

# The faunas of the Viverdon Down area, south-east Cornwall

M.J. WHITELEY



M.J. Whiteley 1981. The faunas of the Viverdon Down area, south-east Cornwall. *Proc. Ussher Soc.*, 5, 186-193.

Seven faunal assemblages are described from permanent exposures and temporary excavations in the Callington - St Mellion area of south-east Cornwall. Five of the assemblages are recorded for the first time and they indicate that both Upper Devonian and Lower Carboniferous sediments are represented. The principal fossil groups utilised include ammonoids, ostracods, conodonts and trilobites. Structural inversion is implied from lithological, faunal and comparative data and regional structural patterns developed to the north suggest that the Viverdon Down succession represents an isolated remnant of a fold nappe which incorporates a complex imbricate zone.

M.J. Whiteley, Department of Geology, University of Exeter, North Park Road, Devon EX4 4QE.

## Introduction

This report forms part of a collaborative project currently in progress under the combined auspices of the Institute of Geological Sciences and the University of Exeter. The revision of the Tavistock and Launceston geological map (Sheet 337, 1:50,000) includes a reappraisal of the Carboniferous rocks that crop out along the southern margin of the Sheet between Callington and Calstock. The area of relatively high relief 3km south-east of Callington is known as Viverdon Down and here detailed geological mapping and temporary excavations have provided new information concerning the ages and distribution of strata. Rocks of Upper Devonian age are recognised for the first time within the tract of Carboniferous sandstones and slates that comprise most of the region. The constraints imposed by the disposition and ages of various rock units permits a provisional structural interpretation which is consistent with proposals developed for the ground farther north (cf. Turner 1981) where good exposure and borehole data provide stratigraphical control. Previous editions of geological maps indicate that the Viverdon Down area consists mainly of Culm Measure shales and grits with several small, isolated cappings of older cherts occupying the high ground. Although no precise explanation has been offered to accommodate this apparent structural inversion, the probable presence of low-angle thrust faulting was recognised at the turn of the century by MacAlister (1911, p.47) and his accurate observations are only now being reconsidered and interpreted within a regional tectonic framework quite unknown in his time.

The discovery of several new fossil localities in the area supplements published information and allows the recognition of seven faunal assemblages. The

distribution of these assemblages in terms of space and time is shown in Figs. 1 and 2 respectively, and selected species are illustrated in Fig. 4. Each locality is described, its faunal content documented and a possible structural setting is presented. Two tectonic units are recognised in the area on the basis of differing lithologies and faunas and they are separated by a low-angle thrust. To the north a group of black slates, massive cherts, thin sandstones, dolerite and picrite predominate, whilst thick, feldspathic sandstones, dolerite and chert occur in the south between Viverdon Down and St Mellion. The faunas have been recovered mainly from the southern unit which is considered to be thrust over the underlying northern unit, both forming part of a tectonically complex allochthonous succession.

## Locality and faunal descriptions

### *Thrustle's Nest*

Large scale excavations for the siting of farm buildings at GR 3623 6732 (locality 1) exposed 3m of bluish grey slate beneath 1.5m of head. The slate is finely micaceous and commonly displays purple manganese staining on parting surfaces. The slates pass down into grey silts and rare fine-grained sandstones and this unit has yielded occasional decalcified nodules, some of which are fossiliferous. Ammonoids recovered include *Cymaclymenia striata*, *Kallocklymenia* sp. (= *Gonioclymenia speciosa* of Petter 1960), *Cymaclymenia* spp., juvenile forms of *Kosmoclymenia* spp., ?*Imitoceras* sp., and indeterminate orthocones. This fauna closely resembles those described by Wedekind (1914) and Petter (1960) of *Clymenia-Stufe* age (Upper Devonian V). The cranidium of *Phacops* (*Phacops*) *wedekindi* and a small bivalve have

