Università di Trieste
LAUREA MAGISTRALE IN GEOSCIENZE
Curriculum Geofisico
Curriculum Geologico Ambientale

Anno accademico 2015 – 2016

Geologia Marina

Parte I

Modulo 5.3 Mari Italiani – Adriatico

Docente
Valentina Volpi

ADRIATIC REGION and ADRIA Plate

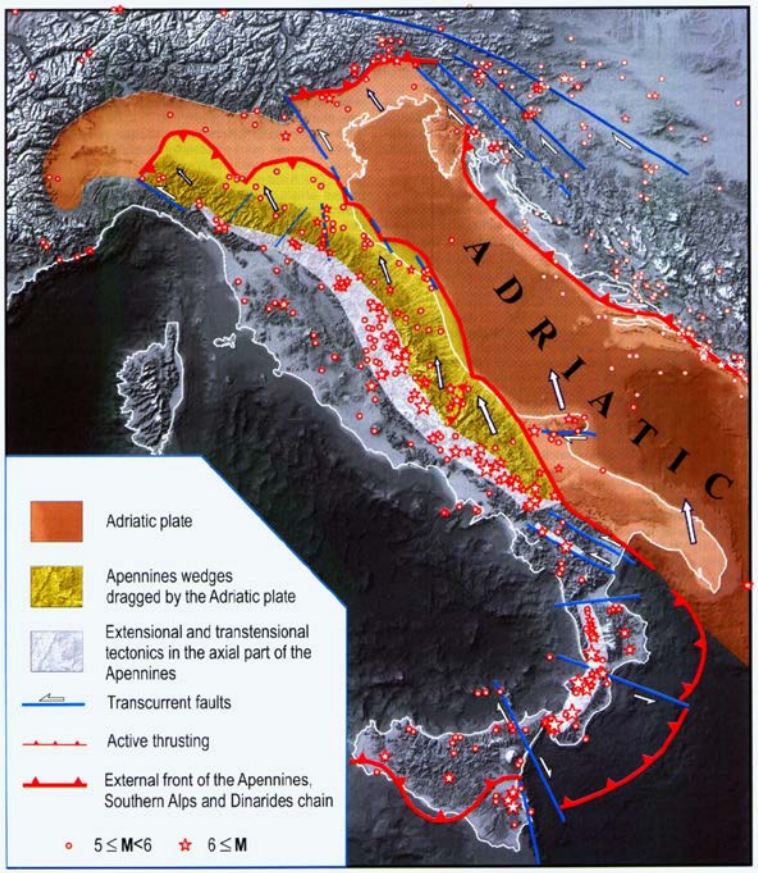
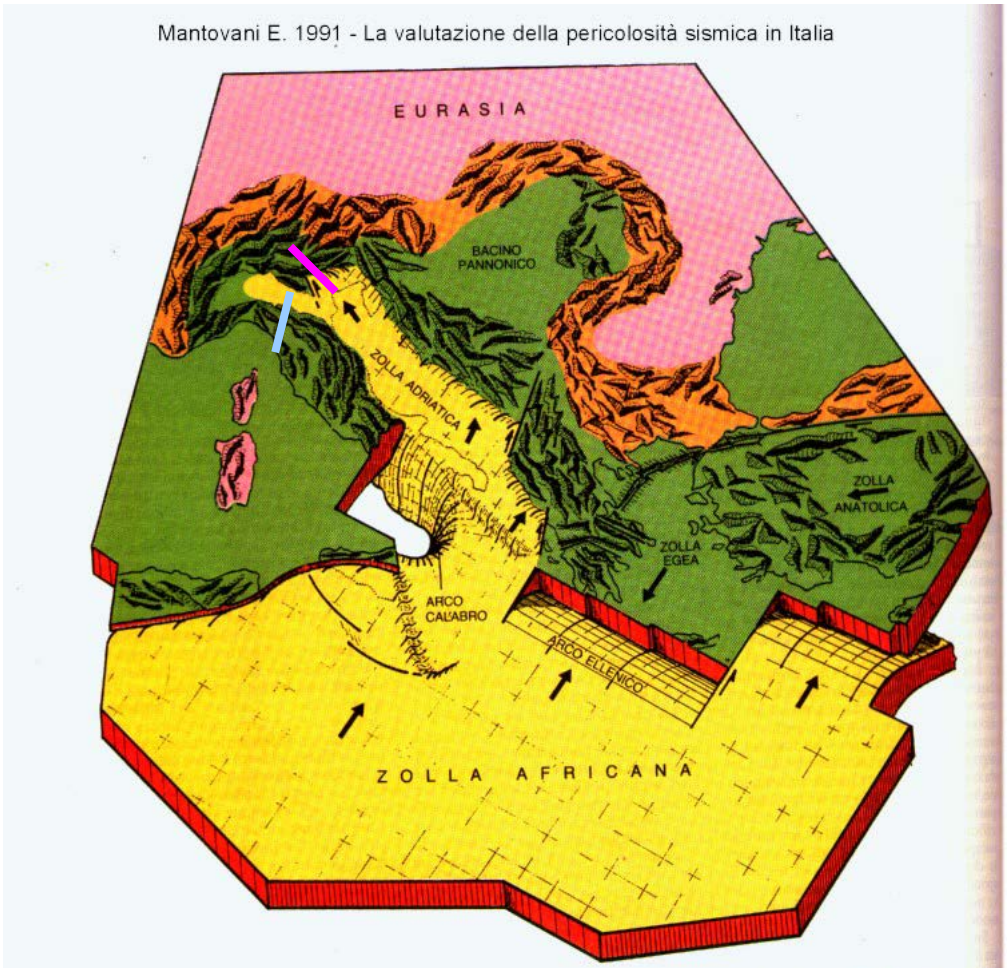


Fig. 5 - Middle Pleistocene to Present tectonic activity and major earthquakes (stars and dots) are explained as an effect of the relative motion between the Tyrrhenian-Western Apennines system (grey area) and the Adriatic-Eastern Apennines system (brown and yellow domains). Empty arrows indicate the motion, with respect to Eurasia, of the Adriatic plate and of the Apenninic wedges dragged by it. Seismicity information is taken from GRUPPO DI LAVORO CPTI (2004). See text for explanations.
– L'attività tettonica post-Pleistocene medio e i maggiori terremoti (stelle e punti) sono interpretati come effetti del movimento relativo tra il dominio Tirreno-Appennino occidentale (zona scura) e il dominio Adriatico-Appennino orientale (zone nocciola e gialla). Le frecce vuote indicano il movimento (rispetto all'Eurasia) della placca Adriatica e della parte esterna di catena Appenninica trascinata da questa placca. La cinematica proposta implica trascorrenze sinistra nell'Appennino Lucano e tettonica distensiva/transtensiva nella rimanente parte della catena (dalla zona Irpina all'Appennino settentrionale), in accordo con i campi di deformazione dedotti dalle deformazioni recenti e dalla sismicità. Vedi testo per spiegazioni. Gli epicentri sono presi da: Gruppo di Lavoro CPTI (2004).

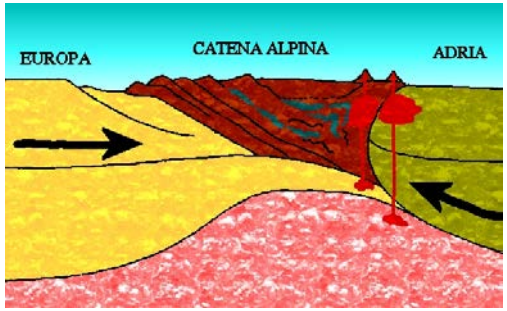
Boll. SGI 125 (2006) fasc. 3, 273-291, 6 ff.

(Viti et al., 2006)

PLATE MARGINS CONFIGURATION IN THE MEDITERRANEAN REGION



1)



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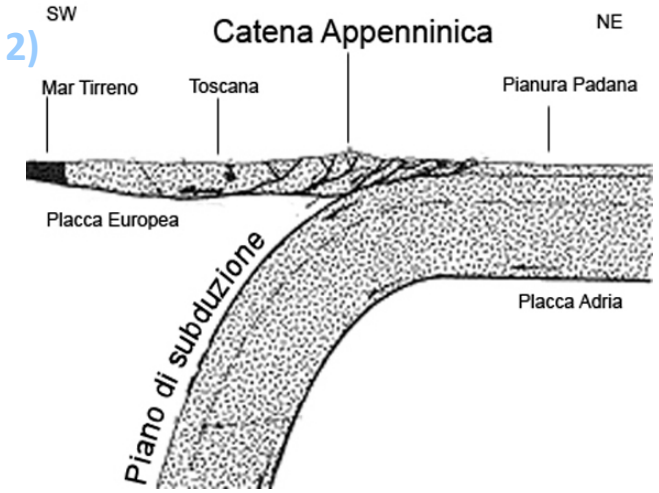
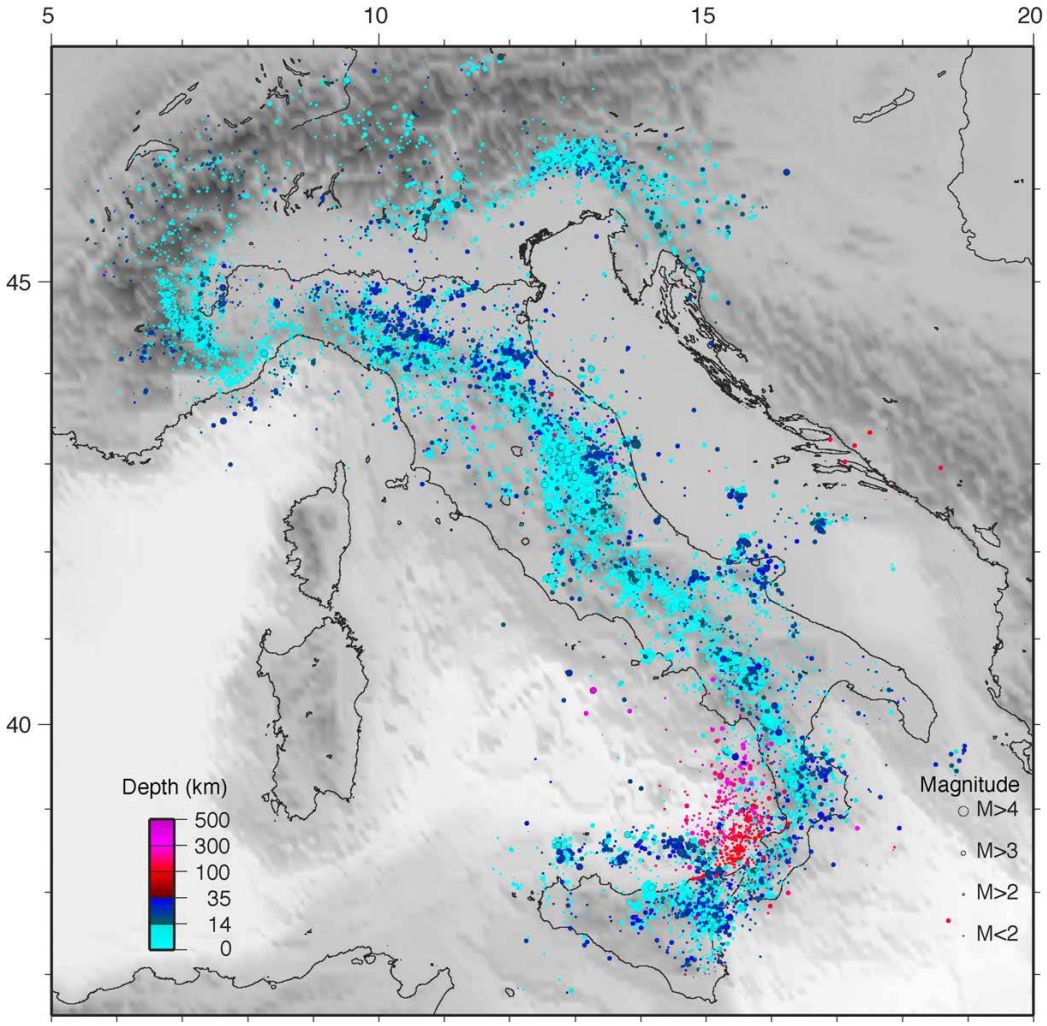


EARTHQUAKES LOCATIONS LIMIT THE BORDER OF THE ADRIA PLATE



(Chiarabba et al., 2005)

250 M.A. – Early Mesozoic

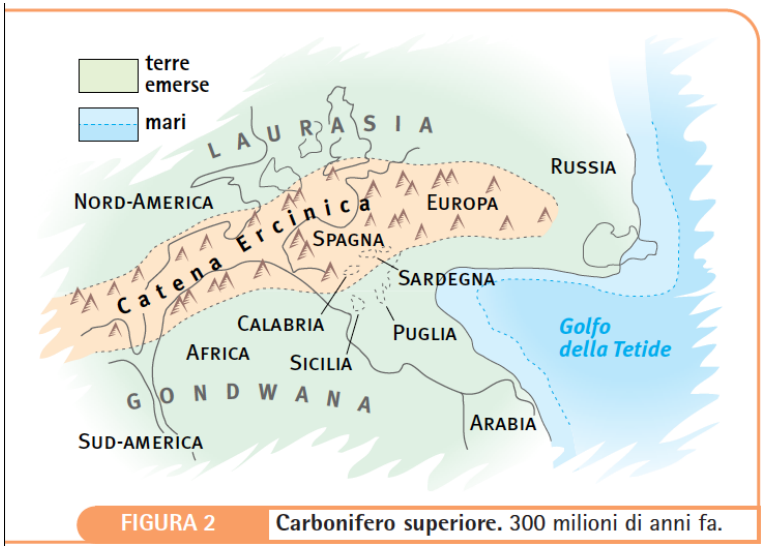


FIGURA 2 **Carbonifero superiore.** 300 milioni di anni fa.

At the end of the Paleozoic era, with the collision between Laurasia and Gondwana, the continents were are included in the so-called single mass called “Pangea”.

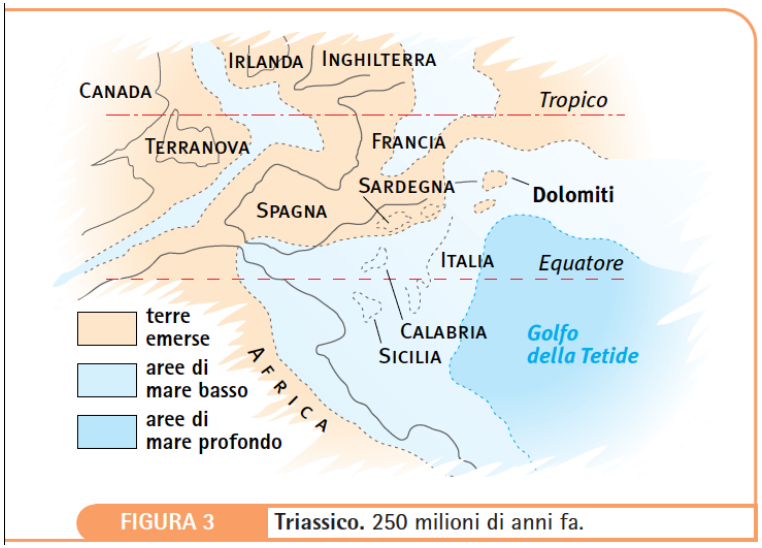


FIGURA 3 **Triassico.** 250 milioni di anni fa.

At the Equator latitude, an ocean (Tetide – Tethys) separated the Asia from the Southern lands (Africa, India, Australia). The Italian region was located at the centre of this “supercontinent”, between Africa And Europe, just at the western end of the Tethys.

150 M.A - Middle Mesozoic

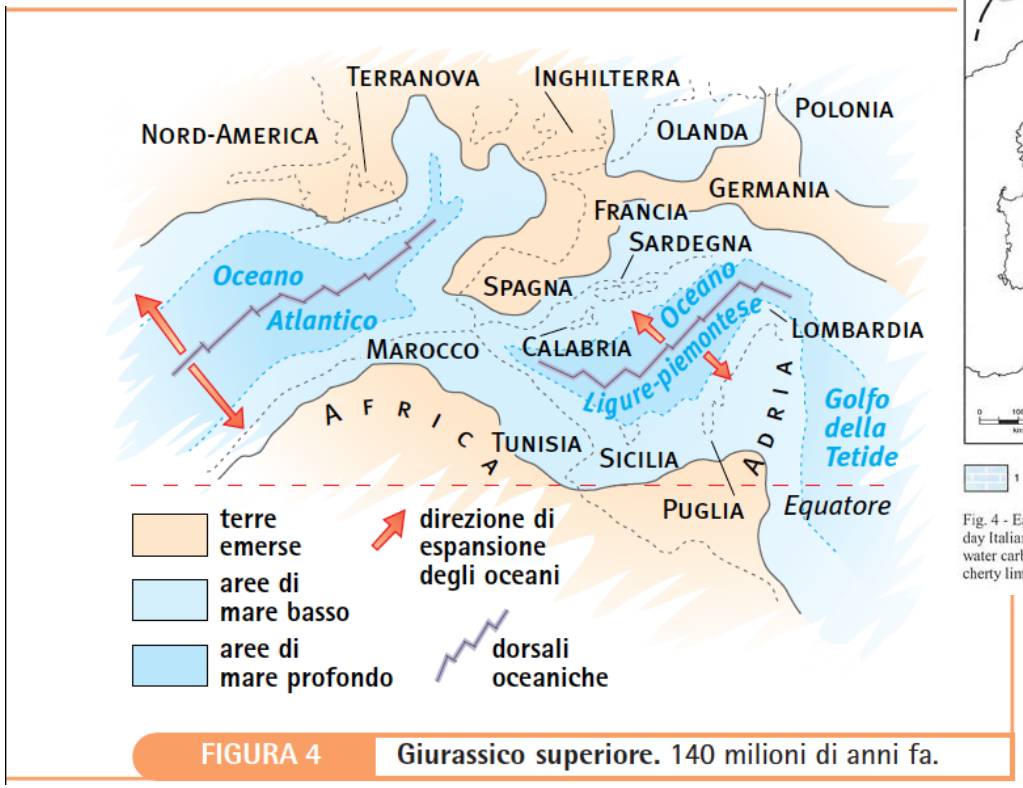


FIGURA 4 **Giurassico superiore.** 140 milioni di anni fa.

