- ΓΕΩΛΟΓΙΚΕΣ ΚΑΙ ΓΕΩΧΗΜΙΚΕΣ ΕΝΔΕΙΞΕΙΣ ΠΟΥ ΥΠΟΔΕΙΚΝΥΟΥΝ ΤΗΝ ΥΠΑΡΞΗ ΑΠΟΘΕΜΑΤΩΝ ΥΔΡΟΓΟΝΑΝΘΡΑΚΩΝ:
- 1. Η ΣΥΓΚΛΙΣΗ ΤΩΝ ΛΙΘΟΣΦΑΙΡΙΚΩΝ ΠΛΑΚΩΝ
- 2. Η ΥΠΑΡΞΗ ΥΠΟΘΑΛΑΣΣΙΑΣ ΡΑΧΗΣ ΜΕ ΠΡΙΣΜΑΤΑ ΠΡΟΣΑΥΞΗΣΗΣ
- 3. Η ΥΠΑΡΞΗ ΕΝΕΡΓΩΝ ΛΑΣΠΟΗΦΑΙΣΤΕΙΩΝ ΠΟΥ ΕΚΛΥΟΥΝ ΘΕΡΜΟΓΕΝΕΤΙΚΟ $^{13}CH_4$ ΜΕ $C_1/C_{2+} > 80$
- 4. Η ΥΠΑΡΞΗ ΠΟΛΥ ΜΕΓΑΛΩΝ ΠΟΣΟΤΗΤΩΝ ΥΔΡΙΤΩΝ ΘΕΡΜΟΓΕΝΕΤΙΚΗΣ ΠΡΟΕΛΕΥΣΗΣ

ΠΡΙΣΜΑΤΑ ΠΡΟΣΑΥΞΗΣΗΣ: ~1.500 km Μήκος, ~50 km Πλάτος,

Επιφάνεια ~75.000 km2

Γεωδυναμική περιγραφή της Λεκάνης Ανατολικής Μεσογείου: Α Μεσογειακή Ράχη και Β Αβυσσική Λεκάνη του Ηροδότου, Barrier et. al., 2004.

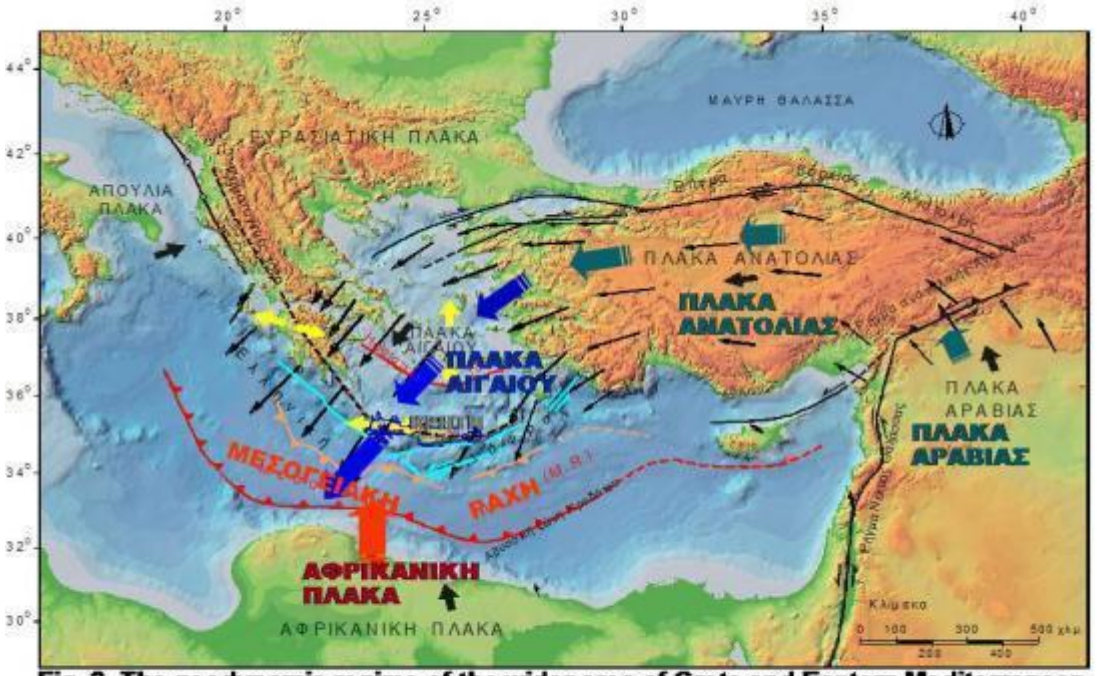


Fig. 2. The geodynamic regime of the wider area of Crete and Eastern Mediterranean. Arabian plate pushing counterclockwise the Anatolian plate which in turn pushes sideways the Aegean plate. The latter overrides the African plate which subducts under the island of Crete, Pavlaki, 2006

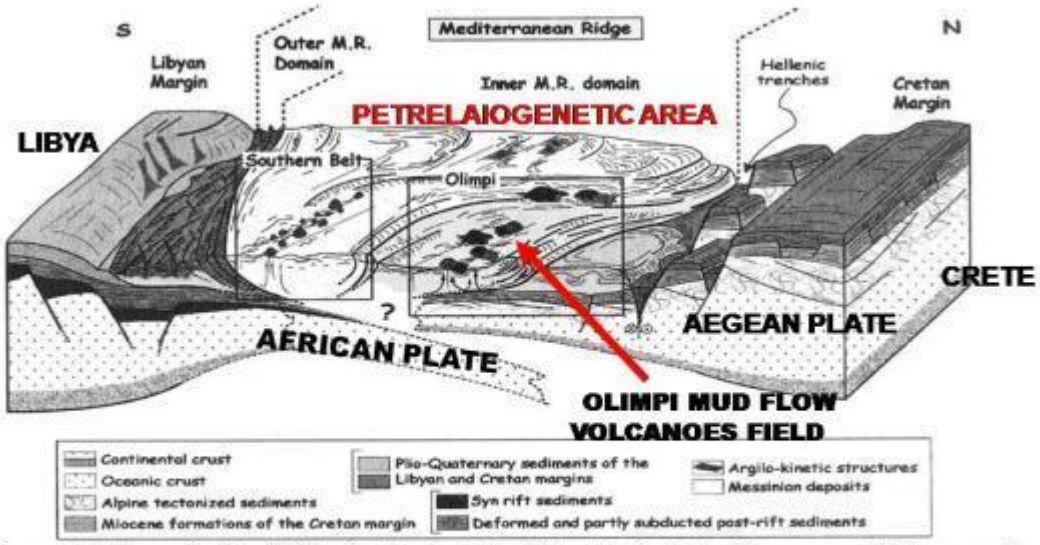
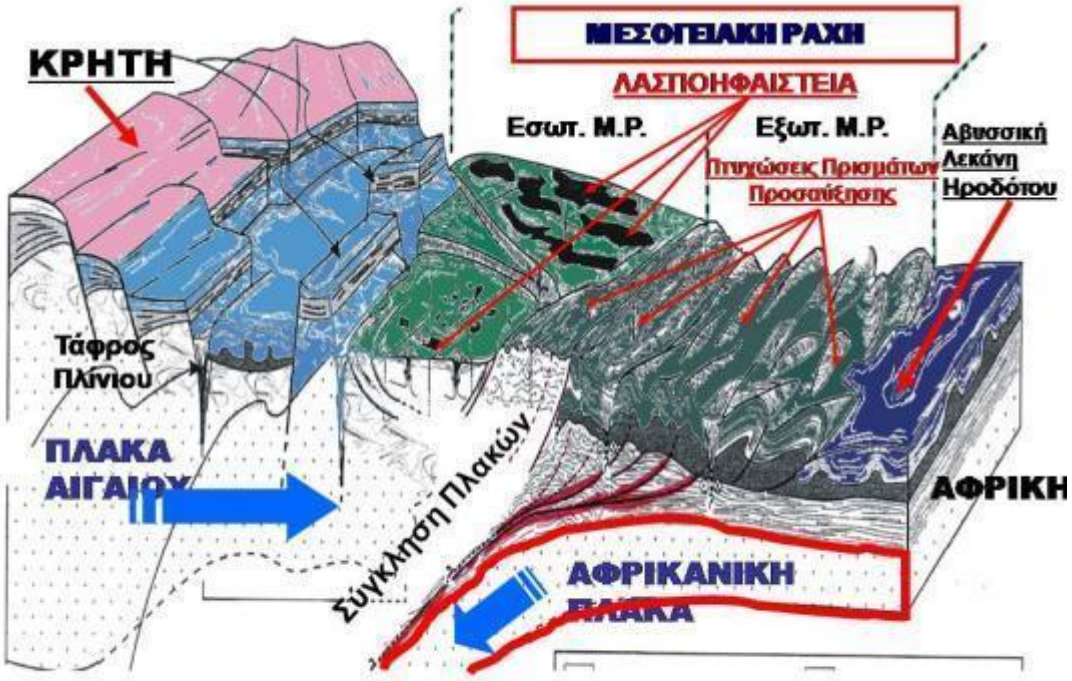


Figure 4. Interpretative 3D tectonic sketch of the Central Mediterranean Ridge and the Olimpi and the Southern Belt mud fields. Two different source levels are proposed for the two mud fields, the Olimpi field being related to relatively shallow mud formations, with high fluid contents and the Southern field being connected to deeper mud sources with lower fluid contents, Huguen, et. al., 2005



Ανάγλυφη Απεικόνιση Παρουσίας Λασποηφαιστείων, Λεπιώσεων & Πτυχώσεων Πρίσματος Επαύξησης, βάσει ερμηνείας πρόσφατων Σεισμικών Καταγραφών Ανάκλασης Νότια της Κρήτης, Μουντρακης,2001, Παυλάκη, 2006

Multi-Client Promotional Presentation of PGS by J. Robinson at the ministry of Energy and Climatic Changes, Athens, Greece (ΥΠΕΚΑ), 2011

Summary of the South Mediterranean Sea offshore Crete

- **Hydrocarbon seeps** have been recorded adjacent to mud volcanoes

- **Interpretation of deep seismic data suggests** not only the presence of Messinian salt, but also pre-Messinian sediment

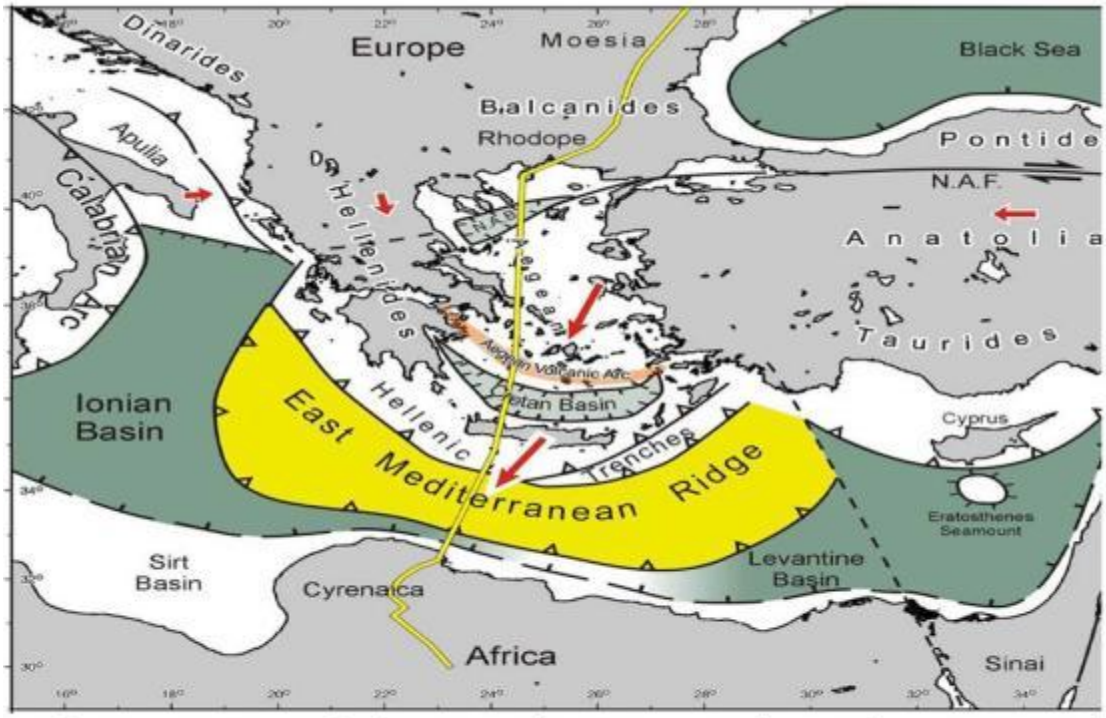
- Hydrocarbon analyses of mud from ODP cores **suggests the presence of an active hydrocarbon system at depth**

- Potential analogues to the Messinian facies in Libya and across the Mediterranean.

- High risks related to trapping mechanisms, however potential exists.

- **Accretionary prisms are productive across the world**

i.e. (Barbados, West Timor, Irrawady-Andaman Oceanic Island Arc system)



Εικόνα 13. Η Μεσογειακή Ράχη και τα κύρια γεωτεκτονικά στοιχεία στην Ανατολική Μεσόγειο και στην ευρύτερη περιοχή της γεωτομής VII από την Μοισία έως την Κυρηναϊκή Papanicolaou et. al., 2004