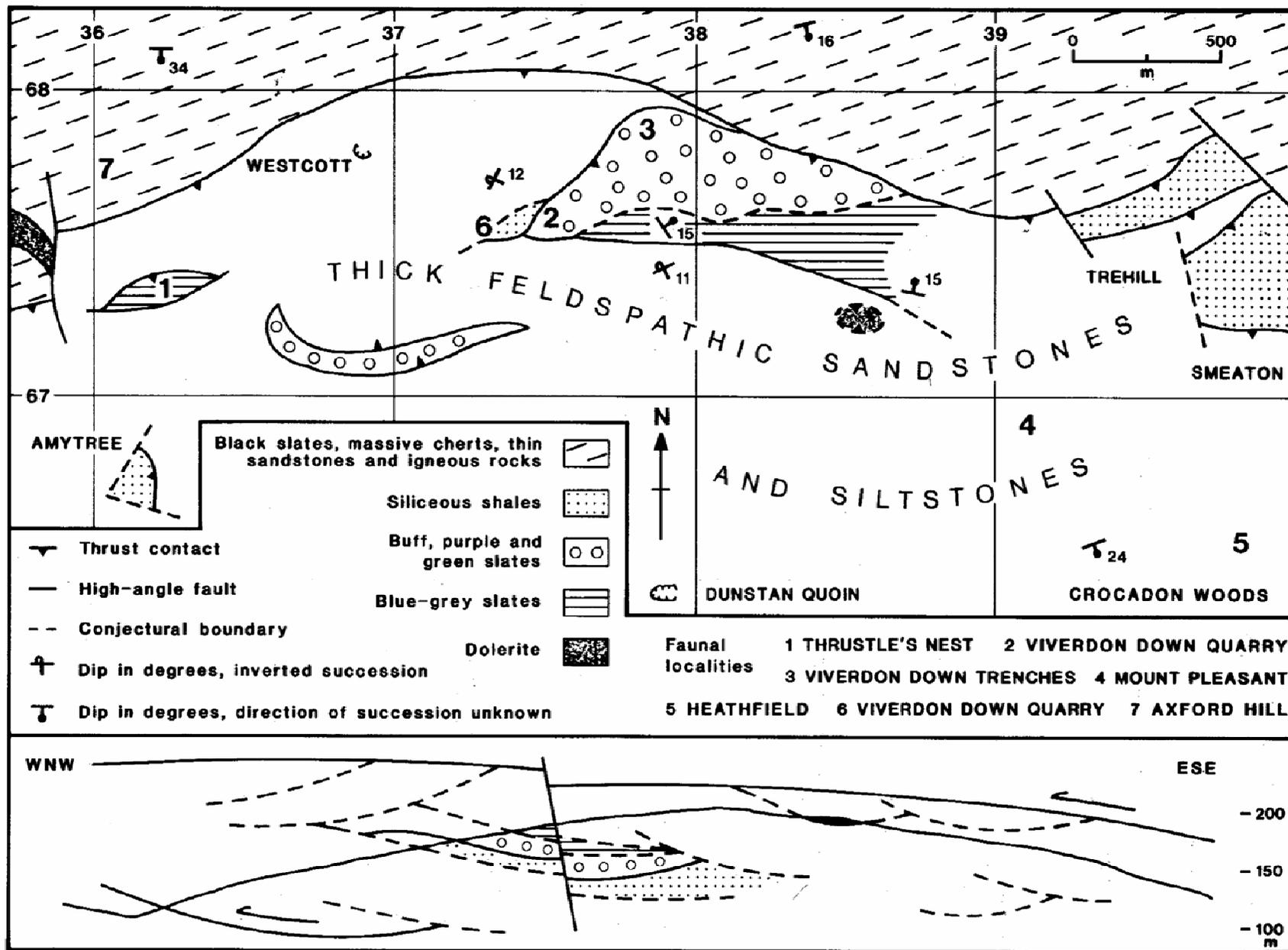


Figure 1. Geological map and cross-section of the Viverdon Down area showing the principal localities included in the text.

