Northern ‘Dinantian’ successions, Carboniferous, Northern England

From Earthwise
Jump to navigation Jump to search


Contents

- 1 Introduction
  - 1.1 Inverclyde Group
- 2 Bibliography

Introduction

Representative sections and correlations for the Tournaisian to middle Visean (Asbian) sequences. P916072.

Correlation chart for the traditional district-based Carboniferous lithostratigraphies (named on the figure) and the regional group lithostratigraphy adopted in this account (identified by colour). P916068.
Mudstone and argillaceous dolostone (‘cementstone’) of the Ballagan Formation (Inverclyde Group) exposed in Akenshaw Burn, Northumberland [NY 609 896] (S Arkley, P709473).

Representative sections and correlations for the Stainmore Formation, Yoredale Group. P916074.

The early Carboniferous sedimentary succession of the Northumberland Trough is distinct from those seen across the rest of the region. For much of early Carboniferous times, the Northumberland Trough was a narrow gulf-like extension of the open sea, widening to the south-west and with marine influence decreasing towards the north and east. A corresponding reduction in stratigraphically useful fauna means that a detailed biostratigraphical correlation of the succession across the region is difficult, particularly towards the bottom of the sequence. The sedimentary lithostratigraphy reflects the interplay of fluviodelatic and shallow marine depositional systems. The emergent margins of the basin were sources of clastic sediment during the early period of deposition, but for much of Dinantian times axial drainage systems were dominant, building from the north and east towards a shallow sea in the west. Thereafter, marginal clastic deposition adjacent to
the active North Solway fault system persisted in the Solway Basin. These variations are illustrated in the representative lithostratigraphical sections and correlations for the Tournaisian to Visean strata that are presented in (P916072).

**Inverclyde Group**

Along the southern margin of the Southern Uplands Block, the lowest Carboniferous strata are of terrestrial and peritidal facies; they are very similar to the Inverclyde Group of the Midland Valley of Scotland. In recognition of this similarity, recent work has extended the group name and some component formation names into the northern part of the Northumberland Trough (P916067) and (P916068). The position of the Devonian–Carboniferous boundary is not clear, and along the northern margin of the trough, some rocks of Old Red Sandstone lithofacies are included within the Inverclyde Group. Amongst these are coarse conglomerates, developed locally at the base of the group, which now crop out along the flanks of the Cheviot massif and represent the oldest basin-fill deposits currently exposed: examples include the conglomerates at Roddam Dene, Ramshope Burn and Windy Gyle. They are all believed to be coeval with the Kinnesswood Formation of the Midland Valley of Scotland, and so are probably of post-Devonian, early Tournaisian age. The best exposed, at Roddam Dene, is a clast- to matrix-supported, massive, imbricate conglomerate containing subangular to rounded, pebble- to boulder-size clasts of Cheviot andesite with minor amounts of Lower Palaeozoic sedimentary rock and rare Cheviot granite. It is interpreted as the product of ephemeral streams that drained the deeply eroded margins of a Cheviot landmass during the semi-arid weathering conditions of early Carboniferous times.

Another small outcrop of strata reminiscent of the Kinneswood Formation lies on the south-west side of the Cheviot massif around Cottonshope Head (NT 801 061). There, the Cottonshope basalt lavas (see below) are underlain and interbedded with a sequence of red or grey sandstones, dark mudstone with ochreous concretions, and thin bands of concretionary, carbonate-rich ‘cornstone’. This sedimentary assemblage has been traditionally described as the ‘Lower Freestone Beds’, but with the recent recognition of the cornstone lithology its association with the Kinneswood Formation, and therefore a Tournaisian age, seems probable.

The initial, fault-controlled subsidence of the Northumberland–Solway Trough was accompanied along its northern margin by extrusion of basalt lavas. On the northern flank of the Solway Basin (and cropping out mostly in Scotland) such lavas comprise the Birrenswark Volcanic Formation, and on the south side of the Solway Basin the Cockermouth Volcanic Formation. Farther east, the southernmost exposures of the Kelso Volcanic Formation (again with a mostly Scottish outcrop) impinge on the northern margin of the Northumberland Basin in a small area near Carham (NT 7985 3838), whilst the Cottonshope Volcanic Formation crops out on the south-west flank of the Cheviot massif. The volcanic lavas in the Birrenswark and Kelso formations are mostly composed of mildly alkaline basalt with rare hawaiite or mugearite; they are interbedded with red sandstone and with a few thin units of tuffaceous and volcanioclastic rocks. Up to about 90 m of lava comprise the Birrenswark Formation with up to about 120 m of lava forming the Kelso Formation, though in both cases the thickest part of the succession lies north of the border in southern Scotland. The Cottonshope Formation comprises up to three lava flows of tholeiitic, olivine-phyric basalt with a cumulative thickness of 24 m; a Tournaisian age is established for the lavas from their association with the subjacent Kinneswood Formation strata.

