Geology 3006 WEXFORD FIELD TRIP

17 - 19th February 2006

STOP 1: HOOK HEAD LIGHTHOUSE (Lower Carboniferous)

1. What rock term(s) would you use to describe the rocks exposed on the foreshore at the lighthouse?
2. Describe the fauna they contain; what are the implications for the environment of deposition?
3. Why the absence of sedimentary structures?

STOP 2: WEST OF HOOK HEAD (Lower Carboniferous)

1. List five differences between the rock type on the coast here and that seen previously at the lighthouse.
2. Describe and illustrate the sedimentary structures present. Comment on the likely sediment transport processes and the possible environmental setting and post-depositional evolution.

STOP 3: TEMPLETOWN BAY (Cambrian/Devonian)

1. Sketch and comment on the fold seen on the foreshore at the back of the beach.
2. Comment on the possible depositional process which emplaced the sandstone bed and on the environment of deposition.
3. What was the provenance of the conglomerates exposed at the south end of the beach?
4. Describe the texture of the conglomerate using appropriate terms. Can you detect bedding in the conglomerates?
5. What depositional mechanism(s) might account for the deposition of the conglomerates.
6. Assess the nature of the contact between the conglomerates and the interbedded sandstones and shales to the north.
7. What are the wider implications of this exposure for the geological evolution of SE Ireland?

STOP 4: SANDEEL BAY (Late Devonian)

1. Sketch and annotate the field photograph using a tracing paper overlay to identify the main stratification planes and contacts between different lithologies. How many lithologies can you identify (there are at least 4) and what is the nature of the contacts between them?
2. Construct a 1:25 scale vertical graphic log through the exposure, illustrating the variation in lithology, grain size and sedimentary structures through the succession.
3. Use your compass clinometer to measure bedding and the orientation of at least three cross-beds. Also measure the orientation of the scour marks on the base of the lowest sandstone bed and the orientation of the large-scale dipping surfaces descending through the main sandbody.
4. Comment on the combination of processes which might account for the different lithologies. What is the significance of the grain size changes developed across the main surfaces?
5. What environment might this section represent? How is it different from that at Templetown Bay and how can we explain this?
6. What is the significance of the variable colour developed in this exposure.

STOP 5: KILN BAY to WOARWAY BAY (Upper Devonian to Lower Carboniferous)

You will be split into teams and each will make a graphic log of part of the succession. We will then assemble a composite section and discuss the vertical change in character of the succession over the full logged interval. The graphic logging should be undertaken at a vertical scale of 1:50. Pay particular attention to the lithology (use an acid bottle). Measure any directional structures e.g. ripple marks and trough axes.

2. For each, what was the dominant sediment source, mechanism of sediment transport and deposition, and what palaeogeographical inferences can be made on the basis of the palaeocurrent data.
3. Comment on the significance of the fossils and trace fossils encountered at different levels in the stratigraphy
4. What might have controlled the depositional evolution evident through the section? Think about tectonics, sea level, climate, hinterland relief and sediment supply.

DAY 2

STOP 6: HARRYLOCK BAY to LUMSDIN'S BAY (Devonian-Carboniferous)

1. What is the significance of the nodular carbonate in the fine grained mudrocks at the base of the section?
2. Compare and contrast the succession at Lumsdin's Bay with that logged at Woarway Bay, about a kilometre away. What surfaces and deposits are likely to extend the full distance between the two sites and which are likely to be impersistent?
3. Comment on the displacement evident on the fault on the south side of Lumsdins Bay.

STOP 7: BOOLEY BAY to DOLLAR BAY (Cambrian)

1. What is the way-up of the beds on the south side of Booley Bay? List the different criteria that can be used to confirm the way-up direction.
2. Examine and sketch the range of sole structures developed on the sandstone beds. Use your compass clinometer to measure the bedding and the pitch of the lineation formed by the sole structures. What was the direction of flow and can this be confirmed by structures within the sandstone beds?
3. Do the sandstones have a systematic internal structure. Illustrate some of the bed profiles in your notebook. Does the Bouma sequence apply and, if so, what divisions are present?
4. Use the facies character to comment on the likely lateral trends away from this outcrop. Can we make some predictions? Compare this succession with the one of similar age you have seen at Bray. List five key differences.
5. What are the curious circular structures preserved on some bed bases?
6. Comment on the possible origin of the anomalous thick black shale beds interleaved with the thin bedded sandstones.
7. Does the palaeocurrent direction remain consistent up the succession?
8. Why is convolution so common in this succession.

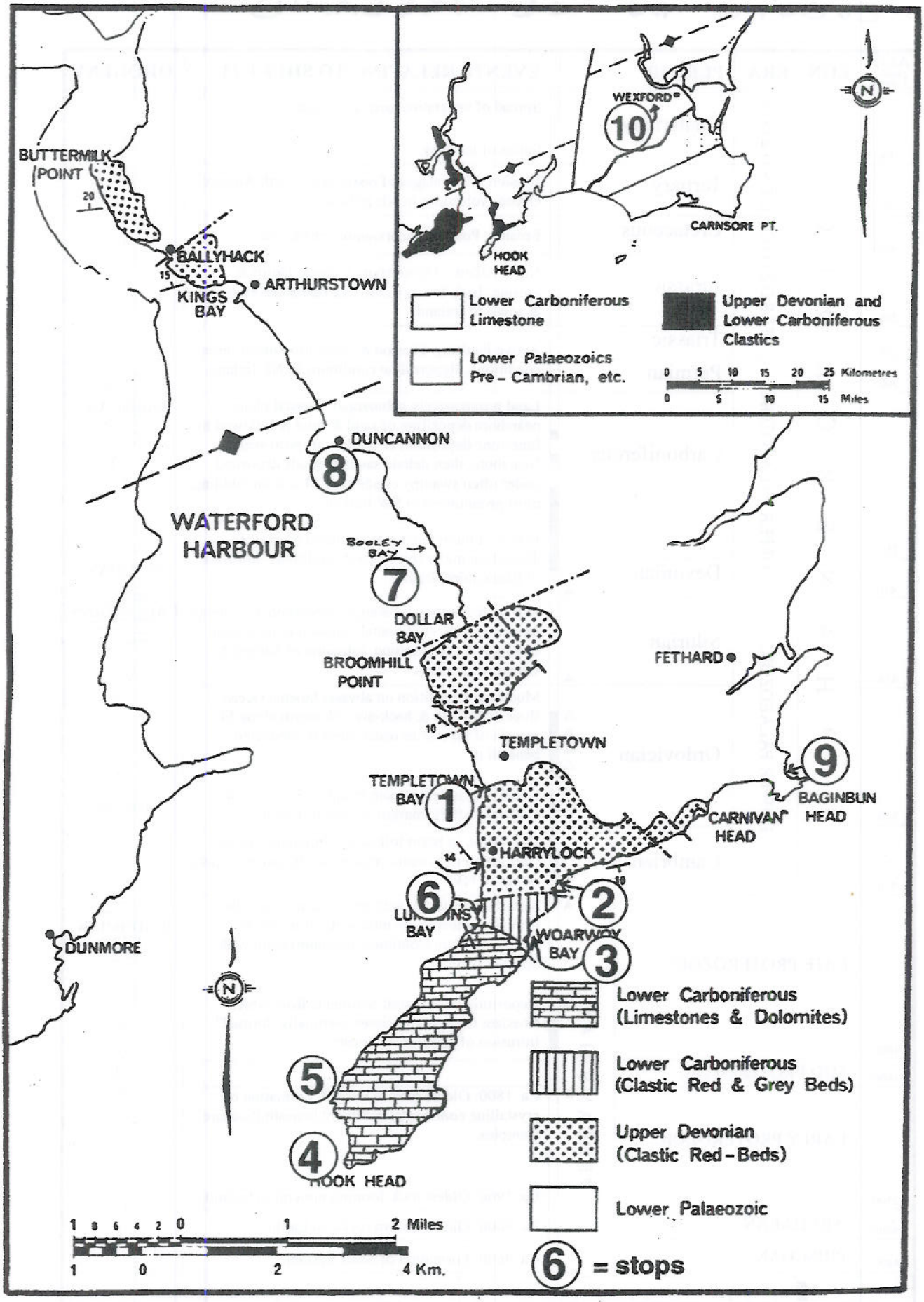
STOP 8: DUNCANNON (Ordovician – Caradoc)

1. Was the volcanism subaerial or subaqueous?
2. What is the origin of the breccia bodies associated with the lavas?
3. Can you identify individual flows?

STOP 9: BAGINBUN HEAD (Cambrian)

1. Compare the succession here with that at Booley Bay. Where would you place them in relation to one another.
2. Comment on the different structure of the sandstone beds here.

