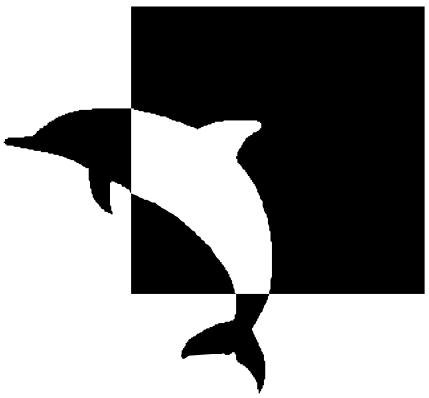
SOUTH WEST DYFED FIELD EXCURSION.

Friday 31st March – Friday 7th April, 2006

Name ……

Caravan ……



University of Southampton
School of Ocean and Earth Science

Introduction
The field guide has been produced to provide background information.
It should be taken into the field each day for reference.

Safety: You must follow the safety code given to you at the beginning of the academic year, not only for your own safety but for that of others.
The main hazards are slippery rocks on the foreshore (especially those covered in sea-weed).

Behaviour: The good name of Southampton University is dependent on your good behaviour. Please keep the caravans clean, avoid causing damage, and do not make excessive noise after 11:00pm. If there is any serious incident involving our group we will all be asked to leave.

Aims and objectives of the course: To develop powers of observation and methods of recording geological information including:
- describing (in words and sketches with appropriate measurements) and interpreting geological features)
- measuring and describing sedimentary successions
- making a sketch section of the structure and stratigraphy of cliff exposures
- measuring the orientation and displacement of faults
- observing the textural and boundary relationships of igneous rocks
- noting the relationship between geological and geomorphological features
- plotting a simple geological map

Most of these data should be recorded in your field notebook. Where necessary, special sheets will be supplied for logging or mapping.

The following will be assessed (flexibility is required for adverse weather)
1. Sketch section of the cliffs at Broad Haven (Field Notebook)
2. A sedimentary log of part of the Marloes section (Log Sheets)
3. Field map of either Freshwater East or St Davids (F only if StD is impossible due to circumstances)

Itinerary (all tide times local and for Milford Haven):

	COACH A	**COACH B**	**LOW/HIGH TIDE**
Saturday April 1	Tenby Techniques training Notebook training Section reconstruction	Freshwater E Stackpole Techniques training Mapping training Notebook training	08.04 – 7.4 m 14.21 – 0.4 m 20.20 – 7.1 m
Sunday April 2	Freshwater E Stackpole Mapping training Notebook training	Tenby Techniques training Notebook training Simple section walk	08.43 – 6.9 m 14.57 – 0.9 m 20.57 – 6.6 m
Monday April 3	Broadhaven *Assessed Notebook*	Marloes Training log *Assessed log*	09:21 – 6.4 m 15.33 – 1.5 m 21.36 – 6.1 m

Tuesday April 4	Marloes Training log *Assessed log*	Broadhaven *Assessed Notebook*	10.03 – 5.8 m 16.11 – 2.0 m 22.20 – 5.6 m
Wednesday April 5	St Davids (Caefai Bay) *Assessed map*	St Davids (Caefai Bay) *Assessed map*	10.54 – 5.2 m 17.02 – 2.6 m 23.20 – 5.1 m
Thursday April 6	Strumble Abereiddy Lithologies transect	Strumble Abereiddy Lithologies transect	12.11 – 4.7 m 18.33 – 2.9 m 01.00 – 4.9 m

Tides: Tides change during the week as indicated in the table above (Note: add an additional hour if the trip includes the change from GMT to BST). This year's tidal window is rather bad, and we will need to wait especially towards the end of the week (except for Strumble) for the tide to go down. Hence the buses depart at different times every day. There is nothing we can do about this.

Coach bookings (from outside reception):

Day 1:
Coach A Freshwater East - depart from Kiln Park at **10:00**. Return around 19:00.
Group B walks to Tenby section.
Day 2:
Coach B Freshwater East - depart from Kiln Park at **10:00**. Return around 19:00.
Group A walks to Tenby section.
Day 3:
Coach A Broadhaven - to depart from Kiln Park at **10:30.** Return around 19:00.
Coach B Marloes - to depart from Kiln Park at **10:30.** Return around 19:00.
Day 4:
Coach B Broadhaven - depart from Kiln Park at **10:30**. Return around 19:00.
Coach A Marloes - depart from Kiln Park at **10:30**. Return around 19:00.
Day 5:
Coaches A & B St Davids - depart from Kiln Park at **10:30**. Return around 19:30.
Day 6:
Coaches A & B Strumble - depart from Kiln Park at **09:30**. Return around 19:00.

	United States		European Union	
Year	DST Begins at 2 a.m.	DST Ends at 2 a.m.	Summertime period begins at 1 a.m. UT	Summertime period ends at 1 a.m. UT
2002	April 7	October 27	March 31	October 27
2003	April 6	October 26	March 30	October 26
2004	April 4	October 31	March 28	October 31
2005	April 3	October 30	March 27	October 30
2006	**April 2**	**October 29**	**March 26**	**October 29**
2007	March 11	November 4	March 25	October 28
2008	March 9	November 2	March 30	October 26
2009	March 8	November 1	March 29	October 25

US calculator valid 1976-2099; EU 1996-2099. Change with up/down key.

NB. As you can see from the table from http://webexhibits.org/daylightsaving/b.html, Europe changes into Summertime on March 26th, 2006. Therefore, the time transition doe this year NOT affect our schedule.

AIMS AND OBJECTIVES FOR THE MAJOR FIELD LOCATIONS

Locations: Tenby, Abereiddi & Strumble Head

Aims:
1) To complete geological traverses through coastal sections around the town of Tenby and coastal locations of Abereiddi and Strumble Head.
2) To develop skills of field location, observation and recording.

Approach:
a) Students divided into groups and a traverse through the local geology completed, locating, making observations and recording information in a systematic way. Learn to make/register observations while walking!!!
b) Notebooks collected upon return to campsite/exiting the bus. These will be reviewed, annotated, and returned the following day.

Location: Marloes

Aims: To consider environment of deposition of a sedimentary section following the completion of a sedimentary logging exercise.

Note: Although high tide is after 18.00, be careful not to be too far along the section to East by late afternoon.

Approach:
a) A section suitable for logging identified and brief introduction to logging from staff/demonstrator.
b) Students complete first sedimentary log.
c) Over lunch initial logs observed and comments made to individual students.
d) Completion of second sedimentary log – to be handed in upon exiting the bus, and to be *marked* that evening.
e) Observe other aspects of the succession before returning to the coach.

Location: Freshwater E

Aim: To develop understanding of changes observed at major stratigraphic boundaries and recognition of structures in the field.

Approach:
1) To observe section of Devonian stratigraphy
2) To complete a simple map of the Silurian/Devonian Boundary at Freshwater East [The Freshwater Map will be collected and annotated].
3) To observe structurally complex section and wrench fault at Stackpole Key and practise making and annotating a simple map-view sketch (**this stop is not likely in 2006**).

Location: Broadhaven

Aim: To develop an understanding of Geological structures in the field, in particular the nature of Variscan structures in SW Wales.

Approach:
a) To complete a traverse through a coastal section at Broadhaven.
b) To complete sketches of cliff sections containing interesting geological structures. Sketches should be functional, recognisable, and annotated (size, directions, rock-types, etc.)

The notebooks will be collected in at the end of the section and *marked*.

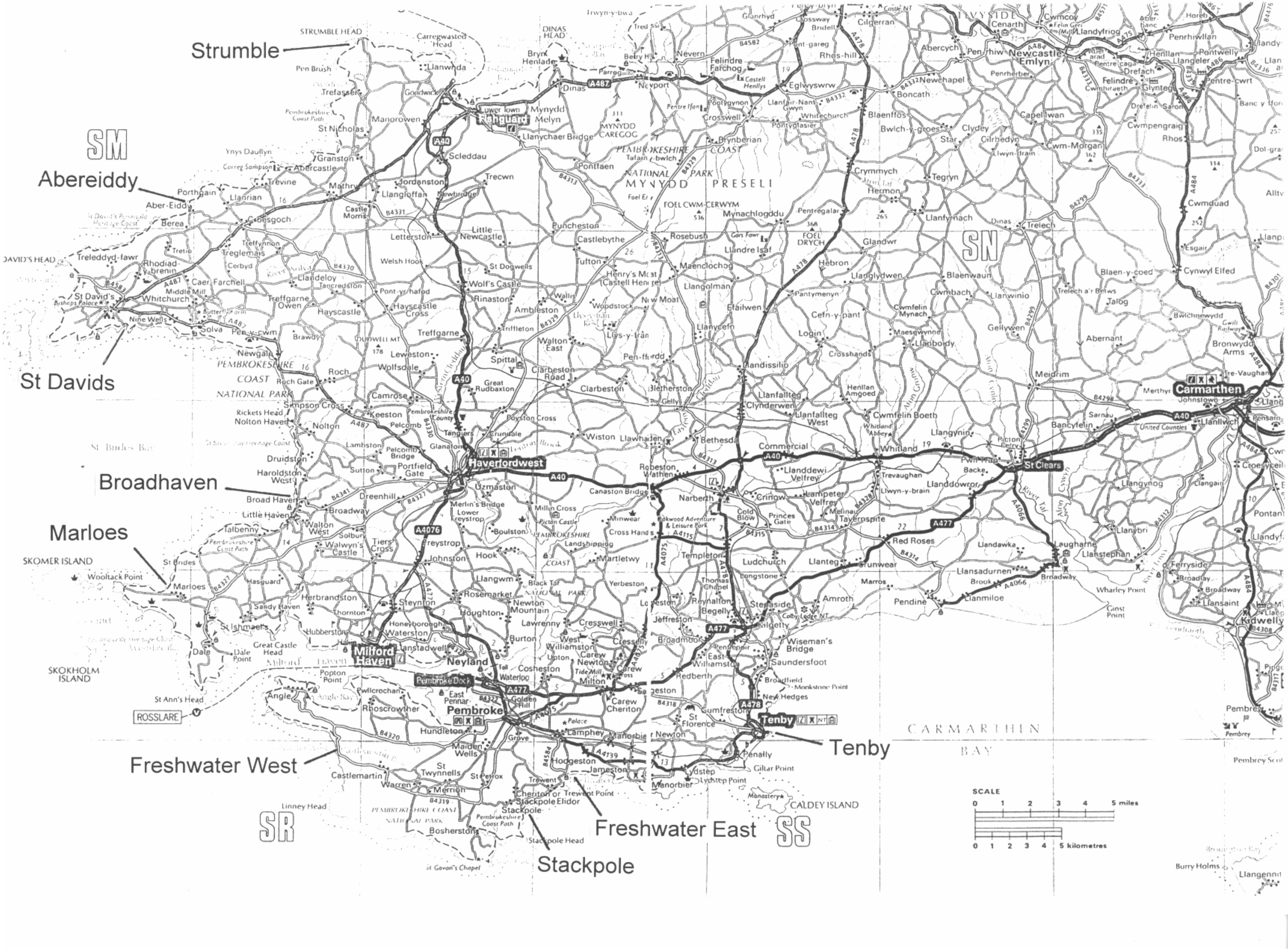
St Davids & Solva

Aim: To develop an understanding of the Lower Palaeozoic Stratigraphy of the region.

Approach:
a) Complete a map of the lower Palaeozoic strata exposed in Carfai Bay. [The map will be collected in at the end of the day and *marked*].
b) Visit to Solva harbour to walk a section (time permitting – **this stop is not likely in 2006**). Note sedimentary and in particular igneous outcrops.

Course Leaders:

Staff:	**Demonstrators:**
Prof Eelco Rohling (coordinator)	Emily Morris
Dr Ian Harding	Robert Thorne
Dr Ralf Schiebel	Steve Arnold
Dr Clive Trueman	Jenny Stanford
	Rebecca Moreman (?)


Strumble
Abereiddy
St Davids
Broadhaven
Marloes
Freshwater West
Stackpole
Freshwater East
Tenby
SM
SN
SR
SS
CARMARTHEN BAY
SCALE
0 1 2 3 4 5 miles
0 1 2 3 4 5 kilometres

Introduction

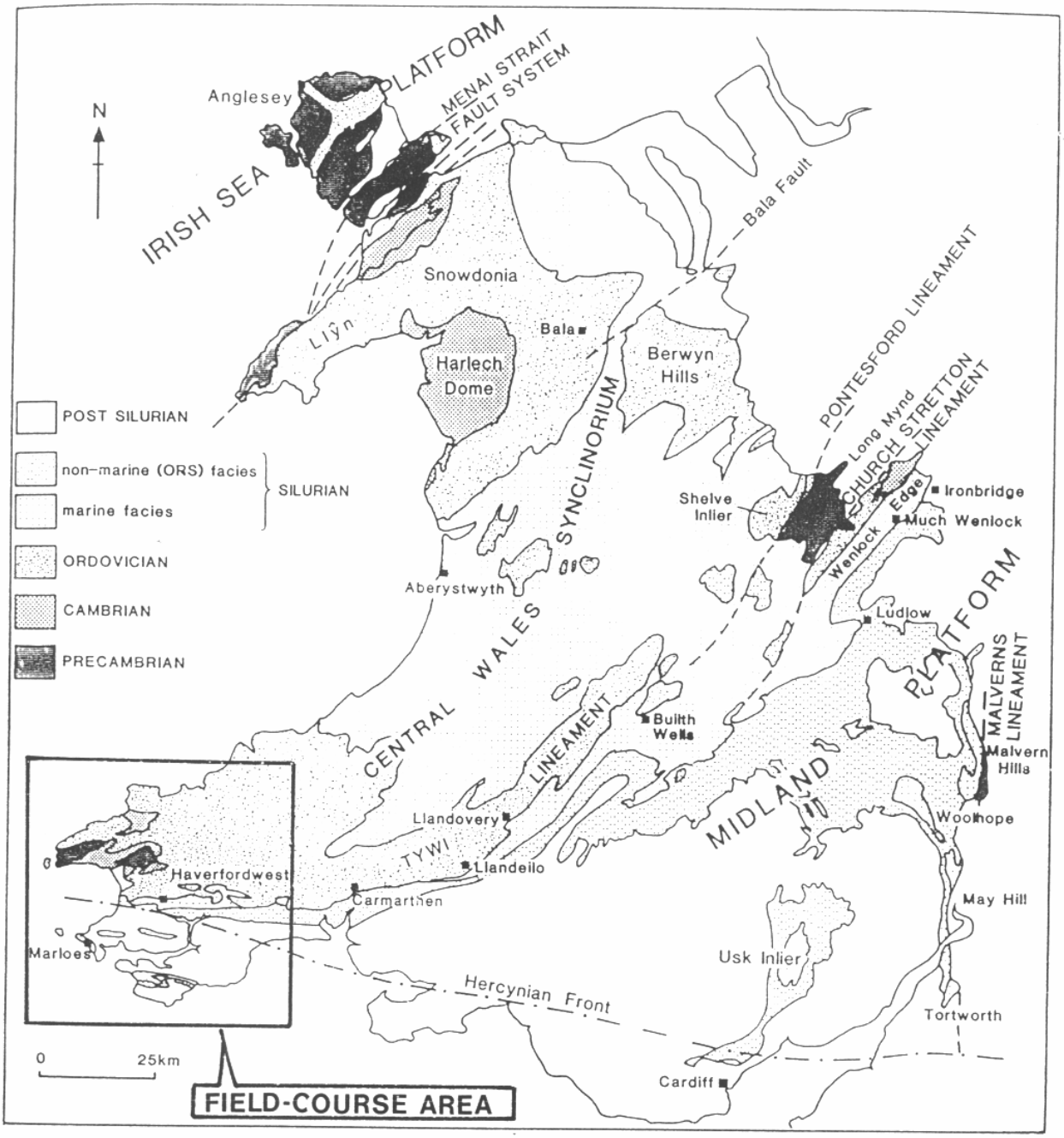


Fig. 3. Distribution of Precambrian and Lower Palaeozoic rocks and major tectonic lineaments of Wales and the Welsh Borderland (modified after Bassett et al. 1986).

