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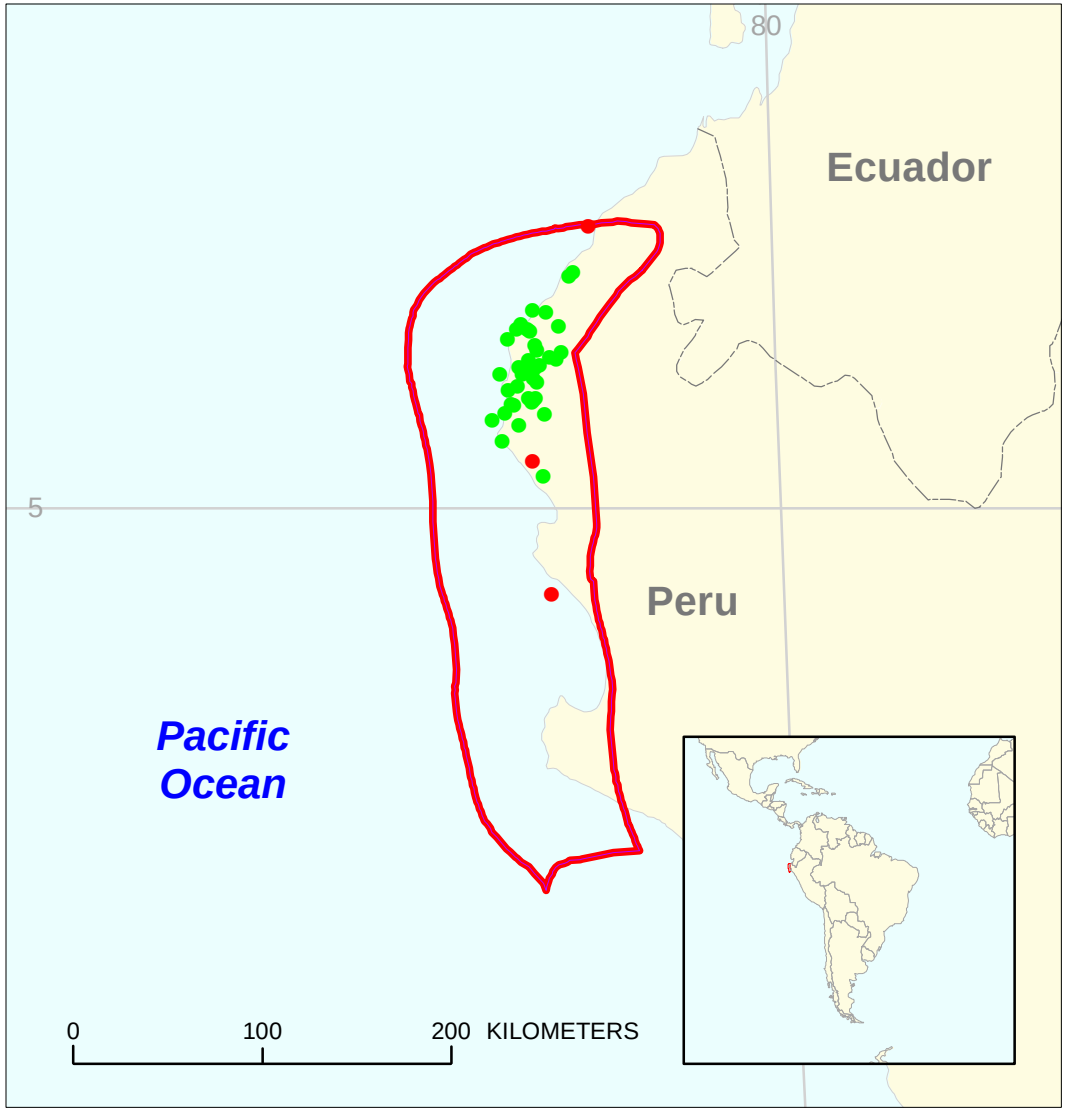
Cretaceous-Paleogene Basin Assessment Unit 60810101



