Structural Elements and Petroleum Exploration on the Apulian Platform, Hellenic Fold and Thrust Belt, Zakynthos Island (western Greece)*

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Abstract

The Fold and Thrust Belt in the western part of the Hellenic foreland, has been examined with respect to its geotectonic evolution and source rock potential. The upper Miocene to Pliocene clastic sedimentary sequence provides a great opportunity to reconstruct the regional Fold and Thrust development and to estimate its oil and gas generation potential. The occurrence of a late Oligocene in age, slumped interval suggests intense slope instability. This interval was initially accumulated in a deep water depositional environment, as evidenced by the common occurrence of both complete and incomplete Bouma sequences and is most likely related to the Ionian thrust activity. It is thus envisaged that the Ionian thrust should be positioned further westwards of the Zakynthos Island. The former Ionian thrust should most likely correspond to a younger, smaller scale and of local influence tectonic event. A total number of twenty seven mudstone samples were analyzed using Rock-Eval pyrolysis method. Organic geochemical data indicate that the containing organic matter is present in sufficient abundance and with good enough quality to be regarded as potential source rocks. The present Rock-Eval pyrolytic yields and calculated values of hydrogen and oxygen indexes imply that the recent organic matter is of Types II and III kerogen. The observed kerogen types suggest both gas and oil generation potential. The thermal maturity assessed from Tmax suggests an immature stage of the organic material along with the occurrence of layers having reached the very early mature stage.

Selected References


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Western Greece represents the southern edge of the Alpine orogenic system of the Periadriatic chains.

Developed by the relative motion of the African and Eurasian tectonic Plates since the Mesozoic.

It is composed of the most external zones of the Hellenic FTB namely, Gavrovo, Ionian and pre-Apulian zones.
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 Tyrrenian sea,
15. South Apennine.

✓ Pre-Apulian zone is bounded to the west by the Apulian platform while eastwards it is bounded by the Ionian Zone.

✓ Pre-Apulian zone is extended from the southwestern Albania, is exposed in the Ionian Islands and do not extend much further south than Zakynthos Island.

✓ Ionian zone is exposed from southwestern Albania to the southern parts of Greece.
Stratigraphy of Ionian zone Zelilidis et al., 2003
Clastic deposits of Miocene and Pliocene

Karakitsios & Rigakis 2007
Konstantopoulos & Zelilidis, 2012
- 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
The study area is situated at the western part of Greece, at the southern edge of the Dinarides-Albanides-Hellenides active margin.

It has been influenced by both a compressional and an extensional tectonic regime.

Zakynthos Island is part of the parautochthonus Apulian lithospheric plate of Hellenic mountain belt and contains rocks of two different geotectonic zones:

- the western Pre-Apulian zone and
- the eastern Ionian zone
The region under study was influenced by the Ionian thrust during the early Pliocene. As a result, the area was fragmented and separated into two discrete sedimentary basins, the westward Alikanas foreland basin (hosting the oldest rocks seen in the area) and the eastward Gerakas piggy-back basin.

The study area was served as a continental shelf during Tortonian and thus, mudstones that contain rare sandstone beds were accumulated (Keri area).

Messinian evaporites have been also identified (Agios Sostis area). Such salts evolve into a depositional sequence that contains evaporitic beds of turbiditic origin and further upslope, early Pliocene deep-sea sands.

The sedimentation develops with the deposition of shelf deposits with hummocky cross-stratification. This depositional environment is represented by “trubi” marly limestone.
Tectonostratigraphy

• The activity of the Ionian thrust during the early Pliocene is the most important tectonic event that affected the study area. This orogenic event separated the main basin into two discrete sub-basins, a westward foreland and an eastward piggy-back basin.

• The foreland basin is typified by major NNW – SSE anticline, which is cross-cut by both eastward and westward directed faults. Vrachionas anticline was developed during the Pliocene as part of the foreland-propagating fold and thrust system within Pre-Apulian zone.

• The Pre-Apoulian zone is characterized by a compression regime, after Miocene time, followed by a Pliocene extension regime.

• Nowadays, there is a shift in the tectonic regime and the study area is typified by a NNE – SSW directed regime.

• Finally, palaeomagnetic measurements indicate a late Pleistocene 25° clockwise rotation.
**Section one:**

This section is cited at the southern end of Keri gulf. It is 8 m in total thickness and is composed of at least eight coarsening upward sedimentary cycles. Each cycle is up to 1m in total thickness and is represented by a basal mudstone that evolves upslope into coaly beds. Coals are with 30cm in total thickness.

**Section two:**

This section corresponds to the laterally equivalent of section one is located at Keri gulf and is presented with up to 6 meters total thickness.

This outcrop consists of a basal grey/brown mudstone up to 25cm thick interbedded with thin-bedded sandstones. There is an upward increase in mudstone-sandstone ratio.
Section three:
This section is located northeast of the section two between the Keri gulf and Agios Sostis peninsula.

In this area a sedimentary succession with up to 65m in total thickness is exposed.

This sequence is characterized by a thick slump horizon, placed at the top and with 25m in total thickness.

This slump horizon overlies sandstone beds, one meter thick with no evidence of deformation.

The deformation unit underlies undisturbed mudstone strata.

Throughout the sedimentary sequence Bouma subdivision are the dominant sedimentary features.
The western margins of Pindos foreland during the last stage of sedimentation, when the foreland basin changed to piggy-back basin.
Thick slumped Oligocene turbiditic deposits within Miocene shelf deposits
Sedimentary structures within slumped horizon
Section four:

This section represents the upper parts of the studied stratigraphy.

In the current research samples were collected at the base of the section.

The upper parts of both sections four and five are represented by carbonates.

The “Trubi” marly limestones are considered as the typical early Pliocene sedimentary facies of the Mediterranean.

Such facies are overlain the turbiditic sequence, which contains sandstone and re-sedimented evaporitic turbidites.

Both the upper part of the studied section four (overlying the stratigraphic column of this work), and the upper part of the Kalamaki cross-section (Section five) consist of the typical for the Mediterranean environment during the Early Pliocene, "trubi" marly limestone, formed over Pliocene turbiditic sequence, with sandstone and resedimented evaporitic clasts turbidites.
One cycle of section four at Agios Sostis and fourteen cycles of section five in Kalamaki display the influence of the Ionian thrust during the depositional evolution.

The section five is intimately related to the activity of the Ionian thrust because of its proximity to the thrust front whereas; the remotely positioned section four is little influenced by the thrust activity.
Publications for this region from our lab


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