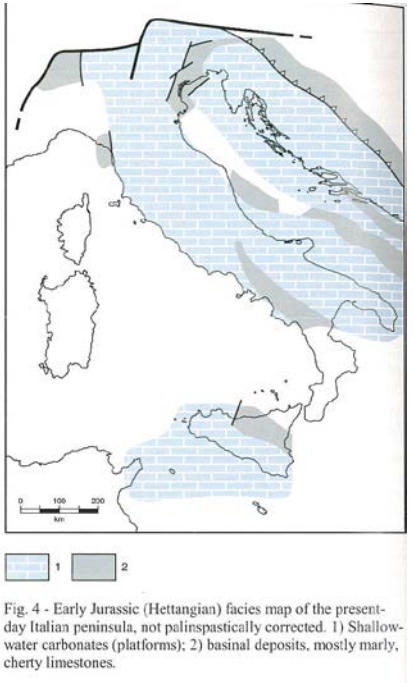


Fig. 4 - Early Jurassic (Hettangian) facies map of the present-day Italian peninsula, not palinspastically corrected. 1) Shallow-water carbonates (platforms); 2) basinal deposits, mostly marly, cherty limestones.

Starting from Triassic, the Atlantic ocean started to open, separating Africa from America. This process induced the formation of a small ocean (Liguro-Piemontese). It separated Europe from Africa: Sardinia and Calabria were on the Europen side, while Sicilia, and mainland Italy were part of the Africa continent.

The Italian region was in part formed by a deep sea of the Liguro-piemontese ocean and in part by a shallow water areas coincident with the north Africa margin, whose border presented an indetattion called “Adria”. It still remains the deep substratum of the Italian peninsula and of the Adriatic basin.

100 M.A. – Alpine orogenesis

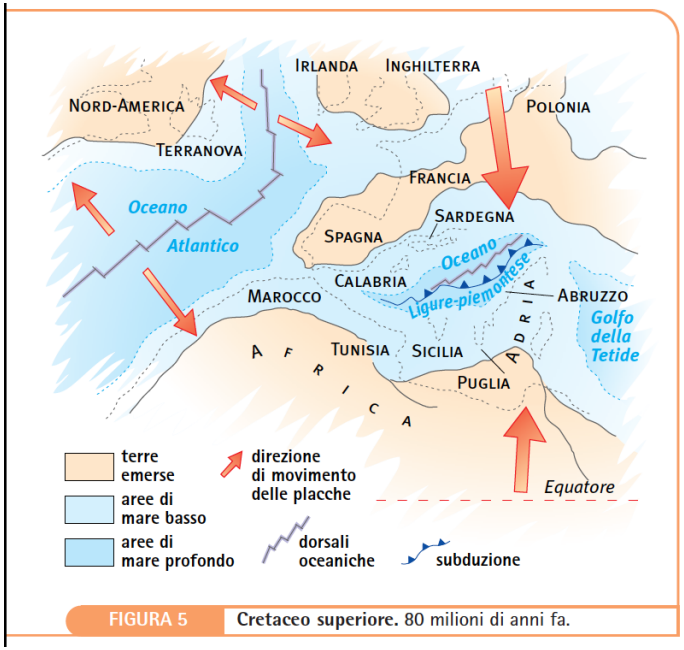


FIGURA 5 **Cretaceo superiore.** 80 milioni di anni fa.

At the end of Mesozoic (Cretaceous) the Ligure-Piemontese Ocean started to close, due to the convergence between Africa and Eurasia that produced the Alpine orogenesis.
The oceaninc crust, interposed between the continental blocks was then sudducted and swallowed up in the mantle

65 – 30 M.A. – Early Cenozoic

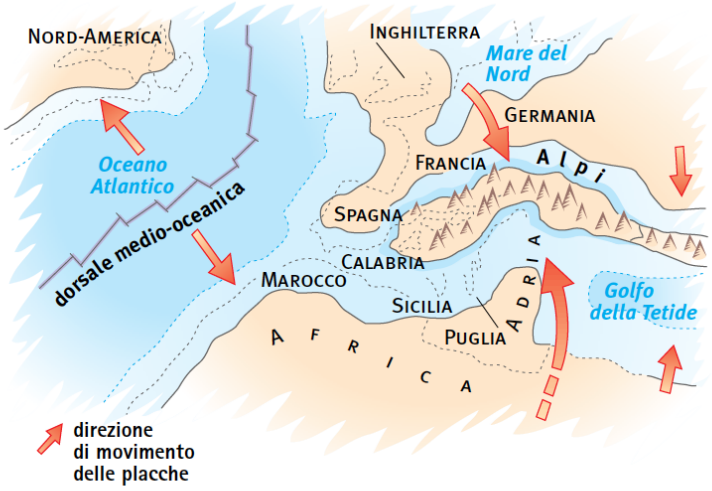


FIGURA 6 **Eocene.** 50 milioni di anni fa.

The closure of the Ligure-Piemontese ocean was completed, and the African and European continental blocks started to collide.
The Alpine chain originated from the convergent movements between the two colliding plates, and the metamorphic and sedimentary blocks of the European and Africa crust were piled up.
Adria and the other southern Italian region were still in a quite marine environemnt, deep (Marche, Toscana) or shallow (Abruzzo, Puglia and Sicily).

Last 30 M.A – Apennine orogenesis

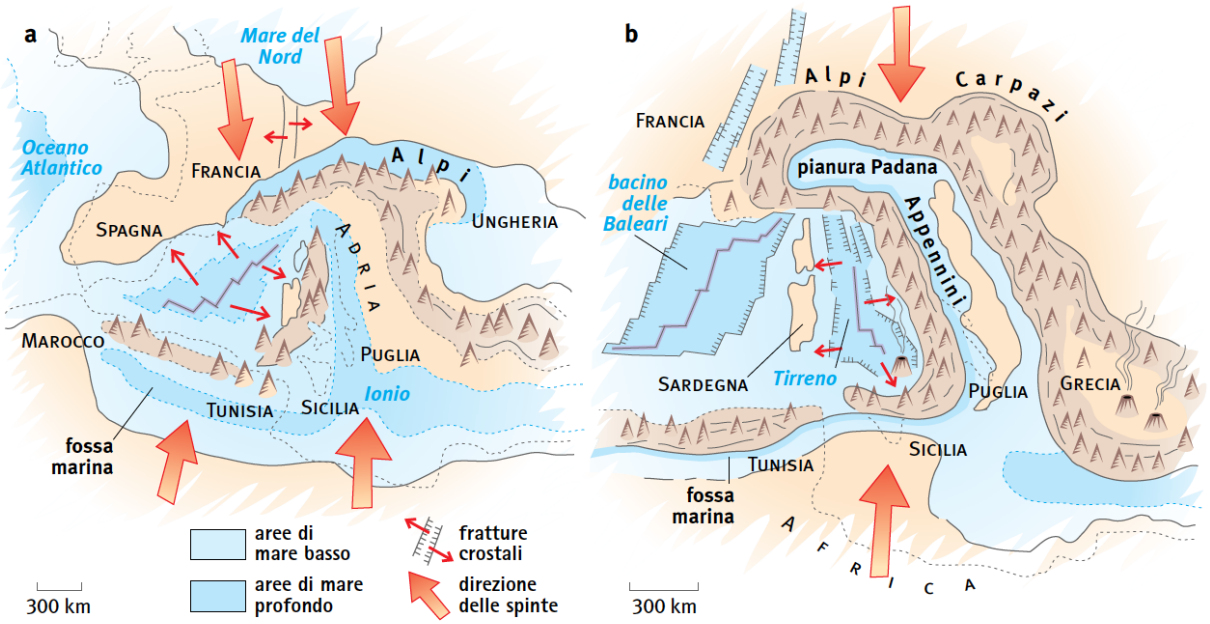


FIGURA 7 **Pliocene.** 5 milioni di anni fa.

The collision between Africa and Europe has continued for the next 30 MA up to Present, forming the complicated structural setting. Some deep crustal fractured formed (Balearic and Thyrrenian basins) which guided the Apennines orogenesis. Apennines extends from Northern Italy to Sicily and northern Africa (Tunisia, Marocco, Atlante mountains).
The Apennine formation occured in two main phases: the first related to the opening of the Balearic basin and the second phase, from 10 MA, the opening of the Thyrrenian Sea.

6 MA: the closure of the Strait of Gibraltar led to the isolation of the Mediterranean and in a few tens of years it remained isolated and came close to drying up; at the seafloor layers of chalk, limestones and salt were deposited.

Last 2 M.A. - Glaciation

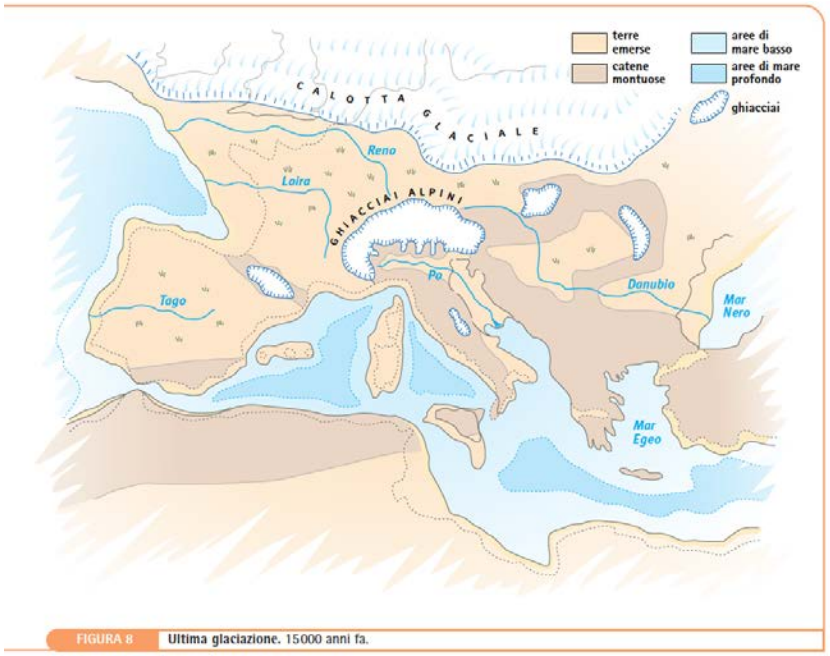


FIGURA 8 Ultima glaciazione. 15000 anni fa.

Present

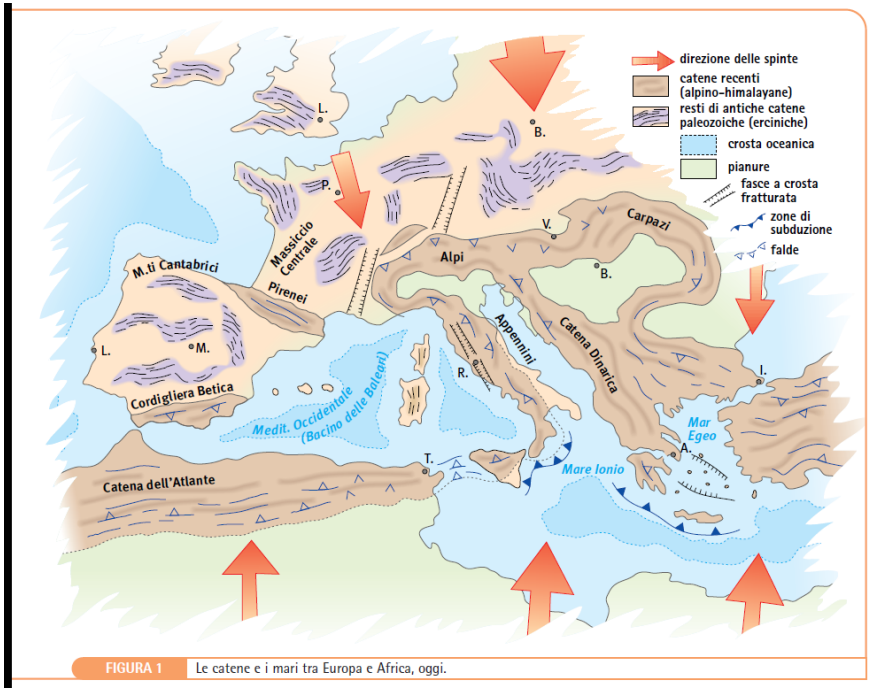
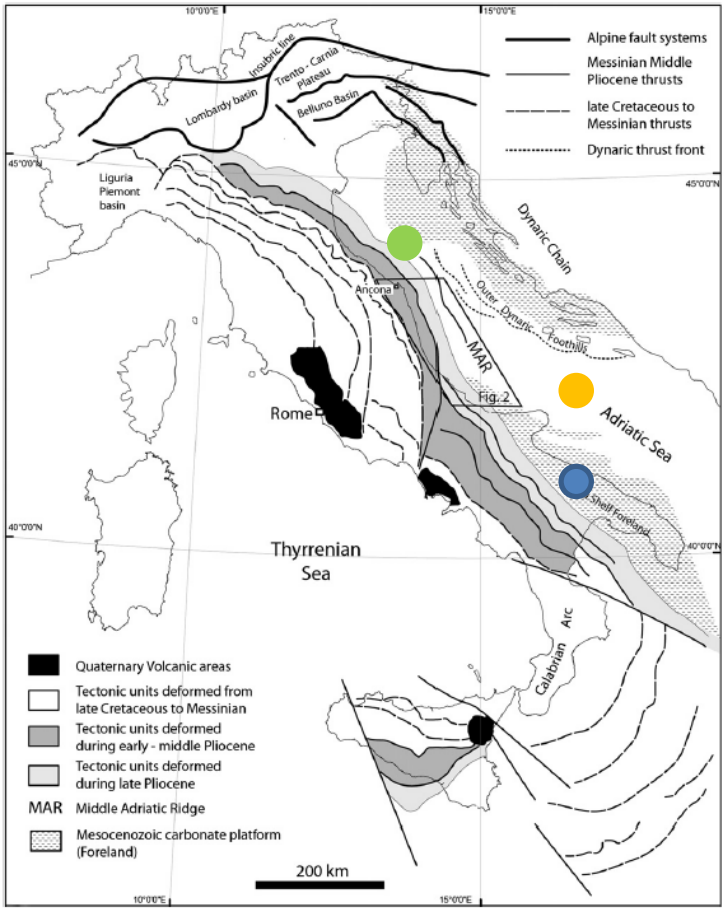


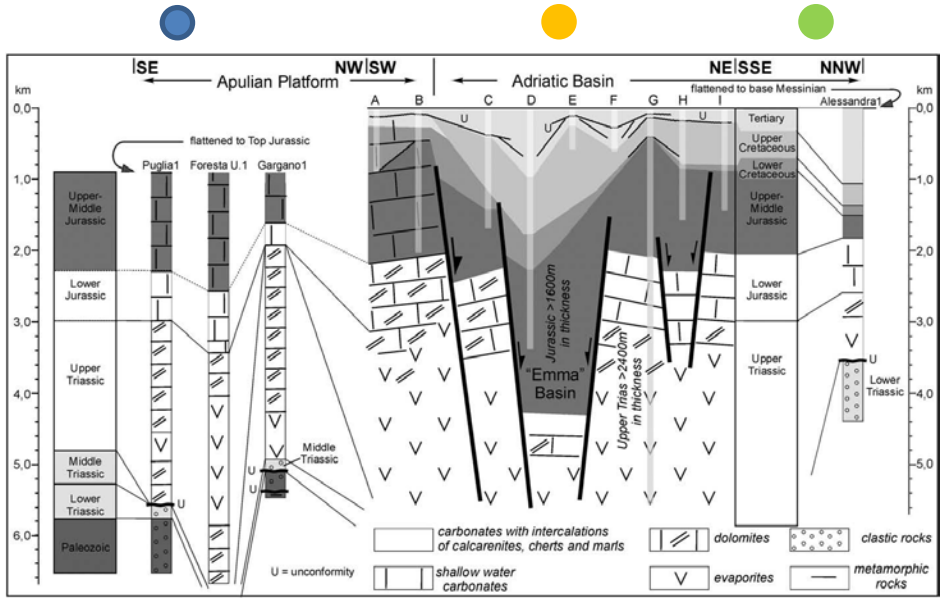
FIGURA 1 Le catene e i mari tra Europa e Africa, oggi.

In the past 2 MA and in particularly, the configuartion of the Italian region has not changed significanlty, except for the uplifting of the Apennines and the filling of the marine deep around the chain with sediments coming from the Alps and Apennines that formed the Po Plain and the the southern Adriatic basin, which were both partly involved in the orogenesis. The South Adriatic was also influenced by the Dinaric chain induced by the subduction of the Adria below Europe, to to its east border.
Over the last 800.000 years, erosional activities included the effect of glaciers transport. Great glaciers were common during the coldest phases of the glaciations (see the U shaped Alpine valley)

STRATIGRAPHY OF THE APULIAN PLATFORM AND ADRIATIC BASIN
(calibrated from wellbore data)

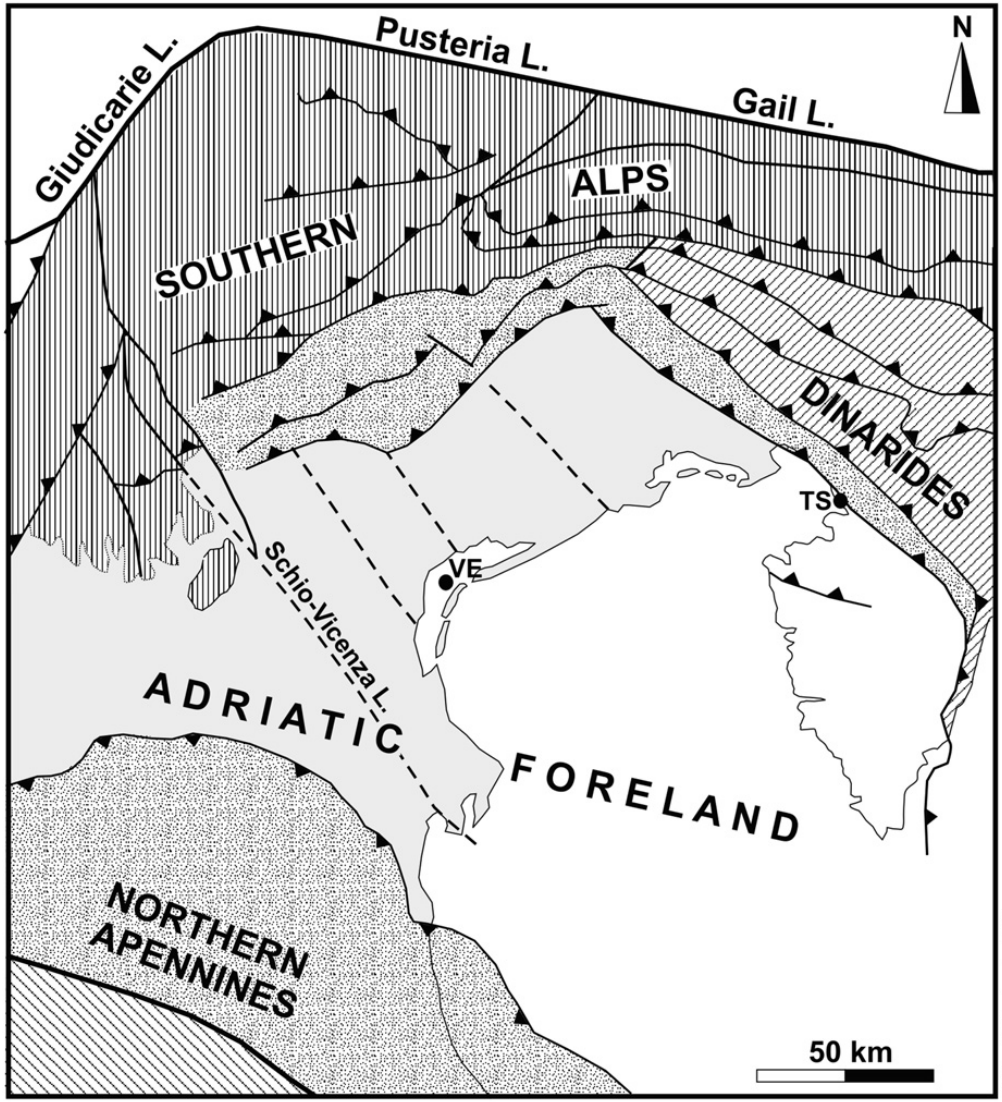


(Casero e Bigi, 2013)

