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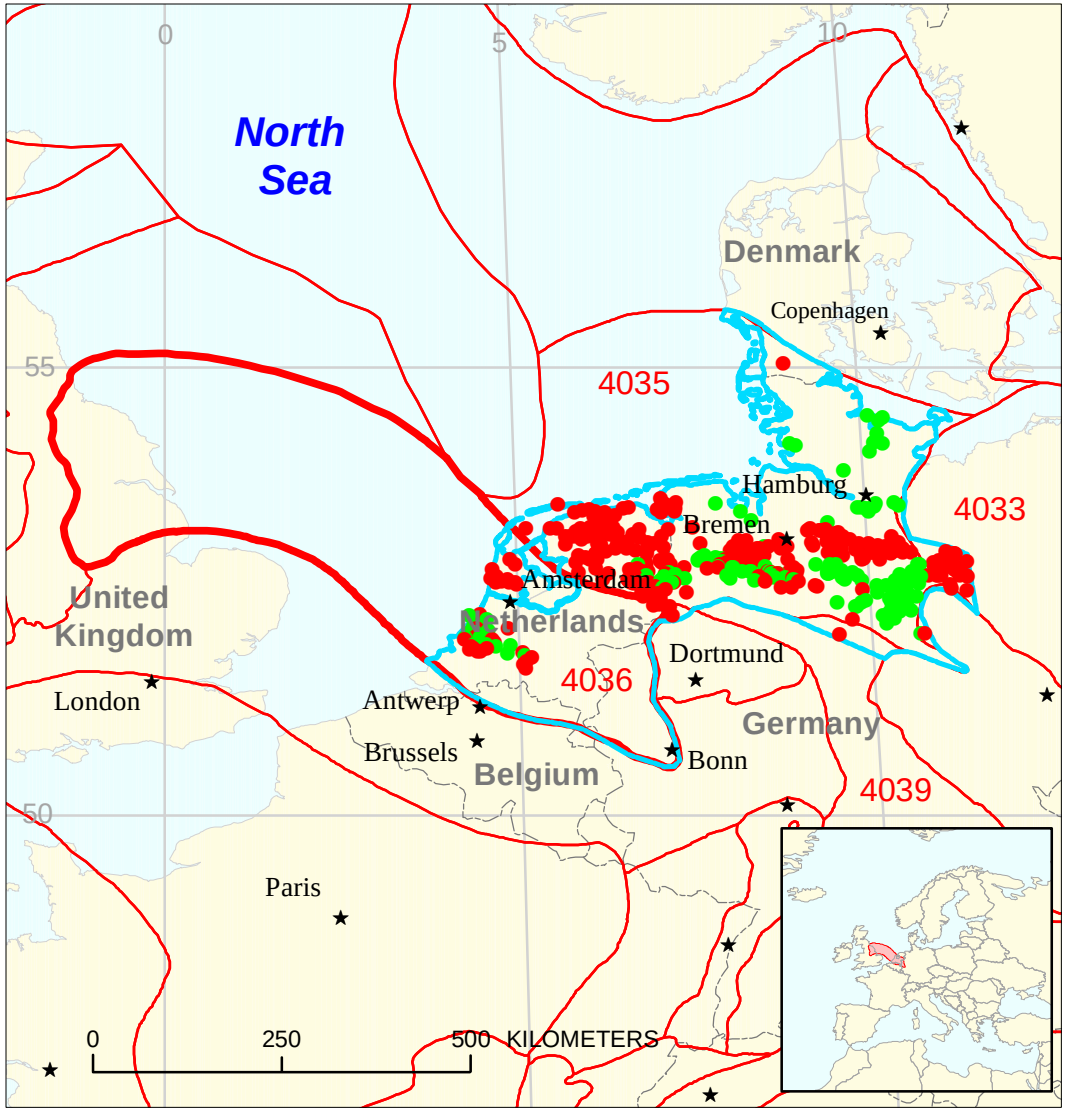
Southern Permian Basin-Europe Onshore Assessment Unit 40360102



