Hydrocarbon Prospectivity in Apulian Platform and Ionian Zone, in Relation to Strike-Slip Fault Zones, Foreland and Back-Thrust Basins of Ionian Thrust in Greece*

Avraam Zelilidis¹, Panagiotis Konstantopoulos², and Angelos Maravelis³

Search and Discovery Article #10496 (2013)**
Posted June 17, 2013

*Adapted from oral presentation given at AAPG European Regional Conference & Exhibition, Barcelona, Spain, April 8-10, 2013
**AAPG©2013 Serial rights given by author. For all other rights contact author directly.

1University of Patras, Greece (a.zelilidis@upatras.gr)
2Expoil Consulting Services (tkonstan@upatras.gr)
3School of Environmental and Life Sciences, University of Newcastle, Callaghan 230 8 NSW, Australia (Angelos.Maravelis@newcastle.edu.au)

Abstract

The Greek part of the FTB in the Balkan Peninsula was taken into consideration regarding its hydrocarbon potential since it exhibits, in broad terms, similar geological history to the prolific Albanian oil and gas provinces. Likewise, the hydrocarbon potential of Italy’s Apulian Platform, adjoining in the westerly offshore, may serve as an analogue. Regional analysis indicates a Mid- Mesozoic hydrocarbon system as the main system in Western Greece that compares well with that of Albania. Moreover, the so far speculative Mid-to-Late-Tertiary hydrocarbon system (equal to that of Albania) also occurs. The source rocks in the Tertiary system are mainly attributed to organic carbon-rich mudstones within the Late-Oligocene to Early/Middle-Miocene turbidites. Sand-rich deposits within the submarine fan system may serve as potential reservoirs while additionally the post-Alpine clastic succession (Neogene) and the Triassic evaporites appear to constitute cap rocks and seals. The resulting plays are similar in both countries yet not identical.

The opportunities presented herein are: (1) the Ionian thrusts’ foreland basin, (2) the Ionian thrusts’ back-arc (piggy-back) basin, (3) the basin north of the Borsh-Khardhqiqt strike-slip fault, and (4) the Preveza Basin, north of the Cephalonia transfer fault. Fundamentally, the four basins suggested for further scrutiny all have in common that they represent sedimentary (sub-)basins of substantial thicknesses which are, in one way or another, correlated with tectonic movements, i.e. the evolution of the Hellenide FTB. Based on regional seismic lines, and on regional oil-geological considerations, locally particular opportunity areas (“scenes”) have been identified. Given the limited availability of well and seismic data in Western Greece, additional activities that would be helpful in avoiding negative results in exploring those basins are needed.
Selected References


Holton, J., 1999, Southern Italy; 1, S. Apennines success bodes well for potential off southern Italy: Oil and Gas Journal, v. 97/48, p. 65-68.


Hydrocarbon prospectivity in Apulian platform and Ionian zone, in relation to Strike-slip fault zones, Foreland and Back-Thrust basins of Ionian Thrust in Greece

Avraam Zelilidis, Professor
Department of Geology, University of Patras

Dr. Panagiotis Konstantopoulos

Angelos Maravelis, Lecturer
School of Environmental and Life Sciences, University of Newcastle, Callaghan 2308 NSW, Australia, Angelos.Maravelis@newcastle.edu.au
The Northwestern part (A), with the red, shows the Apulian platform, the Southern part (B), with the deep blue, show the Mediterranean Ridge, the North Aegean sea (C) with green, show the troughs with Prinos and Epanomi hydrocarbon fields, and (D) Levantine basin with huge oil and gas fields of Cyprus and Israel (modified from Chamot-Rooke et al., 2005).
Ministry published on 4/11/2011 a Map with seismic lines and with boreholes

WITH DETAILS FOR
Area 1: Diapontia islands
Area 2: west of Corfu island
Area 3: Preveza
Area 4: Patraiikos gulf
Area 5: Katakolon
NON EXCLUSIVE SEISMIC PROJECT

4/3/2012

1) TGS-NOPEC GEOPHYSICAL COMPANY ASA
2) DOLPHIN GEOPHYSICAL
3) ION GEOPHYSICAL CORPORATION
4) SPEC PARTNERS LTD
5) CGGVERITAS
6) PETROLEUM GEO-SERVICES (PGS)
7) SPECTRUM GEO LIMITED
8) FUGRO MULTICLIENT SERVICES AS
OPEN DOOR
2/7/2012
Katakolo 3-4 mb
Patraikos 200mb
Ioannina 50-80mb

1/7/2012 ???
10-15 onshore areas
Evros, Kavalla, Serres,
Thessaloniki, Grevena,
Aitolioakarnania,
Messenia, Achaia, Kriti,
e.t.c.
ONSHORE AREA OF IOANNINA

