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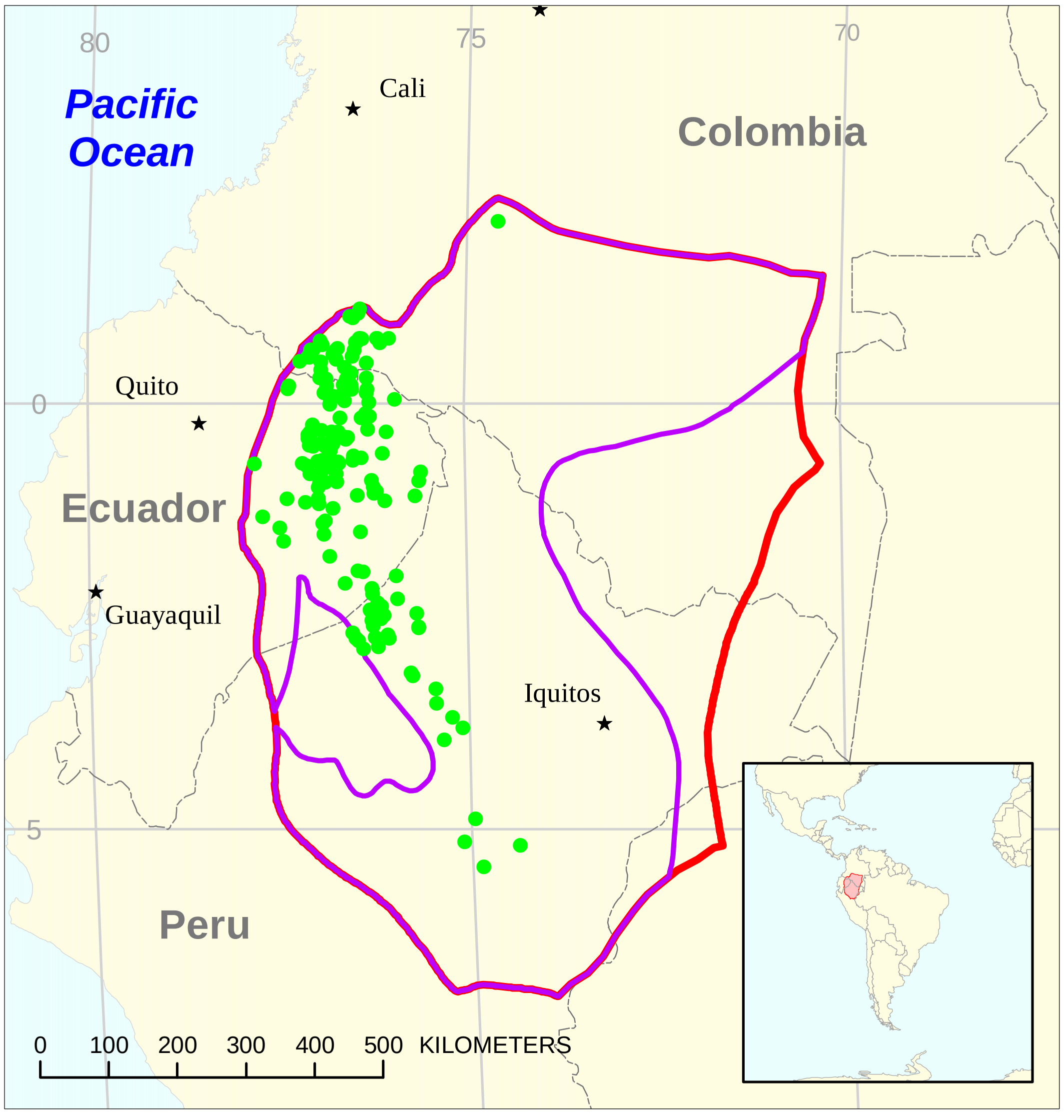
Hollin-Napo
Assessment Unit 60410101



Hollin-Napo Assessment Unit 60410101

Putumayo-Oriente-Maranon Basin Geologic Province 6041

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: Putumayo-Oriente-Maranon Basin (6041) **GEOLOGIST:** D.K. Higley

TOTAL PETROLEUM SYSTEM: Mesozoic-Cenozoic (604101)

ASSESSMENT UNIT: Hollin-Napo (60410101)

DESCRIPTION: All petroleum production from this province is from Cretaceous and minor Tertiary age reservoirs. Cretaceous shales are also the primary hydrocarbon source rocks.

SOURCE ROCKS: The major oil and gas source rocks in the province are Early through Late Cretaceous Shales of marine and mixed marine and terrestrial depositional environments. These are the Cretaceous (1) Caballos Formation and Villeta "U" Sandstone of the Putumayo Basin, (2) the Hollin and Napo Formations of the Oriente Basin, and (3) Raya and Chonta Shales of the Maranon Basin. The Triassic and Jurassic Pucara and Sarayaquillo Groups of the Maranon Basin also exhibit some potential as source rocks.