Sourthern Permian Basin-Europe Onshore Assessment Unit 40360102
Anglo-Dutch Basin Geologic Province 4036
Other geologic province boundary

Geologic Summary

Detailed map of this assessment unit

Exploration/Discovery-History Data

- Plots of Known Field Sizes
- Plots of Grown Resources
- Tables

Assessment Input Data

Assessment Results

- Assessment Unit Summary
- Detailed Assessment Results
- Undiscovered Field-Size Distributions

USGS PROVINCE: Anglo-Dutch Basin (4036) **GEOLOGIST:** D.L. Gautier

TOTAL PETROLEUM SYSTEM: Carboniferous-Rotliegend (403601)

ASSESSMENT UNIT: Southern Permian Basin-Europe Onshore (40360102)

DESCRIPTION: The total petroleum system and corresponding assessment unit coincide with the extent of thermally mature Westphalian (coal measure) source rocks and related gas and liquid accumulations in the onshore area adjacent to the southern North Sea on the European continent, mainly in the Netherlands and Germany.

SOURCE ROCKS: Coals and carbonaceous shales, mainly of Westphalian and Stephanian (Upper Carboniferous) age, were deposited in the foreland north of the Variscan orogenic belt. The organic matter in the coal measures consists mainly of Type III terrigenous kerogen, although Type II kerogen is also present. The coals and carbonaceous shales constitute two distinct source rock components, with the coals containing approximately 60 percent TOC and Type III kerogen, whereas the carbonaceous shale have approximately 1 percent TOC and mixed Type II and Type III kerogen.

MATURATION: Source rocks became mature for oil and other liquids as early as Triassic time in some areas and for natural gas by early Jurassic time. Principal gas generation occurred in late Jurassic and Late Cretaceous time. In some areas gas generation has probably continued to the present.

MIGRATION: Initial gas migration probably accompanied earliest generation, and has continued to the present. Migration pathways are mainly along porous and permeable sandstones, as well as fractures in fine-grained sedimentary rocks.

RESERVOIR ROCKS: Best reservoir rocks are in the Rotliegend, particularly in eolian sandstone facies of several types. The entire Rotliegend contains reservoir intervals, but eolian dunes generally provide the highest quality reservoirs. Other Rotliegend reservoir facies include sheet flood and fluvial sandstones and relatively coarse grained fluvial channel deposits. Reservoir quality in the Rotliegend is strongly influenced by both depositional facies and by diagenetic processes, particularly precipitation of authigenic illite. In addition to the Rotliegendes, reservoir quality rocks are included in the Carboniferous fluvial channels, and in the Zechstein and Lower Cretaceous intervals.

TRAPS AND SEALS: Excellent regional seals are provided by evaporite and carbonate rocks of the Zechstein. Local lithologic variations provide stratigraphically heterogeneous distributions of gas accumulations.