LOCALITIES TO BE VISITED



EVENTS IN SE IRELAND

AGE (Million Years)	EON	ERA	PERIOD	EVENTS RELATING TO SHEET 23	OROGENY
1.6	PHANEROZOIC	CENOZOIC	Quaternary	Spread of vegetation, arrival of man. Series of ice ages.	
65			Tertiary	Erosion. Final stages of opening of North Atlantic Ocean. Volcanoes in NE Ireland.	
135		MESOZOIC	Cretaceous	Erosion. Possible incursion of "chalk" sea.	
205			Jurassic	North Atlantic Ocean starts to open. Uplift & erosion. Irish Sea & Celtic Sea basins develop east & south of Ireland.	
250			Triassic	Active Faulting. Erosion & deposition under desert conditions. Hypersaline conditions in NE Ireland.	
290		UPPER PALAEOZOIC	Permian		
355			Carboniferous	Land progressively submerged. Coastal plain, nearshore deposition of sand & mud is followed by limestone deposition in shallow tropical seas. Nearshore, then deltaic sands & muds deposited under often swampy conditions. Mountain building, most pronounced in SW Ireland.	VARISCAN
410			Devonian ▲	Period of mountain building, rapid erosion & deposition under semi-desert conditions. Intrusion of Blackstairs Granite.	ACADIAN
438		LOWER PALAEOZOIC	Silurian ▲	Marine & continental margin deposition. Closure of Iapetus Ocean, continental collision & mountain building. Active faulting, intrusion of Saltees & Carnsore Granites.	CALEDONIAN
510			Ordovician △△△△ ▲△	Mudstone deposition on abyssal Iapetus Ocean floor. Island arc & back-arc volcanism along SE margin of Iapetus as ocean floor is subducted beneath it. Uplift of Cambrian basin margin to form local landmass off SE margin of Iapetus Ocean.	MONIAN
570			Cambrian ▲	Deposition in basin followed continental rifting. Generation of oceanic crust in newly formed Iapetus Ocean to NW.	
1000	LATE PROTEROZOIC	PRECAMBRIAN	▲ ▲	Mountain building, with production of Rosslare Complex gneisses by intense deformation & metamorphism. Continued metamorphism with uplift & cooling. Deposition of ancestral sediments from which Rosslare Complex gneisses eventually formed? Intrusion of gabbros & diorite.	CADOMIAN
1600	MID PROTEROZOIC				
2500	EARLY PROTEROZOIC		▲	Ca. 1800: Oldest rock in Ireland. Formation of crystalline continental basement beneath Rosslare Complex. Ca. 1960: Oldest rock-forming mineral in Ireland.	
4000	ARCHAEAN			Ca. 4000: Oldest known rocks on Earth.	
4600	PRISCOAN			Ca. 4600: Formation of Solar System.	

■ Sedimentary rocks of this age present in South Wexford ▲, △ Period of intrusive igneous activity, volcanism

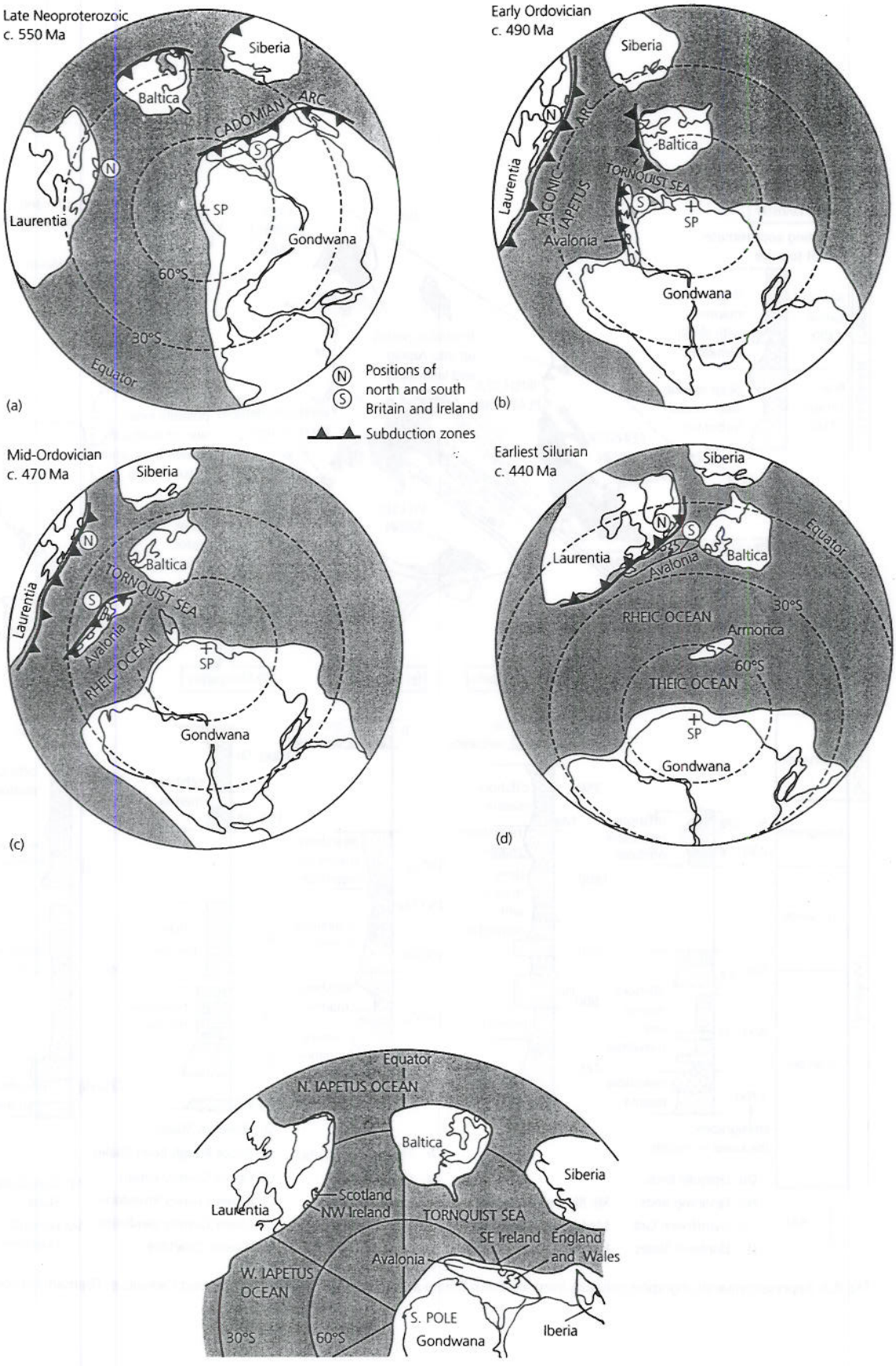


Fig. 9.1 Palaeocontinental reconstructions for Late Cambrian time (modified from Torsvik *et al.* 1996, with permission from Elsevier Science (2000)).

