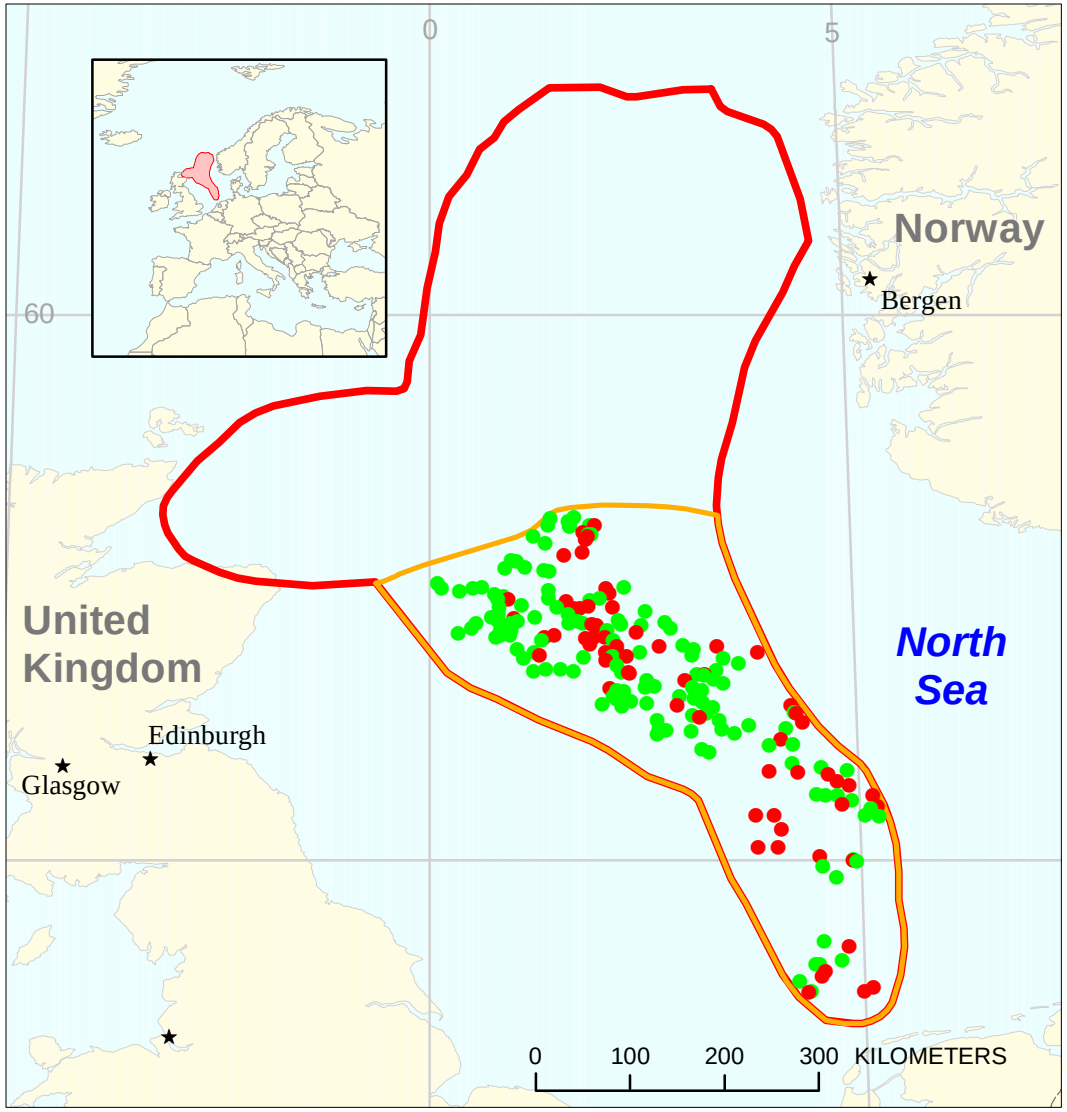
Go to Table of Contents

Go to index map

Central Graben
Assessment Unit 40250103



Central Graben Assessment Unit 40250103

North Sea Graben Geologic Province 4025

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: North Sea Graben (4025) **GEOLOGIST:** D.L. Gautier

TOTAL PETROLEUM SYSTEM: Kimmeridgian Shales (402501)

ASSESSMENT UNIT: Central Graben (40250103)

DESCRIPTION: The total petroleum system and corresponding assessment unit coincide with the extent of oil and gas accumulations and thermally mature, organic matter-rich marine shales of late Jurassic and earliest Cretaceous age in and adjacent to the Central Graben of the northern North Sea.

