The structure and evolution of the Northumberland–Solway Basin and adjacent areas

Subsurface memoir

LONDON: HMSO 1995
CONTENTS

One Introduction 1
Summary of previous research 3
Outline of geological history 6

Two Lower Palaeozoic 8
Lake District and Alston Block 8
Southern Uplands 8
Iapetus convergence zone 8
Influence of basement structure on Carboniferous basin development 9

Three Late Devonian–Early Carboniferous: synextensional phase of basin development 11
Syndepositional faulting 13
Basin-bounding fault-systems 13
Antithetic fault-systems 15
Oblique faults 15
Synextensional rocks (Courceyan to Holkerian) 18
The Northumberland–Solway Basin 18
Upper Old Red Sandstone 18
Early Carboniferous volcanic rocks 19
Lower Border Group 19
Middle Border and Fell Sandstone groups 21
The Vale of Eden Basin and the Stainmore Trough 22

Four Late Dinantian–Silesian: postextensional phase of basin development 25
Upper Border Group 25
Liddesdale and Alston groups 27
Stainmore Group 27
Coal Measures 32

Five Variscan structures and basin inversion 38
Solway Basin 38
Northumberland Trough and Cheviot Block 42
Vale of Eden Basin and Alston Block 42
Stainmore Trough 42
Igneous intrusions (Whin Sill Suite) 43
The origin of the structures 43

Six Post-Variscan events 46
Permian and early Mesozoic sedimentation 46
Post-early Jurassic faulting 47
Cenozoic basin inversion and uplift 48

Seven Economic geology 49
Coal 49
Hydrocarbons 49
Coal-bed methane 51
Geothermal energy 51
Underground storage/disposal of fluids 51
Evaporites 52
Mineral deposits 52

References 53
Appendices 61
1 Geological Survey maps and memoirs published following the primary geological survey 61
2 Geological Survey maps and memoirs published following the 20th century resurvey 62
3 Generalised records of selected boreholes 64

Index 68
Maps 74

FIGURES
1 Location map x
2 Simplified geological map of the region 1
3 Principal subsurface structures influencing Carboniferous sedimentation in the region 2
4 Areas licensed in the period 1980–1992 for hydrocarbon exploration and location of hydrocarbon exploration wells 3
5 Summary of Carboniferous stratigraphy of the region 5
6 Perspective view of the top of Caledonian basement rocks in the region, viewed from the south-west 7
7 Perspective view of the top of Caledonian basement rocks in the region, viewed from the north-west 7
8 Relationship between the Northumberland Trough and the inferred late-Acadian crustal shear zone 9
9 Development of a sedimentary basin by initial fault-controlled synextensional subsidence followed by regional postextensional subsidence, giving a ‘steer’s head’ profile 11
10 Seismic reflection profile across the Stublich–Ninety Fathom fault system, which forms the southern margin of the Northumberland Trough 12
11 Seismic reflection profile across the Northumberland Trough, showing northwards onlap of early basin-filling strata on to Lower Palaeozoic basement rocks 13
12 a. Cross-section through the Northumberland Trough, the Alston Block and the northern part of the Stainmore Trough 14
b. Cross-section through the Solway and Vale of Eden basins 14
c. Cross-section through the Northumberland Trough and the Bewcastle Anticline 14
13 Seismic reflection profile across the Butterknowle Fault, which forms the northern margin of the Stainmore Trough 16
14 Seismic reflection profile across the Back Burn Fault (north-east Solway Basin), showing Variscan reversal of a Dinantian syndepositional normal fault 17
15 Courceyan palaeoenvironments and lithofacies in the region: Lower Border Group (lower part) and equivalents 20