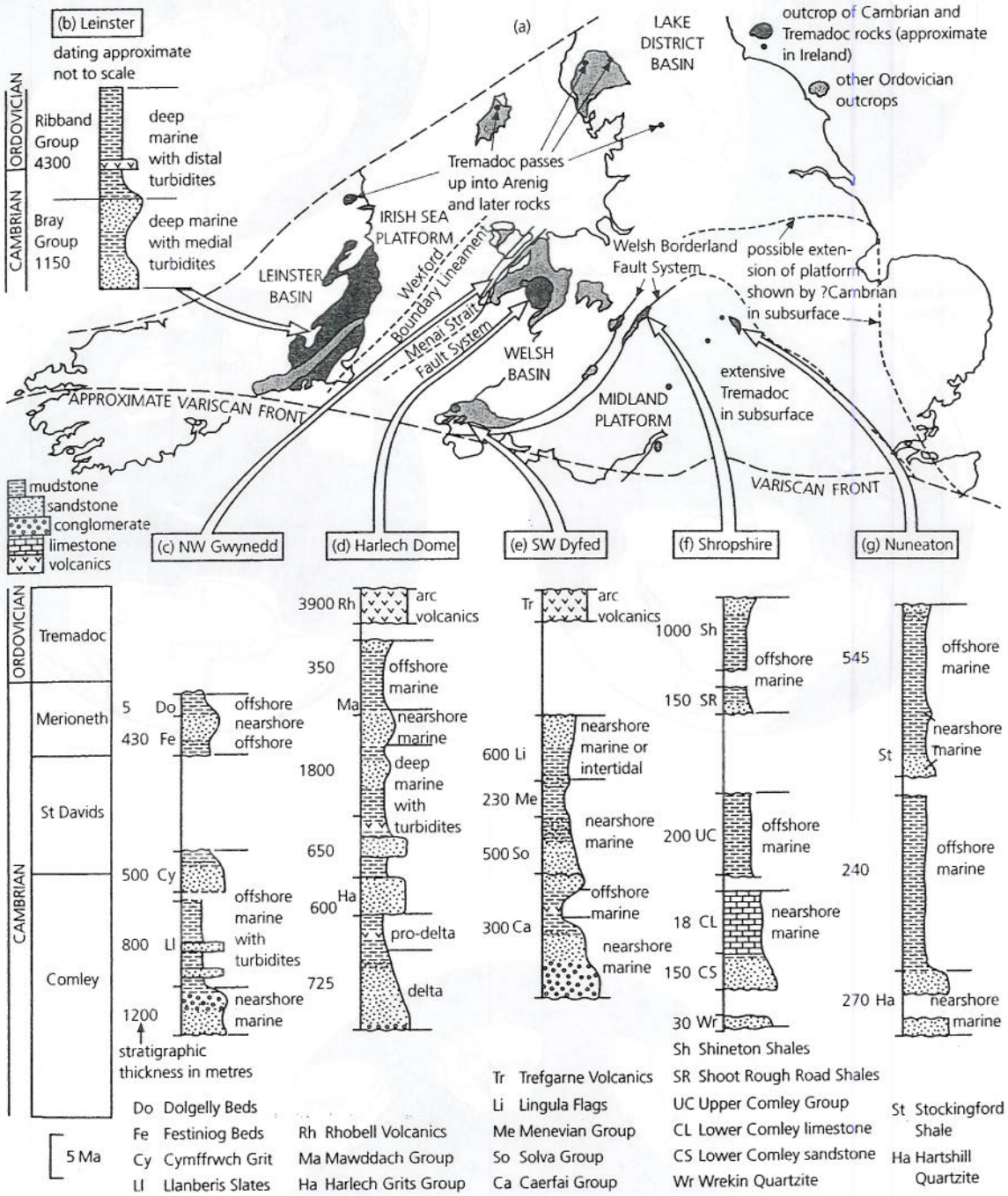
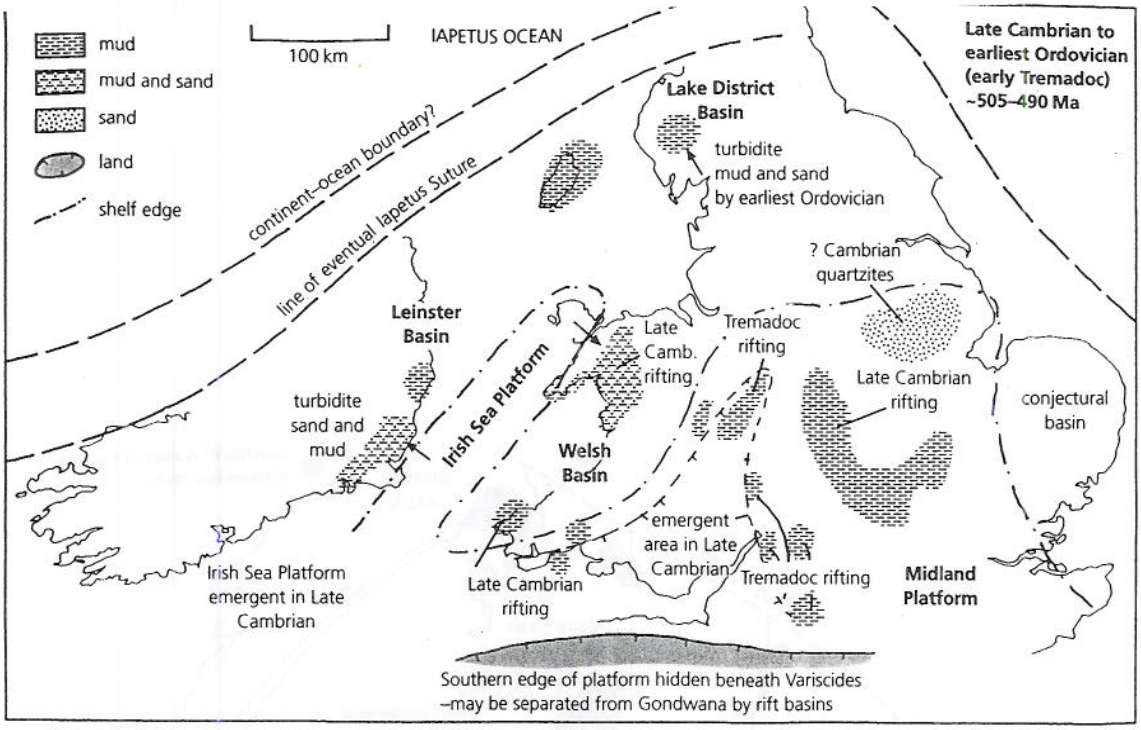
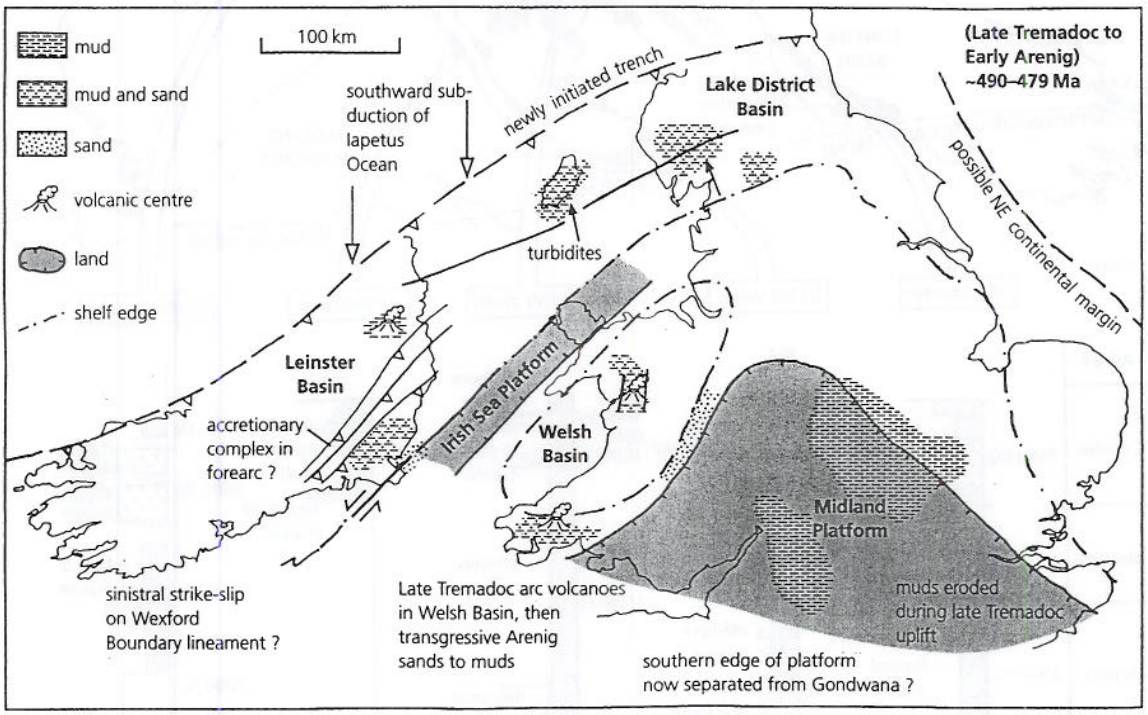
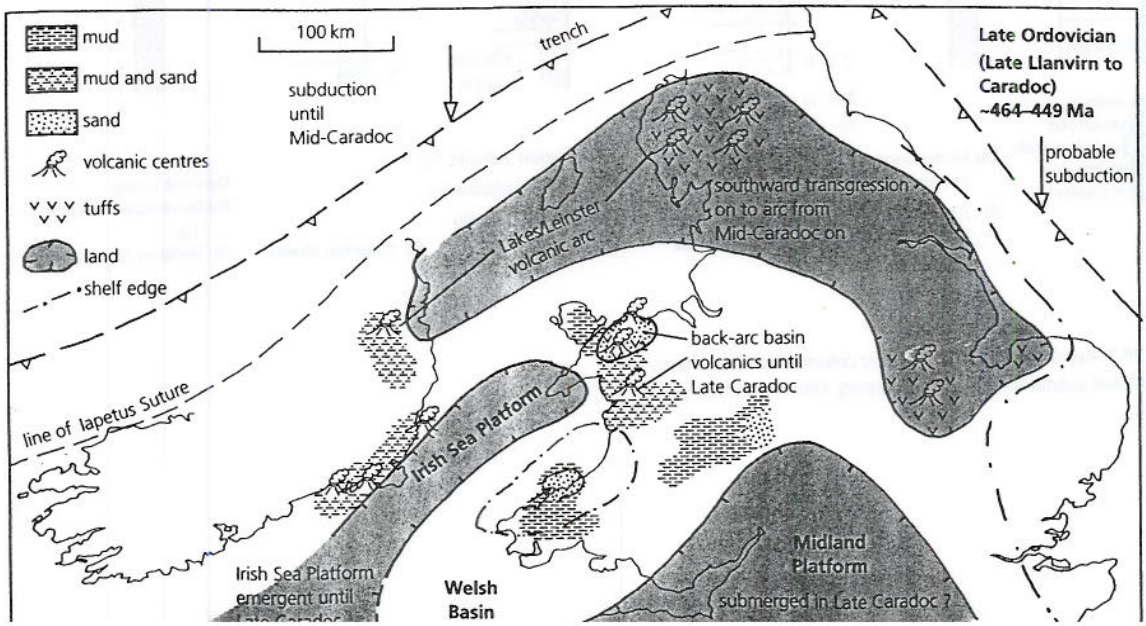


Fig. 9.3 Representative stratigraphic columns from southern Britain and Ireland for Cambrian and lowest Ordovician (Tremadoc) rocks.


mud
mud and sand
sand
land
shelf edge
100 km
IAPETUS OCEAN
Late Cambrian to earliest Ordovician (early Tremadoc) ~505–490 Ma
continent–ocean boundary?
line of eventual Iapetus Suture
Lake District Basin
turbidite mud and sand by earliest Ordovician
? Cambrian quartzites
Leinster Basin
Late Camb. rifting
Tremadoc rifting
Late Cambrian rifting
conjectural basin
turbidite sand and mud
Irish Sea Platform
Welsh Basin
emergent area in Late Cambrian
Tremadoc rifting
Midland Platform
Irish Sea Platform emergent in Late Cambrian
Late Cambrian rifting
Southern edge of platform hidden beneath Variscides –may be separated from Gondwana by rift basins


mud
mud and sand
sand
volcanic centre
land
shelf edge
100 km
(Late Tremadoc to Early Arenig) ~490–479 Ma
southward sub-duction of Iapetus Ocean
newly initiated trench
Lake District Basin
possible NE continental margin
turbidites
Leinster Basin
Irish Sea Platform
accretionary complex in forearc ?
Welsh Basin
Midland Platform
sinistral strike-slip on Wexford Boundary lineament ?
Late Tremadoc arc volcanoes in Welsh Basin, then transgressive Arenig sands to muds
muds eroded during late Tremadoc uplift
southern edge of platform now separated from Gondwana ?


mud
mud and sand
sand
volcanic centres
tuffs
land
shelf edge
100 km
trench
subduction until Mid-Caradoc
Late Ordovician (Late Llanvirn to Caradoc) ~464–449 Ma
probable subduction
Lakes/Leinster volcanic arc
southward transgression on to arc from Mid-Caradoc on
back-arc basin volcanics until Late Caradoc
line of Iapetus Suture
Irish Sea Platform
Midland Platform
Irish Sea Platform emergent until
Welsh Basin
submerged in Late Caradoc ?

