Valencia Trough (Offshore Spain): Petroleum Systems and Play Types*

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Abstract

The Western part of the Mediterranean Region is one of the least explored areas for hydrocarbons in the entire Tethys region. The Valencia Trough, offshore Spain, is located between the Catalan coast and the Balearic Islands and it represents one of the most attractive basins for HC exploration, using new concepts and technologies. The petroleum system of the Valencia Trough has been recently reviewed and integrated with 1D basin models on some wells, focusing on the evaluation of the source rock, the reservoir, and the seals. The oldest reported source rock in the area is the Upper Jurassic Mas D'Ascla Formation (highest TOC value 1.26%). In the easternmost part of the Valencia Trough, Paleogene continental rift basins formed before the early Miocene major rifting phase are characterized by the presence of continental and lacustrine sediments. Locally there are evidence of coal, with TOC values up to 11.5%, and a thickness of 150m. In the Miocene Alcanar Group there are organic-rich units that are considered to be the most prolific source rock of the Valencia Trough. The intervals rich in organic matter are in the Burdigalian-Langhian sequences. The most important reservoir of the Valencian Trough is characterized by karst limestones and dolostones of Cretaceous and Jurassic age. The karst development generated diffuse vuggy porosity and enhanced fracture porosity. Clastic reservoirs are not exploited, but traces of hydrocarbons have been found in the Castellon Group, whereas the Pliocene Ebro sandstones are considered a potentially good reservoir for biogenic gas. The main seals are represented by the Cambrils Group shales, Castellon Shales, and shales intercalated in the Ebro Group. A review of all the available data (seismic and wells) allow the definition of 4 different plays in the area. The petroleum plays in the Valencia Basin involve both carbonates and clastic sequences and range from Mesozoic structural and structural-stratigraphic traps to Plio-Pleistocene delta and turbidite deposits. They can be sub-divided into: Casablanca and Amposta Play, Castellon Play, Ebro Play, and Rosas Play.

References Cited


VALENCIA TROUGH (OFFSHORE SPAIN): PETROLEUM SYSTEMS & PLAY TYPES

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AAPG 2017 Annual Convention & Exhibition –
Theme 10: International Regions Highlights
OUTLINE

1. DATASET & OBJECTIVES OF THE STUDY
2. GEOLOGICAL FRAMEWORK
3. PREVIOUS EXPLORATION
4. STRATIGRAPHY
5. OIL TYPES & BASIN MODELLING
6. PLAY TYPES
7. CONCLUSIONS
OBJECTIVES & DATASET

OBJECTIVES:
1. DESCRIBE THE PROVED AND POTENTIAL PETROLEUM SYSTEMS
2. EVALUATE THE EXPLORATION POTENTIALS OF THE DEEP WATER PART OF THE BASIN

DATASET:
• >13000 km 2D SEISMIC LINES
• WELL REPORTS
• WELL LOGS
• PUBLICATIONS & OUTCROP DATA
• THE VALENcia TROUGH IS OLDEST TERTIARY WESTERN MEDITERRANEAN BASIN,
• THE TERTIARY SEQUENCE RELATED TO THE FORMATION OF THE BASIN IS 2 TO 6 KM THICK
• THE BASIN IS SURROUNDED BY TERTIARY THRUST BELT SYSTEMS (BETIC-BALEARIC, CATALAN-COASTAL & PYRENEES)
BASIN MARGINS – SW BORDER

STEEP SW MARGIN
BASIN MARGINS – NW BORDER

THICK PROGRADING TERTIARY SEQUENCE
• TWO MAIN FAULT FAMILIES:
  o NE-SW (RELATED TO THE RIFTING & TO THE BETIC-BALEARIC THRUST BELT SYSTEM)
  o NW-SE (MAINLY RELATED TO REGIONAL-SCALE TRANSFER ZONES)
• SAME FRACTURE TRENDS CAN BE OBSERVED ALSO ONSHORE (BALEARIC ISLANDS & IBERIA)
PREVIOUS EXPLORATION ACTIVITY

- Exploration in the Gulf of Valencia started in 1968, with the first commercial discovery.
- By 1976, with just 22 exploration wells drilled, most of the hydrocarbon had been found (Amposta, Dorada, Montanazo and Tarraco oil fields).
- Since 1994, 3D seismic started to be used as an exploration tool and, consequently, a high rate of success has been achieved and new accumulations discovered; they, in spite of their small sizes (3 to 10 million barrels of oil), have been immediately developed.
- Less than 200 wells drilled since late 60’s
- Only 1 well in the deep-water part of the basin
- Basin areal extent 63,000 sq km
## HYDROCARBON DISCOVERIES

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<th>FIELD/DISCOVERY</th>
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<td>Bocarte 1</td>
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<td>2009*</td>
<td>Montanazo-Lubina</td>
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</table>
• DISCOVERED IN 1975, STILL IN PRODUCTION
• RESERVOIRS ARE KARSTIFIED MESOZOIC CARBONATES
• LIGHT OIL (33.7° API)
• CUMULATIVE PRODUCTION (2015) – 149 MMbbl
VOLCANISM

