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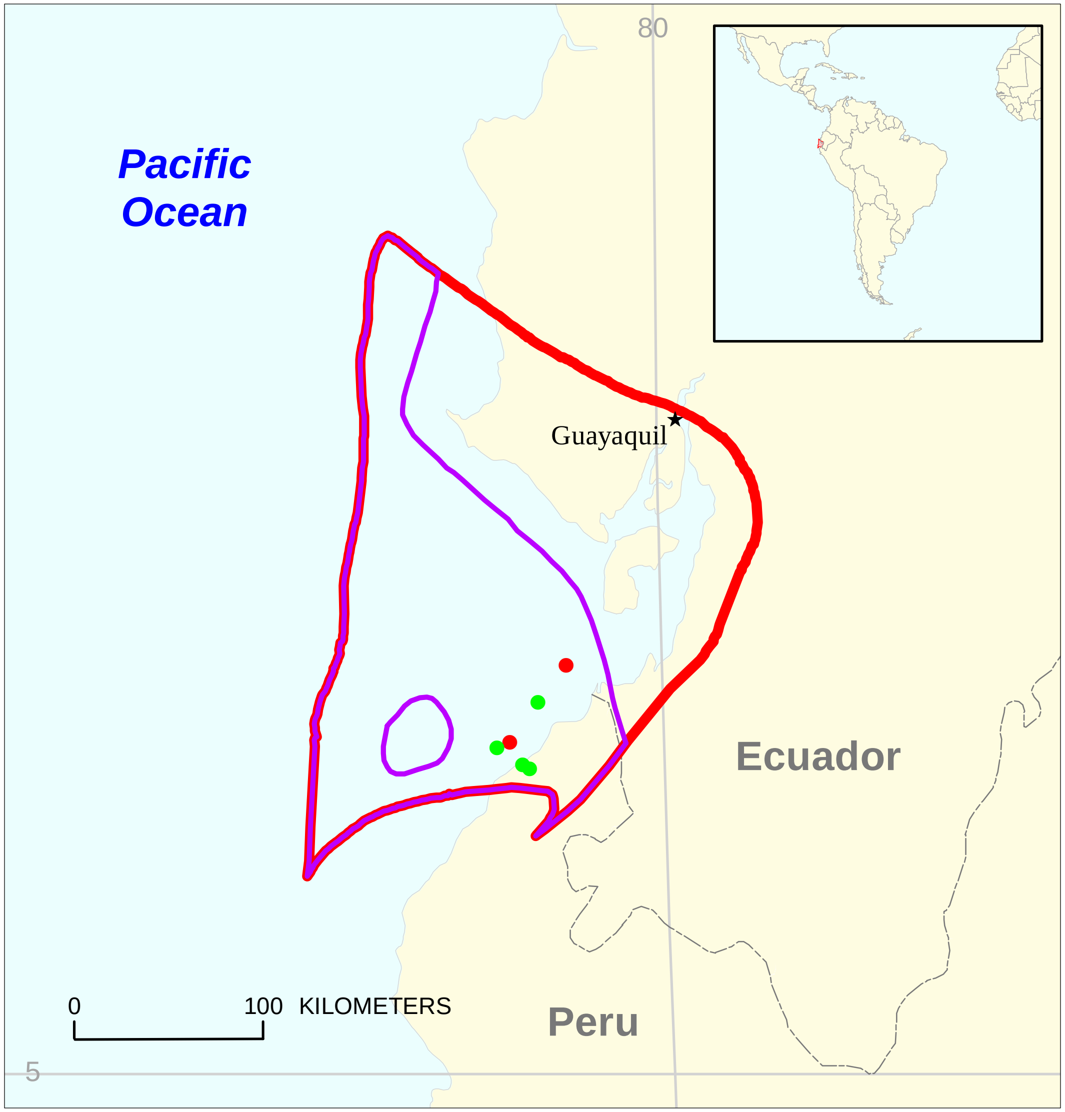
Neogene Pull-Apart Basin Assessment Unit 60830101