Introduction

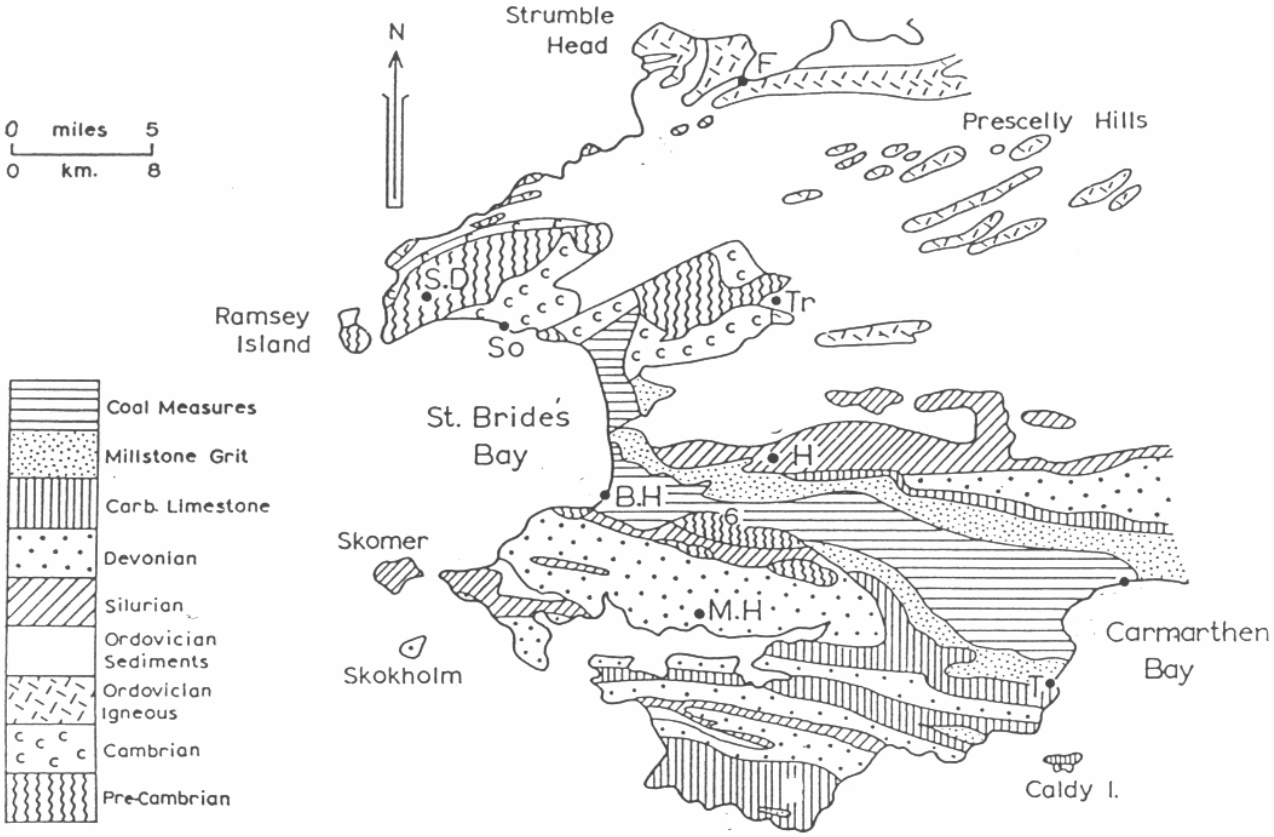
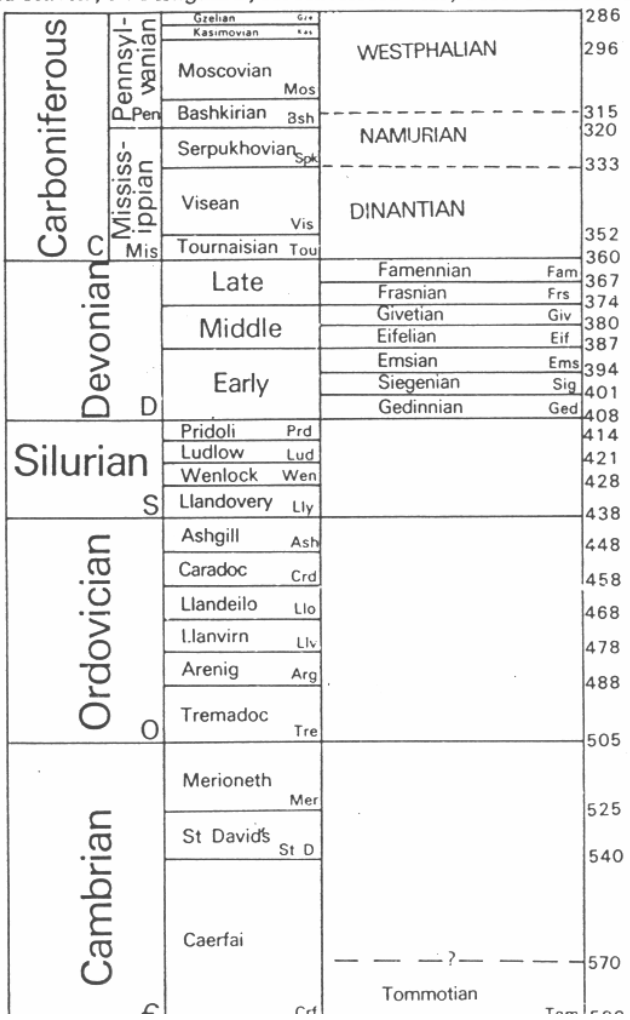
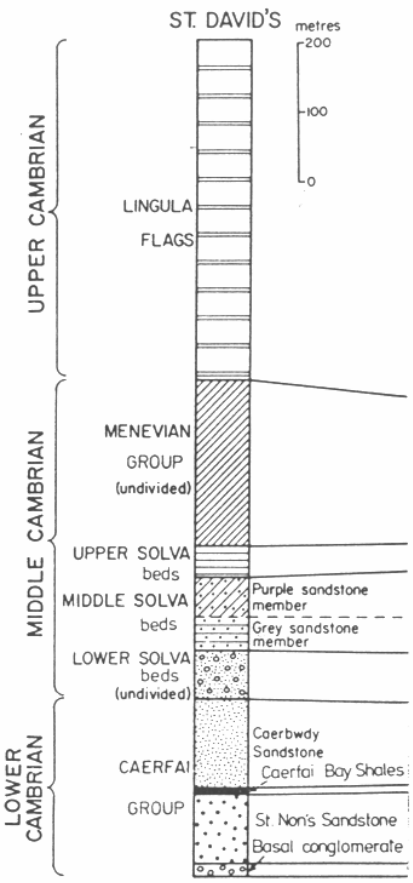


Fig. 1. The general geology of Pembrokeshire (based on Geological Survey, Quarter-Inch Sheet 13). Key: A: Amroth; BH: Broad Haven; F: Fishguard; H. Haverfordwest; MH: Milford Haven; SD: St. David's; SO: Solva: T: Tenby; Tr: Trefgarn



Solva and Caerfai (Cambrian)



from Williams and Stead (1982)

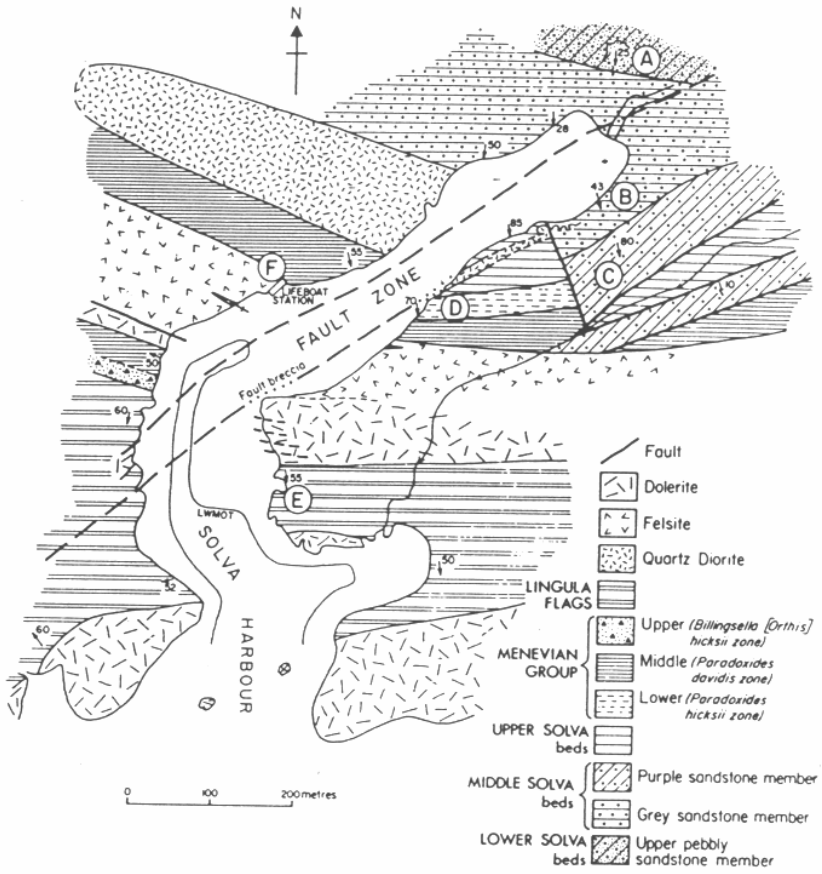
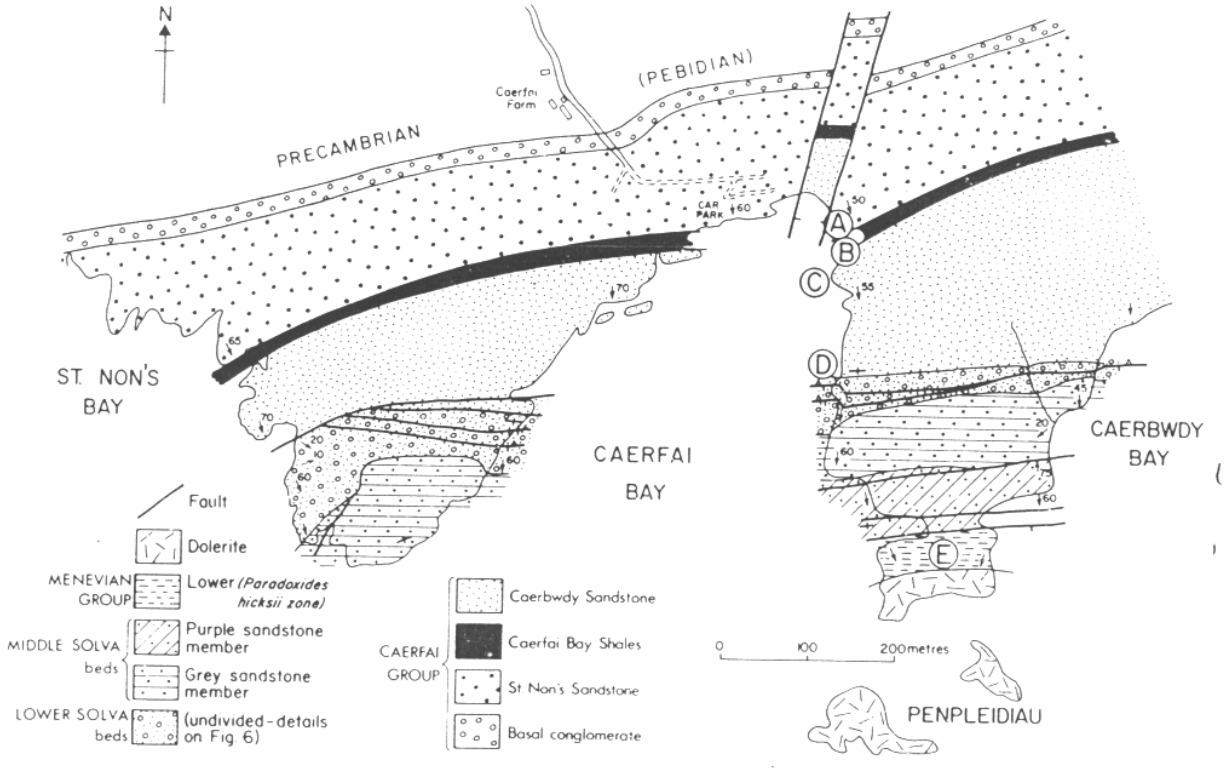


Fig. 4. Geological map of Solva Harbour (locality 3). Circled letters indicate outcrops referred to in the text.

