

# Tectonic events responsible for Britain's oil and gas reserves: a summary

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In 1964, following the implementation of the 'Continental Shelf Act', the first offshore licenses in the United Kingdom were awarded. Subsequent exploration activities have resulted in the discovery of some 20 billion barrels of oil reserves and 70 trillion cubic feet of recoverable gas, most of which are located in the North Sea Basin. It is no surprise, therefore, that most of the papers presented in this volume concentrate on this area, where a particular and favourable tectonic evolution has led to the coincidence of good source rocks, sufficiently deeply buried; good reservoir development; and timely trap formation in relation to hydrocarbon generation and migration. It is the purpose of this contribution to summarize the various tectonic phases which have contributed to the complex geological evolution of the British Isles and surrounding territorial waters and trace their impact upon the development of the hydrocarbon habitat.

## Caledonian framework

The basic tectonic framework of NW Europe was created during Ordovician-early Devonian times, as a result of the closure of the Iapetus Ocean. Whereas in Norway this led to a NW-SE directed collision between the Laurentian and Fennoscandian Shields, in Britain a more complex accretion of Precambrian continental blocks and island arcs onto the N American craton occurred (Coward). The resulting heterogeneity of this basement complex had a critical influence on subsequent tectonic episodes, during which existing basement lineaments were reactivated to varying degrees. In the Northern North Sea and the Atlantic Margin west of the Shetlands, there is an important SW-NE structural grain, reflecting reactivation of Caledonian thrusts. In the Central and Southern North Sea, the predominant NW-SE lineaments probably are related to a diffuse transform zone between the Fennoscandian Shield and accreted terrains.

## Devono-Carboniferous

During the Devonian the post-orogenic collapse of the Caledonides was accompanied by a major sinistral translation between the Laurentian and Fennoscandian Shields. In the Northern North Sea these movements gave rise to the rapid subsidence of pull-apart basins (Midland Valley, Orcadian Basin) in which thousands of metres of Old Red Sandstone accumulated, locally providing lacustrine conditions with consequent deposition of organic-rich clays. The early Carboniferous evolution of the British Isles was governed by north-south extension along a series of NW-SE and NE-SW trending faults located along zones of Caledonian weakness (Northumberland, Stainmore, Craven, Gainsborough and Widmerpool Gulf Basins). From the Namurian onwards, crustal stretching ceased and broad regional subsidence was initiated, coincident with a major climatic change from semi-arid to monsoonal conditions. This resulted in the development of major south to southwest directed deltaic drainage systems with extensive coal deposition, forming both excellent gas-prone source rocks and potential reservoirs (Leeder & Hardman, Fraser & Gawthorpe).

## Variscan orogeny

As a result of the closure of the Proto-Tethyan Ocean south of Britain and the subsequent collision of Laurasia and Gondwana, intra-plate stresses were transmitted into the Variscan foreland resulting in extensive deformation. In the East Midlands area, uplift and folding of the hanging walls of the main extensional fault trends created the principal traps (Fraser & Gawthorpe). Elsewhere, in the Silverpit area of the Southern North Sea, gas accumulations in Carboniferous reservoirs are also located in areas of Variscan inversion. Subsequently, during the latest Carboniferous-early Permian,

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**Nigel H. Woodcock, R. A. Strachan**



## **Tectonic Events Responsible For Britains Oil And Gas Reserves:**

Tectonic Events Responsible for Britain's Oil and Gas Reserves Richard Frederick Paynter Hardman, James Brooks, 1990

**Petroleum Geology of Northwest Europe** A. J. Fleet, S. A. R. Boldy, 1999-09 A review of the extensive advances made in the understanding the petroleum geology of the Atlantic margin of northwest Europe of the North Sea and of adjacent areas since the last conference in 1992 In particular the volume focuses on the development of and application of 3D seismic time lapse 4D and other innovative seismic tools the ongoing refinement of sequence and other stratigraphic approaches including the integration of detailed biostratigraphic data the development of modelling at both the reservoir and basin scale which can respond to new data acquisition and be used to assess uncertainties at the reservoir scale and scenarios at the basin scale