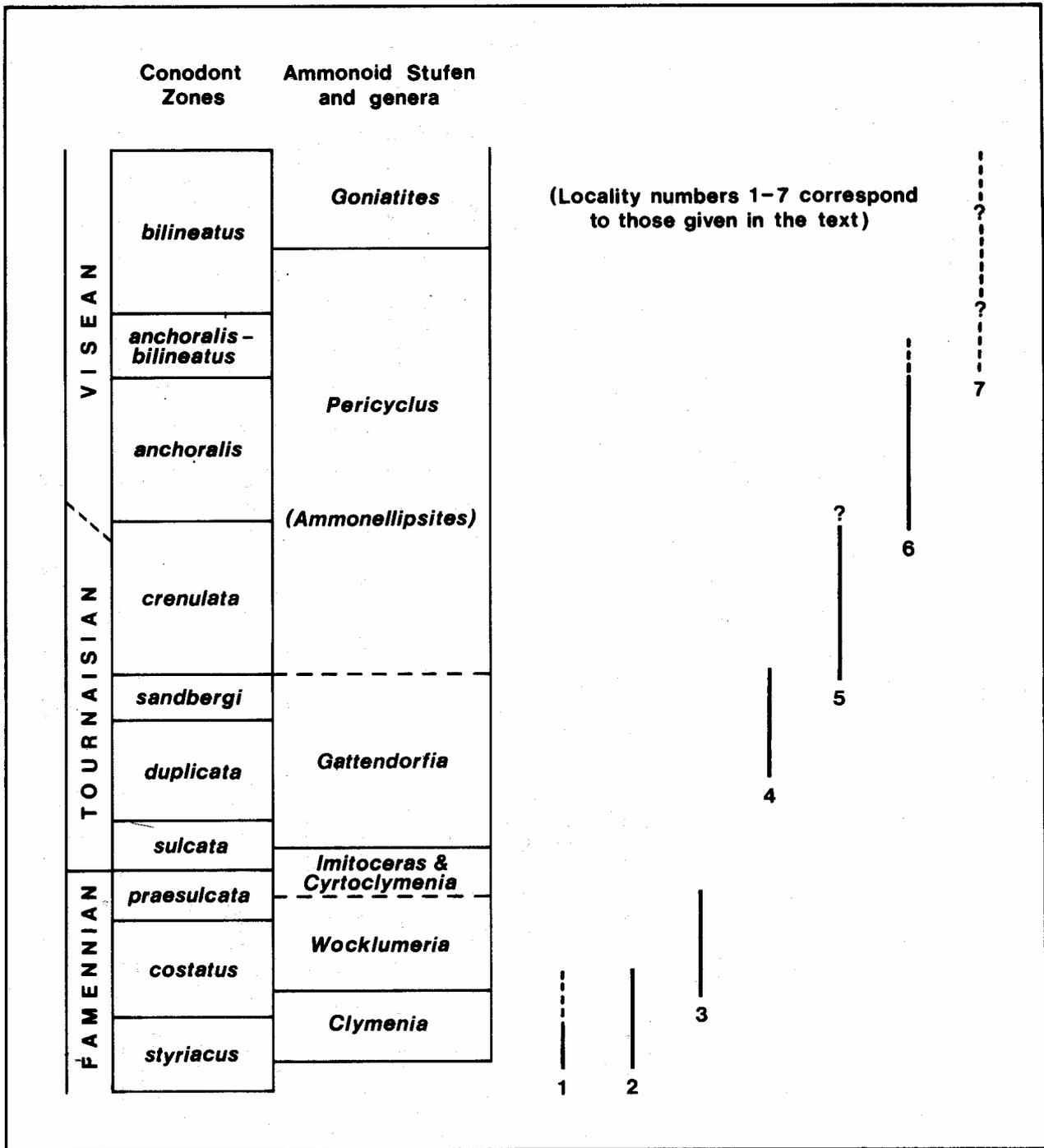


Figure 2. The stratigraphical distribution of the Viverdon Down faunas in relation to standard conodont and ammonoid zonations.

also been found at this locality. A high angle fault trending approximately east-west defines the southern limit of this isolated Upper Famennian block and juxtaposes thick sandstones and siltstones against it (Fig. 1). Deeply weathered, grey and yellow feldspathic sandstones with thin, interbedded siltstones characterise the unit to the south of the fault and some of the dark silty layers are crowded with comminuted plant debris or more intact organic horizons resembling rootlet beds. The sandstones are up to 0.5m thick, poorly sorted and coarse-grained, identical to lithologies recovered from Viverdon Down some 1.5km to the north-east.