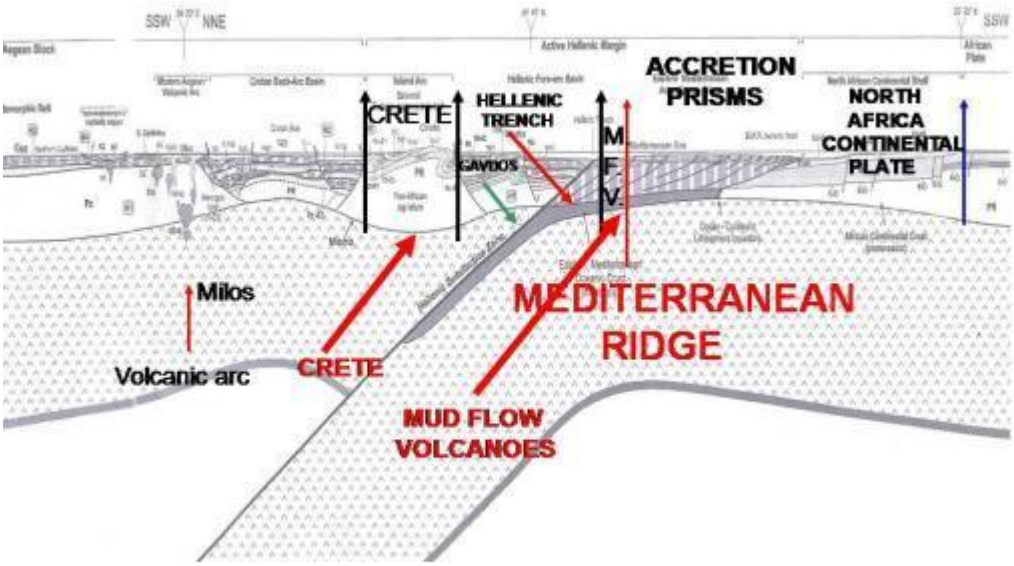
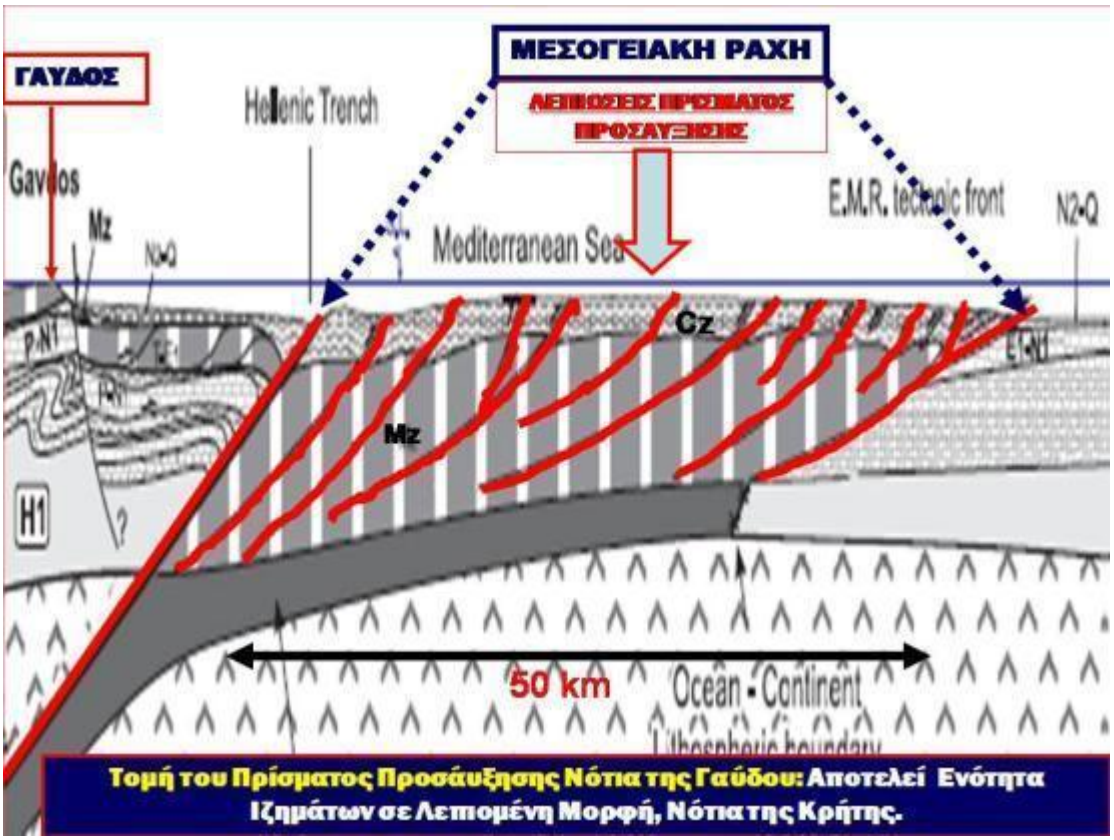
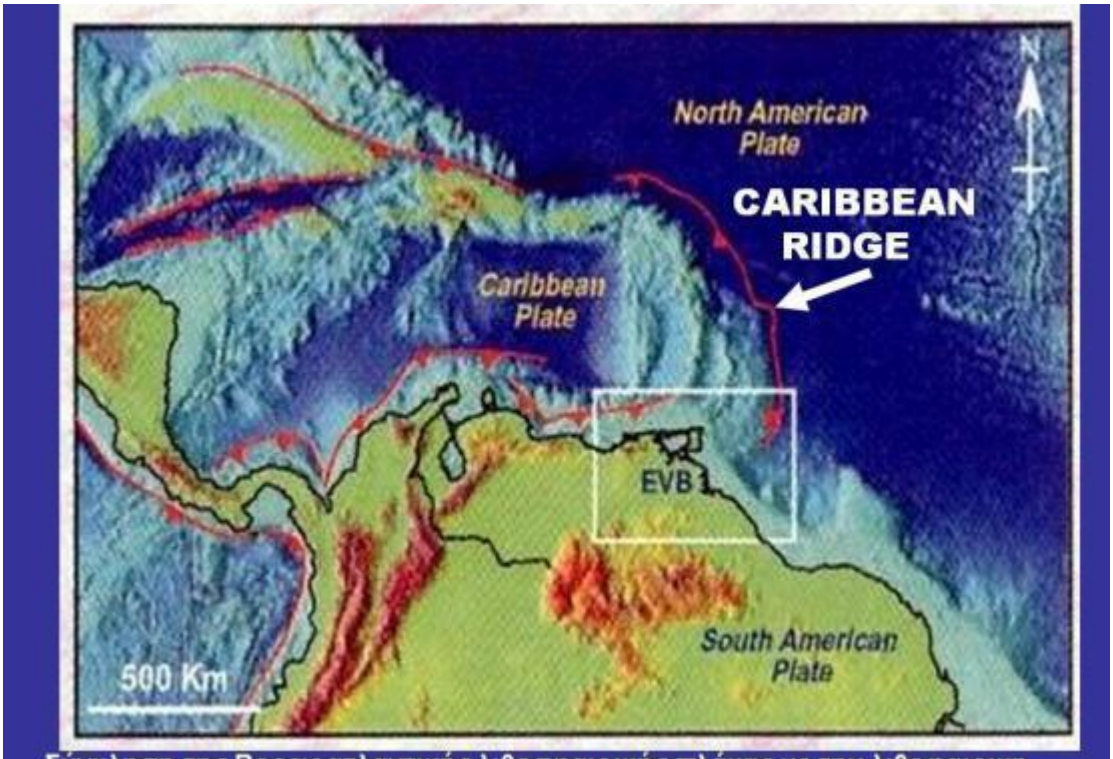
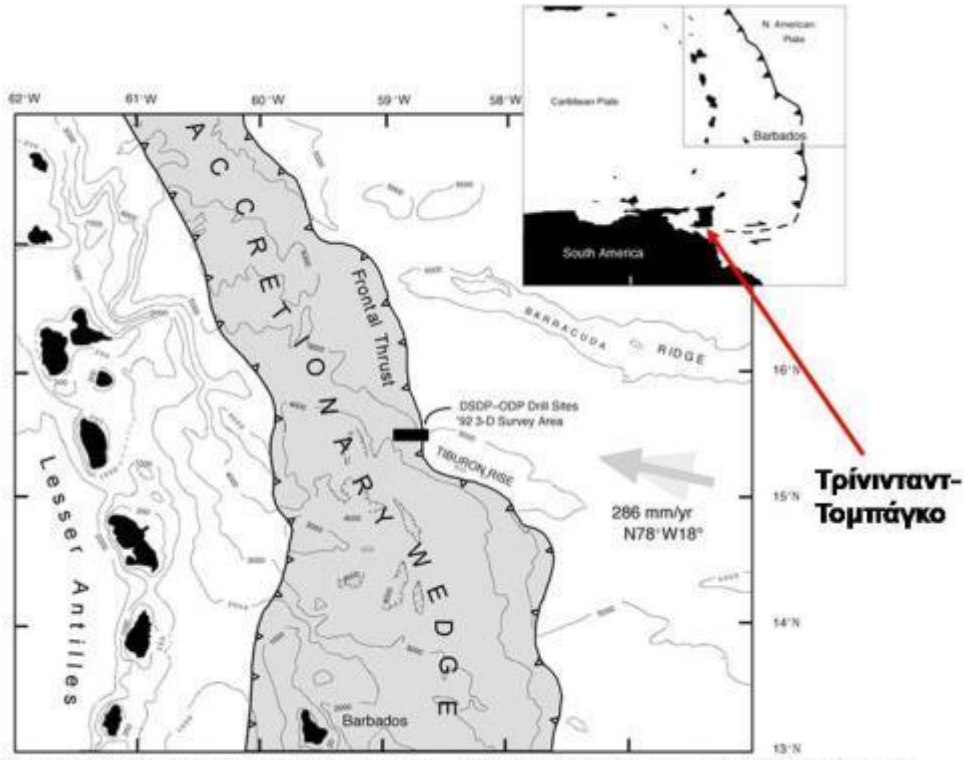


Figure 7. Portion of the Transmediterranean section, (Transmed. VII), starting from Cyrenaica and ending in the Aegean volcanic arc. Papanicolaou et. al., 2004 from Gavazza et. al., 2004



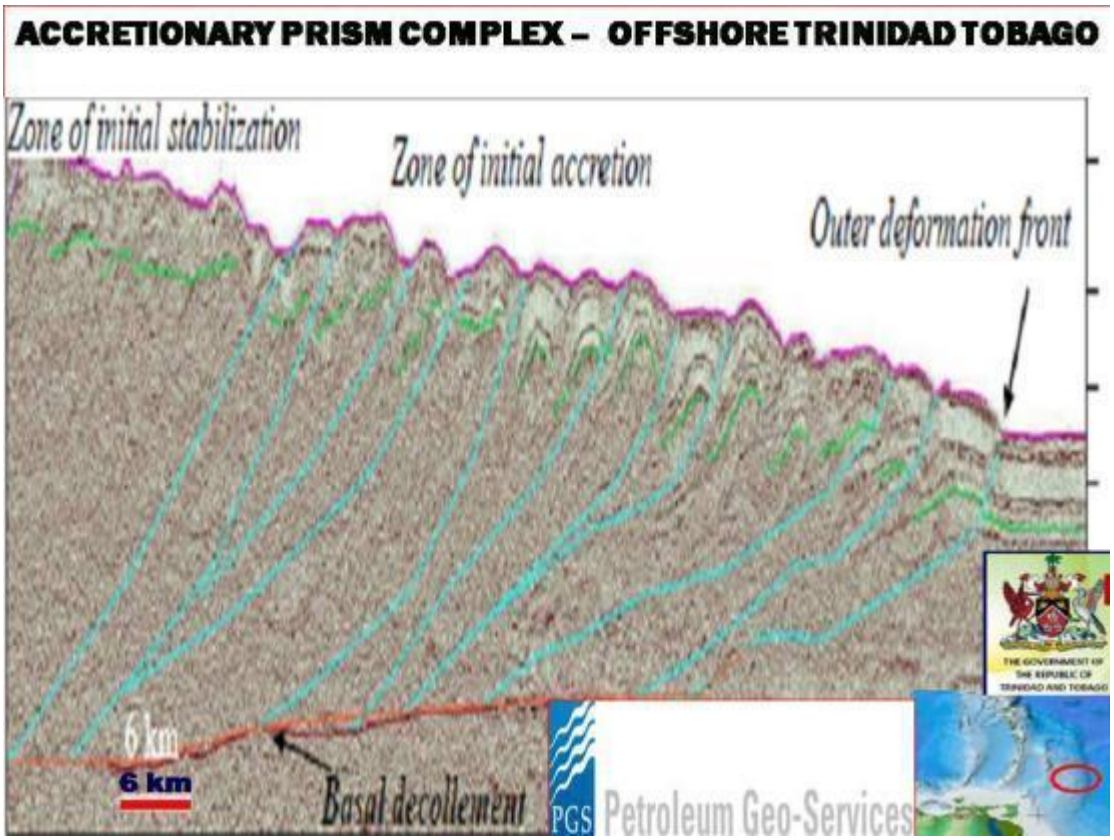


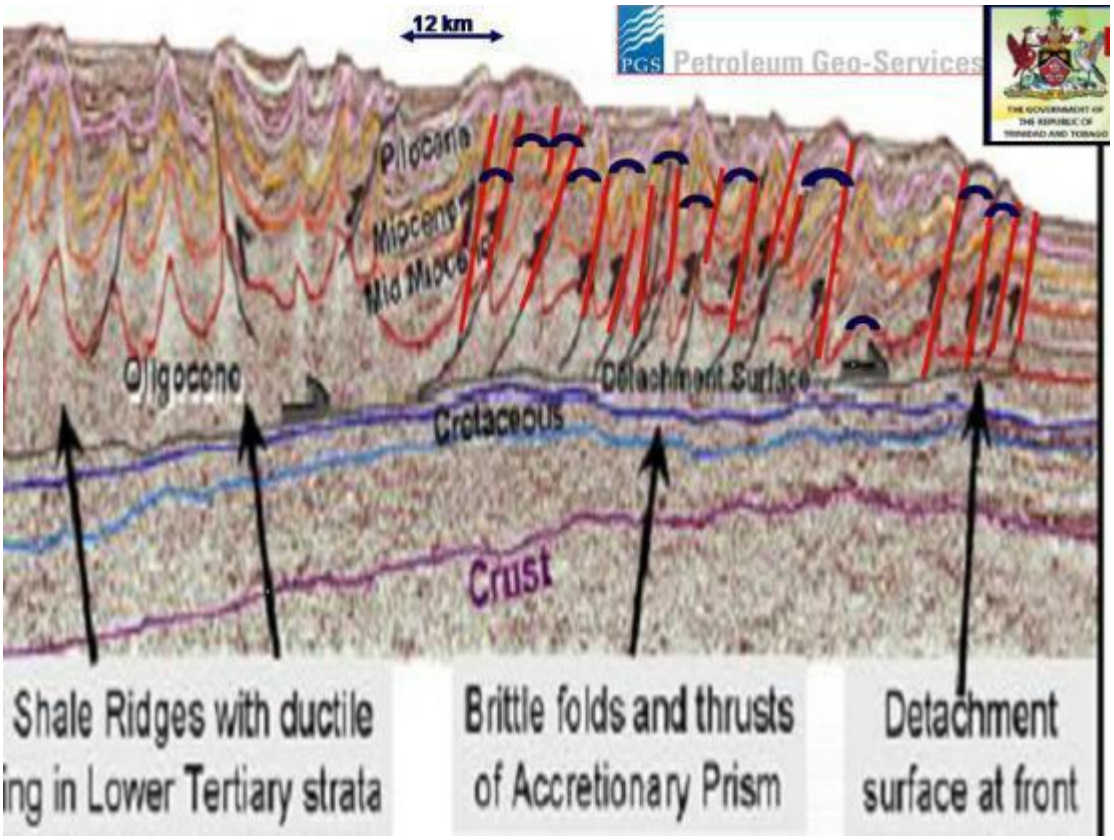
Σύγκληση της Βορειοατλαντικής λιθοσφαιρικής πλάκας με την λιθοφαιρικη πλάκα της Καραβαικής. Δημιουργία της Καραβαικής Ράχης