MATURATION: Primary time of source rock maturation is the regionally pervasive late Miocene-early Pliocene (Quechua III) event that is expressed by thrusting and compressional folding over most of sub-Andean Peru (Mathalone and Montoya, 1995). Across South America, source rock units as old as Ordovician and as young as Neogene (Miocene and Pliocene time) have become mature in the Neogene phase(s) of basin development (Pindell and Tabbutt, 1995). Marksteiner and Aleman (1996) believe the main phase for hydrocarbon generation and migration was from Late Cretaceous to Middle Eocene.

MIGRATION: Almost all of the current production is from within the zone of source rocks that are thermally mature for oil, suggesting that lateral migration is limited and that migration is primarily vertical or from bounding shales. Ramon (1996) believes that oil migration in the Putumayo Basin has primarily been stratigraphically updip, with only limited vertical migration through faults; reservoirs are laterally drained and vertically isolated. Oils are commonly biodegraded and (or) water-washed in reservoirs located near the eastern margin of the area of thermally mature source rocks.

RESERVOIR ROCKS: Primary reservoir intervals are the (1) Cretaceous Villeta Formation in the Putumayo Basin, with lesser amounts of oil in the Cretaceous Caballos and Tertiary Pepino Formations, (2) the 'U' and 'T' Sandstones of the Cretaceous Napo Formation in the Oriente Basin, with lesser production from the Tena Formation, and the 'M1' Sandstone of the Napo Formation, and (3) Cretaceous Agua Caliente, Chonta, and Vivian Formations in the Maranon Basin.

TRAPS AND SEALS: Existing fields in the Putumayo-Oriente-Maranon Basin largely produce structurally trapped oil. Most of the reservoirs in fluvio-deltaic and marine sandstones of the Hollin and Napo Formations are low-relief north-south oriented anticlines of two distinct types: (1) footwall anticlines associated with normal faults or (2) hanging wall anticlines associated with reverse faults (Dashwood and Abbotts, 1990). Stratigraphic traps are formed mainly by termination of porous and permeable fluvial or marine sandstone facies against lower-depositional-energy mudstone and mudstone-sandstone sequences. Reservoir seals are primarily interbedded marine shales and overlying Cretaceous and Tertiary Shales.

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Jordan, D., Wade, H.W., Schultz, D., Vavra, C., Reinoso, H., 1997, Transgressive deposits of the Hollin Formation, Oriente Basin, Ecuador: American Association of Petroleum Geologists and Society of Economic Paleontologists and Mineralogists, Annual Meeting Abstracts, 6th meeting notes, p. 57.

Marksteiner, R., and Aleman, A.M., 1996, Petroleum systems along the foldbelt associated to the Maranon-Oriente-Putumayo foreland basins: American Association of Petroleum Geologists Bulletin, v. 80, no. 8, p. 1,311.

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Pindell, J.L., and Tabbutt, K.D., 1995, Mesozoic-Cenozoic Andean paleogeography and regional controls on hydrocarbon systems, *in* Tankard, A.J., Suarez S., R., and Welsink, H.J., Petroleum basins of South America: American Association of Petroleum Geologists Memoir 62, p. 101-128.