Neogene Pull-Apart Basin Assessment Unit 60830101

Progreso Basin Geologic Province 6083

Geologic Summary

Detailed map of this assessment unit

Assessment Input Data

Assessment Results

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

U.S. GEOLOGICAL SURVEY WORLD PETROLEUM ASSESSMENT 2000— DESCRIPTION AND RESULTS
U.S. Geological Survey World Energy Assessment Team

USGS PROVINCE: Progreso Basin (6083) **GEOLOGIST:** D.K. Higley

TOTAL PETROLEUM SYSTEM: Neogene (608301)

ASSESSMENT UNIT: Neogene Pull-Apart Basin (60830101)

DESCRIPTION: The Progreso-Tumbes-Santa Elena Basin is located along the coast of northern Peru and southern Ecuador. The basin is divided from north to south into the Paleogene Santa Elena sub-basin, and the Neogene Progreso and Tumbes sub-basins. The Peru Bank is part of the Cretaceous-Paleogene assessment unit. Progreso-Tumbes has been described as a pull-apart sub-basin. Oil and gas production from this Neogene assessment unit is primarily from Miocene-age sandstones in the Tumbes sub-basin. Travis and others (1975) estimate offshore-undiscovered resources of 335 MMBO for this Neogene assessment unit. While they were not assessed as part of this study, offshore Ecuador and Peru exhibit excellent potential for gas hydrate resources (Miller and others, 1991).

SOURCE ROCKS: The probable hydrocarbon source rocks are marine shales that are interbedded and overlie the reservoir intervals. No source rock geochemical studies have been published regarding which marine shales may have sourced oil and gas across this basin. Probable source rocks in the Progreso-Tumbes sub-basin are upper Oligocene to possibly early Miocene Heath Formation and the Miocene-age Cardalitos Formation (Zuniga-Rivero and others, 1998).

MATURATION: Paleozoic through Tertiary source rocks across Colombia, Ecuador, and Peru became thermally mature for oil generation during Neogene phases of basin development (Pindell and Tabbutt, 1995). Miocene and younger is the probable timing of source rock maturation for Tertiary and older reservoirs across the basin (Jaillard and others, 1995; Pindell and Tabbutt, 1995).

MIGRATION: Probable onset of migration is mid-Miocene time, after the opening of the Gulf of Guayaquil by movement along the Dolores-Guayaquil megashear and creation of the Progeso-Tumbes sub-basin. Close association of potential source and reservoir rocks suggests that emplacement of oil in reservoirs could have begun soon after the start of hydrocarbon generation.

RESERVOIR ROCKS: Primary oil and gas reservoirs of the Progreso-Tumbes sub-basin are marine sandstones of the Miocene-age Zorritos and Subibaja Formations, and the upper Oligocene to possibly early Miocene Heath Formation. Thickness range of the sedimentary section in the Tumbes basin is 6,000 to 12,000 m (20,000 to 40,000 ft), increasing seaward (AIPC, no date).

TRAPS AND SEALS: While the Progreso-Tumbes-Santa Elena Basin has been characterized as a forearc basin, it lies seaward of the Coastal range, which has been identified as a “trench-slope break” or “outer-arc ridge” environment; Kingston (1994) indicates a closer basin configuration might be named trench-slope basin. Evidence for growth faulting in the Progresso Basin is mostly in lower Miocene, Oligocene, Eocene, and Paleocene formations on top of the metamorphosed Pennsylvanian Amotape and Precambrian basement rocks (AIPC, no date). Some of the tectonic events that influenced hydrocarbon generation, migration, and trap formation are listed below:

1. Early-middle Eocene boundary–New fore-arc basins were created. This is attributed to collision of coastal Ecuador with the Andean margin.
2. Eocene–Inca Orogeny–This is the period of erosion of the Cretaceous section in Progreso and Tumbes that involves right-lateral and rotational movement associated with the Dolores-Guayaquil megashear and possibly the Troncho Mocho wrench fault. This Eocene event resulted in emergence of the southern coastline of Ecuador (Santa Elena peninsula) (Jaillard and others, 1995)
3. Upper Oligocene-Miocene time–Separation of the Nazca Plate from the South American Plate with active subduction at the Peru-Chile trench and creation of the Neogene (Tumbes, Progreso) fore-arc basins (Jaillard and others, 1995) and deposition of the thick Miocene section.
4. Middle Miocene–Block faulting across the Progreso and Talara basins and renewed growth of the Andes Mountains.
5. Mid-Pliocene–Horst and graben, gravity and basement-involved faulting, mostly in the Tumbes sub-basin (AIPC, no date).

Overlying and interbedded marine shales are the major reservoir seals, both for shallow and deepwater deposits. Lateral seals are (primarily normal) fault offsets, and lateral depositional or erosional pinchout of the mostly marine sandstones into shales. Sediment sources are mainly from the east, northeast, and southeast (Petroperu, 1999; Pindell and Tabbutt, 1995), depositional patterns associated with these fluvial, shoreline, turbidite, marine and other facies strongly influence types and locations of seals.

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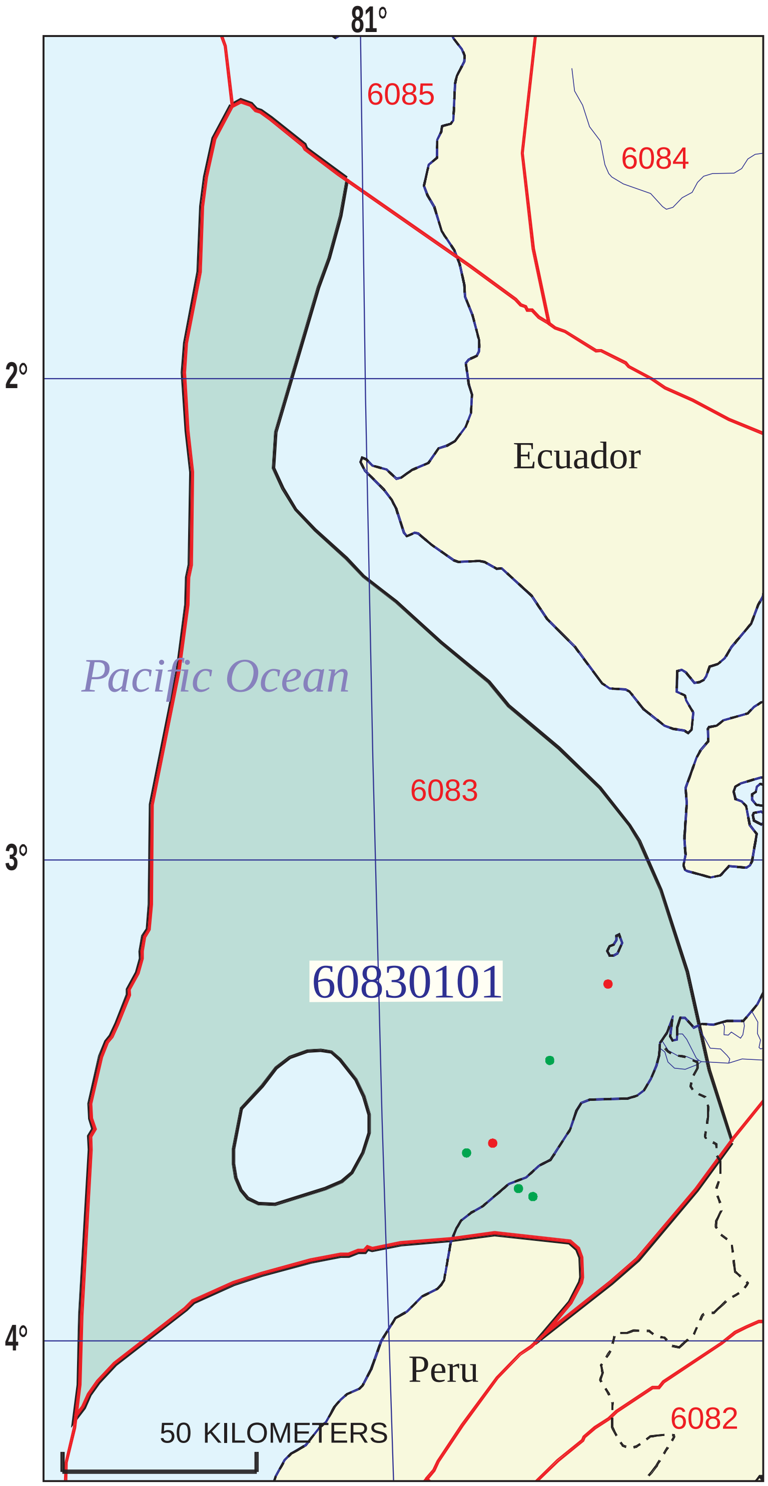