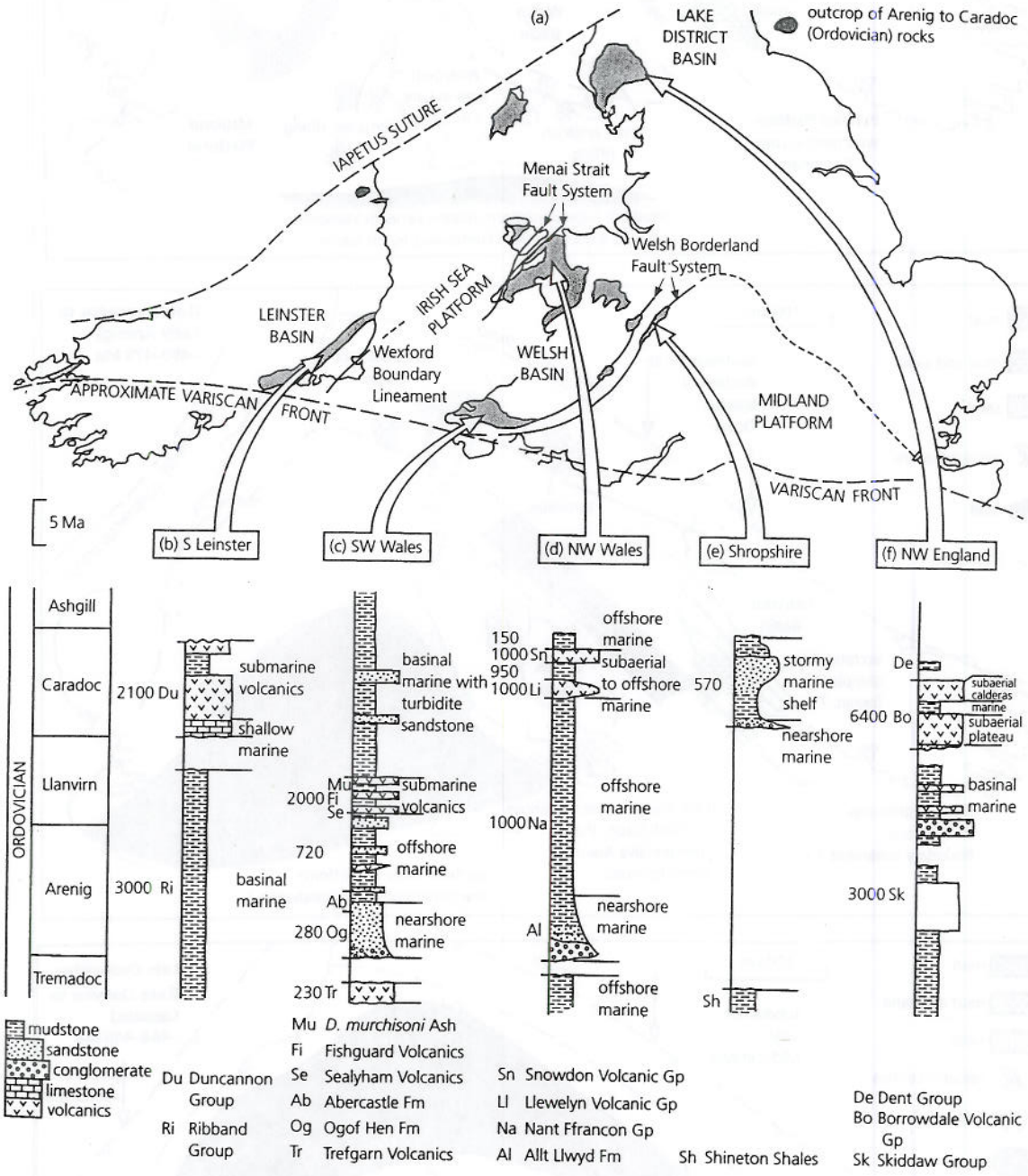
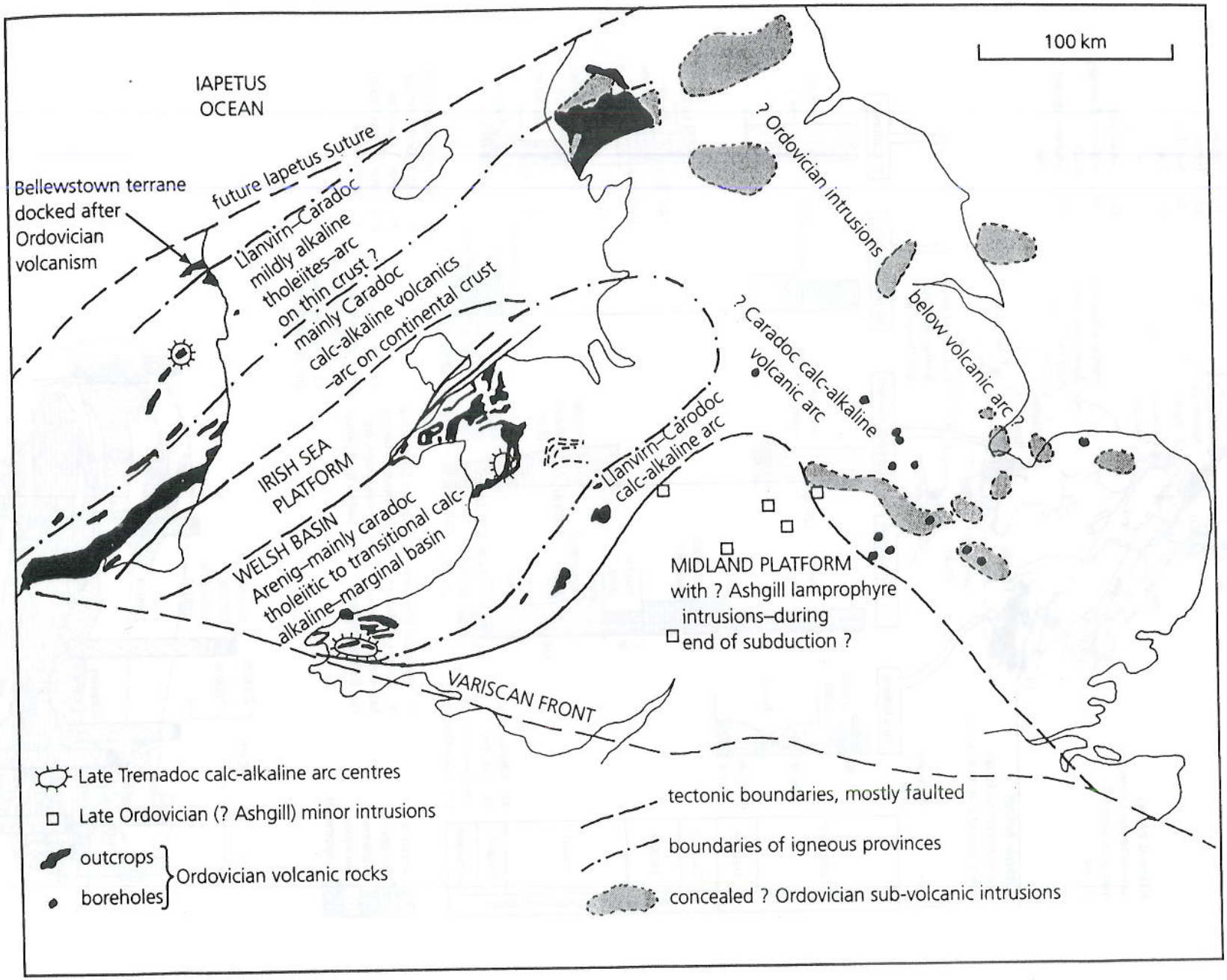
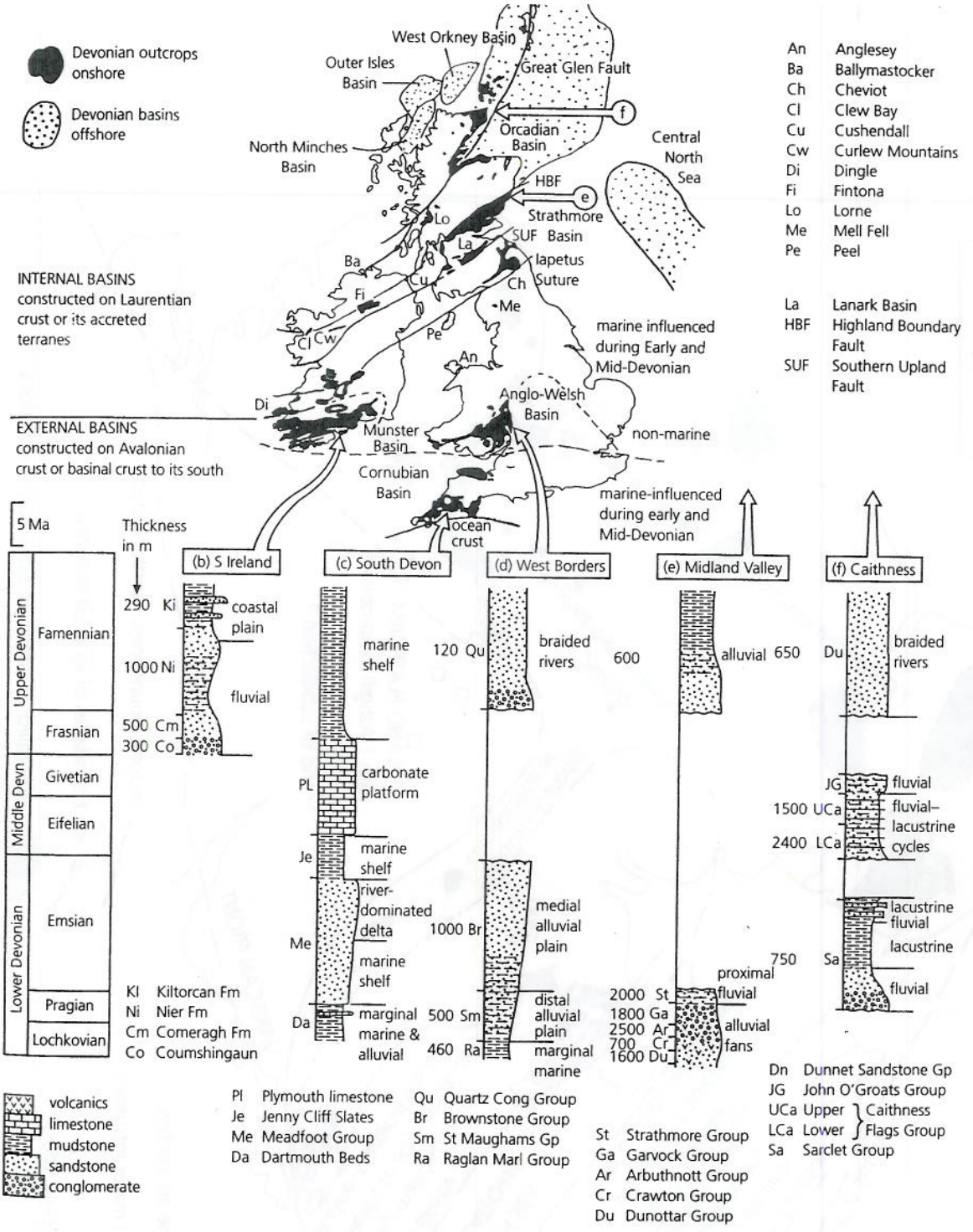


