Present Day and Paleo Hydrodynamics of the Marañon Basin, Peru

Impact on Oil Migration, Oil Quality and Trapping, Implications for Exploration and Production

Summary Presentation
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This project was conducted by
Rakhit Petroleum Consulting Ltd.

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Objectives

1. **Study influence of hydrodynamics on the migration and preservation of oil in the basin.**

2. **Map paleo and present oil migration fairways to identify prospective areas for future exploration.**
1. Petroleum Geology
2. Paleo Hydrogeology and Dynamic Oil Migration
3. Hydrogeology and Dynamic Oil Migration
4. Conclusions
Location Map
Marañón Basin, Peru

Marañón Basin Study

200 km

Cuenca Bagua

Cuenca Huallaga

Cuenca Trujillo

Cuenca Salaverry

Cuenca Sechura

Cuenca Talaara

Cuenca Progreso

Cuenca Lancones

Cuenca Marañón

ECUADOR

COLOMBIA

BRASIL
Present Day Structural Cross-Section
Maraño Basin - Santiago Basin

Cross-section supplied by:
Stratigraphic Column and Tectonic Events

Peru

From Mathalone and Montoya, 1995
Pressure versus Elevation Graph
Marañon Basin, Peru

1. "Paleo" Recharge
2. Flow Convergence
3. Present Day Recharge

Regional Water Gradient

Pressure (psi)
Elevation (ft)
Whole crude gas chromatograph of oil from the Cretaceous Vivian Formation in the Jibaro Field, Marañón Basin (GeoMark, 1997). The hydrocarbon fraction to the right of C15 is highly biodegraded. A later phase of migration is indicated by presence of nonbiodegraded C1 to C15 hydrocarbons.  

Burial History Graph
Chonta Paleo Kitchen, Marañon Basin, Peru

After PeruPetro, 2002.

Maturity versus Time Graph in Piuntza IX in the Central Santiago-Nieva Tectonic Depression

Legend:
- Red: Modeled Wells
- Blue: Non Modeled Wells

Location of Modeled Wells and Pseudo Wells

Chonta Entering Paleo Kitchens
Summary Petroleum Systems
Marañon Basin, Peru

- **Jurassic**
  - Pucara

- **Triassic**

- **Paleocene**
  - Chonta

- **Late Cretaceous**
  - Cutucu Uplift

- **Oligocene**

- **Miocene**

- **Pliocene**
  - Late Pliocene - Recent Kitchen

- **2nd Phase**
  - Late Cretaceous - Middle Eocene Kitchen

- **1st Phase**
  - Middle Eocene and older structures
  - Inversion Quechua
  - Inversion Incaic (Start Cutucu Uplift)
  - Inversion Peruana

- **Middle Eocene and younger structures**
  - Trapping of "New" Oil and Re-migrated "Old" Oil
  - Paleo-Trapping and Local Biodegradation of "Old" Oil

Ma

- 0
- 10
- 20
- 30
- 40
- 50
- 60
- 210
Kitchens

No Cretaceous source rocks present.

1) Pozo Time
Pucara shale expels oil in SW Maraño. Older source rocks (eg. Ene Shale?) also effective?

2) Present Day
Pucara shale in main stage gas window. Older sources probably over-mature.

RESERVOIRS
- Vivian Sandstone
- Upper Chonta Ss (Pona)
- Lower Chonta Ss (Cetico)
- Agua Caliente Sandstone
- Cushabatay Sandstone

POZO TIME MIGRATION
- Yahuarango Shale
- Chonta Shale
- Raya Shale
- Pucara Formation
- Ene Shale

ReQUIRES FAULT CHARGE

Non-Source Facies
Present Day Migration
Northern Marañon Basin, Peru

Kitchens

1) Pozo Time
The "Quito" Kitchen located west of the northern Marañon expelled oil from Cretaceous reservoirs.

Possible oil expulsion from pre-Cretaceous source rocks (Ene Shale?). Access to reservoirs via Situche graben faults?

