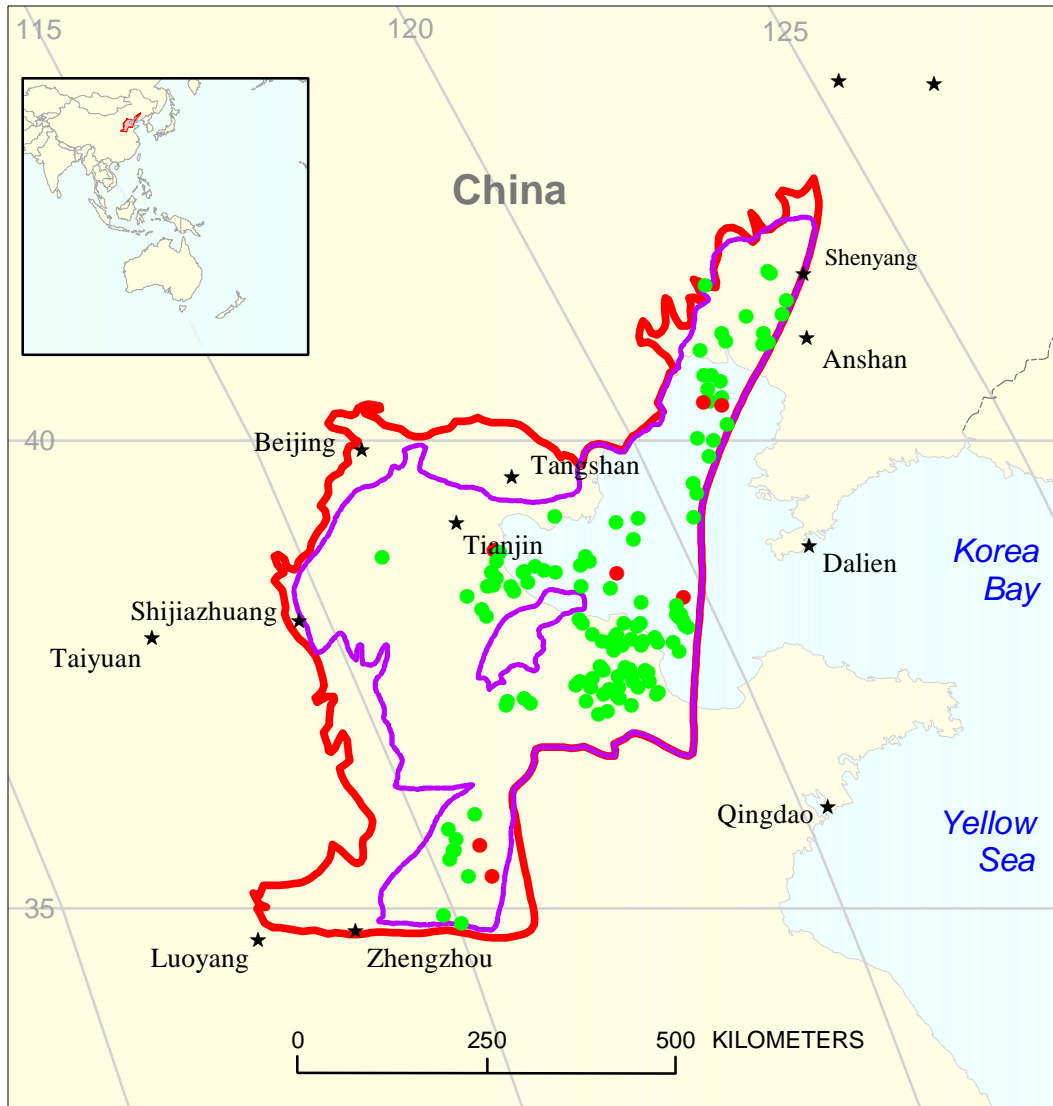




Tertiary Lacustrine Assessment Unit 31270101



-  Tertiary Lacustrine Assessment Unit 31270101
-  Bohaiwan Basin Geologic Province 3127

USGS PROVINCE: Bohaiwan Basin (3127)

GEOLOGIST: R.T. Ryder

TOTAL PETROLEUM SYSTEM: Shahejie-Shahejie/Guantao/Wumishan (312701)

ASSESSMENT UNIT: Tertiary Lacustrine (31270101)

DESCRIPTION: The assessment unit is characterized by oil and gas fields trapped in anticlines, fault blocks, and a variety of stratigraphic traps. Reservoirs consist of Tertiary lacustrine and fluvial sandstone. The fields are confined to six major sub-basins of extensional origin (Bozhong, Huanghua, Liaohe, Linqing/Dongpu, Jiyang, Jizhong), each having one or more pod(s) of active Eocene source rocks. The Bozhong sub-basin is located in offshore Bohai Bay whereas the Jizhong, Linqing/Dongpu, and most of the Jiyang sub-basins are located onshore. The Huanghua and Liaohe sub-basins have large offshore parts. The giant Shengli field complex is located in the Jiyang sub-basin.