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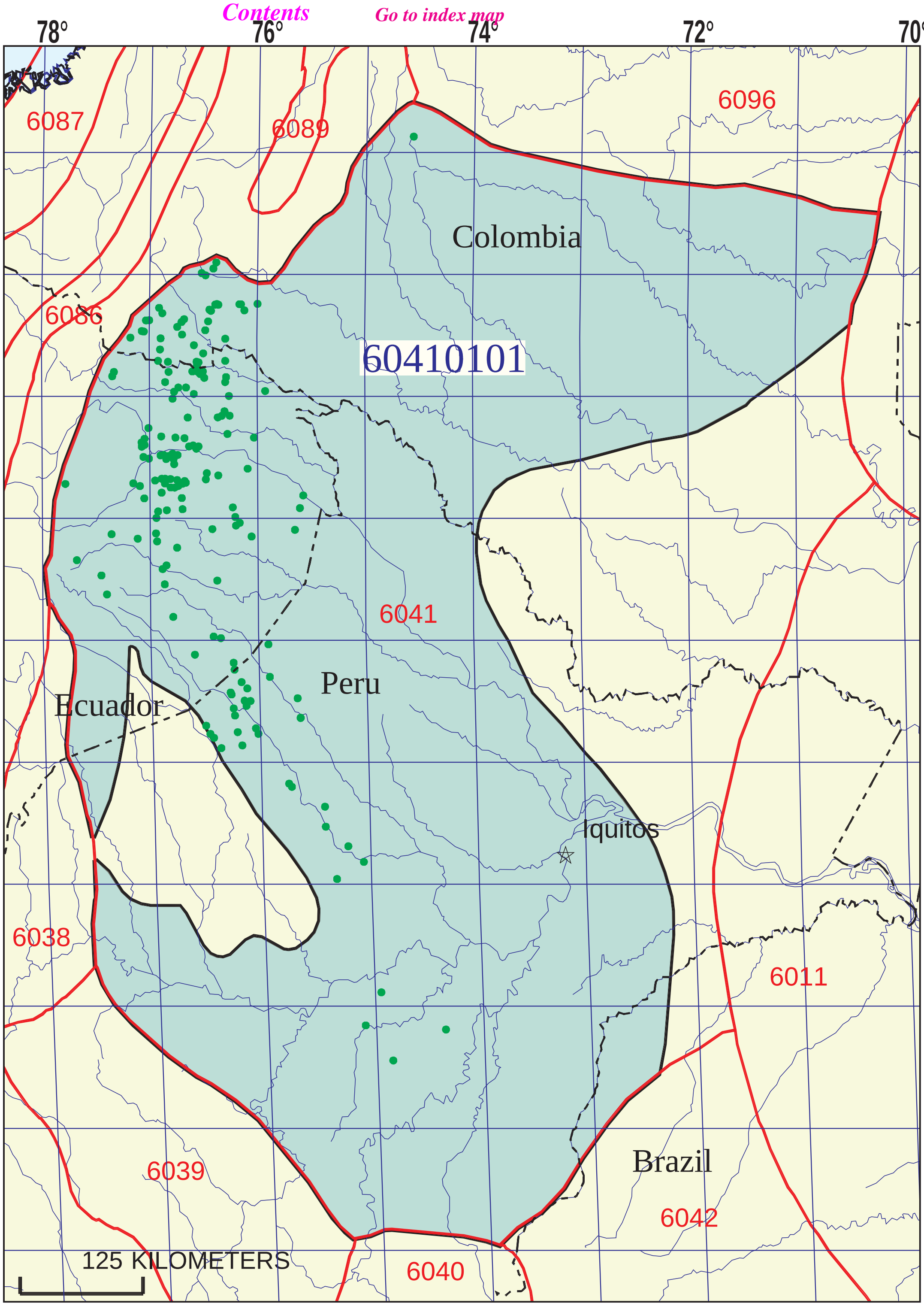
U.S. GEOLOGICAL SURVEY WORLD PETROLEUM ASSESSMENT 2000— DESCRIPTION AND RESULTS
U.S. Geological Survey World Energy Assessment Team



Hollin-Napo
Assessment Unit - 60410101

EXPLANATION

- Hydrography
- Shoreline
- 6041 Geologic province code and boundary
- Country boundary
- Gas field centerpoint
- Oil field centerpoint
- 60410101 Assessment unit code and boundary

Projection: Robinson. Central meridian: 0

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

Date:…………………………..	2/4/99		
Assessment Geologist:……..	D.K. Higley		
Region:………………………..	Central and South America	Number:	6
Province:………………………	Putumayo-Oriente-Maranon Basin	Number:	6041
Priority or Boutique………….	Priority		
Total Petroleum System:……	Mesozoic-Cenozoic	Number:	604101
Assessment Unit:……………	Hollin-Napo	Number:	60410101
* Notes from Assessor	Rocky Mountain Region growth factors.		

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: 131 Gas: 0
Established (>13 fields) X Frontier (1-13 fields) ______ Hypothetical (no fields) ______

Median size (grown) of discovered oil fields (mmboe):
1st 3rd 31.5 2nd 3rd 13.2 3rd 3rd 12.2
Median size (grown) of discovered gas fields (bcfg):
1st 3rd ______ 2nd 3rd ______ 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)

	min. no. (>0)	median no.	max no.
Oil fields:…………………………………	30	120	300
Gas fields:………………………………			

Size of Undiscovered Fields: What are the anticipated sizes (**grown**) of the above fields?:
(variations in the sizes of undiscovered fields)

	min. size	median size	max. size
Oil in oil fields (mmbo)………………..……	1	9	750
Gas in gas fields (bcfg):…………………..			

Assessment Unit (name, no.)
Hollin-Napo, 60410101

AVERAGE RATIOS FOR UNDISCOVERED FIELDS, TO ASSESS COPRODUCTS
(uncertainty of fixed but unknown values)

Oil Fields:	minimum	median	maximum
Gas/oil ratio (cfg/bo)…………………………...……….	125	250	375
NGL/gas ratio (bngl/mmcfg)……………………...….	10	20	30

Gas fields:	minimum	median	maximum
Liquids/gas ratio (bngl/mmcfg)……………….……..			
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)…………………….………….	8	24.3	46
Sulfur content of oil (%)…………………………...…..	0.03	0.61	3.05
Drilling Depth (m) ……………...…………….……..	900	3200	4900
Depth (m) of water (if applicable)……………...…….			

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

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Assessment Unit (name, no.)
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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. Colombia represents 31 areal % of the total assessment unit

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

2. Ecuador represents 15 areal % of the total assessment unit

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

3. Peru represents 54 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%)……		0	

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

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Undiscovered Field-Size Distribution