2) Present Day
Cretaceous source rocks expel oil in NW Marañon. Pre-Cretaceous source rocks expel gas but Situche graben faults now closed?
Recoverable Oil Reserves
Marañon Basin, Peru

Total 734 MMBO: 50 % in 3 Fields
62% in Vivian, 37% in Chonta

(Data from Mathalone and Montoya, 1995).
Recent discoveries in Block 67 (Dorado, Paiche, Piraña) not included.
Oil Gravity
Vivian Formation, Marañon Basin, Peru

[Map showing oil gravity distribution with color bars indicating API values from 0 to 46, and a scale bar for distance in km.]
Outline

1. Petroleum Geology
2. Paleo Hydrogeology and Dynamic Oil Migration
3. Hydrogeology and Dynamic Oil Migration
4. Conclusions
Petroleum Hydrogeology of the Marañon Basin
Early Tertiary - Pojo Time (~40 Ma)

Driving Forces for Brine Flow in the West

Freshwater Flow
Brine Flow
Oil Migration
Fault Conduit
Source Rock

PLIO PLIOCENE
MIO MIOCENE
PAL PALEOCENE
K CRETACEOUS
VIV VIVIAN S S
CHON CHONTAL

CUSH CUSHABAY
JU JURASSIC
TR TRIASSIC
PZ PALEOZOIC
PE PRECAMBRIAN

POZO SEA
VIVIAN UPLANDS

PROTO ANDEAN UPLIFT
Major Molasse Source Area

PROTO CUTUCU UPLIFT

Sea Level

Western Oil Kitchen

Sediment Load
Compaction

Salt Dissolution

OIL WINDOW

Tectonic Compression

SANTIAGO BASIN
Before Quecha Inversion = Western Oil Kitchen

Extensive Paleo Biodegradation c. 65°C

Freshwater Recharge

CUSH, VIV

Before Quecha Inversion = Western Oil Kitchen

Driving Forces for Brine Flow in the West

Freshwater Flow
Brine Flow
Oil Migration
Fault Conduit
Source Rock
Paleo - Hydraulic Head
Vivian Formation, Marañon Basin, Peru

Hydraulic Head (m)

Water Flow

Paleo Flow Convergence

Peru

Colombia

Brasil

Ecuador
Paleo - Water Salinity
Vivian Formation, Marañon Basin, Peru
Summary Paleo - Oil Migration
Vivian Formation, Marañon Basin, Peru

[Map showing oil charged fairways and paleo accumulation areas in the Marañon Basin, Peru.]
Outline

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Petroleum Hydrogeology of the Marañon Basin
Late Pliocene (c. 5 Ma) - Present

Driving Forces for Brine Flow in the West

Freshwater Flow
Brine Flow
Oil Migration
Fault Conduit
Source Rock

Pliocene
Miocene
Paleocene
Cretaceous
Vivian Ss
Chonta

Cushabatay
Jurassic
Triassic
Paleozoic
Precambrian

Strong Freshwater Recharge

Weak 'Paleo' Water Flow
No Present Day Biodegradation (Reservoirs Too Hot)

BASE PLIO

SANTIAGO BASIN

CUTUCU UPLIFT

CORDILLERA REAL
Structure
Vivian Formation, Marañon Basin, Peru
Hydraulic Head
Vivian Formation, Marañon Basin, Peru
Water Salinity
Vivian Formation, Marañon Basin, Peru
Oil Migration
Vivian Formation, Marañon Basin, Peru
Summary of Oil Migration and Re-Migration
Vivian Formation, Marañon Basin, Peru
Tilted Oil/Water Contacts
Vivian Formation, Marañon Basin, Peru
Tilted Oil/Water Contact, Shiviyacu Field
Vivian A Sand, Marañon Basin, Peru

Cross-section supplied by:
Loreto Structure Prognosis

Despite the 1X well being wet, there is potential for hydrodynamic trapping on the northeast flank of the Loreto Dome. Given the immense size of the structure (2 km of closure and 50 km wide) the reserves trapped could be considerable. Calculations for 40º API, with a predicted oil/water contact tilt of 7 m/km in the Cushabatay, indicate that over a billion BBls of oil could be trapped. Reservoir quality and oil charge are serious risk factors.
1. Petroleum Geology

2. Paleo Hydrogeology and Dynamic Oil Migration

3. Hydrogeology and Dynamic Oil Migration

4. Conclusions
Conclusions

1. The basin is hydrodynamically active due to outcrop of major aquifers at high elevation in Andes Foothills.

2. Main Vivian reservoir contains oil fields with oil/water contact tilts up to 15 m/km.

3. The southern basin received only paleo oil charge. Three narrow re-migrated oil fairways with potential tilted accumulations are mapped.
4. The northern basin received both paleo and present day oil charge. Four broad oil fairways with potential accumulations exist.

5. A major hydrodynamic trap may exist downdip of the shelf edge in the northern basin.

6. Biodegradation was widespread during paleo-time but is limited to the shallow basin margins today.
This study, “Present Day and Paleo Hydrodynamics of the Maraño Basin, Peru,” is available in paper or PDF format, for a modest copy charge.

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