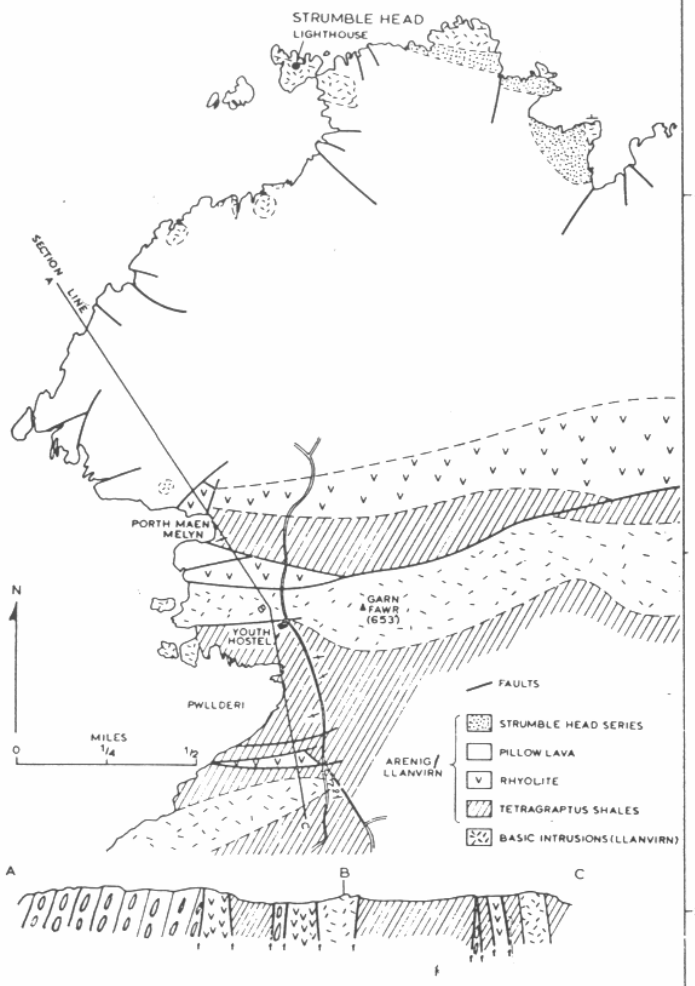
from Williams and Stead (1982)



from Bassett (1982)

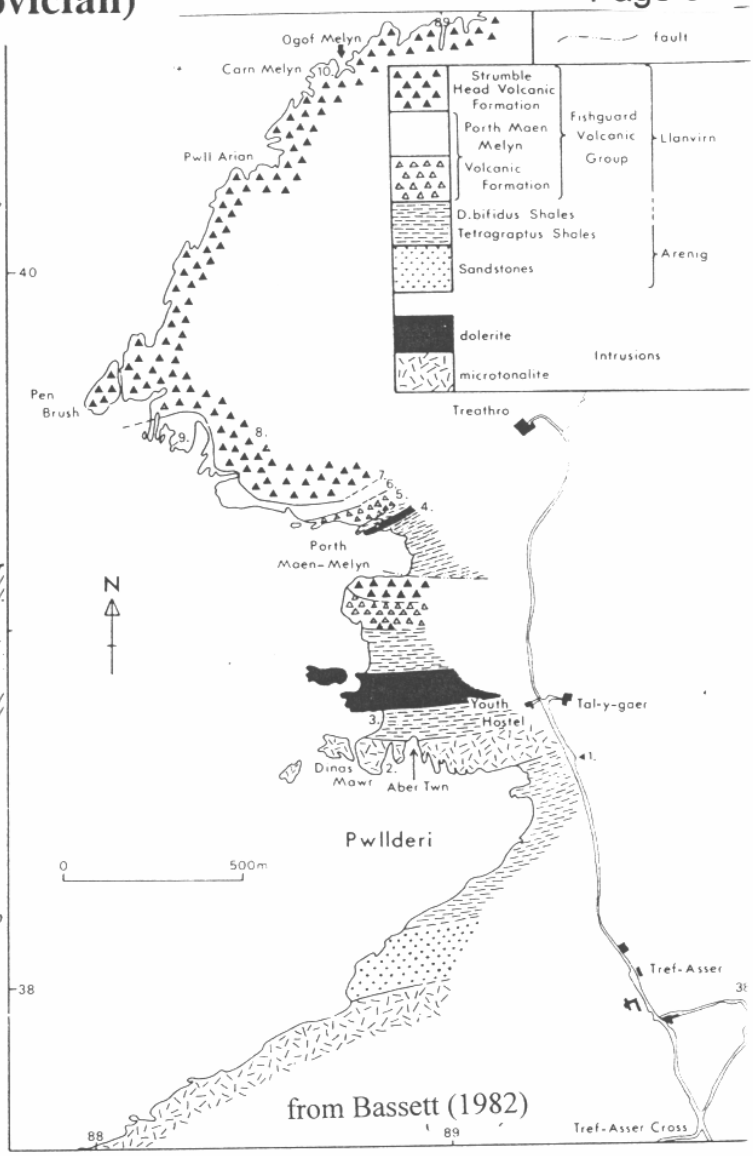
Geological map of the Caerfai Bay area (locality 6). Circled letters indicate outcrops referred to in the text.

Strumble and Abereiddi (Ordovician)



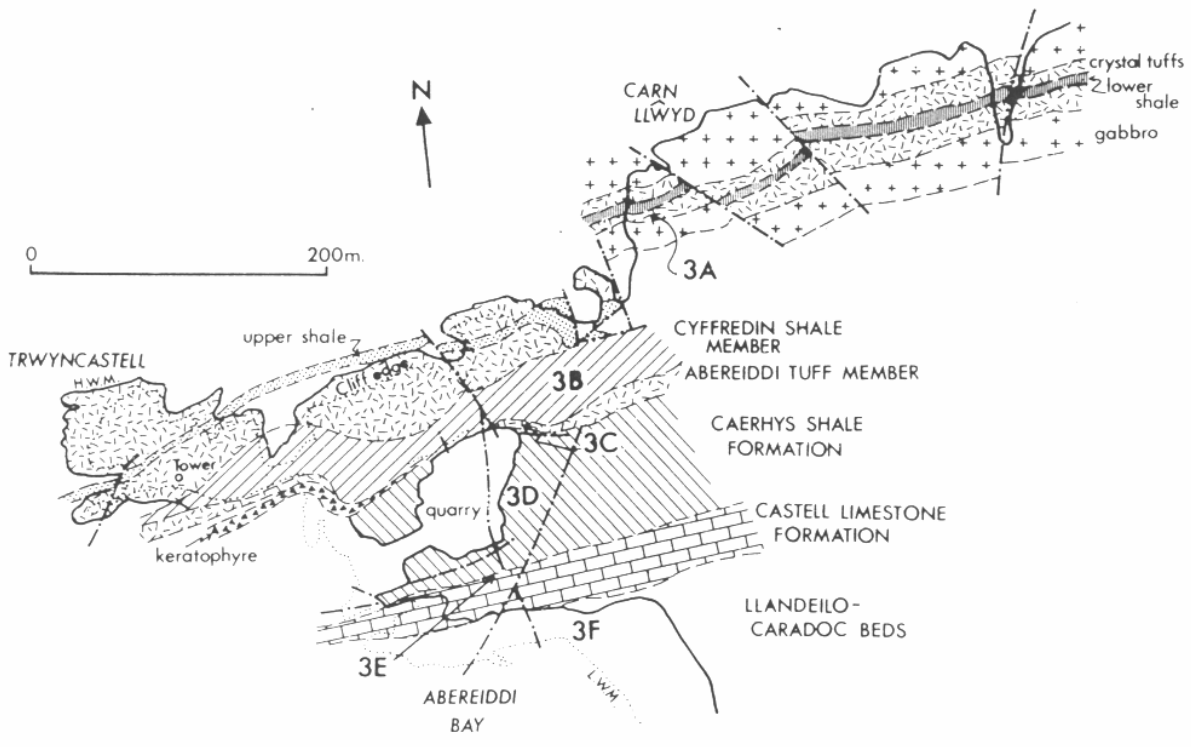
Sketch map of the area around Porth Maen and Strumble Head.

from Bassett and Bassett (1971)



Geological sketch map of the Pwllderi to Ogof Melyn area.

from Bassett (1982)



Geological map of the N side of Abereiddi Bay and Carn Llŵyd.

from Bassett (1982)

Ordovician

Graptolite zones (Jenkins 1979)	Series (no designated stages)	Formations (Jenkins 1979)	Members (Jenkins 1979)	Horizon of guide localities	past lithostratigraphy mostly after Cox 1916 and/or Cox et al. 1930
? gracilis		Llandeilo – Caradoc shales		4A 3F	Dicranograptus shale
? gracilis / inclitus	Llandeilo	Castell Limestone		3E	Castell Limestone
		Caerhys Shale		3D 4B	(unnamed shales) Black et al. 1972 murchisoni shales
priscus	Llanvirn "upper"	Llanrian Volcanic	Abereiddi Tuff / Cyffredin shale / "Lower Rhyolitic Tuff"	3C 3B 3A 2D	Llanrian Group (with murchisoni ash)
? coelatus / confertus subzone / dentatus	Llanvirn "lower"	Aber Mawr Shale		2C 2B 2A	Bifidus shales
? hirundo–gibberulus ?	Arenig	? Penmaen Dewi Shale		1C	Tetragraptus shales
		Ogof Hên		1B	Abercastle, Porth Gain Beds
	Merioneth (upper Cambrian)	Lingula Flags		1A	Lingula Flags

Stratigraphical units occurring in the Abereiddi area.

from Hughes, et al. (1982)

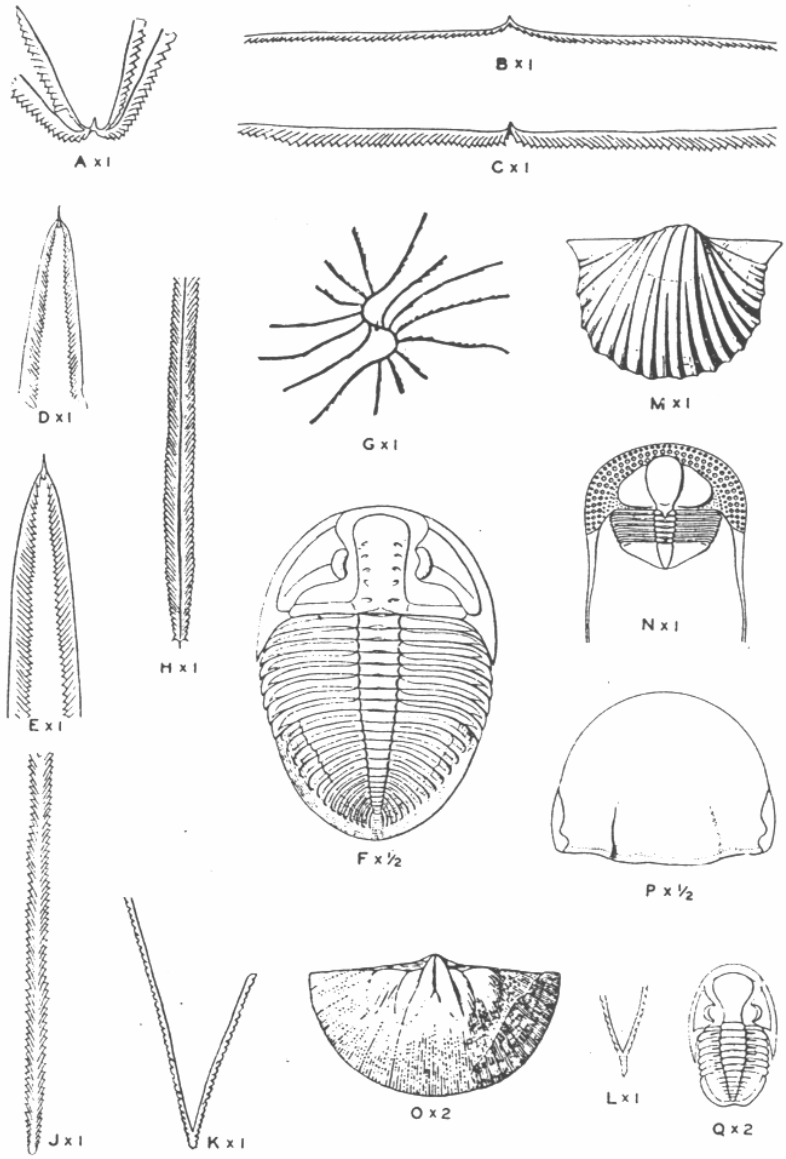
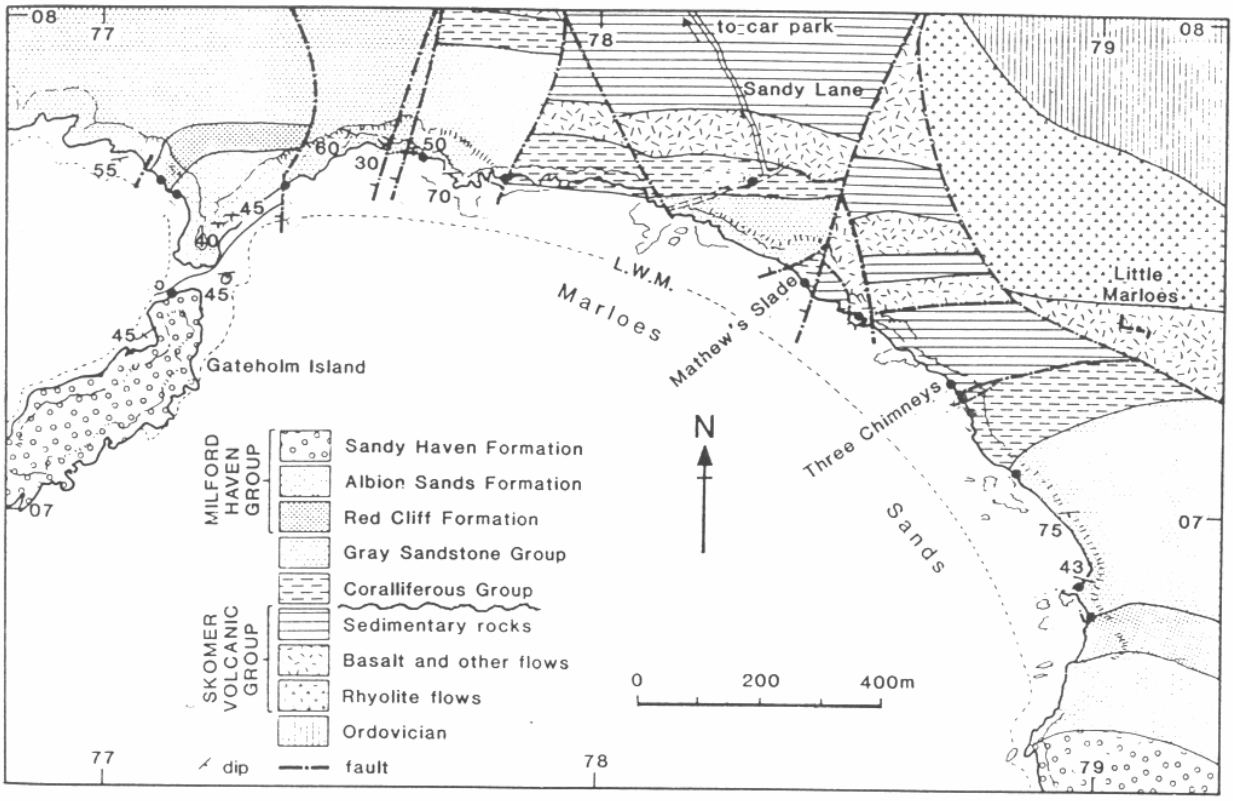


FIG. 9. *Fossils of the Ordovician rocks* (Graptolite drawings after Elles and Wood.)

