Granton Shore, Lothian

[NT 245 771]

Introduction

Foreshore exposures near Granton Harbour, near Wardie, along Edinburgh's Firth of Forth shoreline in East Lothian, Scotland (Figure 3.9) and (Figure 3.15) expose a sequence of Upper Viséan strata of Lower Carboniferous (Asbian, *c.* 332 Ma) age. These include the internationally famous Granton 'Shrimp Bed', renowned mainly for fossils of the conodont animal found here but it also has an important arthropod fauna of eumalacostracan crustaceans, especially the shrimps *Tealliocaris woodwardi, Waterstonella grantonensis* and *Crangopsis socialis.*

The Granton 'Shrimp Bed' was discovered in 1919 by D. Tait and its lithology and regional setting were first described by him in 1925. He also listed the fauna and figured a slab covered with many of the small crustacean fossils and reported that they were considered to belong to the genus *Tealliocaris* by B.N. Peach 'but that some of the species are new to science'. According to Briggs and Clarkson (1983) the Harvard palaeontologist P.E. Raymond subsequently collected material from the site with Tait and apparently prepared a description of the most abundant crustacean, which he considered to be a new species; the paper was never published. Not until 1979 was the common crustacean species, *Waterstonella grantonensis,* named and described by Schram.

The discovery in the early 1980s of the fossilized traces of soft tissues associated with conodont assemblages from the 'Shrimp Bed' at Granton (Briggs *et al.,* 1983) coincided with a wider project on Scottish Carboniferous Crustacea and revitalized interest in all aspects of the 'Shrimp Bed'. As a result a detailed account of its lithology and palaeontology was published by Briggs and Clarkson in 1983.

Description

The Granton 'Shrimp Bed' of Upper Viséan (Asbian) age lies within the Granton Sandstones of the Lower Oil Shale Group (see (Figure 3.10)) and Calciferous Sandstone Measures. Two units occur within the Granton Sandstone — the lower Craigleith Sandstone (30 m thick) and upper Ravelston Sandstone (110 m thick) separated by about 100 m of shale within which lies the 'Shrimp Bed'. The Granton Sandstones underlie the Wardie Shales that are exposed to the east of Granton Harbour and have yielded a well-known fish fauna (Dineley and Metcalf, 1999).

The Wardie Shales lie within the Lower Oil Shale Group whose oil shales are largely of non-marine origin and were deposited in a large fresh or brackish water lake that covered the eastern end of the Midland Valley of Scotland. The lake was intermittently flooded by marine incursions from the east and the 'Shrimp Bed' lies within a lime-rich layer deposited during such an incursion.

The 'Shrimp Bed' was originally found by Tait in two locations of which the more easterly, the old Granton land and sea quarries have been lost due to infilling associated with land reclamation. Much of the second, westerly outcrop along the Muirhouse shore has been covered up more recently by construction of an esplanade and breakwater. Only two small exposures remain and these were re-discovered by S.P. Wood in 1978 and J.G. Sharp in 1981.

Some 20 m of the Wardie Shales are exposed at Granton Shore and within them is a 45 cm interval that includes three thin bands of laminated limestone. The lower Bands 1 and 2 (each around 4cm thick) (Figure 3.15), are lithologically similar but more fissile and less limy than the upper Band 3, which is significantly thicker (14–20 cm). All three bands appear to be largely of algal origin and consist of alternating dark and light laminae that pass laterally into microbreccias.

Band 3 is by far the most fossiliferous and has yielded all the material recorded by Briggs and Clarkson (1983) and is considered by them to have also been the source of Tait's specimens as they share the same distinctive lithology. The abundant crustaceans are confined to four bedding planes within Band 3 but other elements of the fauna (worm-like

forms and branching organisms) occur throughout the Band.

The limestones are predominantly dolomitic with alternating layers of calcareous mud and dark brown-black carbonaceous material up to 1 mm thick with some of the latter preserving algal filaments. Shrinkage cracks on bedding planes, microbreccias and pull-apart structures suggest dewatering or dessication, perhaps linked with intermittent subaerial exposure. The crustacean fossils are generally well preserved and are normally found on undisturbed laminae.

