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Southeastern Fold Belt
Assessment Unit 31420101

Southeastern Fold Belt Assessment Unit 31420101

Sichuan Basin Geologic Province 3142

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USGS PROVINCE: Sichuan Basin (3142) **GEOLOGIST:** R.T. Ryder

TOTAL PETROLEUM SYSTEM: Maokou/Longtang-Jialingjiang/Maokou/Huanglong (314201)

ASSESSMENT UNIT: Southeastern Fold Belt (31420101)

DESCRIPTION: The assessment unit is characterized by structurally controlled gas fields in Carboniferous, Permian, and Triassic marine shelf carbonate reservoirs in the southeastern fold belt of the basin. The gas was derived from a deeply buried pod of mature Permian source rocks that extends across the entire basin. Most gas accumulations are overpressured.

SOURCE ROCKS: The dominant source rocks are oil-prone marine argillaceous limestone with black shale of the Lower Permian Maokou Formation and gas-prone coal beds of the Upper Permian Longtang Formation. The source rock sequence of the Maokou Formation is located in the lower one-third of the formation and is about 50 to 75 m thick. Total organic carbon (TOC) values for the Maokou Formation source rocks range from 0.3 to 1.8 percent and average about 1 percent. The net thickness of coal beds in the Longtang Formation ranges from about 2 to 5 m.

MATURATION: The source rocks have been mature with respect to oil generation since about Middle Jurassic time and mature with respect to gas generation since about Early Cretaceous time. The absence of oil in the assessment unit suggests that it has been thermally converted to gas. An absence of oil is consistent with the 1.5 to 2 vitrinite reflectance values for Permian coal beds in the southeastern fold belt. Approximately 1 to 3 km of uplift and erosion has occurred in the Sichuan basin since the early Paleogene. A geothermal gradient of about 20 to 25°C/km probably accompanied oil and gas generation.

MIGRATION: Because of an absence of carrier beds, most oil and gas that was generated in the Middle Jurassic to Early Cretaceous remained in the source rock until widespread folding and tectonic fracturing occurred during Late Cretacous (Yenshanian) to early Cenozoic (Himilayan) compression. After this fracturing event, gas either remained in place or migrated vertically as much as 1,500 m from the mature Permian source rocks into core and crestal regions of faulted detachment anticlines. Oil had converted to gas before significant migration occurred.

RESERVOIR ROCK: Primary reservoir rocks consist of limestone and dolomite of Carboniferous (Huanglong Formation), Early Permian (Maokou and Qixia Formations), Late Permian (Changxing Formation), Early Triassic (Jialingjiang Formation), and Middle Triassic (Leikoupo Formation) age. Reservoir quality is generally poor (porosity of 4 to 8 percent and permeability of ~0.1 mD) and, thus, usually tectonic fractures are required to improve gas deliverability. Also, reservoir quality is improved by caverns and solution-enhanced fractures formed by circulating groundwater during periods of subaerial exposure of the shelf and (or) post-orogenic uplift. The best reservoirs (porosity of 10 to 15 percent and permeability of several tens of millidarcies) consist of grainstone, patch reefs (bioherms), and vuggy dolomite.

TRAPS AND SEALS: The major traps are large faulted anticlines of thin-skin decollement origin. Combination anticlinal-stratigraphic traps (unconformity and facies-change varieties)

may provide additional entrapment. Lower and Middle Triassic evaporite, Lower Triassic marine red mudstone, and Middle and Upper Jurassic nonmarine red mudstone provide the best regional seals.

