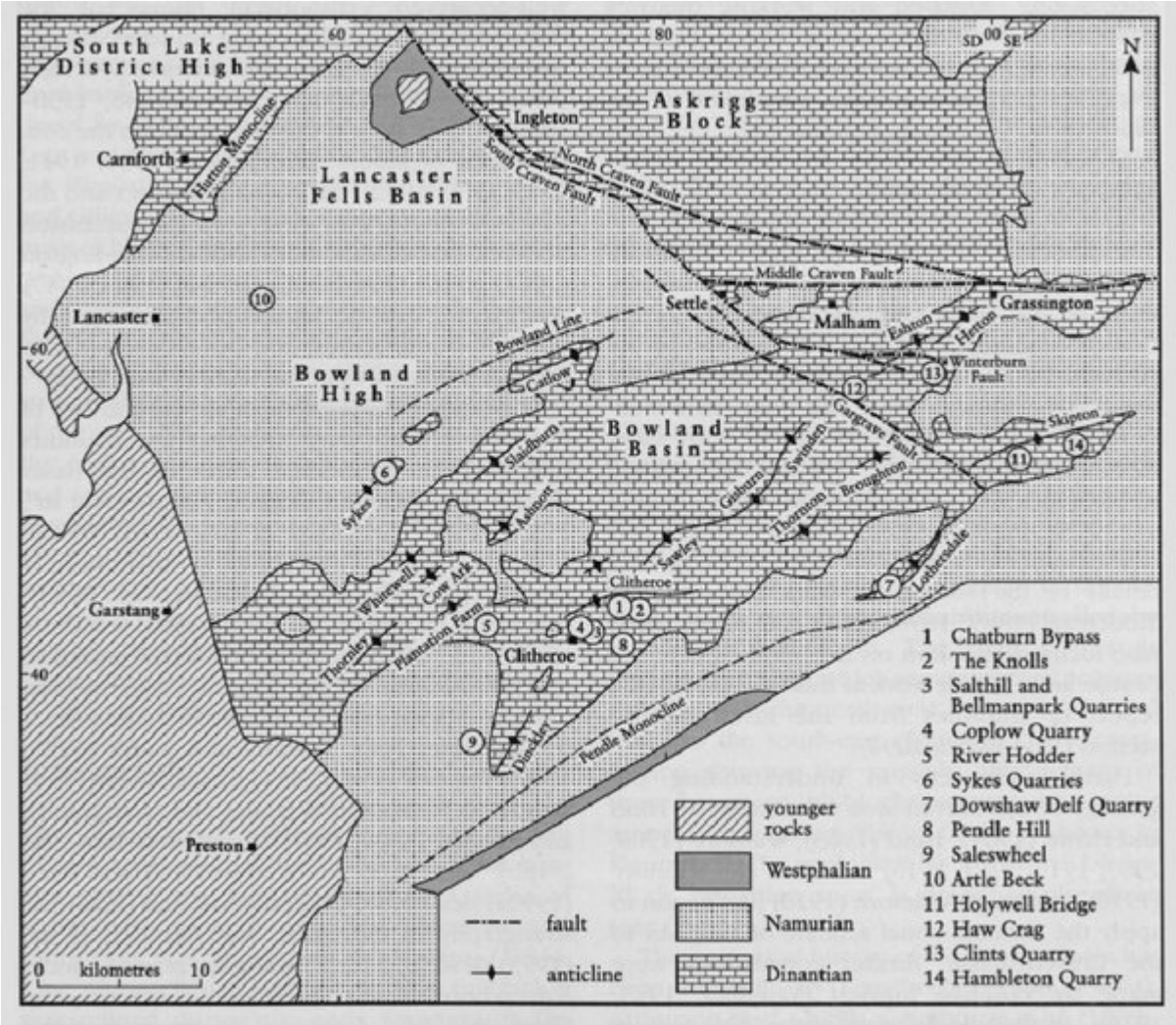
Conclusions

This site demonstrates a variety of effects that deep-seated faults had on sedimentation whilst the Earth's crust was being stretched and extended during Early Carboniferous times.

