

Atlas of Palaeogeography and Lithofacies

Dedicated to the memory of the late
Professor L.J. Wills
Honorary Fellow of the Geological Society
Lyell medallist and Wollaston medallist
Author of *A Palaeogeographical Atlas of the British Isles*, the inspiration for this volume

References to this volume

It is recommended that reference to all or part of this Atlas should be made in one of the following ways.

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J. C. W. COPE, J. K. INGHAM & P. F. RAWSON

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List of Contributors

- R. Anderton, formerly Department of Applied Geology, University of Strathclyde (now BP Glasgow)
- M. G. Bassett, Department of Geology, National Museum of Wales, Cardiff, CF1 3NP
- R. E. Bevins, Department of Geology, National Museum of Wales, Cardiff, CF1 3NP
- B. J. Bluck, Department of Geology and Applied Geology, The University of Glasgow, Glasgow, G12 8QQ
- M. J. Bradshaw, formerly Department of Geology, University of Aston (now Brunei Shell Petroleum Sendirian Berhad, Seria, Negara Brunei Darussalam, Borneo)
- M. D. Brasier, Department of Earth Sciences, The University, Parks Road, Oxford, OX1 3PR
- P. J. Brenchley, Department of Earth Sciences, PO Box 147, The University, Liverpool, L69 3BX
- R. Cave, University College of Wales, Aberystwyth, SY23 3DB
- J. C. W. Cope, Department of Geology, University of Wales College of Cardiff, PO Box 914, Cardiff, CF1 3YE
- D. W. Cripps, formerly Department of Geology, University of Aston (now The Robertson Group, Ty'n-y-Coed, Llanrhos, Llandudno, LL30 1SA)
- D. T. Donovan, Department of Geological Sciences, University College London, Gower Street, London, WC1E 6BT
- R. A. Fortey, Department of Palaeontology, British Museum (Natural History), Cromwell Road, London, SW7 5BD
- W. Gibbons, Department of Geology, University of Wales College of Cardiff, PO Box 914, Cardiff, CF1 3YE
- C. C. Graham*, British Geological Survey, Murchison House, West Mains Road, Edinburgh, EH9 3LA
- P. D. Guion, Department of Geology and Physical Science, Oxford Polytechnic, Headington, Oxford, OX3 0BP
- J. M. Hancock, Department of Geology, Royal School of Mines, Imperial College, Prince Consort Road, London, SW7 2BP
- C. H. Holland, Department of Geology, Trinity College, Dublin 2, Ireland
- M. K. Howarth, Department of Palaeontology, British Museum (Natural History), Cromwell Road, London, SW7 5BD
- C. P. Hughes, Department of Earth Sciences, Sedgwick Museum, Downing Street, Cambridge, CB2 3EQ
- J. K. Ingham, Hunterian Museum, The University of Glasgow, Glasgow, G12 8QQ
- H. C. Ivimey-Cook*, British Geological Survey, Nicker Hill, Keyworth, Nottingham, NG12 5GG
- J. D. Lawson, Department of Geology and Applied Geology, The University of Glasgow, Glasgow, G12 8QQ
- J. W. Murray, Department of Geology, The University, Southampton, SO9 5NH
- P. G. Nicholson, Department of Geology and Applied Geology, The University of Glasgow, Glasgow, G12 8QQ
- P. F. Rawson, Department of Geological Sciences, University College London, Gower Street, London, WC1E 6BT
- A. W. A. Rushton*, British Geological Survey, Nicker Hill, Keyworth, Nottingham, NG12 5GG
- C. T. Scrutton, Department of Geological Sciences, The University of Durham, South Road, Durham, DH1 3LE
- G. D. Sevastopulo, Department of Geology, Trinity College, Dublin 2, Ireland
- D. B. Smith, Geoperm, 79 Kenton Road, Newcastle upon Tyne, NE3 4NL
- A. Straw, Department of Geography, The University, Exeter, EX4 4QE
- A. R. H. Swan, School of Geological Sciences, Kingston Polytechnic, Penrhyn Road, Kingston upon Thames, KT1 2EE
- J. C. M. Taylor, 41 High Trees Road, Reigate, RH2 7EN
- G. Warrington*, British Geological Survey, Nicker Hill, Keyworth, Nottingham, NG12 5GG
- I. M. West, Department of Geology, The University, Southampton, SO9 5NH
- W. A. Wimbledon, 15 Stoney Lane, Shaw, Newbury, RG13 2NG

*These contributors publish with the approval of the Director, British Geological Survey (NERC).

Editorial

To produce a compilative work such as this atlas, which has necessarily involved a large number of contributors, inevitably generates problems; to pretend there have been no problems in its gestation would be disingenuous.

The selection of specialist contributors to each System, and to each part of each System seemed, at the time, the best way to proceed; inevitably this led to problems. Firstly there were those who produced high quality work promptly, whose understandable impatience has had to be reconciled with those whose more leisurely approach could not be hastened. Then there were a few who produced work which was not to our required specifications and for them, and those who failed to produce anything, replacement contributors had to be found. Some replacement contributors also failed to produce the required work and the editors have perforce become major contributors to some of the sections of this atlas in areas outside of their own specialist knowledge. The editors have also had to reconcile some strongly conflicting interpretations of contiguous maps from different authors, and would like to acknowledge the willingness of these authors to allow their views to be compromised to produce a coherent series of maps. The final result is the editors' responsibility.