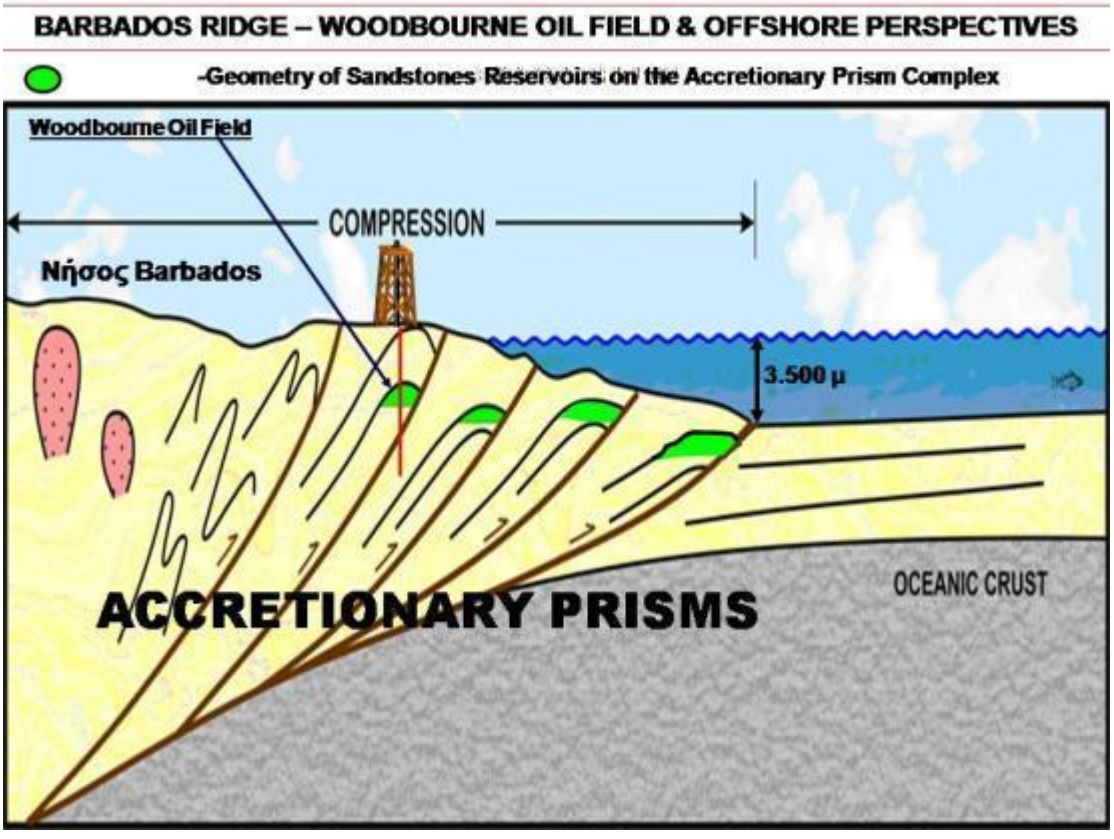


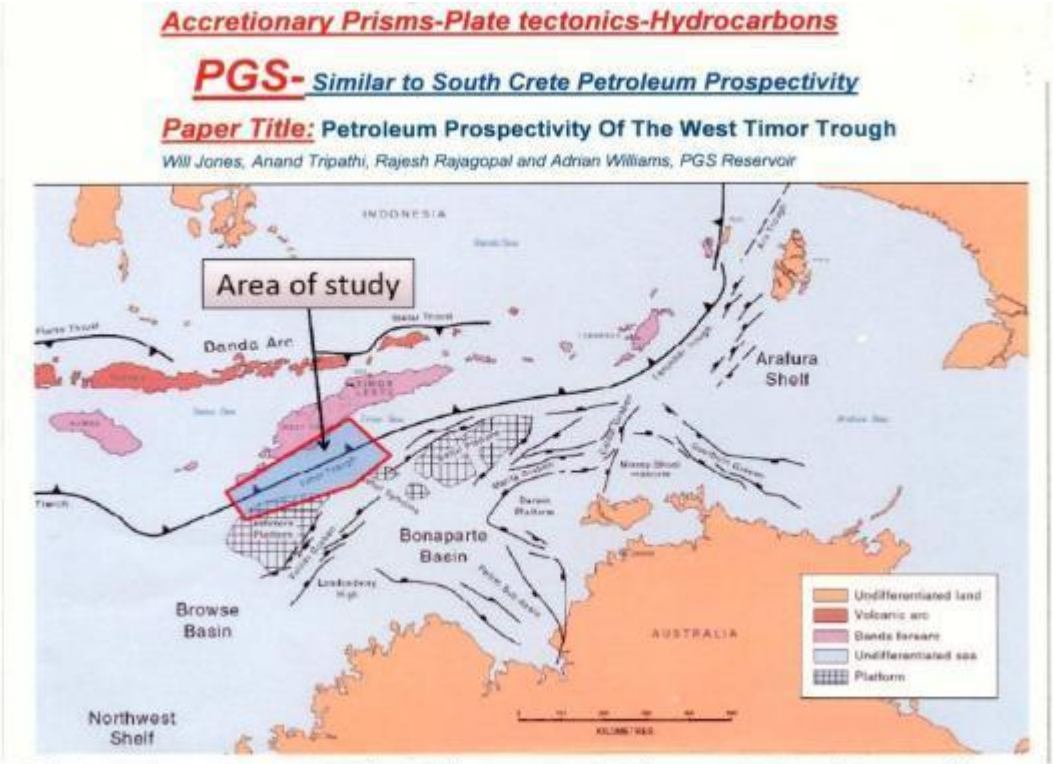
Πρίσματα προσαύξησης στην Καραβαϊκή θάλασσα μπροστά από τις Μικρές Αντίλλες νήσους


Exploration Opportunities for Trinidad and Tobago Deep Atlantic
THE GOVERNMENT OF THE REPUBLIC OF TRINIDAD AND TOBAGO
MINISTRY OF ENERGY AND ENERGY AFFAIRS
The Ministry of Energy and Energy Affairs
2012
BARBADOS
AREA OF ACCRETIONARY PRISMS
TRINIDAD
TOBAGO
100 km
PGS
Trinidad & Tobago Licensing Round on 40,000 km2 Blocks, waters depths ranging from 1.000m to 3.500m.

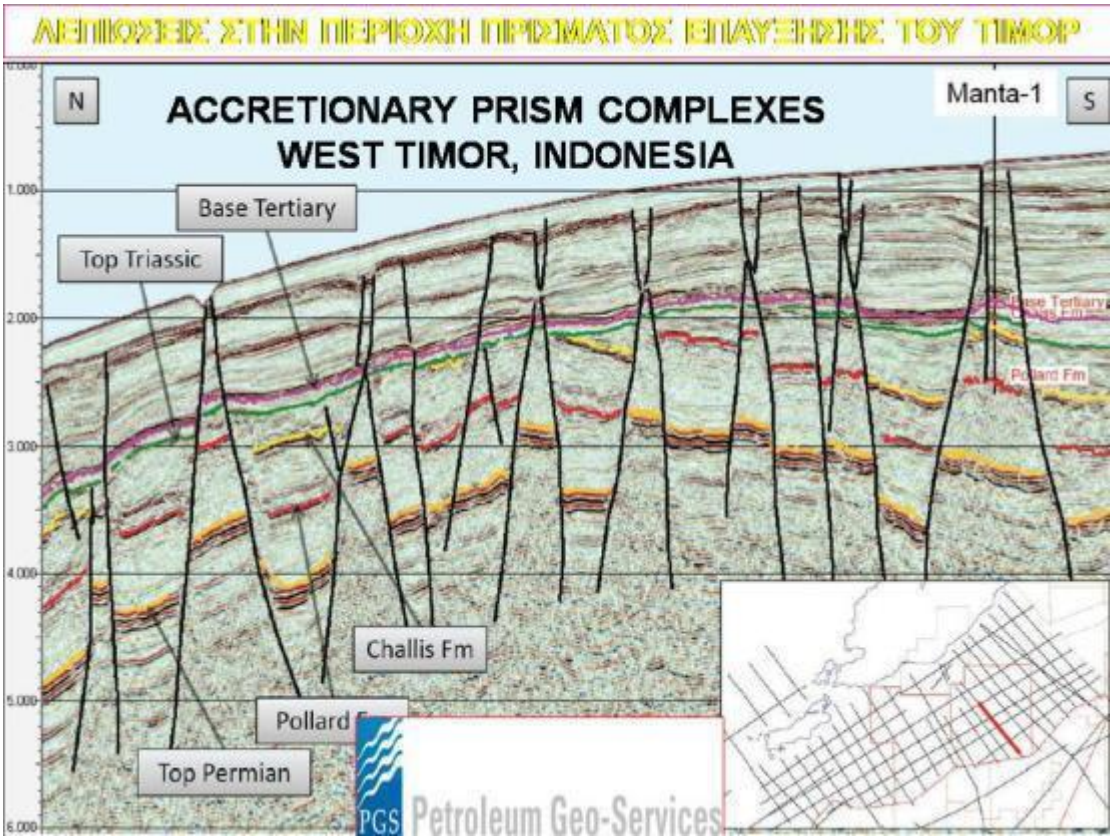

ACCRETIONARY PRISM COMPLEX – OFFSHORE TRINIDAD TOBAGO
Zone of initial stabilization
Zone of initial accretion
Outer deformation front
6 km
6 km
Basal decollement
PGS Petroleum Geo-Services

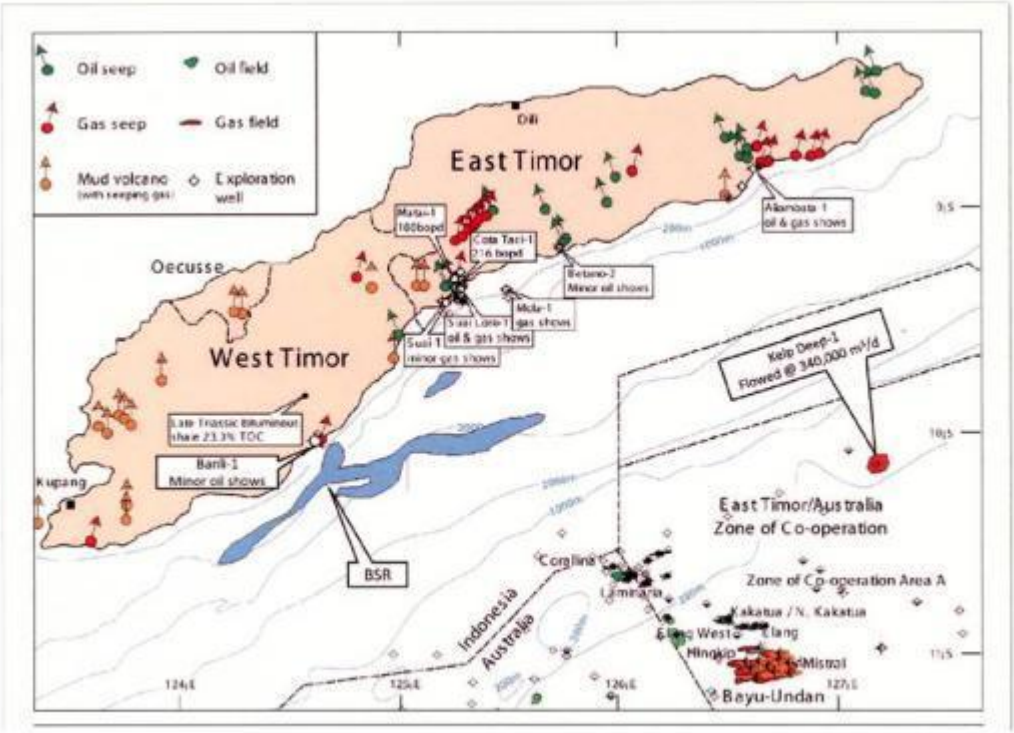

12 km
PGS Petroleum Geo-Services
Pliocene
Miocene
Mid Miocene
Oligocene
Detachment Surface
Cretaceous
Crust
Shale Ridges with ductile
ing in Lower Tertiary strata
Brittle folds and thrusts
of Accretionary Prism
Detachment
surface at front


BARBADOS RIDGE – WOODBOURNE OIL FIELD & OFFSHORE PERSPECTIVES
-Geometry of Sandstones Reservoirs on the Accretionary Prism Complex
Woodbourne Oil Field
COMPRESSION
Νήσος Barbados
3.500 μ
ACCRETIONARY PRISMS
OCEANIC CRUST

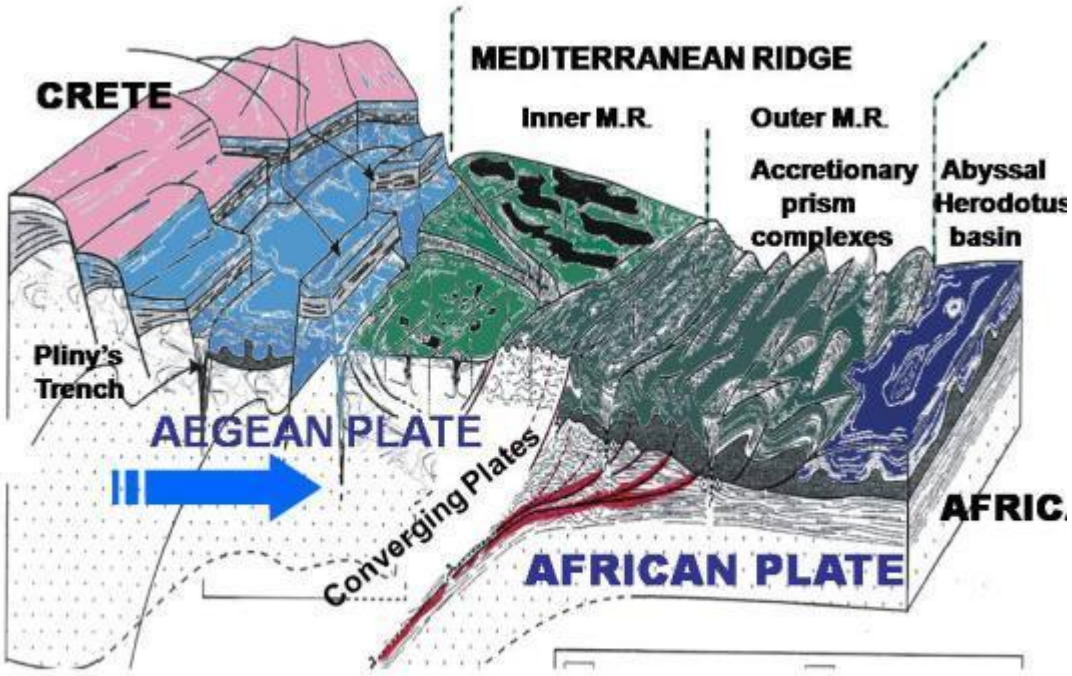


Σύγκληση της Αυστραλιανής Πλάκας με την Πλάκα του Ινδικού Ωκεανού στην νήσο Τιμόρ, Ινδονησία. Δημιουργία Ράχης. Ομοιότητα με Κρήτη





Oil and gas fields in East Timor, Indonesia. (Κοιτάσματα Υδρογονανθράκων στη νήσο Τιμόρ, Ινδονησία)



Fig, 3. Conversion of the African plate with the Aegean plate south of Crete in the region of Eastern Mediterranean. Distortion of the wider sub-Sea region. Formation of trenches and the Mediterranean Ridge, Pavlaki, 2006

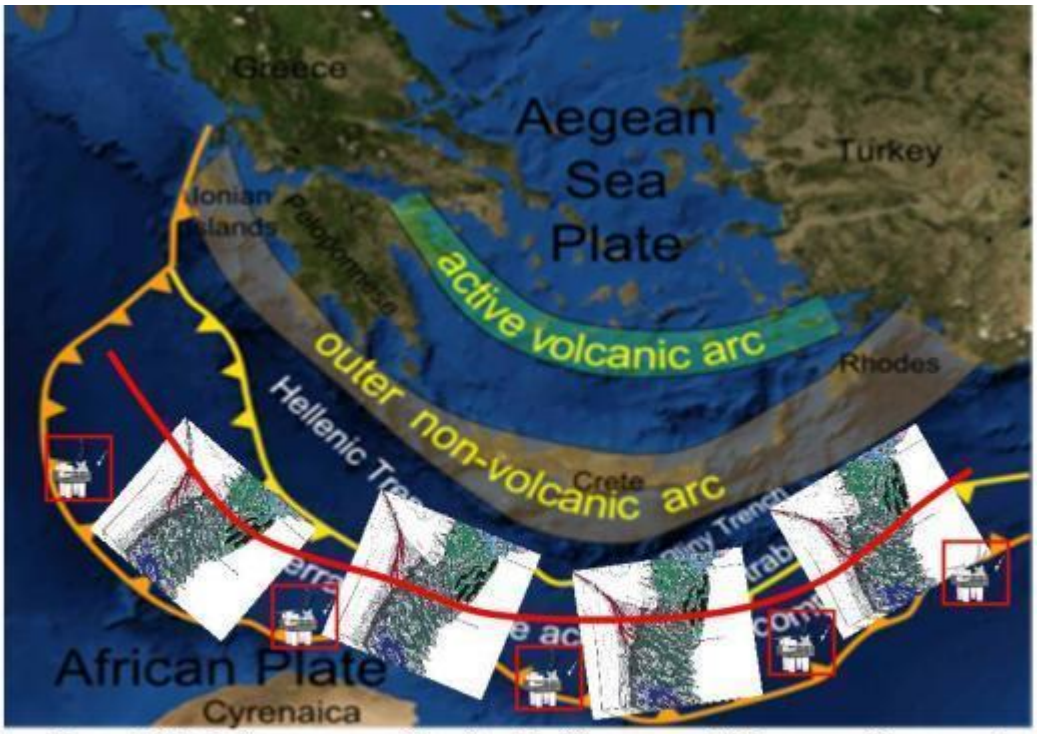


Figure 24. The Area covered by the Mediterranean Ridge accretionary prisms. Its implication for potential hydrocarbon reserves, en. Wikipedia org/…./Mediterranean Rid…

Figure 1. Geotectonic map of Eastern Mediterranean and Greece, Hachette literature generate, Paris, France, 1993.