Cretaceous-Paleogene Basin Assessment Unit 60810101

Talara Basin Geologic Province 6081

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: Talara Basin 6081 **GEOLOGIST:** D.K. Higley

TOTAL PETROLEUM SYSTEM: Cretaceous-Tertiary (608101)

ASSESSMENT UNIT: Cretaceous-Paleogene Basin (60810101)

DESCRIPTION: Although this basin has been characterized as a forearc basin, it lies seaward of the Coastal range and has been identified as a "trench-slope break" or "outer-arc ridge" environment; a better basin configuration may be trench-slope basin (Kingston, 1994; Zuniga-Rivero and others, 1999). Talara is a Paleogene age basin that is located along the northern coast of Peru and has produced more than 1.35 billion barrels of oil and 340 billion cubic feet of gas (Petroconsultants data through 1996). Perupetro (1999) indicates greater than 1.4 BBO have been recovered from more than 12,000 onshore wells; offshore wells have produced about 285 MMBO. Zuniga-Rivero and others (1998) listed a generalized estimated ultimate recovery (EUR) of more than 2 BBO or 25 TCF of gas for the offshore Talara Basin. Travis and others (1975) estimated offshore potential at 1 BBO; they did not believe that the onshore portion had significant potential for future discoveries. Kingston's (1994) offshore potential of 1.2 BBO and 1.4 TCFG was based on comparing the areas of productive onshore with the offshore area. The southernmost part of the onshore and offshore basin appears to be gas prone, but oil reserves could be present in unexplored areas (Zuniga-Rivero and others, 1999). While it is not assessed as part of this study, offshore Peru has excellent potential for gas hydrate resources (Miller and others, 1991).

SOURCE ROCKS: There are no published geochemical studies of potential hydrocarbon source rocks in the Talara Basin. Probable Cretaceous age hydrocarbon source rocks are the Albian Muerto Limestone and marine shales of the Campanian Redondo Formation (AIPC, no date; Perupetro, 1999; Zuniga-Rivero and others, 1998). These are also the probable main source rocks for oil and gas production from the Pennsylvanian Amotape Formation. This reservoir is mostly quartzite and any associated shales would probably be overmature for hydrocarbon generation. Possible Tertiary hydrocarbon source rocks are the Eocene San Cristobal Formation (lower Eocene of the Salina Group), the Chacra (lower Eocene); the lower Talara (middle Eocene), and the Chira-Heath (upper Eocene-lower Oligocene) formations (Perupetro, 1999). Lower Eocene Pale Greda neritic marine shales and the Paleocene Balcones Shale (Mal Paso Group) are also believed to be important organic-rich source rocks (AIPC, no date; 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). Maturation of source rocks within the entire column probably began during Miocene time, when the sediments across the Talara Basin approached their maximum thickness. Kingston (1994), however, believes that the stratigraphic section was thick enough by the end of Eocene time for source rocks to have generated hydrocarbons. This is possible for Cretaceous source rocks, but Tertiary source rocks may not have been buried deep enough for this to have occurred. Talara Basin sequence has a maximum aggregate thickness of 8,500 m (28,000 ft) of Paleogene sediments on top of about 6,000 m (20,000 ft) of Mesozoic strata (Zuniga-Rivero and others, 1998).

MIGRATION: Onset of migration was probably Miocene time, soon after the start of hydrocarbon generation, because of the proximity of source to reservoir rocks. Gas chromatograms of Paleocene oils from several fields scattered across the basin give evidence of two or more stages of migration; minor to extensive biodegradation is overprinted by later migrated oil that is nonbiodegraded (Geomark data through 1997). Migration is probably still occurring. Oil seeps, such as those near the La Brea field, have been used by the native people for many centuries. Median API gravity is 31.8° for 36 oils across the basin (Geomark data through 1997; Petroconsultants data through 1996).