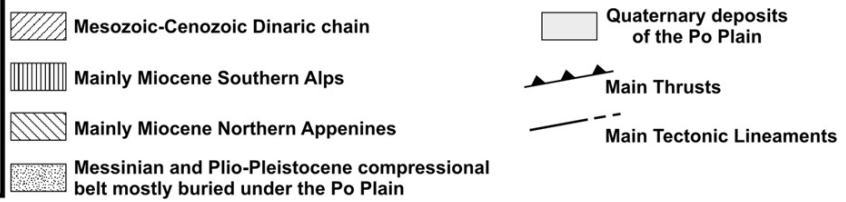


(Scisciani & Calamita, 2009)

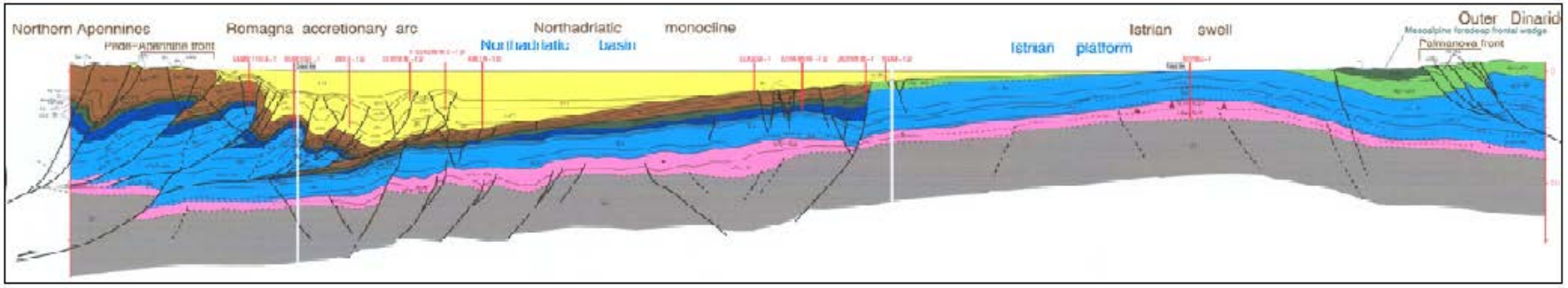
NORTHERN ADRIATIC



Structural map of the Northern Adriatic Sea region (modified from Castellarin et al., 2006).

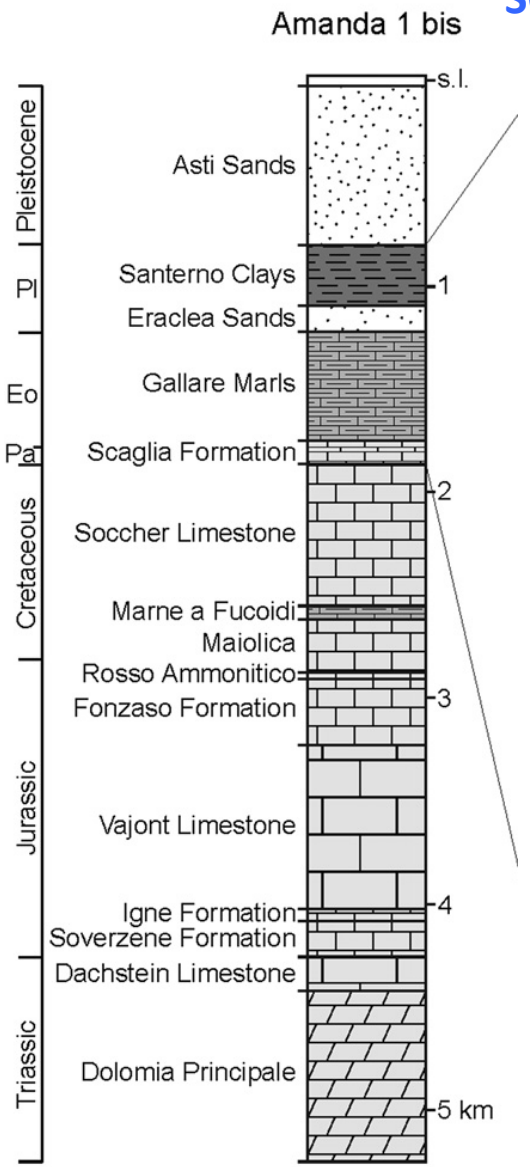


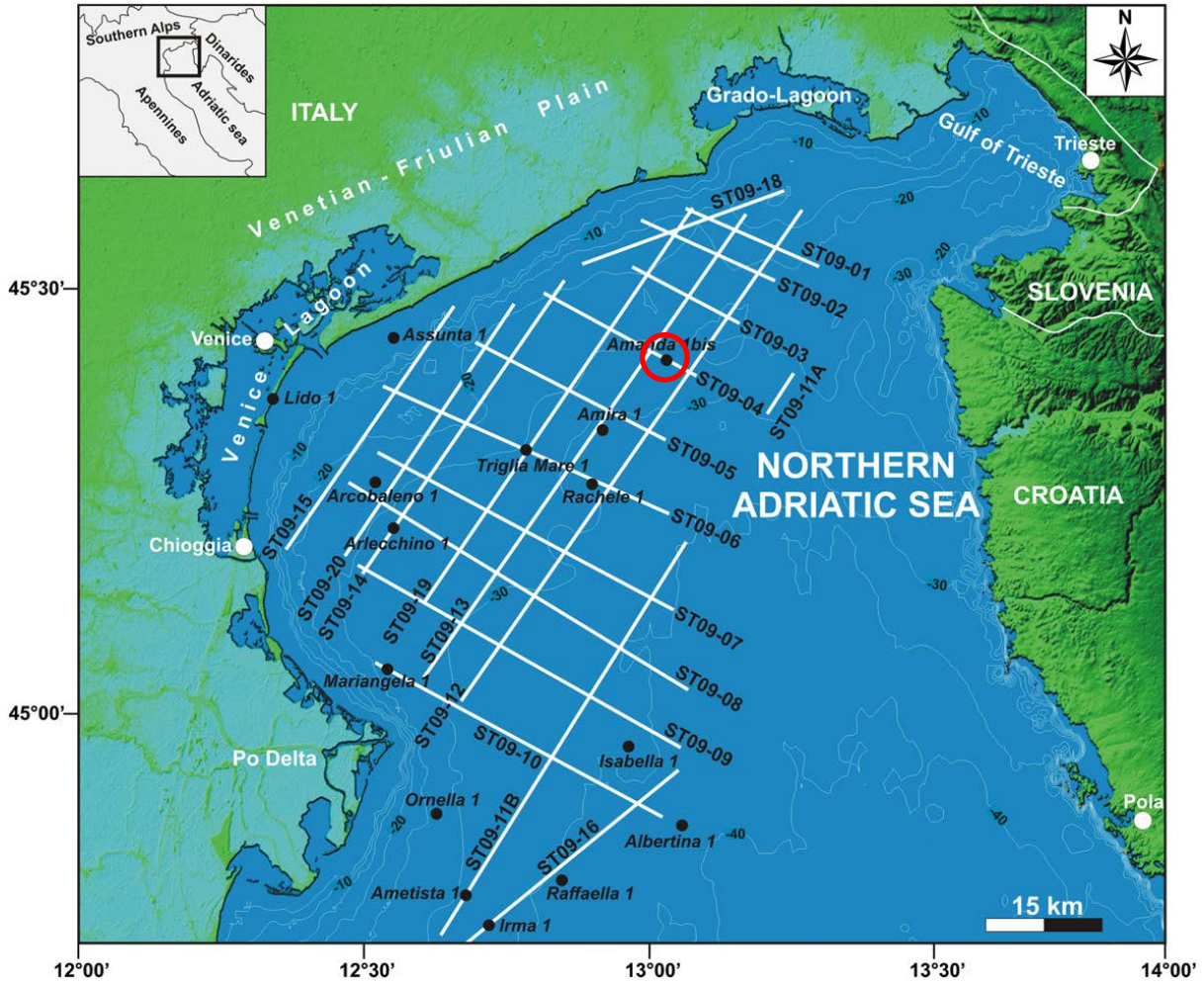
MORPHOLOGY AND PRESENT STRUCTURAL SETTING – NORTHERN ADRIATIC



(Fantoni & Franciosi, 2010)

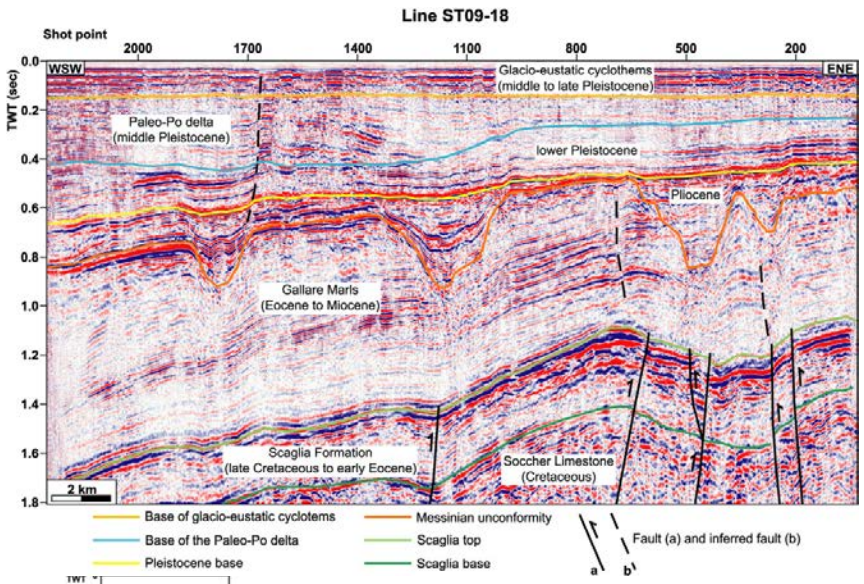
SCHEMATIC STRATIGRAPHY from AMANDA well data

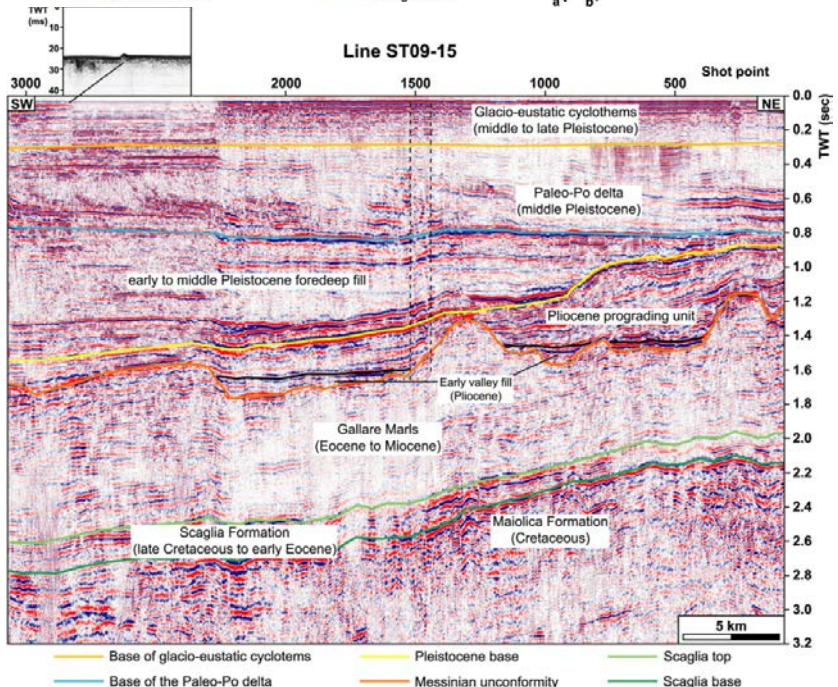


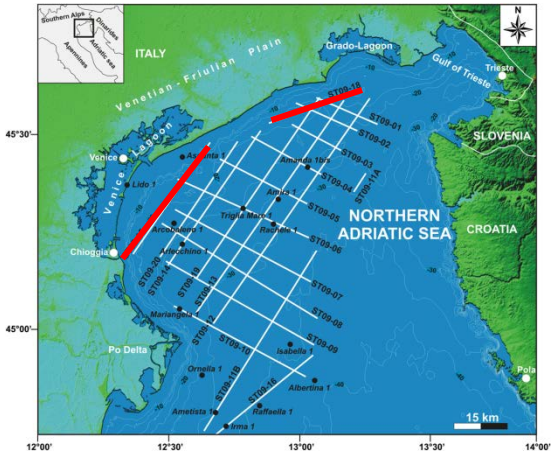


Donda et al., 2014. Deep-sourced gas seepage and methane-derived carbonates in the Northern Adriatic Sea. Basin Research (2014) 1–15, doi: 10.1111/bre.12087

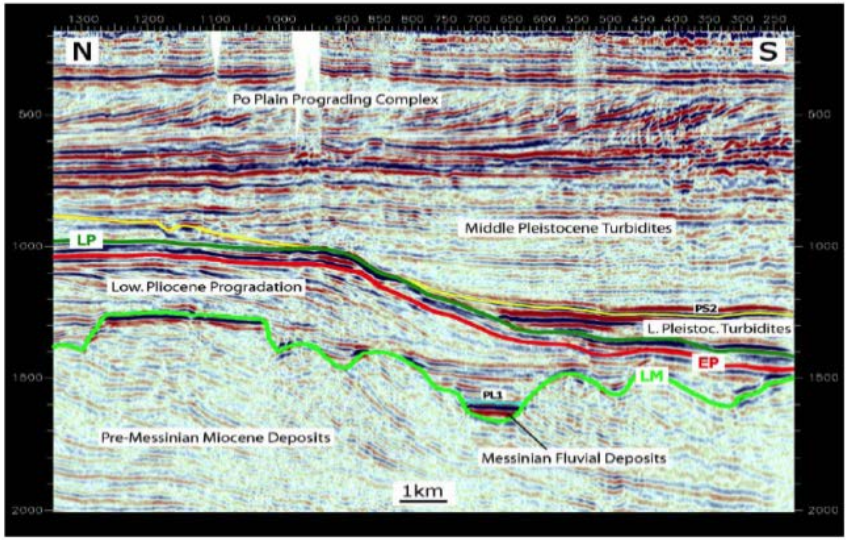
SEISMOSTRATIGRAPHY – NORTHERN ADRIATIC





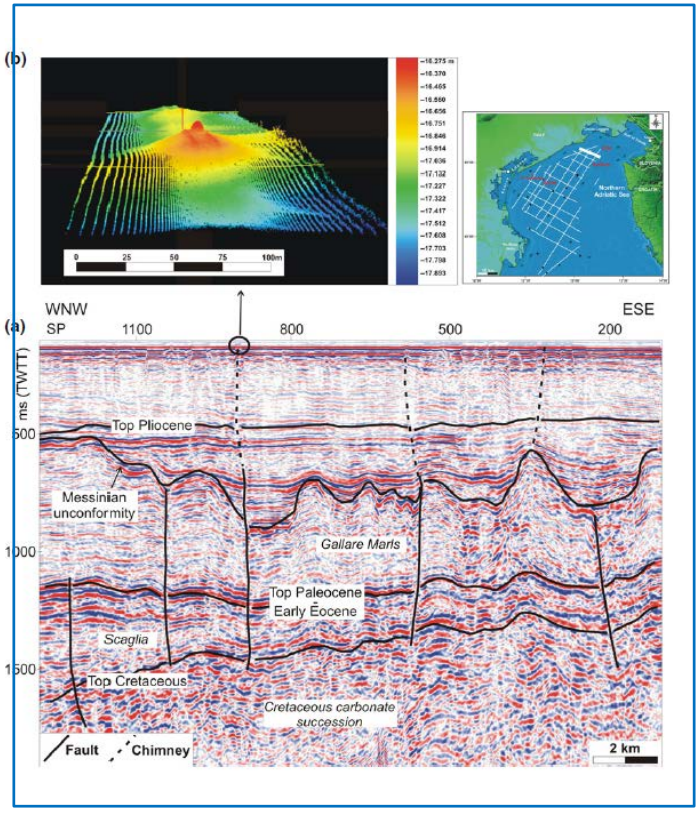


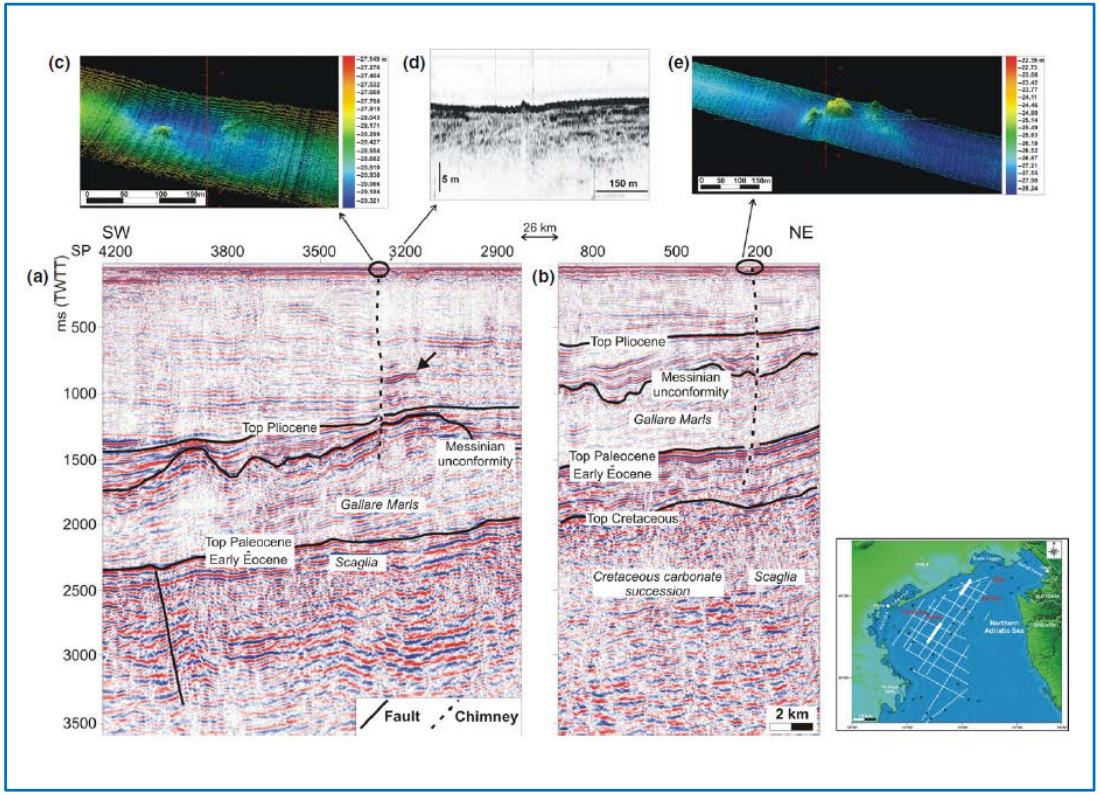
Donda et al., 2014. Deep-sourced gas seepage and methane-derived carbonates in the Northern Adriatic Sea. Basin Research (2014) 1–15, doi: 10.1111/bre.12087