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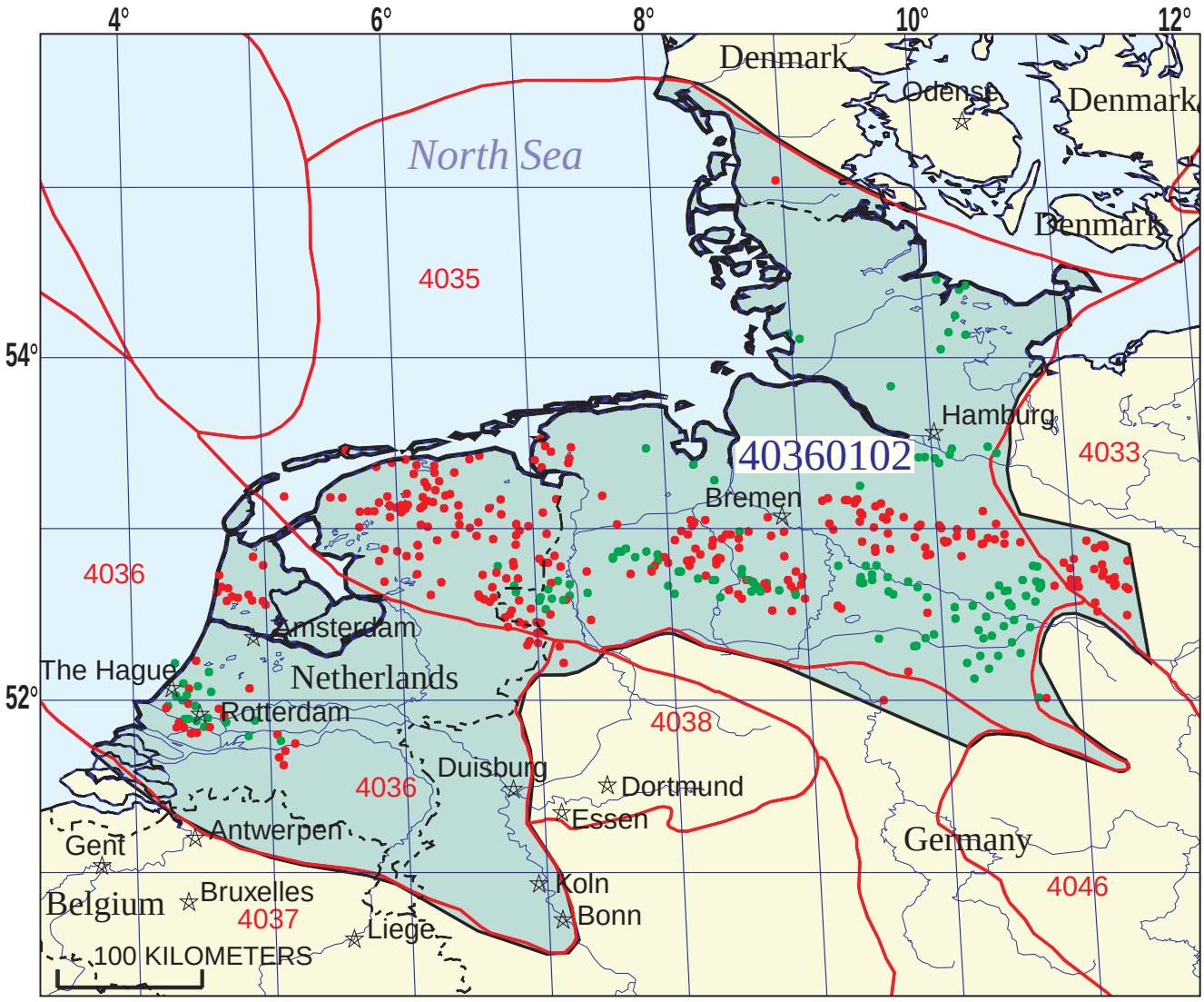


Southern Permian Basin-Europe Onshore Assessment Unit - 40360102

EXPLANATION

- Hydrography
- Shoreline
- 4036 Geologic province code and boundary
- Country boundary
- Gas field centerpoint
- Oil field centerpoint
- 40360102 Assessment unit code and boundary

Projection: Robinson. Central meridian: 0

SEVENTH APPROXIMATION
NEW MILLENNIUM WORLD PETROLEUM ASSESSMENT
DATA FORM FOR CONVENTIONAL ASSESSMENT UNITS

Date:……..	6/26/98		
Assessment Geologist:……..	D.L. Gautier		
Region:……..	Europe	Number:	4
Province:……..	Anglo-Dutch Basin	Number:	4036
Priority or Boutique……	Priority		
Total Petroleum System:……	Carboniferous-Rotliegend	Number:	403601
Assessment Unit:……..	Southern Permian Basin-Europe Onshore	Number:	40360102
* Notes from Assessor			

CHARACTERISTICS OF ASSESSMENT UNIT

Oil (<20,000 cfg/bo overall) **or** Gas (≥20,000 cfg/bo overall):… Gas

What is the minimum field size?……. 1 mmboe grown (≥1mmboe)
(the smallest field that has potential to be added to reserves in the next 30 years)