RESERVOIR ROCKS: Thickness of the Tertiary through Cretaceous section across the basin ranges from about 8,500 to 18,000 m (28,000 to 58,000 ft), increasing seaward (Zuniga-Rivero and others, 1998). The Talara oilfields have as many as a dozen producing intervals per well from mostly Eocene age nearshore-marine sandstones, and all reported production is commingled (Petroconsultants data through 1996). Age of oil and gas reservoirs is primarily Eocene with lesser Middle to Upper Cretaceous; there is minor hydrocarbon production from the Pennsylvanian Amotape Formation. Main reservoirs are the Eocene Talara Group (including the Helico and Terebratula Formations), Salina Group (including the Mogollon and San Cristobal Formations), and the Cabo Blanco, Clavel, Echinocyamus, Ostrea, Parinas, Pale Greda, Pena Negra, Rio Bravo, and Verdun (Lagunitos Group) Formations (Petroconsultants data through 1996). Paleocene reservoirs are the Balcones and Mesa Formations. One field produces gas from the Oligocene Mancora Formation (Petroconsultants data through 1996). Four fields produce hydrocarbons from sandstones of the Cretaceous Redondo Shale, and the Ancha, and Petacas Formations of the basal Mal Paso Group; oil and gas in four fields is produced from quartzites of the Pennsylvanian Amotape Formation (Petroconsultants data through 1996). Three of these fields also produce oil from Eocene and (or) Cretaceous sandstones; the now-abandoned Zorro field produced about 100,000 BO from only the Amotape Formation (Petroconsultants data through 1996).

TRAPS AND SEALS: Upper Oligocene-Miocene time is characterized by separation of the Nazca from the South American Plate with active subduction at the Peru-Chile trench and creation of new Progreso and Tumbes fore-arc basins north of Talara (Jaillard and others, 1995). Middle Miocene time is associated with block faulting, mostly extensional tectonics, and renewed growth of the Andes Mountains east of the Talara Basin. While earlier tectonic activity affected folding, faulting, and depositional patterns across the basin, mid- to late-Tertiary extensional regime is associated with the high-angle normal faulting that trapped and redistributed hydrocarbons, resulting in the current fault-block reservoirs (Zuniga-Rivero and others, 1998).

