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RESOURCES PERSPECTIVES of the SOUTHERN PERMIAN BASIN AREA

J.C. DOORNENBAL, TNO Built, Environment and Geosciences, Geological Survey of the Netherlands,, hans.doornenbal@tno.nl

Summary

The Southern Permian Basin (also referred to as Central European Basin) is Europe's largest sedimentary basin. It is a typical intracontinental basin that evolved from latest Carboniferous to recent times and extends from eastern England to the Belarussian-Polish border and from Denmark to South Germany.

The Southern Permian Basin Atlas (SPBA) project is a joint project between the Geological Surveys of Belgium, Denmark, Germany, The Netherlands, Poland, and the UK and is being supported by a wide range of E&P companies, government licensing authorities, universities and research institutes. The aim of the Atlas is to present an overview of the results of over 150 years of petroleum exploration and research in this basin area. As this gas and oil province continues to mature and with field sizes inevitably decreasing, more and more careful data integration and geoscientific effort is required to discover new reserves. The subsurface characterization provided in the Atlas will also be of great value to governments, researchers and other individuals interested in the deep subsurface.

Introduction

The Atlas reviews the entire Southern Permian Basin (SPB) area, covering the British, Dutch, German, Danish and Polish sectors (see **figure 1**). The Southern Permian Basin Atlas (SPBA) Project, which was initiated by Ken Glennie, officially started in March 2005 and will be published in April 2010.



Figure 1 Location map showing the areas covered by the Southern Permian Basin Atlas and the Millennium Atlas

A key objective of the Atlas is to stimulate the petroleum E&P industry to continue their activities in this mature basin. As the Southern Permian Basin gas and oil province continues to mature and with field sizes inevitably decreasing, more and more careful data integration and geoscientific effort is required to discover new reserves and to augment the recovery of proven hydrocarbon accumulations. The large volume of data that is or will be made available publicly allows the production of an authoritative compilation to support the E&P industry in their efforts to fully develop the basin. At the same time, easy and inexpensive access to the accumulated knowledge held by educational bodies will lead to a better

understanding of the Southern Permian Basin area and the documentation of this knowledge will assist in the training of the next generation of petroleum geologists. The Atlas will be available on paper (A2 size) and on CD in an interactive PDF format. The SPBA database and

all GIS maps (print scale 1: 3.000.000) will also be offered as a separate GIS product on DVD.

Contents Atlas

The Atlas addresses the geologic evolution and hydrocarbon potential per stratigraphic interval. The paleogeographic and tectonic evolution has been covered within the framework of the principal stratigraphic intervals, from the Precambrian basement to the Holocene. The various structural and stratigraphic settings are elucidated by a thorough set of hydrocarbon field examples, overview maps, and illustrations. In addition, petroleum generation, migration, trapping, and production as well as the history of exploration and licensing in the basin has been covered, together with a summary of resource assessments. Other potential options for use of the deep subsurface such as gas and CO₂ storage and geothermal aspects have been also addressed. The content of the Atlas has been generated through contributions from authoritative international experts, survey material, and data from petroleum exploration companies.

Activities of the project

The Atlas actually got off the ground as a four year project in March 2005 when the steering committee was established consisting mainly of representatives from the National Geological Surveys and from E&P industry sponsors. TNO has exercised overall management of the project (i.e. technical, secretarial, and financial) and the British Geological Survey (BGS) has supervised the editing of the Atlas.

The main activities of the project were GIS mapping (see **figure 2**) and writing of the chapters. Special software was used with great success for submitting, exchanging and sharing kinds of information via a shared environment.

One of the key deliverables of the project is a comprehensive mapping database, including a 3D geological model of the SPBA area, overviews of gas and oil fields, geochemical, seismic and well data. Last years TNO has developed various avenues of sharing a 3D database using novel freely available techniques, including a 3D viewer and a novel technique developed in Google Earth to share information.

Currently the project is in its final phase of final editing.

Petroleum provinces

Six petroleum systems have been defined for the SPBA area, that are characterized by a unique source rock type and age. In addition, petroleum provinces have been delineated, that host one or more petroleum systems. By combining the source rock maps with tectonic elements and the presence of known oil or gas accumulations, a total of 12 petroleum provinces have been defined, related to Paleozoic source rocks (**figure 3**) and related to Mesozoic source rocks (**figure 4**). More than 1300 hydrocarbon fields have been discovered so far in the SPBA area. Fields related to a petroleum province are considered to have been charged from a common source rock and each field has been linked to one of these petroleum provinces. Finally creaming curves could be prepared for almost all petroleum provinces.