Ghielmi, M., Minervini, M., Nini, C., Rogledi, S., Rossi, M., Vignolo, A., 2010. Sedimentary and tectonic evolution in the eastern Po-Plain and northern Adriatic Sea area from the Messinian to Middle Pleistocene (Italy). Rendiconti Scienze Fisiche e Naturali Accademia Lincei 21, 131e166

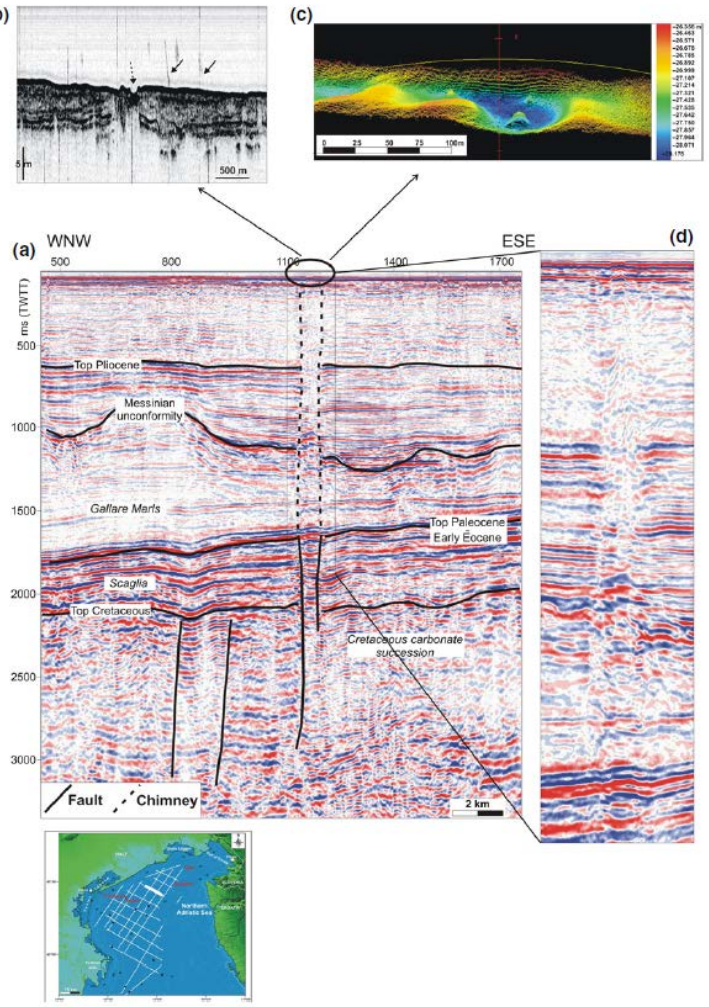
GAS SEEPS IN THE NORTHERN ADRIATIC

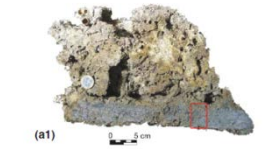


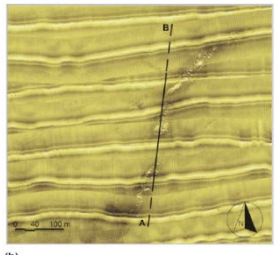


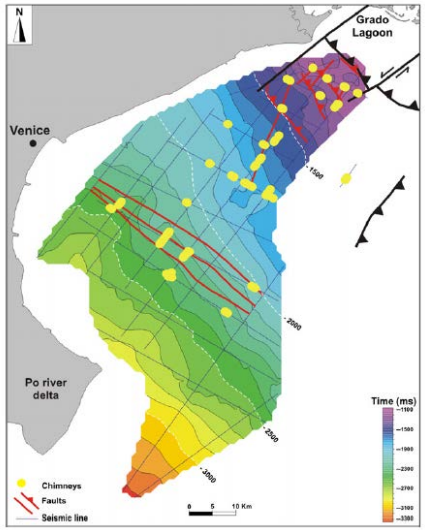
(Donda et al., 2014)

GAS SEEPS IN THE NORTHERN ADRIATIC





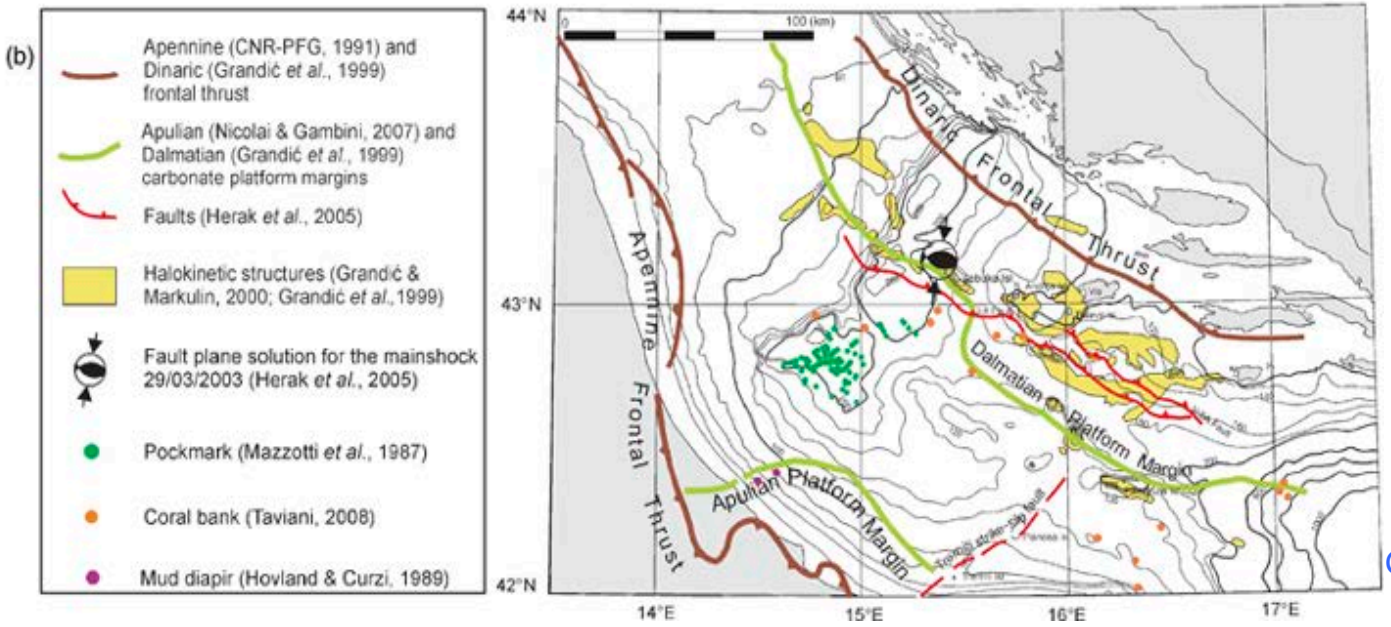




(Donda et al., 2014)

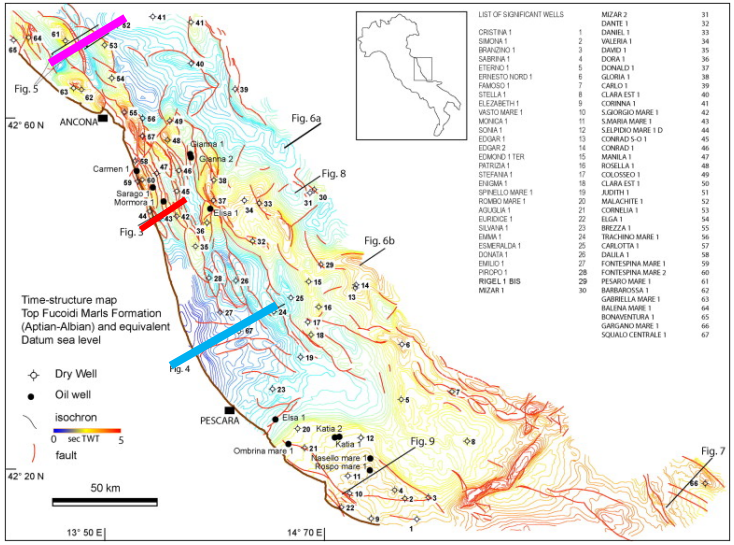
CENTRAL ADRIATIC
Structural setting

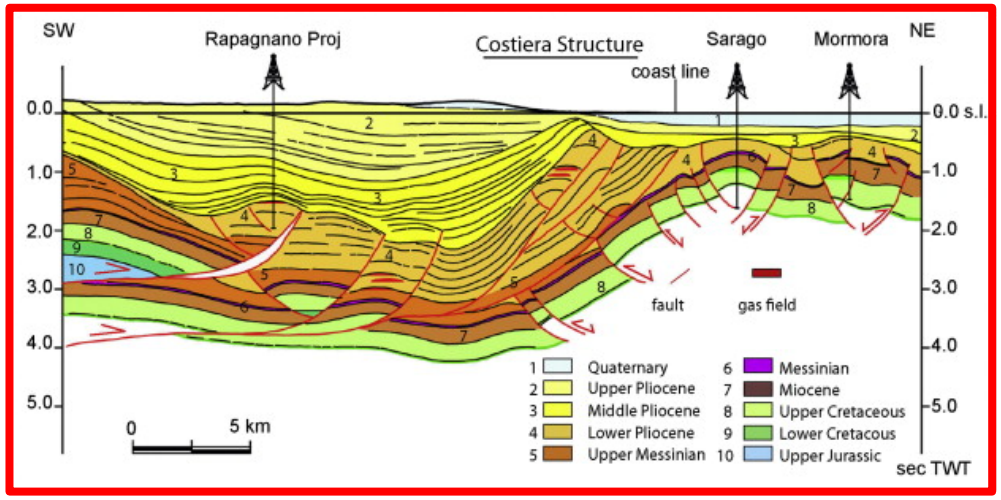
3 main deformation phases:
- extensional in the late Jurassic
- contractional/transtensional in the late Cretaceous
- compressional in the middle-late Pliocene and re-activation of pre-existing tectonic features

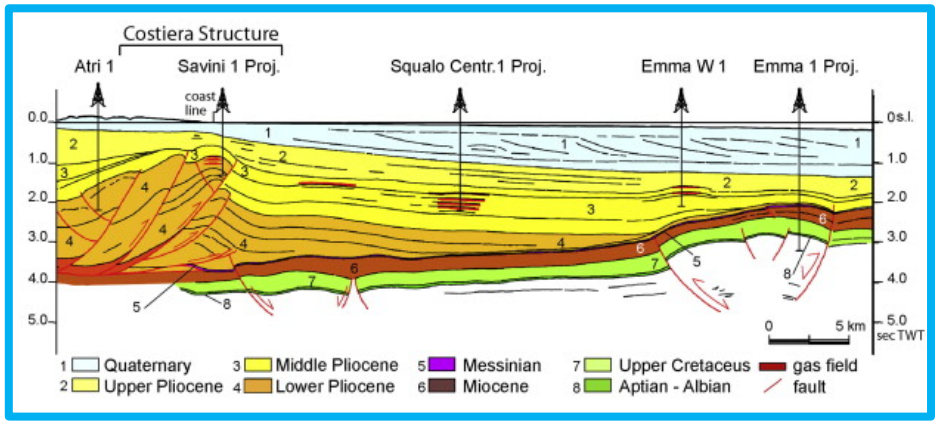


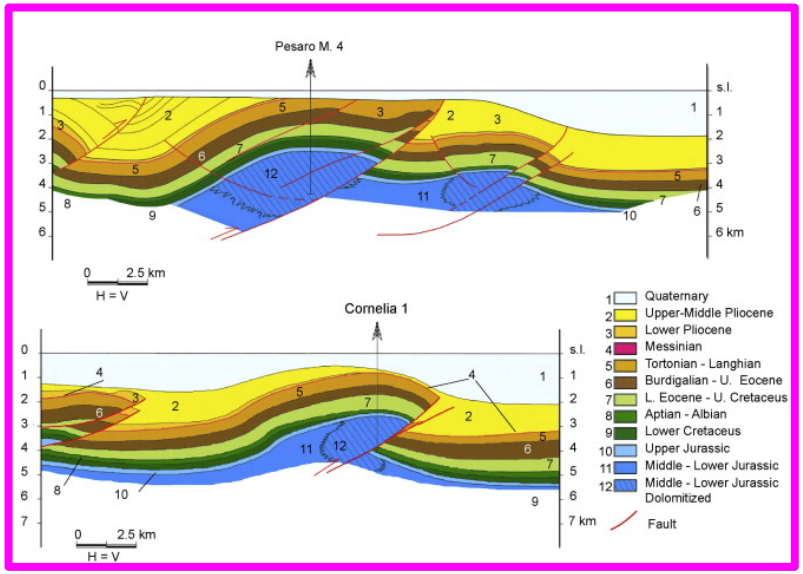
Geletti et al., 2008

CENTRAL ADRIATIC – Tectonic style





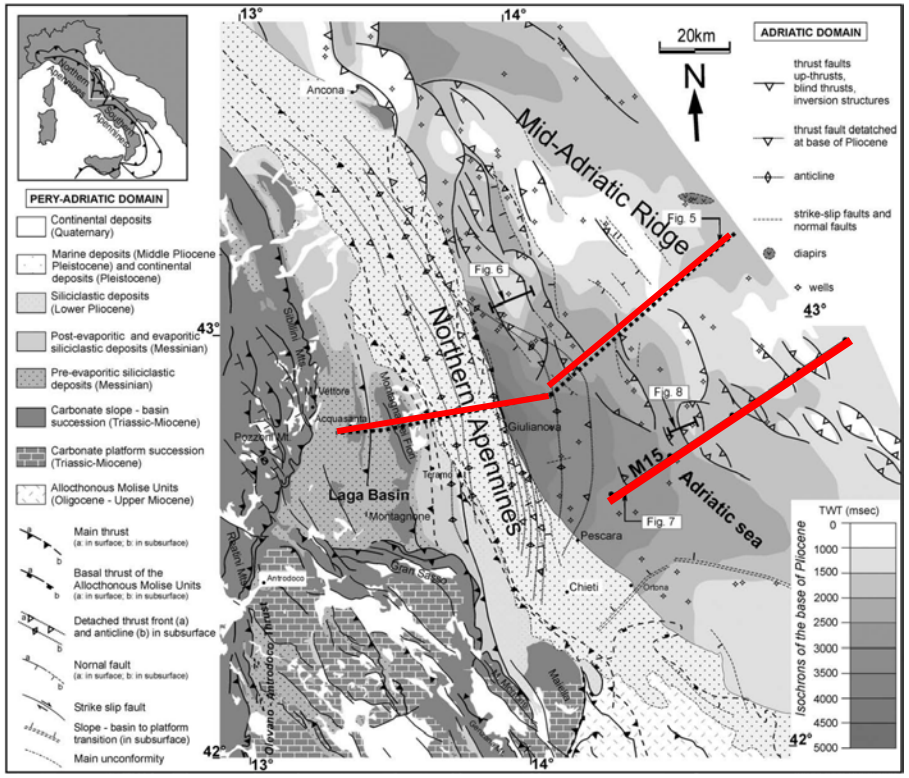


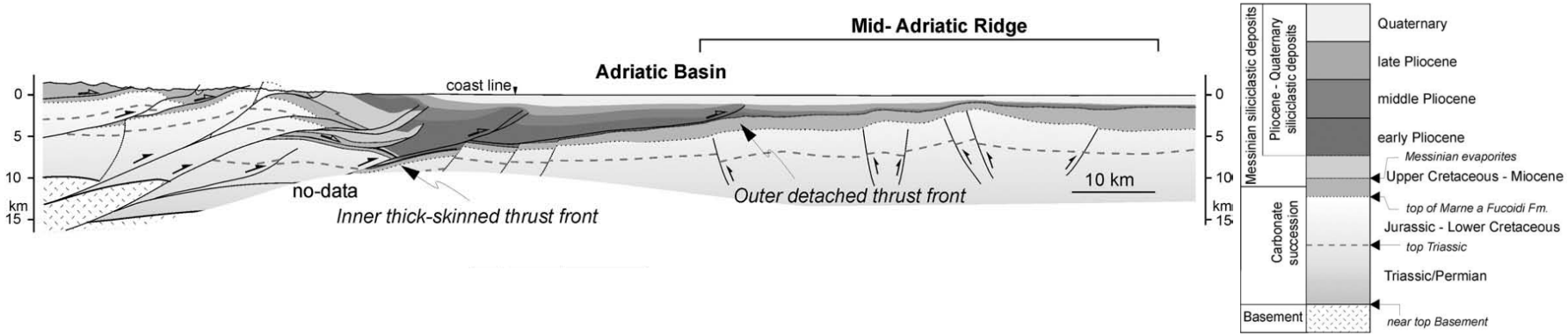


(Casero e Bigi, 2013)

