Go to Table of Contents

Go to index map

Subtle Traps
Assessment Unit 31440101

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Songliao Basin Geologic Province 3144

USGS PROVINCE: Songliao Basin (3144) **GEOLOGIST:** R.T. Ryder

TOTAL PETROLEUM SYSTEM: Qingshankou-Putaohua/Shaertu (314401)

ASSESSMENT UNIT: Subtle Traps (31440101)

DESCRIPTION: The assessment unit is characterized by oil and gas fields trapped primarily in small anticlines, combination structural/stratigraphic traps, and stratigraphic traps. Reservoirs consist of Lower Cretaceous lacustrine-deltaic and fluvial sandstone. Most fields are confined to a pod of active Lower Cretaceous source rocks that occupy the central part of the basin.

SOURCE ROCKS: Deep-water lacustrine shale and mudstone of Early Cretaceous age are the source rocks. The dominant source rock is the Qingshankou Formation (Aptian). The second most important source rock is the Nenjiang Formation (Member 1)(Albian). The thickness of the Qingshankou Formation source rock is more than 500 m whereas the thickness of the Nenjiang Formation (Member 1) source rock is about 27 to 222 m. Total organic carbon (TOC) of the Qingshankou and Nenjiang Formations ranges from about 1.5 to 8.4 percent.

MATURATION: The Qingshankou Formation reached peak maturity with respect to oil and gas generation in the Upper Cretaceous (upper Campanian; ~75 Ma). A high geothermal gradient (~45°C/km) and an additional 1000 m of uppermost Cretaceous rocks (now eroded) seem to be requirements for oil and gas generation in the basin. There is little evidence that immature oils have been generated at low vitrinite reflectance values (%Ro ~0.50-0.55).

MIGRATION: Oil and gas is confined largely to the pod of mature source rocks. Several fields outside the pod of mature source rocks indicate that lateral migration was limited to about 50 km. Local vertical migration of oil and gas probably occurred along normal faults in the Lower Cretaceous sequence but does not extend into uppermost Cretaceous and Tertiary rocks.

RESERVOIR ROCK: Reservoir rocks consist of very fine to fine-grained sandstone deposited in fluvial and deltaic systems on the margins of a large basin-centered lake. Typically, the reservoir sandstones are arkosic arenites. Six reservoirs of Early Cretaceous age are recognized in this assessment unit. In ascending order, they are the Yangdachengzi, Fuyu, Gaotaizi, Putaohua, Shaertu, and Heidimiao. These broadly defined reservoirs or pay zones are 200- to 500-m-thick, sandstone-bearing intervals that coincide with one or more formal stratigraphic unit(s). The Putaohua and Shaertu reservoirs are the primary reservoirs. The majority of the sandstone bodies in the six reservoirs are products of a fluvial-deltaic depositional system located at the north end of the basin.

TRAPS AND SEALS: The major traps are small anticlines formed by compaction over extensional fault blocks or by a Late Cretaceous to early Tertiary compressional event that led to partial structural inversion of the rift basin. Also important are anticlinal noses in combination with pinchouts of nearshore lacustrine and fluvial sandstone. Stratigraphic-trap fields (facies-change, paleotopographic, diagenetic, and unconformity varieties) are of secondary importance in comparison to structural-trap fields. The regional seal rock consists of widespread lacustrine

black shale and mudstone of Members 1 and 2 of the Nenjiang Formation and Member 1 and parts of Members 2 and 3 of the Qingshankou Formation.