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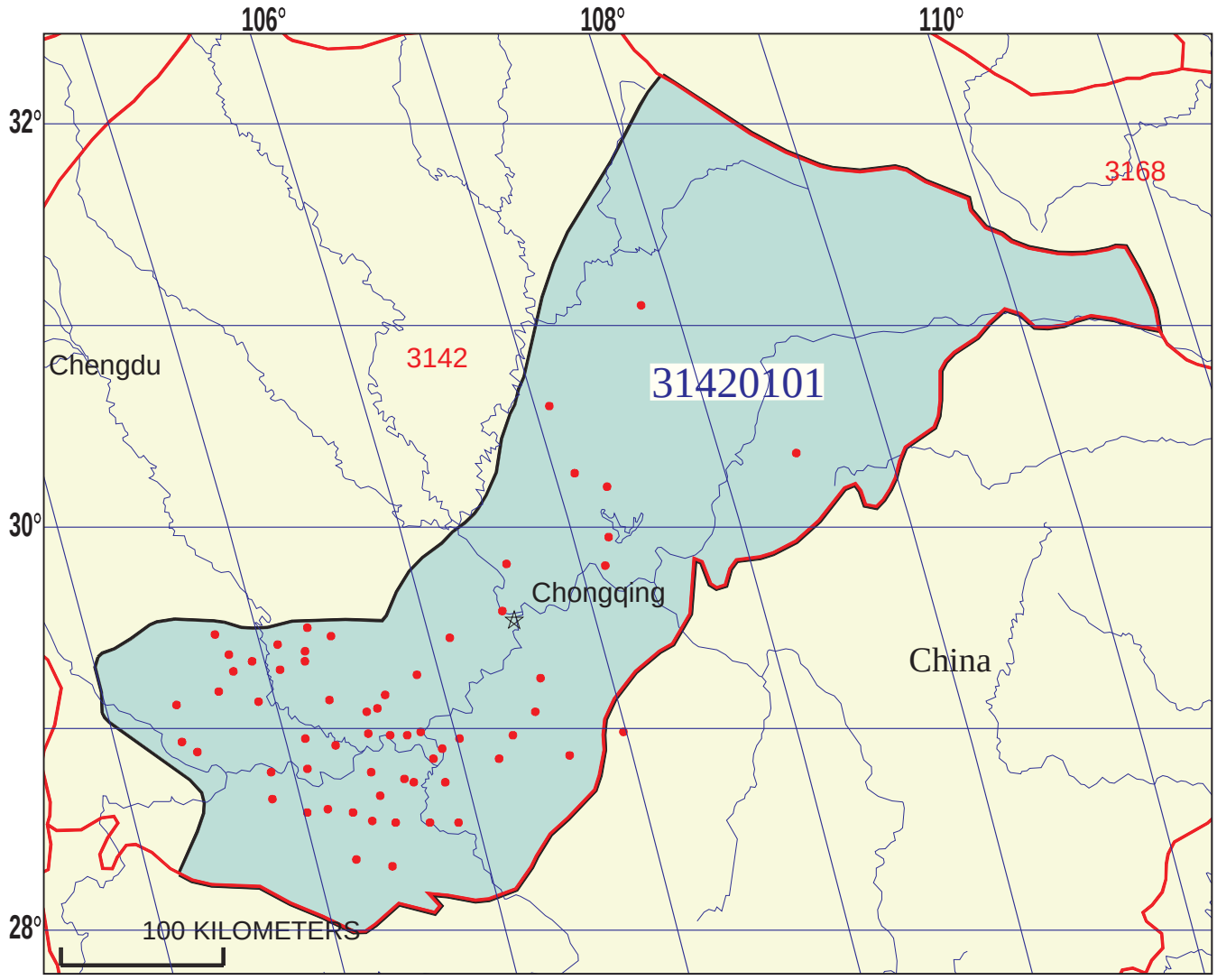

Southeastern Fold Belt
Assessment Unit - 31420101

EXPLANATION

- Hydrography
- Shoreline
- 3142 Geologic province code and boundary
- Country boundary
- Gas field centerpoint
- Oil field centerpoint
- 31420101 Assessment unit code and boundary

Projection: Robinson. Central meridian: 0

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

Date:……..	12/16/99		
Assessment Geologist:……..	R.T. Ryder		
Region:……..	Asia Pacific	Number:	3
Province:……..	Sichuan Basin	Number:	3142
Priority or Boutique……	Boutique		
Total Petroleum System:……	Maokou/Longtang-Jialingjiang/Maokou/Huanglong	Number:	314201
Assessment Unit:……..	Southeastern Fold Belt	Number:	31420101
* Notes from Assessor	MMS growth function. Fields discovered after 1982 may be under-represented in the database. Additional 33 pools containing approximately 3 TCFG had been discovered.		

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: 0 Gas: 57

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

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

Median size (grown) of discovered gas fields (bcfg):
1st 3rd 151 2nd 3rd 64 3rd 3rd 57

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)	_____	median no.	_____	max no.	_____
Gas fields:……min. no. (>0)	5	median no.	70	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	_____	median size	_____	max. size	_____
Gas in gas fields (bcfg):……min. size	6	median size	30	max. size	1500

Assessment Unit (name, no.)
Southeastern Fold Belt, 31420101

AVERAGE RATIOS FOR UNDISCOVERED FIELDS, TO ASSESS COPRODUCTS

(uncertainty of fixed but unknown values)

Oil Fields:	minimum	median	maximum
Gas/oil ratio (cfg/bo)……			
NGL/gas ratio (bngl/mmcfg)……			

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)……			
Sulfur content of oil (%)……			
Drilling Depth (m) ……			
Depth (m) of water (if applicable)……			

Gas Fields:	minimum	median	maximum
Inert gas content (%)……	0.01	1	4.5
CO_2 content (%)……	0.01	0.6	10
Hydrogen-sulfide content (%)……	0.01	0.5	5
Drilling Depth (m)……	1500	3000	5300
Depth (m) of water (if applicable)……			

Assessment Unit (name, no.)
Southeastern Fold Belt, 31420101

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):…			
Portion of volume % that is offshore (0-100%)……			

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	

Southeastern Fold Belt, AU 31420101
Undiscovered Field-Size Distribution