



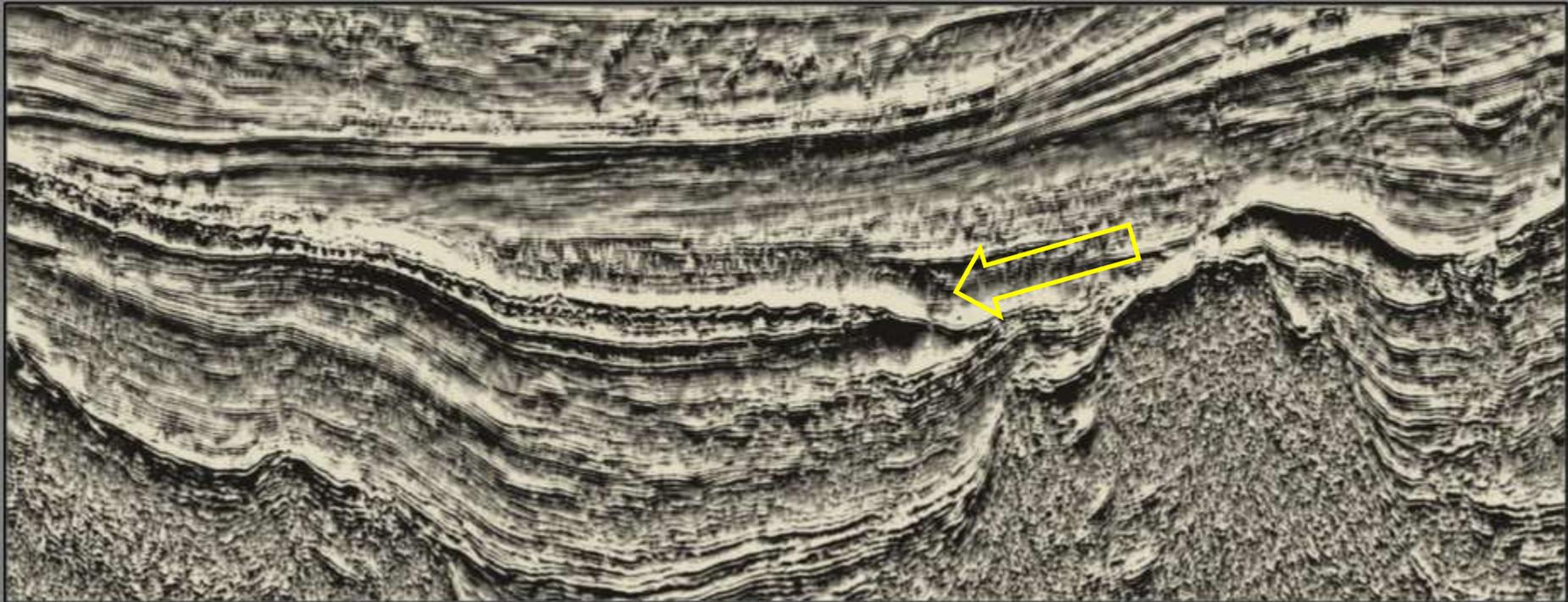
Seismo-stratigraphic analysis of Upper Miocene (Messinian) deposits of the South Adriatic Basin, Croatia