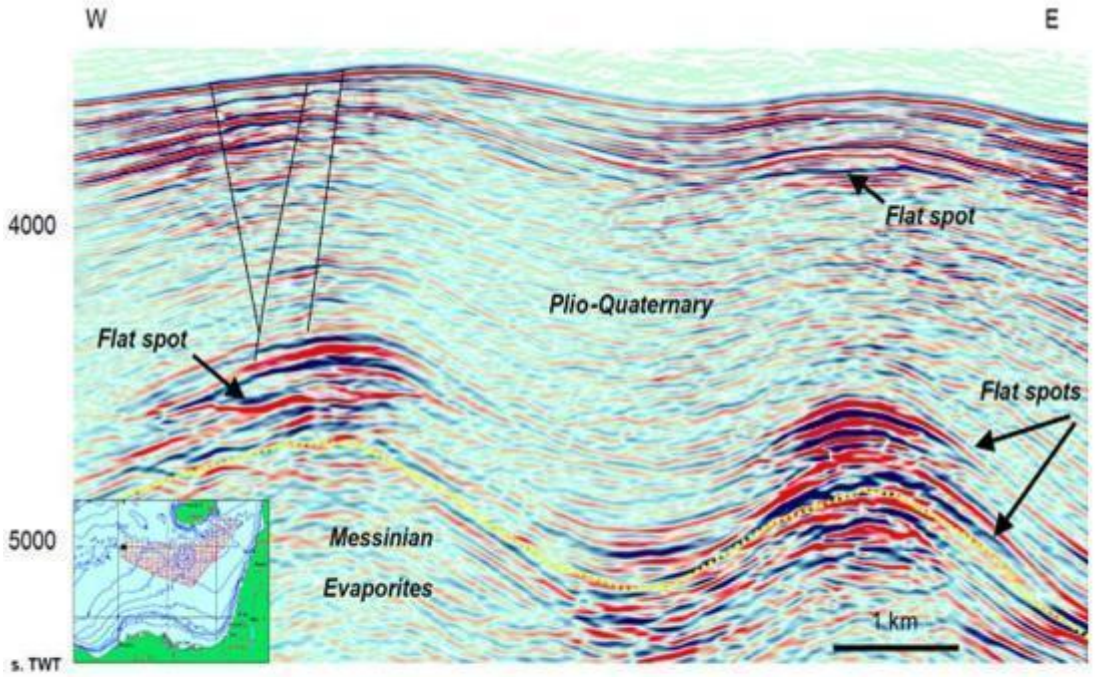
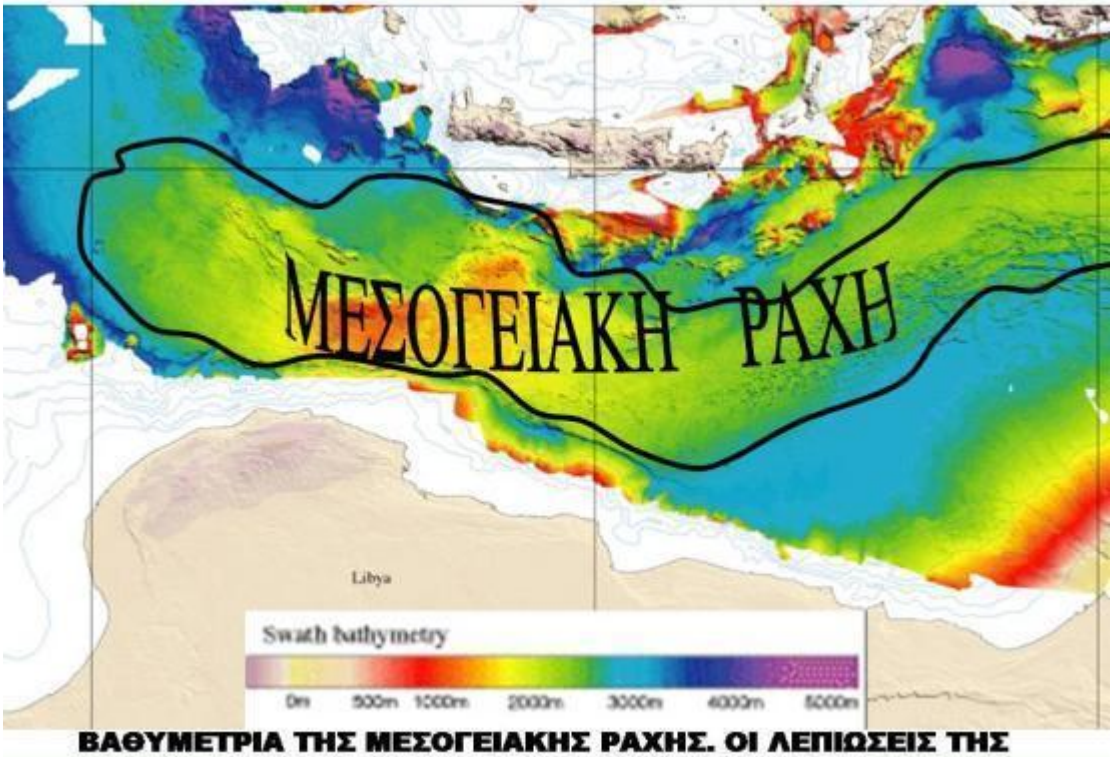
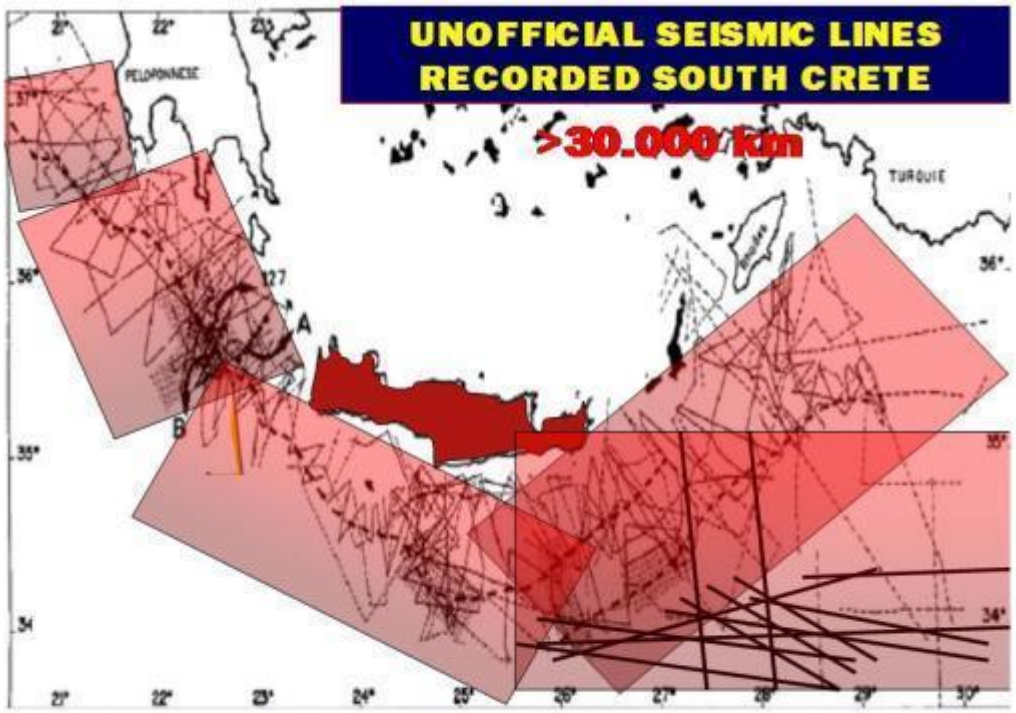


Figure 12a. Plio-Pleistocene salt-related anticlines with flat spots (Block 04) in the Mediterranean Ridge/Herodotus Basin, Montadert, et. al., 2010.



ΒΑΘΥΜΕΤΡΙΑ ΤΗΣ ΜΕΣΟΓΕΙΑΚΗΣ ΡΑΧΗΣ. ΟΙ ΛΕΠΙΩΣΕΙΣ ΤΗΣ ΡΑΧΗΣ, ΠΟΥ ΘΑ ΠΡΕΠΕΙ ΝΑ ΕΧΟΥΝ ΥΔΡΟΓΟΝΑΝΘΡΑΚΕΣ, ΒΡΙΣΚΟΝΤΑΙ ΣΕ ΒΑΘΗ ΜΙΚΡΟΤΕΡΑ ΤΩΝ 2500 Μ.



ΑΝΑΠΤΥΞΗ >2011 ΘΕΩΡΙΚΗΣ ΕΡΕΥΝΑΣ ΠΕΡΙ ΚΡΗΤΗΣ ΜΕΙΚΟΥΣ 30000 ΧΙΛΙΟΜΕΤΡΩΝ ΑΠΟΛΙΝΟΥΣ ΣΕΙΣΜΙΚΩΝ ΓΡΑΜΜΩΝ ΜΕ ΑΡΓΟΝ ΟΙ ΜΑΥΡΕΣ ΓΡΑΜΜΕΣ ΑΠΟ ΤΑ ΝΑΥΤΙΚΑ ΠΛΟΙΑ ΤΗΣ ΝΑΤΟ

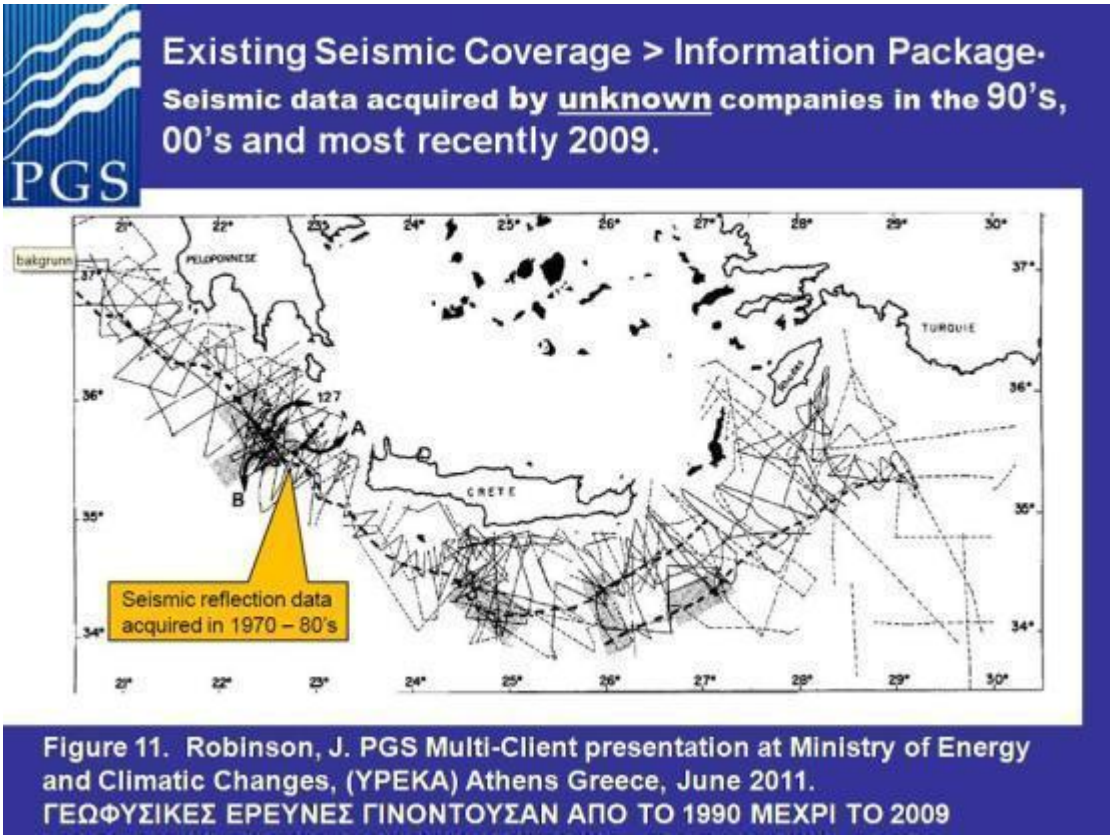


Figure 11. Robinson, J. PGS Multi-Client presentation at Ministry of Energy and Climatic Changes, (ΥΡΕΚΑ) Athens Greece, June 2011.
ΓΕΩΦΥΣΙΚΕΣ ΕΡΕΥΝΕΣ ΓΙΝΟΝΤΟΥΣΑΝ ΑΠΟ ΤΟ 1990 ΜΕΧΡΙ ΤΟ 2009

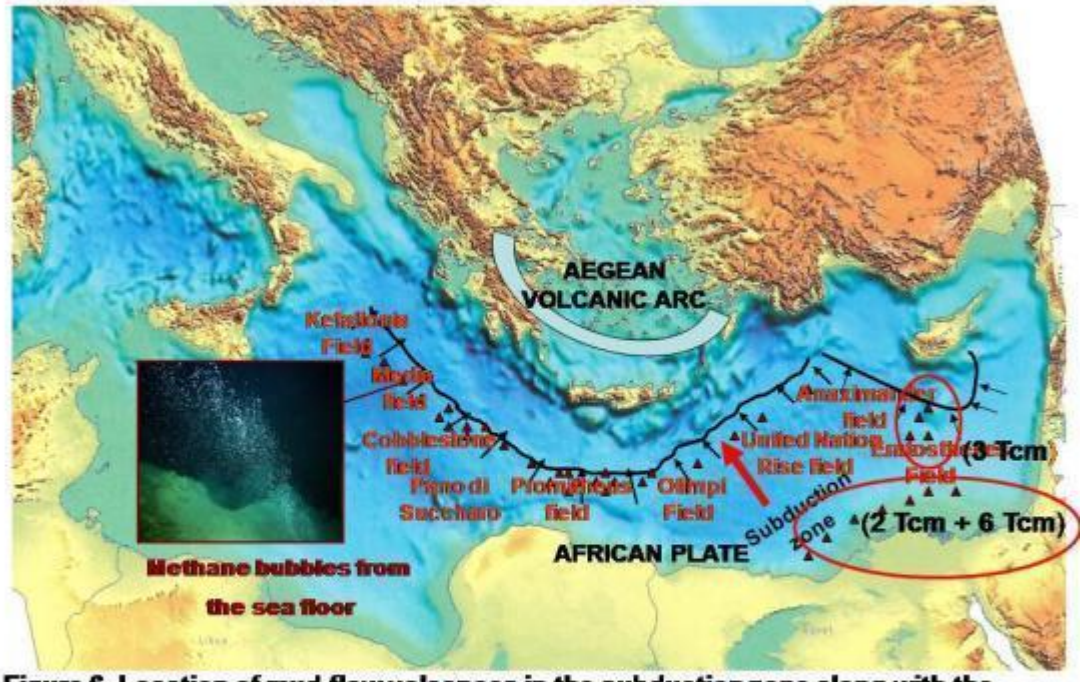


Figure 6. Location of mud flow volcanoes in the subduction zone along with the location of the Aegean volcanic arc. Location of the mud flow volcanoes in the Nile cone and the EEZ of Cyprus. In parenthesis the anticipated amount of natural gas to be found. Modified after Dimitov, 2002