CENTRAL ADRIATIC

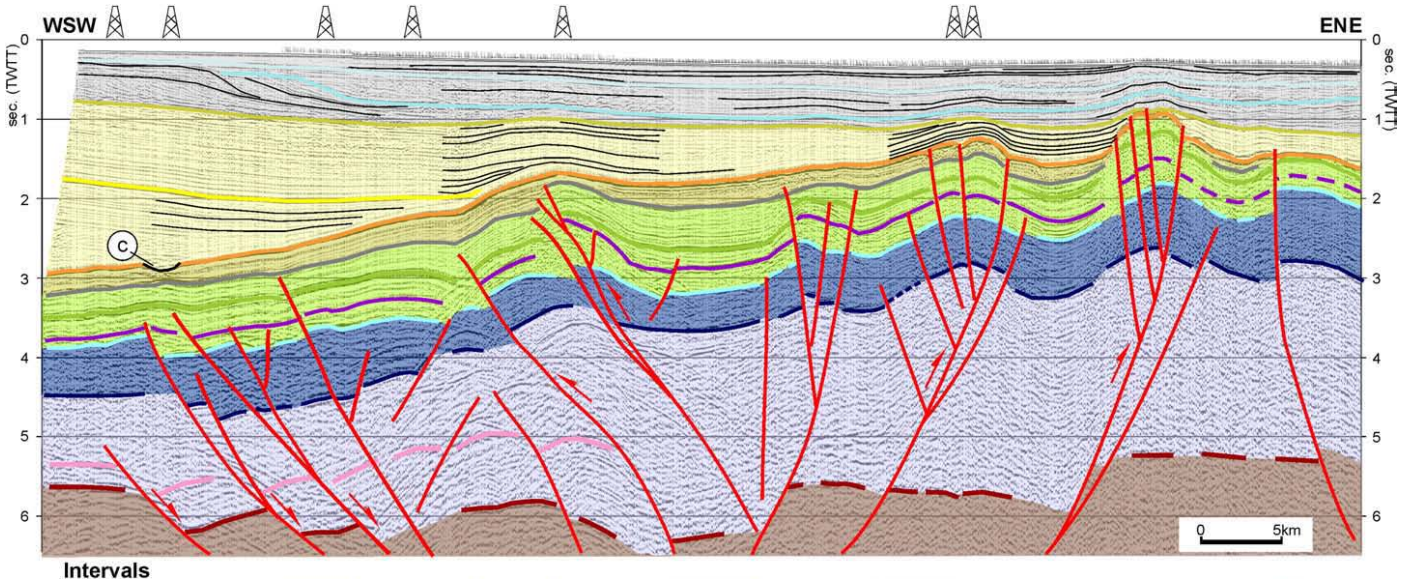
Mid-Adriatic Ridge





CENTRAL ADRIATIC

Mid-Adriatic Ridge



Intervals

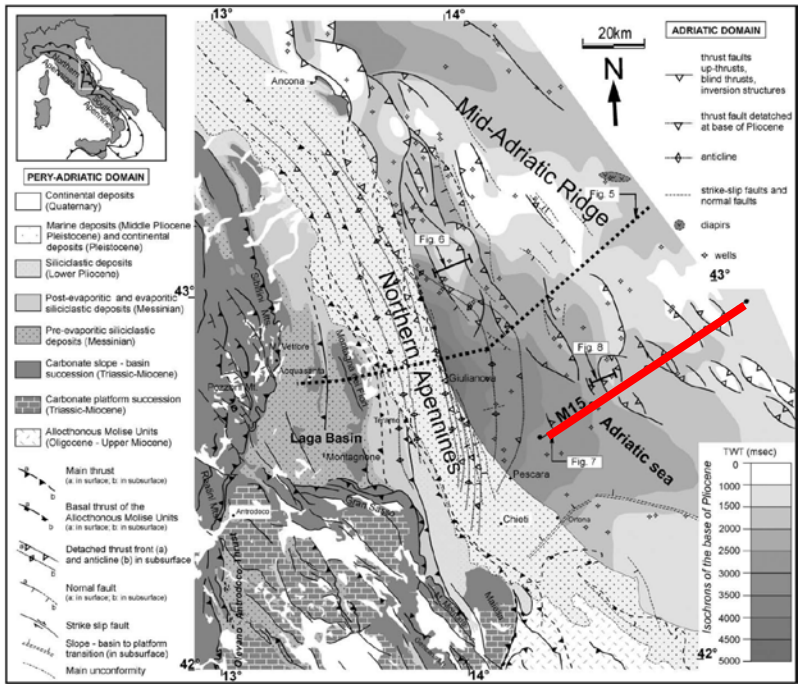
Quaternary | Pliocene | Oligocene-Miocene | Middle Liassic-Eocene | Lower Liassic | Permian-Triassic | Basement

Key Reflectors

- Q1 — Top Lower Pleistocene
- Q2 — Within Lower Pleistocene
- P1 — Top Pliocene
- P2 — near Top middle Pliocene (volcanoclastic level)
- M — Messinian
- E — near Top Eocene (Scaglia Cinerea Fm.)
- LK — Albian-Aptian (Marne a Fucoidi Fm.)
- MJ — middle Jurassic (Rosso Ammonitico Fm.)
- LJ — Top Lower Liassic (Top Calcare Massiccio Fm.)
- Tr1 — near Top Triassic (Top Burano Fm.)
- Tr2 — within Triassic
- P — near Top Basement (Paleozoic)

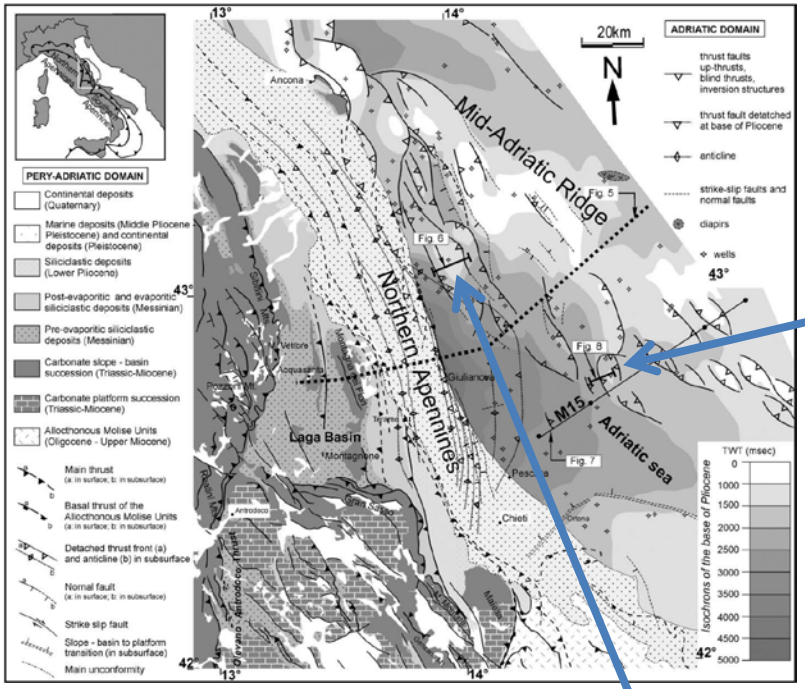
reflectors and unconformities within Pliocene and Quaternary

