Saleswheel, Lancashire

[SD 678 360]

Potential GCR site

Introduction

The Saleswheel section [SD 6775 3595] is situated in the River Ribble, about 1.5 km upstream from Ribchester. The outcrop lies within the lower part of the Millstone Grit (Namurian) and straddles the Pendleian–Arnsbergian boundary, for which it may (in due course) be selected as a type reference section, or stratotype. The site occurs at the down-stream end of a deep gorge cut through sandstones and siltstones of the Pendle Grit and Warley Wise Grit formations (Pendleian) and these are overlain by the Sabden Shales Formation (Arnsbergian) (Figure 6.2). The locality compliments and contrasts with the much thicker Arnsbergian section at Artle Beck (see GCR site report, this chapter), some 25 km to the NNW, near Lancaster. At Saleswheel, the entire Arnsbergian succession was deposited in deep water, away from the direct influence of rivers and deltas that entered the Pennine Basin to the north (contrast with Artle Beck). This has resulted in the formation of a condensed ('sediment starved') Arnsbergian section, which is dominated by shales and lacking in sandstones, but one which, despite its thinness, is stratigraphically more complete than sections of equivalent age to the north. Although deposited In deep water, the effect of sea-level change driven by glacio-eustatic processes is still evident, with several marine bands present. Evidence of distant ocean arc volcanic activity in the form of an ash fall is also preserved. Saleswheel is the type locality for several ammonoids (goniatites) described by Phillips (1836), Moore (1936, 1939) and Riley (1985), who was the first to publish details of this section. Further details of the section are given by Brandon *et al.* (1995, 1998).

Description

A log of the section is illustrated in (Figure 6.17). The base of the section comprises a 7 m-thick massive unit of large-scale, cross-bedded (clinoform), coarse-grained, feldspathic sandstone, which represents the Warley Wise Grit Formation, at the top of the Pendleian Stage. It is underlain by slumped sandstone and siltstone graded beds containing the bivalve *Sanguinolites,* representing the upper part of the Blacko Marine Band ($E_{1c}2$). Its top surface forms the steep dip-slope that dominates the mouth of the gorge. This surface shows evidence of phosphatization and marine bioturbation (misinterpreted as palaeosol rootlets by Riley, 1985) and is overlain sharply by black shales with marine fossils. Especially abundant are fish fragments, conodonts and the hemipelagic bivalves *Obliquipecten* and *Posidonia corrugata.* No ammonoids have been found, but the relative position to faunal bands above and below denotes that this is the Cravenoceras cowlingense Marine Band ($E_{2a}1$), marking the base of the Arnsbergian Stage ((Figure 1.4), Chapter 1). The marine band is about 0.8 m thick, above which the mudstones become much more friable and lack macro-fossils. These 'unfossiliferous' beds (for they will have miospores) also contain ironstone nodules and extend for about 6 m until the next marine band is reached, marked by platy calcareous shales and a layer of micrite nodules (bullions) packed with uncrushed ammonoid larvae and conches at various growth stages. Oil bleeds are common in the nodules and along fractures in the enclosing strata. This is the Eumorphoceras ferrimontanum Marine Band ($E_{2a}2$) which contains the zonal ammonoid, plus *E. erinense, Cravenoceras* and *Metadimorphoceras saleswheelense.* Large orthoconic nautiloids (*Actinoceras*)and scattered crinoid ossicles also occur, as well as the hemipelagic bivalves *Dunbarella yatesae, Obliquipecten* and *Posidonia corrugata.* Conodonts are abundant and exquisitely preserved, with conodont recoveries exceeding 3000 per kilogram of rock (amongst the highest in the UK). Only two genera are present, represented by *Gnathodus bilineatus bollandensis* and several species of *Lochriea.* Shallow-water conodonts are absent. The marine band is about 1.5 m thick, above which fissile friable non-calcareous mudstones return. A 5 mm-thick, soft, pale blue-grey, bentonitic clay occurs within these mudstones, about 6 m above the marine band. Marine shales representing the Cravenoceras gressing-hamense Marine Band re-appear 3 m higher in the sequence. This band is about 0.3 m thick and contains a diverse hemipelagic bivalve fauna with *Actinopteria persulcata, P. corrugata, Obliquipecten* and *Selenimyalina variabilis* (first stratigraphical occurrence), fish and conodonts, but so far ammonoids have not been found.