#### *Viverdon Down Quarry*

The substantial exposure of siliceous shale in a disused quarry on the northern slopes of Viverdon Down (GR 3739 6754, locality 6) yields abundant moulds of conodonts which have been described by Matthews (1969). The fauna includes derived Upper Devonian palmatolepids as well as indices of the *anchoralis*-Zone and it strongly resembles assemblages described from the German Sauerland by Voges (1959). A broadly similar conodont fauna has been recovered from identical siliceous shales exposed in a quarry near Amytree, 1.5km south-west of Viverdon Down Quarry. Localised developments of siliceous rock also occur near Trehill (GR 395 675) and Smeaton (GR 399 672), serving to supplement the meagre record of fine-grained lithologies within the essentially arenaceous southern unit.

Renewed interest in the Viverdon Down Quarry stems from the discovery of a new fauna from the eastern end of the exposure (GR 3746 6754, locality 2) where pink and buff shales directly overlie the siliceous shales of the main face. Some 0.75m of pink-buff shale is preserved at this point in the quarry but well-preserved ostracods, conodonts and bivalves are present. Entomozoid ostracods include *Richterina* (*R.*) *striatula*, *Richterina* (*R.*) *costata* and *Maternella hemisphaerica* and they provide another record of the well documented *hemisphaerica-dichotoma* Zone (= Upper Famennian) which has been extensively recognised in south-west England (Gooday 1978). Conodonts corroborate this age determination with the overlapping ranges of *Palmatolepis gracilis sigmoidalis* and *P. perlobata schindewolfi* indicating an upper *styriacus* to lower *costatus* Zone age (see Fig. 2). The contact between the two dated rock units in this quarry is interpreted as a thrust.

#### *Viverdon Down Trenches*

The continuity of Upper Famennian strata has been proved in a series of trenches excavated around GR 3786 6783 (locality 3). Abundant siliceous nodules are associated with pale yellow and grey silts and these are overlain by greyish-green silts and interdigitated purple and green slates. A rich ostracod fauna indicative of the *hemisphaerica-dichotoma* Zone has been recovered from the fine-grained sediments whilst a diverse but poorly preserved assemblage of silicified trilobites and ammonoids occurs within the nodules. The trilobites are

represented by *Dianops griffithides*, *Phacops* (*P.*) *granulatus*, *Typhloproetus subcarintiicus* and indeterminate fragments of proetid pygidia. Clymenids and goniatites are more numerous than trilobites at this locality and in particular the genus *Cymaclymenia* is well represented. Identification to specific level is rarely possible because of fragmentation and wholesale silicification which commonly makes fine detail. *Cymaclymenia striata*, *Kalloclymenia* aff. *subarmata*, cf. *Kosmoclymenia bisulcata* and juvenile *?Wocklumeria* sp. occur with rare specimens of *Imitoceras* sp. and *?Sporadoceras* sp. Utilisation of all three fossil groups results in the assignment of a *Wocklumeria-Stufe* age (Upper Devonian Zone VI) for this locality.

Lithologically distinct purple and green slates bearing ostracods of this age may be mapped from field clutter for approximately 0.75km to the east and buff ostracod slate occurs in an isolated patch on the south western flank of the Down. Blue-grey slates, indistinguishable from those at Thrustle's Nest, have been proved in the Viverdon Down trenches but their stratigraphical position is not known due to the lack of fauna and insufficient exposure to reveal the nature of boundaries. The Upper Devonian strata always appear to occur in tectonic isolation within a substantial development of feldspathic sandstones which are well exposed in quarries at Westcott (GR 369 678) and Dunstan Quoin (GR 379 664), and they have been proved by trenching on the crest of Viverdon Down. Sandstones from the latter site are ill-sorted, containing numerous small shale pellets, mud flakes and silty nodules. Graded bedding is poorly developed and rapid alternations between coarse sandy bands and fine silts are common, but available evidence from sole marks and grading suggests that the unit is inverted. Subangular quartz grains are supported within a fine-grained feldspathic and micaceous matrix and much of the sandstone is deeply weathered and characteristically open-textured. Spectacular occurrences of comminuted plant debris occur on isolated bedding planes and intact stem-like material up to 7cm in length has been noted along with probable rootlet beds. Two possible depositional environments may be envisaged to accommodate this style of sedimentation: a near-shore, possibly deltaic, area subject to pulses of freshly eroded sediments from a nearby unknown provenance, or a deeper water submarine fan capable of conducting sediments some distance from their source. Reworked nodules, isolated plant-rich horizons and complex bedding relationships as described above are characteristics that might be expected to prevail in such dynamic palaeoenvironments.