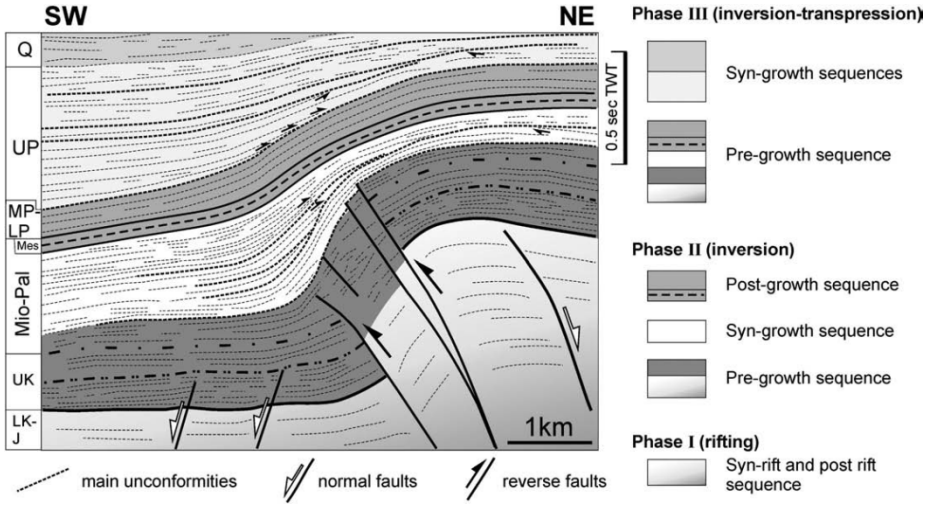
c — incision

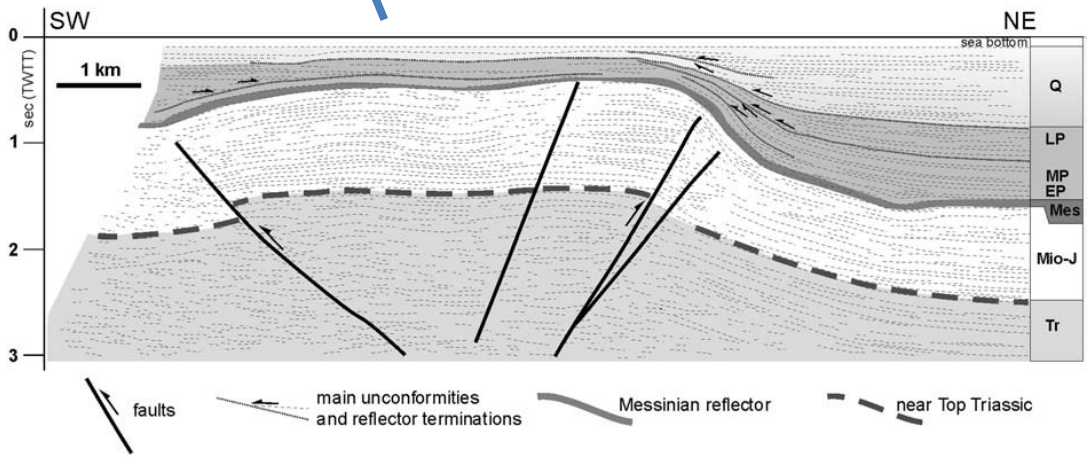


CENTRAL ADRIATIC

Mid-Adriatic Ridge

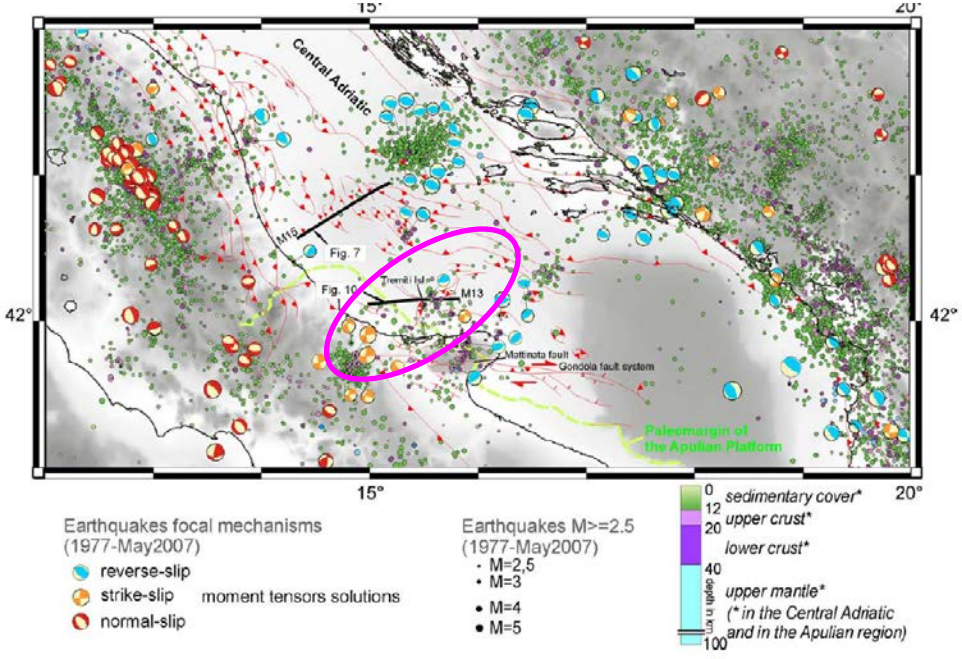


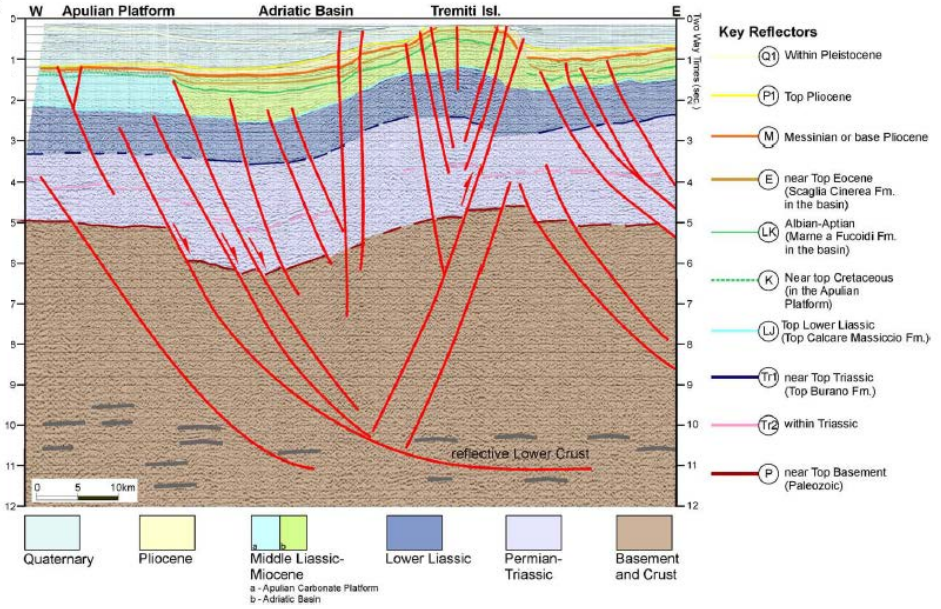




CENTRAL ADRIATIC

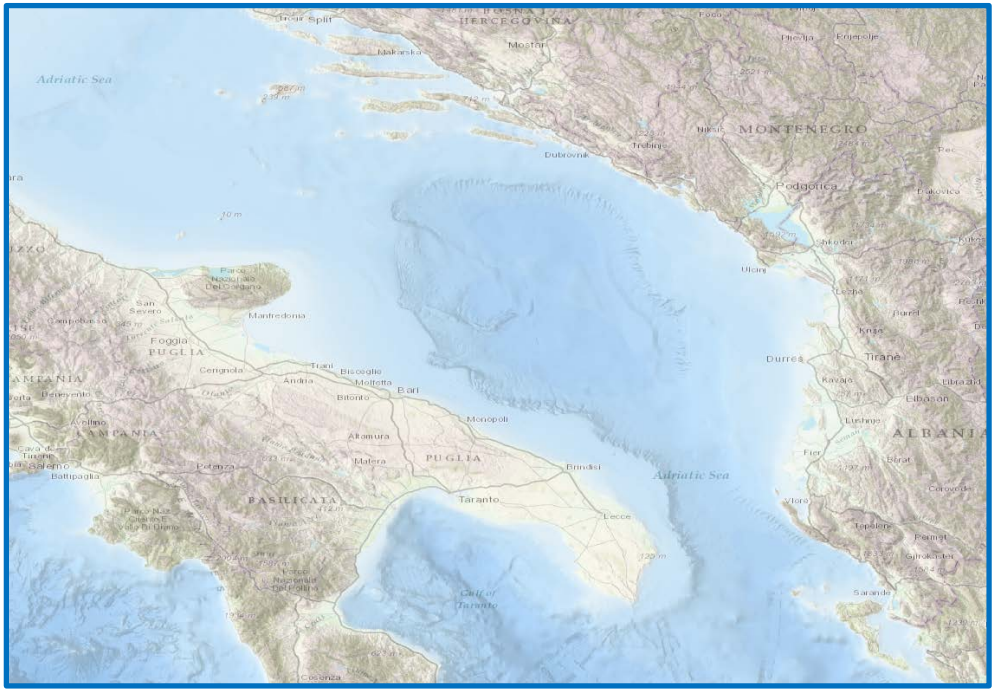
Tremiti Ridge





SOUTHERN ADRIATIC

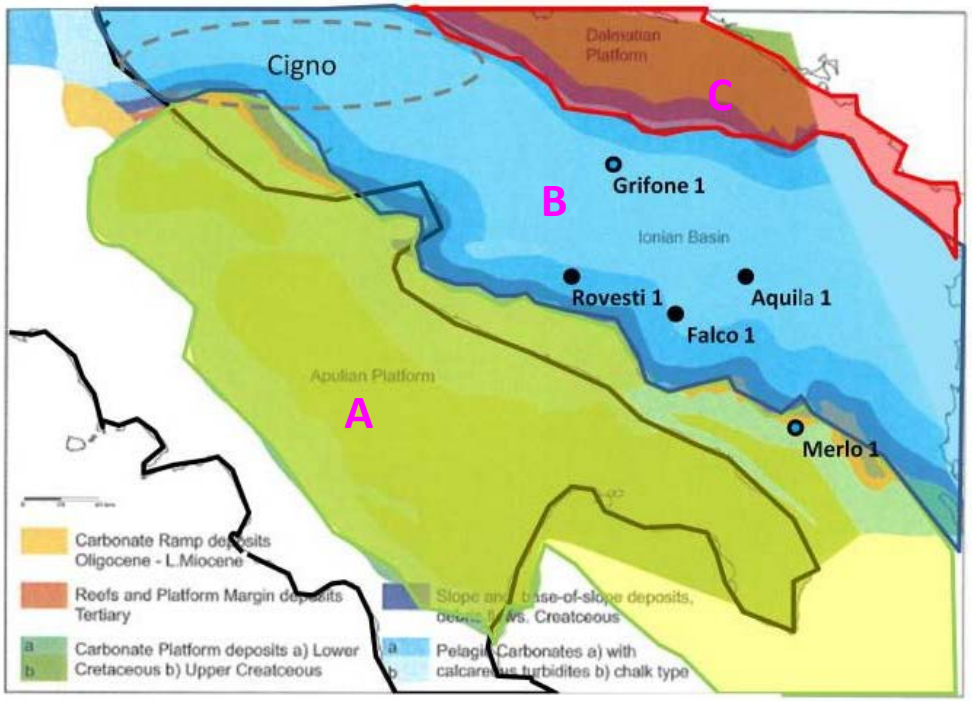
Bathymetry



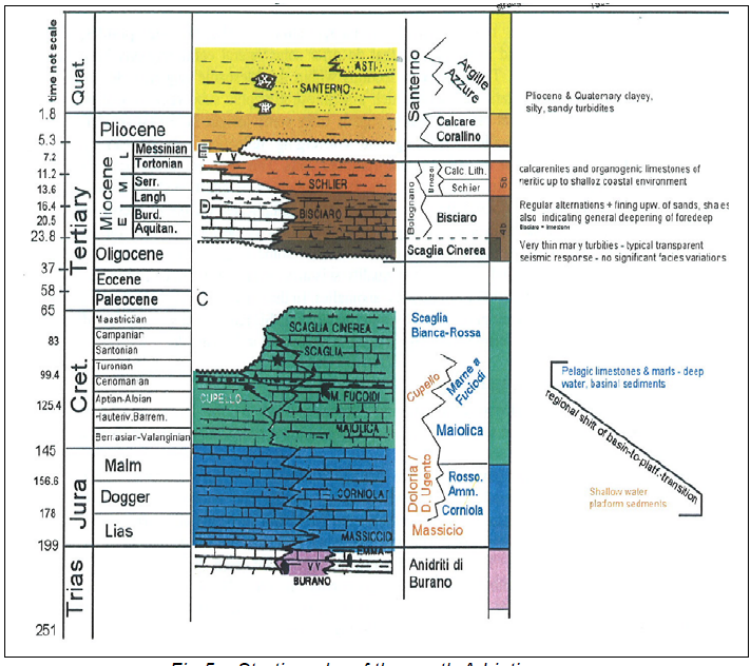
Structural sketch

SOUTHERN ADRIATIC

Stratigraphy



Modified after Nicolai & Gambini 2007

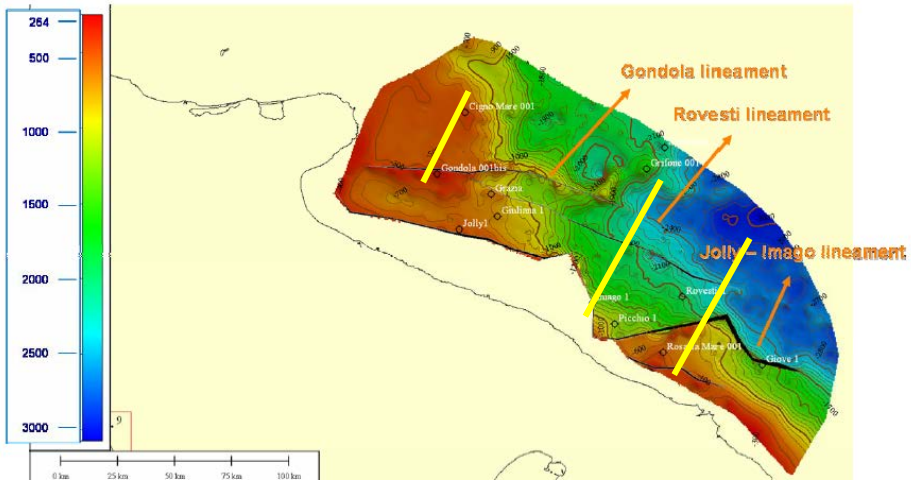


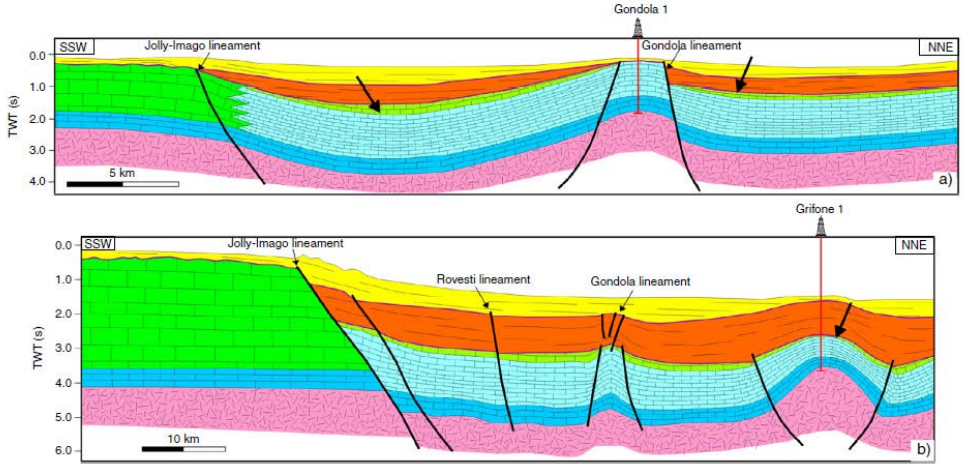
The Apulian zone (A), extending from Puglia region to the external sector of the Ionian islands (pre Apulian area), and characterized by thick carbonate Triassic to Miocene neritic sequences (> 6000 m).

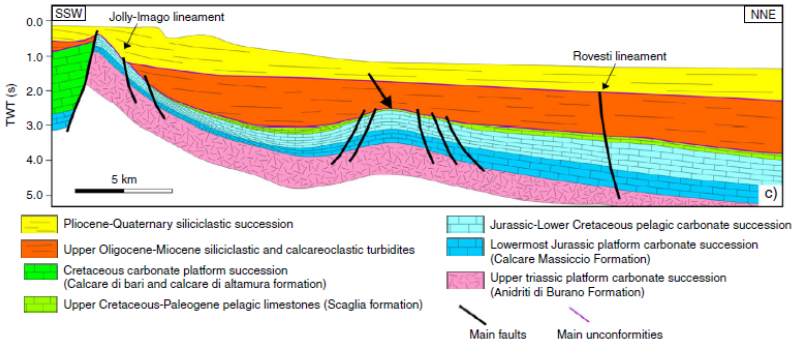
The Ionian zone, (B) It occupies the Southern Adriatic Sea area. Going further north it joins the Umbria-Marche Apennines, whereas to the west it outcrops in the eastern sector of the Gargano. It features neritic sediments up to the Early Jurassic (Early-Middle Lias), becoming pelagic up to the Middle-Late Eocene and finally terrigeneous (flysch) up to the Early Miocene.

The Dalmatian zone, (C) outcrops along the Montenegro coastline, with neritic facies from the Triassic to the Middle Eocene and becoming flyshoidal from the Oligocene to the Early Miocene (Aquitanian).

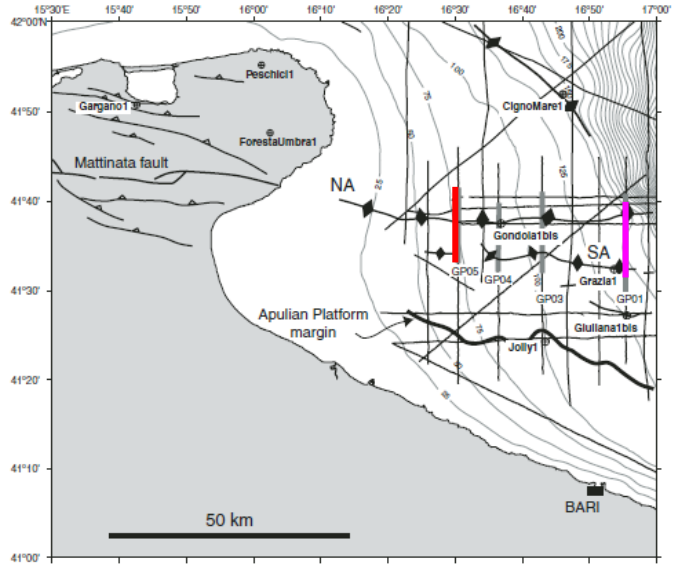
SOUTHERN ADRIATIC
Structural setting

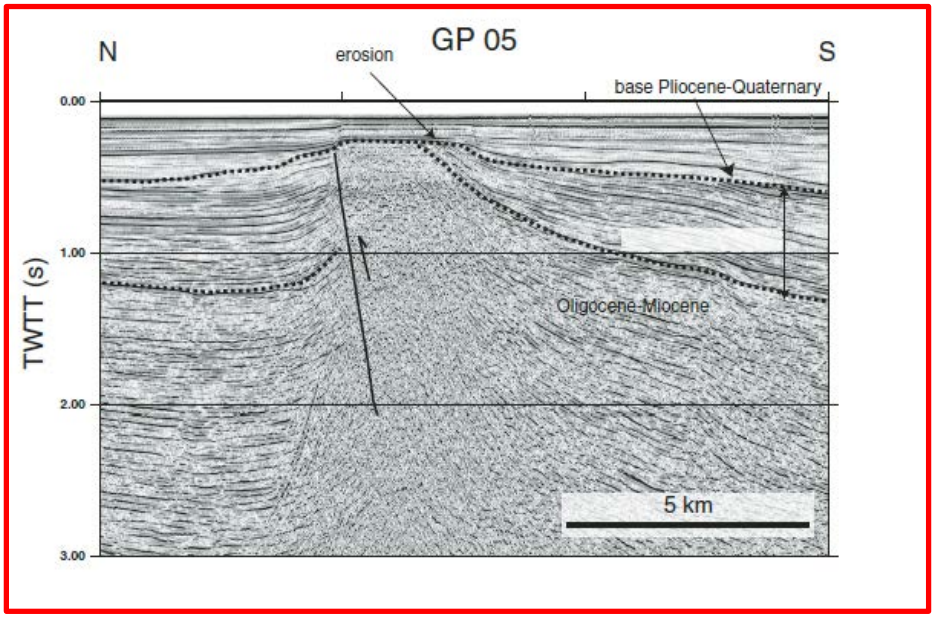


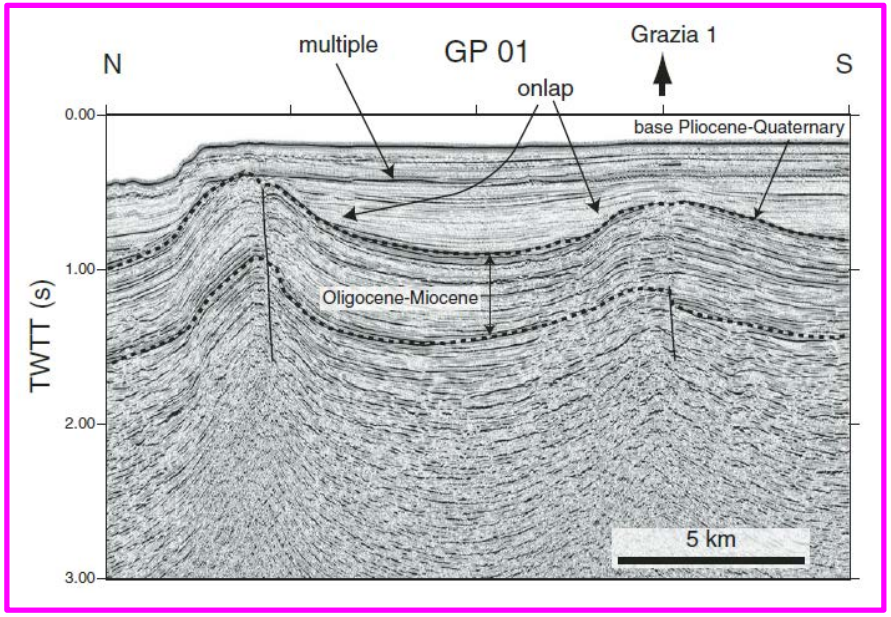


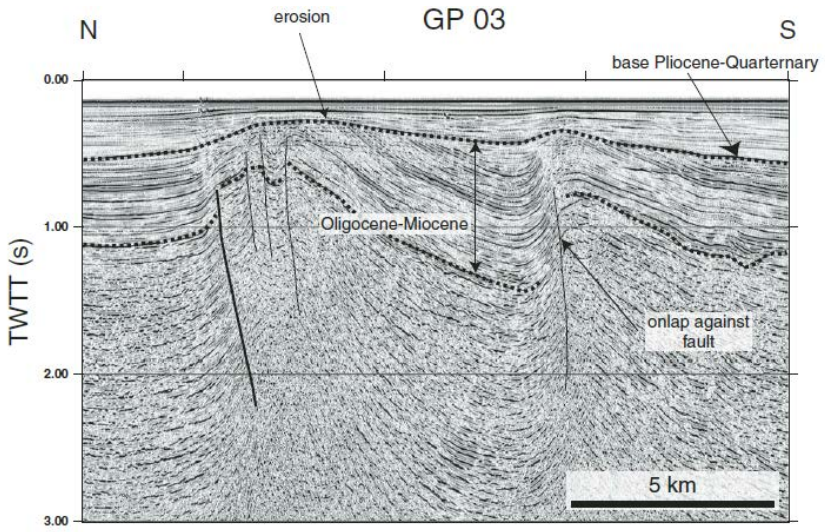


Volpi et al., 2014







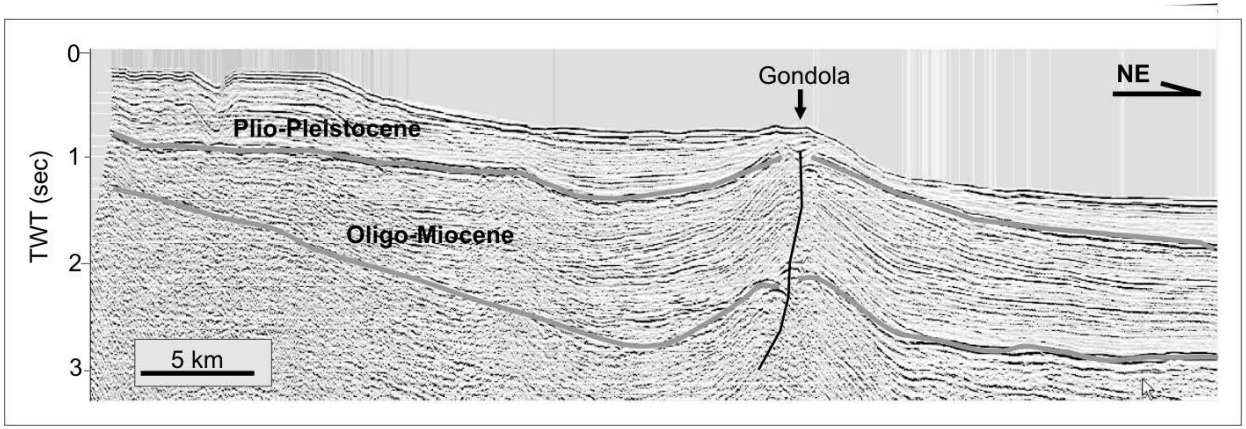


(Argnani et al., 2012)