Open door: block Ioannina
With 60-80 mbo

Competition with data from 1998

Zelilidis et al., 2003
Stratigraphy of Ionian zone
Zelilidis et al., 2003
Oil generated in Albania discovered as far East as Tomorrit anticline, which is within the equivalent of the Ionian zone.
### Source Rocks

<table>
<thead>
<tr>
<th>Formation</th>
<th>Age</th>
<th>Oil Window Time</th>
<th>Current HC Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shale Fragments</td>
<td>Triassic breccia</td>
<td>Late Jurassic</td>
<td>Gas</td>
</tr>
<tr>
<td>Lower Posidonia beds</td>
<td>Toarcian – Aalenian (Jurassic)</td>
<td>Middle Miocene</td>
<td>Oil - Condensate – Gas</td>
</tr>
<tr>
<td>Ammonitico Rosso</td>
<td>Lower Toarcian (Jurassic)</td>
<td>Middle Miocene</td>
<td>Oil – Condensate – Gas</td>
</tr>
<tr>
<td>Upper Posidonia</td>
<td>Callovian-Tithonian (Jurassic)</td>
<td>Upper Miocene</td>
<td>Oil – Condensate – Gas</td>
</tr>
<tr>
<td>Vigla shales</td>
<td>Albian-Cenomanian (Cretaceous)</td>
<td>Miocene</td>
<td>Oil</td>
</tr>
<tr>
<td>Flysch (possible)</td>
<td>Oligocene</td>
<td>At 3650-5900m</td>
<td>Gas</td>
</tr>
</tbody>
</table>

### Reservoir

**Reservoir Type**

- Fractured Carbonates
- Karstified Carbonates
- Strike-slip Faulted Zones
- Sub-marine sandstone turbidites

<table>
<thead>
<tr>
<th>Formation</th>
<th>Rock Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foustapidima Limestones</td>
<td>N/A</td>
</tr>
<tr>
<td>Pantokrator Limestones</td>
<td>Possible Paleo-relief</td>
</tr>
<tr>
<td>Lower Jurassic Limestones</td>
<td>Uplift &amp; Erosion</td>
</tr>
<tr>
<td>Microbrecious Limestones</td>
<td>1-9% 0.05mD</td>
</tr>
<tr>
<td>Oligocene submarine fans</td>
<td>3-24% up to 10mD</td>
</tr>
<tr>
<td>Miocene submarine fans</td>
<td>3-15% up to 10mD</td>
</tr>
</tbody>
</table>
APULIAN PLATFORM
WESTERN GREECE
OFFSHORE AND
ONSHORE AREAS
The red dashed lines are seismic lines. The yellow line is the coastline.
1. Internal Albanides,
2. Internal Helenides,
3. Pindos zone (Krasta),
4. Gavrovo zone (Kruja),
5a. Internal Ionian zone,
5b. Middle Ionian zone,
5c. External Ionian zone,
6. Apulian platform:
   6a. Plateau Rospo,
   6b. Gargano promontory,
   6c. Murge ridge,
   6d. Salento peninsula,
   6e. Apulia plateau,
7. Albanian Alps,
8a. Dures basin, 8b. Ionian-Albania basin,
9. Hellenic trench,
10. Mediterranean ridge,
11. Ionian abyssal plain,
12. Africa, 12a. Hyblean plateau,
13. Calabrian arc,
14. South Tyrrenhian sea,
15. South Apennine.
from Bartello et al., 2008
Synthetic sketch map showing Italian and Albanian hydrocarbon plays with an attempt for correlation with the northwestern part of Greece (Diapontia islands). Cross-sections AA’ and BB’ based on seismic data.
<table>
<thead>
<tr>
<th>Field Area</th>
<th>Formation</th>
<th>Depth (m)</th>
<th>HC Column (m)</th>
<th>Reservoir</th>
<th>Recoverable Reserves BOE</th>
<th>API</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gela</td>
<td>Carbonates</td>
<td>3000-3300</td>
<td></td>
<td>Oil</td>
<td></td>
<td>10-20°</td>
</tr>
<tr>
<td>Val D’ Agri</td>
<td>Carbonates</td>
<td></td>
<td>600-1000</td>
<td>Oil</td>
<td>1020 MM</td>
<td>17-46°</td>
</tr>
<tr>
<td>Monte Alpi &amp; Cerro Falcone</td>
<td>Limestones</td>
<td></td>
<td>702-760</td>
<td>Oil &amp; Gas</td>
<td>600 MM</td>
<td>30-37°</td>
</tr>
<tr>
<td>Tempa Rossa</td>
<td>Limestones</td>
<td>4000</td>
<td>700</td>
<td>Oil &amp; Gas</td>
<td>420 MM</td>
<td>17-22°</td>
</tr>
</tbody>
</table>
This 3D model is divided into four blocks where the Durres basin, the proportional basins in Diapondia Islands and Preveza, are shown (A1, A2, and A3 circles; Zelilidis et al., 2003).
Geological map with proposed gas and oil plays. The red cycles show:

- Diapontia islands,
- Kalpaki area in Ioannina
- Preveza-Lefkada basin
- Arta area

(modified from Zelilidis et al., 2003).
Diapontia Islands with the three potential hydrocarbon regions.