The detailed characteristics of the Granton Shore laminated limestones have been found to compare closely with other fossil and Holocene tidal-flat stromatolite successions. Such characteristics suggest that the Granton assemblage, with its associated dolomitization and evidence of dessication, was deposited and preserved in similar intertidal algal mat environments.

Palaeontology

Although the most common fossils within the Granton 'Shrimp Bed' are eumalacostracan crustaceans, other faunal elements have been found. Two poorly preserved palaeoniscid fish are known along with an unidentifiable coiled nautiloid and bivalve, but Tait's record (1925) of rare gastropods cannot be verified. Similarly, two worm-like forms are unidentifiable. More common are abundant branching organisms that are considered by Briggs and Clarkson (1983) to be the remains of hydroids but could alternatively be algal or bryozoan in origin.

The most famous fossils from the Granton Shore 'Shrimp Bed' are undoubtedly those of the conodont animal. Small tooth-like isolated conodont elements have been described since the early decades of the 19th century, but their biological affinities were debated and disputed until the 1980s and the discovery of the first fossilized conodont animal from the Granton 'Shrimp Bed' (for a review of the history of investigation of conodonts see Sweet and Donoghue, 2001). The first specimen to be found was unbeknowingly recovered many years ago, probably by Taft. It lay unrecognized in the collections of the Institute of Geological Sciences (now the British Geological Survey) until 1982. Since then, several other specimens have been found and described (Aldridge *et al.,* 1993), now the only dispute concerns the exact position of the group as primitive vertebrates.

The crustaceans are all preserved in the dark organic-rich (?algal) layers and are generally very obvious as they contrast with the sediment background being preserved in whitish fluorapatite. It is not clear whether the mineral is replacing the cuticle or is an infill of the body cavity.

The commonest crustacean in the 'Shrimp Bed' is *Waterstonella grantonensis* and is normally found as complete laterally compacted specimens although disarticulated specimens are common on some bedding planes and probably represent exuviae. Most entire specimens preserve all the appendages, even the long delicate antennae and some retain traces of the gut, all of which suggests that the fossil remains are those of carcasses.

Crangopsis, represented by two forms that may be separate species, is also present in some abundance at certain horizons in the 'Shrimp Bed'. The smaller form can easily distinguished from *Waterstonella* in being smaller (14–22 mm in length) but with a thicker cuticle and more robust morphology. It has been found to occur in similar numbers on three horizons. The larger form of *Crangopsis* (up to 50 mm long) occur rarely in Band 3 and has been identified by (Schram, 1979) as *Crangopsis socialis* (Salter, 1861), a species that is common elsewhere in the shrimp bearing sequences of the Midland Valley of Scotland. Both *Crangopsis* and *Waterstonella* were probably filter feeders.

Although Peach thought that the 'shrimp' fossils collected by Tait (1925) were *Tealliocaris,* only four poorly preserved specimens are now recognized from the Granton 'Shrimp Bed'. Slightly more common is the much larger genus *Anthracophausia* that was first named and described by Peach in 1908. The presence of a raptorial second antenna in this genus shows that it was an active predator.

The preservation of the 'Shrimp Bed' crustaceans, which dominate the fauna, is unusual. If the stromatolites were intertidal, it may be that the crustaceans were concentrated in intertidal pools where they died as the pools dried out. The completeness of so many of the fossils indicates that they must have been rapidly covered with algal films and sediment.