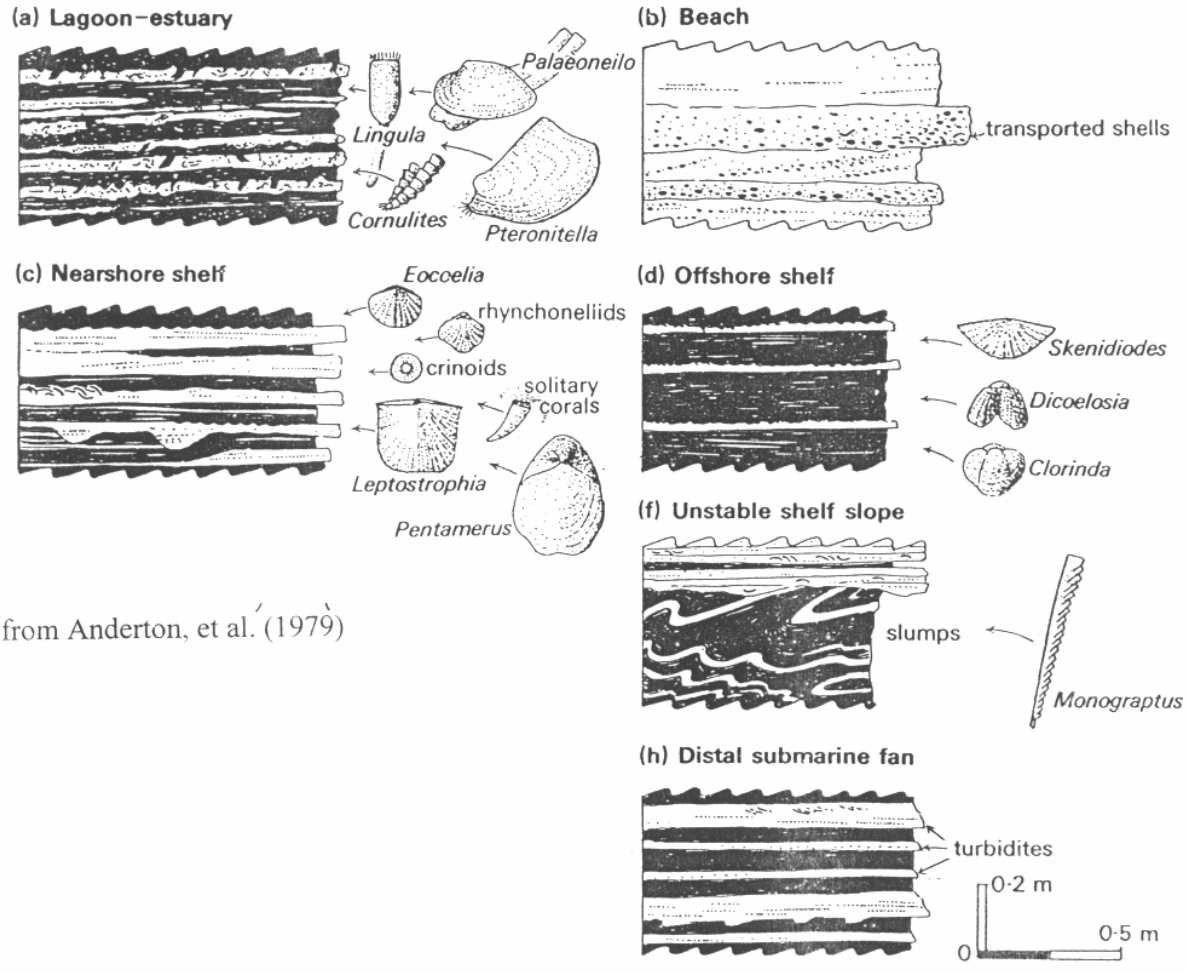
Arenig Series: A. *Tetragraptus serra* (Brongniart); **B.** *Didymograptus extensus* (Hall); **C.** *Didymograptus hirundo* Salter. **Llanvirn Series: D.** *Didymograptus bifidus* (Hall); **E.** *Didymograptus murchisoni* (Beck). **Llandeilo Series: F.** *Ogygiocaris* [*Ogygia*] *debuchii* (Brongniart). **Caradoc Series: G.** *Nemagraptus gracilis* (Hall); **H.** *Diplograptus* [*Mesograptus*] *multidens* Elles and Wood; **J.** *Orthograptus truncatus* (Lapworth); **K.** *Dicranograptus brevicaulis* Elles and Wood; **L.** *Dicranograptus clingani* Carruthers; **M.** *Nicolella actoniae* (J. de C. Sowerby); **N.** '*Cryptolithus* [*Trinucleus*] *concentricus*' auctt. **Ashgill Series: O.** *Sowerbyella sladensis* O. T. Jones; **P.** cephalon of *Illaenus bowmanni* Salter; **Q.** *Phillipsinella parabola* (Barrande).

from British Regional Geology (South Wales)

Marloes (Silurian)

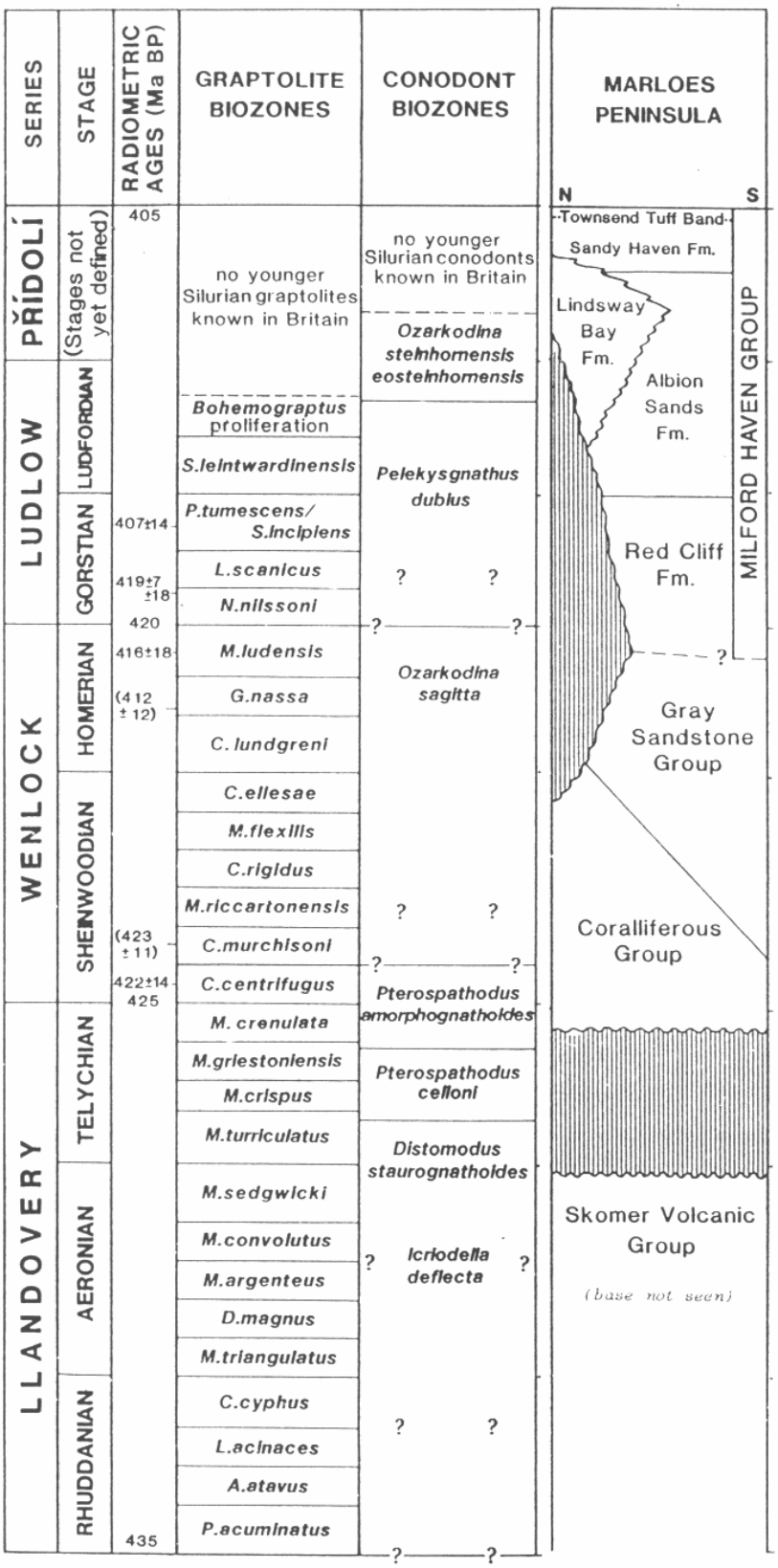


Geological map of Marloes Bay (after Walmsley & Bassett 1976). from Siveter, et al. (1989)



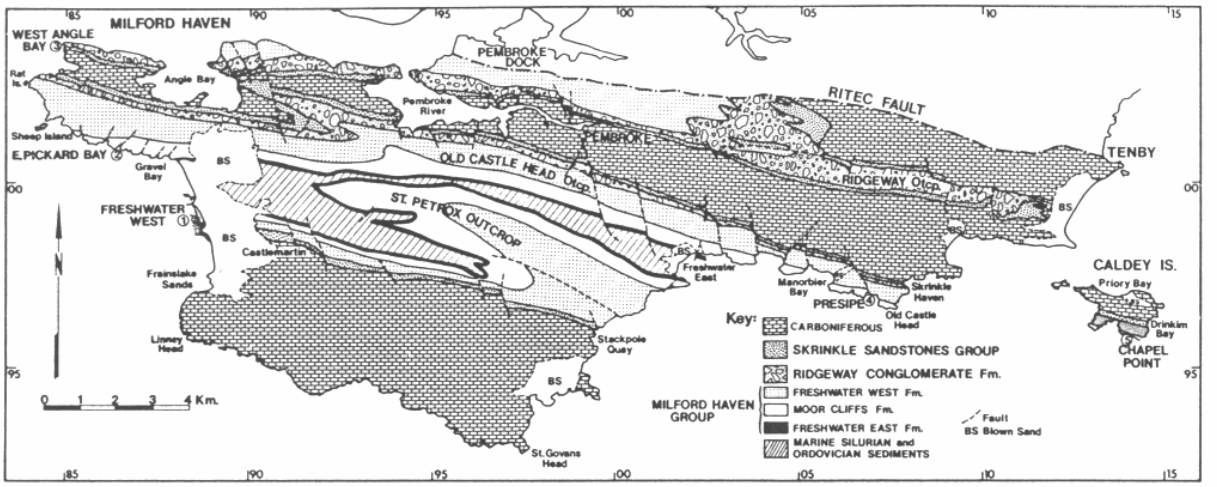
from Anderton, et al. (1979)

Silurian

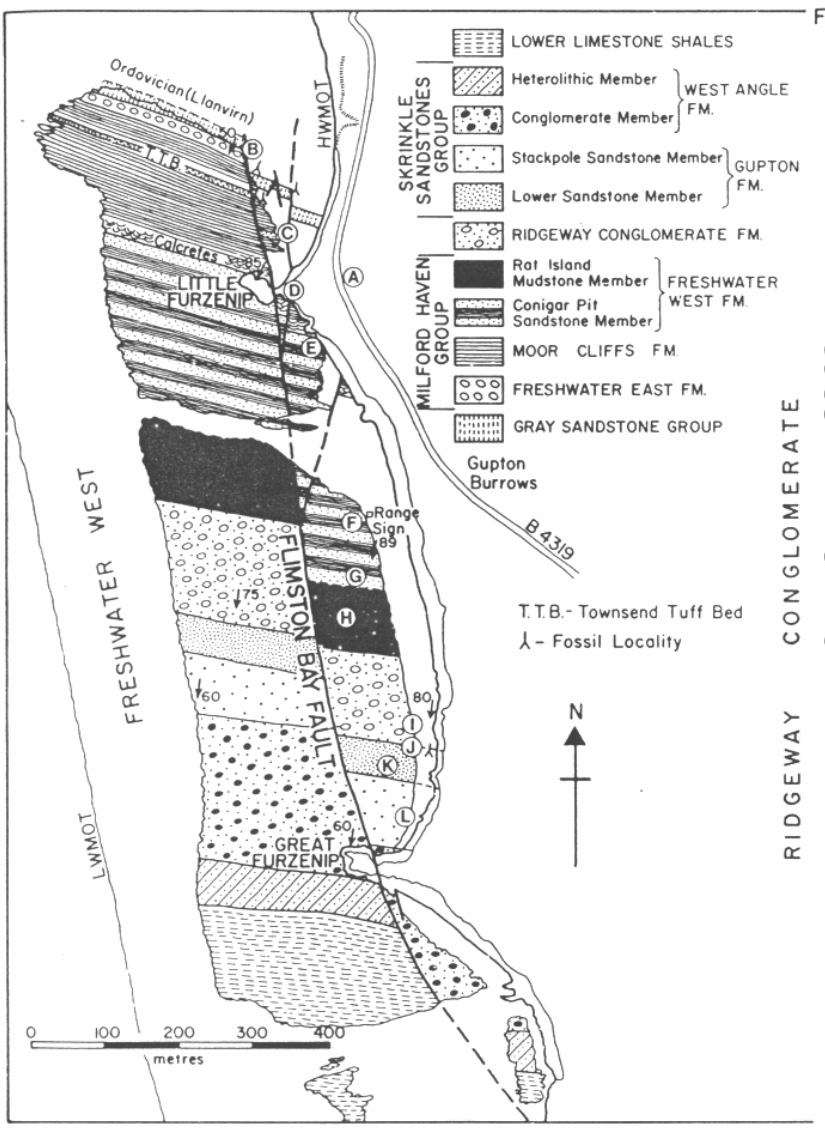


from Siveter, et al. (1989)