#### *Mount Pleasant*

Small exposures of dark grey shales occur at GR 3907 6692 (locality 4) and the same lithology has been recognised as clutter in ploughed fields between that point and the major valley occupying Crocadon Woods. The shales are finely micaceous and are considered to form part of the sandstone-siltstone association which is well exposed in the stream section of Crocadon Woods to the

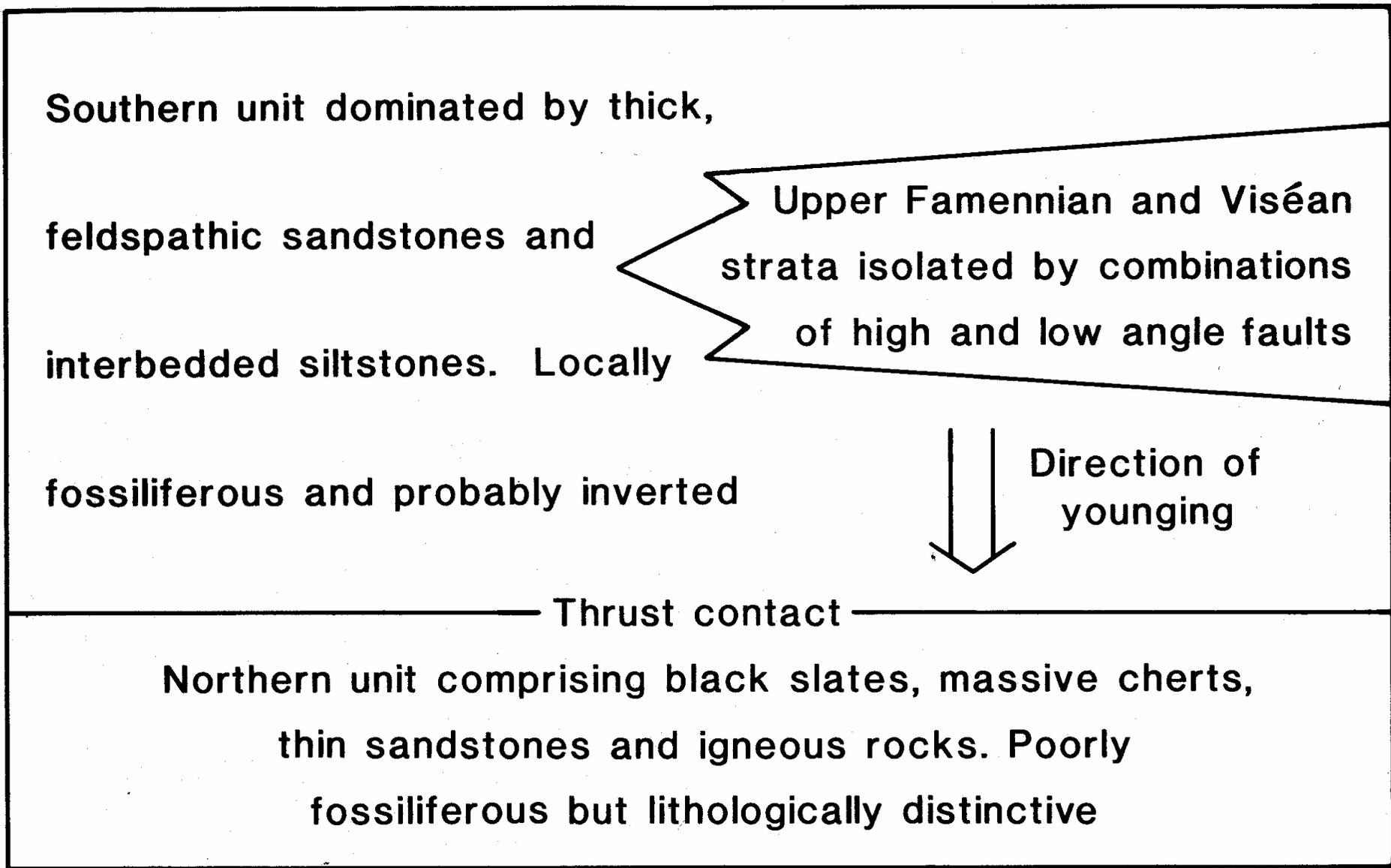


Figure 3. The structural succession in the Viverdon Down area.