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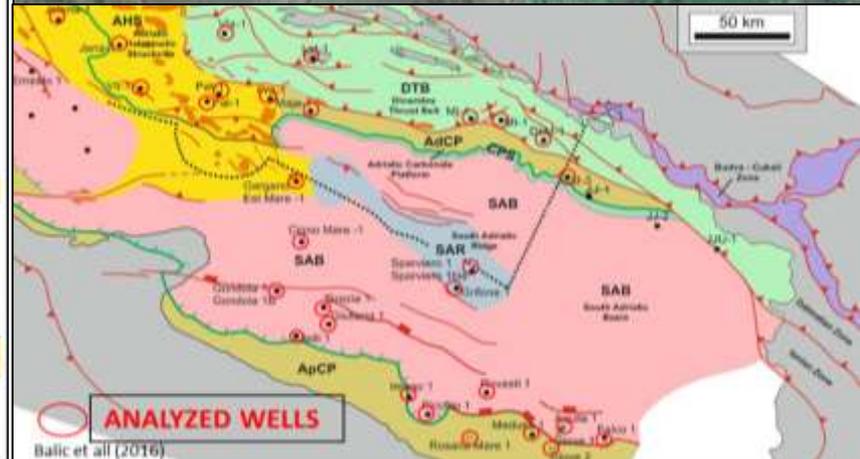
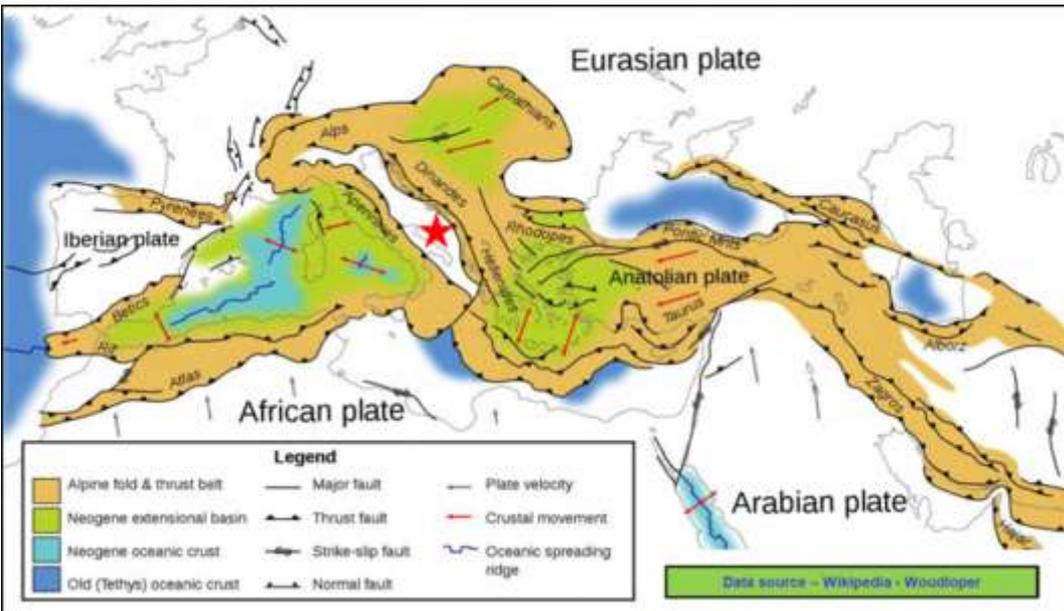




- Introduction (Location, Regional Tectonic Setting, Stratigraphy)
- Well correlation and seismic interpretation
- Distribution of Messinian deposits in South Adriatic Basin (SAB)
- Possible petroleum system potential
- Conclusion

Location, area, database

- ❑ South Adriatic Basin (SAB) is placed between Apenninic and Dinaric-Hellenic orogenic systems
- ❑ It encompasses approximately 50000 square kilometers
- ❑ SAB is Dinaric/Albanic foreland basin



- ❑ The SAB is relatively unexplored; available Croatian and Italian wells were used for analysis of the Messinian deposits (25 wells)
- ❑ Analyzed wells were positioned in the shallow marine, land and marginal marine setting
- ❑ In the basinal area, interpretation is based on the seismic data exclusively; 2D & 3D

Introduction

Regional Tectonic Setting with key Geotectonic Units

Adriatic Halokinetic Structures (AHS)- predominance of halokinetic structures: diapirs and salt-cored anticlines