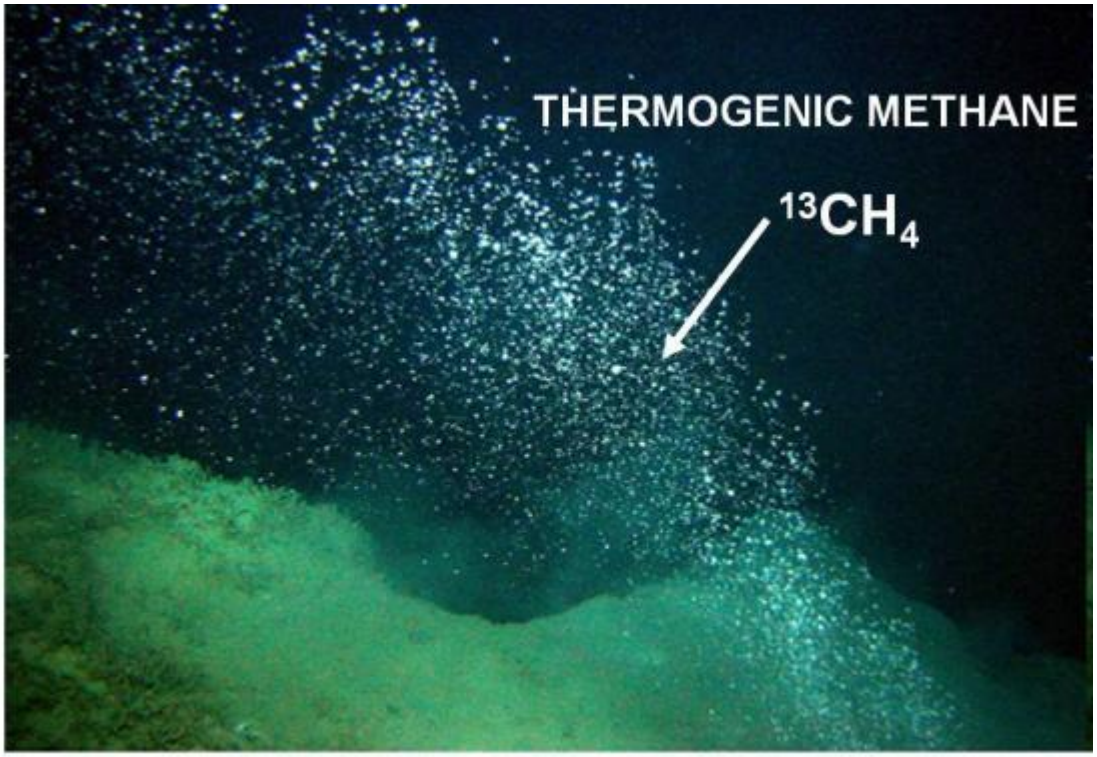


Fig. 9. Methane bubbles from the bottom of the Mediterranean Sea.
www.energybulletin.net/node/51517 - Cached - Similar

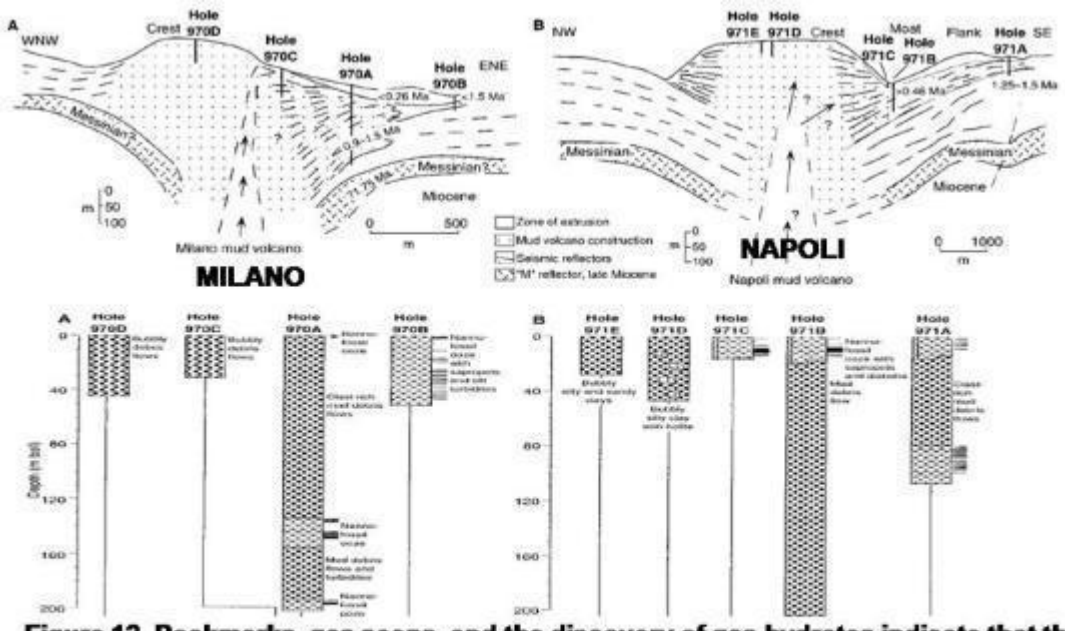


Figure 12. Pockmarks, gas seeps, and the discovery of gas hydrates indicate that the surrounding area is also actively degassing through a vent zone, of which the mud volcanoes are a part. The presence of thermogenic gas is inferred from the ratio of methane to heavier hydrocarbon gases,
indicating a deep source of origin, **Cronin et al., 1997; Robinson et al., 1996**

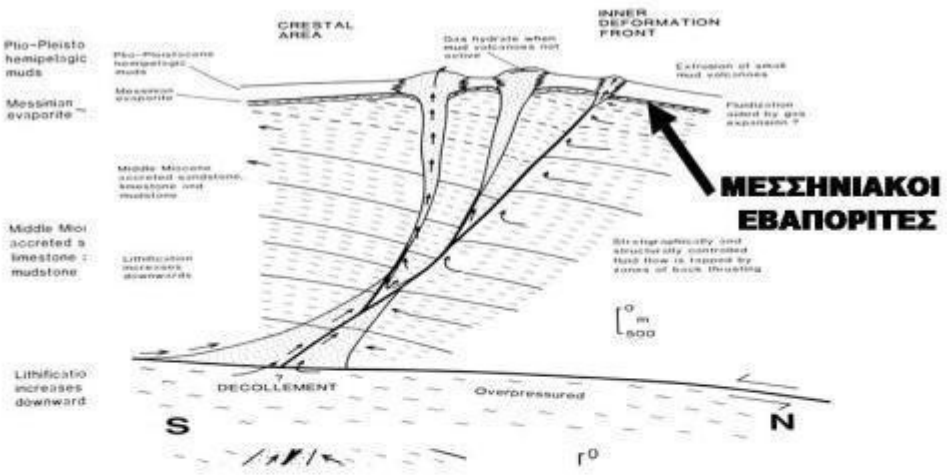


Figure 13. Revised model of mud volcanism on the Mediterranean Ridge accretionary complex, supported by petrographic and mineralogical data from Leg.160. Mud volcanism was initiated >1 Ma ago, following collision following collision of the to the Mediterranean ridge accretionary complex with a promontory of the North African passive continental margin, Robertson and Kopf, 1998

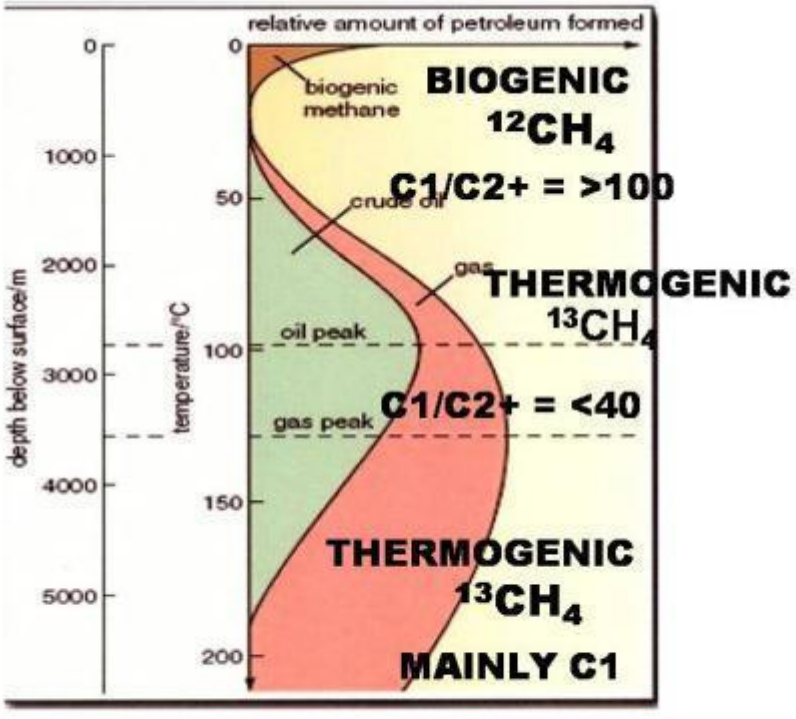


Figure 15. Generation of gases from organic matter with increasing temperature Buruss, and Laughrey, 2009

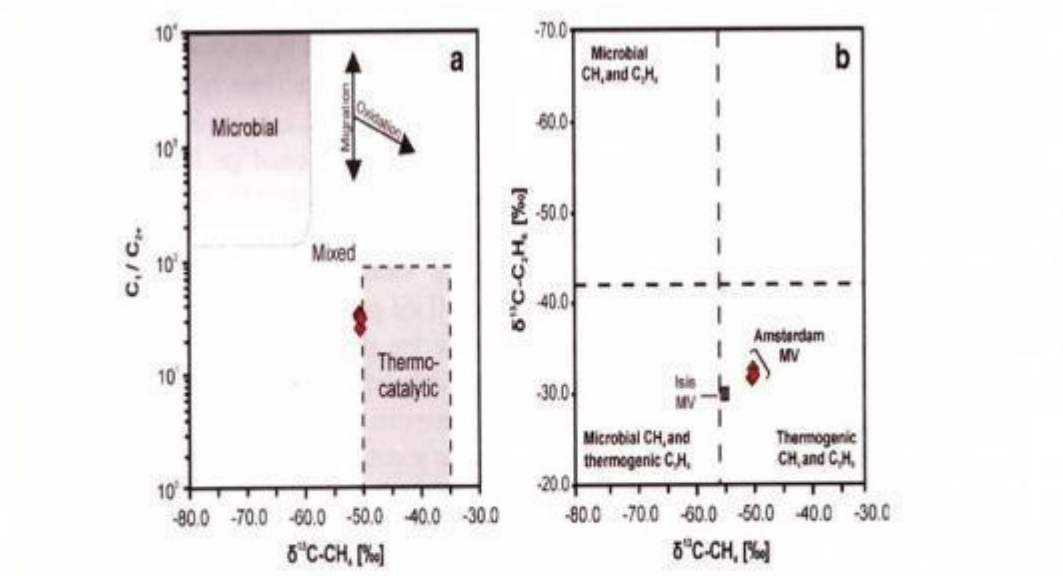
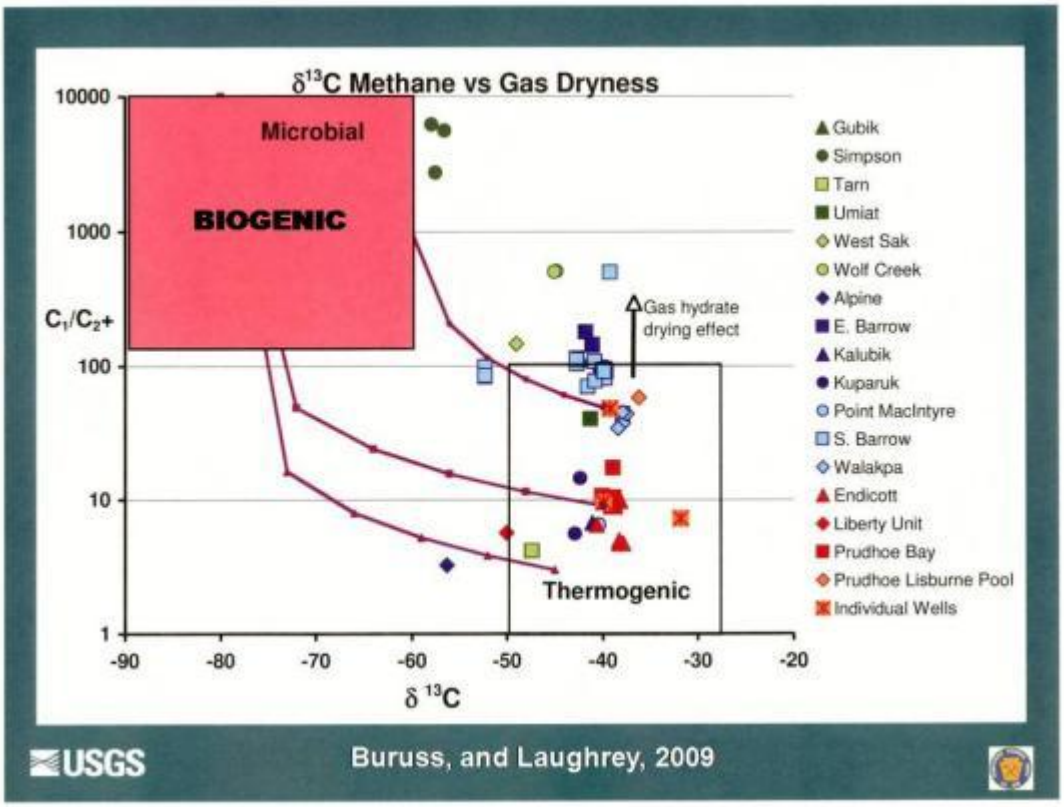


Figure 14. The relation of C_1/C_{2+} vs $\delta^{13}C\text{-}CH_4$ ($^0/_{00}$) and $\delta^{13}C\text{-}C_2H_6$ ($^0/_{00}$) vs $\delta^{13}C\text{-}CH_4$ ($^0/_{00}$) in Amsterdam Mud Flow Volcano, Anaximander Mountain, indicating the thermogenic origin of methane bubbles, Pape et. al., 2010



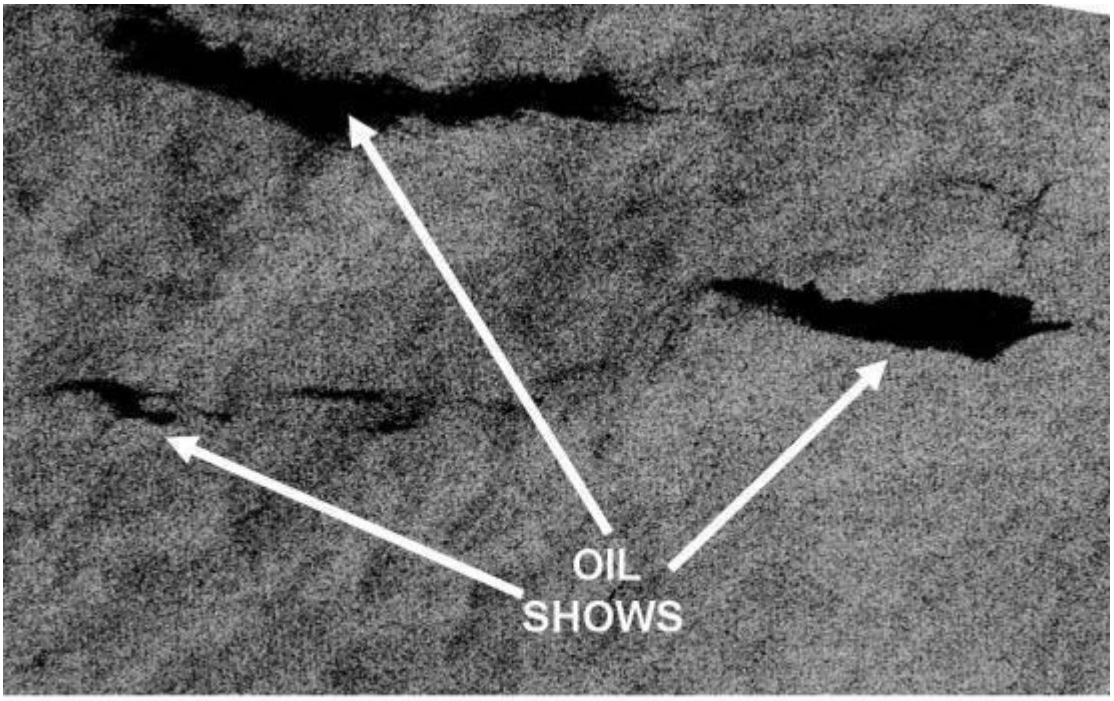


Figure 16. Oil shows resulting from escaping gas bubbles which are coated with oil. Gas bubbles are derived from Active Mud Volcanoes. in offshore Nile Cone, Egypt. Picture taken from satellites. Roberts and Peace, 2007

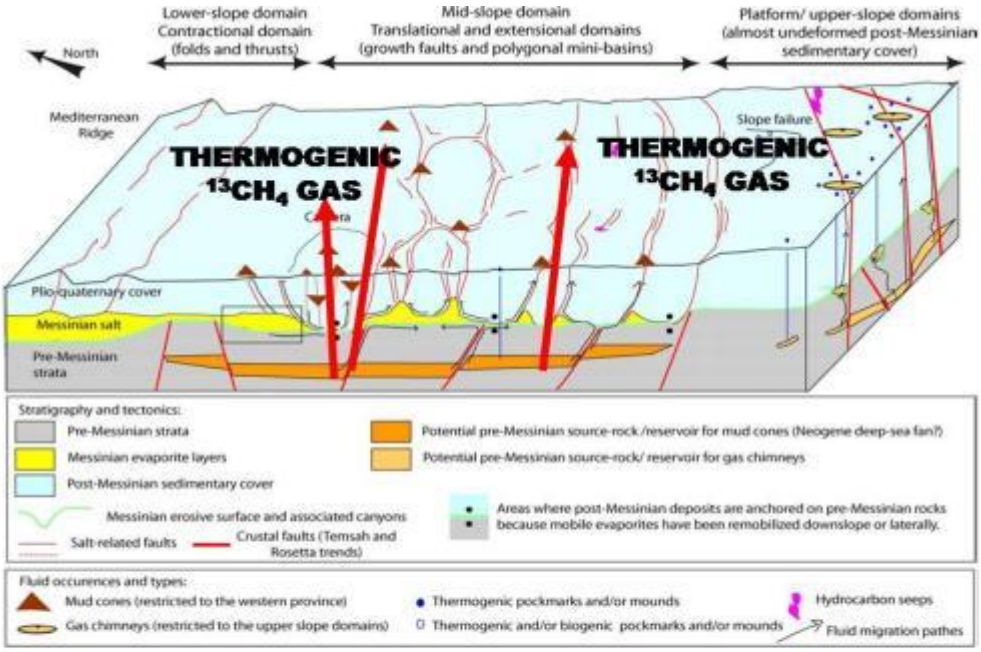


Figure 17. Active Mud Flow Volcanoes (brown triangles), Gas chimneys (brown discs), Thermogenic Pockmarks and Mounds offshore Southern Crete. The pre-Messinian source rocks/ reservoir for the mud cones (brown), are highly visible as well as the reservoir/source for the gas chimneys (light brown), are also visible, Loncke et al., 2004,

Figure 10. Hydrate from the Thessaloniki mud flow volcano of Anaximander mountains, Eastern Mediterranean, Lykousis et. al., 2004.

