Greenleighton Quarry, Northumberland

[NZ 034 917]

Introduction

Greenleighton Quarry, a restored old quarry [NZ 034 917] 10 km south of Rothbury, exposes one of the finest accessible and fossiliferous sections of the lower Pendleian (E_{1a} Great Limestone Cyclothem. The discovery of rare goniatites here has provided critical evidence in defining the position of the Brigantian–Pendleian (basal Namurian) stage boundary throughout northern England and proved vital to the dating and correlation of Stainmore Group sequences across the Northumberland Basin. Details of the succession and palaeontological information are recorded by Fowler (1936) and Fairbairn (1980), while the stratigraphy is discussed in depth by Johnson *et al.* (1962) and Hull (1968).

Description

The exposed section (Figure 3.22) includes 12 m of the Great Limestone and is overlain by 7 m of highly fossiliferous shale which contains thin rippled and bioturbated siltstone–sandstone beds. The sequence is capped by a thin sandstone (Figure 3.23). The Great Limestone is divisible into a lower unit (7 m) of thick limestones with thin mudstone partings (the 'Bench Posts' and 'Main Posts' subdivisions of Fairbairn, 1980) and an upper unit (5 m) of thick limestones with prominent mudstone interbeds (the 'Transitional Posts' and 'Tumbler Beds' subdivisions of Fairbairn, 1980). The fauna of the Great Limestone here includes sponges (*Chaetetes depressus, C. septosus*), corals (*Dibunophyllum, Actinocyathus floriformis laticlavia*), bryozoans (*Tabulipora*), a variety of productoid and spiriferoid brachiopods (e.g. *Latiproductus latissimus* and *Spirifer trigonalis*), nautiloids (*Orthoceras*)and the trace fossil *Zoophycos* (Fowler, 1936; Fairbairn, 1980). Although the distribution of fossils within the sequence is poorly constrained, coral and sponge remains are more common in limestones at the base of the succession while the shelly faunas are more prevalent in the younger mudstones. A list of the fauna from the mudstones of the Tumbler Beds provided by Fairbairn (1980) includes brachiopod taxa in abundance, together with a number of coral, bryozoan, echinoderm, trilobite and bivalve taxa, but it is unclear how many, if any, of these originate from the Greenleighton Quarry site. Although chaetetids occur at the same level as the *Chaetetes* biostrome in the Great Limestone at Brunton Bank Quarry (Johnson, 1958), their development at Greenleighton is less significant.

The shale sequence above the 'Tumbler Beds' is particularly fossiliferous and from it a diverse array of bryozoan, brachiopod, bivalve, cephalopod and echinoderm taxa has been reported (Fairbairn, 1980). The sequence is especially rich in chonetoid, spiriferoid and productoid brachiopods (Johnson *et al.,* 1962). A number of thin and laterally impersistent calcareous siltstones and sandstones in this part of the succession contain dense monospecific assemblages of chonetoids resembling *Rugosochonetes* cf. *celticus.* The interval has also generated the type material of the rhynchonellid *Pleuropugnoides greenleightonensis* (Ferguson, 1966). More importantly, the shales are renowned as the likely source of six specimens of the diagnostic (E_{1a}) goniatite *Cravenoceras leion* (Bisat, 1930) collected from piles of overburden discarded during quarrying operations (Johnson *et al.,* 1962)(see (Figure 3.23)). The goniatites were found as uncrushed specimens in limestone nodules and are believed to have originated from a similar band of nodules from the middle of the shale sequence. This remarkable find, in a sequence that was reputedly devoid of useful goniatite markers, enabled Johnson *et al.* (1962) to fix the position of the base of the Pendleian Stage and, for the first time, establish a line of division between Viséan and Namurian age strata in the Northumberland Basin (see discussion below).