Friable non-marine shales with ironstone nodules are discontinuously exposed over the next 10 m of section, until 1 m of marine shales representing the Saleswheel Marine Band ($E_{2a}2\beta$) is reached (stratotype) in which only poorly preserved anthracoceratid ammonoids and *P. corrugata* have been found. It should be noted that this same marine 'band' in the area around Artle Beck (see GCR site report, this chapter) is over 90 m thick! A further 10 m of discontinuously exposed, friable, ironstone-rich shales intervene up to the Eumorphoceras yatesae Marine Band ($E_{2a}3$). This band is 2 m thick (contrast with 19 m at Artle Beck) and contains the zonal ammonoid, together with *P. corrugata.* Above this, about 4 m of friable shales with ironstones recur. Higher in the sequence are platy, calcareous, marine shales containing large micrite nodules (bullions) crowded with *P. corrugata* and *S. variabilis.* The ammonoids *Asturoceras romanum* (type locality), *Cravenoceras* cf. *subplicatum* and *Metadimorphoceras* occur sparsely. Oil bleeds are common. Large examples of the conodont *G. bilineatus bollandensis* are also present. The overlying 5 m of calcareous, platy mudstones contain, in addition, the zonal ammonoid *Cravenoceratoides edalensis,* plus *Ct. bisati,* characteristic of the Cravenoceratoides edalensis Marine Band ($E_{2b}1$). Although currently unexposed, approximately 5 m further up section is the Eumorphoceras leitrimense Marine Band ($E_{2b}2$), the horizon from which Phillips (1836) obtained the types of *Ct. nitidus.*