Modified after Maillard et al., 2006
VOLCANISM

Alternations of basinal and volcanic deposits

Messinian Unconformity

Sill?
SOURCE ROCKS AND OIL TYPES

Mas D’Ascla Fm (U. Jurassic)
• Supposed to be the source in the Amposta Oil Field
• The highest TOC values (1.26%)

Alcanar Group (Miocene)
• Casablanca oil field
• Low-quality, hydrogen-poor, type III kerogens, with TOC varying from 0.5 to 3%

\[ \delta^{13}C \text{ Aromatics} \]

\[ \delta^{13}C \text{ Saturates} \]

Non marine

Marine

TERTIARY JURASSIC
- ASCLA Fm
- MAESTRAS 0-1
- AMPOSTA
- CASABLANCA
- BOQUERON
- RODABALLO

DELTA L-1

Graph showing the distribution of \( \delta^{13}C \) values for aromatics and saturates.
PLAY TYPES

**LITHOLOGY**

- **PERMIAN**
  - Alcanar Formation
  - Ebro Sands
  - Palaeogene marine faces

- **TRIASSIC**
  - Muschelkalk facies

- **JURASSIC**
  - Middle Jurassic: shallow water limestones
  - Lower: Eocene marls and shales, thickness and slope facies

- **CRETACEOUS**
  - Alcanar Formation
  - Keuper facies
  - Urgonian marine carbonates, algalic continental facies, Purbeckian facies

- **PALEOGENE**
  - Palaeogene marine carbonates and dolostones
  - Cretaceous to Permo-Triassic carbonates and dolostones

**SOURCE**

- Mas D’Ascia
- Ebro clay
- Paleogene marine faces

**RESERVOIR**

- Cretaceous and Jurassic karst limestones and dolostones
- Castillon sands
- Ebro Sands
- Cretaceous to Permo-Triassic carbonates and dolostones

**SEAL**

- Salou and San Carlos Formations
- Ebro Clays
- Salou and San Carlos Formations equivalent

**MIGRATION**

- Vertical and lateral
- Stratigraphic
- Stratigraphic

**TRAP**

- Structural
- Vertical
- Stratigraphic

**HC TYPE**

- Oil and potential Thermogenic gas
- Oil and Thermogenic gas
- Biogenic Gas
- Oil

*The age of the pre-Cretaceous basement may vary from Cretaceous to Palaeogene due to erosion.*
<table>
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<th>HC TYPE</th>
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<td>Cretaceous and Jurassic karst limestones and dolostones</td>
<td>Salou and San Carlos Formations</td>
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<td>Vertical and lateral</td>
<td>Oil and potential Thermogenic gas</td>
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<td>CASTELLON PLAY</td>
<td>Alcanar Formation</td>
<td>Castellon sands</td>
<td>Ebro Clays, Messinian Evaporites</td>
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<td>Paleogene marine faces</td>
<td>Cretaceous to Permo-Triassic carbonates and dolostone Paleogene?</td>
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<td>Oil and potential Thermogenic gas</td>
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**Diagram Description:**
- **MESSINIAN UNCONF.**
- **POSSIBLE ALCANAR SOURCE ROCK**
- **BASEL UNCONF.**

**Diagram Notes:**
- **BALEARIC ISLAND 51A**
CASTELLON PLAY (DISTAb& PROXIMAL)

<table>
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<td>Oil and Thermogenic gas</td>
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</tbody>
</table>

Delta 45
**Paleogene marine facies**

- Cretaceous to Permo-Triassic carbonates and dolostone
- Salou and San Carlos Formations equivalent

**Stratigraphic**

**Lateral**

**Oil?**
CONCLUSIONS

• WIDE FRONTIER EXPLORATION AREA (UNDEREXPLORED, DEEP WATER, COMPLEX GEOLOGICAL EVOLUTION)
• EVIDENCES OF TWO WORKING PETROLEUM SYSTEMS USING INTEGRATED DATA
• 2 MAJOR SOURCE ROCKS:
  ▪ MAS D’ASCLA (U.JURASSIC)
  ▪ ALCANAR (MIocene)
• RESERVOIRS ARE:
  ▪ KARSTIFIED LIMESTONES AND DOLOSTONES (CASABLANCA AND AMPOSTA PLAY)
  ▪ VERTICALLY PROGRADING SILICICLASTIC TURBIDITES TO DELTAIC SYSTEM (CASTELLON PLAY)
  ▪ PROGRADATIONAL AND SHELF-MARGIN DELTAS TO SLOPE TRANSITION (EBRO PLAY)
  ▪ PERMO-TRIASSIC TO CRETACEOUS LIMESTONE AND DOLOSTONES AND PALEogene DEPOSITS (ROSAS PLAY)
• HEAT FLOW AND PRESENCE OF VOLCANIC EDIFICES ARE CRITICAL FACTOR FOR SOURCE-ROCK MATURITY
THANK YOU !