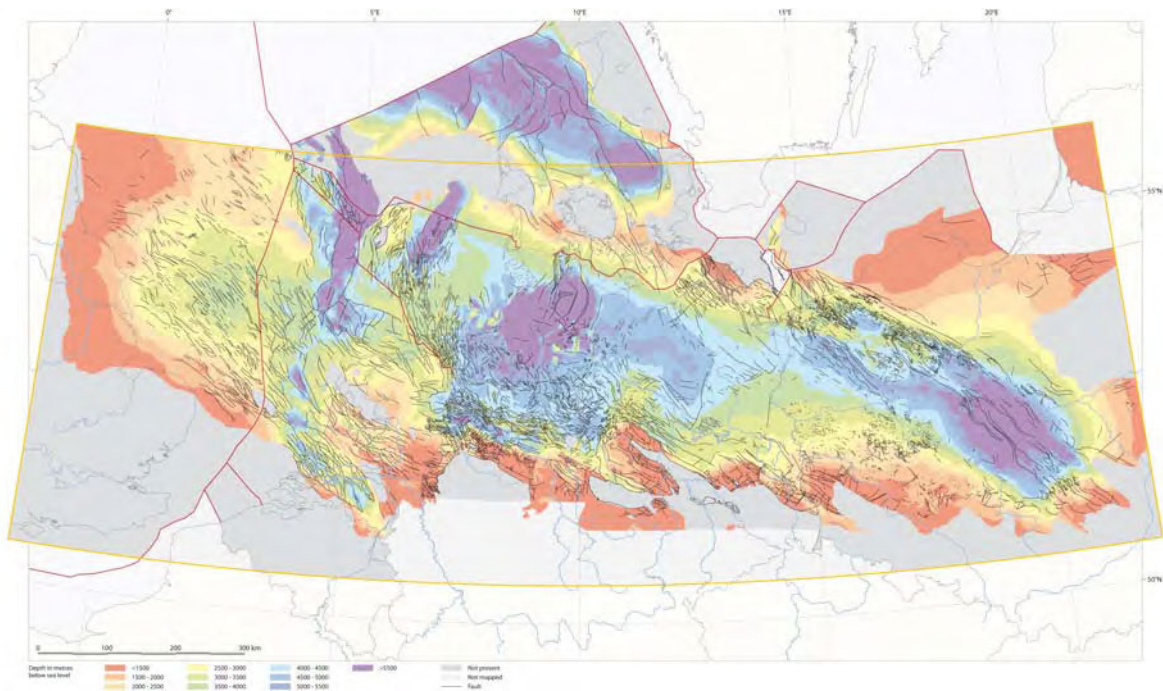


Figure 2 Preliminary depth map of the base of the Zechstein

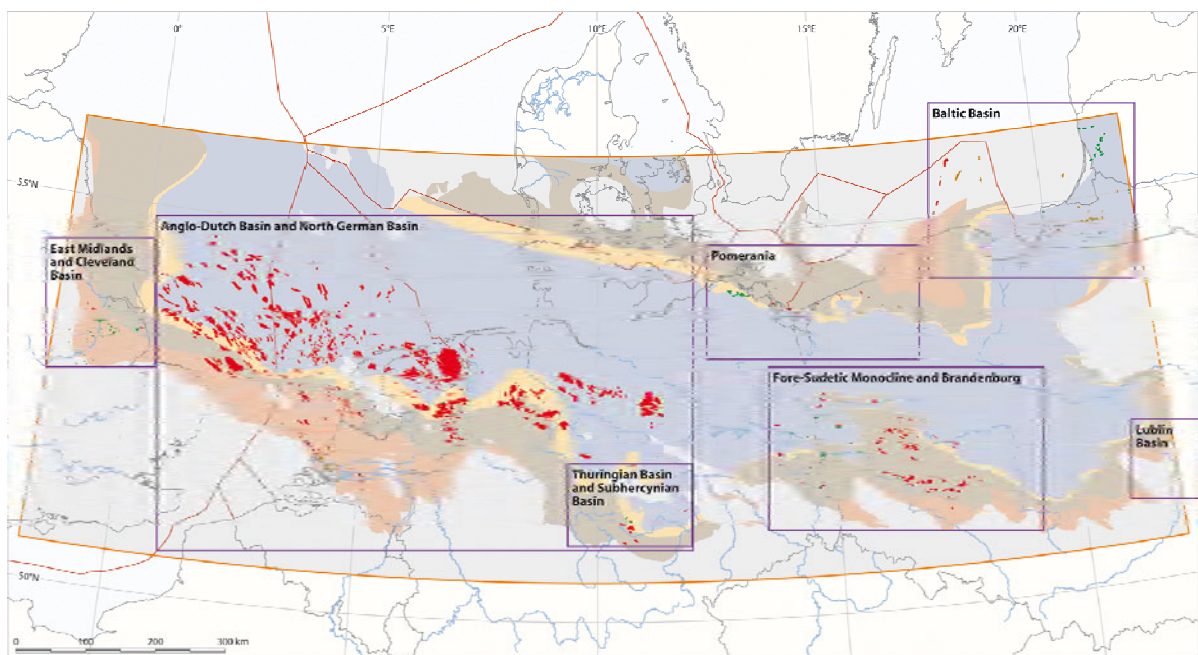


Figure 3: Petroleum provinces related to Paleozoic