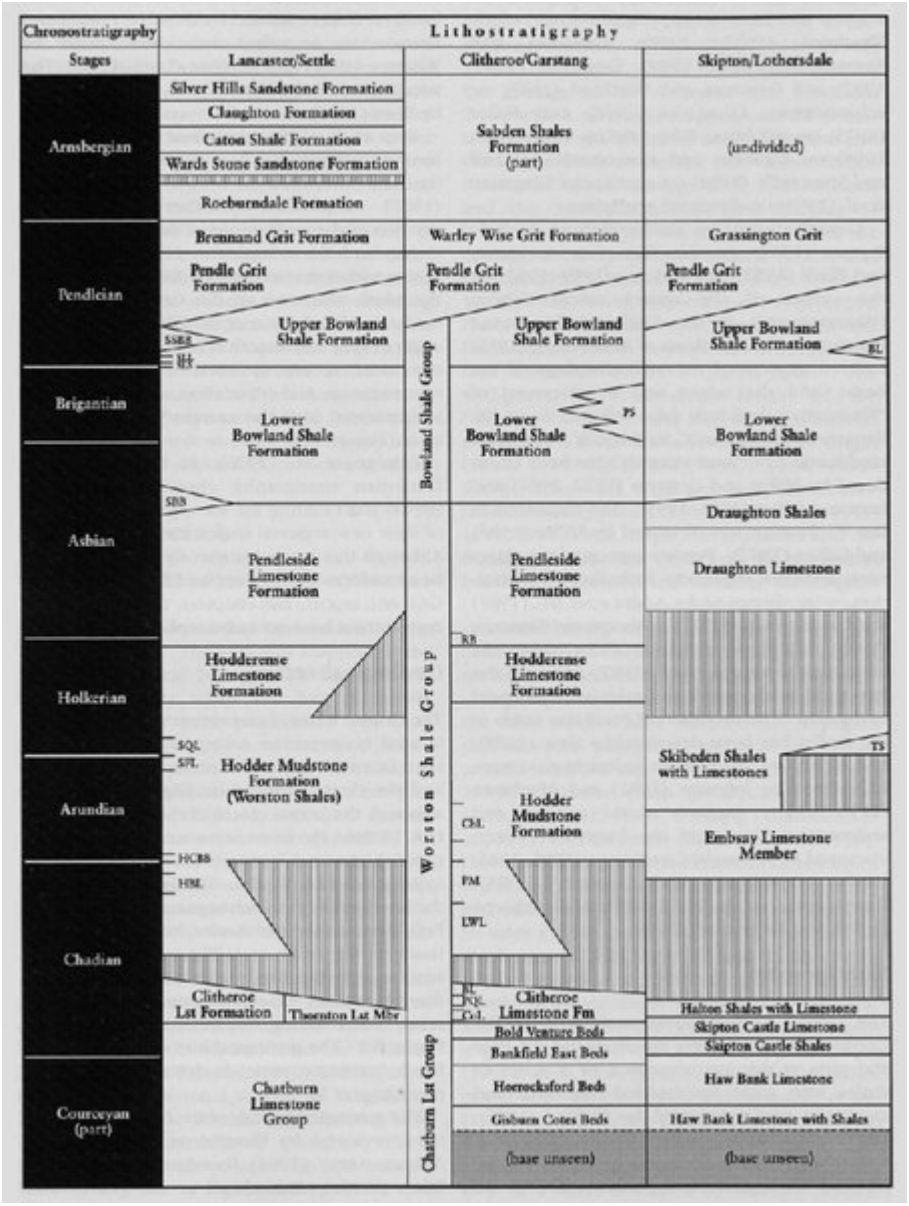
Interpretation

Glacio-eustatic lowstand, in latest Pendleian times, is represented by the Warley Wise Grit Formation, in the form of a prograding mouthbar; a formation that most probably was deposited here in an upper delta-slope environment. A major glacio-eustatic transgression, represented by the basal Arnsbergian C. cowlingense Marine Band, drowned the fluvial system that fed the mouthbar, causing its abandonment and forming a marine flooding surface (the big dip-slope). Sea level remained relatively high through the rest of the early Arnsbergian, with only weak lowstands during glacial periods, preventing significant lowstand penetration of fluvial sediments into the basin from the north. This effect was enhanced by extreme subsidence in the Lancaster area to the north which accommodated much of the clastic supply before it could reach the Saleswheel area farther south. The lowstand deposits at Saleswheel are therefore developed entirely in ironstone-rich friable shales. The ironstones originate from acidic freshwater runoff fed by rivers draining from a metamorphic–granitic source entering the basin from the north. These same rivers were responsible for the deposition of fluvial and turbiditic sandstones in the Lancaster and Skipton areas at this time. The lack of marine macrofossils in these lowstand intervals probably results from a combination of factors, including raising of the carbonate compensation depth (due to the acid runoff), more rapid sedimentation (diluting fossil concentrations) and dilution or replacement of marine basinal waters with freshwater. Interglacial periods are represented by marine bands (highstands). Marine highstands intensified sediment starvation and encouraged fossil condensate horizons to form (marine bands). Volcanic ash, sourced from explosive volcanic eruptions (probably associated with island-arc systems formed along destructive continental margins in central and eastern Europe at this time), occasionally reached the area (Spears *et al.,* 1999). The presence of oily hydrocarbons indicates that the Sabden Shales Formation is an excellent source rock.