south. Indeterminate bivalve fragments and unornamented ostracods are associated with a rich conodont fauna which is dominated by siphonodellids and polygnathids. *Siphonodella quadruplicata*, *S. duplicata*, *S. cooperi*, *Polygnathus inornatus*, *P. triangulus*, *P. communis communis*, *Pseudopolygnathus radinus* and *Elictognathus laceratus* constitute the major elements of the fauna which can be readily assigned to the *sandbergi*-Zone as proposed by Sandberg and others (1978). The discovery of this important mid-Tournaisian fauna contributes towards the emerging framework of conodont biostratigraphy in the Lower Carboniferous rocks of Cornwall (see Stewart 1981b).

#### Heathfield

A road cutting exposing coarse sandstones, cross-stratified siltstones and dark shales at GR 3980 6655 (locality 5) yielded a unique cephalopod fauna which has been described by Matthews (1970). Over 300 small goniatites, mainly less than 3mm in diameter, were recovered from a silicified lens and the fauna is dominated by the genera *Ammonellipsites*, *Gattendorfia* and *Muensteroceras*. The presence of *A. princeps* and *M. complanatum* provides the only firm basis for comparison with cephalopod-based standards in Europe but Matthews argues that the coeval gattendorfiids may favour a late Tournaisian age assignment. Additional goniatite-bearing nodules have been found here but they add no new information. Although no conodonts have been found at this locality it is possible that the goniatites represent an age broadly equivalent to that of the *Siphonodella crenulata* Zone (Matthews 1970, p. 117).

The significance of localities 4, 5 and 6 is that they provide evidence for the age of the tract of sandstones, siltstones and other more restricted rock types that occur around Viverdon Down. Mapped as Upper Culm by pioneer geologists, it would follow that a Namurian or younger age was considered applicable but the evidence presented here indicates that much of the unit is of Tournaisian and early Visean age. However, palynological assemblages, recovered from silty bands within major sandstone units at Dunstan Quoin and St Mellion (GR 389 656), suggest that a Lower Carboniferous age is not ubiquitous and impoverished miospore floras containing *Lycospora* spp. have been recovered. Work continues in an effort to establish the precise age of sediments at various localities in the area and the possibility of a Namurian age cannot be dismissed at present.

#### Axford Hill

The youngest fauna recorded from the Viverdon Down area is from a Sequence of somewhat siliceous pale blue and grey slates which are associated with thin (?tuffaceous) sandstones, massive black cherts and igneous rocks. Exposures in a small drainage ditch at the bottom of Axford Hill (GR 3608 6775, locality 7) produced a diverse assemblage of fragmentary goniatites, lamellibranchs, ostracods, trilobites and conodonts

which have been supplemented by material from a temporary excavation made in an adjacent field. Goniatites bearing distinctive spirally striate ornament are associated with *Posidonia becheri* and *Caneyella membranacea* and this concurrence is prevalent at approximately the P1 - P2 boundary in south-west England. The pygidium of *Archegonus* cf. *aequalis* and numerous long-ranging Dinantian conodonts neither refine nor conflict with the assumption of a middle or upper Visean age for this locality and this uncertainty is reflected in Fig. 2.

At present the Axford Hill material constitutes the most remarkable fauna to be found in the northern tectonic unit although conodonts and ostracods are known from localities to the north-east around Dupath (GR 375 692) and Ashton (GR 391 686). In consequence the stratigraphical range of the unit is not yet known but it is anticipated that a Dinantian age will emerge and thereby demonstrate some time-equivalence with the overthrust southern unit.

### Stratigraphy and structural setting

A virtually complete succession of strata, ranging in age from Upper Famennian to Viséan, is demonstrated in the Viverdon Down area by the faunas described above and summarised in Fig. 2. The combined evidence of inverted sediments and the general distribution of older rocks upon younger rocks indicates that the succession. Probably represents the inverted limb of a large structure. Field relationships show that the highest levels of the sequence are greatly disturbed and laterally discontinuous but the structural succession can be recognised (Fig. 3).