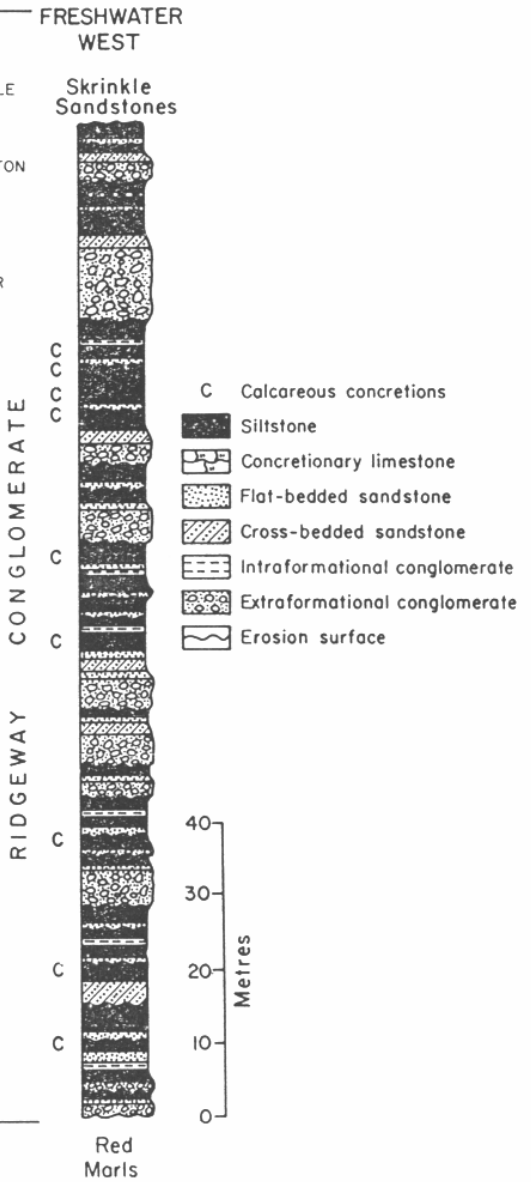
Freshwater West (Devonian)



Geological map of the Pembroke peninsula with emphasis on the Old Red Sandstone outcrops from Bassett (1982)

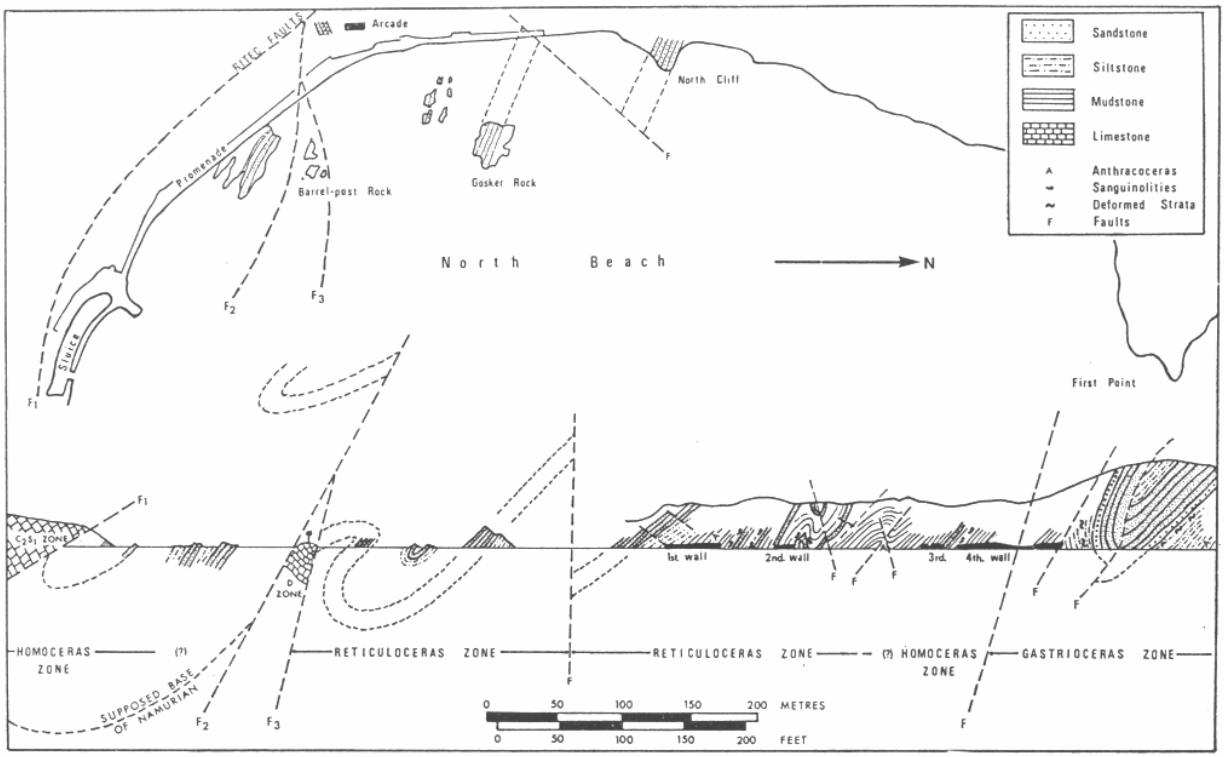


Geological map of Freshwater West from Bassett (1982)

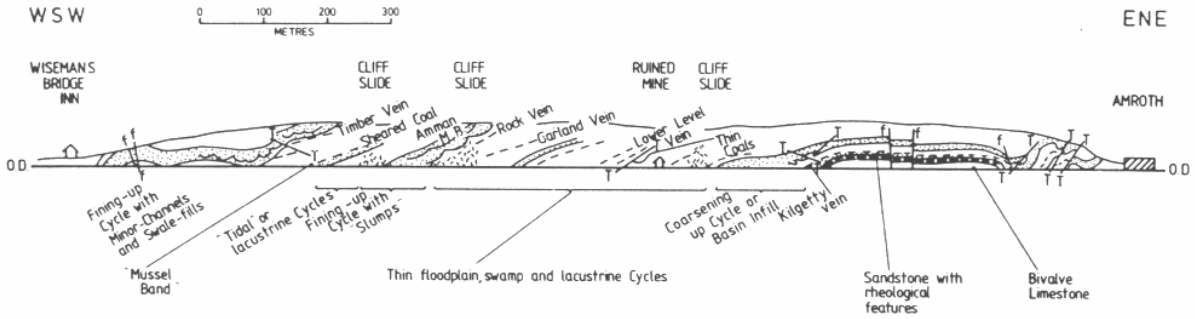


Lithological variation through the Ridgeway Conglomerate from Bassett and Bassett (1971)

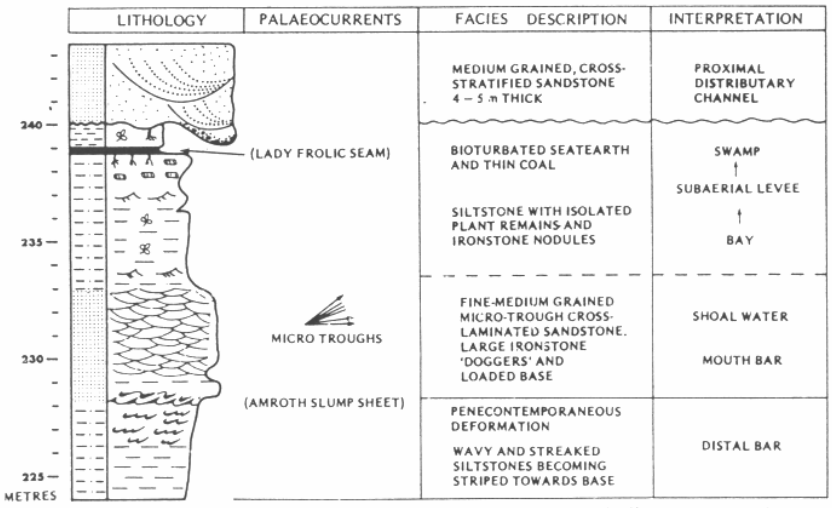
Tenby and Amroth (Carboniferous)



Map and cross section of the cliffs of North Beach, Tenby. from Bassett and Bassett (197



Section showing the structure and sequence of Westphalian A and B strata between Amroth and Wiseman's Bridge.



from Bassett (1982)

Vertical sequence of facies and palaeocurrents. Westphalian A, Amroth.

Carboniferous

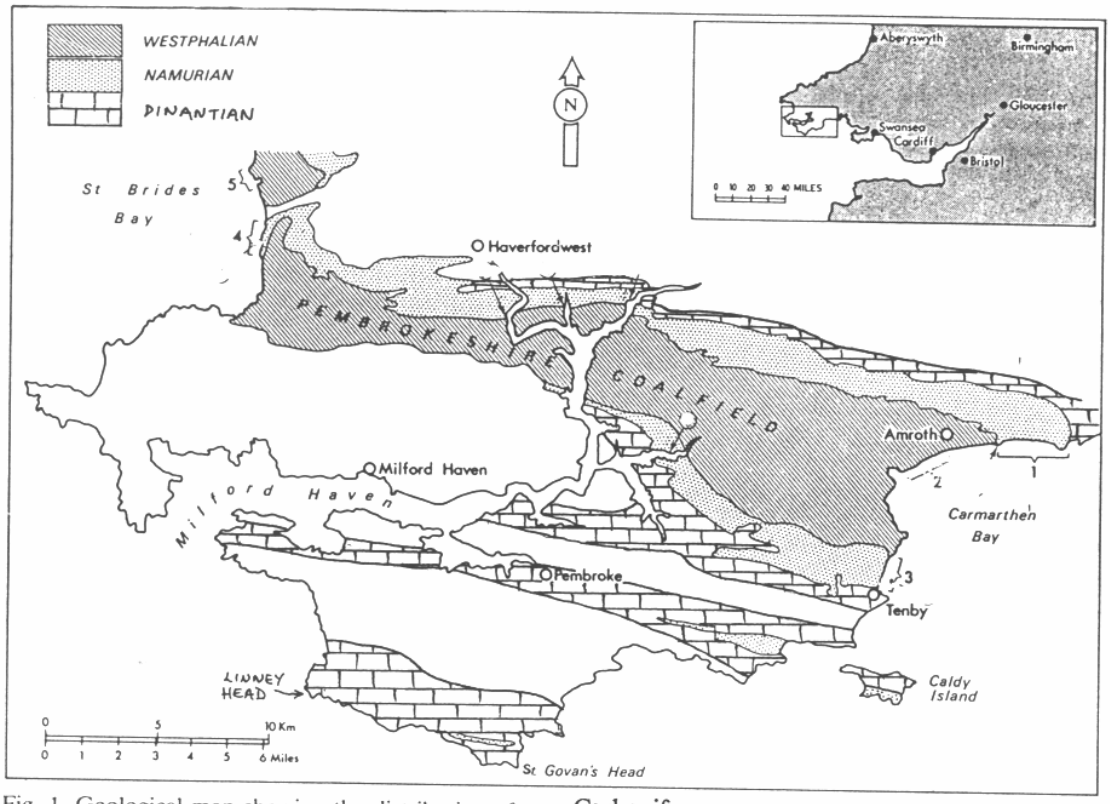


Fig. 1. Geological map showing the distribution of Carboniferous strata in SW Dyfed. Coastal sections: 1, Ragwen Point to Amroth; 2, Amroth to Wiseman's Bridge; 3, Tenby Harbour to Waterwynch Bay; 4, Settling Nose to Broad Haven; 5, Nolton Haven:

from George and Kelling (1982)

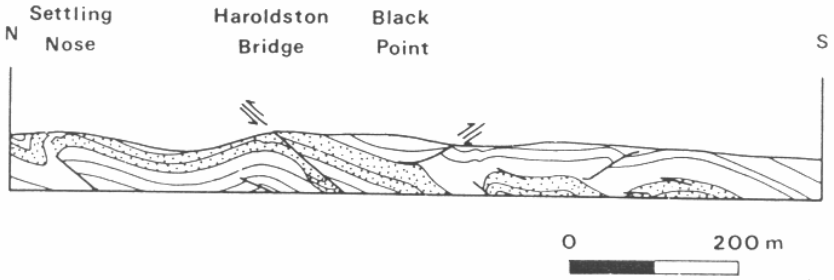


Fig. 26. Cross section of the cliffs near Black Point; for clarity, units of 'Farewell Rock' which are displaced by faults at Settling Nose and Haroldston Bridge have been omitted

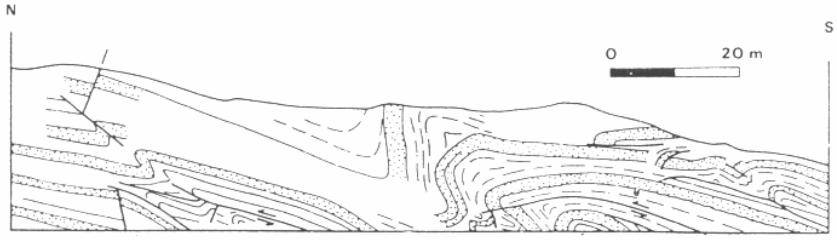


Fig. 25. Cross section of structures visible in the cliffs N of Broad Haven.