A) The first region is north to the Borsh-Khardhiqit fault,
B) the second area is located westward to the Ionian thrust - the Ionian foreland basin. The seismic line Northern to Kerkira shows the foreland,
C) The piggy-back basins of Ionian thrust

The numbers on the seismic line are:
(1) Pliocene-Quaternary sediments,
(2) Middle-Upper Miocene sediments and
(3) Lower Miocene and older formations (modified from Monopolis and Bruneton, 1981).
GULF OF PATRAS

- Miocene clastics
- Pliocene to present clastics
- Mesozoic carbonates
- Oligocene clastics (F)

200 million barrels of oil, according to ministry information based on the Triton results from 1998.
OPEN DOOR: KATAKOLO
KATAKOLO

Gas flow: 11-12 million cubic meter/day for each zone
Oil flow: 1000-1500 barrels/day
Reservoir depth: 2400-2600m
Water depth: 200-350m
Distance from the land: 3.5km
2D seismic data: 6000km
3D seismic data: 100 square km
PREVEZA - PATRAIKOS - KATAKOLO

OPEN DOOR – BLOCK PATRAIKOS
200 MILLION BARRELS OF OIL

OPEN DOOR – BLOCK KATAKOLO
3 MILLION BARRELS OF OIL
1. Diapontia islands

Maravelis et. al., 2012
2. West of Corfu

Maravelis et. al., 2012
3. Paxi Basin

4. Preveza Basin

Maravelis et. al., 2012
WE KNOW the stratigraphy of Pre-Apulian source rocks

<table>
<thead>
<tr>
<th>Era</th>
<th>Formation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pliocene</td>
<td>Scaglia</td>
<td>Gas prone source rocks</td>
</tr>
<tr>
<td>Miocene</td>
<td>Maiolica</td>
<td>Gas prone source rocks</td>
</tr>
<tr>
<td>Eocene</td>
<td>Aptici</td>
<td>Rich source rock horizons</td>
</tr>
<tr>
<td>Cretaceous</td>
<td>Complesso</td>
<td>Four horizons / fair organic matter</td>
</tr>
<tr>
<td>M.-U. Jurassic</td>
<td>Anidritico</td>
<td></td>
</tr>
<tr>
<td>L. Jurassic</td>
<td>Burano</td>
<td>Horizon with residual organic matter</td>
</tr>
<tr>
<td>Triassic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Karakitsios & Rigakis 2007
Karakitsios & Rigakis 2007
Lower Jurassic - Triassic

Type I
Highly Oil prone

Type II
Oil prone

Type III
Gas prone

Quality of organic matter

Karakitsios & Rigakis 2007
Clastic deposits of Miocene and Pliocene

Karakitsios & Rigakis 2007
MEDITERRANEAN RIDGE IN WESTERN GREECE OFFSHORE AREAS
Southern part: Mediterranean Ridge (modified from Chamot-Rooke et al., 2005), separated into three distinct areas.

**AREA A:** Example from seismic line between Cephalonia and Zakynthos Islands (modified from Kokkinou et al., 2005). The red arrows show the possible hydrocarbon fields.
AREA A: Possible hydrocarbon plays:

1. Two major anticlines: Medit. Ridge and Hellenic Trench, 2km under sea-level.

2. Abyssal Plain, 4km under sea-level (Maravelis et al., 2012)
Maravelis et. al., 2012
Modified from Chamot-Rooke et al., 2005
CONCLUSION

OPEN DOOR:

6: Ioannina for 60-80 mbo
7: PatraiKos for 200 mbo
8: Katakilon for 3mbo
1. Central Greece: Mesohellenic biggy-back basin

2. Western Greece
   Ioannena-Kalpaki
   Diapontia Islands
   West of Corfu
   Preveza - Arta
   Patraikos
   West of Zakynthos
   Kyparissiakos
   West of Strofades

3. Crete: NW Basins (Platanos-Kasteli-Maleme), Onshore Messara & Ierapetra Basins, Offshore Gavdos Basin

4. Southeast Aegean Sea
   Karpathos

5. North Aegean
   Lemnos Island
   Thasos Island
Thank you for your attention