Primary seals are overlying and interbedded marine shales, both for shallow and deepwater deposits (Zuniga-Rivero and others, 1998). Lateral seals are (mainly normal) fault offsets, and lateral depositional or erosional pinchout of the mostly marine sandstones into shales. Sediment sources are primarily 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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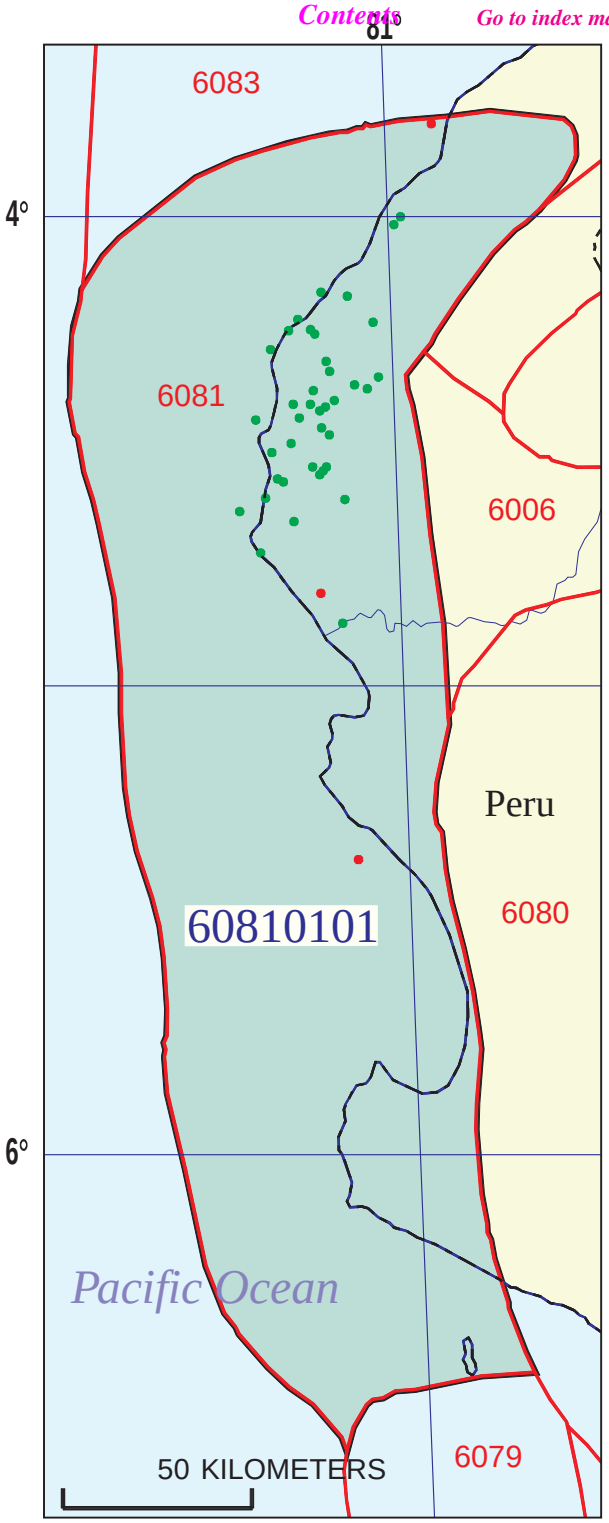


Cretaceous-Paleogene Basin Assessment Unit - 60810101

EXPLANATION

- Hydrography
- Shoreline
- 6081 — Geologic province code and boundary
- Country boundary
- Gas field centerpoint
- Oil field centerpoint
- 60810101 — 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:……..	Talara Basin	Number:	6081
Priority or Boutique……	Boutique		
Total Petroleum System:……	Cretaceous-Tertiary	Number:	608101
Assessment Unit:……..	Cretaceous-Paleogene Basin	Number:	60810101
* 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: 20 Gas: 1
Established (>13 fields) X Frontier (1-13 fields) _____ Hypothetical (no fields) _____

Median size (grown) of discovered oil fields (mmboe):
1st 3rd 20.1 2nd 3rd 15.7 3rd 3rd 8.6
Median size (grown) of discovered gas fields (bcfg):
1st 3rd 72 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)

Oil fields:……min. no. (>0)	5	median no.	80	max no.	175
Gas fields:……min. no. (>0)	2	median no.	25	max no.	60

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	7	max. size	800
Gas in gas fields (bcfg):……min. size	6	median size	40	max. size	1600

Assessment Unit (name, no.)
Cretaceous-Paleogene Basin, 60810101

AVERAGE RATIOS FOR UNDISCOVERED FIELDS, TO ASSESS COPRODUCTS

(uncertainty of fixed but unknown values)

Oil Fields:	minimum	median	maximum
Gas/oil ratio (cfg/bo)……	800	1600	2400
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)……	18	36	41
Sulfur content of oil (%)……	0.03	0.06	0.26
Drilling Depth (m) ……	500	2000	3500
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)……	1000	3000	5500
Depth (m) of water (if applicable)……	0	200	1000

