# Glebe Quarry, Northumberland

[NU 052 006]

## Introduction

Located in the northern part of the Northumberland Basin, the Glebe Quarry GCR site, a disused limestone quarry [NU 0515 0055] 1 km south-west of Rothbury, provides a key section of the Glebe Limestone Member with arguably the thickest continuous development of 'algal' limestone in the north of England. This unit, lying close to the top of the Cementstone Group, provides the clearest possible evidence of the northern limit of marine sedimentation within the Northumberland Trough during the early part of the Carboniferous Period. Although limited biostratigraphical evidence precludes confident dating, recent micropalaeontological work suggests that the section lies at or close to the Chadian–Arundian boundary (Purnell, 1989, 1992; Armstrong and Purnell, 1993). A brief description of the site geology has been given by Garwood (1931), Fowler (1936) and Weston *et al.* (1955) but modern, published accounts of the sedimentology are altogether lacking. In conjunction with other Northumberland Trough GCR sites in the Tweed Basin (Burnmouth) and in the Bewcastle district (Whitberry Burn, Birky Cleugh and Ellery Sike), the outcrops at Glebe Quarry are critical to the understanding of early Carboniferous palaeogeography in northern England.

## Description

Although no formal lithostratigraphy for the Cementstone Group has been established so far, the Glebe Limestone Member recognized by Purnell (1989) forms part of the Rothbury Limestones described by Miller (1887) at the top of the Cementstone Group. The same unit is referred to as the 'Rothbury Algal Limestone' by George *et al.* (1976).

Fowler's (1936) description of the exposed section at Glebe Quarry mentions 6.7 m of well-bedded, grey limestone (Figure 3.26) packed with nodular, concentrically laminated oncoids (Figure 3.27) containing the microscopic calcified sheaths of *Ortonella furcata,* a form once regarded as a filamentous blue-green alga (Riding, 1977) and now assigned to the cyanobacteria. A prominent band of oncoids nearly a metre thick occurs towards the middle of the sequence. Although widely known from other Lower Carboniferous rocks in northern England and southern Scotland (Anderson, 1950; Leeder, 1975b), the prolific development of *O. furcata* in the Glebe Limestone Member led Garwood (1931) to conclude that the species reached its acme at this horizon. The oncoids range up to 3 cm in diameter and are commonly associated with adnate 'spirorbids', a sparse and possibly restricted fauna of small gastropods, ostracodes, crinoid remains and spongiostromate algal forms (Fowler, 1936). The conodonts *Taphrognathus carinatus* and *T. varians* are also reported from this locality (Purnell, 1992).

## Interpretation

Whereas the presence of conodonts and crinoid remains is a clear indication of deposition in a marine environment, their association with oncoids, gastropods and ostracodes, in the absence of open marine forms such as corals and cephalopods, suggests deposition in a restricted but very shallow marginal marine environment that was subject to periodic salinity fluctuations.

A peritidal setting for the majority of fossil oncoids has been suggested by Wright (1990a).

The oncoids resemble those described from the Lower Border Group by Leeder (1975b), who made comparisons with Recent material described by Logan *et al.* (1964) and suggested formation in a shallow subtidal setting where there was persistent but gentle substrate agitation. A similar origin is envisaged for the concentrically laminated oncoids (Figure 3.27) in the Glebe Limestone Member which appear to have grown as a result of the accretion of carbonate around mobile grains. A more precise understanding of the mechanism of oncoid development at this site requires further petrographical investigation.

During Early Carboniferous times the Rothbury area formed part of a shallow hyper-saline gulf with restricted access to the open ocean. While, to the south-west, both fluvio-deltaic and marine processes appear to have influenced the development of Lower Border Group strata at this time, the role of marine processes is less apparent in the formation of the Cementstone Group (their lateral equivalent in the north-east) which were formed dominantly by fluvio-deltaic and lacustrine processes in an arid alluvial-plain setting (Belt *et al.,* 1967; Smith, 1967; Scott, 1971, 1986; Leeder, 1974b, 1975a, 1992; Johnson, 1984; Chadwick *et al.,* 1995).

Leeder (1974b, 1975a) suggested that the development of gulf carbonate lithofacies interleaved with deltaic deposits in the Lower Border Group was related to periodic phases of delta retreat. In a similar way, the Glebe Limestone Member may have formed as a result of a marine incursion over a subsiding north-easterly derived fluvio-deltaic interval within the Cementstone Group, but further studies are clearly required for the succession to be more fully understood.

Despite early difficulties in the dating and correlation of the algal limestones from Rothbury because of the absence of biostratigraphically useful macrofossils (Johnson *et al.* 1995), correlations with the better known sequences in the Bewcastle district to the southwest have been attempted. Garwood (1931) originally suggested an indirect correlation of the Glebe Limestone Member with the highest algal limestone of the Cambeck Formation, while others (Virestoll *et al.,* 1955; Day, 1970; Ramsbottom, 1973) preferred a correlation with *the Main* Algal Formation, which George *et al.* (1976) regarded as uppermost Courceyan in age (but see Birky Cleugh GCR site report, this chapter). Purnell (1989) questioned the validity of these correlations and, on the basis of the occurrence of a *T. varians* conodont biozone fauna, made a tentative correlation of the Glebe Limestone Member with the Bogside Limestone Member at the base of the Bewcastle Formation, a horizon he regarded as basal Arundian in age (Purnell, 1989, 1992; Armstrong and Purnell, 1993). Riley (1993), however, regards the occurrence of both *Taphrognathus carinatus* and *T. varians* as indicative of a late Chadian rather than Arundian age.

## Conclusions

The exposed section of Glebe Limestone Member at the Glebe Quarry GCR site contains arguably the most significant occurrence of sub-tidal oncoidal limestone in the Northumberland Basin and is widely regarded as one of the finest developments of 'algal' limestone of the British Carboniferous System (George, 1958). As the most northerly marine interval within the Cementstone Group, the exposures are of considerable importance in understanding the palaeogeography of the Northumberland Basin during its early syn-extensional phase of development. The locality remains an important research site for studies in carbonate sedimentology and palaeontology.

**References**

*(Figure 3.26) Thin-bedded 'algal' (oncoidal) limestones of the Glebe Limestone Member (Cementstone Group) at Glebe Quarry, Rothbury, Northumberland. (Photo: P.J. Cossey.)*

*(Figure 3.27) Stained acetate peel illustrating the development of sub-spherical oncoids in the Glebe Limestone Member. Scale bar = 1 cm. (Photo: M.A. Purnell.)*