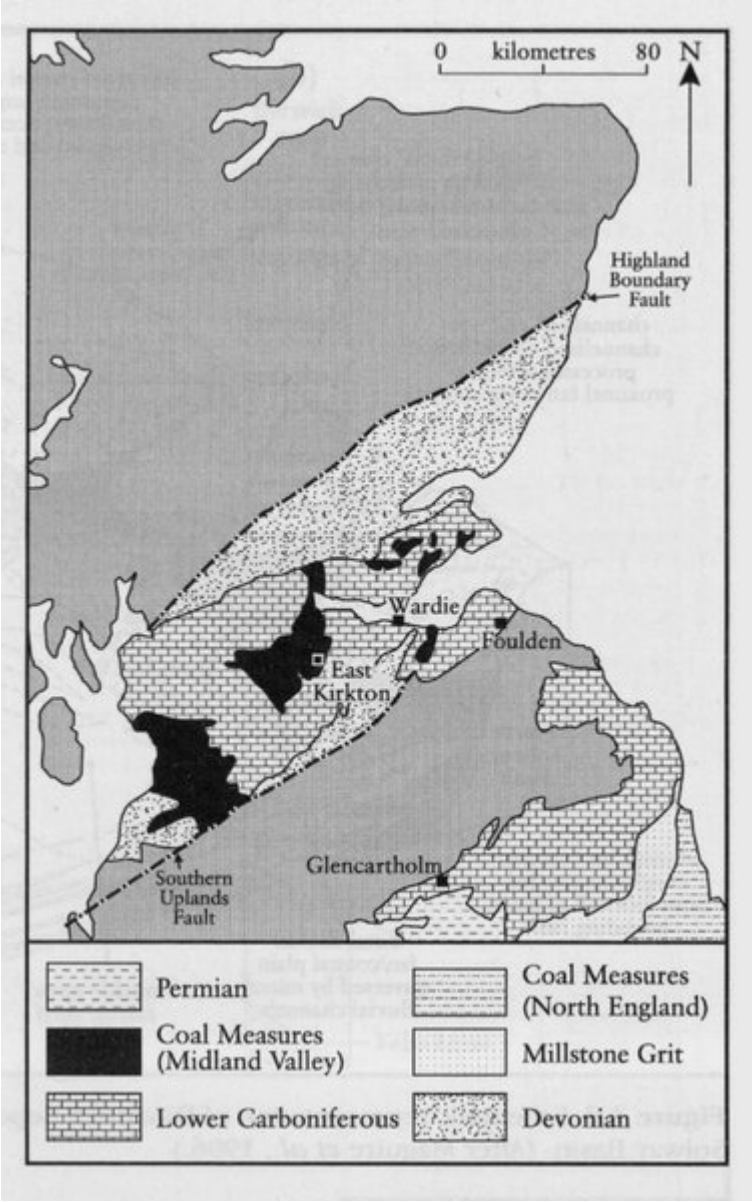
The relative occurrence of the most abundant species is somewhat puzzling. *Waterstonella* only occurs at Granton suggesting a particular kind of restricted environment, perhaps hypersaline. However, *Crangopsis* occurs elsewhere and must have been tolerant of a wider range of salinity conditions. Briggs and Clarkson (1983) suggest as an alternative explanation that preservation of the lightly sclerotized *Waterstonella* requires the exceptional conditions that are only present in the 'Shrimp Bed' at the Granton Shore GCR site.

Comparison of Lower Carboniferous 'shrimp' (eumalacostracan) bearing successions in Scotland and Northern England (Cater *et al.,* 1989) shows common features that can be interpreted as indicative of particular environments of deposition. Twelve shrimp-bearing localities were compared by Cater *et al.* (1989) and most were found to have been deposited in coastal delta-plain or interdistributary bay environments with transitional salinity. None of the shrimp beds was deposited under fully marine conditions but most sequences show some evidence of marine influence. Crustacean diversity is known to increase with salinity and the relatively low diversity (compared with Glencartholm) seen at Granton probably reflects deposition in a brackish water interdistributary bay.