SOURCE ROCKS: Source rocks are deep-water lacustrine shale and mudstone of Eocene and Oligocene age. The dominant source rock is the upper Eocene part of the Shahejie Formation (Member 3). Additional source rocks are the lower Eocene part of the Shahejie Formation (Member 4), Oligocene part of Shahejie Formation (Member 1), and Eocene Kongdian Formation (Member 2). The thickness of Member 3 of the Shahejie Formation in each sub-basin is approximately 1,000 m and its total organic carbon (TOC) values range from about 1 to 4.5.

MATURATION: The Shahejie Formation (Member 3) has been mature with respect to oil generation since about the middle Oligocene/early Miocene. Member 3 is largely immature with respect to gas generation. In contrast, the Shahejie (Member 4) and Kongdian (Member 2) Formations have been mature with respect to gas generation since about the middle Miocene. The Shahejie Formation (Member 1) is immature with respect to oil and gas generation in most sub-basins. A relatively high geothermal gradient of about 32 to 36°C/km accompanied oil and gas generation. Some heavy oil (<22° API) in the assessment unit may be immature oil that was generated at vitrinite reflectance (%Ro) values of about 0.50 to 0.55.

MIGRATION: Only very local lateral migration of oil and gas occurred in the sub-basins and it was confined to the pods of mature source rocks. However, approximately 1,000 to 2,000 m of vertical migration along normal faults is required in several sub-basins (Bozhong, Huanghua, Jiyang) to transfer hydrocarbons derived from Eocene source rocks into structurally higher Neogene sandstone reservoirs.

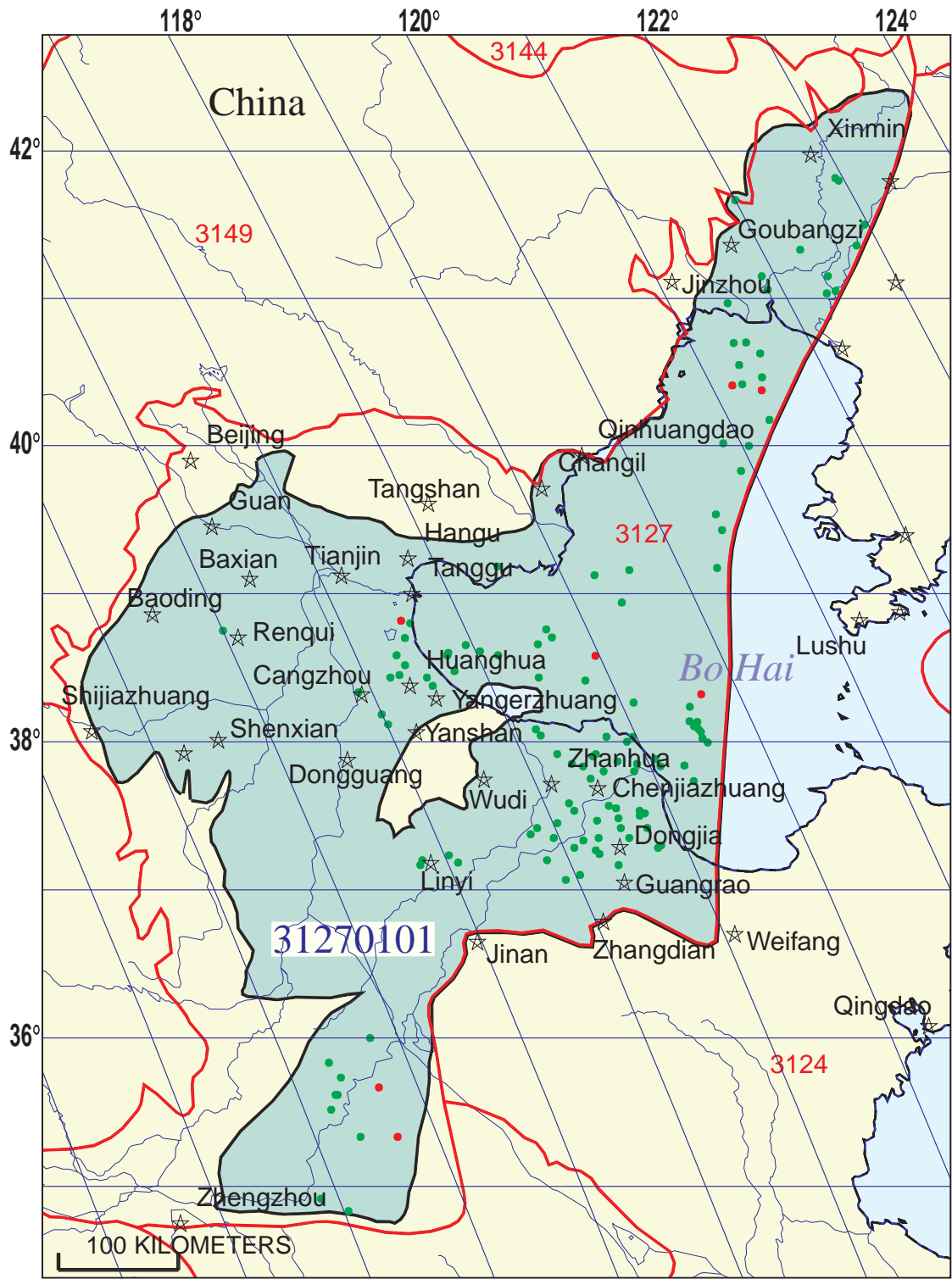
RESERVOIR ROCK: Reservoir rocks are deep-water lacustrine turbidite, lacustrine deltaic, and fluvial sandstone units of Tertiary age. These sandstone reservoirs occupy the Eocene part of the Shahejie Formation (Members 2, 3), Oligocene Dongying Formation, Miocene Guantao Formation, and Miocene/Pliocene Minghuazhen Formation. Typically, the reservoir sandstones are feldspathic arenites.