An inverted succession described by Turner (1981) from the Chillaton area, some 15km north-east of Viverdon Down, was named the Chillaton Unit and it represents the inverted limb of a fold nappe. Varied lithologies within that Unit range from 'schwollen' to basinal facies south of the Chillaton area and the relationship between the somewhat dissimilar palaeoenvironments invoked for the Chillaton Unit and the Viverdon Down succession is discussed by Turner and others (in preparation). Bounding the top of the Chillaton Unit is a complex discontinuity known as the Main Thrust and immediately beneath it an imbricate zone has been recognised in which horizontal and gently dipping shears predominate. The imbricate zone may be up to 100m thick and within it rocks of differing age and lithology may become tectonically isolated and superimposed. The structural and stratigraphical similarities between the Chillaton and Viverdon Down areas are too strong to be ignored. The entire succession at Viverdon Down is considered to be equivalent to the Chillaton Unit and the dislocation that exists between the northern and southern elements at Viverdon is seen as a comparatively small-scale thrust

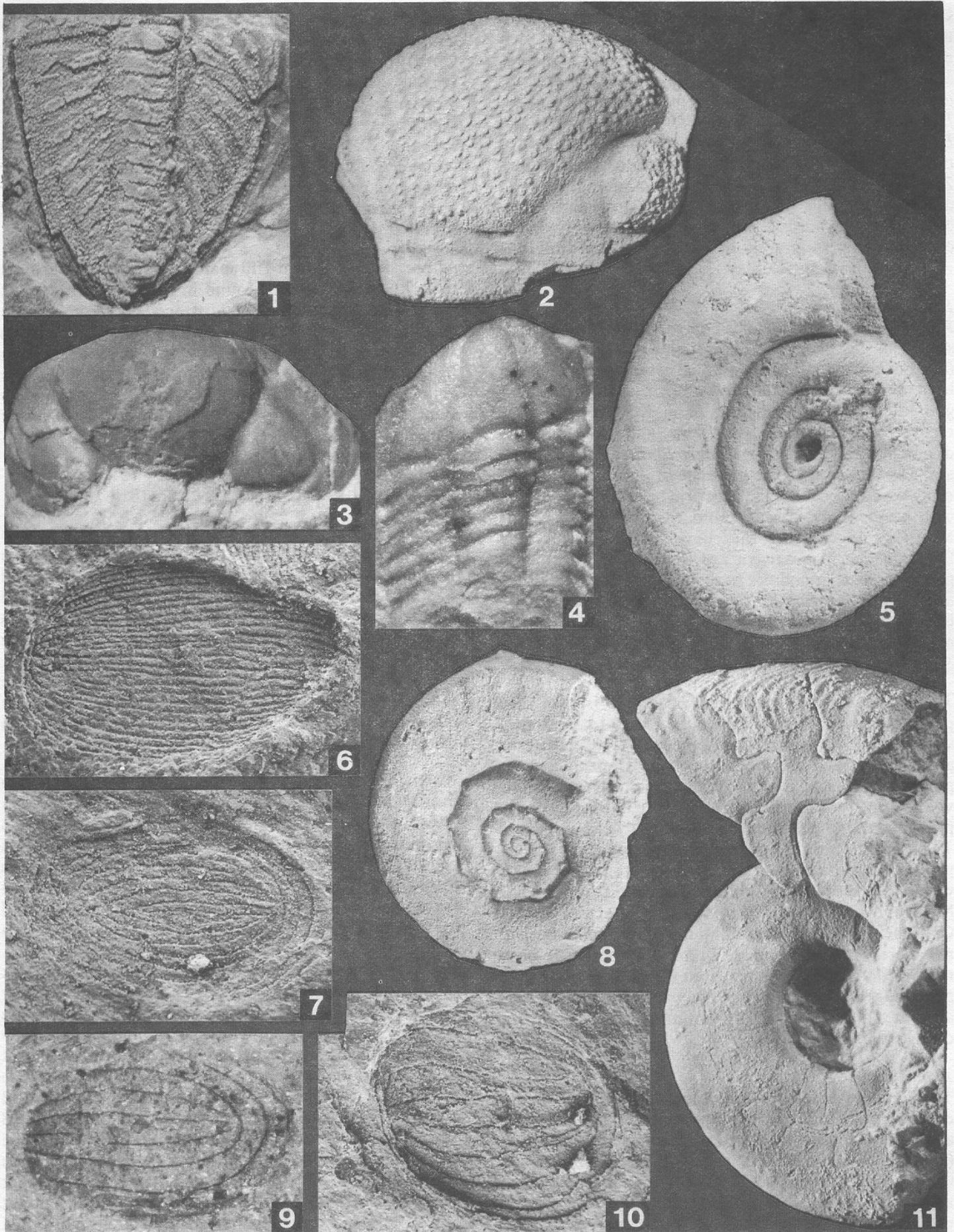


Figure 4. See p. 193 facing for explanation.