source rocks have been defined for the SPBA area.

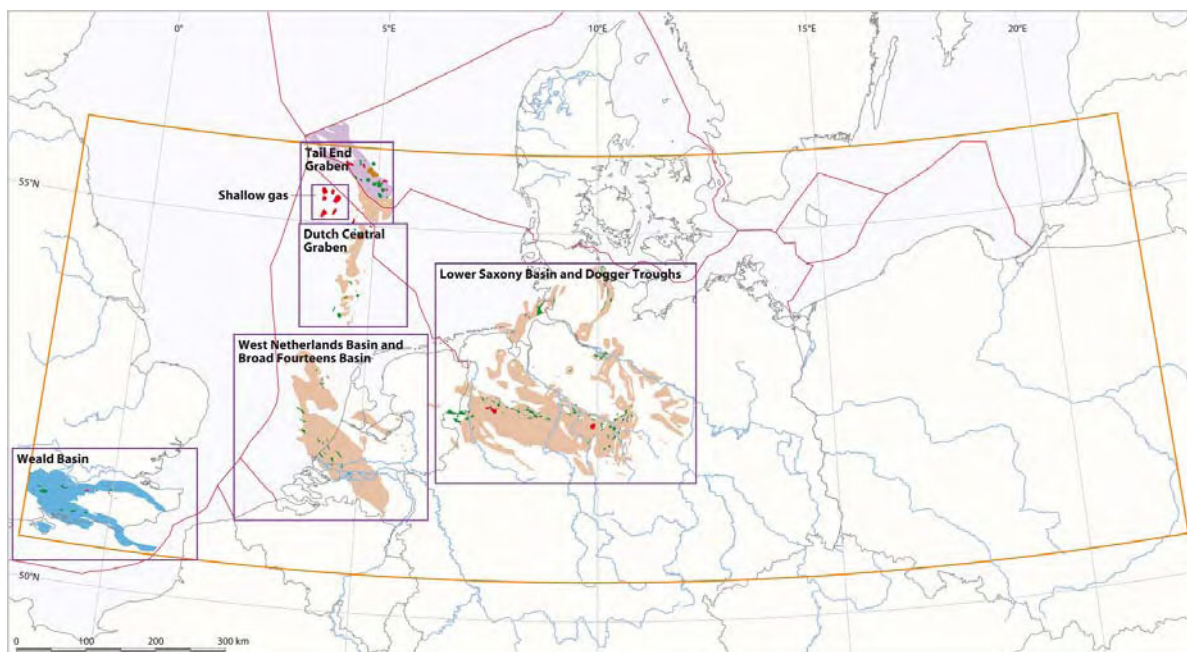


Figure 4: Petroleum provinces related to Mesozoic source rocks have been defined for the SPBA area.