In total there are over 30 contributors to whom the editors have to express their thanks, one of whom, Adrian Rushton, was the only one of the original co-ordinators to stay the course. In addition there are numerous others whose assistance is acknowledged in each chapter. Finally, there are the large number of individuals whose contributions may be too minor for formal acknowledgement, but whose unstinted provision of odd snippets of information has saved countless hours of work by editors and contributors and has made the maps more accurate or up to date. Our colleagues on the Society's Stratigraphy Committee, under whose auspices the Atlas project evolved, have provided a constant spur to our activities and have provided innumerable suggestions to improve the publication.

The Atlas has been produced under the co-ordinating editorship of John Cope, who has had special responsibilities for the Precambrian to Permian maps and text; Peter Rawson's responsibility has involved the editing of the

Triassic to Recent contributions, whilst Keith Ingham, as editor in charge of all artwork, has been responsible for choices of colour and drafting schemes; the final appearance of the Atlas owes much to his skills.

The Geological Society has provided encouragement and major financial support for the project since its inception. The Society acknowledges the generous support of Industry in the production of this Atlas, in particular from the following companies:

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In order to make the Atlas available at a price which should enable widespread circulation, substantial contributions were made from the Henry Wood Trust Fund of the Geological Society and also from the Royal Society of London.

JCWC

The editors are indebted to Professor Bernard Leake for his unstinted support and encouragement in seeing this Atlas into production. We have benefited from the experience of staff at Lovell Johns and of Alan Cooper, who have provided considerable advice in the drafting of the maps.

Technical Note

The coloured maps in this Atlas were produced on Apple Macintosh computers, principally a IICX 4/40. The software used was Aldus Freehand. Final film for the printer was produced on a Linotronic 300R Image Setter.

Editorial to the revised reprint

This edition of the atlas is a reduced-size reprint of the original A3 atlas. That work, the most expensive publishing venture hitherto undertaken by the Society, has covered its costs, so the opportunity exists to produce this smaller sized version at a low cost.

Inevitably in the time that has elapsed since the atlas was produced there have been some major publications that have impinged upon the map reconstructions. The decision was made, to enable the price to be kept as low as possible, that no amendments would be made to the maps or text for this edition, but that this editorial page could be used to draw the readers' attention to points where revision is needed. It is not possible in the limited space available to mention the large number of minor modifications needed to the maps, but an attempt has been made here to summarize some of the more significant changes required.

Terranes. Controversy still exists about some of the terrane boundaries shown on the map, but the hypothesis of Terrane Tectonics has gained wide acceptance. Unresolved problems include the status of the Grampian Group – was it, as the map suggests, the basal part of the Dalradian Supergroup (in which case the Great Glen Fault is a terrane boundary) or was it the uppermost group of the Moine Supergroup (in which case the Great Glen Fault is simply a post-Moine fault)? At the southern end of the Dalradian outcrop similar problems concern the fossiliferous rocks that crop out along the Highland Boundary Fault zone across the Scottish Highlands and westwards to western Ireland. These fossiliferous units may be part of a largely hidden terrane (the Highland Border Subterrane as depicted on the map), whilst others argue that they are the youngest component of the Dalradian Supergroup. For a detailed account of the Scottish Precambrian rocks, the reader is referred to the revised Precambrian correlation charts (Gibbons & Harris 1994).

Precambrian. New dates for the Torridonian (Turnbull *et al.* 1996) suggest a Stoer Group age of 1199 ± 70 Ma (PC1a) and 977 ± 39 Ma for the Applecross Formation (PC1b). New dates for the Precambrian–Cambrian boundary (Bowring *et al.* 1993; Landing *et al.* 1998) suggest that map PC3a should be around 565 Ma and PC3b around 545 Ma.

Cambrian. New dates for the Cambrian (Bowring *et al.* 1993; Davidek *et al.* 1998; Landing *et al.* 1998) require revisions to the dates of the Cambrian maps. Revised suggested dates are: C1a 520 Ma, C1b 510 Ma, C2a 498 Ma, C2b 520 Ma.

Ordovician. Revisions of the British Ordovician series (Fortey *et al.* 1995) propose that the Llandeilo Series be largely subsumed within an enlarged Llanvirn Series and relegated to stage-level, with the *gracilis* Biozone marking the base of a revised Caradoc Series. New dates for the Ordovician (Tucker & McKerrow 1995; Davidek *et al.* 1998) also require changes as follows: O1a 487 Ma, O1b 478 Ma (now = earliest Whiterock), O2a 466 Ma, O2b 458 Ma, O3a 454 Ma, O3b 446 Ma, O4a 487 Ma, O4b 480 Ma, O5a 466 Ma, O5b 458 Ma (under the new scheme for the British Ordovician series, this would now be earliest Caradoc), O6a 456 Ma, O6b 455 Ma, O7a 454 Ma, O7b 451 Ma, O8a 446 Ma, O8b 444 Ma.