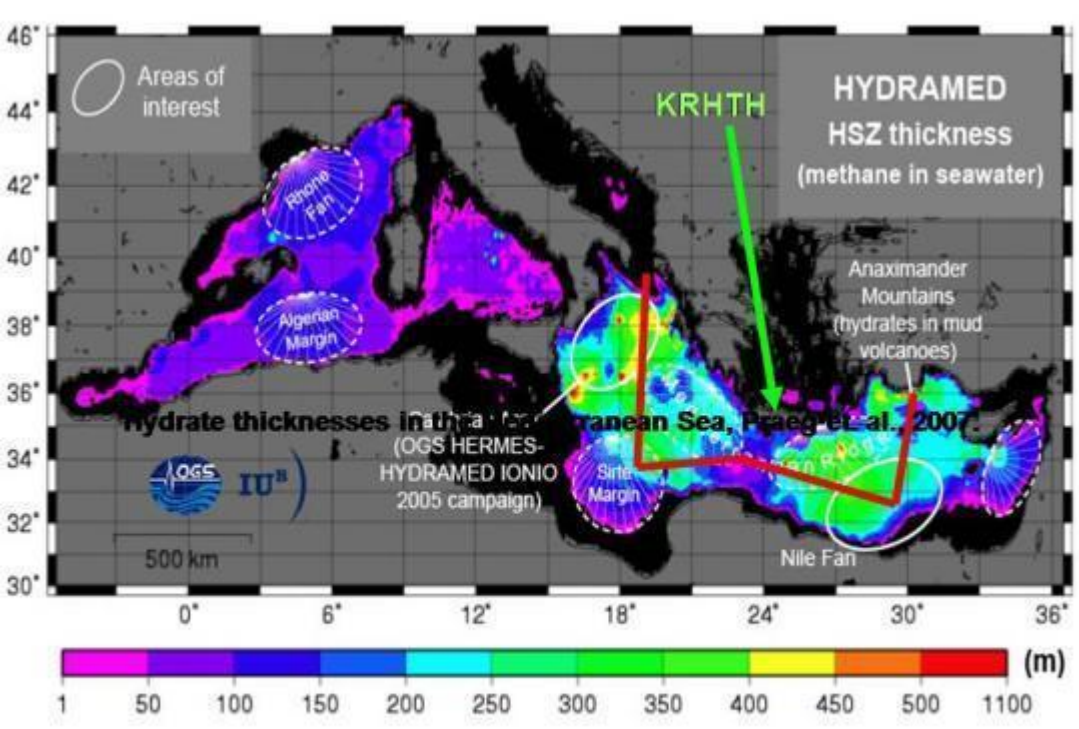


Figure 11. Hydrate thicknesses in the Mediterranean Sea, Praeg et. al., 2007.
Red line — denotes Greece's EEZ

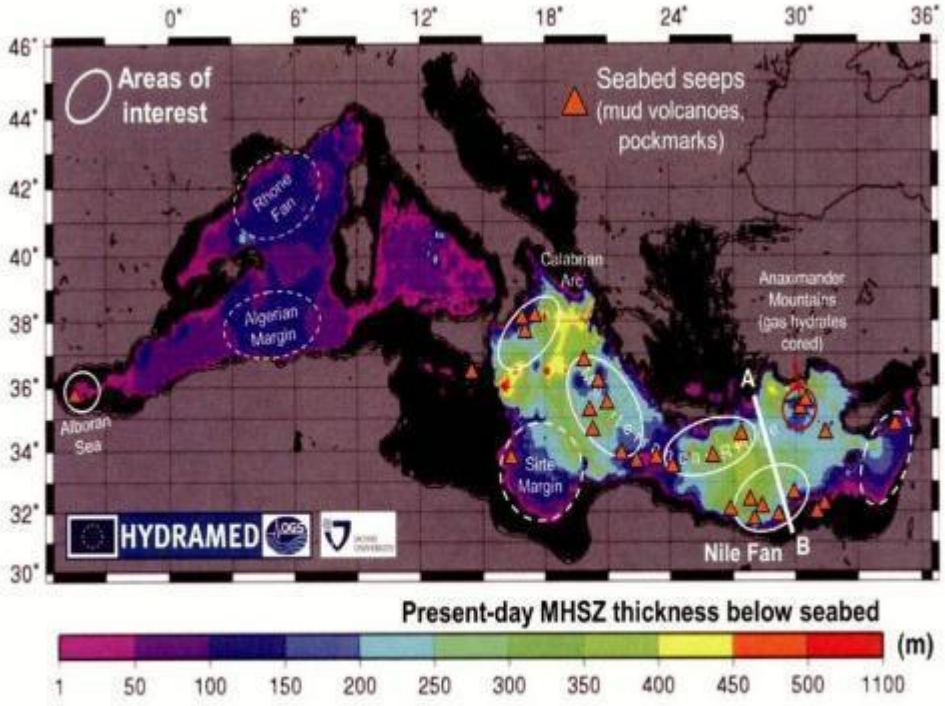


Figure 2. Modelled methane hydrate stability zone for present-day conditions, with areas of interest for hydrate occurrence; orange triangles indicate the general locations of known seabed seeps (various sources).

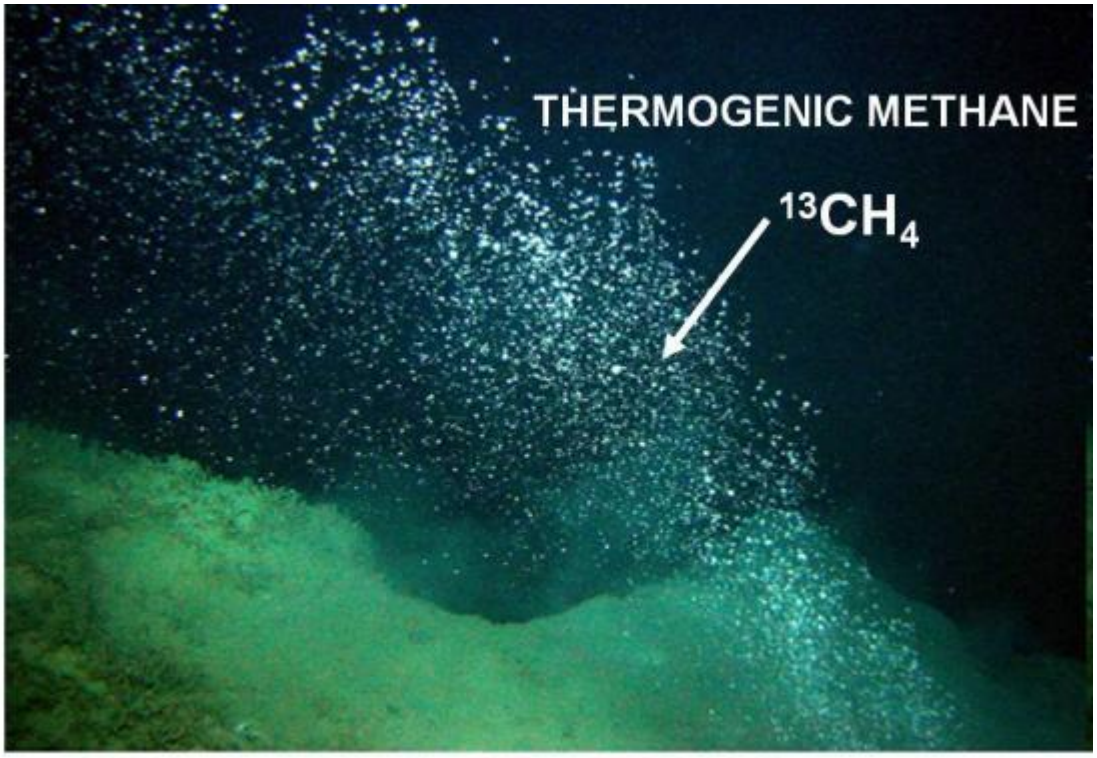


Fig. 9. Methane bubbles from the bottom of the Mediterranean Sea.
www.energybulletin.net/node/51517 **- Cached - Similar**

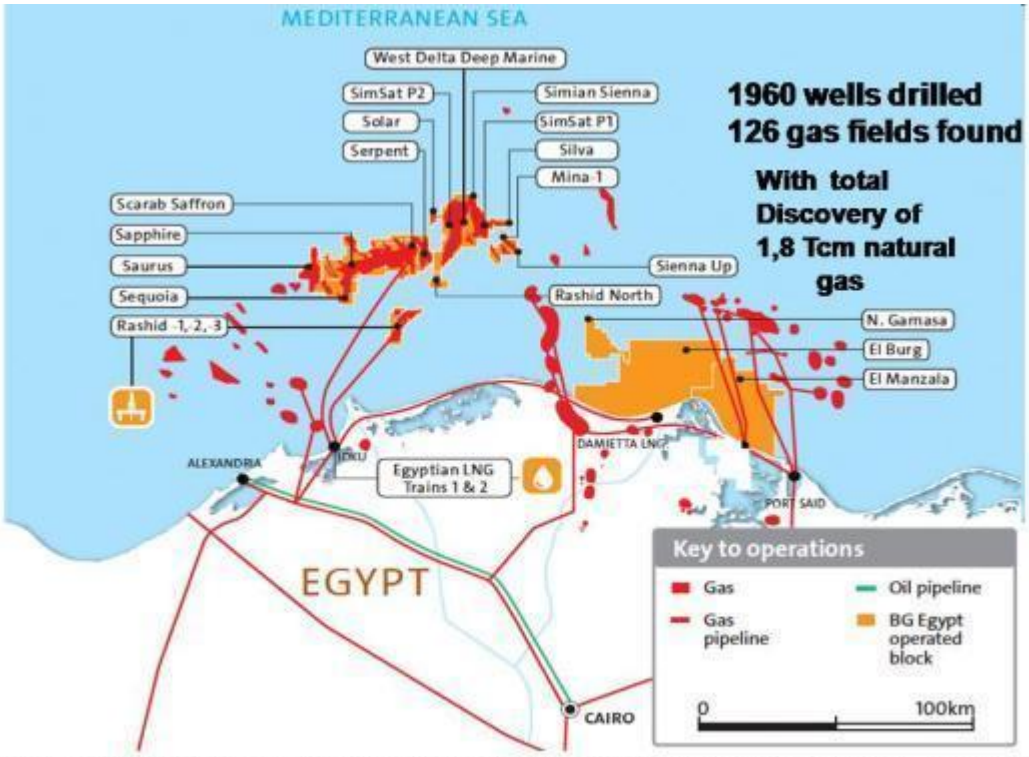
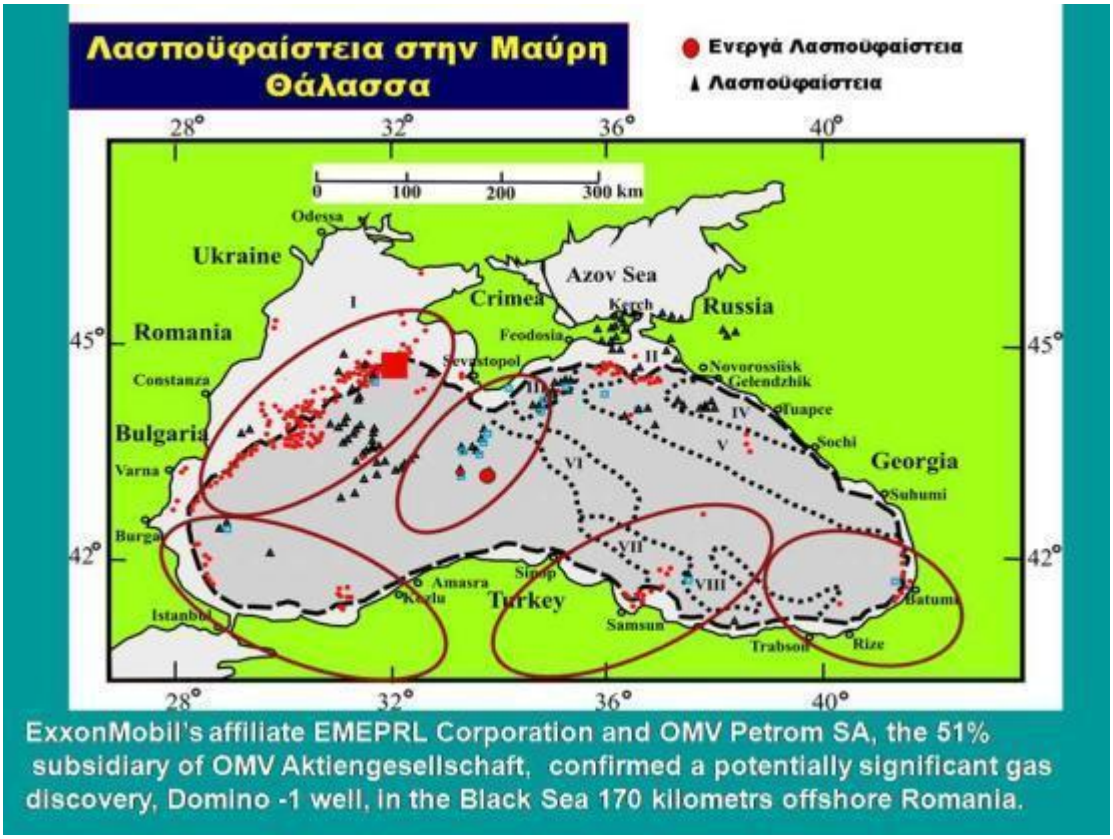
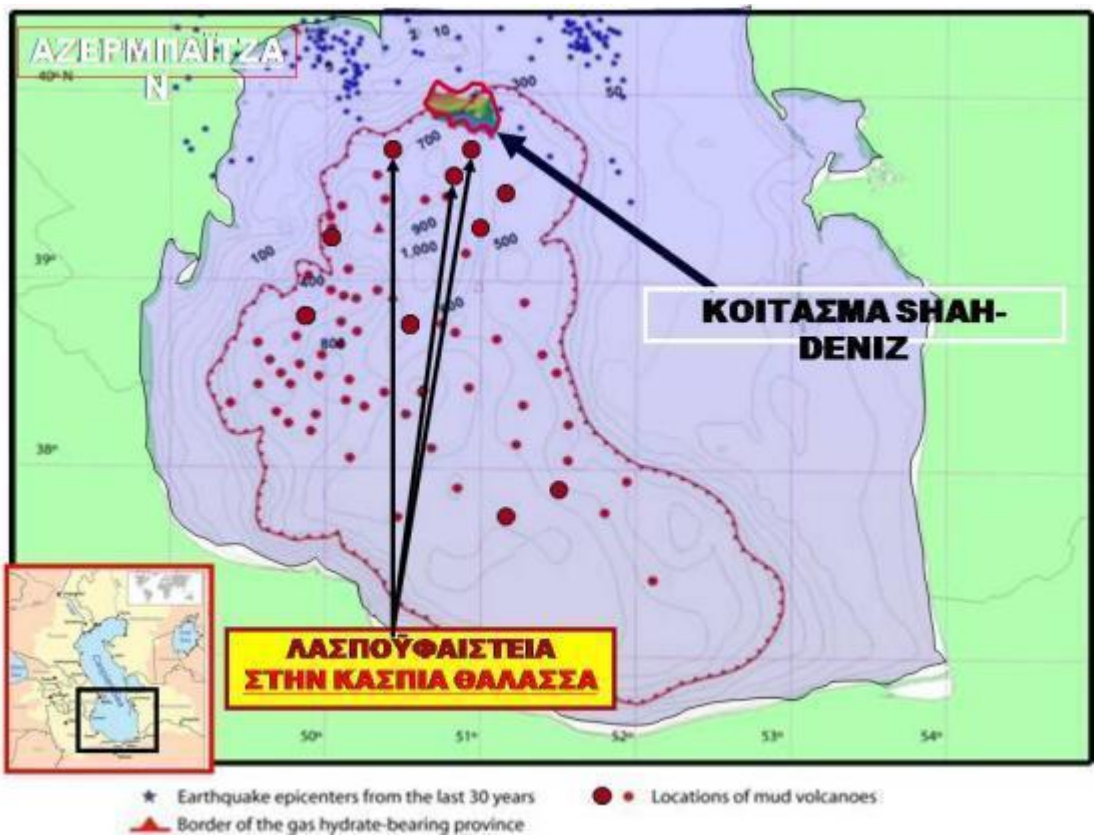
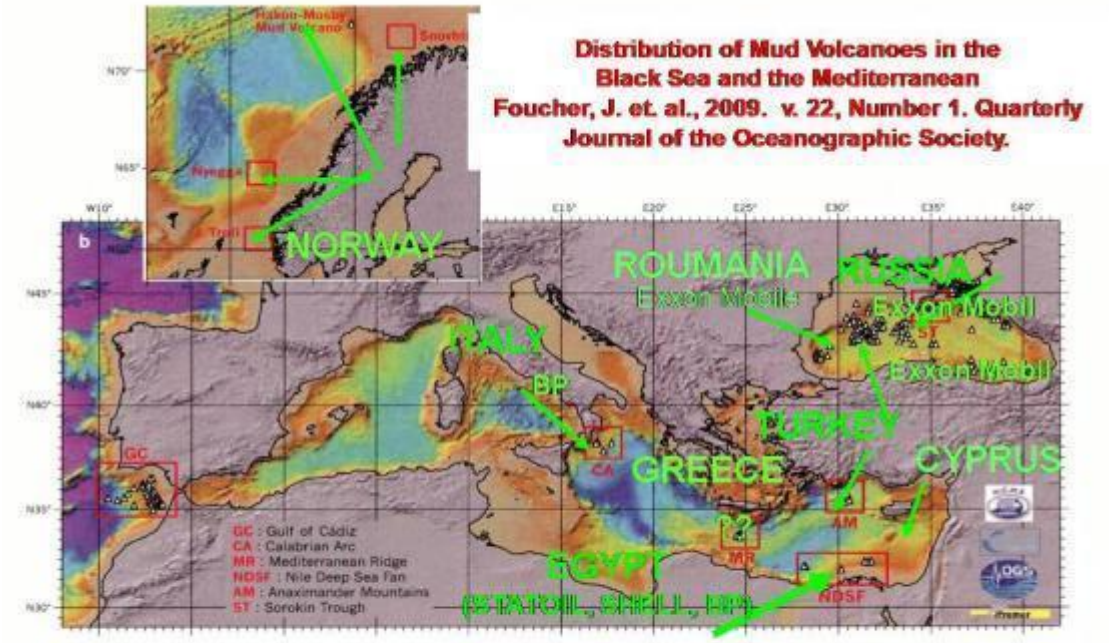