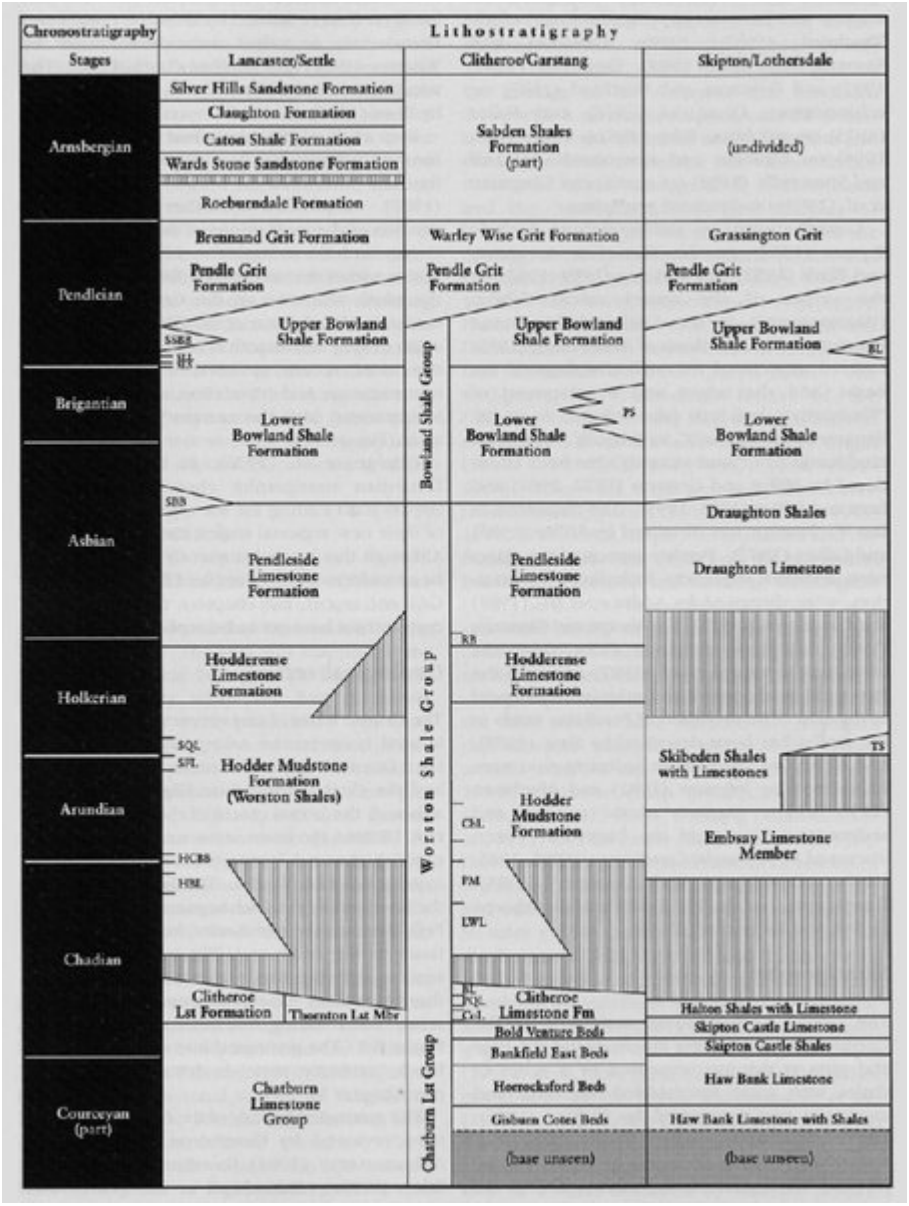
Such effects, in this case, controlled the junction (slope) between a shallow-water carbonate system (ramp) to the north and a deeper-water area to the south in which carbonate turbidites were deposited. Fault movements at depth below this junction also triggered the down-slope movement of partially consolidated masses of gravitationally unstable sediment in the form of slumps and slides.

Toward the end of the Carboniferous Period, the crust was compressed, giving rise to the anticlinal structure in which the site is exposed. The Sykes Anticline and similar structures trending along the Bowland Line to near Skipton, probably held significant hydrocarbons before being breached by erosion, and serve as good models for hydrocarbon traps (gas seeps still occur in the eastern part of the pericline in the adjacent valley of Whitendale to the east).