TRAPS AND SEALS: The major traps are rollover and compaction anticlines and fault blocks of extensional origin. Stratigraphic traps (lithologic, onlap, and unconformity varieties) account for about 25 percent of the traps. Regional seals consist of the upper parts of the Dongying and

Guantao Formations and Member 3 of the Shahejie Formation. Many local seals exist throughout the Eocene and Oligocene lacustrine sequence.

REFERENCES:

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Tertiary Lacustrine Assessment Unit - 31270101

EXPLANATION

- Hydrography
- Shoreline
- 3127 Geologic province code and boundary
- - - Country boundary
- Gas field centerpoint
- Oil field centerpoint
- 31270101 — Assessment unit code and boundary

Projection: Robinson. Central meridian: 0

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

Date:.....	<u>4/27/99</u>		
Assessment Geologist:.....	<u>R.T. Ryder</u>		
Region:.....	<u>Asia Pacific</u>	Number:	<u>3</u>
Province:.....	<u>Bohaiwan Basin</u>	Number:	<u>3127</u>
Priority or Boutique:.....	<u>Priority</u>		
Total Petroleum System:.....	<u>Shahejie-Shahejie/Guantao/Wumishan</u>	Number:	<u>312701</u>
Assessment Unit:.....	<u>Tertiary Lacustrine</u>	Number:	<u>31270101</u>
* Notes from Assessor	<u>MMS growth factor.</u>		

CHARACTERISTICS OF ASSESSMENT UNIT

Oil (<20,000 cfg/bo overall) or Gas (\geq 20,000 cfg/bo overall):... Oil

What is the minimum field size?..... 5 mmboe grown (\geq 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:	<u>104</u>	Gas:	<u>6</u>
Established (>13 fields) <u>X</u>	Frontier (1-13 fields)	<u> </u>	Hypothetical (no fields)	<u> </u>

Median size (grown) of discovered oil fields (mmboe):			
1st 3rd <u>84</u>	2nd 3rd <u>58</u>	3rd 3rd <u>23</u>	
Median size (grown) of discovered gas fields (bcfg):			
1st 3rd <u>231.8</u>	2nd 3rd <u>71.8</u>	3rd 3rd <u> </u>	

Assessment-Unit Probabilities:

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

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

4. ACCESSIBILITY: Adequate location to allow exploration for an undiscovered field \geq minimum size.....	<u>1.0</u>
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UNDISCOVERED FIELDS

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

Oil fields:.....min. no. (>0)	<u>15</u>	median no.	<u>60</u>	max no.	<u>160</u>
Gas fields:.....min. no. (>0)	<u>5</u>	median no.	<u>22</u>	max no.	<u>60</u>

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	<u>5</u>	median size	<u>18</u>	max. size	<u>750</u>
Gas in gas fields (bcfg):.....min. size	<u>30</u>	median size	<u>80</u>	max. size	<u>3000</u>

AVERAGE RATIOS FOR UNDISCOVERED FIELDS, TO ASSESS COPRODUCTS

(uncertainty of fixed but unknown values)

<u>Oil Fields:</u>	minimum	median	maximum
Gas/oil ratio (cfg/bo).....	250	500	750
NGL/gas ratio (bnl/mmcf).....	30	60	90
<u>Gas fields:</u>	minimum	median	maximum
Liquids/gas ratio (bnl/mmcf).....	22	44	66
Oil/gas ratio (bo/mmcf).....			