Interpretation

Although goniatites are relatively uncommon elements of the Yoredale succession in the Northumberland Basin, significant finds by Johnson *et al.* (1962) and Hull (1968) have facilitated the recognition of a number of Namurian stage boundaries and, in particular, the junction between the Viséan and Namurian series. The latter (formerly also the boundary between the Lower and Upper Carboniferous subsystems) is characterized by an upward change in the

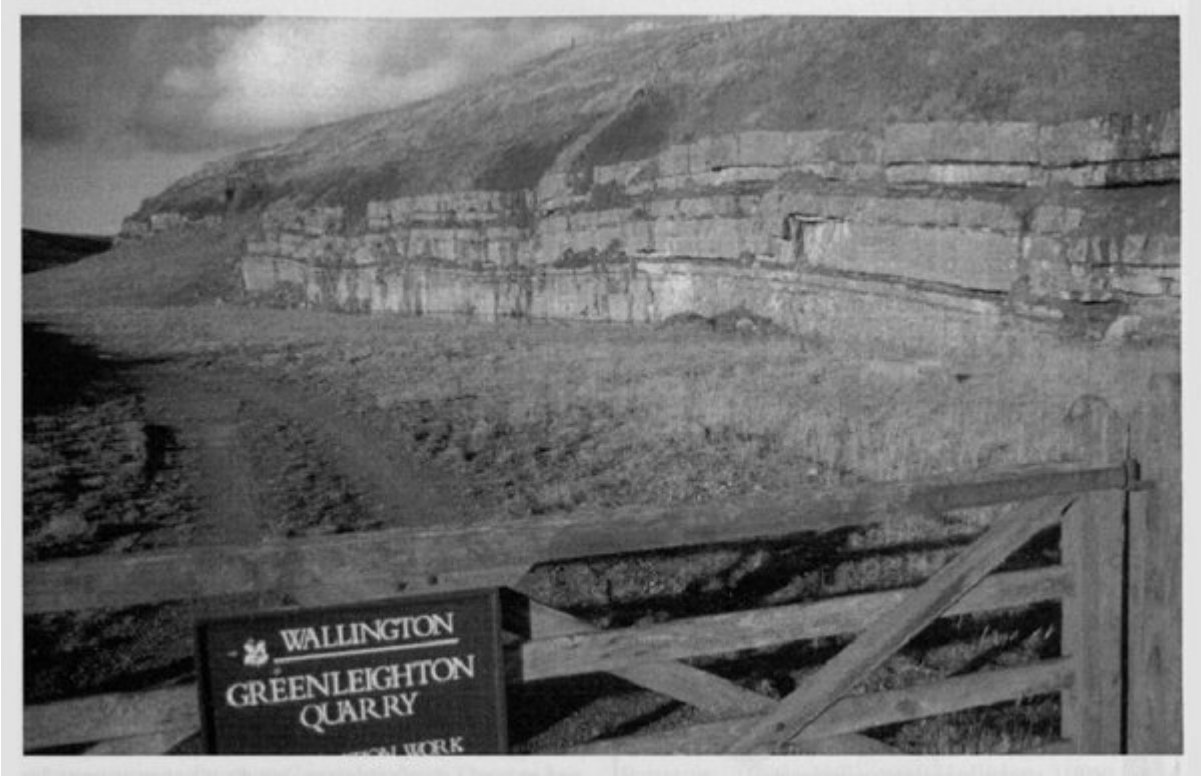
goniatite faunas and the replacement of *Sudeticeras* and *Girtyoceras* by *Cravenoceras* and *Eumorphoceras* (Bisat, 1950). The discovery of *Cravenoceras leion* (E_{1a}) from shale above the Great Limestone at Greenleighton Quarry, and *Girtyoceras? costatum* (P_{2c}) from 2 m above the Undersett Limestone (= 4 Fathom Limestone) in the Mount Pleasant Borehole near Barnard Castle, together with records of *?Cravenoceras* and *Eumorphoceras pseudobilingue* from the intervening beds (Hudson, 1941; Black, 1950; Rayner, 1953; Wilson, 1960a), led Johnson *et al*. (1962) and Hull (1968) to establish the Brigantian–Pendleian stage boundary (and the base of the Namurian Series) in sandy facies beds close to, but below, the base of the Great Limestone. This is further supported by the discovery of *Eumorphoceras* close above the Great Limestone at Brunton Bank, Chollerford (Johnson, 1986) and from the Throckley Borehole, Newcastle (Richardson, 1965; Ramsbottom, 1966). The Great Limestone has since been widely used as a key lithostratigraphical marker at the base of the Namurian Series and in particular for regional stratigraphical correlations across northern England and southern Scotland (Taylor *et al.,* 1971; Ramsbottom *et al.,* 1978; Johnson *et al.,* 1995). Further refinement of the position of the base of the Pendleian Stage in the Northumberland Basin is expected with advances in micropaleontological and palynological research.