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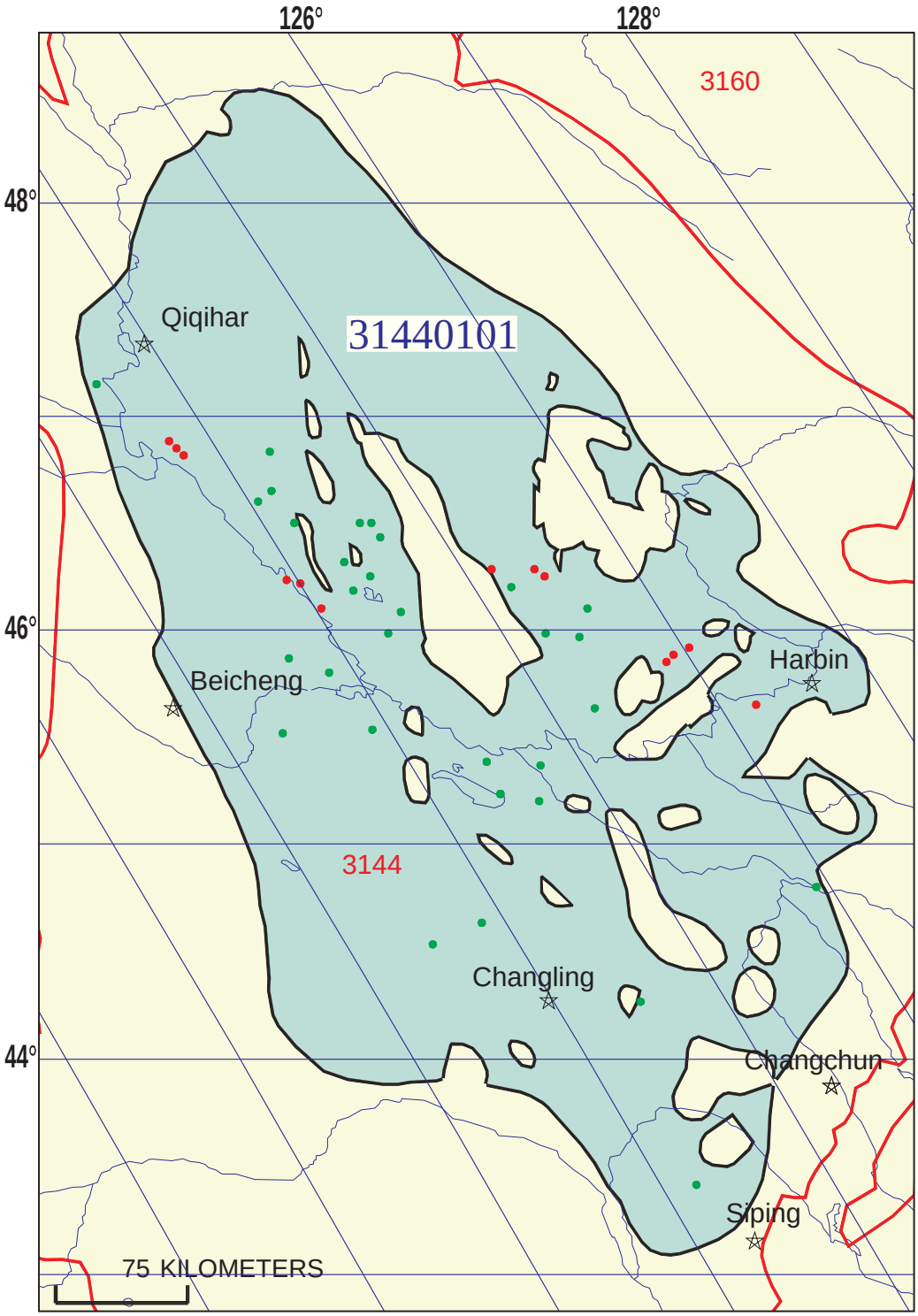

Subtle Traps
Assessment Unit - 31440101

EXPLANATION

- Hydrography
- Shoreline
- 3144 Geologic province code and boundary
- Country boundary
- Gas field centerpoint
- Oil field centerpoint
- 31440101 Assessment unit code and boundary

Projection: Robinson. Central meridian: 0

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

Date:……..	11/20/98		
Assessment Geologist:……..	R.T. Ryder		
Region:……..	Asia Pacific	Number:	3
Province:……..	Songliao Basin	Number:	3144
Priority or Boutique……	Priority		
Total Petroleum System:……	Qingshankou-Putaohua/Shaertu	Number:	314401
Assessment Unit:……..	Subtle Traps	Number:	31440101
* Notes from Assessor			

CHARACTERISTICS OF ASSESSMENT UNIT

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

What is the minimum field size?……. 5 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: 29 Gas: 8

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

Median size (grown) of discovered oil fields (mmboe):

1st 3rd	2nd 3rd	3rd 3rd
15.7	37.7	43.1

Median size (grown) of discovered gas fields (bcfg):

1st 3rd	2nd 3rd	3rd 3rd
62.1	43	

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)	10	median no.	30	max no.	50
Gas fields:……min. no. (>0)	5	median no.	20	max no.	50

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	5	median size	20	max. size	150
Gas in gas fields (bcfg):……..	min. size	30	median size	60	max. size	400

Assessment Unit (name, no.)
Subtle Traps, 31440101

AVERAGE RATIOS FOR UNDISCOVERED FIELDS, TO ASSESS COPRODUCTS

(uncertainty of fixed but unknown values)

Oil Fields:	minimum	median	maximum
Gas/oil ratio (cfg/bo)……	165	330	500
NGL/gas ratio (bngl/mmcfg)……	30	60	90

Gas fields:	minimum	median	maximum
Liquids/gas ratio (bngl/mmcfg)……	22	44	66
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)……	22	34	45
Sulfur content of oil (%)……	0.05	0.2	0.36
Drilling Depth (m) ……	300	1500	2800
Depth (m) of water (if applicable)……			