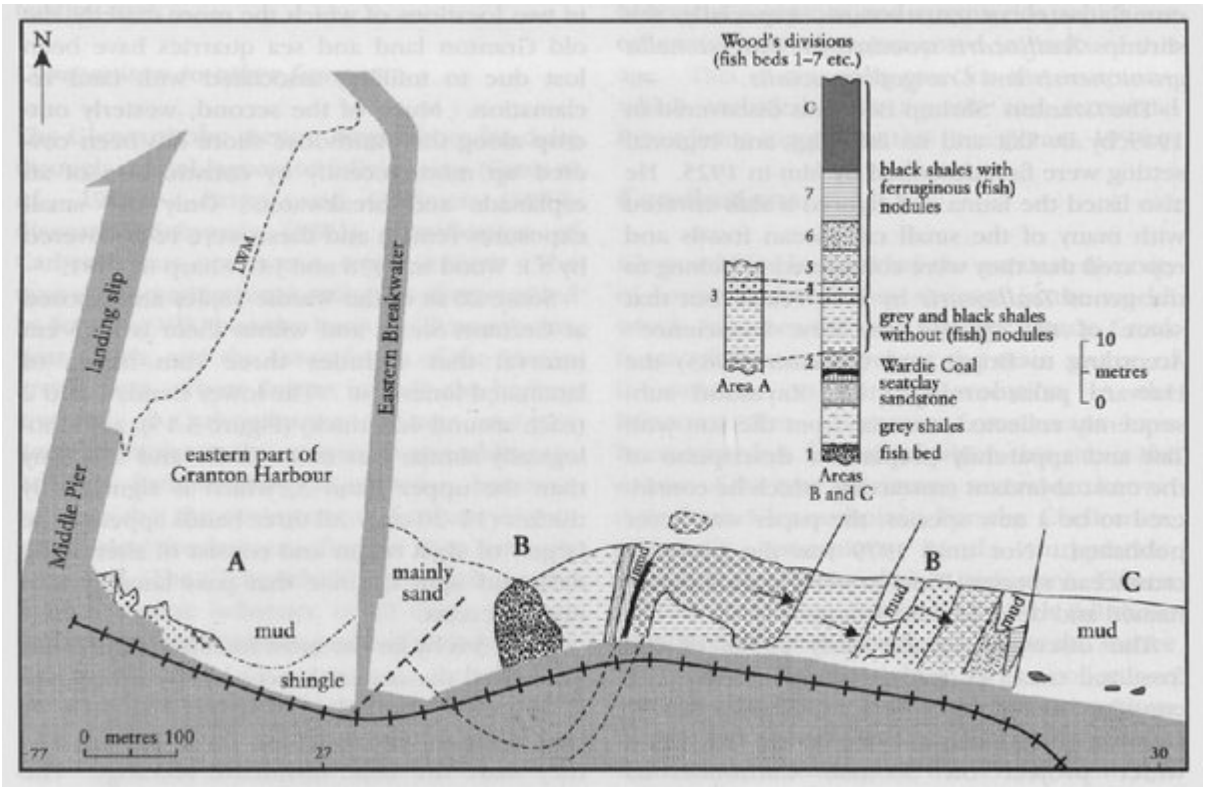
Conclusion

The remaining foreshore exposures of the Granton 'Shrimp Bed' near Granton Harbour in East Lothian are of considerable importance for their fossil eumalacostracan 'shrimps', especially as there is a unique endemic element to the fauna — *Waterstonella grantonensis.* The site is part of a network of other Scottish Lower Carboniferous Oil Shale sites that includes Glencartholm and Foulden. The Granton site is also of international reknown for the co-occurring primitive vertebrate conodont animal *Clydagnathus.*