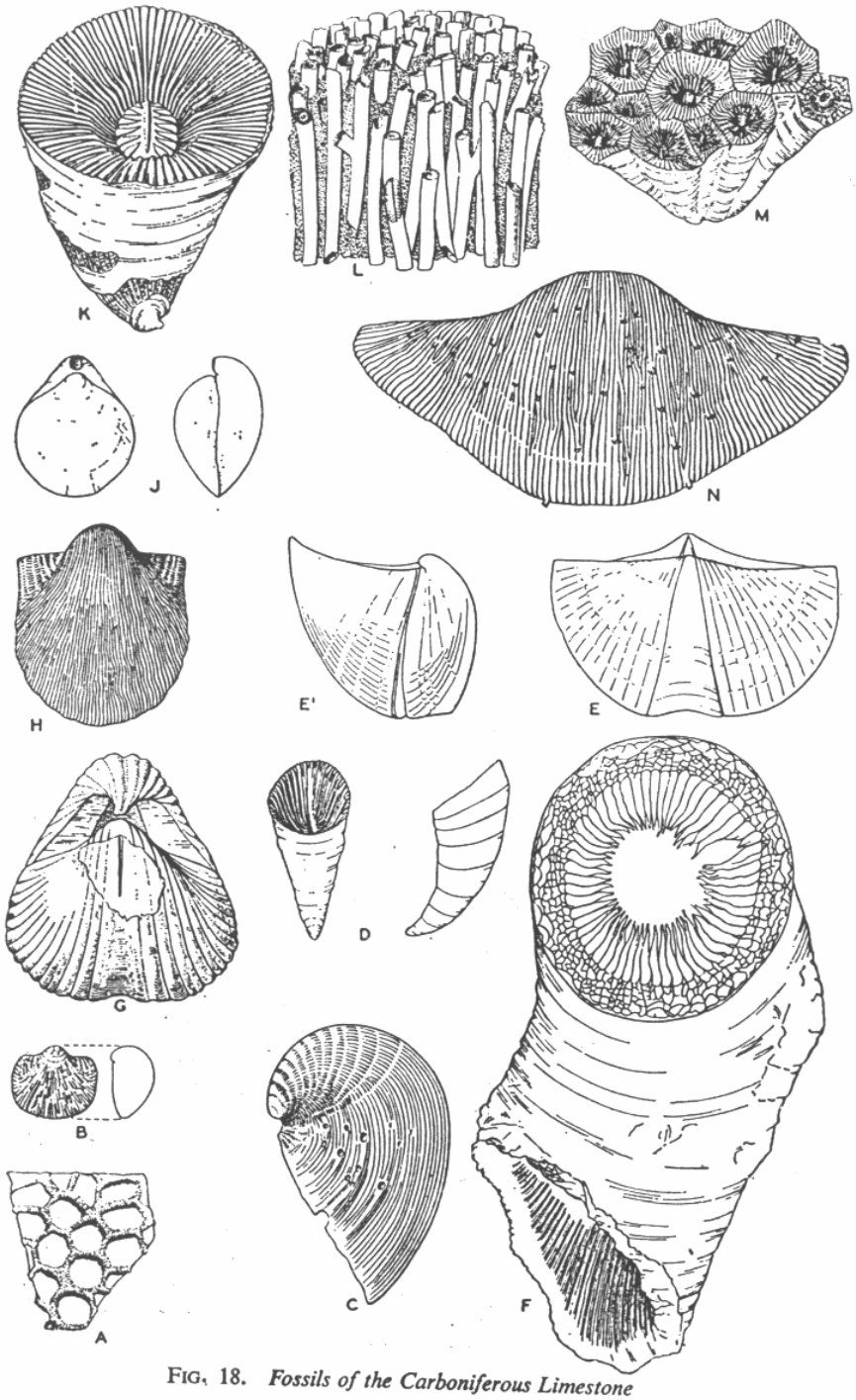
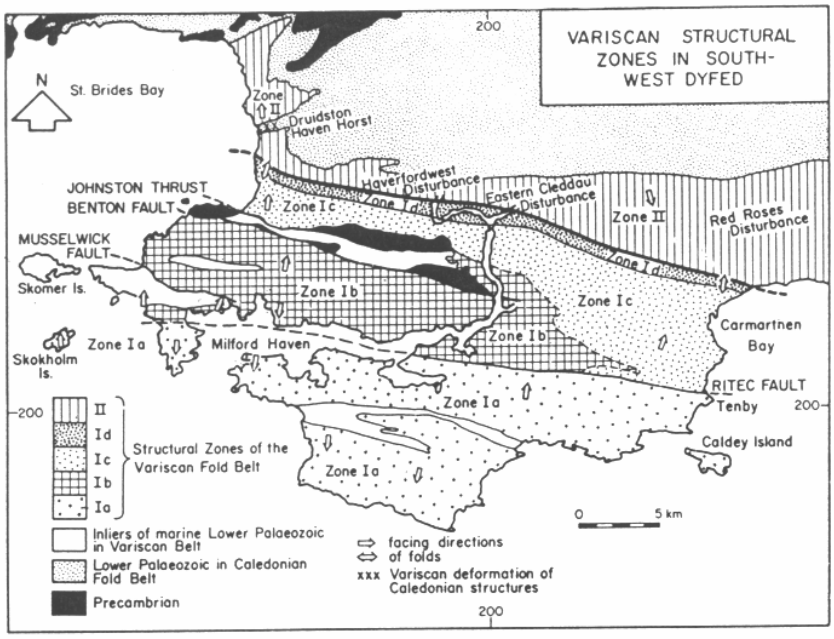


FIG. 18. *Fossils of the Carboniferous Limestone*

(All natural size.)

A. *Vaughania* [*Cleistopora*] *vetus* Smyth; **B.** *Avonia* [*Productus*] *bassa* (Vaughan); **C.** *Dictyoclostus* [*Productus*] *vaughani* (Muir-Wood); **D.** *Hapsiphyllum* [*Zaphrentis*] *konincki* (Milne Edwards and Haime), two views; **E.** *Syringothyris cuspidata* (J. Sowerby), mut. *cyrtorhyncha* North, two views; **F.** *Caninia cylindrica* Scouler; **G.** *Davidsonina* [*Cyrtina*] *carbonaria* (McCoy); **H.** *Linoproductus* [*Productus*] *corrugatohemisphericus* (Vaughan); **J.** *Composita* [*Seminula*] *ficoidea* (Vaughan), two views; **K.** *Dibunophyllum bipartitum bipartitum* (McCoy); **L.** *Lithostrotion junceum* (Fleming); **M.** *Lonsdaleia floriformis* (Martin), forma *crassiconus* McCoy; **N.** *Gigantoproductus* [*Productus*] *latissimus* (J. Sowerby).

Stackpole Quay and Structure



Map of structural zones in SW Dyfed (from Hancock *et al.* 1981, fig. 2.)

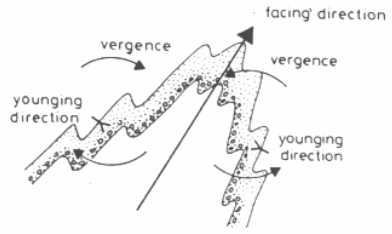
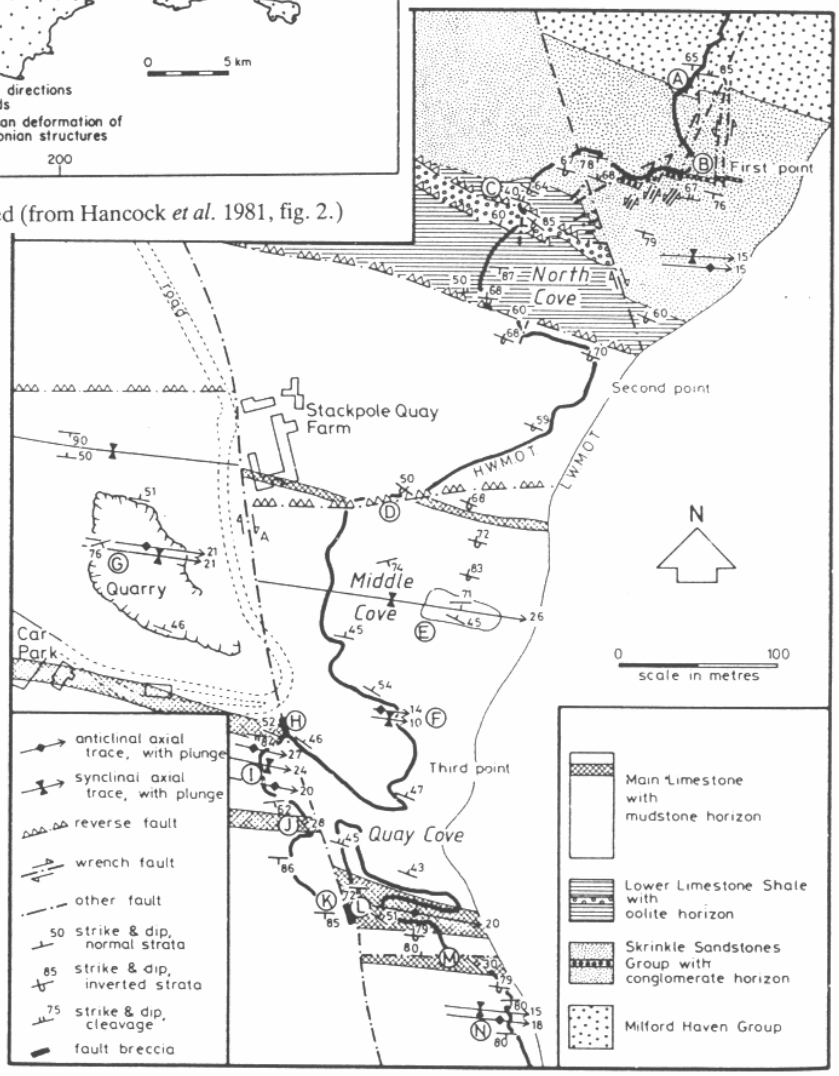
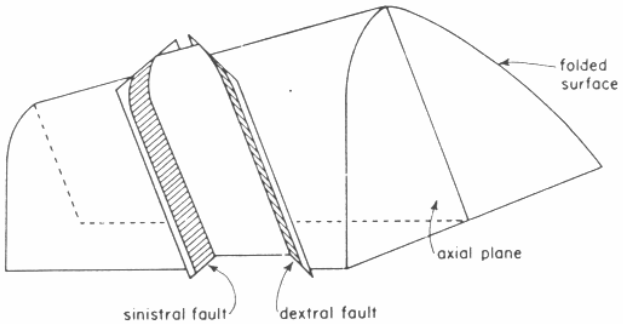


Fig. 2. Schematic profile to explain the meanings of the terms vergence, younging direction, and facing direction. The usage of vergence adopted here follows that proposed by Roberts (1976) for the horizontal direction in the plane of the fold-profile, towards which the upper component of rotational asymmetry shown by inequant folds is directed.



Structural map of the Stackpole Quay region

from Bassett (1982)



Block diagram showing the geometrical relationship between conjugate small wrench faults and folds in Zone Ia.