Fig. 10.3 Representative stratigraphic columns from southern Britain and Ireland for Ordovician (Arenig, Llanvirn and Caradoc) rocks.


100 km
IAPETUS OCEAN
future Iapetus Suture
Bellewstown terrane docked after Ordovician volcanism
Llanvirn–Caradoc mildly alkaline tholeiites–arc on thin crust ?
mainly Caradoc calc-alkaline volcanics –arc on continental crust
IRISH SEA PLATFORM
WELSH BASIN
Arenig–mainly caradoc tholeiitic to transitional calc-alkaline–marginal basin
? Ordovician intrusions below volcanic arc ?
? Caradoc calc-alkaline volcanic arc
Llanvirn–Caradoc calc-alkaline arc
MIDLAND PLATFORM with ? Ashgill lamprophyre intrusions–during end of subduction ?
VARISCAN FRONT
Late Tremadoc calc-alkaline arc centres
Late Ordovician (? Ashgill) minor intrusions
outcrops
boreholes
Ordovician volcanic rocks
tectonic boundaries, mostly faulted
boundaries of igneous provinces
concealed ? Ordovician sub-volcanic intrusions



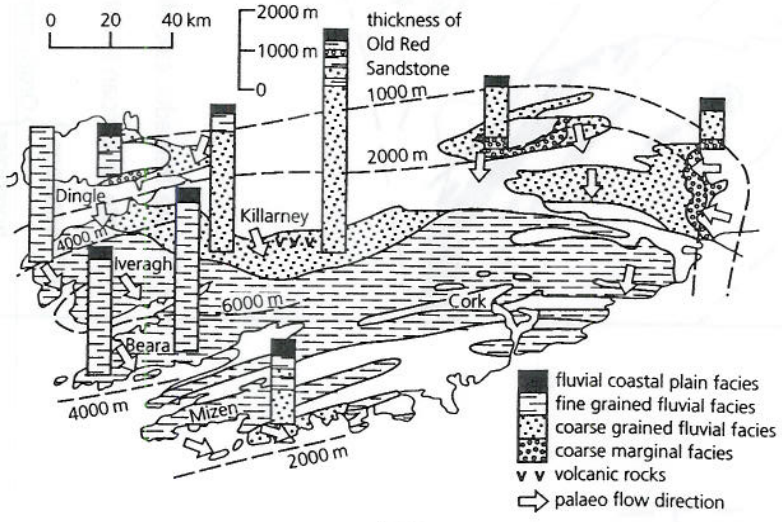
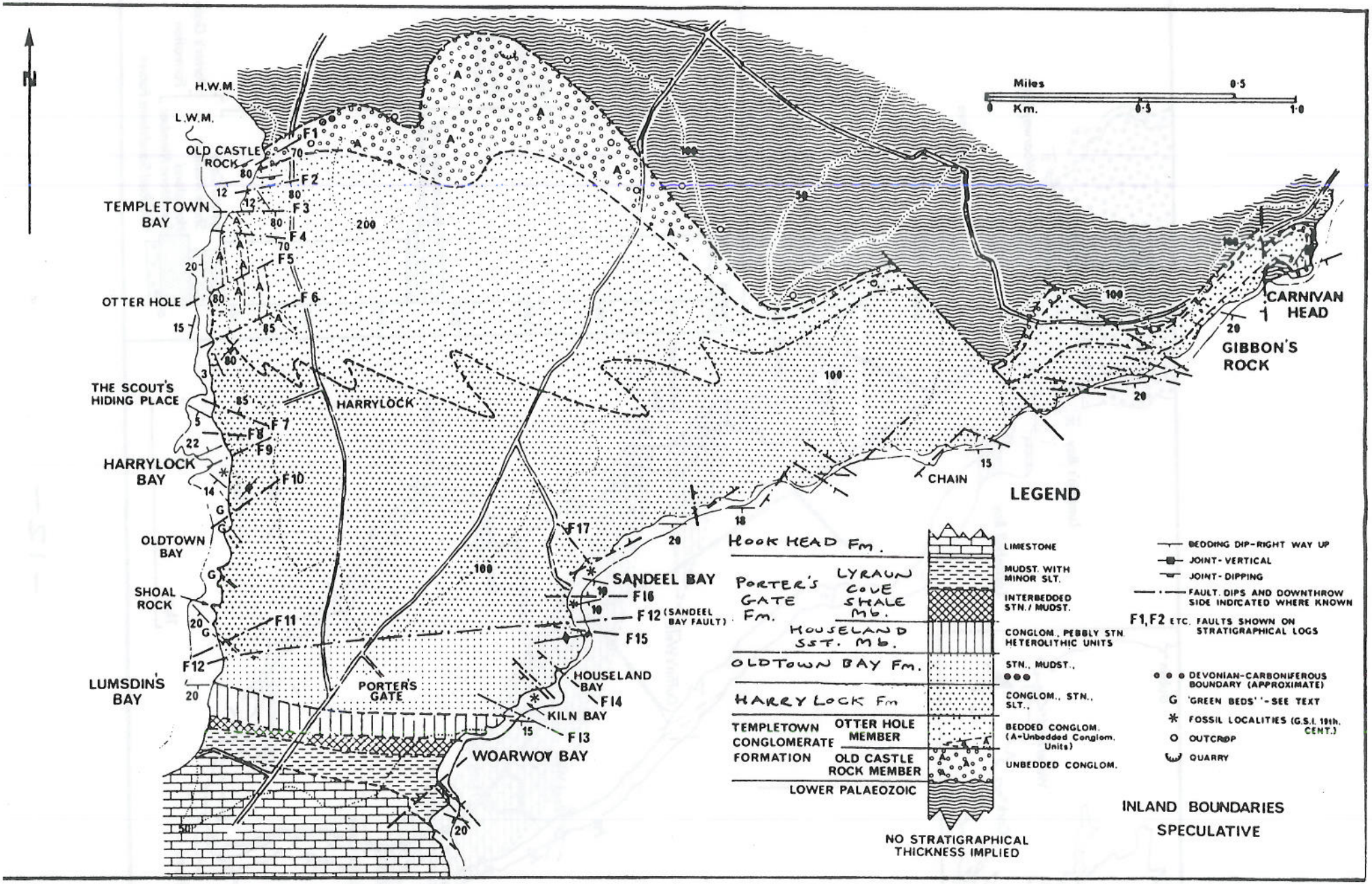
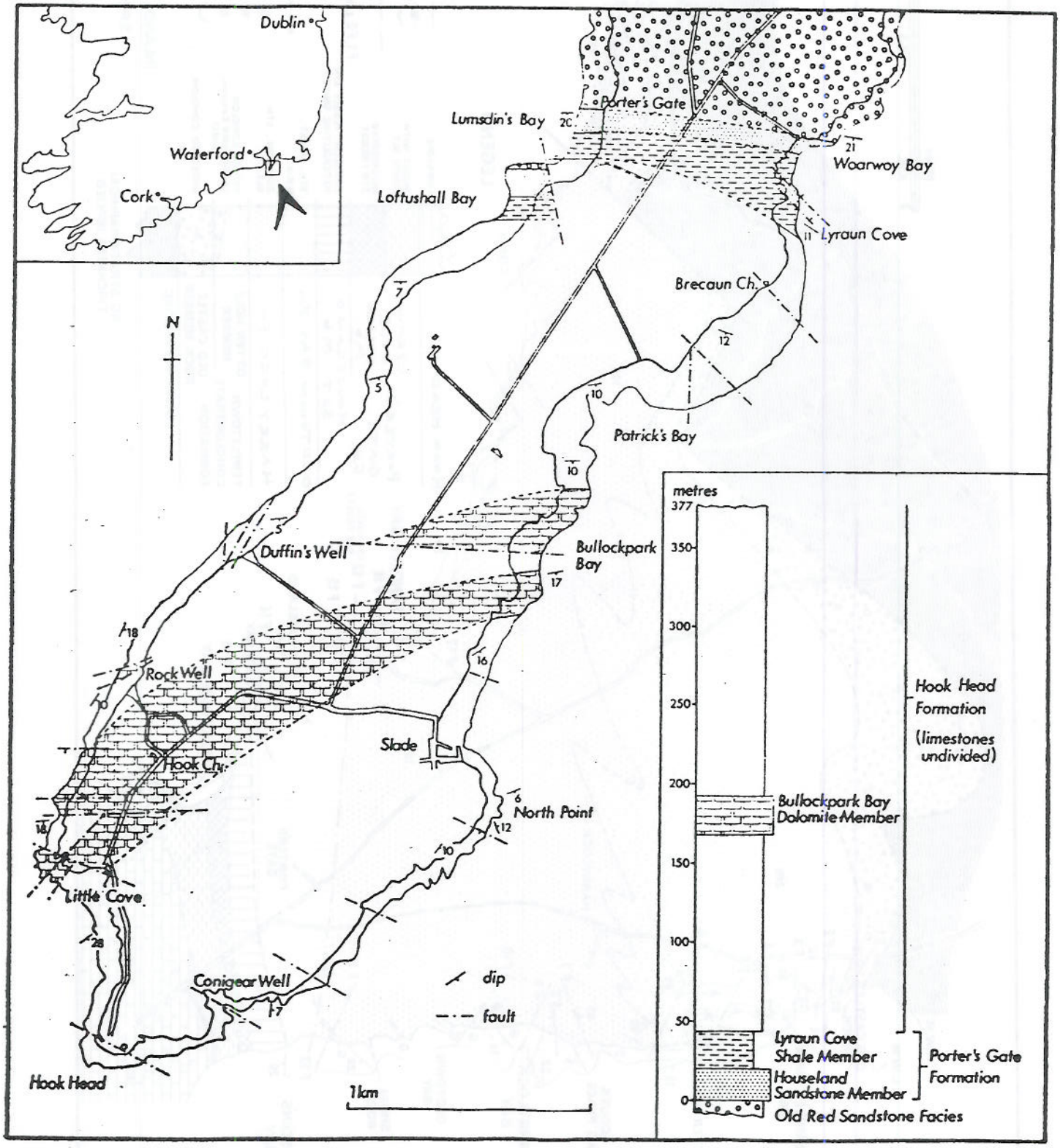
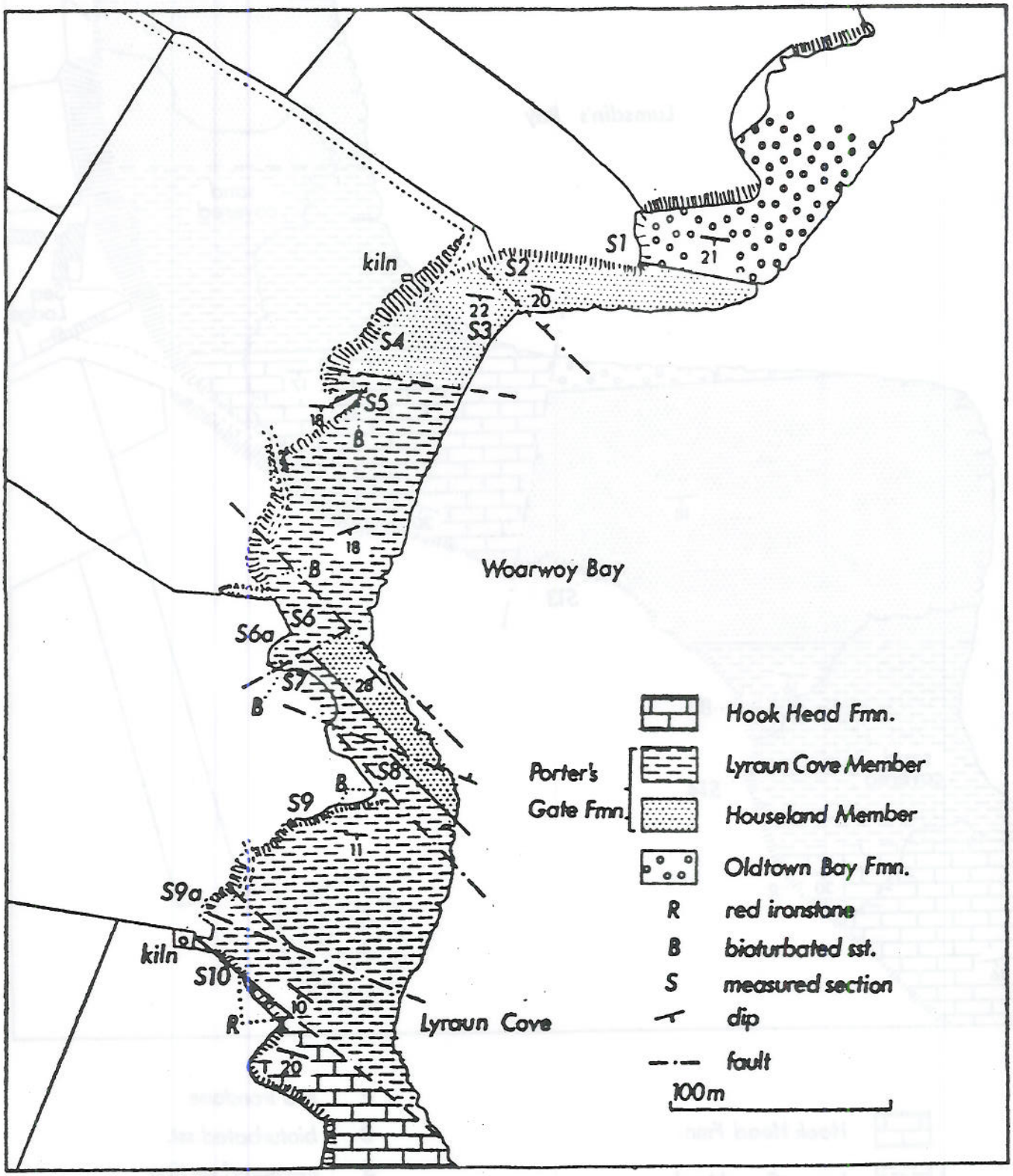
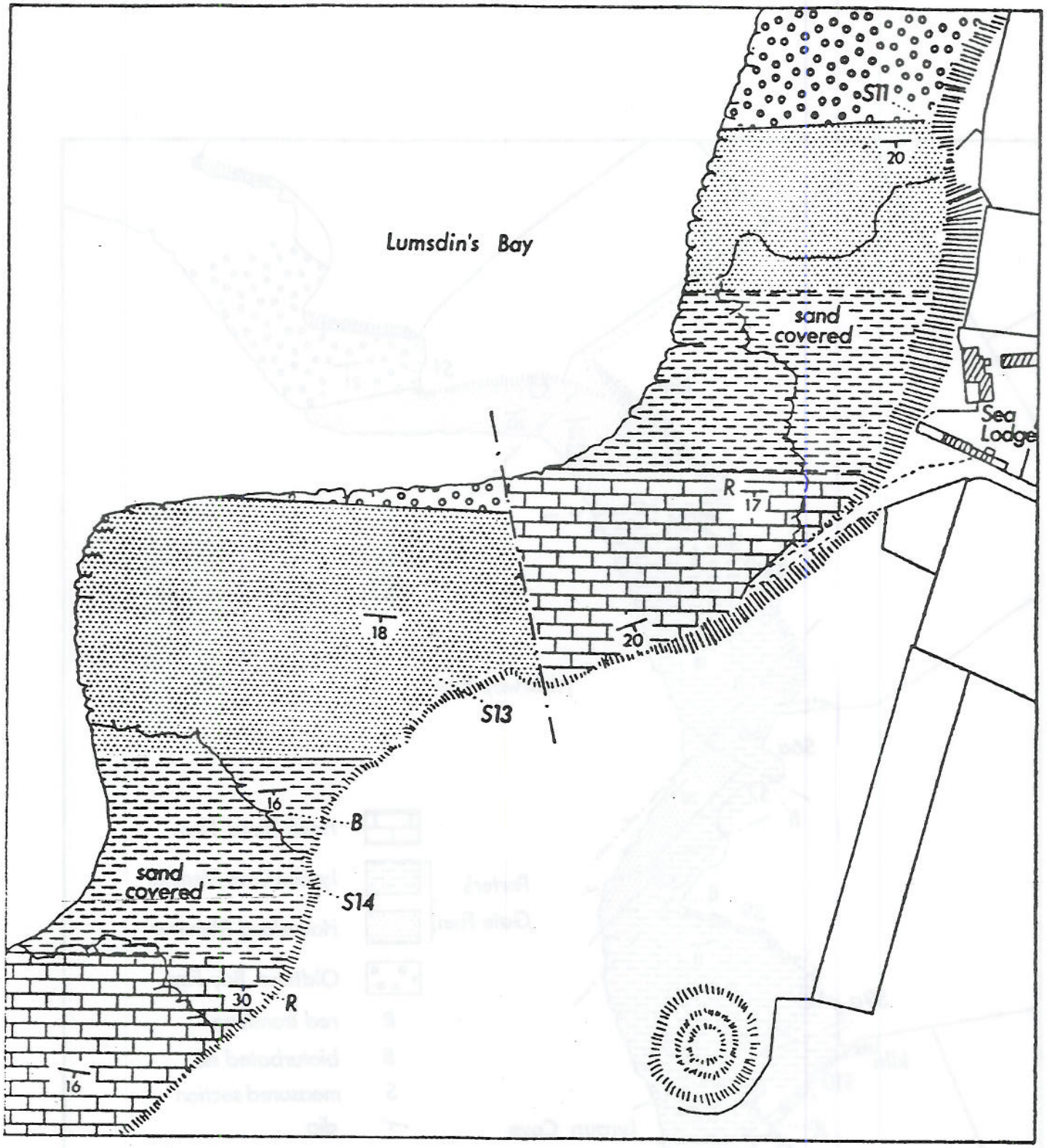