SOURCE ROCKS: Virtually all significant oil and gas accumulations in the northern North Sea are believed to have been generated within certain fine-grained, organic-carbon-rich marine strata of late Jurassic and earliest Cretaceous age. These Kimmeridgian shales accumulated in oxygen-starved rift basins and may locally thicken to 3000 m. The actual source rocks are black shales that display high radioactivity and have total organic carbon (TOC) contents of 2 percent to 15 percent or more and average about 5 percent TOC. The typical kerogen types within the hot shales are mixtures of organic matter commonly described as Type II kerogen, reflecting a mixture of planktonic marine algae and degraded terrigenous humic organic matter.

MATURATION: Burial of Central Graben source rocks has been more or less continuous from the time of deposition until the present day. Some source rocks achieved thermal maturity with respect to oil and gas generation as early as Late Cretaceous time and continuing to the present day in some areas. Thus newly generated oil and gas has been available to traps almost continuously during post-early Cretaceous Central Graben history. Locally, the continuous time-temperature process was interrupted by structural inversion, also in Late Cretaceous time.

MIGRATION: The near-universal predominance of upper Jurassic marine shales as source rocks in the Central Graben has resulted in a wide variety of migration styles and pathways, including stratigraphically downward migration into pre-Jurassic reservoirs rocks in fault blocks.

RESERVOIR ROCKS: Pre-rift rocks as old as Devonian, and including nonmarine Carboniferous fluvial sequences associated with the Coal Measures, Permian Rotliegendes sandstones, Zechstein carbonates, and Triassic and lower Jurassic sandstones in fault blocks have been variously charged with hydrocarbons. Middle and Upper Jurassic sandstones, deposited simultaneously with rifting in the Central Graben, form significant reservoirs for fields such as Fulmar and Ula. These syn-rift reservoirs include both shallow water and deep-water marine facies, evidently reflecting topography present during the formation of the Central Graben rifts. Lower Cretaceous reservoir sandstones are also present, having formed within the framework of the post-rift topography of the Central Graben. Chalk reservoirs dominate the Upper Cretaceous to lowermost Danian strata of the Central Graben. The most productive chalk reservoirs of the Central Graben occur in slump blocks and other structures associated with salt tectonics. Paleogene submarine fan complexes provide reservoirs for some of the most outstanding fields of the North Sea, including Forties.

TRAPS AND SEALS: Central Graben traps include fault blocks draped with Jurassic mudstones, Cretaceous chalk, or shale of Tertiary age. In contrast to the Viking Graben and Moray Firth, salt tectonics is responsible for much of the structural complexity that provides opportunities for hydrocarbon entrapment. Stratigraphic traps are dominant in the upper Jurassic and younger sandstones. Seals are Jurassic shale, Cretaceous chalk, or Tertiary shale.

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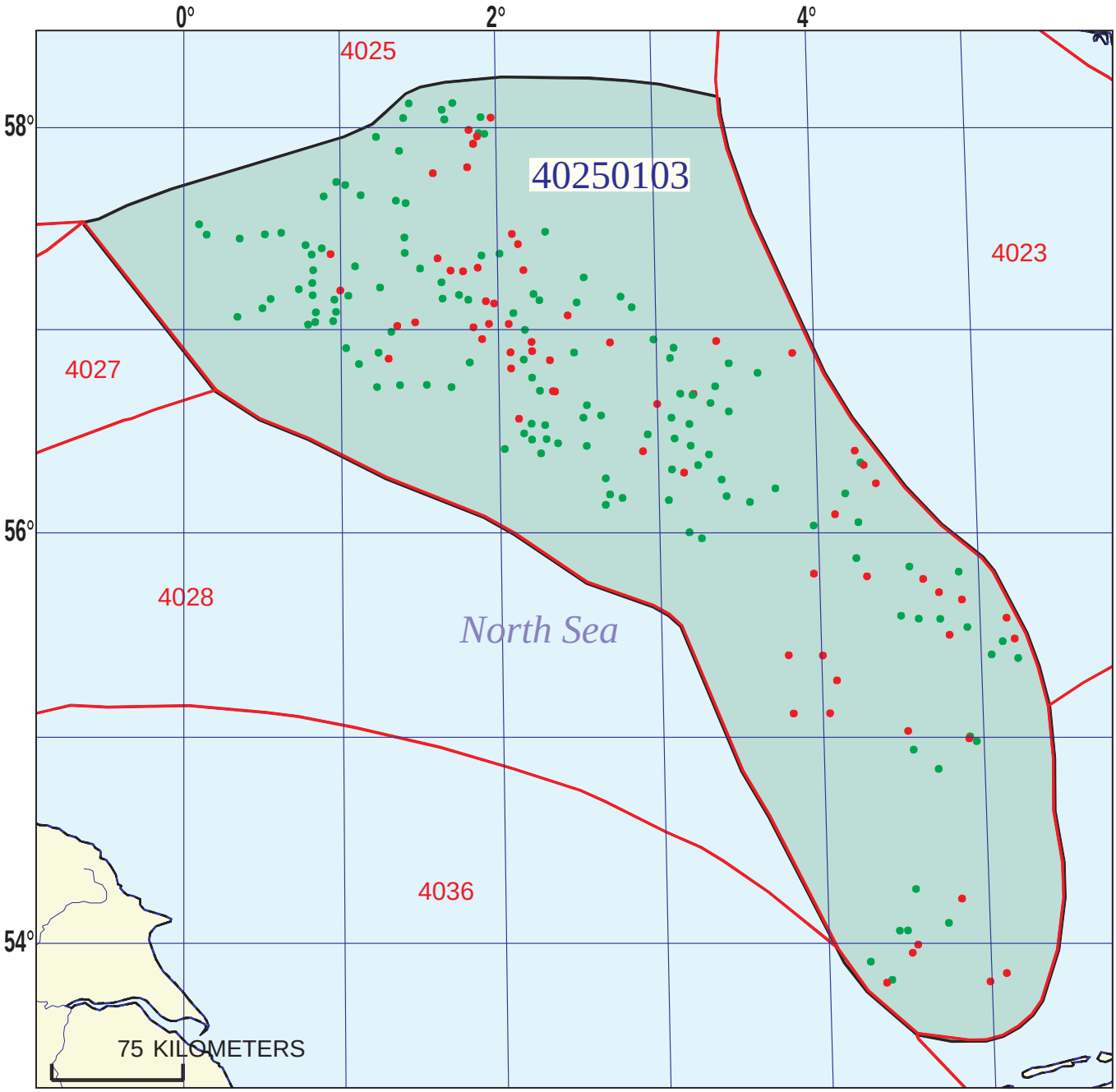