Assessment Unit (name, no.)
Cretaceous-Paleogene Basin, 60810101

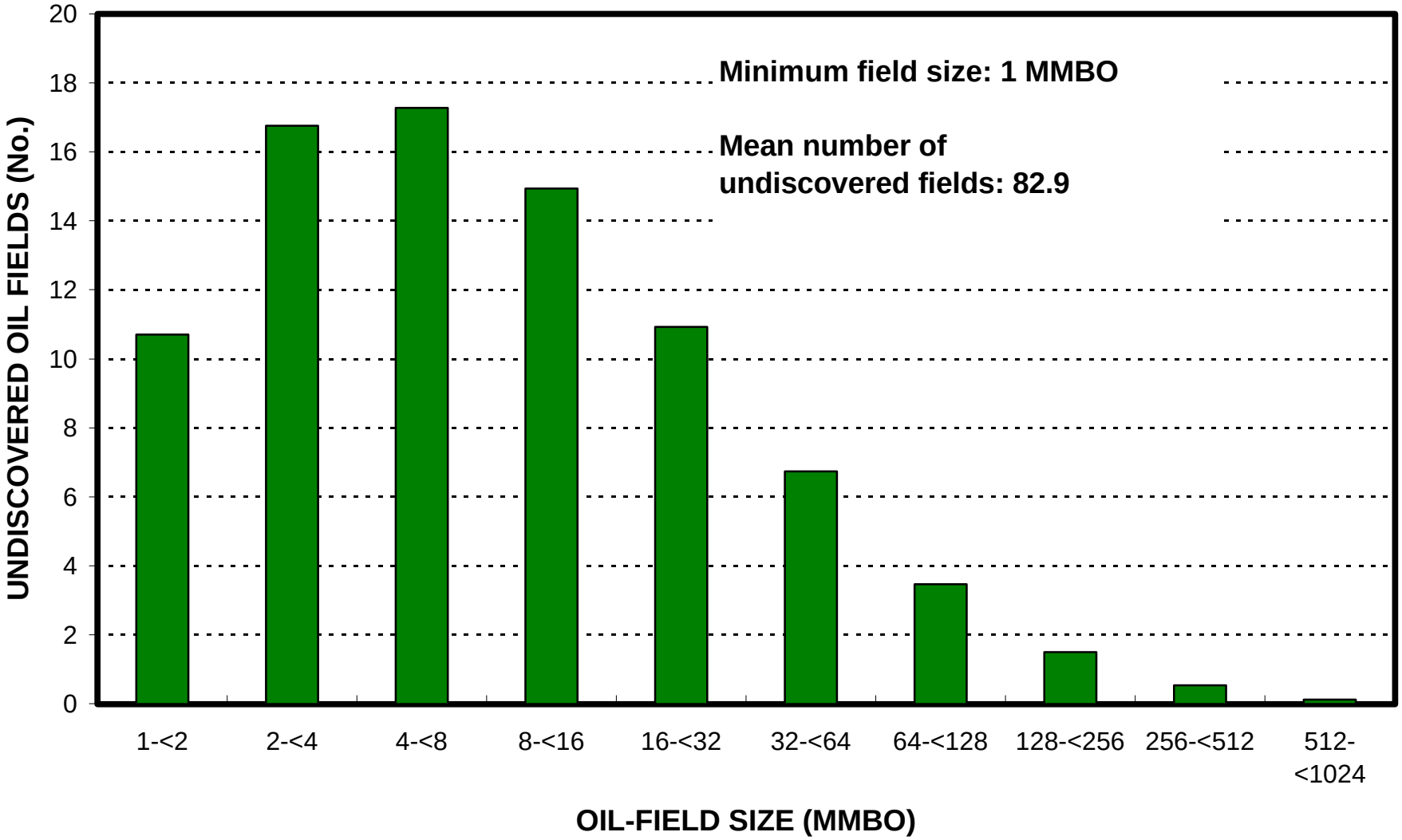
ALLOCATION OF UNDISCOVERED RESOURCES IN THE ASSESSMENT UNIT TO COUNTRIES OR OTHER LAND PARCELS (uncertainty of fixed but unknown values)

1. Peru 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%)……		85	

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%)……		85	

Cretaceous-Paleogene Basin, AU 60810101
Undiscovered Field-Size Distribution



Cretaceous-Paleogene Basin, AU 60810101
Undiscovered Field-Size Distribution