United Kingdom Oil and Gas Fields G. Goffey, J. G. Gluyas, 2020-12-03 Geological Society Memoir 52 records the extraordinary 50 year journey that has led to the development of some 458 oil and gas fields on the UKCS It contains papers on almost 150 onshore and offshore fields in all of the UK's main petroliferous basins These papers range from look backs on some of the first developed gas fields in the Southern North Sea to papers on fields that have only just been brought into production or may still remain undeveloped and includes two candidate CO<sub>2</sub> sequestration projects These papers are intended to provide a consistent summary of the exploration appraisal development and production history of each field leading to the current subsurface understanding which is described in greater detail As such the Memoir will be an enduring reference source for those exploring for developing producing hydrocarbons and sequestering CO<sub>2</sub> on the UKCS in the coming decades It encapsulates the petroleum industry's deep subsurface knowledge accrued over more than 50 years of exploration and production

*Extensional Tectonics: Faulting and related processes* Robert E. Holdsworth, Johnathan P. Turner, Geological Society of London, 2002

*The Geology of Fluvial Deposits* Andrew D. Miall, 2013-12-20 Fluvial deposits represent the preserved record of one of the major nonmarine environments They accumulate in large and small intermontane valleys in the broad valleys of trunk rivers in the wedges of alluvial fans flanking areas of uplift in the outwash plains fronting melting glaciers and in coastal plains The nature of alluvial assemblages their lithofacies composition vertical stratigraphic record and architecture reflect an interplay of many processes from the wandering of individual channels across a floodplain to the long term effects of uplift and subsidence Fluvial deposits are a sensitive indicator of tectonic processes and also carry subtle signatures of the climate at the time of deposition They are the hosts for many petroleum and mineral deposits This book is about all these subjects The first part of the book following a historical introduction constructs the stratigraphic framework of fluvial deposits step by step starting with lithofacies combining these into architectural elements and other facies associations and then showing how these in turn combine to represent distinctive fluvial styles Next the discussion turns to problems of correlation and the building of large scale stratigraphic frameworks These basin scale constructions form the basis for a discussion of causes and processes including autogenic processes of channel shifting

and cyclicity and the larger questions of allogenic tectonic eustatic and climatic sedimentary controls and the development of our ideas about nonmarine sequence stratigraphy

*Key Issues in Petroleum Geology* F. John Gregory, Philip Copestake, Julian M. Pearce, 2007 This volume contains a compilation of 17 seminal papers taken from various Geological Society Special Publications and the Journal of the Geological Society on the use and application of stratigraphy in petroleum geology over the last 20 years The volume focuses on case studies in fundamental stratigraphy applied and integrated stratigraphy and alternative methods of stratigraphy The book is introduced with an original scientific and historical review of the subject all papers are set in context with both the benefits of the techniques and some of the shortcomings highlighted By compiling these papers commercial stratigraphers John Gregory Philip Copestake and Julian Pearce have created a volume intended for a wide readership However it is of particular relevance for the training of undergraduate students studying courses on petroleum geology basin development and sequence stratigraphy as well as for all postgraduate students working in petroleum related scientific fields It is also intended as a volume of general use for geoscientists entering the petroleum industry as well as current workers requiring an overview

**Sediment Provenance Studies in Hydrocarbon Exploration and Production** R.A. Scott, H.R. Smyth, A.C. Morton, N. Richardson, 2014-06-25 Sediment provenance studies concern the origin composition transportation and deposition of detritus and therefore are an important part of understanding the links between basinal sedimentation and hinterland tectonics and unroofing Such studies can add value at many stages of hydrocarbon exploitation from identifying regional scale crustal affinities and sediment dispersal patterns during the earliest stages of exploration to detailed correlation in producing reservoirs and understanding the impact of mineralogy on reservoir diagenesis The volume showcases the wide variety of techniques available using examples and applications from all aspects of sediment provenance research The papers are organized into four sets around the following themes Overview applications of provenance information in hydrocarbon reservoir sandstones Provenance diagenesis and reservoir quality Provenance studies linking sediment to source Looking forward development of techniques and data handling This book is dedicated to the memory of Maria Mange and Robert A Scott

*Petroleum Geology of the Southern North Sea* Karen Ziegler, Stephen R. Daines, P. Turner, Peter Turner, 1997