Gas Fields:	minimum	median	maximum
Inert gas content (%)……			
CO_2 content (%)……			
Hydrogen-sulfide content (%)……			
Drilling Depth (m)……	300	1500	2800
Depth (m) of water (if applicable)……			

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Subtle Traps,31440101

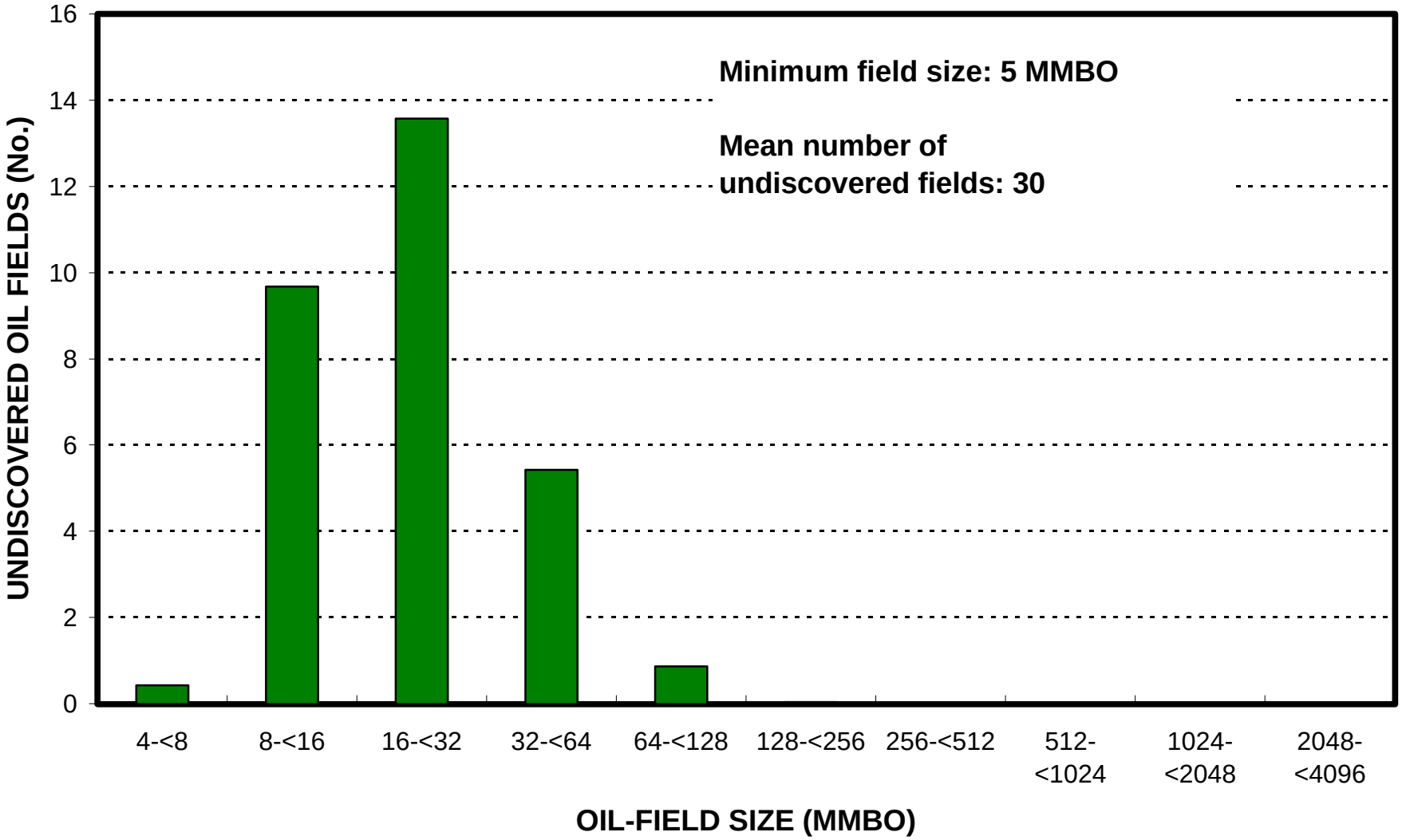
ALLOCATION OF UNDISCOVERED RESOURCES IN THE ASSESSMENT UNIT TO COUNTRIES OR OTHER LAND PARCELS (uncertainty of fixed but unknown values)

1. China represents 100 areal % of the total assessment unit

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

Subtle Traps, AU 31440101
Undiscovered Field-Size Distribution



Subtle Traps, AU 31440101
Undiscovered Field-Size Distribution