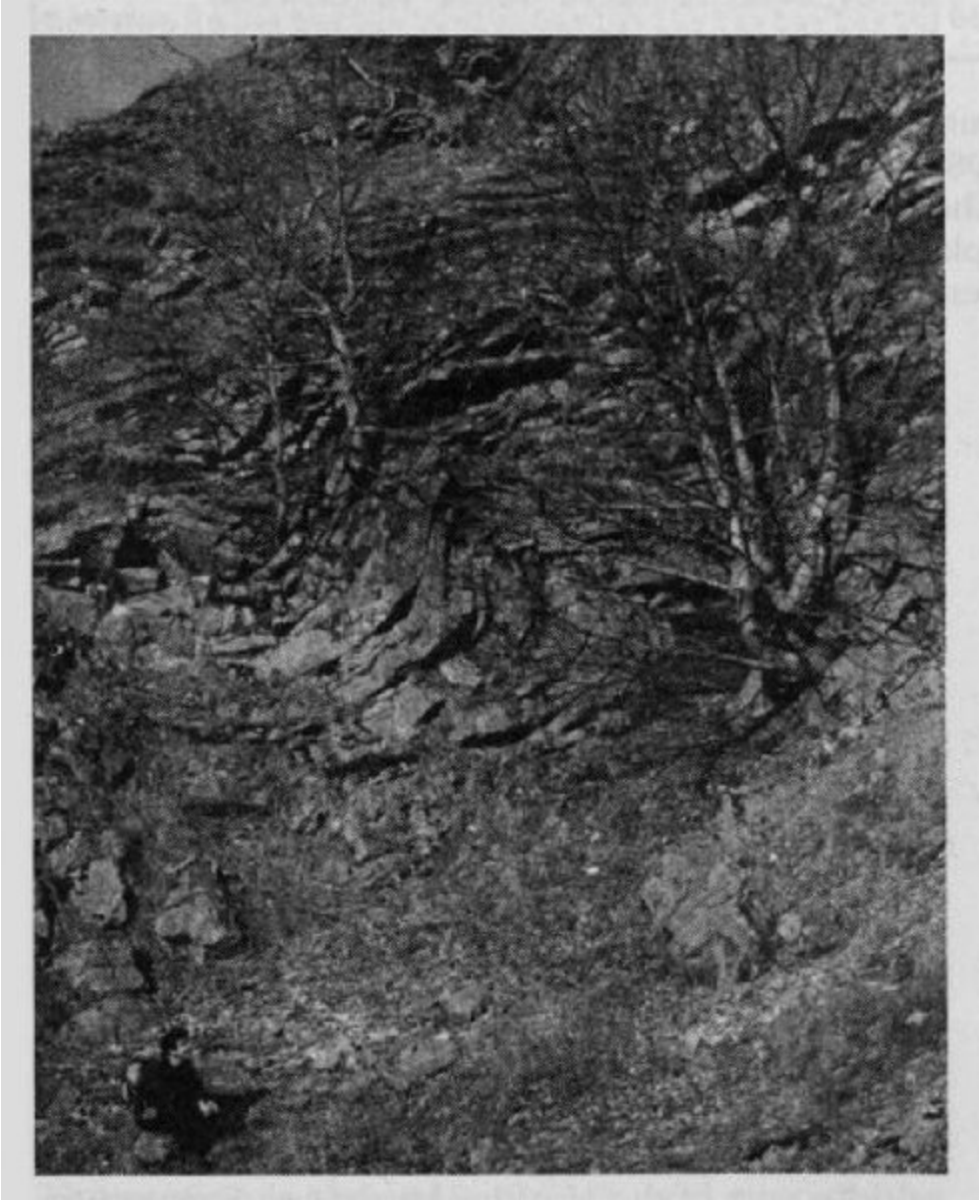
References



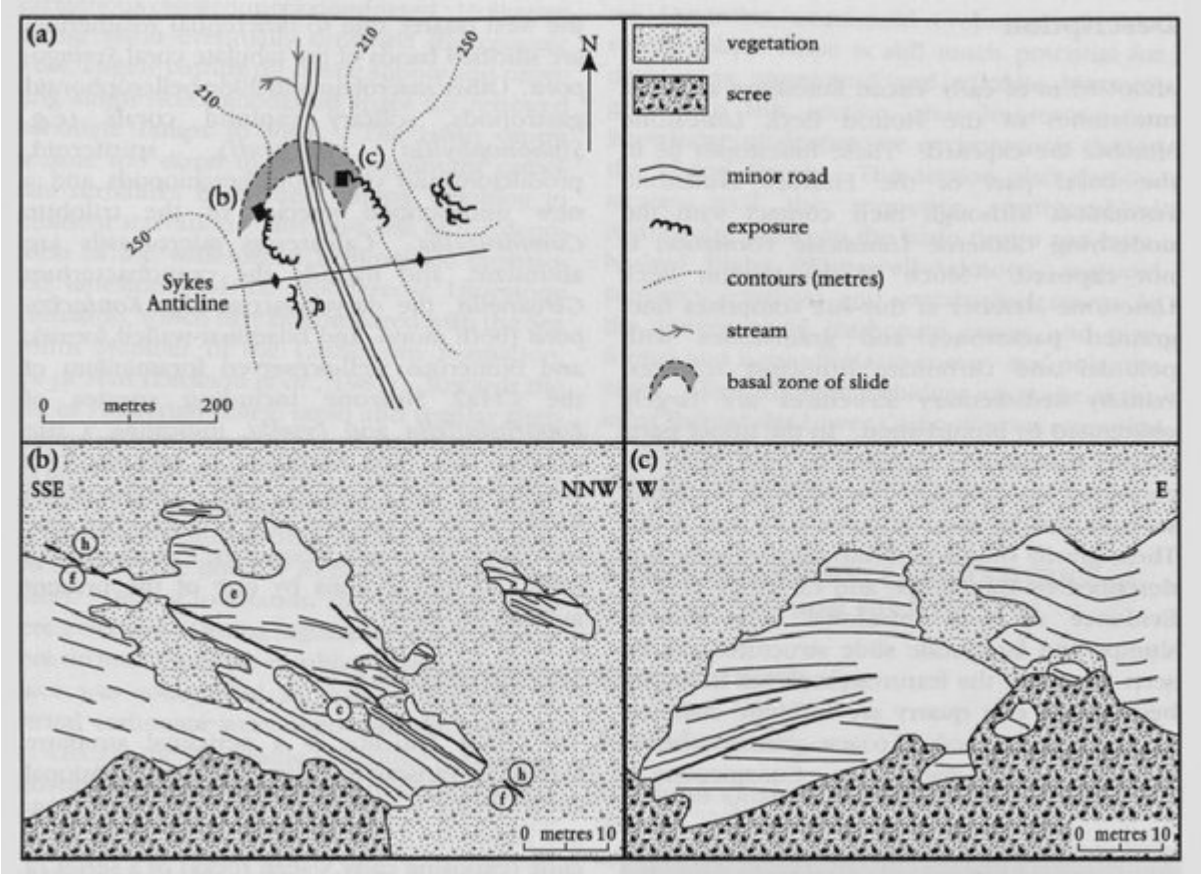
(Figure 6.1) Geological map of the Craven Basin illustrating the distribution of Carboniferous outcrops and the locations of GCR sites described in the text. Note that in the Bowland Basin area, the hinge traces of major folds within the Ribblesdale Fold Belt are also shown. The Central Lancashire High lies to the south of the Pendle Monocline beneath the area obscured by the key. Based on Riley (1990a) and Brandon et al. (1998).



(Figure 6.2) Simplified stratigraphical chart for the Lower Carboniferous succession of the Craven Basin. (HBL — Hetton Beck Limestone Member; HCBB Haw Crag Boulder Bed; SFL — Scaleber Force Limestone Member; SQL — Scaleber Quarry Limestone Member; SBB — Scaleber Boulder Bed; SLS — Sugar Loaf Shales; SLL — Sugar Loaf Limestone; SSBB School Share Boulder Bed; CoL — Coplow Limestone Member; PQL — Peach Quarry Limestone Member; BL — Bellman Limestone Member; LWL — Limekiln Wood Limestone Member; PM — Phynis Mudstone Member; ChL — Chaigley Limestone Member; FIB — Rad Brook Mudstone Member; PS — Pendleside Sandstones Member; TS — Twiston Sandstone Member; BL — Berwick Limestone.) Areas of vertical ruling indicate non-sequences. Not to scale. Compilation based on Hudson and Mitchell (1937), Metcalfe (1981), Arthurton et al. (1988), British Geological Survey (1989), Riley (1990a, 1995), Aitkenhead et al. (1992), Brandon et al. (1995, 1998).



(Figure 6.13) Deformational structures (possible slump folds; R. Gawthorpe, pers. comm., 2000) in the late Chadian Hetton Beck Limestone Member (Worston Shale Group) at Sykes Quarry (east), Forest of Bowland. (Photo: P.J. Cossey.)



(Figure 6.14) Geometry of large-scale gravity slide structures in the late Chadian Hetton Beck Limestone Member at Sykes Quarries. After Gawthorpe and Clemmey (1985). (a) Map illustrating the locations of the sections shown in figures (b) and (c). (b) Sykes Quarry (west) showing deformational bed geometries (e — extensional; c — compressional) associated with the principal slide plane (h — hanging wall; f — footwall). (c) Sykes Quarry (east) showing slide planes at right angles to those seen at Sykes Quarry (west) interpreted as lateral ramps. Bold lines in (b) and (c) are slide planes.