Neogene Pull-Apart Basin Assessment Unit - 60830101

EXPLANATION

Hydrography
Shoreline
6083 Geologic province code and boundary
Country boundary
Gas field centerpoint
Oil field centerpoint

60830101 Assessment unit code and boundary

Projection: Robinson. Central meridian: 0

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

Date:………………………….	12/17/99		
Assessment Geologist:……..	D.K. Higley		
Region:………………………..	Central and South America	Number:	6
Province:………………………	Progreso Basin	Number:	6083
Priority or Boutique………….	Boutique		
Total Petroleum System:……	Neogene	Number:	608301
Assessment Unit:……………	Neogene Pull-Apart Basin	Number:	60830101
* 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?………. 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: 1 Gas: 2
Established (>13 fields) ______ Frontier (1-13 fields) X Hypothetical (no fields) ______

Median size (grown) of discovered oil fields (mmboe):
1st 3rd 4 2nd 3rd ______ 3rd 3rd ______
Median size (grown) of discovered gas fields (bcfg):
1st 3rd 348 2nd 3rd 57 3rd 3rd ______

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)	1	median no.	5	max no.	14
Gas fields:………………………………min. no. (>0)	1	median no.	10	max no.	30

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	3	max. size	200
Gas in gas fields (bcfg):……………………min. size	6	median size	18	max. size	1200

Assessment Unit (name, no.)
Neogene Pull-Apart Basin, 60830101

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	600	1000
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)……………………………….	20	35	45
Sulfur content of oil (%)……………………...…..	0.05	0.26	0.5
Drilling Depth (m) ……………...…………………..	100	1200	3400
Depth (m) of water (if applicable)……………...….	0	200	1000

Gas Fields:	minimum	median	maximum
Inert gas content (%)……………………....……			
CO_2 content (%)……………………………….....…			
Hydrogen-sulfide content (%)……………...…….			
Drilling Depth (m)………………………………….	1500	2500	3500
Depth (m) of water (if applicable)………………….	0	200	1000

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

1. Peru represents 88 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):……………..…			
Volume % in parcel (areal % x richness factor):…		90	
Portion of volume % that is offshore (0-100%)……		85	

Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):……………..…			
Volume % in parcel (areal % x richness factor):…		90	
Portion of volume % that is offshore (0-100%)……		85	

2. Ecuador represents 12 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):……………..…			
Volume % in parcel (areal % x richness factor):…		10	
Portion of volume % that is offshore (0-100%)……		90	

Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):……………..…			
Volume % in parcel (areal % x richness factor):…		10	
Portion of volume % that is offshore (0-100%)……		90	

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Neogene Pull-Apart Basin, AU 60830101
Undiscovered Field-Size Distribution