The results of detailed sedimentological work have yet to be published, but the general character of the succession reflects the typical Yoredale pattern of fossiliferous marine limestones and shales capped by coarser clastic beds of deltaic origin (Johnson, 1962).

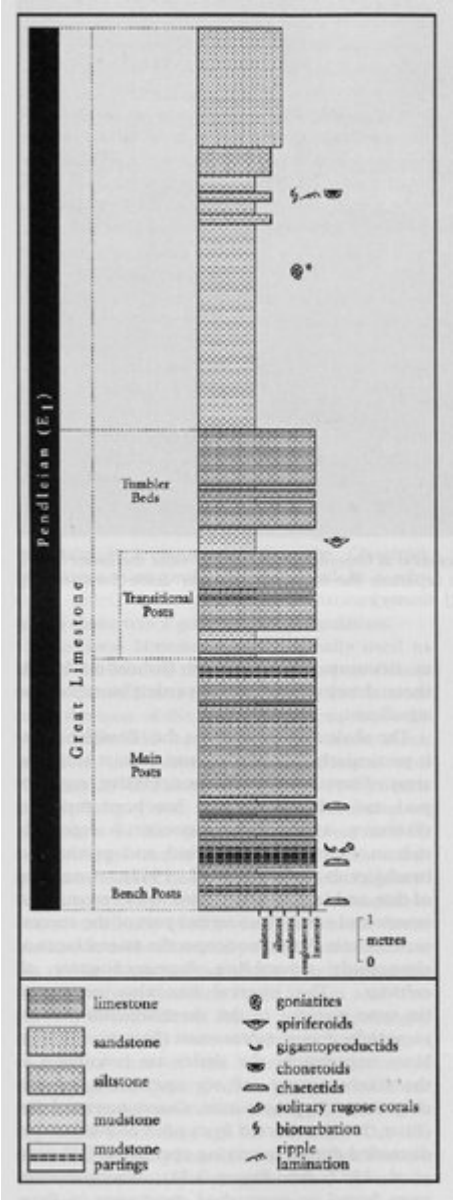
Conclusions

The discovery of the E_{1a} Zone goniatite *Cravenoceras leion* at Greenleighton Quarry has been used to fix the position of the base of both the Pendleian Stage and the Namurian Series close to the base of the Great Limestone. Its occurrence in a richly fossiliferous sequence makes this site one of the most important localities for the dating and correlation of Lower Carboniferous successions in the Northumberland Basin. In addition, the site remains of critical importance to future research, particularly in areas of biostratigraphy, sedimentology and palaeoecology.

References



(Figure 3.22) General view of the Great Limestone succession at Greenleighton Quarry. Note the lower of two thin mudstones within the limestone sequence that separates the lower 'Main Posts' from the overlying 'Tumbler Beds'. See text for further details. (Photo: P.J. Cossey.)



(Figure 3.23) Section of the Lower Namurian (Pendleian) Great Limestone succession at Greenleighton Quarry. An asterisk marks the position of a horizon of limestone nodules that Johnson et al. (1962) regarded as the most likely source of the basal E_{1a} goniatite marker Cravenoceras leion found in the tips nearby. Based on Johnson et al. (1962) and Fairbairn (1980).