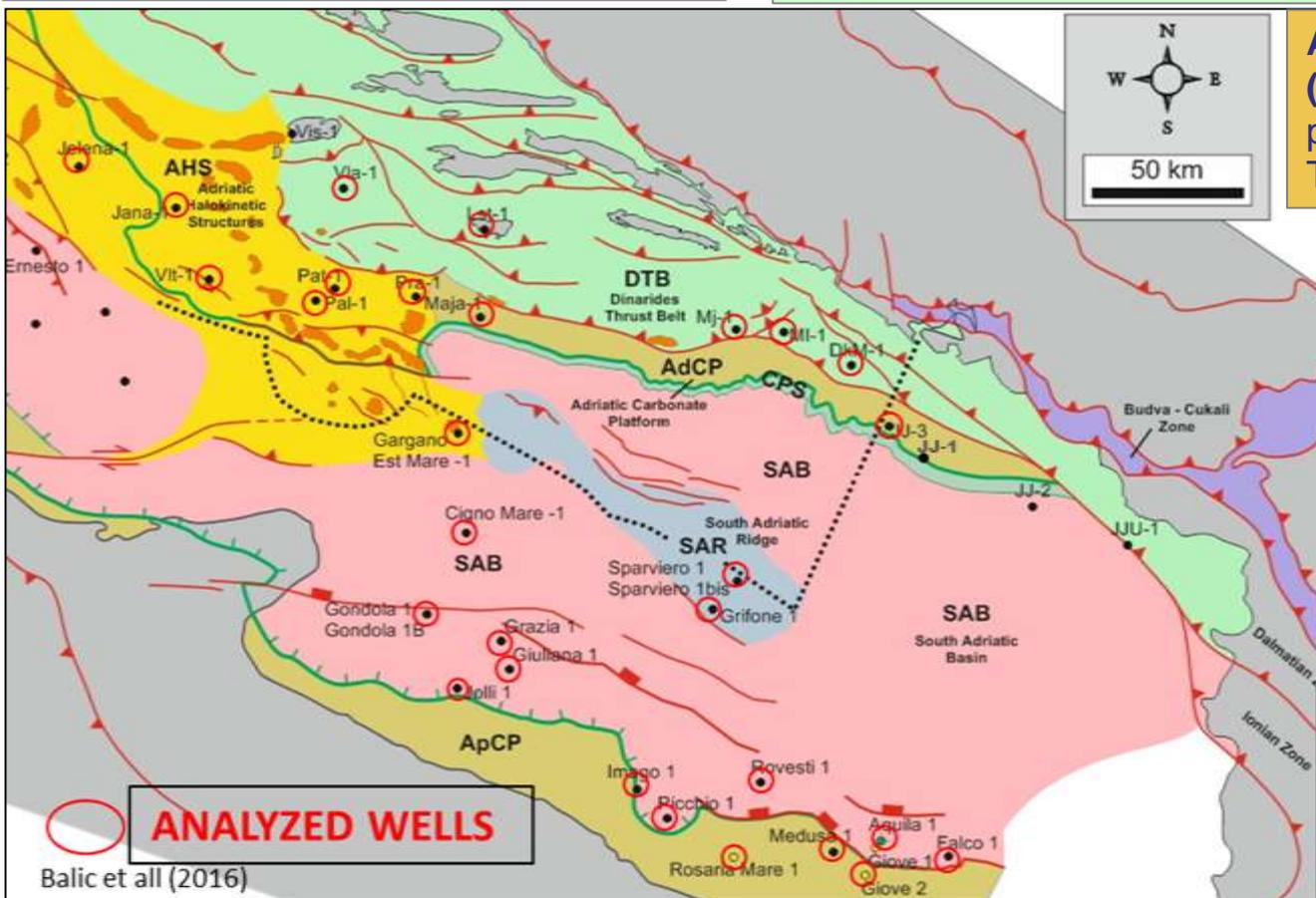
Dinarides Fold-Thrust Belt (DTB)- formed along the eastern margin of the Adriatic plate during Middle Eocene – Miocene as a result of SW-propagation of thrusting from the Internal Dinarides

Adriatic Carbonate Platform (AdCP) - are remnant of the wider platform that existed from Late Triassic to Late Cretaceous time

Carbonate Platform Slope (CPS)-transition from the AdCP into the South Adriatic Basin

South Adriatic Ridge (SAR)- the NW-SE striking belt of salt-cored anticlines in continuation with the Adriatic halokinetic structures (AHS)