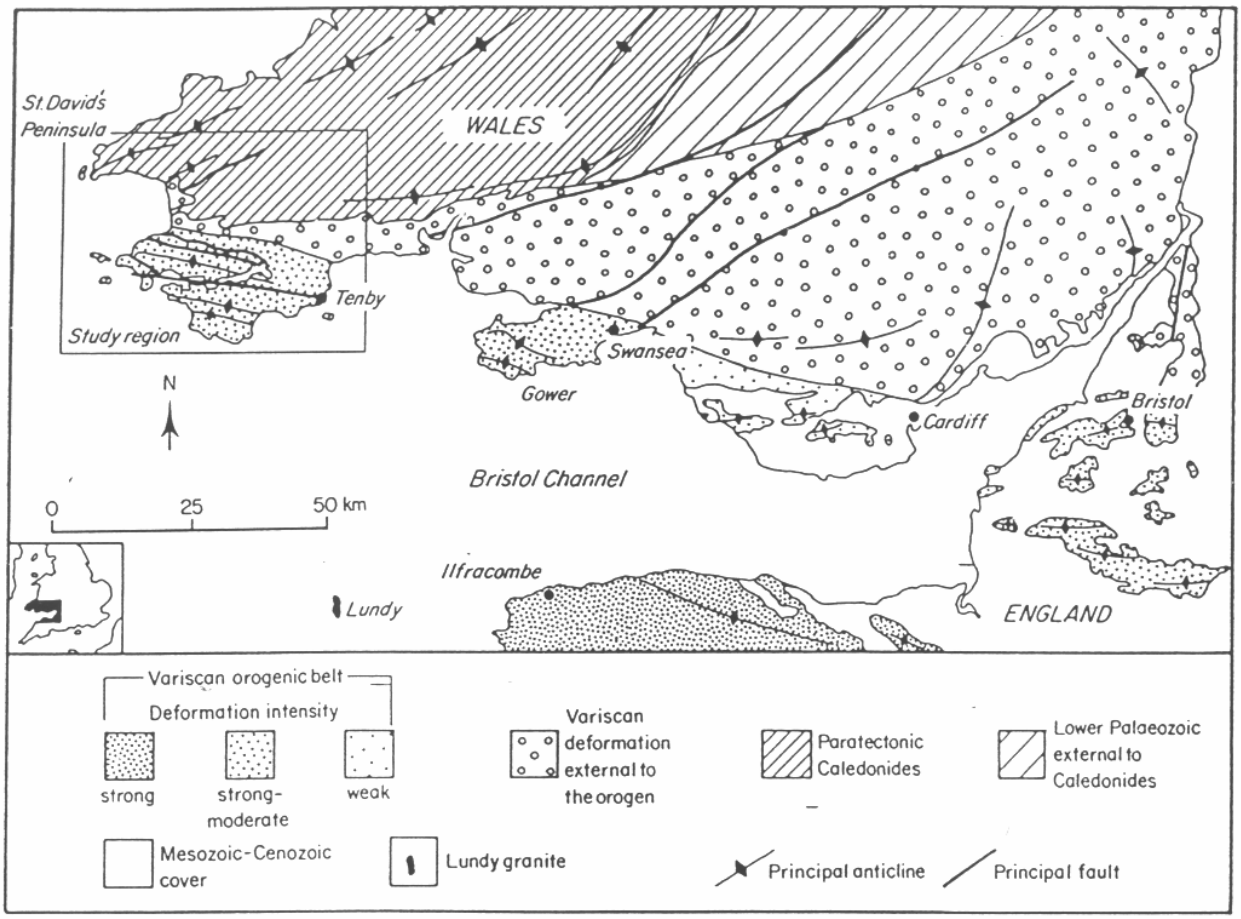
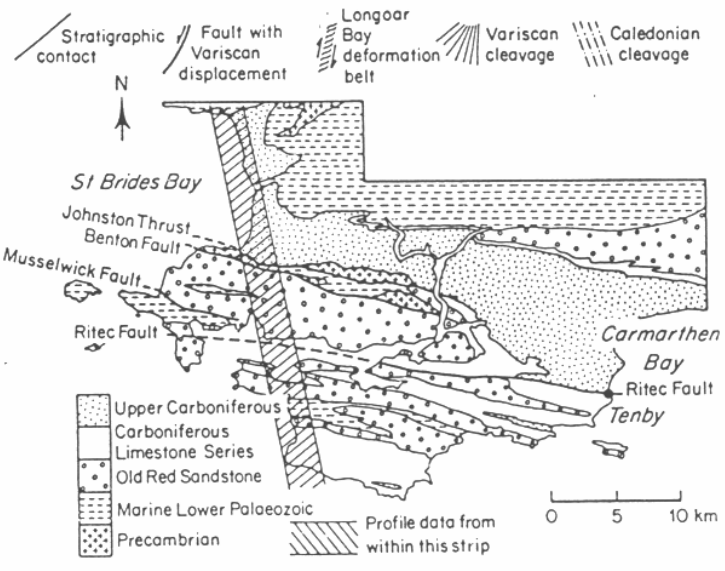
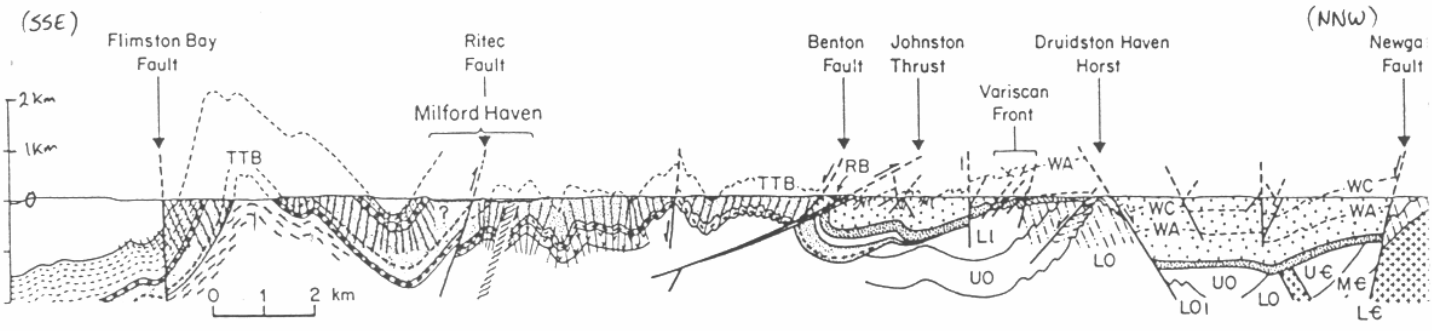


Figure 3.1 Location of the study region within the tectonic domains of South Wales. Modified after Dunning (1966) and Hancock *et al* (1981, figure 1).

Figure 3.2 Synoptic profile across the Variscan fold belt in southwest Dyfed. Sources: I.G.S. sheets 226/227, 228 and 244/245 at 1:50,000 and 1:63,360; Allen *et al* (1976); Allen and Williams (1978); Cantrill *et al* (1916); Dixon (1921); Dunne (1980); Dunning (1964); Hancock (1973); Hancock *et al* (1981); Jenkins (1962); Stead and Williams (1971); Strahan *et al* (1914); Sulivan (1966); Tringham (1979); Walmsley and Bassett (1976); (1981, encl. II).



from Hancock, et al. (1981)



Appendix 1

SCHEME FOR RECORDING SEDIMENTARY ROCKS IN YOUR NOTEBOOK (AFTER TUCKER M. E., 1982)

1. Identify lithology by establishing mineralogy/composition of the rock
2. Examine the grain size of the individual minerals present
3. Examine the texture of the rock - grain shape, roundness, fabric and colour
4. Describe the nature of the bedding planes and the geometry of the beds
5. Look for sedimentary structures on bedding surfaces, within beds and on undersurfaces
6. Search for fossils and note types present and their modes of occurrence and preservation
7. Measure all sedimentary structures which give palaeocurrent directions
8. Record details of sequence by means of field sketch (with scale) and/or graphic log
9. At a later date, and with more data, consider environmental interpretations

(NOTE THAT IT IS INCORRECT TO USE FORMATION NAMES WHEN DESCRIBING LITHOLOGY. A PROPER LITHOLOGICAL DESCRIPTION SHOULD BE GIVEN).

1. Description of mudrocks

Features to note when describing mudrocks. The adjectives given may also be used for describing limestones and sandstones

Mudrock features	Possibilities and descriptive terms
A Note the colour	e.g., grey, red, green, variegated, mottled, etc.
B See how the mudrock falls apart	e.g., fissile (shale), non-fissile (mudstone), blocky, earthy, flaggy, papery, cleaved (slate).
C Look for sedimentary structures	e.g., bedded or laminated, bioturbated, or massive (apparently structureless).
D Check non-clay minerals present	e.g., quartzitic, micaceous, calcareous, gypsiferous, pyritic, sideritic, etc.
E Assess the organic content	e.g., organic-rich, bituminous, carbonaceous, organic-free.
F Look for fossils	e.g., fossiliferous, graptolitic, ostracod.

2. Description of limestones

The simplest classification based on the dominant grain-size (A) is given opposite. Folk's classification based on dominant constituent may be applied if possible (B)

A	2mm	62μm
Calcirudite	*Calcarenite*	*Calcilutite*

B *Dominant constituent*	*Rock type*	
	Sparite cement	*Micrite matrix*
oöids	oosparite	oomicrite
peloids	pelsparite	pelmicrite
bioclasts	biosparite	biomicrite
intraclasts	intrasparite	intramicrite
in situ growth : biolithite		

3. Description of sandstones

Terms used for grain size classification in siliclastic rocks are given opposite Alternative Latin terms sometimes used are:

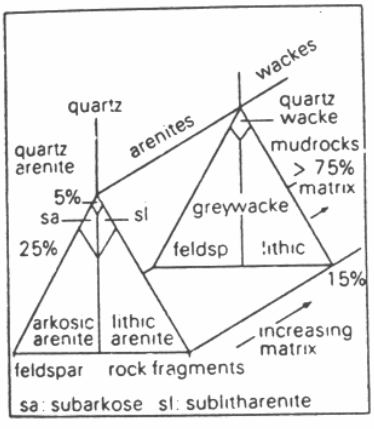
Rudite = >2mm

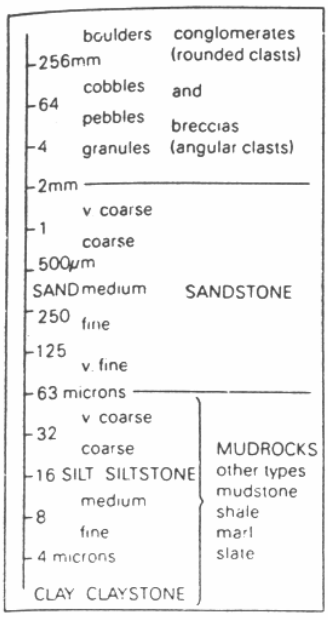
Arenite = 2mm - 63microns

Lutite = <63 microns

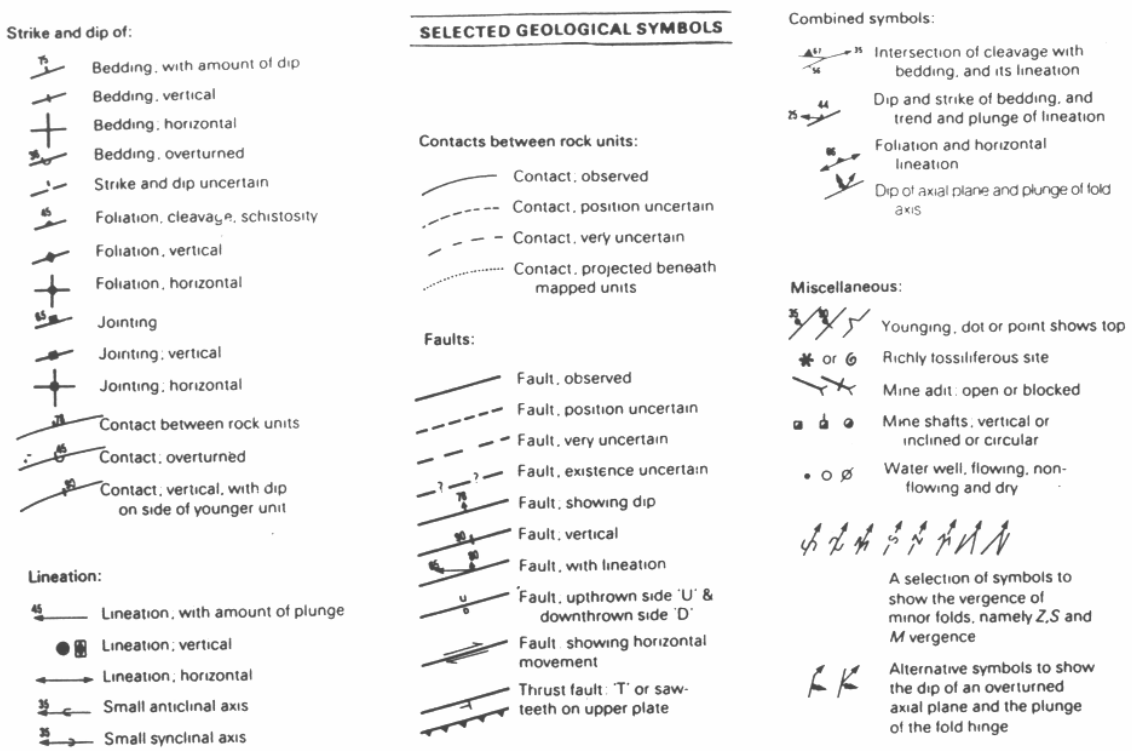
Thus the term arenite is interchangeable with sandstone, and the term lutite with mudrock

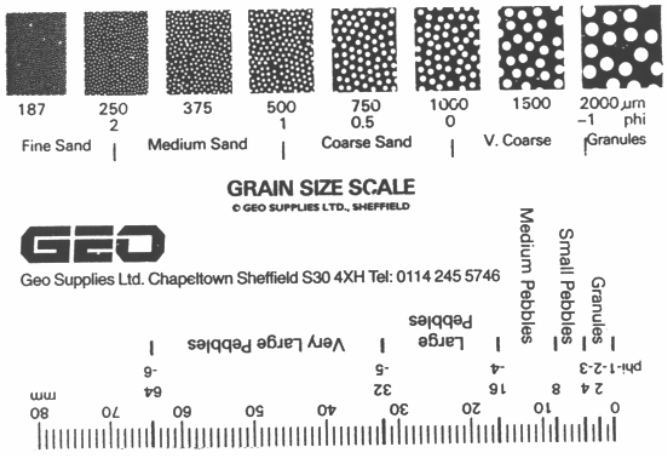
Classification of sandstones. Careful use of a handlens in the field should enable recognition of the main sandstone types: quartz arenite, arkose, litharenite and greywacke (after Pettijohn *et al.*, 1973).