The two major petroleum systems of the Southern Permian Basin are sourced by the gas-prone Westphalian (upper Carboniferous) coal measures and the oil-prone Posidonia Shale (lower Jurassic). They account for the bulk of the exploited petroleum. Other petroleum systems are less productive and restricted to a few play regions, but they still provide a significant economic benefit.

Their enormous thickness, wide distribution, and favourable burial history have made the Westphalian coal measures the most important source rocks of the SPBA area. Superposition of this huge hydrocarbon source by a variety of reservoir facies and top seals resulted in a great number of economically viable plays. Local enrichments in condensate, nitrogen, and sulphur were contributed from ancillary biogenic as well as from abiogenic sources.

The Posidonia petroleum system is sourced from oil-prone marine shales deposited in a restricted marginal sea at high sea level. In the western SPB, the Posidonia has reached the oil/gas window and is an excellent source rock. Eastward transition to terrestrial facies has deprived the lower Jurassic equivalents in the Polish Trough from becoming source rocks.

Besides the widely explored petroleum systems, there is an unfathomed potential from shallow gas, especially in the North Sea.

Discovery history of reserves Carboniferous Petroleum System

The Carboniferous, in particular the Westphalian coal measures, provides the principal source rock interval in the most important petroleum province of the Southern Permian Basin area, namely the “Anglo-Dutch and North German basins”. Distribution of these coals and their maturity largely dictates the distribution of hydrocarbon accumulations. To date, an estimated total of $6,25 \times 10^{12} \text{ m}^3$ ($=220 \times 10^{12} \text{ ft}^3$) gas have been discovered in reservoirs that are inferred to be sourced by the Carboniferous petroleum system (**figure 5**). Oil generated from Carboniferous source rocks is of minor importance with only $27 \times 10^6 \text{ m}^3$ in the area.

Exploration has now reached the late mature exploration phase and only minor reserves have been added since 2000, which is very encouraging for the future of such a mature province.

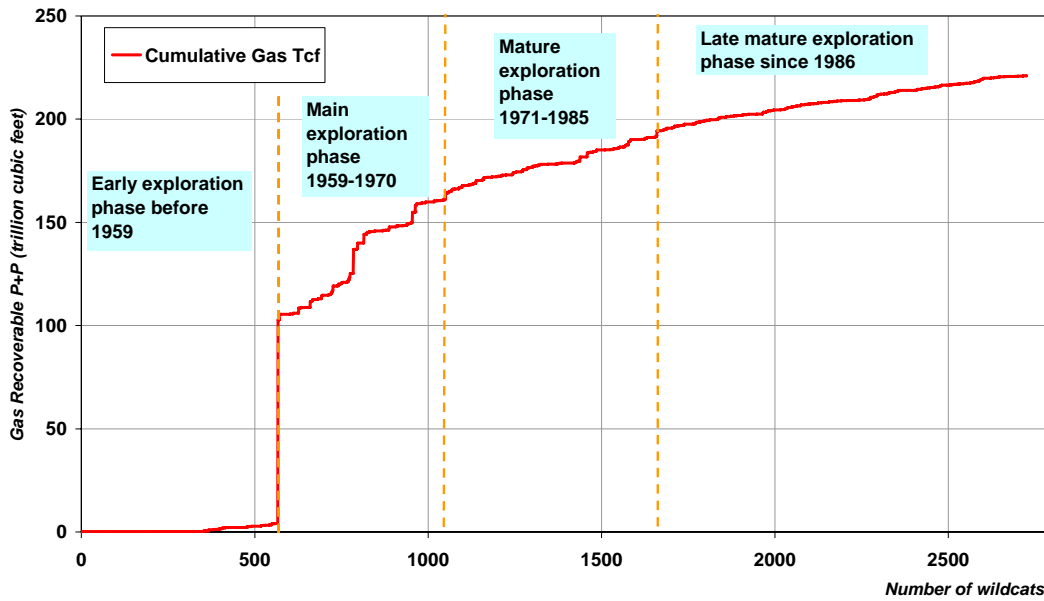


Figure 5: Reserves Addition by “Creaming Curve” for the Carboniferous Petroleum System in the Southern Permian Basin with subdivision of different exploration phases. The discovery of the Groningen gas field in 1959 changed the exploration paradigm and an intensified search for deeper Upper Permian Rotliegend targets started in the sixties.