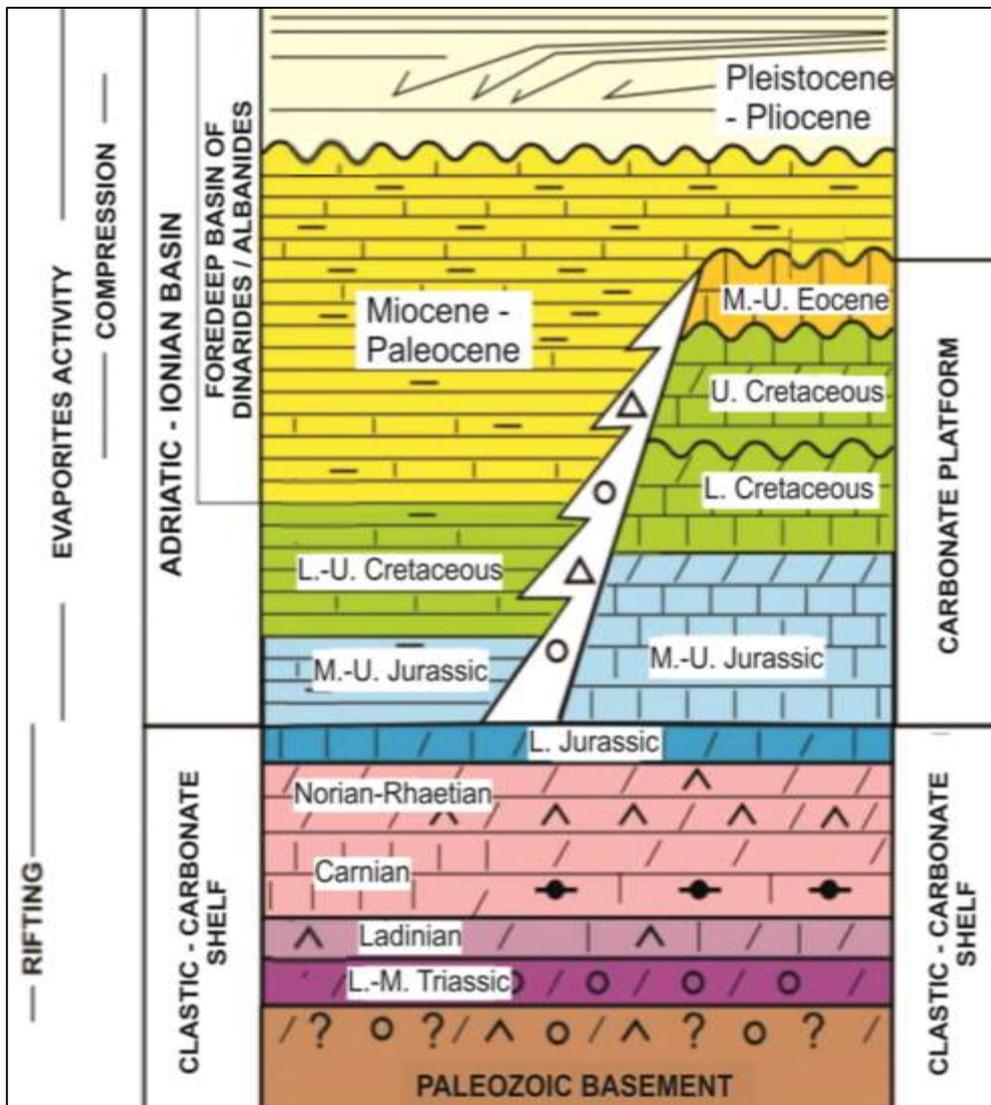
South Adriatic Basin (SAB)- the formation begins during the Late Triassic / Early Jurassic rifting with pelagic carbonate and siliciclastic deposition during Mesozoic and Paleogene-Miocene times, respectively



Apulian Carbonate Platform (ApCP) - part of the stable and relatively undeformed foreland of the Apennine thrust belt