Figure 23. Distribution of natural gas reservoirs offshore Egypt, Neftegaz, EU, 2010
Rigzone, 2010



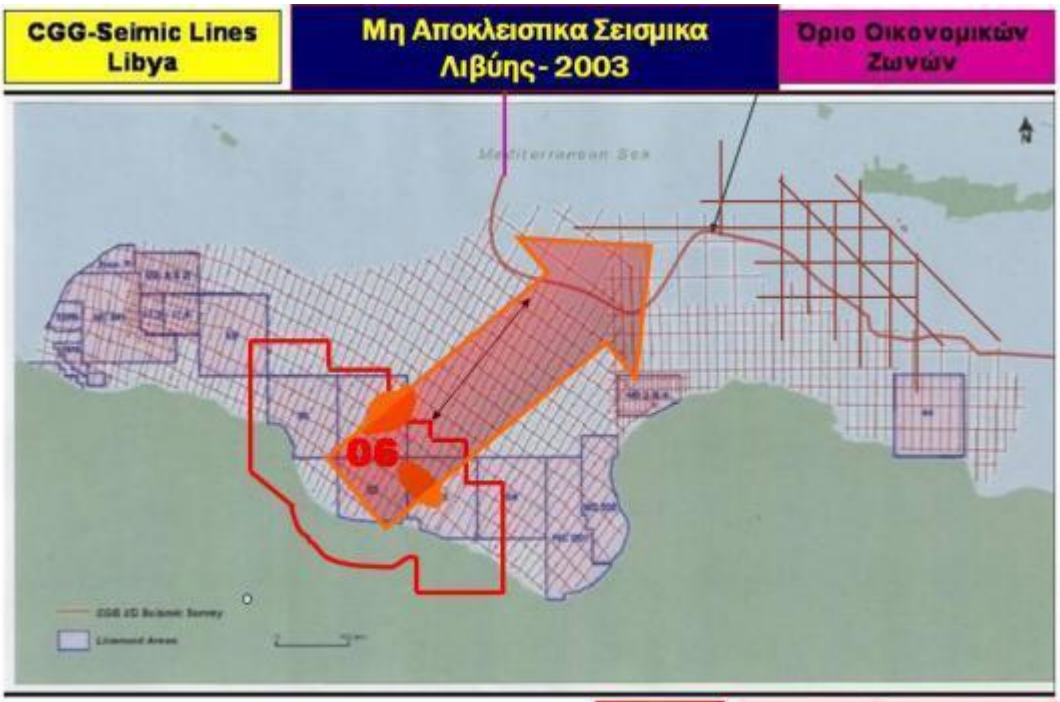
ExxonMobil's affiliate EMEPRL Corporation and OMV Petrom SA, the 51% subsidiary of OMV Aktiengesellschaft, confirmed a potentially significant gas discovery, Domino -1 well, in the Black Sea 170 kilometrs offshore Romania.





Εικόνα 26. Κατανομή των ενεργών λασποηφαιστείων στον Βόρειο Ατλαντικό, Μαύρη Θάλασσα και την Μεσόγειο, Foucher, et. al., 2009. Τα πράσινα τόξα υποδεικνύουν περιοχές έρευνας και εκμετάλλευσης υδρογονανθράκων γύρω από τα λασποηφαίστεια.

Figure 25. Geological and geophysical data maps by ASTRIUM, an EADS Co.
https://webmail.isc.tuc.gr/exchweb/bin/redir.asp?URL=http://www.astrium-geo.com/en/222-east-mediteranean



Εικόνα 34. CGG Veritas geophysical company
Compagnie General de Geophysique, France

OIL SEARCH LIMITED SIPETROL HELLENIC PETROLEUM

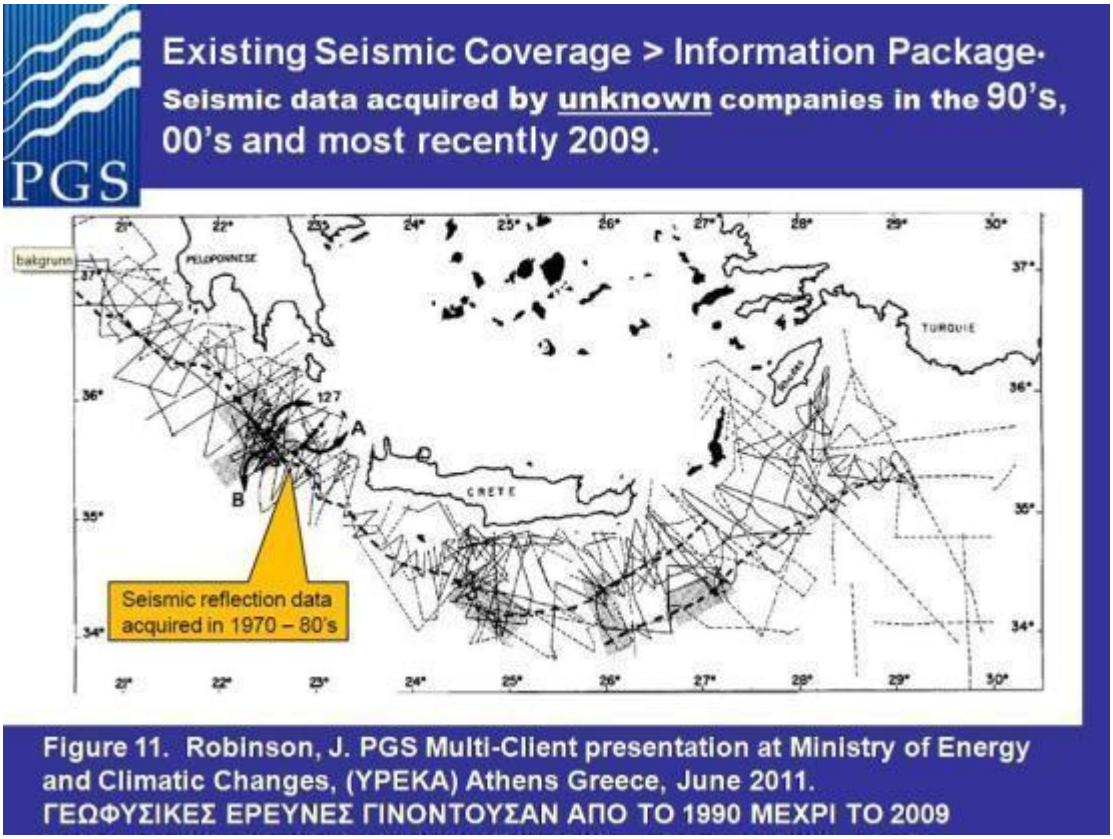
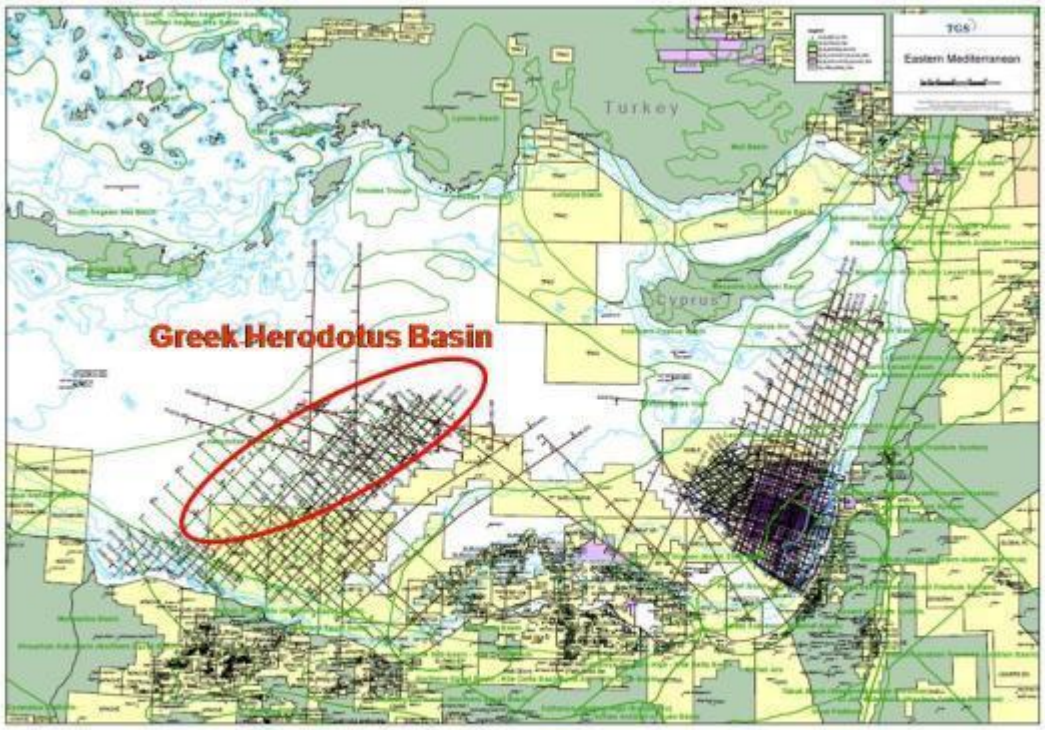
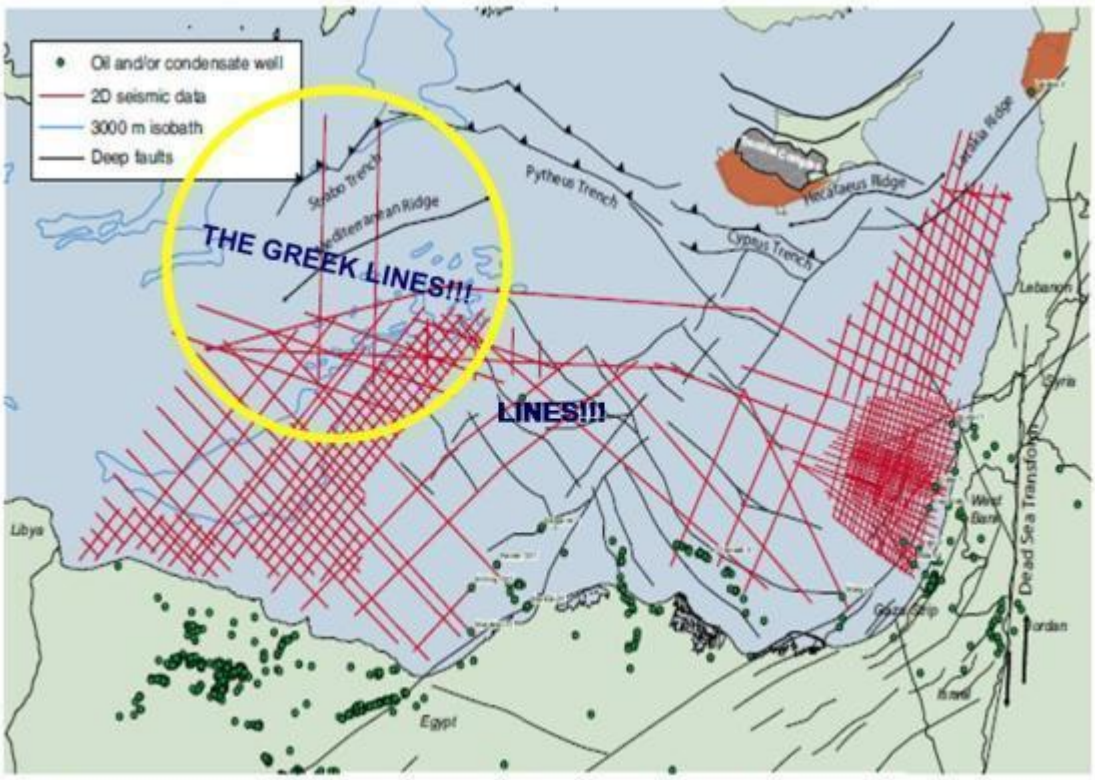


Figure 11. Robinson, J. PGS Multi-Client presentation at Ministry of Energy and Climatic Changes, (ΥΠΕΚΑ) Athens Greece, June 2011.
ΓΕΩΦΥΣΙΚΕΣ ΕΡΕΥΝΕΣ ΓΙΝΟΝΤΟΥΣΑΝ ΑΠΟ ΤΟ 1990 ΜΕΧΡΙ ΤΟ 2009



Εικόνα 33. Οι ελληνικές περιοχές της TGS NOPEC και η θέση της Ελληνικής Λεκάνης του Ηροδότου, TGS NOPEC, 2010



TGS-Nopec acquired 16,000 km of non-exclusive 2D seismic data in the eastern Mediterranean Sea.