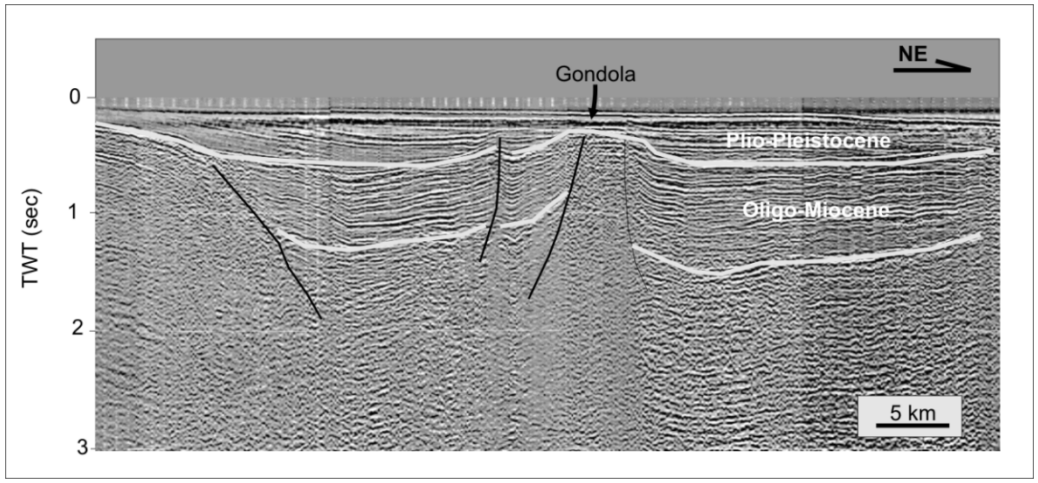
SOUTHERN ADRIATIC

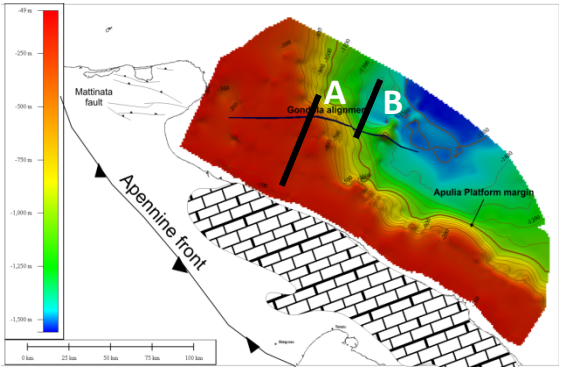
Gondola fault system

A



B

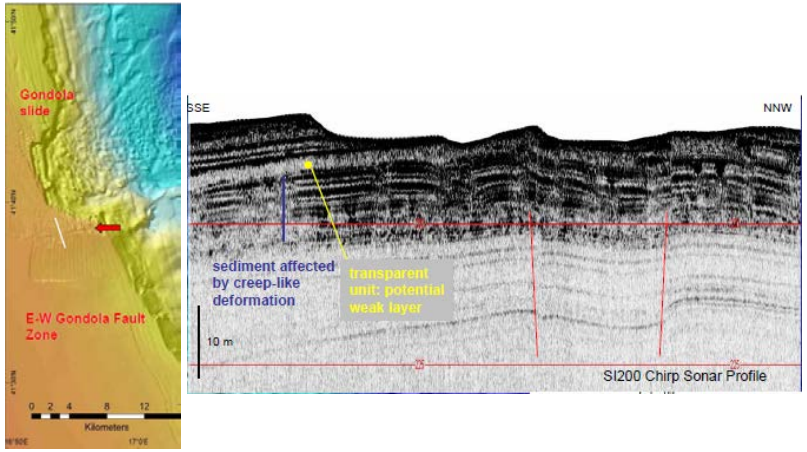


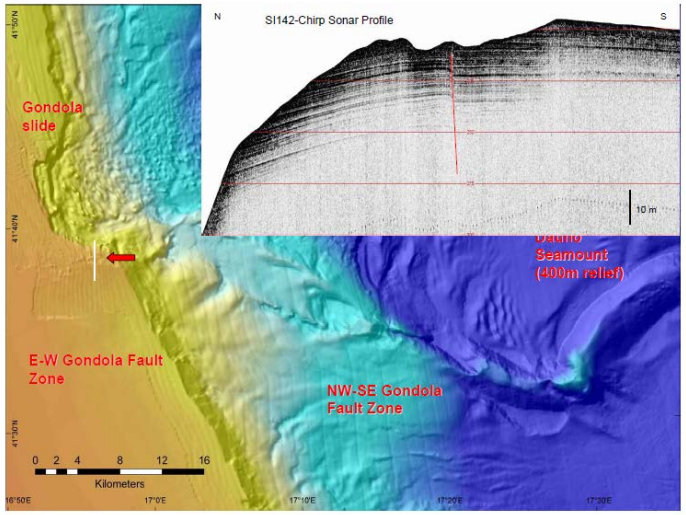


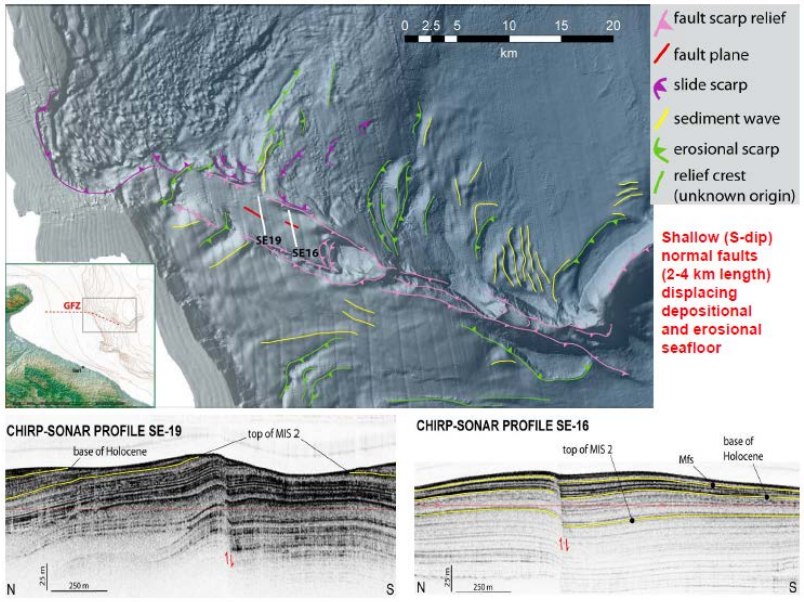
SOUTHERN ADRIATIC

Gondola fault system

Seafloor evidence and shallow deformation

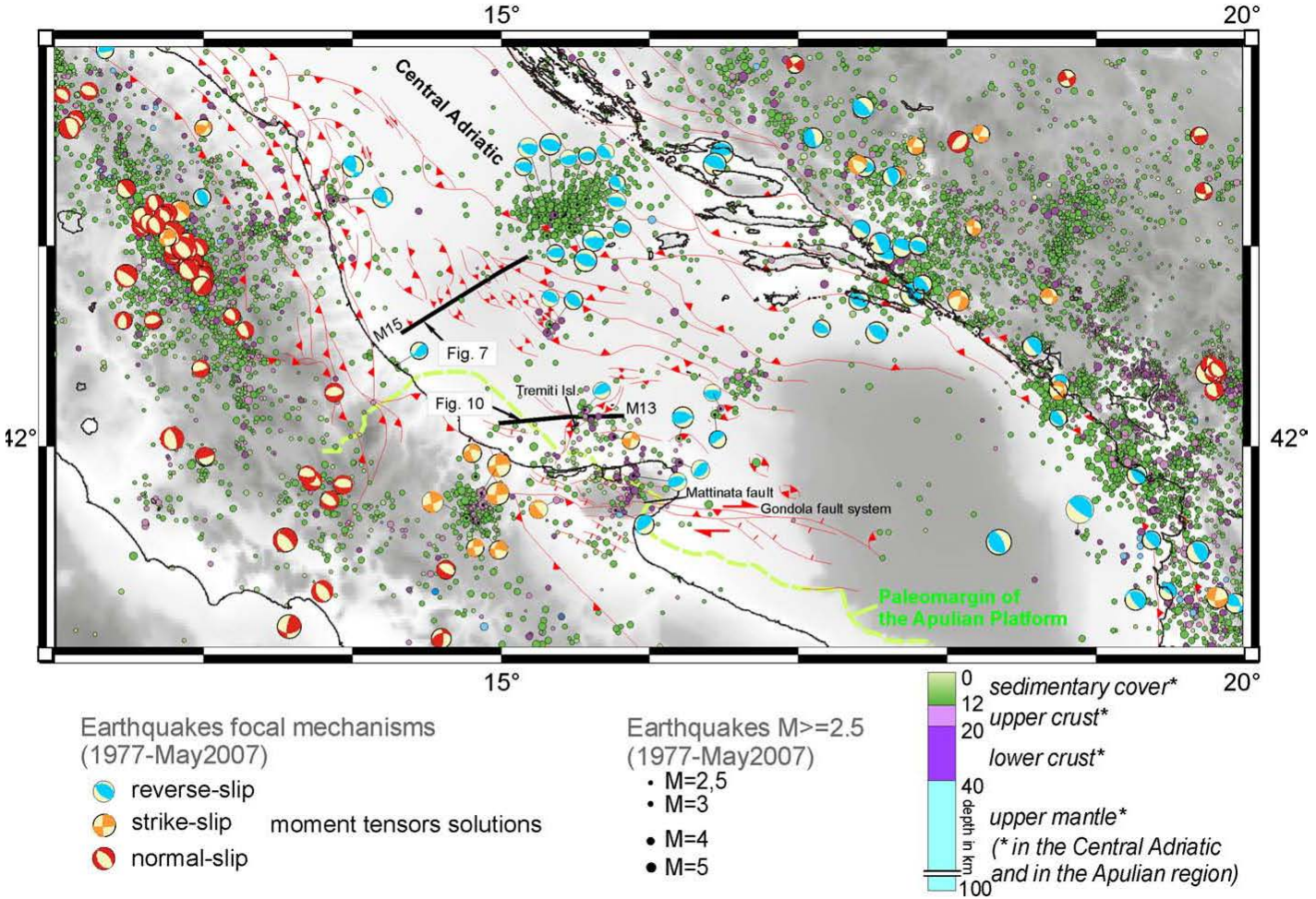






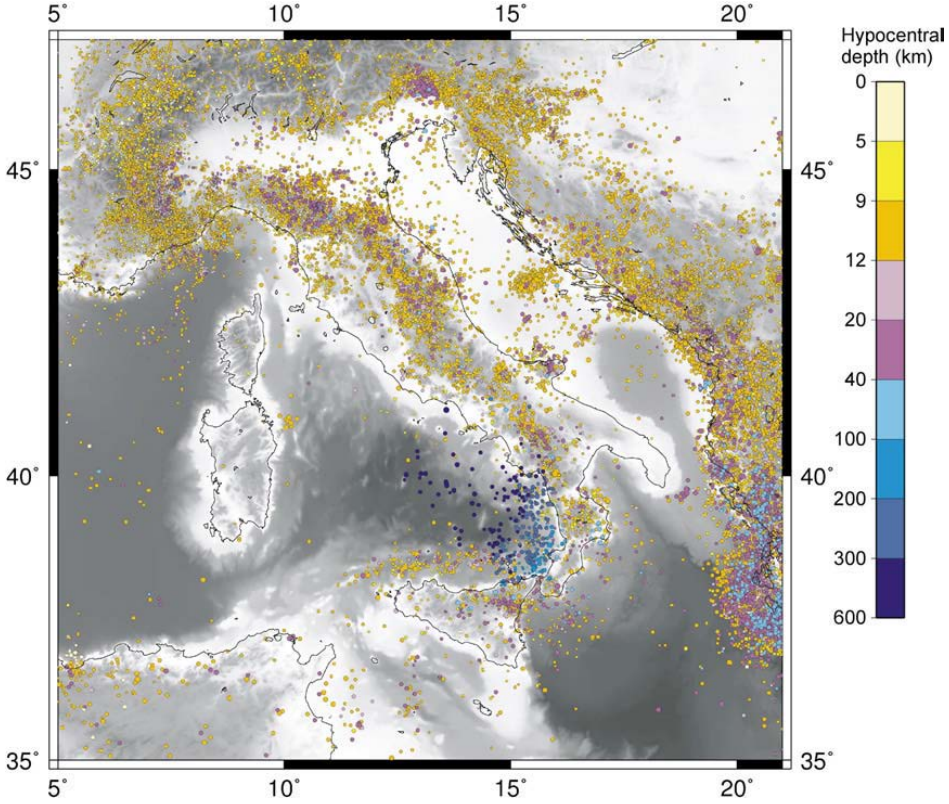
Ridente et al., 2010

SEISMICITY OF THE ADRIATIC REGION

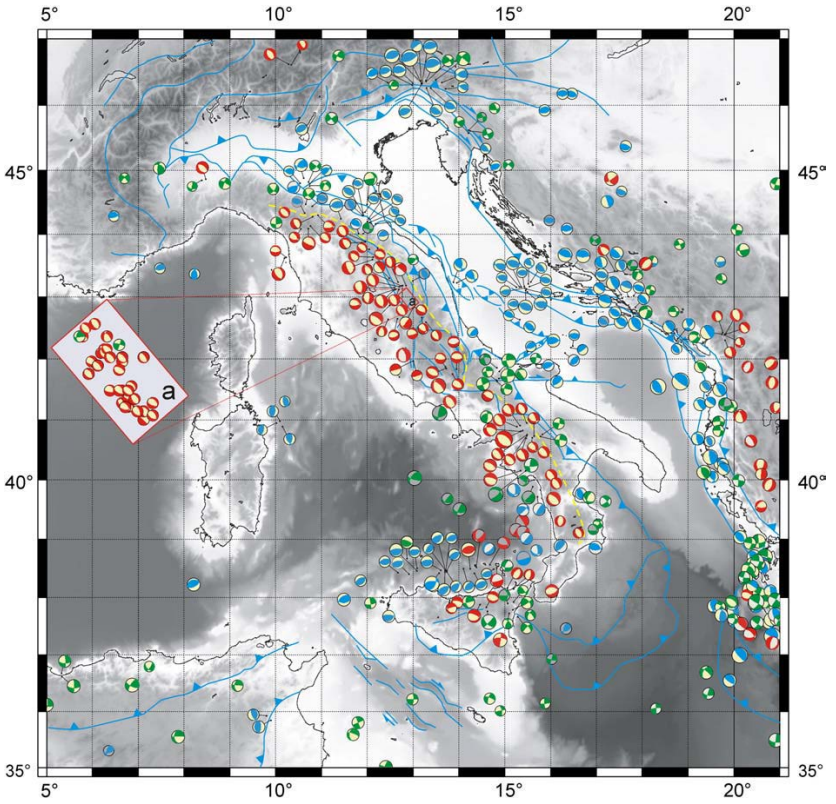


SEISMICITY OF THE ADRIATIC REGION

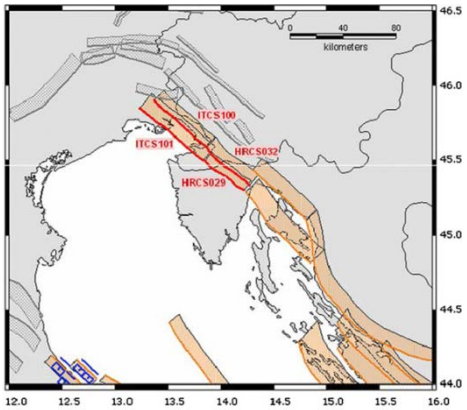
Hypocentral depth



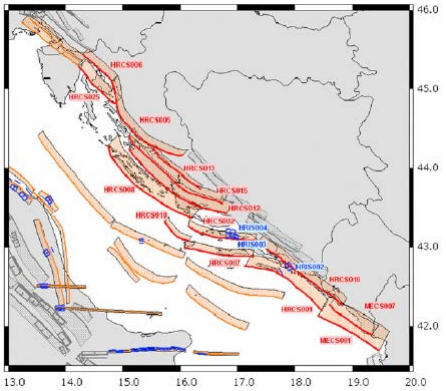
Focal mechanisms



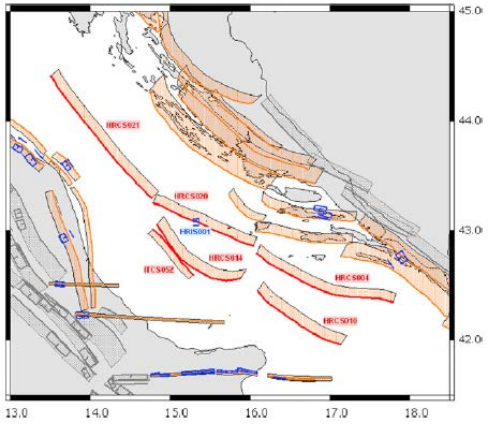
DISS INGV – Italian seismicity catalogue



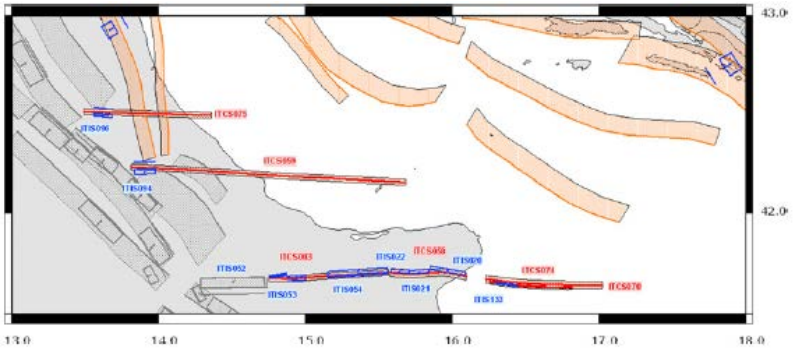
Region name	North-Eastern Adriatic
Region code	AD1
Structural setting	External Dinarides thrust belt
Principal faulting style	reverse to reverse-dextral strike slip
Largest Earthquake	14.08.1574 M_w 5.6 Lupoglav earthquake
Largest Tsunami	26.03.1511 I 2 Venice/Trieste tsunami



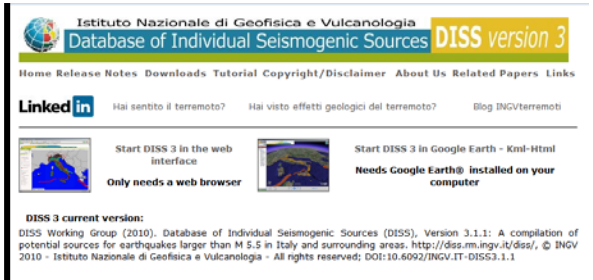
Region name	Eastern Adriatic
Region code	AD2
Structural setting	Internal and central part of External Dinarides thrust belt
Principal faulting style	thrusting, reverse to reverse-dextral strike slip
Largest Earthquake	06.04.1667 M_w 7.2 Dubrovnik earthquake
Largest Tsunami	06.04.1667 I 4 Dubrovnik tsunami



Region name	Central Adriatic
Region code	AD3
Structural setting	External parts of the External Dinarides and Apennines, Middle Adriatic
Principal faulting style	thrusting
Largest Earthquake	02.07.1844 M_w 5.6 Adriatic earthquake
Largest Tsunami	unknown

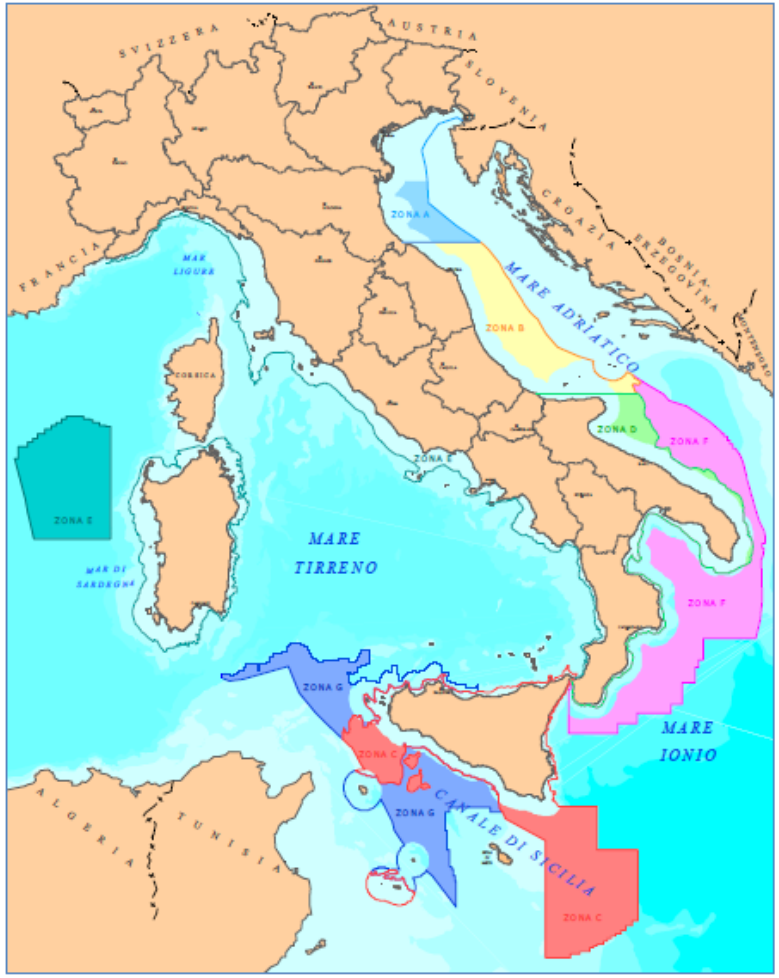


Region name	Southern Western Adriatic
Region code	AD4
Structural setting	Apulian foreland shear zone
Principal faulting style	dextral strike-slip
Largest Earthquake	30.07.1627 M_w 6.7 Gargano earthquake
Largest Tsunami	30.07.1627 I 5 Gargano tsunami