Introduction

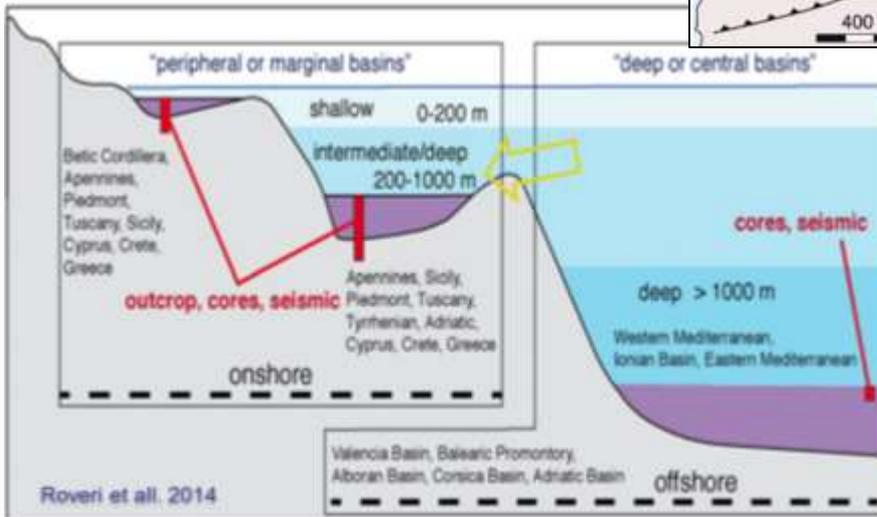
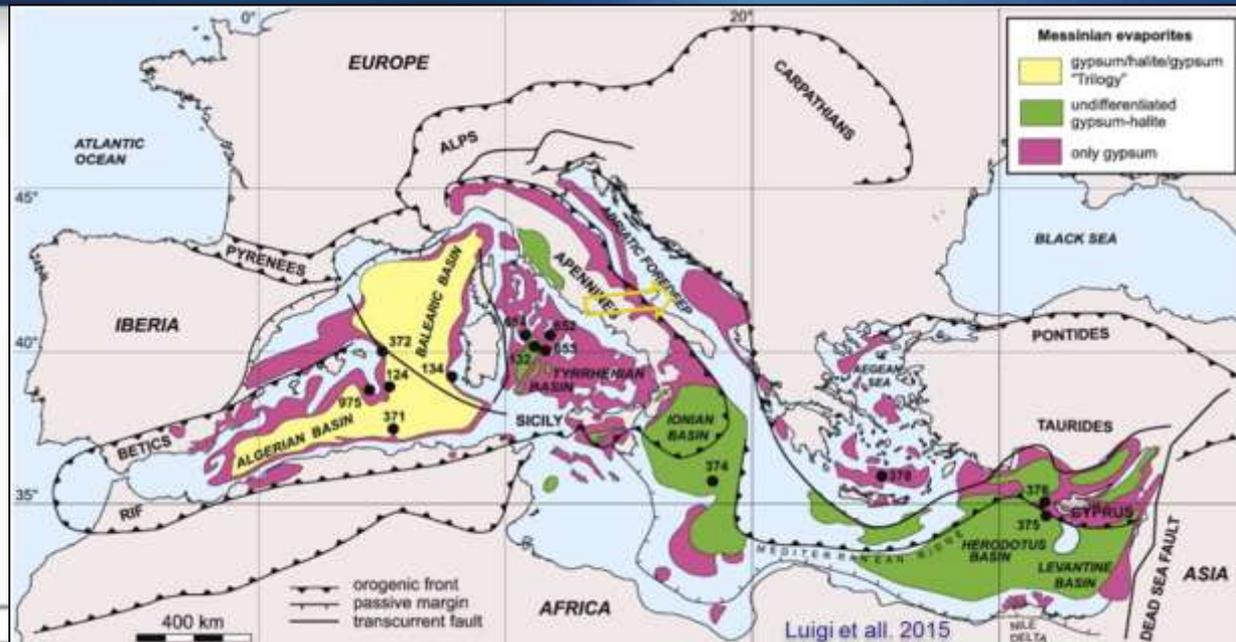
Stratigraphy and Tectonics



- ❑ Plio-Pleistocene transgressive-regressive clastic sequence
- ❑ As result of compression, foredeep Dinaride / Albanide basin formed from Paleocene –Miocene; shallow water platform carbonates and deep water basin carbonate-clastite deposit
- ❑ Middle Jurassic tectonic activity led to basin differentiation (shallow platform and basin part)
- ❑ During Triassic and L. Jurassic prevails clastic-carbonates shelf sedimentation with evaporite sequence as result of rifting