Explanation of Figure 4.

1. *Archegonus* cf. *aequalis*. Axford Hill, plan view of pygidium. (x8).
  2. *Phacops* (*Phacops*) *wedekindi*. Thrustle's Nest, view showing faceted eye and granulose glabella. (x5)
  3. *Dianops griffithides*. Viverdon Down Trenches, plan view of cephalon (x3).
  4. *Typhloproetus subcarintiacus*. Viverdon Down Trenches, plan view of cephalon and thorax. (x9)
  5. *Kosmoclymenia* sp. (juvenile form). Thrustle's Nest. (x3)
  6. *Richterina* (*Richterina*) *striatula*. Viverdon Down Trenches. (x35)
  7. *Maternella dichotoma*. Viverdon Down Trenches. (x35)
  8. *Kalloclymenia* sp. Thrustle's Nest (x4)
  9. *Maternella hemisphaerica*. Viverdon Down Trenches (x35)
  10. *Maternella hemisphaerica*. Viverdon Down Trenches (x35)
  11. *Cymaclymenia striata*. Thrustle's Nest (x4)
- 
- 

within this Unit. The highest topographic levels of the Down preserve the complex imbricate zone Of the Main Thrust and in consequence the right-way-up limb overlying the Main Thrust is not represented here.

*Acknowledgements.* The trilobite and conodont faunas discussed in this paper were kindly identified by Dr E.B. Selwood and Mr I.J. Stewart respectively. I also wish to thank Mr V.J. Holloway for granting access to the temporary excavation at Thrustle's Nest and allowing trenching work to be undertaken at Axford Hill. Mr R.N. Bush and the late Major Coryton supported the excavations on Viverdon Down and provided local information of considerable value.

## References

- Gooday, A.J. 1978. The Devonian. 101-120, in Bate, R. and Robinson, E. (eds.) A stratigraphical index of British Ostracoda. *Geol. J. Spec. Issue* 8.
- MacAllister, D.A. 1911. Southern area. 44-47, in Reid, C., Sherlock, R.L., MacAllister, D.A. and Dewey, H. The geology of the Country around Tavistock and Launceston. *Mem. Geol. Surv.*, H.M.S.O. London.
- Matthews, S.C. 1969. A Lower Carboniferous conodont fauna from east Cornwall. *Palaeontology*, 12 262-275.
- Matthews, S.C. 1970. A new cephalopod fauna from the Lower Carboniferous of east Cornwall. *Palaeontology*, 13, 112-131.
- Petter, G. 1959. Clyménées du Sahara. *Publs. Serv. Carte géol. Algér.* (N.S.), *Paléont. Mem.*, 6, 1-76.
- Sandberg, C.A., Leuteritz, K. and Brill, S.M. 1978. Phylogeny, speciation and zonation of *Siphonodella* (Conodonta, Upper Devonian and Lower Carboniferous). *Newsl. Stratigr.*, 7, 102-120.
- Stewart, I.J. 1981b. Late Devonian and Lower Carboniferous conodont faunas from north Cornwall and their stratigraphical significance. *Proc. Ussher Soc.*, 5, 179-185.
- Turner, P.J. 1981. Aspects of the structure of the Chillaton area, south-west Devonshire. *Proc. Ussher Soc.*, 5, 153-162.
- Voges, A. 1959. Conodonten aus dem Untercarbon I und II (*Gattendorfia* - und *Pericyclus* - Stufe) des Sauerlandes. *Paläont. Z.*, 33, 266-314.
- Wedekind, R. 1914. Monographie der Clymenien des Rheinischen Gebirges. *Abh. K. Ges. Wiss. Göttingen., Math. Phys., N.F.*, 10, 1-73.

This paper is published with the approval of the Director, Institute of Geological Sciences (N.E.R.C.)