Multi-Client Promotional Presentation of PGS by J. Robinson at the ministry of Energy and Climatic Changes, Athens, Greece (ΥΠΕΚΑ), 2011

Summary of the South Mediterranean Sea offshore Crete

- **Hydrocarbon seeps** have been recorded adjacent to mud volcanoes
- **Interpretation of deep seismic data suggests** not only the presence of Messinian salt, but also pre-Messinian sediment
- Hydrocarbon analyses of mud from ODP cores **suggests the presence of an active hydrocarbon system at depth**
- Potential analogues to the Messinian facies in Libya and across the Mediterranean.
- High risks related to trapping mechanisms, however potential exists.
- Accretionary prisms are productive across the world i.e. (Barbados, Makran, Irrawady-Andaman Oceanic Island Arc system)

HYDROCARBON POTENTIAL IN GREECE

Play Name	Prinos	Ionian	S. Mediter.	Cretan Sea
Source	Miocene Shale	Neogene Shales	Cretaceous – Palaeogene Shales	Miocene Shale
Reservoir	Miocene Turbidites	Pliocene Turbidites	Miocene – Pliocene Turbidites	Miocene Deltaics
Seal	Miocene Evaporites	Pliocene Shales	Miocene Evaporites	Miocene Evaporites / Pliocene Shales
Trap	Structural	Stratigraphic	Stratigraphic	Combination
Type Basin	Prinos	Ionian	Levantine	Cretan

(3,45 Tcm ??)

Table 30. Source rocks, Reservoirs, Seals Traps and Type basin.
A promotional multi client presentation of PGS by J. Robinson at the ministry of Energy and Climatic Changes, Athens, Greece (ΥΠΕΚΑ), 2011

Figure 31. The Levantine Basin with its recent oil and gas discoveries.
Assessed potential for further discoveries of natural gas 122 tcf (3,45 tcm) and oil 1,7 billion barrels, USGS Technical Report, 2010

•ΑΠΌ ΥΠΑΡΧΟΥΣΕΣ ΚΑΤ' ΑΝΑΛΟΓΙΑΝ ΣΤΑΤΙΣΤΙΚΕΣ ΓΝΩΣΤΩΝ ΟΙΚΩΝ ΓΕΩΣΤΡΑΤΗΓΙΚΗΣ ΑΞΙΟΛΟΓΗΣΗΣ (π.χ. ΟΙΚΟΣ STATFORD, ERGO SOLUTIONS) ΤΑ ΑΝΑΜΕΝΟΜΕΝΑ ΣΥΜΒΑΤΙΚΑ ΑΠΟΘΕΜΑΤΑ Υ/Α ΝΟΤΙΑ ΤΗΣ ΚΡΗΤΗΣ, ΥΠΟΛΟΓΙΖΟΝΤΑΙ ΝΑ ΕΙΝΑΙ ΤΗΣ ΤΑΞΗΣ ΤΩΝ **20 - 30** Δις Βαρέλια Ισοδυνάμου Πετρελαίου - δηλ. οι Ανάγκες της Ελλάδος για ~150 ΧΡΟΝΙΑ.

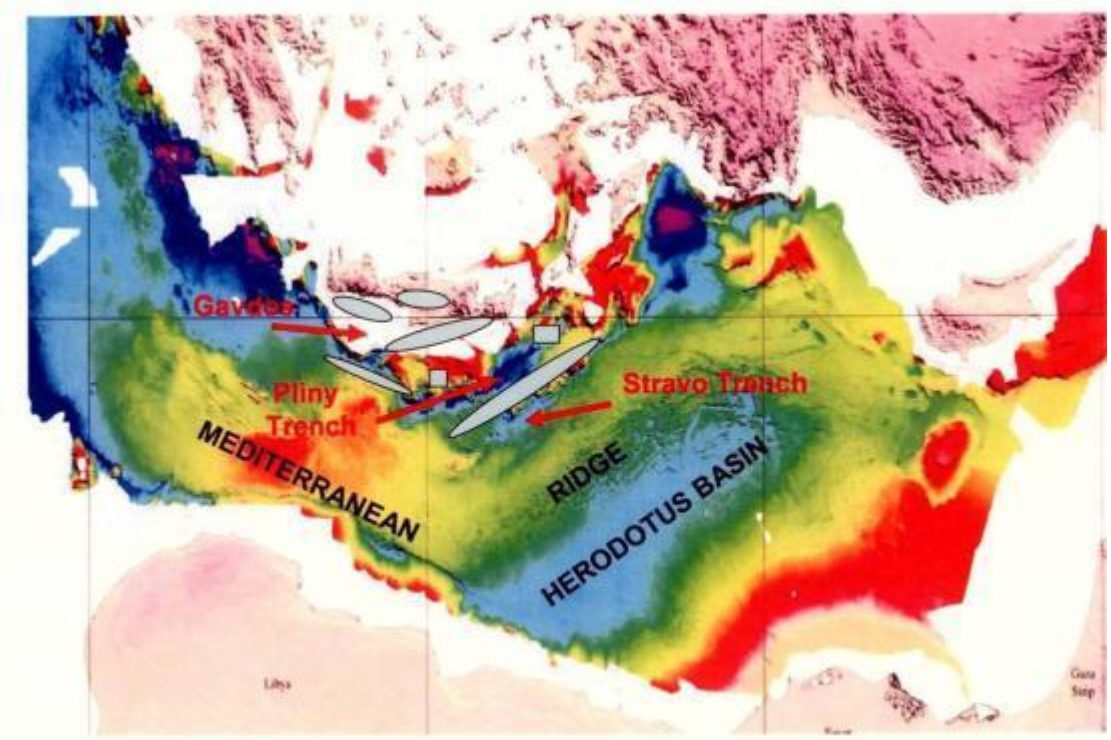


Figure 29. Suggested Hydrocarbon Fields, pale blue, ⬭, offshore Crete according to Maravelis et. al., 2012

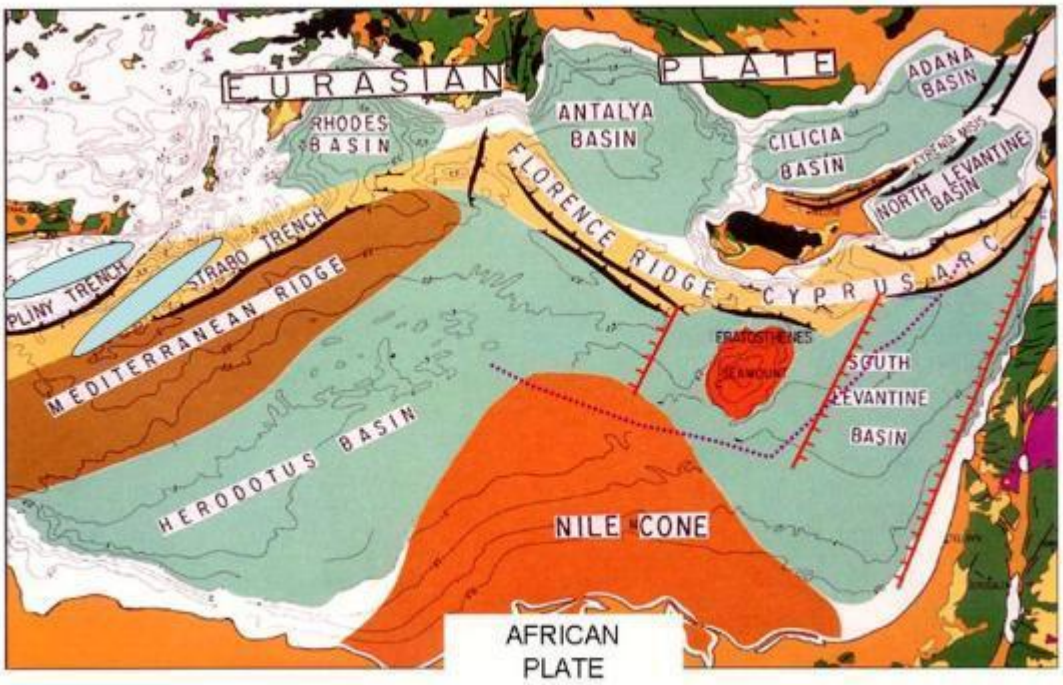
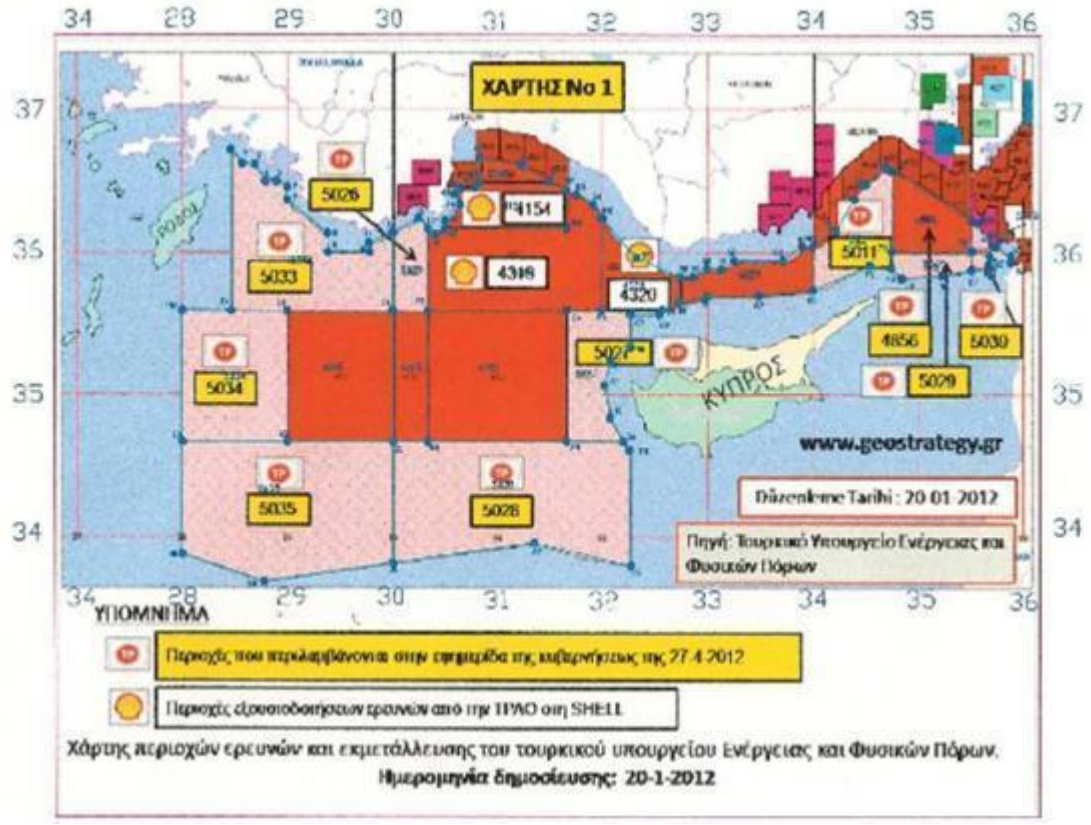


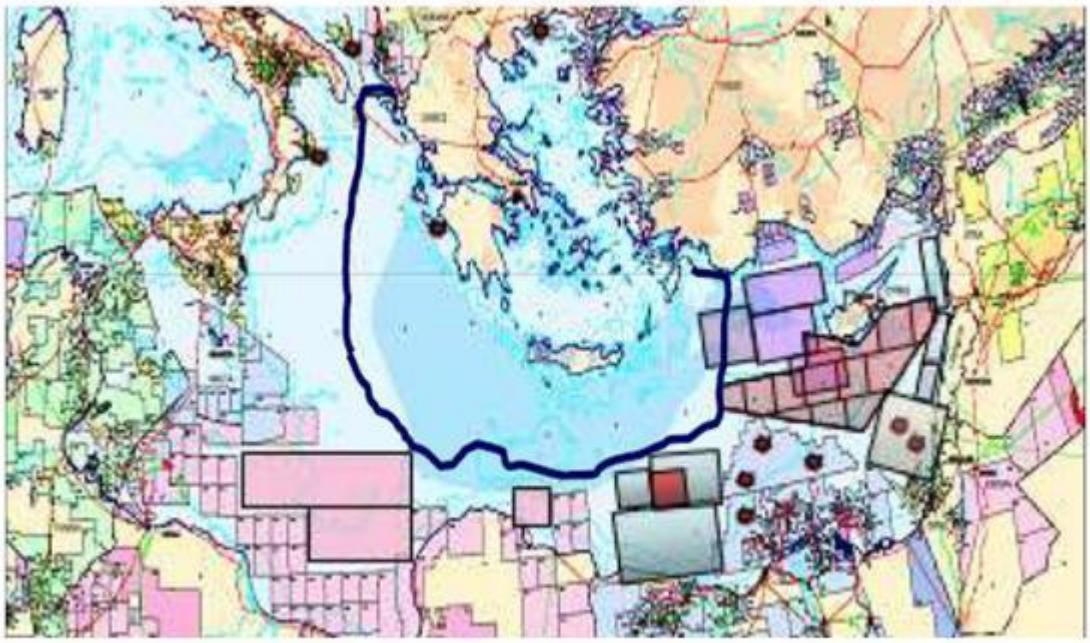
Figure 29. Suggested Hydrocarbon Fields, pale blue, ⬭,offshore Crete according to Maravelis et. al., 2012

Όρια της προς έρευνα περιοχής που βασίζονται στην αρχή της μέσης γραμμής/γραμμή ίσης απόστασης μεταξύ όλων των εδαφών των εμπλεκόμενων κρατών..International Public Invitation for the participation in Non-Exclusive seismic Survey on the Continental shelf of Western and Southern Greece. June 7, 2011, www.maniatisy.gr/index.php?



- THE NET RESULT FROM THIS INTERNATIONAL INVITATION BY YPEKA WAS THAT 8 GEOPYSICAL COMPAMIES HAVE ASKED PERMISSION TO CARRY OUT THE NON-EXCLUSIVE 2D AND 3D GEOPHYSICAL SURVEYS INDICATING BEYOND ANY DOUBT THAT HYDROCARBON FIELDS MUST EXIST OFFSHORE SOUTHERN CRETE.

THE FACT THAT 3 COMPANIES NAMELY, CGG VERITAS, SPECTRUM AND TGS-NOPEC, WHO DID ILLEGALLY GEOPHYSICAL SURVEYS OFFSHORE CRETE WANT TO PARTICIPATE IN THE COMPETITION PROVES BEYOND ANY DOUBT THE EXISTENCE OF HYDROCARBONS.



Η ΜΟΝΗ ΧΩΡΑ ΠΟΥ ΔΕΝ ΚΑΝΕΙ ΕΡΕΥΝΑ ΥΔΡΟΓΟΝΑΝΘΡΑΚΩΝ ΑΠΟ ΤΟ 1997 ΕΙΝΑΙ Η ΕΛΛΑΔΑ


ΕΥΧΑΡΙΣΤΩ


ΠΟΛΥ