Number of discovered fields exceeding minimum size:…… Oil: 100 Gas: 230

Established (>13 fields) X Frontier (1-13 fields) _____ Hypothetical (no fields) _____

Median size (grown) of discovered oil fields (mmboe):
1st 3rd 15.5 2nd 3rd 6.25 3rd 3rd 11

Median size (grown) of discovered gas fields (bcfg):
1st 3rd 130 2nd 3rd 85 3rd 3rd 55

Assessment-Unit Probabilities:

Attribute	Probability of occurrence (0-1.0)
1. **CHARGE:** Adequate petroleum charge for an undiscovered field ≥ minimum size……	1.0
2. **ROCKS:** Adequate reservoirs, traps, and seals for an undiscovered field ≥ minimum size……	1.0
3. **TIMING OF GEOLOGIC EVENTS:** Favorable timing for an undiscovered field ≥ minimum size	1.0

Assessment-Unit GEOLOGIC Probability (Product of 1, 2, and 3):……..…….....…. 1.0

4. **ACCESSIBILITY:** Adequate location to allow exploration for an undiscovered field ≥ minimum size……..……..…… 1.0

UNDISCOVERED FIELDS

Number of Undiscovered Fields: How many undiscovered fields exist that are ≥ minimum size?:
(uncertainty of fixed but unknown values)

Oil fields:……min. no. (>0)	3	median no.	10	max no.	25
Gas fields:……min. no. (>0)	30	median no.	150	max no.	300

Size of Undiscovered Fields: What are the anticipated sizes (**grown**) of the above fields?:
(variations in the sizes of undiscovered fields)

Oil in oil fields (mmbo)…… min. size	1	median size	5	max. size	60
Gas in gas fields (bcfg):…….. min. size	6	median size	30	max. size	3000

Assessment Unit (name, no.)
Southern Permian Basin-Europe Offshore, 40360102

AVERAGE RATIOS FOR UNDISCOVERED FIELDS, TO ASSESS COPRODUCTS

(uncertainty of fixed but unknown values)

Oil Fields:	minimum	median	maximum
Gas/oil ratio (cfg/bo)……	450	900	1350
NGL/gas ratio (bngl/mmcfg)……	1	2	4

Gas fields:	minimum	median	maximum
Liquids/gas ratio (bngl/mmcfg)……	1	2	4
Oil/gas ratio (bo/mmcfg)……			

SELECTED ANCILLARY DATA FOR UNDISCOVERED FIELDS

(variations in the properties of undiscovered fields)

Oil Fields:	minimum	median	maximum
API gravity (degrees)……	10	35	50
Sulfur content of oil (%)……			
Drilling Depth (m) ……	500	1500	4000
Depth (m) of water (if applicable)……			

Gas Fields:	minimum	median	maximum
Inert gas content (%)……	10	40	80
CO_2 content (%)……	0.5	3	10
Hydrogen-sulfide content (%)……			
Drilling Depth (m)……	100	3500	6000
Depth (m) of water (if applicable)……			

Assessment Unit (name, no.)
Southern Permian Basin-Europe Offshore, 40360102

ALLOCATION OF UNDISCOVERED RESOURCES IN THE ASSESSMENT UNIT TO COUNTRIES OR OTHER LAND PARCELS (uncertainty of fixed but unknown values)

1. Germany represents 66 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		75	
Portion of volume % that is offshore (0-100%).....		0	

Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		85	
Portion of volume % that is offshore (0-100%).....		0	

2. Netherlands represents 34 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		25	
Portion of volume % that is offshore (0-100%).....		0	

Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		15	
Portion of volume % that is offshore (0-100%).....		0	

3. Province 4035 represents 70 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		75	
Portion of volume % that is offshore (0-100%).....		0	