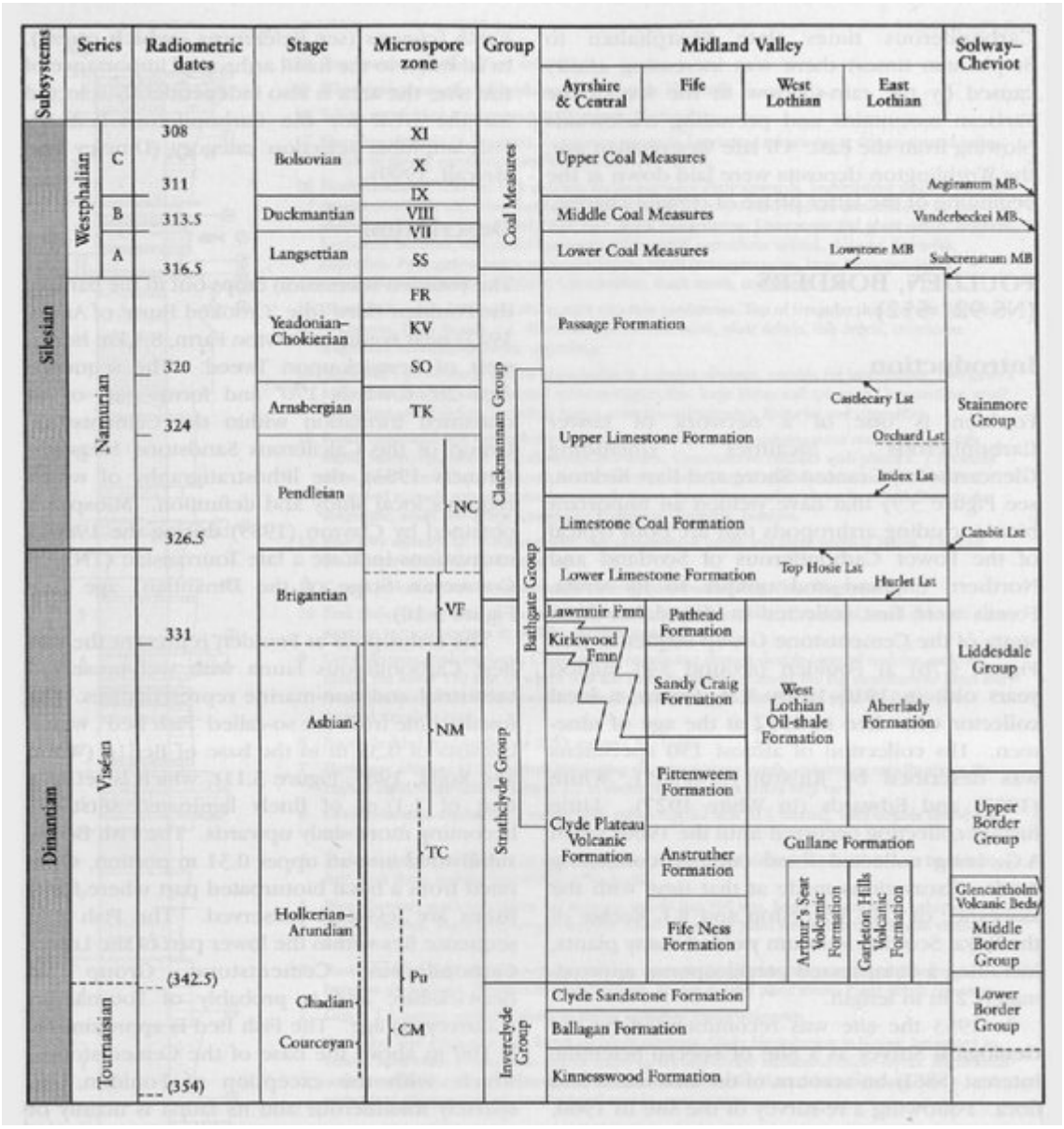
References



(Figure 3.9) Geological sketch map of southern Scotland and northern England with the positions of the Scottish Carboniferous GCR arthropod sites shown. Wardie is near to the Granton Shore GCR site.



(Figure 3.15) Sketch map and geological section at the Granton Shore GCR site, East Lothian. (After Wood, 1975.)



(Figure 3.10) Lithostratigraphical and chronostratigraphical divisions of the Carboniferous Period'in the Midland Valley and Southern Borders. Key marine bands (MB) and limestones (Lst) used in correlation are noted. No clear evidence for Chokierian or Alportian stages has been found in Scotland, possibly reflecting a mid-Carboniferous depositional break.