Introduction

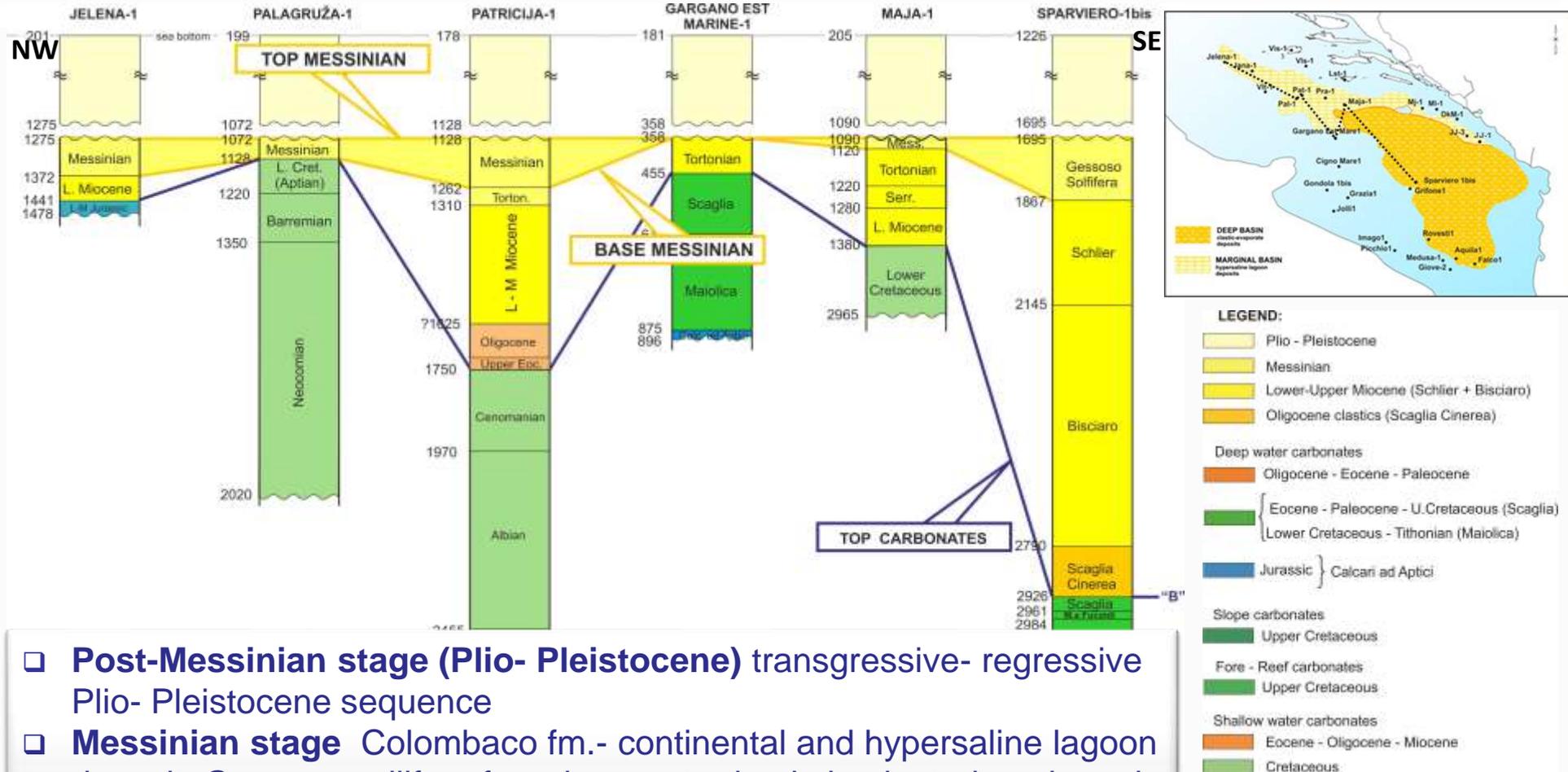
Distribution of Messinian evaporite in the Mediterranean