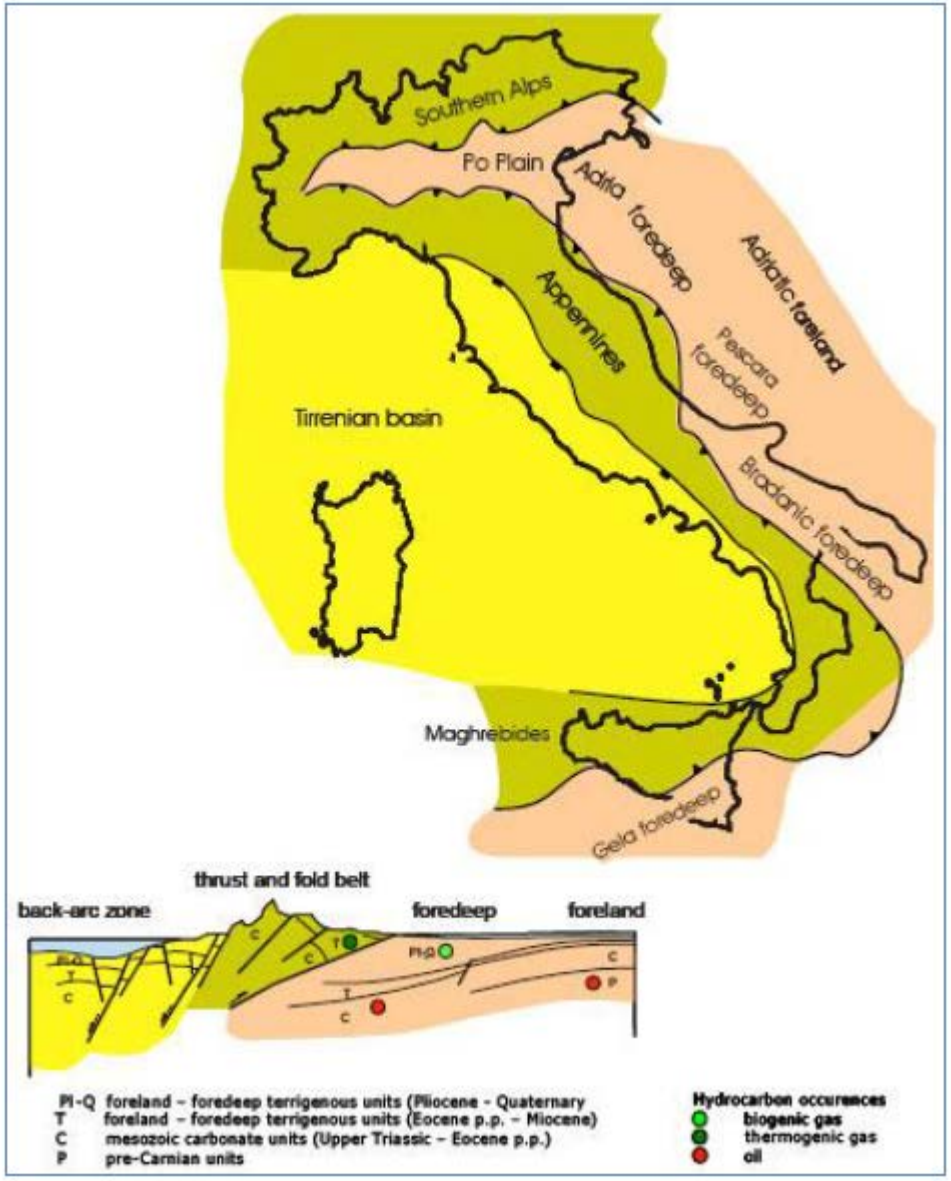
HYDROCARBON EXLORATION

Zone marine originariamente aperte alle attività minerarie (Elaborazione dell'Ufficio cartografia della DGRME)

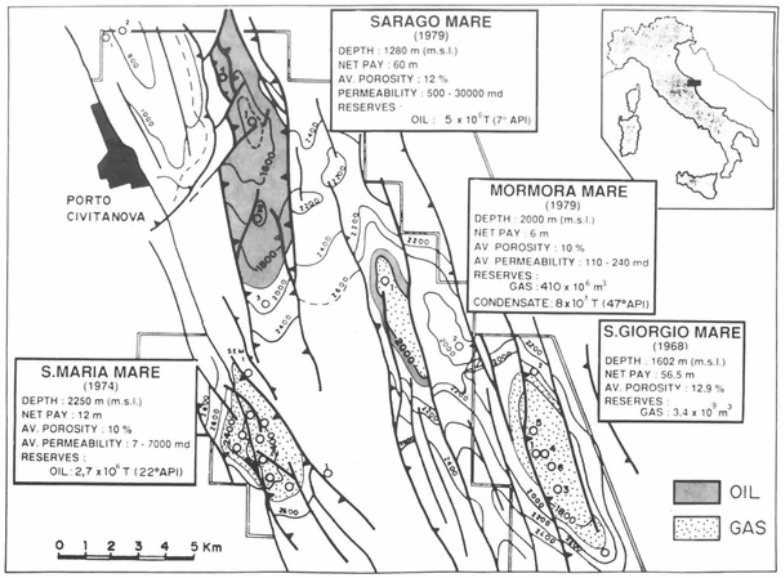


Zone marine aperte alle attività minerarie e rimodulate con D.M. 8/08/2013 (Elaborazione dell'Ufficio cartografia della DGRME)

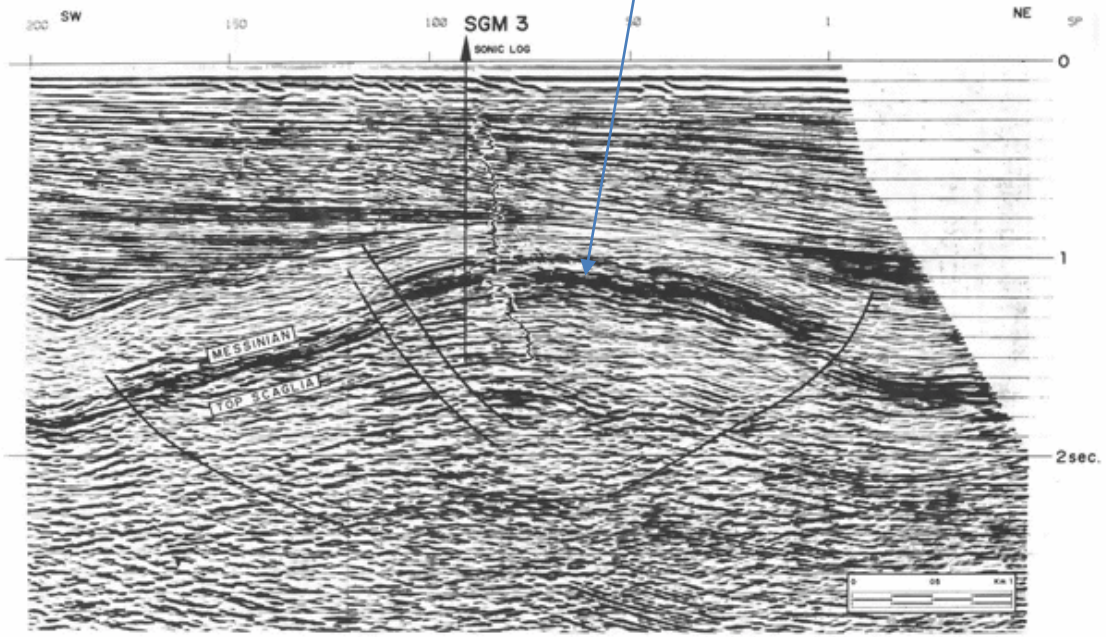
LOCATION OF THE MAIN HYDROCARBON FIELDS AND STRUCTURAL SETTING



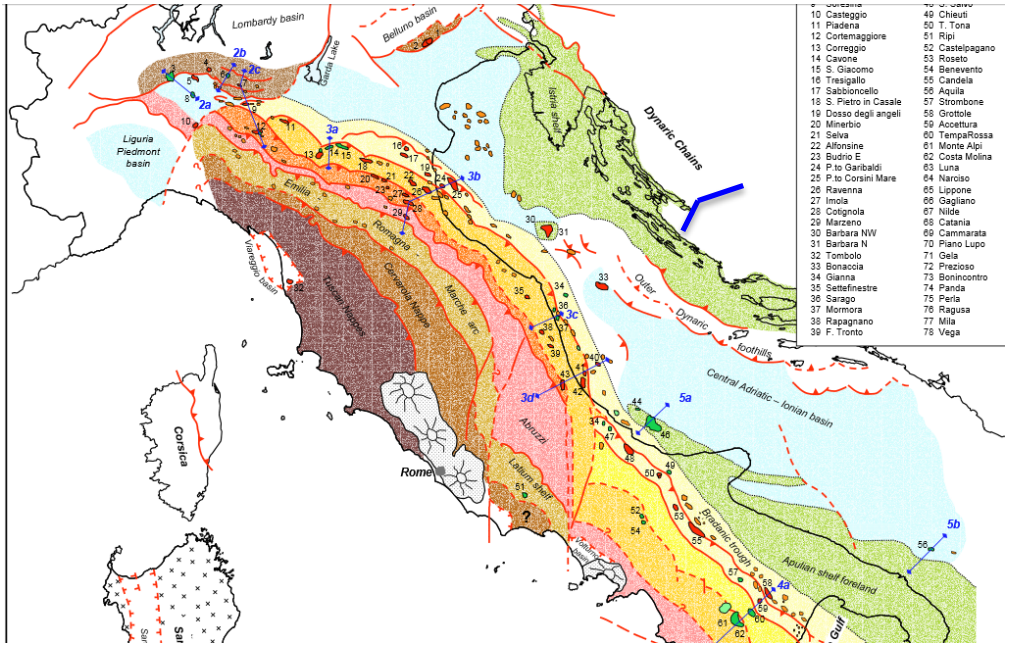
CRETACEOUS – PALEOGENE HYDROCARBON FIELDS



Reservoir (oil-gas): fractured carbonates (Cretaceous – Paleogene)

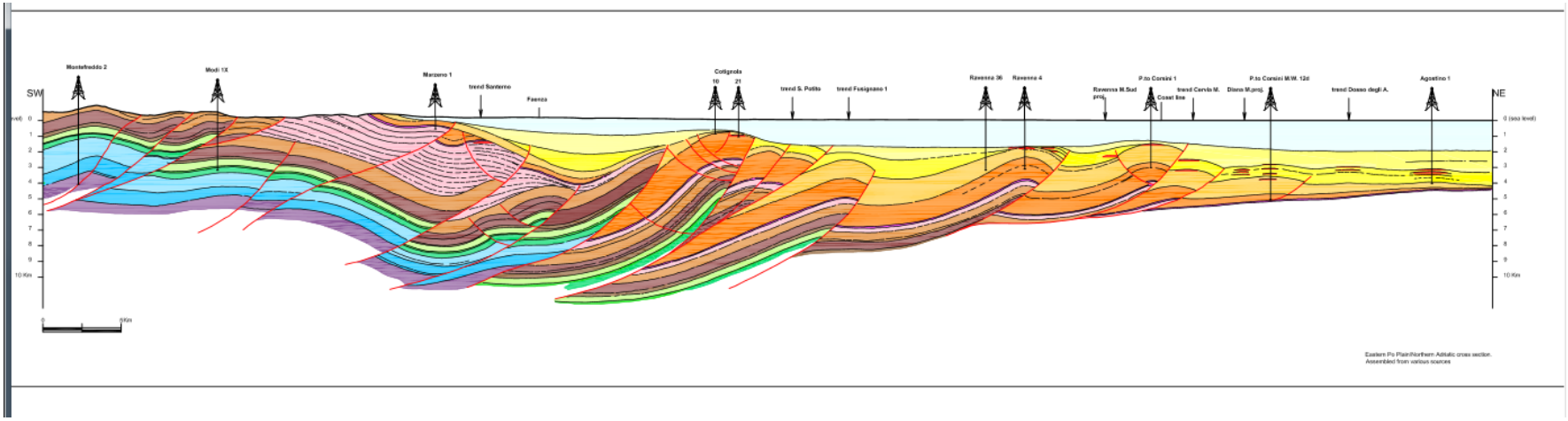


LOWER PLIOCENE/PLEISTOCENE HYDROCARBON FIELDS



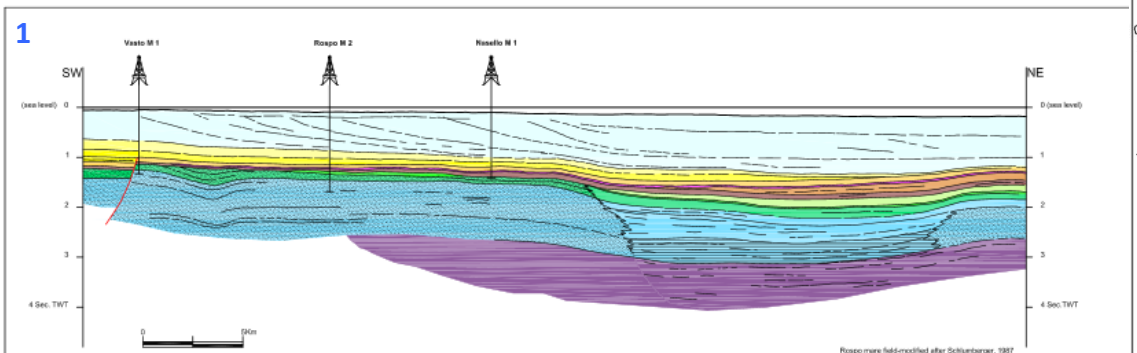
Reservoir (gas): turbiditic sands of the foredeep (lower Pliocene)

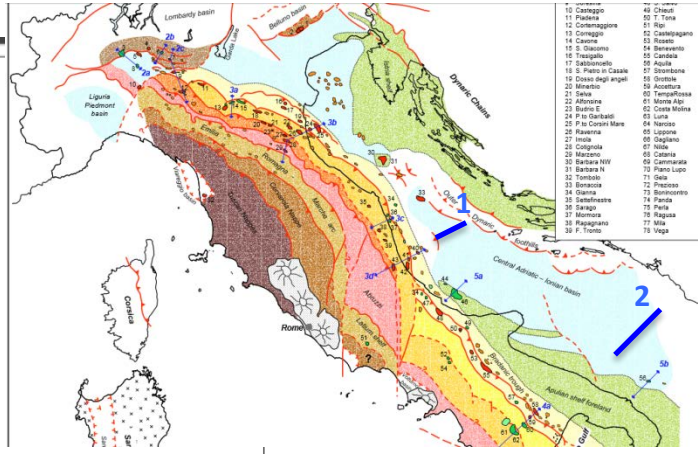
Reservoir (gas): positive structures of the thrusts (Pleistocene)



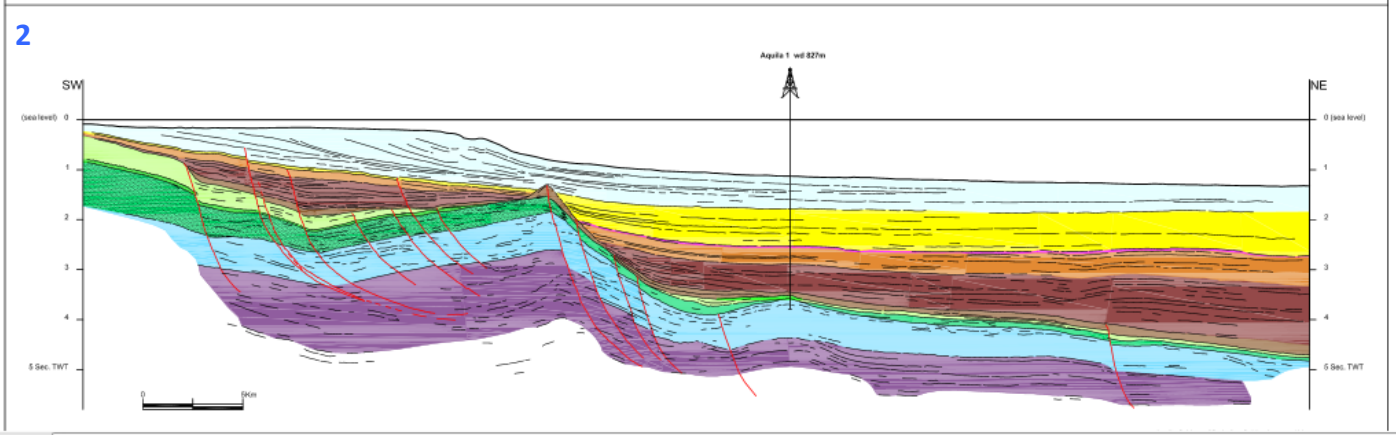
CRETACEOUS CARBONATE HYDROCARBON FIELDS

Reservoir (oil): top of the platform carbonates, fractured due to erosion (period of emersion of structural high) or to deformation (Cretaceous – Paleogene)





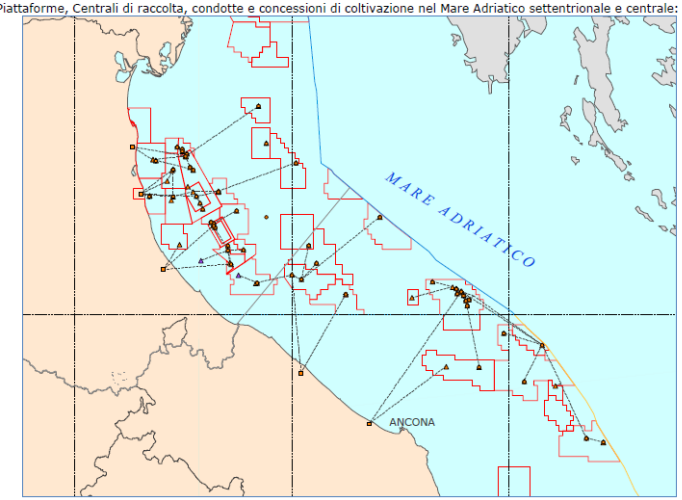
Sect. 5a



Casero, 2004

CARTE DEGLI IMPIANTI ATTIVI IN MARE - SITUAZIONE AL 31 DICEMBRE 2014

Piattaforme, Centrali di raccolta, condotte e concessioni di coltivazione nel Mare Adriatico settentrionale e centrale:

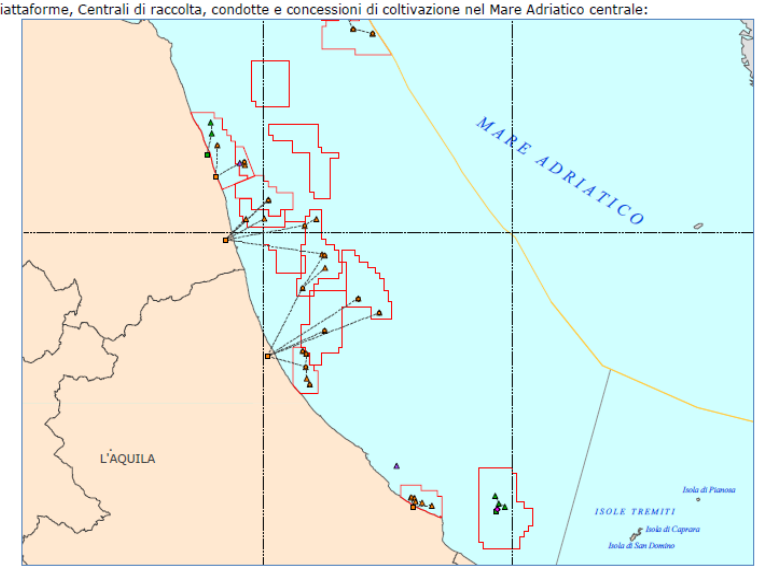


POZZI ATTIVI NELL'OFFSHORE ITALIANO AL 31 DICEMBRE 2014

	Zona A	Zona B	Zona C	Zona D	Zona F	Zona G	Totale
Produttivi	230	79	22	28	2	0	361
Potenzialmente produttivi	253	68	22	1	1	4	349
Altra utilizzo	10	3	1	0	0	0	14
Totale	493	150	45	29	3	4	724

	Zona A	Zona B	Zona C	Zona D	Zona F
Gas naturale	230	47	0	28	0
Olio greggio	0	32	22	0	2
Totale	230	79	22	28	2

Piattaforme, Centrali di raccolta, condotte e concessioni di coltivazione nel Mare Adriatico centrale:



(Elaborazioni dell'Ufficio cartografia della DGRME)