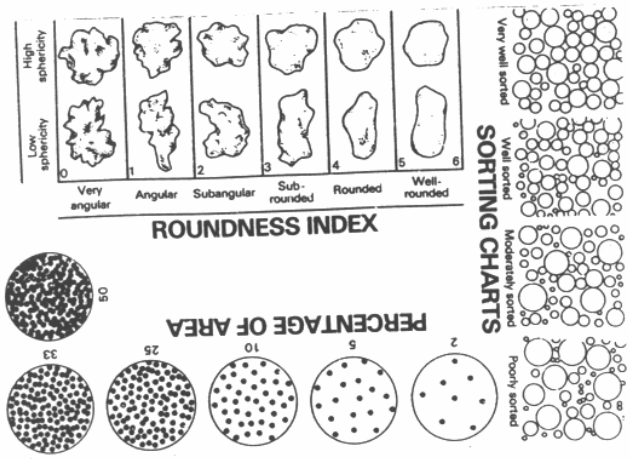




Appendix 2

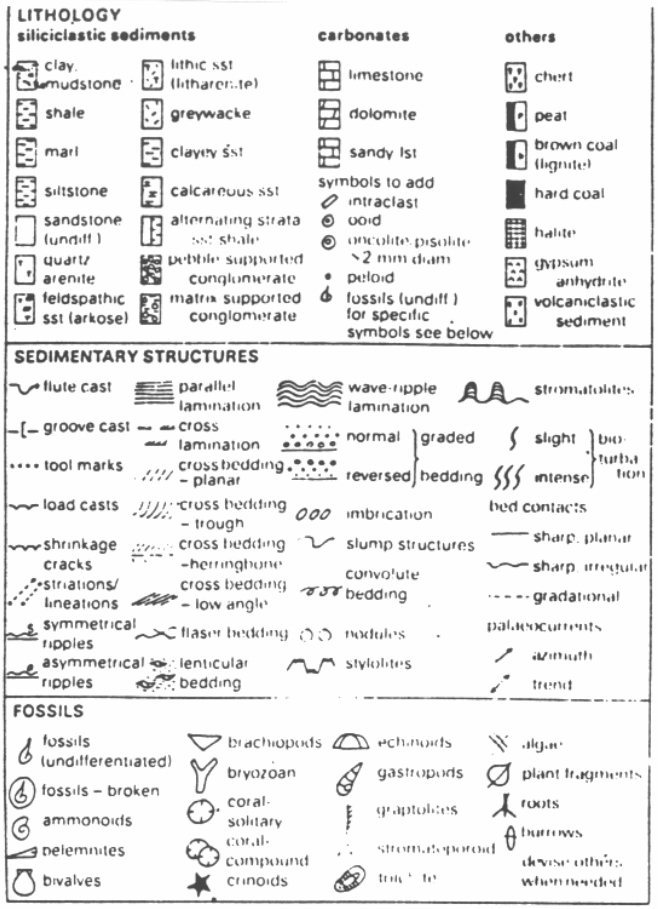

SELECTED GEOLOGICAL SYMBOLS
Strike and dip of:
Bedding, with amount of dip
Bedding, vertical
Bedding, horizontal
Bedding, overturned
Strike and dip uncertain
Foliation, cleavage, schistosity
Foliation, vertical
Foliation, horizontal
Jointing
Jointing, vertical
Jointing, horizontal
Contact between rock units
Contact, overturned
Contact, vertical, with dip on side of younger unit
Lineation:
Lineation, with amount of plunge
Lineation, vertical
Lineation, horizontal
Small anticlinal axis
Small synclinal axis
Contacts between rock units:
Contact, observed
Contact, position uncertain
Contact, very uncertain
Contact, projected beneath mapped units
Faults:
Fault, observed
Fault, position uncertain
Fault, very uncertain
Fault, existence uncertain
Fault, showing dip
Fault, vertical
Fault, with lineation
Fault, upthrown side 'U' & downthrown side 'D'
Fault showing horizontal movement
Thrust fault: 'T' or saw-teeth on upper plate
Combined symbols:
Intersection of cleavage with bedding, and its lineation
Dip and strike of bedding, and trend and plunge of lineation
Foliation and horizontal lineation
Dip of axial plane and plunge of fold axis
Miscellaneous:
Younging, dot or point shows top
or
Richly fossiliferous site
Mine adit, open or blocked
Mine shafts, vertical or inclined or circular
Water well, flowing, non-flowing and dry
A selection of symbols to show the vergence of minor folds, namely Z,S and M vergence
Alternative symbols to show the dip of an overturned axial plane and the plunge of the fold hinge


187
250
2
375
500
1
750
0.5
1000
0
1500
2000 μm
-1 phi
Fine Sand
Medium Sand
Coarse Sand
V. Coarse
Granules
GRAIN SIZE SCALE
© GEO SUPPLIES LTD., SHEFFIELD
GEO
Geo Supplies Ltd. Chapeltown Sheffield S30 4XH Tel: 0114 245 5746
Medium Pebbles
Small Pebbles
Granules
Large Pebbles
Very Large Pebbles
phi -1 -2 -3
-4
-5
-6
mm
0 10 20 30 40 50 60 70 80
2 4 8 16 32 64


High sphericity
Low sphericity
0 Very angular
1 Angular
2 Subangular
3 Sub-rounded
4 Rounded
5 Well-rounded
6
ROUNDNESS INDEX
PERCENTAGE OF AREA
50
33
25
10
5
2
SORTING CHARTS
Very well sorted
Well sorted
Moderately sorted
Poorly sorted

Appendix 3

GRAPHIC LOGS



2.4 Graphic logs

The standard method for collecting field data of sedimentary rocks is to construct a graphic log of the sequence (Figs. 2.1 and 2.2). They immediately give a visual impression of the section, and are a convenient way of making correlations and comparisons between equivalent sections from different areas; repetitions, cycles and general trends may become apparent.

The vertical scale used depends on the detail required and available. For precise work, 1:10 or 1:5 is used but for many purposes 1:50 (that is 1 cm on the log equals 0.5 metre) or 1:100 (1 cm equals 1 metre) is adequate.

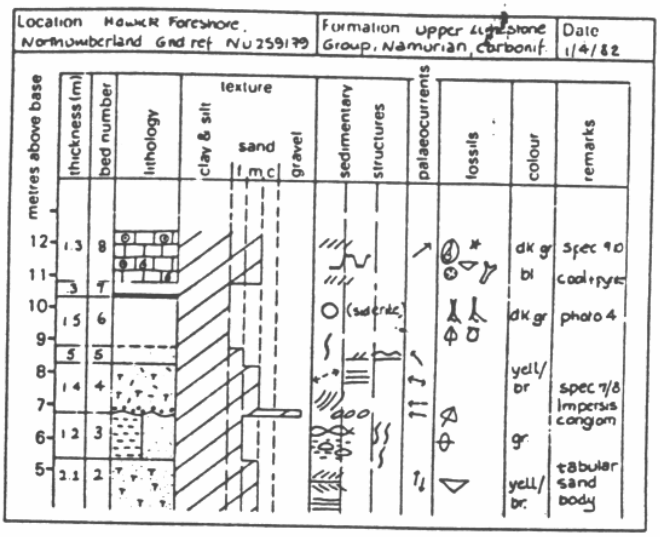
There is no set format for a graphic log; indeed, the features which can be recorded do vary from sequence to sequence. Features which it is necessary to record and which therefore require a column on the log are: bed or rock unit thickness; lithology; texture, especially grain-size; sedimentary structures; palaeocurrents; colour; and fossils. The nature of bed contacts can also be marked on the log. A further column for special or additional features ('remarks') can also be useful. If you are going to spend some time in the field then it is worth preparing the log sheets before you go. An alternative is to construct a log in your field notebook, but this is less satisfactory since the page size of most notebooks is too small.

Where exposure is continuous or nearly so, then there is no problem concerning the line of the log; simply take the easiest path. If outcrop is good but not everywhere continuous it may be necessary to move laterally along the section to find outcrops of the succeeding beds. Some small excavations may be required where rocks in the sequence, often mudrocks, are not exposed; otherwise enter 'no exposure' on the log. It is best to log from the base of the sequence upwards.

2.4.1 *Bed/rock unit thicknesses*

These are measured with a tape measure; care must be exercised where rocks dip at a high angle and the exposure surface is oblique to the bedding. Attention needs to be given to where boundaries are drawn between units in the sequence; if there are obvious bedding planes or changes in lithology then there is no problem. Thin beds, all appearing identical, can be grouped together in a single lithological unit, if the log has a small scale. Where there is a rapid alternation of thin beds of differing lithology, they can be treated as one unit and notes made of the thicknesses and character of individual beds noting any increases or decreases in bed thickness up the sequence. It is often useful to give each bed or rock unit a number so as to facilitate later reference beginning at the stratigraphically lowest bed.

An example of a graphic log::



2.4.2 *Lithology*

On the graphic log, this is recorded in a column by using an appropriate ornamentation, Fig. 2.2. If it is possible to subdivide the lithologies further, then more symbols can be added, or coloured pencils used. If two lithologies are thinly interbedded, then the column can be divided into two by a vertical line and the two types of ornament entered. More detailed comments and observations on the lithology should be entered in the field notebook, reference to the bed or rock unit being made by its number.

2.4.3 *Texture (grain-size)*

On the log there is a horizontal scale (the textural column), showing clay and silt, sand (divided into fine, medium and coarse) and gravel. Gravel can be divided further if coarse sediments are being logged. To aid the recording of grain-size (or crystal-size), fine vertical lines can be drawn for each grain-size class boundary. Having determined the grain-size of a rock unit, mark this on the log and shade the area; the wider the column, the coarser the rock. Ornament for the lithology and/or sedimentary structures can be added to this textural column. Other textural features, such as grain fabric, roundness and shape, should be recorded in the field notebook, although distinctive points can be noted in the remarks column. Particular attention should be given to these features if conglomerates and breccias are in the sequence (Section 4.6).

2.4.4 *Sedimentary structures and bed contacts*

Sedimentary structures and bed contacts present in the rock sequence can be recorded in a column by symbols. Sedimentary structures occur on the upper and lower surfaces of beds as well as within them. Thus separate columns can be drawn up for surface and internal sedimentary structures if they are both common. Symbols for the common sedimentary structures are shown in Fig. 2.2. Measurements, sketches and descriptions of the structures should be made in the field notebook.

Note whether boundaries are (a) sharp and planar, (b) sharp and scoured or (c) gradational: each can be represented in the lithology column by a straight, irregular or dashed line respectively.

2.4.5 *Palaeocurrent directions*

For the graphic log, these can be entered either in a separate column or adjacent to the textural log as an arrow or trend line. The measurements themselves should be retained in the field notebook.

2.4.6 *Fossils*

Fossils indicated on the graphic log record the principal fossil groups present in the rocks. Symbols which are commonly used are shown in Fig. 2.2. These can be placed in a fossil column alongside the sedimentary structures. If fossils make up much of the rock (as in some limestones) then the symbol(s) of the main group(s) can be used in the lithology column. Observations on the fossils themselves should be entered in the field notebook (Chapter 6).

2.4.7 *Colour*

The colour of a sedimentary rock is best recorded by use of a colour chart, but if this is not available then simply devise abbreviations for the colour column.

2.4.8 *'Remarks' column*

This can be used for special features of the bed or rock unit, such as degree of weathering and presence of authigenic minerals (pyrite, glauconite, etc.) and supplementary data on the sedimentary structures, texture or lithology. Specimen numbers can be entered here and the location of photographs or of sketches in your notebook.

CORE/SECTION LOG Observer.....

WELL/CORE:..... SHEET No:.....

LOCALITY/FORMATION:..... DATE:.....

m above base	Thick-ness m	Bed	Lithology	STRUCTURE	Mean Grain Size Mud | Sand | Gravel cl si vf f m c vc	FURTHER NOTES: Colour, sorting, bioturbation COMPOSITION: Terrigenous, biogenic, organic

SAFETY ON FIELD COURSES

Geological fieldwork is an activity involving some inherent special risks and hazards, e.g. in coast exposures, quarries, mines, river sections, and mountains. Severe or dangerous weather conditions may also be encountered at any season, especially on mountains or the coast.

In accordance with the Health and Safety at Work Act, field leaders are advised that they should follow certain precautions and should take every reasonable care concerning the safety of members of their parties. However, *the potential dangers make it imperative that everyone should cooperate by behaving responsibly in order to reduce the risk of accidents.* Each individual is responsible for his or her own safety.

If you suffer from any medical condition (including asthma, vertigo and agrophobia) you must tell the leader before the start of the field course.

BEHAVIOUR

Observe all safety instructions given by party leaders or supervisors. Anyone not conforming to the standards required may be dismissed from the field course.

Stay with the party, except by clear arrangement with the leaders. Assemble where requested (e.g. outside a quarry) in order to receive specific instructions regarding likely hazards.

Observe instructions for reporting after completion of work.

Report any injury or illness.

CLOTHING

Wear adequate clothing and footwear for the types of weather and terrain likely to be encountered. Shirt, loose-fitting trousers, warm sweater, brightly coloured anorak with hood, are normally desirable in the U.K. A woollen hat (in addition to the hood of the anorak) is useful in winter or on high ground. Cagoule and waterproof over-trousers are essential for wet weather. Jeans are generally unsuitable because they do not give sufficient protection when wet and are subjected to a cold wind, but are adequate if waterproof over-trousers are also worn.

Walking boots with rubber mountaineering soles are normally essential. Sports shoes are unsuitable for mountains, quarries and rough country. Wellingtons are generally best reserved for walking through shallow water, peat bogs and the like.

Leaders will refuse to allow ill-equipped persons on their field courses.

SAFETY EQUIPMENT AND PRACTICE

Wear a safety helmet when visiting old quarries, cliffs, scree slopes, etc. or wherever there is a risk from falling objects. It is obligatory to do so when visiting working quarries, mines and building sites.

Wear safety goggles (or safety glasses with plastic lenses) for protection against flying splinters when hammering rocks or chisels.

Do not use one geological hammer as a chisel and hammer it with another; use only a soft steel chisel.

Avoid hammering near another person, or looking towards another person hammering.

Field course leaders carry a first aid kit but you are advised to bring your own first aid kit for personal use.

DISTRESS SIGNAL

The international distress signal is 6 whistle blasts, torch flashes, shouts or waves of a bright coloured cloth with a gap of 1 minute between each repetition. Acknowledgement of this signal is by 3 whistle blasts, or etc.

PRECAUTIONS

Take special care near the edges of cliffs and quarries, or any other steep or sheer faces, particularly in gusting winds.

Ensure that rocks above are safe before venturing below. Quarries with rock faces loosened by explosives are especially dangerous.

Avoid working under an unstable overhang.

Avoid loosening rocks on steep slopes.

Do not work directly above or below another person.

Never roll rocks down slopes or over cliffs for amusement.

Do not run down steep slopes.

Beware of landslides and mudflows occurring on clay cliffs and in clay-pits, or rockfalls from any cliffs.

QUARRIES

Avoid touching any machinery or equipment in quarries, mines or building sites.

Never pick up explosives, or detonators from rock piles; if found, inform the management immediately.

Comply with safety rules, blast-warning procedures, and any instructions given by officials.

Keep a sharp look-out for moving vehicles etc.

Beware of sludge lagoons.

CLIFFS AND CUTTINGS

Do not climb cliffs, rock facies or crags, unless this has been approved as an essential part of the work.

Take great care when walking or climbing over slippery rocks below high-water mark on rocky shores.

More accidents to geologists, including fatalities, occur along rocky shorelines than anywhere else.

Beware of traffic when examining road cuttings.

Avoid hammering, and do not leave rock debris on the road-way or verges.

Railway cuttings and motorways are not open to geologists, unless special permission has been obtained from the appropriate authorities.

GENERAL BEHAVIOUR

All participants in geological field courses, or undertaking independent fieldwork, are expected to observe sensible standards of behaviour, to conduct themselves with consideration for others, particularly in hotels or other accommodation, and not to damage property in any way (e.g. by climbing over walls, leaving gates open, trampling crops).

Please do not disturb the environment more than is absolutely necessary.

Do not collect specimens unless required for serious study.

Do not hammer outcrops casually or indiscriminately.

Do not disturb living plants and animals.

Do not leave litter, including rock chippings.

Observe conservation requirements. Remember that public access is an acute problem in the countryside and especially in areas designated as National Parks.