Fig. 13.6 Sedimentary facies and thickness of the Upper Old Red Sandstone of the Munster Basin (after Graham 1983).


N
H.W.M.
L.W.M.
OLD CASTLE ROCK
TEMPLETOWN BAY
OTTER HOLE
THE SCOUT'S HIDING PLACE
HARRYLOCK BAY
OLDTOWN BAY
SHOAL ROCK
LUMSDIN'S BAY
HARRYLOCK
PORTER'S GATE
WOARWOY BAY
KILN BAY
HOUSELAND BAY
SANDEEL BAY
F12 (SANDEEL BAY FAULT)
CHAIN
CARNIVAN HEAD
GIBBON'S ROCK
Miles 0·5
Km. 0·5 1·0
LEGEND
HOOK HEAD Fm.
PORTER'S GATE Fm.
LYRAUN COVE SHALE Mb.
HOUSELAND SST. Mb.
OLDTOWN BAY Fm.
HARRY LOCK Fm
TEMPLETOWN CONGLOMERATE FORMATION
OTTER HOLE MEMBER
OLD CASTLE ROCK MEMBER
LOWER PALAEOZOIC
LIMESTONE
MUDST. WITH MINOR SLT.
INTERBEDDED STN./MUDST.
CONGLOM., PEBBLY STN. HETEROLITHIC UNITS
STN., MUDST.,
CONGLOM., STN., SLT.,
BEDDED CONGLOM. (A=Unbedded Conglom. Units)
UNBEDDED CONGLOM.
BEDDING DIP-RIGHT WAY UP
JOINT-VERTICAL
JOINT-DIPPING
FAULT. DIPS AND DOWNTHROW SIDE INDICATED WHERE KNOWN
F1,F2 ETC. FAULTS SHOWN ON STRATIGRAPHICAL LOGS
DEVONIAN-CARBONIFEROUS BOUNDARY (APPROXIMATE)
G 'GREEN BEDS' - SEE TEXT
FOSSIL LOCALITIES (G.S.I. 19th. CENT.)
OUTCROP
QUARRY
NO STRATIGRAPHICAL THICKNESS IMPLIED
INLAND BOUNDARIES SPECULATIVE


Dublin
Waterford
Cork
Porter's Gate
Lumsdin's Bay
Woarwoy Bay
Loftushall Bay
Lyraun Cove
Brecaun Ch.
N
Patrick's Bay
Duffin's Well
Bullockpark Bay
Rock Well
Hook Ch.
Slade
North Point
Little Cove
Conigear Well
Hook Head
dip
fault
1km
metres
377
350
300
250
200
150
100
50
0
Hook Head Formation (limestones undivided)
Bullockpark Bay Dolomite Member
Lyraun Cove Shale Member
Houseland Sandstone Member
Porter's Gate Formation
Old Red Sandstone Facies


kiln
S1
S2
S3
S4
S5
S6
S6a
S7
S8
S9
S9a
S10
kiln
R
B
21
22
20
18
18
28
11
10
20
Woarwoy Bay
Lyraun Cove
Hook Head Fmn.
Porter's Gate Fmn.
Lyraun Cove Member
Houseland Member
Oldtown Bay Fmn.
R red ironstone
B bioturbated sst.
S measured section
dip
fault
100m

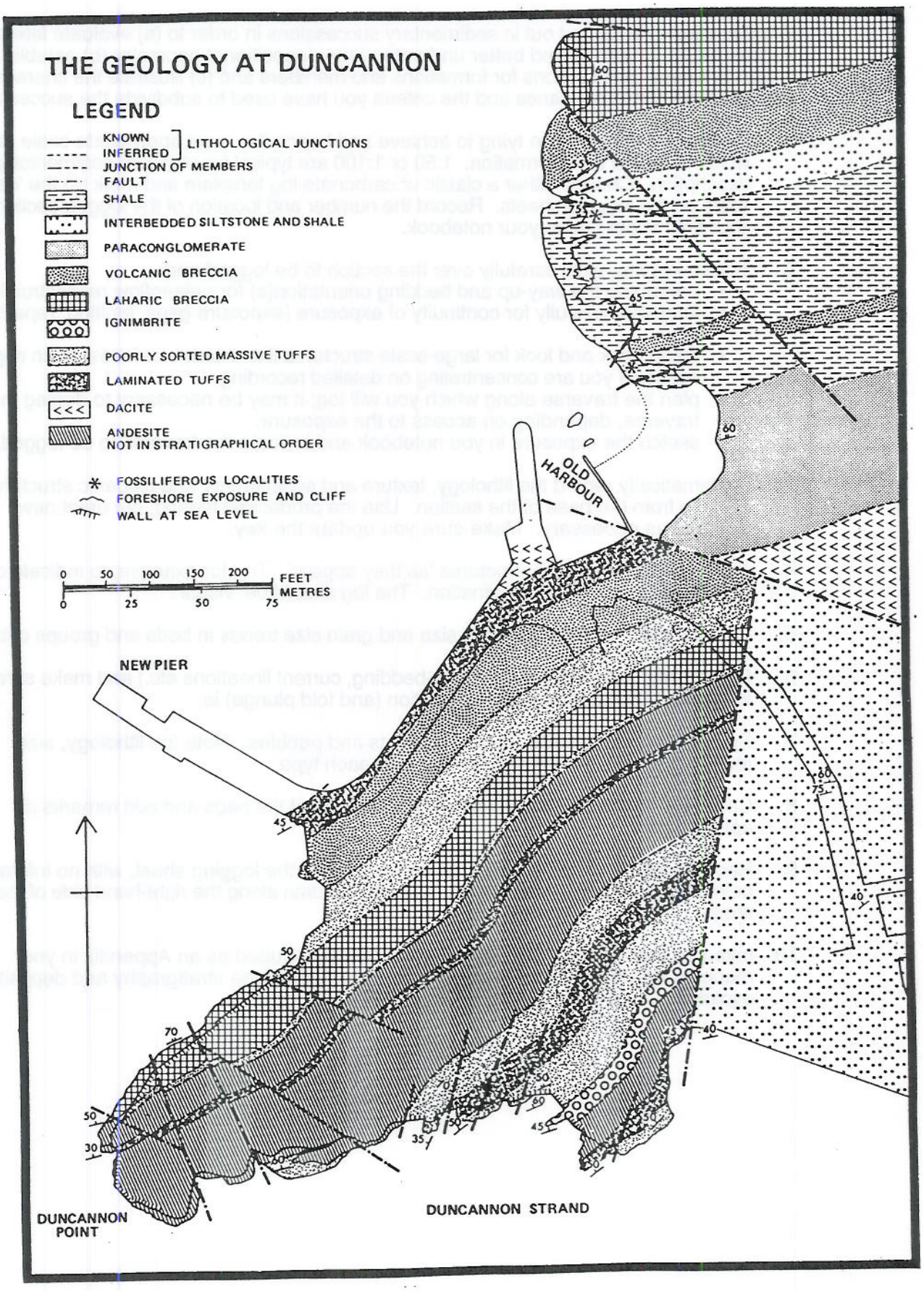


Hook Head Fmn.

Porter's Gate Fmn.
- Lyraun Cove Member
- Houseland Member

Oldtown Bay Fmn.

R red ironstone
B bioturbated sst.
S measured section
dip
fault
100m


THE GEOLOGY AT DUNCANNON
LEGEND
KNOWN
INFERRED
LITHOLOGICAL JUNCTIONS
JUNCTION OF MEMBERS
FAULT
SHALE
INTERBEDDED SILTSTONE AND SHALE
PARACONGLOMERATE
VOLCANIC BRECCIA
LAHARIC BRECCIA
IGNIMBRITE
POORLY SORTED MASSIVE TUFFS
LAMINATED TUFFS
DACITE
ANDESITE
NOT IN STRATIGRAPHICAL ORDER
FOSSILIFEROUS LOCALITIES
FORESHORE EXPOSURE AND CLIFF
WALL AT SEA LEVEL
0 50 100 150 200 FEET
0 25 50 75 METRES
OLD HARBOUR
NEW PIER
DUNCANNON POINT
DUNCANNON STRAND

GRAPHIC LOGGING - OUTCROPS

Graphic logging is carried out in sedimentary successions in order to (a) evaluate lateral and vertical facies variations and better understand the depositional geometry (b) establish typical or formal type sections for formations and members and (c) illustrate the character of formation/member boundaries and the criteria you have used to subdivide the succession.