Central Graben
Assessment Unit - 40250103

EXPLANATION

- Hydrography
- Shoreline
- 4025 Geologic province code and boundary
- Country boundary
- Gas field centerpoint
- Oil field centerpoint
- 40250103 Assessment unit code and boundary

Projection: Robinson. Central meridian: 0

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

Date:……..	8/3/99		
Assessment Geologist:……..	D.L. Gautier		
Region:……..	Europe	Number:	4
Province:……..	North Sea Graben	Number:	4025
Priority or Boutique……	Priority		
Total Petroleum System:……	Kimmeridgian Shales	Number:	402501
Assessment Unit:……	Central Graben	Number:	40250103
* Notes from Assessor	MMS growth function.		

CHARACTERISTICS OF ASSESSMENT UNIT

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

What is the minimum field size?……. 2 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: 128 Gas: 61
Established (>13 fields) X Frontier (1-13 fields) _____ Hypothetical (no fields) _____

Median size (grown) of discovered oil fields (mmboe):
1st 3rd 76.5 2nd 3rd 15.9 3rd 3rd 59.7
Median size (grown) of discovered gas fields (bcfg):
1st 3rd 290 2nd 3rd 498 3rd 3rd 224

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)	30	median no.	125	max no.	300
Gas fields:……min. no. (>0)	15	median no.	60	max no.	150

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	2	median size	15	max. size	1000
Gas in gas fields (bcfg):……min. size	12	median size	70	max. size	4000

Assessment Unit (name, no.)
Central Graben, 40250103

AVERAGE RATIOS FOR UNDISCOVERED FIELDS, TO ASSESS COPRODUCTS

(uncertainty of fixed but unknown values)

Oil Fields:	minimum	median	maximum
Gas/oil ratio (cfg/bo)……	400	800	1200
NGL/gas ratio (bngl/mmcfg)……	30	60	90

Gas fields:	minimum	median	maximum
Liquids/gas ratio (bngl/mmcfg)……	25	50	75
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)……	20	38	50
Sulfur content of oil (%)……			
Drilling Depth (m) ……	250	3200	5000
Depth (m) of water (if applicable)……	10	75	150

Gas Fields:	minimum	median	maximum
Inert gas content (%)……			
CO_2 content (%)……			
Hydrogen-sulfide content (%)……			
Drilling Depth (m)……	800	3200	6000
Depth (m) of water (if applicable)……	10	75	150

Assessment Unit (name, no.)
Central Graben, 40250103

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

1. United Kingdom represents 38.1 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		50	
Portion of volume % that is offshore (0-100%).....		100	

Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		30	
Portion of volume % that is offshore (0-100%).....		100	

2. Norway represents 24.7 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		40	
Portion of volume % that is offshore (0-100%).....		100	

Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		30	
Portion of volume % that is offshore (0-100%).....		100	

3. Netherlands represents 22.5 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		6	
Portion of volume % that is offshore (0-100%).....		100	

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

4. Denmark represents 8.2 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		2	
Portion of volume % that is offshore (0-100%).....		100	

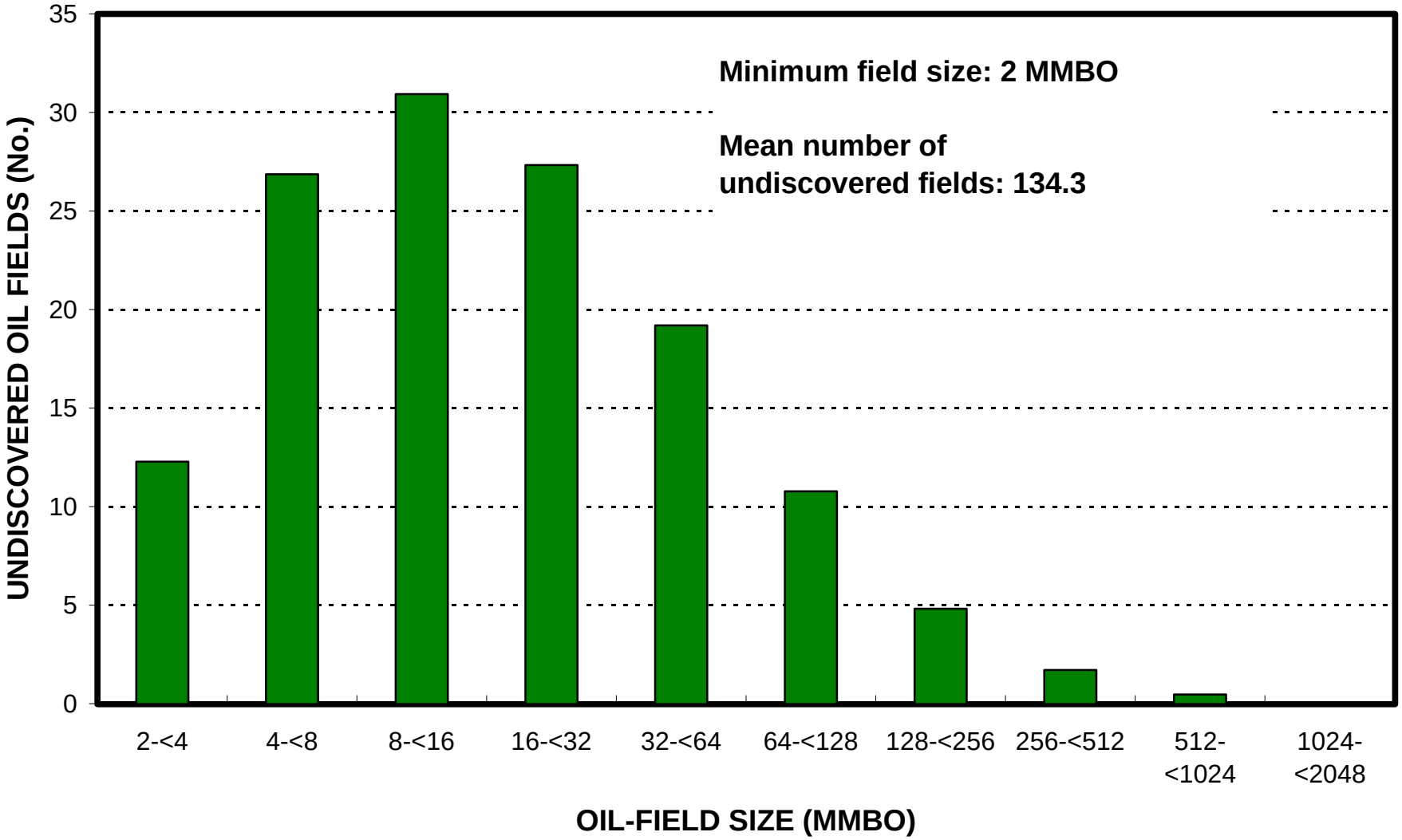
Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		7	
Portion of volume % that is offshore (0-100%).....		100	

5. Germany represents 6.5 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):……			
Volume % in parcel (areal % x richness factor):…		2	
Portion of volume % that is offshore (0-100%)……		100	

Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):……			
Volume % in parcel (areal % x richness factor):…		8	
Portion of volume % that is offshore (0-100%)……		100	

Central Graben, AU 40250103
Undiscovered Field-Size Distribution



Central Graben, AU 40250103
Undiscovered Field-Size Distribution