Mesozoic Resource Potential in the Southern Permian Basin B. Kilhams, P.A. Kukla, S. Mazur, T. McKie, H.F. Mijndieff, K. van Ojik, 2018-08-31 The Southern Permian Basin as its name suggests is a historical heartland for hydrocarbon production from the Palaeozoic Rotliegend interval However in this mature basin the Mesozoic presents further possibilities to offer resource security to NW Europe Such opportunities include increasing efficiency in the production of discovered hydrocarbons exploration for further hydrocarbons both conventional and unconventional and efficient exploration for and production of geothermal energy All these potential resources require a grounding in technically sound geoscience via traditional scientific observation and the application of new technologies to unlock their value The main aim of this volume is to bring together the work of academics and industry

workers to consider cross border geoscience including contributions on Poland Germany The Netherlands the United Kingdom and adjacent areas The work presented intends to contribute to the development and discovery of further Mesozoic energy resources across the basin

**Cross Border Themes in Petroleum Geology I: The North Sea** S. Patruno, S. G. Archer, D. Chiarella, J. A. Howell, C. A.-L. Jackson, H. Kombrink, 2022 A cross border approach to exploration appraisal and development is important in mature basins such as the North Sea where the low hanging fruit have long gone This approach emphasizes the need to see the basin as one geological entity in order to maximize economic recovery and prepare the area for the energy transition This volume offers an up to date geology without borders view of the stratigraphy sedimentology tectonics and oil and gas exploration trends of the entire North Sea basin along with the challenges associated with differences in data continuity and nomenclature across median lines This volume includes overviews of cross border play statistics lithostratigraphic naming conventions and exploration performance through to new facies models for cross border areas As such this volume will be a valuable reference for every geoscientist working in the North Sea for years to come

*Geological History of Britain and Ireland* Nigel H. Woodcock, R. A. Strachan, 2009-04-01 Britain Ireland and their surrounding areas have a remarkably varied geology for so small a fragment of continental crust This region contains a fine rock record from all the geological periods from Quaternary back to Cambrian and a less continuous but still impressive catalogue of events back through nearly 2500 million years of Precambrian time This protracted geological history would have been interesting enough to reconstruct if it had been played out on relatively stable continental crust However Britain and Ireland have developed instead at a tectonic crossroads on crust traversed intermittently by subduction zones and volcanic arcs continental rifts and mountain belts The resulting complexity makes the geological history of this region at once fascinating and perplexing *Geological History of Britain and Ireland* tells the geological story of the region at a level accessible to undergraduate geologists as well as to postgraduates professionals or informed amateurs The book takes a multi disciplinary rather than a purely stratigraphical approach and aims to bring to life the processes behind the catalogue of historical events Full coverage is given to the rich Precambrian and Early Palaeozoic history as well as to later events more relevant to hydrocarbon exploration The book is profusely illustrated and contains guides to further reading and full references to data sources making it an essential starting point for more detailed studies of the regional geology All British Earth science undergraduates will be required to spend some time studying British Geological History and this book will be the only one available to British undergraduates The book takes a process based approach rather than simply describing the regional stratigraphy Lavishly illustrated with high quality diagrams

*Sequence Stratigraphy on the Northwest European Margin* R.J. Steel, V.L. Felt, E.P. Johannesson, C. Mathieu, 1995-07-04 Sequence Stratigraphy presently one of the most rapidly growing areas in geology is concerned with the documentation and prediction of how sandstones potential hydrocarbon reservoirs and shales potential source rocks are distributed in time and space within sedimentary basins The book takes a

critical look at some of the sequence stratigraphy concepts and provides an account of how these have been applied recently in NW Europe North Sea mid Norway and E Greenland Barents Sea and Svalbard mainly in connection with the exploration for oil and gas There is currently no similar book available

**Generation, Accumulation and Production of Europe's Hydrocarbons III** Anthony M. Spencer, 2012-12-06 The 30 contributions of this volume cover the main European regions for oil and gas exploration the North Sea and adjacent areas the central and eastern Mediterranean including offshore Albania central and eastern Europe including Poland Hungary the Russian platform and offshore Bulgaria Main topics are investigations to sequence stratigraphy 3D quantitative restoration and balanced structural sections using the LOCACE equipment Additional studies deal with a Monte Carlo method for generating models of porosity and permeability with facies characterization using wireline logs or with petrographic applications of image analysis As further reading this volume is of significant interest for researchers in oil and gas industries but also for scientists at universities

Mineralogical and Geochemical Approaches to Provenance E. Troy Rasbury, Sidney R. Hemming, Nancy R. Riggs, 2012-01-01