SELECTED ANCILLARY DATA FOR UNDISCOVERED FIELDS

(variations in the properties of undiscovered fields)

<u>Oil Fields:</u>	minimum	median	maximum
API gravity (degrees).....	15	36	50
Sulfur content of oil (%).....	0.05	0.5	3
Drilling Depth (m)	1000	2500	4500
Depth (m) of water (if applicable).....	0	20	40
<u>Gas Fields:</u>	minimum	median	maximum
Inert gas content (%).....	0.5	2.5	5
CO ₂ content (%).....	0.1	0.5	2
Hydrogen-sulfide content (%).....	0	0.05	5
Drilling Depth (m).....	2000	4000	7000
Depth (m) of water (if applicable).....	0	20	40

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

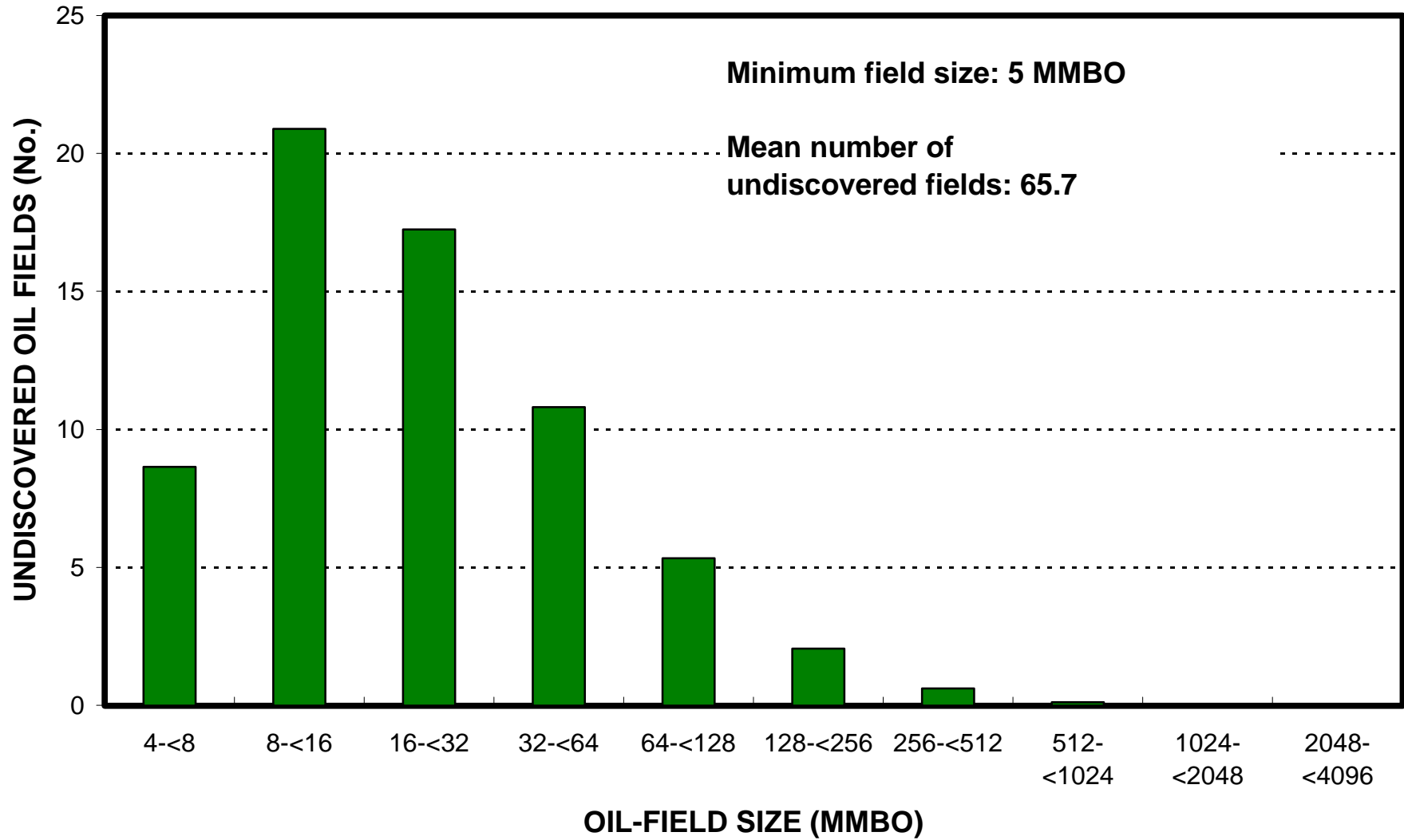
* 27% of assessment unit is offshore

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

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

Tertiary Lacustrine, AU 31270101

Undiscovered Field-Size Distribution



Tertiary Lacustrine, AU 31270101

Undiscovered Field-Size Distribution