1. Decide on what you are tying to achieve and hence the most appropriate scale at which to record the information. 1:50 or 1:100 are typical for standard sedimentological description. Choose either a clastic or carbonate log template and mark up the 'depth' scale on the logging sheets. Record the number and location of the logged section on your field sheet and in your notebook.

2. Before logging, walk carefully over the section to be logged and:
   - determine the way-up and bedding orientation(s) for palaeoflow reconstruction.
   - examine carefully for continuity of exposure (exposure gaps, faulting, repetition etc.)
   - stand back and look for large-scale structures like erosion surfaces which might be missed if you are concentrating on detailed recording.
   - plan the traverse along which you will log; it may be necessary to dogleg the traverse, depending on access to the exposure.
   - sketch the exposure in you notebook and indicate the traverse to be logged.

3. Systematically record the lithology, texture and sedimentary and biogenic structures, working from the base of the section. Use the predefined legend, but erect new symbols as necessary. Make-sure you update the key.

4. As a general rule, draw structures 'as they appear'. Try, for example, to indicate cross-bed dips with the correct inclination. The log should be 'visual'.

5. Pay particular attention to grain size and grain size trends in beds and groups of beds.

6. Record any directional data (cross-bedding, current lineations etc.) and make sure you know what the local bedding orientation (and fold plunge) is.

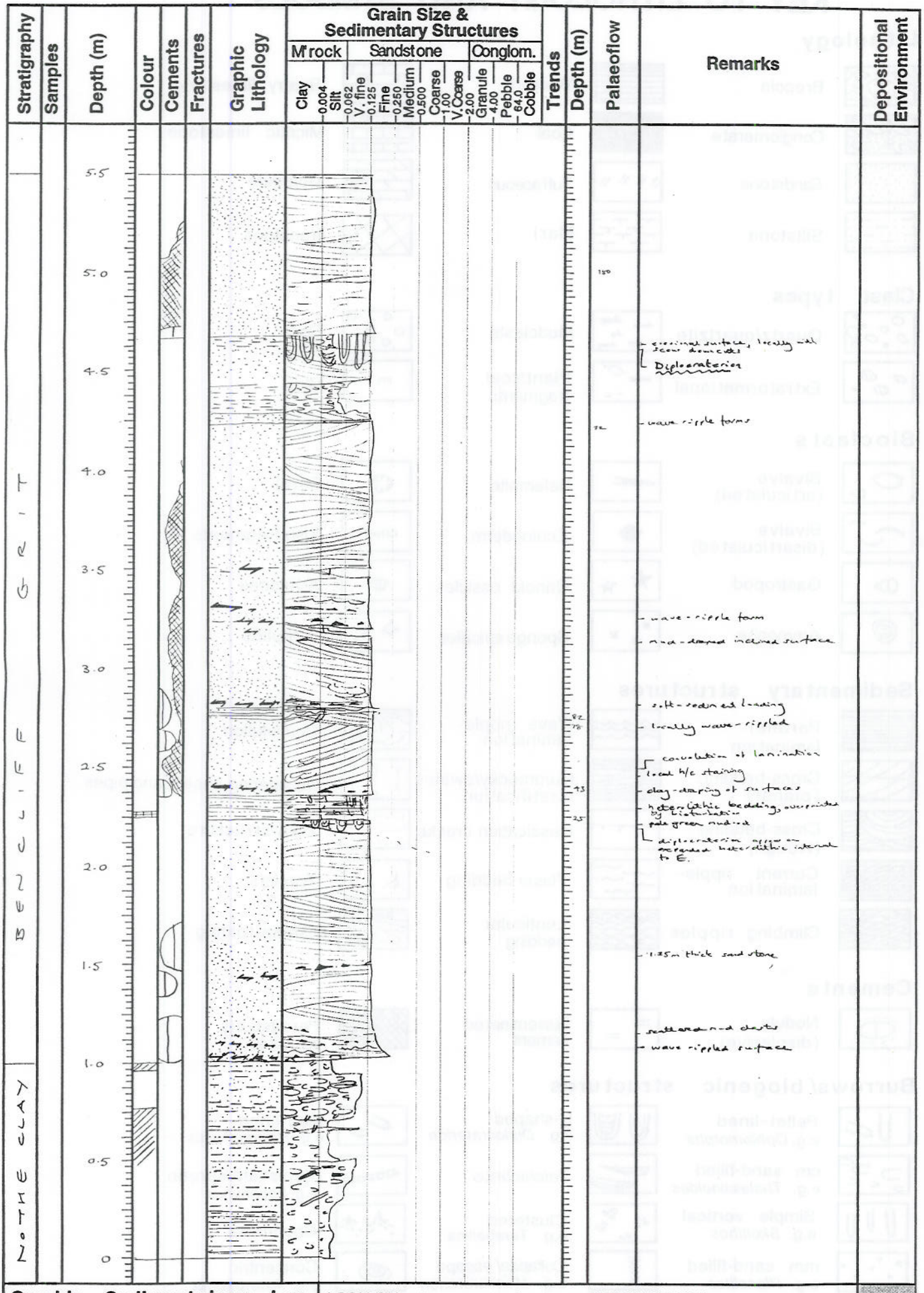
7. Special attention should be paid to clasts and pebbles. Note the lithology, size, rounding and approximate abundance of each type.

8. Comment on the lateral continuity and geometry of the beds and add remarks as appropriate.

9. Record OBSERVATIONS and measurements on the logging sheet, with no inferences or interpretations apart from in the summary column along the right-hand side of the sheet.

10. Inked up versions of the logging sheets can be included as an Appendix in your mapping report and used to support your analysis of the stratigraphy and depositional evolution.

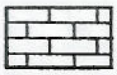
EXAMPLE


Stratigraphy
Samples
Depth (m)
Colour
Cements
Fractures
Graphic Lithology
Grain Size & Sedimentary Structures
M'rock
Sandstone
Conglom.
Clay
Silt
V. fine
Fine
Medium
Coarse
V. Coarse
Granule
Pebble
Cobble
0.004
0.062
0.125
0.250
0.500
1.00
2.00
4.00
64.0
Trends
Depth (m)
Palaeoflow
Remarks
Depositional Environment
BEN CLIFF GRIT
NOTHE CLAY
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
150
72
82
70
73
25
- erosional surface, locally with scour down cuts
Diplocraterion
- wave ripple forms
- wave-ripple form
- mud-draped inclined surface
- soft-sediment loading
- locally wave-rippled
- convolution of lamination
- local H/c staining
- clay-draping of surfaces
- heterolithic bedding, overprinted by bioturbation
- pale green mudrock
- diplocraterion appear on exposed heterolithic interval to E.
- 1.25m thick sandstone
- scattered mud clasts
- wave rippled surface
Graphic Sedimentology Log
LOCALITY:
GRID REFERENCE:

Lithology


Breccia


Mudrock

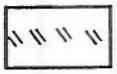

Sparry limestone

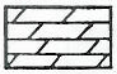

Conglomerate

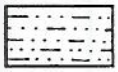

Coal

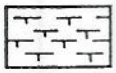

Micritic limestone


Sandstone


Tuffaceous


Dolomite

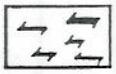

Siltstone

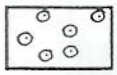

Marl


Ironstone

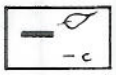
Clast types

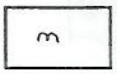

Quartz/quartzite


Mudclasts

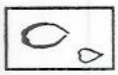

Ooids


Extraformational

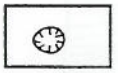

Plant/coal fragments

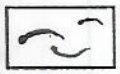

Mica

Bioclasts

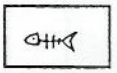

Bivalve (articulated)

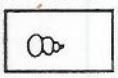

Belemnite


Coral

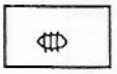

Bivalve (disarticulated)


Echinoderm


Fish fragments

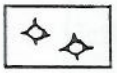

Gastropod


Crinoid ossicles


Arthropod

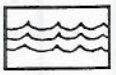

Ammonite


Sponge spicules


Serpulids

Sedimentary structures

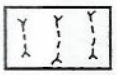

Parallel-lamination


Wave ripple-lamination

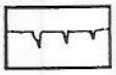

Convolution


Cross-bedding (planar)

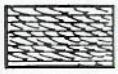

Hummocky/swaley stratification


Dewatering sheets and pipes


Cross-bedding (trough)


Dessication cracks


Dish-structure


Current ripple-lamination

Flaser bedding

Rootlets

Climbing ripples

Lenticular bedding

Slump-folding

Cements

Nodule (displacive)

Disseminated cement

Pervasively cemented

Burrows/ biogenic structures

Pellet-lined
e.g. *Ophiomorpha*

U-shaped
e.g. *Diplocraterion*

Mud-lined
e.g. *Palaeophycus*

cm sand-filled
e.g. *Thalassinoides*

Teichichnus

Meniscate/spretin
e.g. *Zoophycus*

Simple vertical
e.g. *Skolithos*

Clustered
e.g. *Terebellina*

Chondrites

mm sand-filled
e.g. *Planolites*

Collapse/ escape
e.g. *Monocraterion*

Concentric
e.g. *Asterosoma*