**Dynamics of the Norwegian Margin** Geological Society of London, 2000 The papers and research results presented here have been prepared as part of the Integrated Basin Studies project This project had the objective of studying the lithospheric and upper crustal processes governing the formation and evolution of extensional and foreland basins and to decipher the role of tectonics sea level and sedimentary processes in the filling of such basins The Dynamics of the Norwegian Margin module focused on the rifted sedimentary basins of the northern North Sea and off Mid Norway This prolific hydrocarbon province has an extensive industry and scientific database and offers a unique opportunity to study fundamental earth processes from failed rifting to crustal breakup and accretion of oceanic crust A set of new models for basin formation and filling has been derived including linking of sedimentary basin faulting to lower crustal deformation signature and variability of syn rift infill correlation of mineralogy to seismic signature nature and characteristics of volcanic margin formation and distribution of present day stress field

*Permo-carboniferous Magmatism and Rifting in Europe* B. Marjorie Wilson, 2004

**Industrial Structural Geology** F.L. Richards, N.J. Richardson, S.J. Rippington, R.W. Wilson, C.E. Bond, 2015-10-22 The practical application of structural geology in industry is varied and diverse it is relevant at all scales from plate wide screening of new exploration areas down to fluid flow behaviour along individual fractures From an industry perspective good structural practice is essential since it feeds into the quantification and recovery of reserves and ultimately underpins commercial investment choices Many of the fundamental structural principles and techniques used by industry can be traced back to the academic community and this volume aims to provide insights into how structural theory translates into industry practice Papers in this publication describe case studies and workflows that demonstrate applied structural geology covering a spread of topics including trap definition fault seal fold and thrust belts fractured reservoirs fluid flow and geomechanics Against a background of evolving ideas new data types and advancing computational tools the volume highlights the need for

structural geologists to constantly re evaluate the role they play in solving industrial challenges      **Surge Tectonics: A New Hypothesis of Global Geodynamics** Arthur A. Meyerhoff, I. Taner, A.E.L. Morris, W.B. Agocs, M.

Kamen-Kaye, Mohammad I. Bhat, N. Christian Smoot, Dong R. Choi, 2012-12-06 TECTONICS AND PHYSICS Geology although rooted in the laws of physics rarely has been taught in a manner designed to stress the relations between the laws and theorems of physics and the postulates of geology The same is true of geophysics whose specialties seismology gravimetry magnetism magnetotellurics deal only with the laws that govern them and not with those that govern geology's postulates The branch of geology and geophysics called tectonophysics is not a formalized discipline or subdiscipline and therefore has no formal laws or theorems of its own Although many recent books claim to be textbooks in tectonophysics they are not they are books designed to explain one hypothesis just as the present book is designed to explain one hypothesis The textbook that comes closest to being a textbook of tectonophysics is Peter H. Wyllie's 1971 book *The Dynamic Earth* Teachers students and practitioners of geology since the very beginning of earth science teaching have avoided the development of a rigorous but not rigid scientific approach to tectonics largely because we earth scientists have not fully understood the origin of the features with which we are dealing This fact is not at all surprising when one considers that the database for hypotheses and theories of tectonics particularly before 1960 has been limited to a small part of the exposed land area on the Earth's surface

The Geology of Stratigraphic Sequences Andrew D. Miall, 2013-06-29 Sequence stratigraphy represents a new paradigm in geology The principal hypothesis is that stratigraphic successions may be subdivided into discrete sequences bounded by widespread unconformities There are two parts to this hypothesis First it suggests that the driving forces which generate sequences and their bounding unconformities also generate predictable three dimensional stratigraphies In recent years stratigraphic research guided by sequence models has brought about fundamental improvements in our understanding of stratigraphic processes and the controls of basin architecture Sequence models have provided a powerful framework for mapping and numerical modeling enabling the science of stratigraphy to advance with rapid strides This research has demonstrated the importance of a wide range of processes for the generation of cyclic sequences including eustasy tectonics and orbital forcing of climate change The main objective of this book is to document the sequence record and to discuss our current state of knowledge about sequence generating processes      *The BIRPS Atlas* Simon L. Klemperer, Richard Hobbs, British Institutions Reflection Profiling Syndicate, 1991 The BIRPS Atlas presents the 100 deep seismic reflection profiles collected around the British Isles by the BIRPS Group BIRPS British Institutions Reflection Profiling Syndicate at desk top scale

The Enigmatic Realm of **Tectonic Events Responsible For Britains Oil And Gas Reserves**: Unleashing the Language is Inner Magic

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