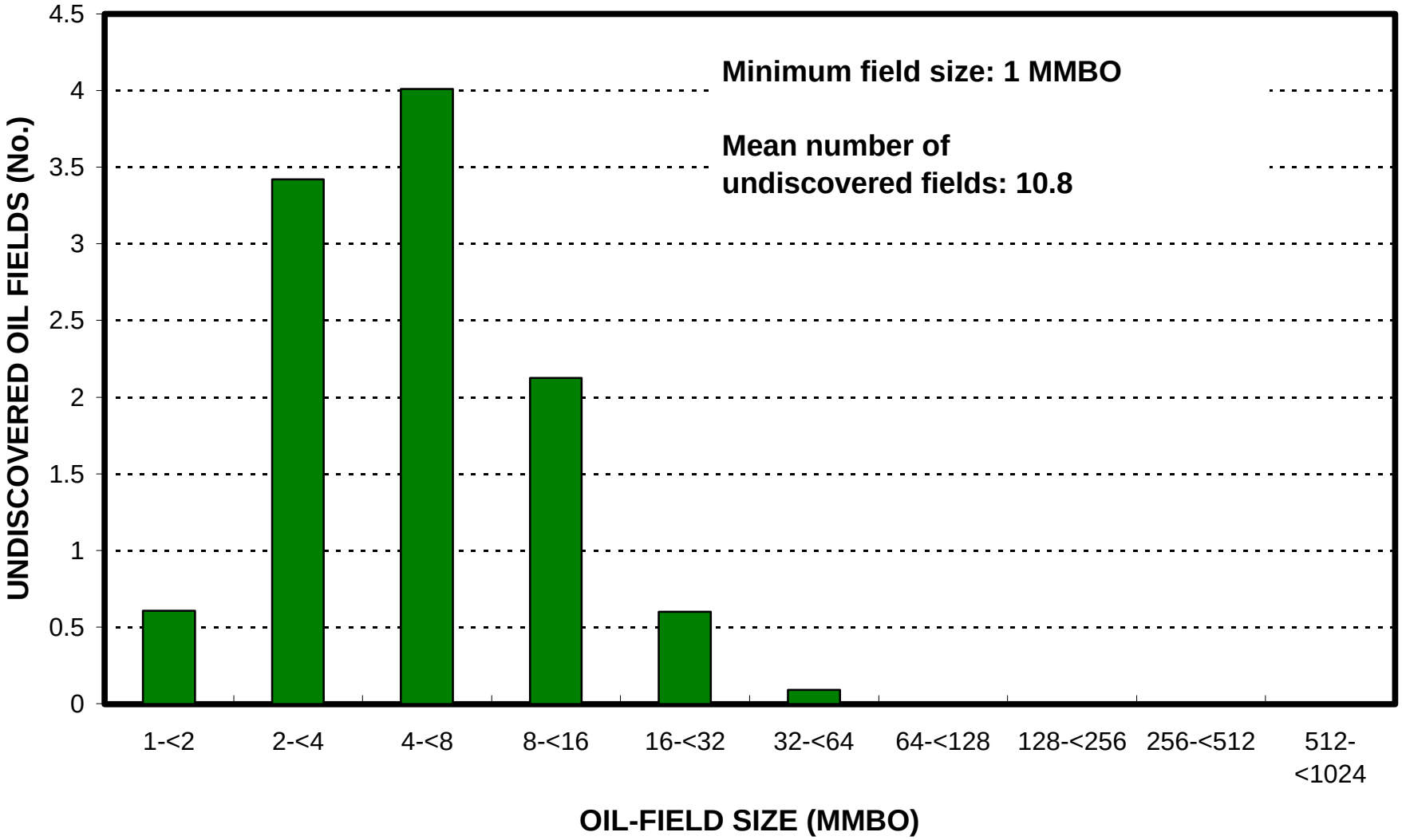
Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		85	
Portion of volume % that is offshore (0-100%).....		0	

4. Province 4036 represents 30 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		25	
Portion of volume % that is offshore (0-100%).....		0	

Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		15	
Portion of volume % that is offshore (0-100%).....		0	

Southern Permian Basin-Europe Onshore, AU 40360102
Undiscovered Field-Size Distribution



Southern Permian Basin-Europe Onshore, AU 40360102
Undiscovered Field-Size Distribution