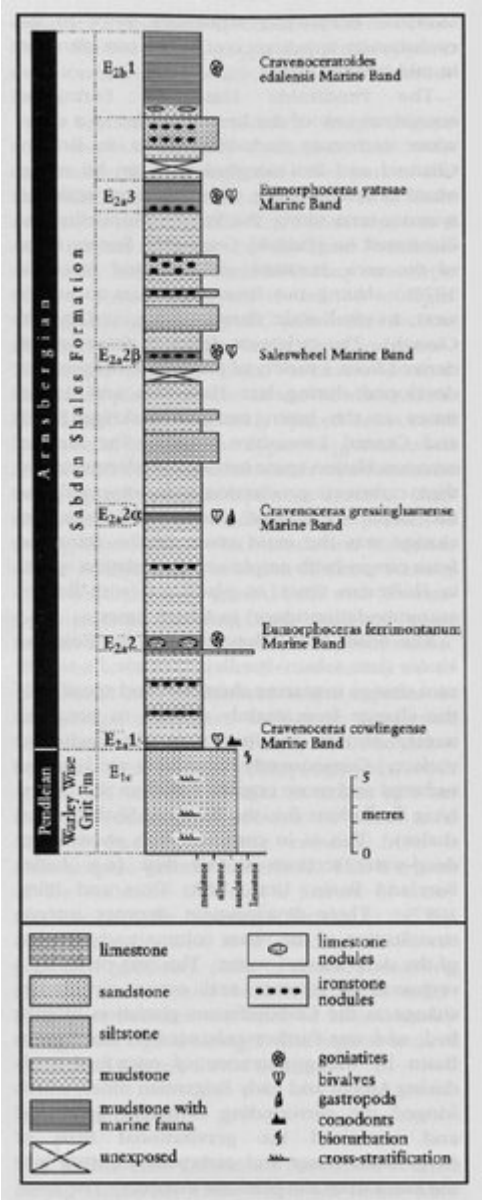
Conclusions

Saleswheel is a classic Millstone Grit section and was one of the first localities to have been cited for its fossils in British scientific literature (Phillips, 1836; e.g. the ammonoid *Cravenoceratoides nitidus*). The contrast of depositional style with outcrops of a similar age to the north is striking; this being attributed to the lack of any direct fluvial influence in the deposition of the Sabden Shales Formation and to sediment starvation. The marine flooding surface at the base of E_{2b} is particularly significant as it represents one of the last major and widespread Lower Carboniferous highstands that can be traced with confidence from the USA, through Europe into Asia, prior to the lowering of sea level at the end of the Arnsbergian (cf. Upper Carboniferous at the Gill Beck (Stonehead Beck) GCR site; Cleal and Thomas, 1996) and associated unconformity development (e.g. between the Mississippian and Pennsylvanian in the USA). The section also demonstrates the hydrocarbon source-rock quality of the Sabden Shales Formation, a formation that has contributed to the development of commercial oil and gas accumulations in the Irish Sea Basin to the west.