Silurian. New dates for the Silurian (Tucker & McKerrow 1995) suggest the following revised dates for the Silurian maps: S1a 443 Ma, S1b 434 Ma, S2a 433 Ma, S2b 431 Ma, S3a 427 Ma, S3b 424 Ma, S4a 423 Ma, S4b 422 Ma, S5a 421 Ma, S5b 420 Ma, S6a 443 Ma, S6b 434 Ma, S7 431 Ma, S8a 427 Ma, S8b 419 Ma, S9 418 Ma.

The record of rapid Rhuddanian and Aeronian subsidence in the Woolhope and Usk basins recorded by Butler *et al.* (1997) requires modification to the first Silurian map (S1a). These basins, that developed during rifting of the western part of the Midland Platform, were bordered north-westwards by the Neath Disturbance and eastwards by the Malvern line. Huntley Quarry (indicated on the map) lies at the eastern boundary of this area where thinner marginal successions accumulated. The southern margin of this depositional area (as for map S1b) is conjectural.

For northern parts of southern Britain, it is now clear that Eastern Avalonia was closer to Laurentia by the late Ordovician than was envisaged when the *Atlas* was drawn up and that its initial docking against the Laurentian margin took place earlier in the Silurian. It was completed in early Devonian times, with a component of anticlockwise rotation (Soper & Woodcock 1990). By mid-Ludlow times a migrating foreland basin was established over the Lake District that accumulated some 7 km of turbidites, probably largely derived from a Southern Uplands source, but with input from Scandia too (Cooper *et al.* 1993) (requiring amendments to maps S5a and S5b). By the start of Prídolí times this basin was largely filled and was subtidal (map S8b).

Devonian. New dates are suggested for three of the Devonian maps. The suggested dates are: D1 415 Ma, D2 400 Ma, D3 375 Ma, D4 368–363 Ma. Cooper *et al.* (1993) suggested that the post-Acadian Mell Fell Conglomerate of the Shap area could be of Middle Devonian age. Within the palaeogeographical picture presented in the *Atlas*, this deposit would fit more easily onto map D4 rather than D3.

Carboniferous. Dating of the Carboniferous continues to present problems and there are major unresolved discrepancies between the dates obtained by

the Ar-Ar method and those obtained from Pb/U, Rb/Sr and K/Ar methods (Menning *et al.* 1997). The suggested compromise dates for the maps are: C1 354 Ma, C2 348 Ma, C3 343 Ma, C4 337 Ma, C5 325 Ma, C6 315 Ma, C7 312 Ma, C8 309 Ma, C9 304 Ma.

The identification of early Dinantian evaporites in the Solway Basin extending over more than 1000 km² implies arid and semi-arid conditions across that basin around Chadian and Arundian ages (Ward 1998). Cyclic successions were correlated with glacio-eustatic sea-level oscillations and the identification of this facies requires evaporite symbols over the Solway Basin on maps C3 and C4.

Permian and Triassic. No changes are proposed for the maps of these periods. Edwards *et al.* (1997) recognized that the Crediton Trough of central Devon is an E–W basin that has a fill of Late Carboniferous–Early Permian sediments that is overlain unconformably by a Late Permian sequence, the two successions being separated by a hiatus of at least 20 million years duration.

Jurassic. For the Jurassic, the late Toarcian uplift has been now firmly associated with thermal doming of the North Sea centred on the Rattray volcanic centre. The effects of this thermal doming have been discussed in detail by Underhill & Partington (1993); they show that the area affected was greater than 1250 km in diameter and have charted the history of the doming and the subsequent deflation that persisted through to the late Oxfordian. This work allows better palaeogeographical restraint on the maps for the Aalenian–Oxfordian interval and also suggests that there was a marine connection through the Hebrides through to the Moray Firth across the Great Glen in Bathonian–Oxfordian times (Underhill & Partington 1993, fig. 4).

Cretaceous. In the Upper Cretaceous the palaeogeographies represented by maps K4a and K4b may now be considered as somewhat conservative reconstructions. The identification of doming centred on the Irish Sea (Cope 1994) initially suggested from inversion indicated by Apatite Fission Track Analysis (Lewis *et al.* 1992, Holliday 1993) strongly suggests that there was a considerable Chalk thickness not only over the Irish Sea, but right over mainland Wales (at least by the Campanian, if not much earlier). The amount of land shown over the Lake District and the Southern Uplands may also be too great. Cope (1998) has reconstructed a likely Jurassic and Cretaceous cover for the Irish Sea area and its environs.

Palaeogene. The doming of the Irish Sea, referred to under 'Cretaceous' above probably took place in the earliest Palaeocene and map Pg1 should be modified to show an Irish Sea centred uplift of some 2–2.5 km whose effects reached at least as far south as the Chiltern Hills and are responsible for the 2° regional south-easterly dip of the Anglo-Welsh area (Cope 1994).

Neogene and Quaternary. No changes are proposed for these maps.

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