The Cockermouth Volcanic Formation is formally a component of the Ravenstonedale Group but can conveniently be considered here with the other Tournaisian volcanic formations. It consists of four to six lava flows with a cumulative thickness of about 100 m, and consists of tholeiitic, olivine-phyric basalt with subordinate andesite. No clastic rocks are preserved within the lava sequence, though outcrops of lapilli-tuff a little to the south, on Little Mell Fell, have been interpreted as the remains
The lavas of the Birrenswark and Kelso volcanic formations interfinger with, and are conformably overlain by the Ballagan Formation (P709473), a sequence of interbedded sandstone, mudstone and argillaceous dolostone (or ‘cementstone’); some of the mudstones contain halite and gypsum pseudomorphs whilst traces of anhydrite have been reported. The overall lithofacies is indicative of a lacustrine to lagoonal depositional environment with intermittent marine incursions. In the Tweed Basin, the Ballagan Formation attains a thickness of some 430 m and is conformable with the underlying Old Red Sandstone strata. It thence thins over the Cheviot Block, where it overlaps onto pre-existing topography around the eastern flank of the massif, but then abruptly thickens again southward and westward into the Northumberland Basin. A clastic sequence forms the highest part of the Ballagan Formation in the Langholm area of southern Scotland. This, the Whita Sandstone (P916068), was introduced into the northern part of the Solway Basin from a provenance in the Southern Uplands of Scotland. Though its outcrop does not extend south of the border, it is probably equivalent to thin sandstone beds seen within the upper part of the Ballagan Formation farther south in northern England. Across its northern England outcrop, the Ballagan Formation passes conformably up into the Lyne Formation of the succeeding Border Group, though the transition is diachronous and at the regional scale the two formations are partly lateral equivalents.

The Border Group is made up of the Lyne Formation and the Fell Sandstone Formation. The boundaries between the two formations are strongly diachronous, and though in the Bewcastle and Bellingham areas the Fell Sandstone Formation conformably overlies the Lyne Formation, at Brampton the two are lateral equivalents. In the north-east part of the Northumberland Trough, the Lyne Formation is missing and the Fell Sandstone rests unconformably on the Ballagan Formation (P916068) and (P916072).

In its fullest development, at outcrop, the Lyne Formation comprises cyclical sequences of fine-grained subarkosic sandstone, siltstone, mudstone and limestone. Traces of anhydrite are also present but, in the subsurface, the Easton Borehole proved that thick anhydrite deposits are interbedded through about 1300 m of clastic strata (the Easton Anhydrite Member) at about the level of the Bewcastle and Lynebank members. Deposition took place in a fluctuating network of peritidal, deltaic and fluvial environments subject to occasional marine incursions, with the anhydrite probably accumulating under sabkha conditions. The oldest Lyne Formation strata were most likely deposited during the late Tournaisian; fossil evidence establishes a Chadian age but the formational base is nowhere exposed and is most probably strongly diachronous. The Lyne Formation has a likely maximum thickness in excess of 1500 m, and may be very much thicker in the axial part of the Northumberland–Solway Trough. Most of its sandstones were deposited from lobate deltas that intermittently migrated from north-east to south-west along the axis of the developing basin. Limestone beds are generally quite thin, many originated as peritidal accumulations of ooidal pellets whilst some are algal or stromatolitic. The stratigraphically highest assemblage of limestone beds, forming the Cambeck Member, are shelly, algal limestones with an early Visean (possibly Arundian) fauna of bivalves, brachiopods and rare corals. The earliest marine limestones, with a restricted but abundant brachiopod fauna, first appear in the south-west part of the basin and only later did marine incursions extend to the north-east.

The Fell Sandstone Formation (P709474) has an arcuate outcrop around the flanks of the Cheviot Massif from Burnmouth in south-east Scotland through Northumberland into the Brampton–Bewcastle areas of Cumbria, thence to Thirlstane on the north coast of the Solway Firth. It was laid down during a time of source area uplift when a fluvial depositional system advanced from the north-east into the Northumberland Trough. The source area involved was a topographic high to the north and east comprising Grampian and Fenno-Scandinavian structural blocks and their Devonian molasse basins. A continuous steady uplift of the source area provided a constant supply of
submature clastic sediment, with complementary subsidence of the basin maintaining the fluviodeltaic depositional environment. Deposition was probably effected by several braided river systems, each occupying a belt several kilometres wide, and constrained by intrabasinal faulting to the axial region of the Northumberland Trough. Additional evidence for extensional faulting during deposition of the Fell Sandstone Formation is provided by the presence within it, on the northern side of the Solway Basin, of extrusive lavas — the Kershopfoot Basalt.

The earliest fluvial deposits accumulated in the north-east of the Northumberland Trough where the dominant subarkosic sandstones are interbedded with sparse red mudstones and seatearths, the latter only very rarely associated with thin coals. The fluvial sandstone passes westward and diachronously into a succession of fluviodeltaic and shallow marine deposits and, in the Bewcastle area, splits into at least two major sandstone units separated by finer-grained marine strata that are laterally continuous with the Cambeck Member of the Lyne Formation. In contrast, towards the central part of the Northumberland Trough, the base of the Fell Sandstone Formation (defined by the Whithberry Marine Band) is conformable above the Lyne Formation.

The Fell Sandstone Formation attains its maximum thickness of about 350 metres near Harbottle in Northumberland, where it consists almost entirely of sandstone. Elsewhere, the proportion of sandstone to mudstone varies considerably and boreholes show that in places the Fell Sandstone may contain up to 40 per cent of finer-grained lithologies. The diachronous base of the formation becomes generally younger towards the south-west: Chadian in north-east England where the Fell Sandstone directly overlies the Ballagan Formation, and variously Chadian to Holkerian farther south-west where the Fell Sandstone overlies the Lyne Formation. The youngest Fell Sandstone Formation strata range up into the early Asbian. The succession is largely unfossiliferous, although ostracods and the large bivalve Archanodon jukesii (Bailey) have been recorded together with some plant fossils.

**Bibliography**


Category:
- Northern England

Navigation menu

Personal tools
- Not logged in
- Talk
- Contributions
- Log in
- Request account

Namespaces
- Page
- Discussion

Frameworks