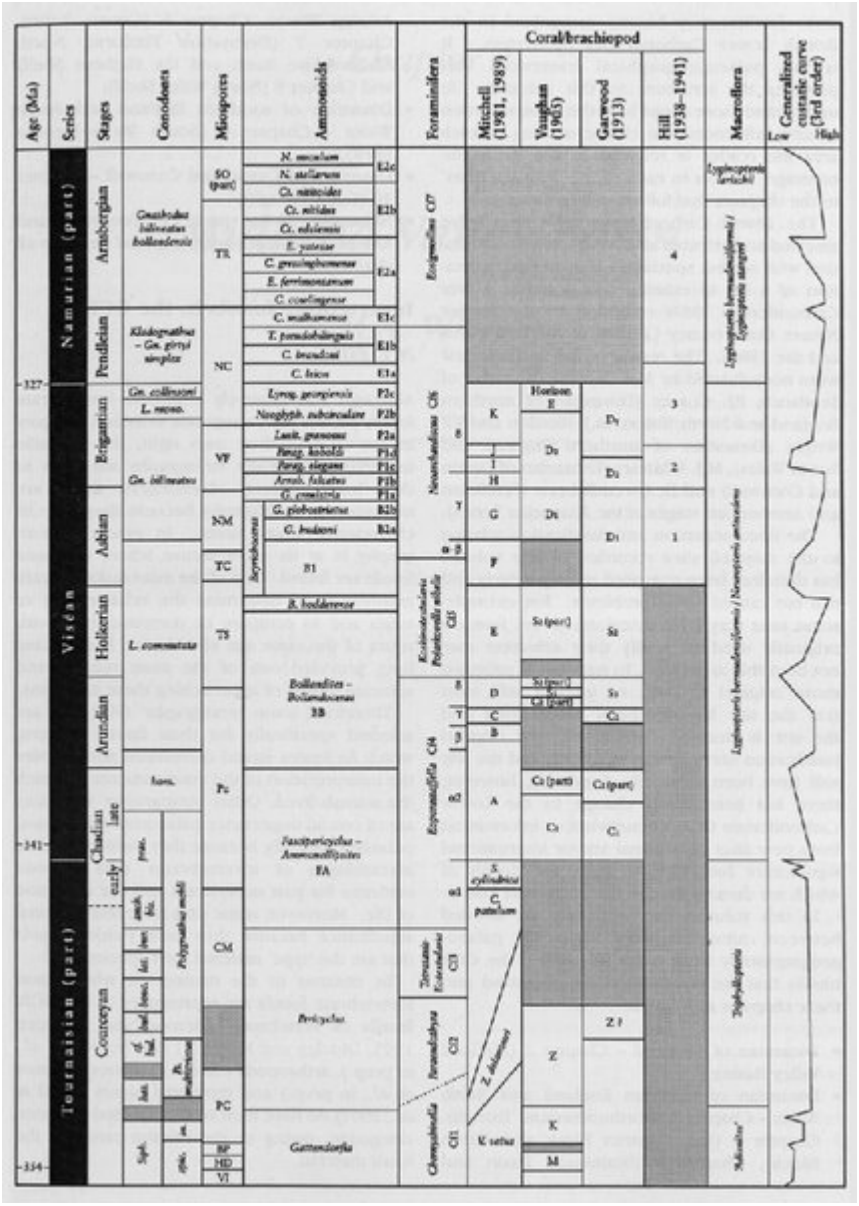
References



(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 6.17) Sedimentary log of the upper part of the Warley Wise Grit Formation (Pendleian) and the lower part of the Sabden Shales Formation (Arnsbergian) exposed in the bed of the River Ribble at Saleswheel, illustrating the position of marine bands referred to in the text. Based on Riley (1985) and Brandon et al. (1998).



(Figure 1.4) Chronostratigraphical and biostratigraphical classification schemes for the Lower Carboniferous Subsystem. After Riley (1993, fig. 1) with additional information for the Pendleian and Arnsbergian stages supplied by the same author. Absolute age data from Guion et al. (2000) based mainly on information by Lippolt et al. (1984), Hess and Lippolt (1986), Leeder and McMahon (1988) and Claoue-Long et al. (1995). Ammonoid abbreviations used in this figure: N. — Nuculoceras; Ct. — Cravenoceratoides; E. — Eumorphoceras; C. — Cravenoceras; T. — Tumulites; Lyrog. — Lyrogoniatites; Neoglyph. — Neoglyphioceras; Lusit. — Lusitanoceras; Parag. — Paraglyphioceras; Arnsb. — Arnsbergites; G. — Goniatites; B. — Bollandoceras. Conodont abbreviations used: Gn. — Gnathodus; Gn. collinsoni — Gnathodus girtyi collinsoni; L. mono. — Lochriea mononodosa; L. — Lochriea; horn. — Gnathodus homopunctatus; prae. — Mestognathus praebeckmanni; and,. — Scaliognathus anchoralis; bis. — Polygnathus bischoffi; bur. — Eotaphrus burlingtonensis; lat. — Doliognathus latus; bout. — Dollymae. bouckaerti; bul. — Eotaphrus bultyncki; has. — Dollymae bassi; siph. — Siphonodella; Ps. — Pseudopolygnathus; in. — Polygnathus inornatus; spit. — Polygnathus spicatus. Stipple ornament shows interzones (conodonts and miospores) or non-sequences (brachiopods).