Schematic classification of the Messinian sub-basin in the Mediterranean

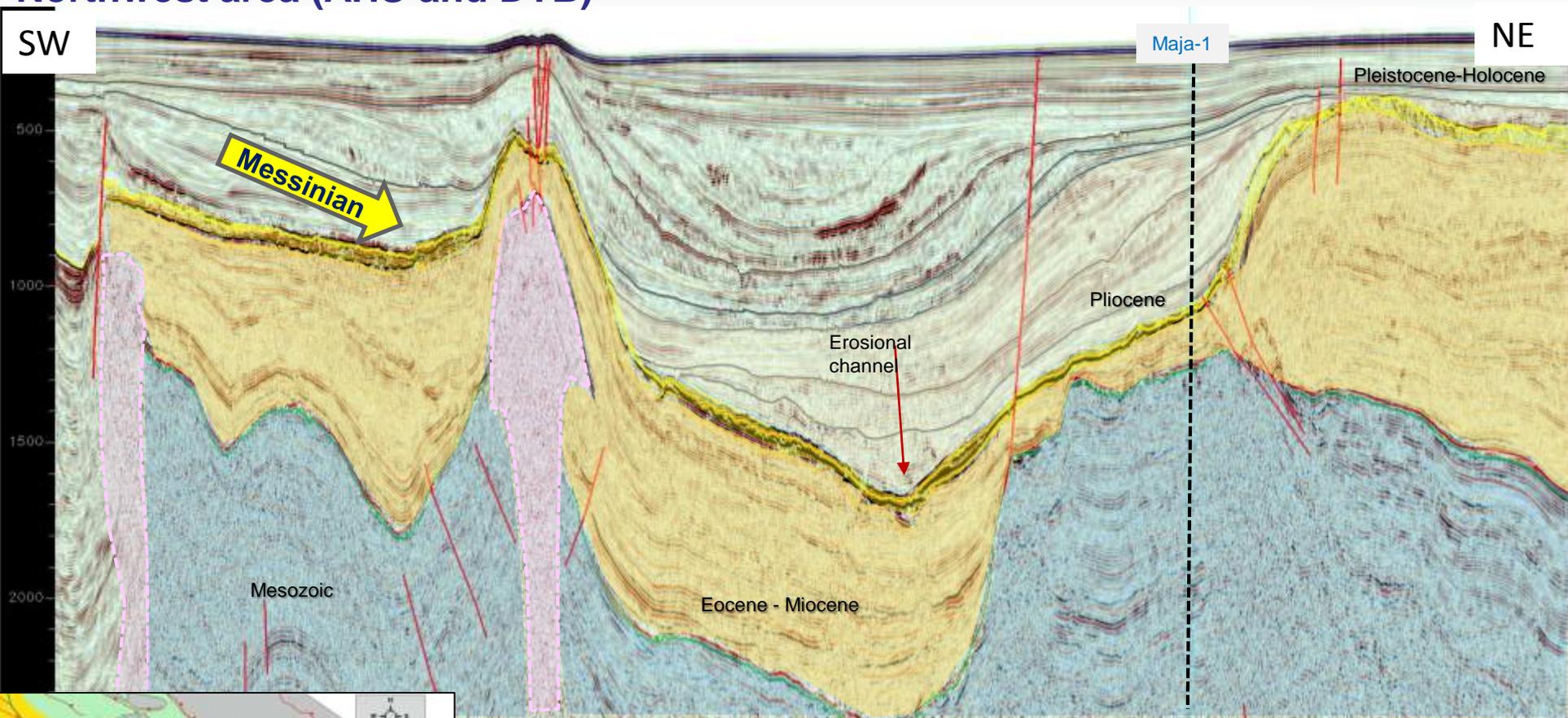
- ❑ Messinian evaporite present in many wells in SAB (anhydrite and gypsum)
- ❑ SAB is marginal part of Mediterranean Messinian

South Adriatic Basin well correlation NorthWest-SouthEast



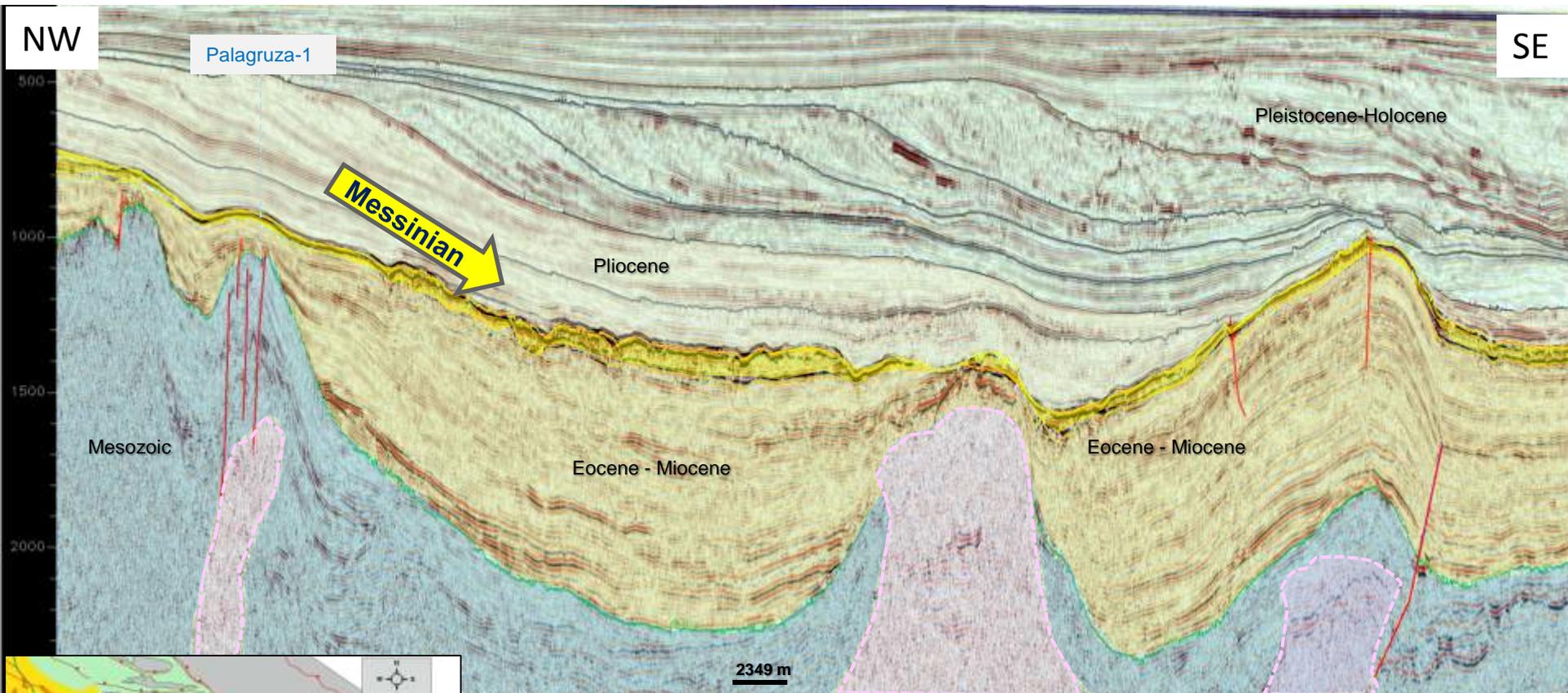
- ❑ **Post-Messinian stage (Plio- Pleistocene)** transgressive- regressive Plio- Pleistocene sequence
- ❑ **Messinian stage** Colombaco fm.- continental and hypersaline lagoon deposit, Gessoso solifera fm. -deep water basin laminated marls and gypsum of shallow water and sabkha-like environments
- ❑ **Pre-Messinian stage (Cretaceous - Miocene)** shallow water Cretaceous and Eocene carbonates and Eocene-Miocene clastic deposit

Northwest area (AHS and DTB)



- ❑ Thickness : from 40m (Maja-1) to 120m towards basin (seismic)
- ❑ Erosional channels
- ❑ Depocenter was not changed during Oligo-Miocene to Pleistocene
- ❑ Dinaric thrust strong influence on Messinian level
- ❑ Permo-Triassic halocinetic disturbed younger deposits, Mess. also!

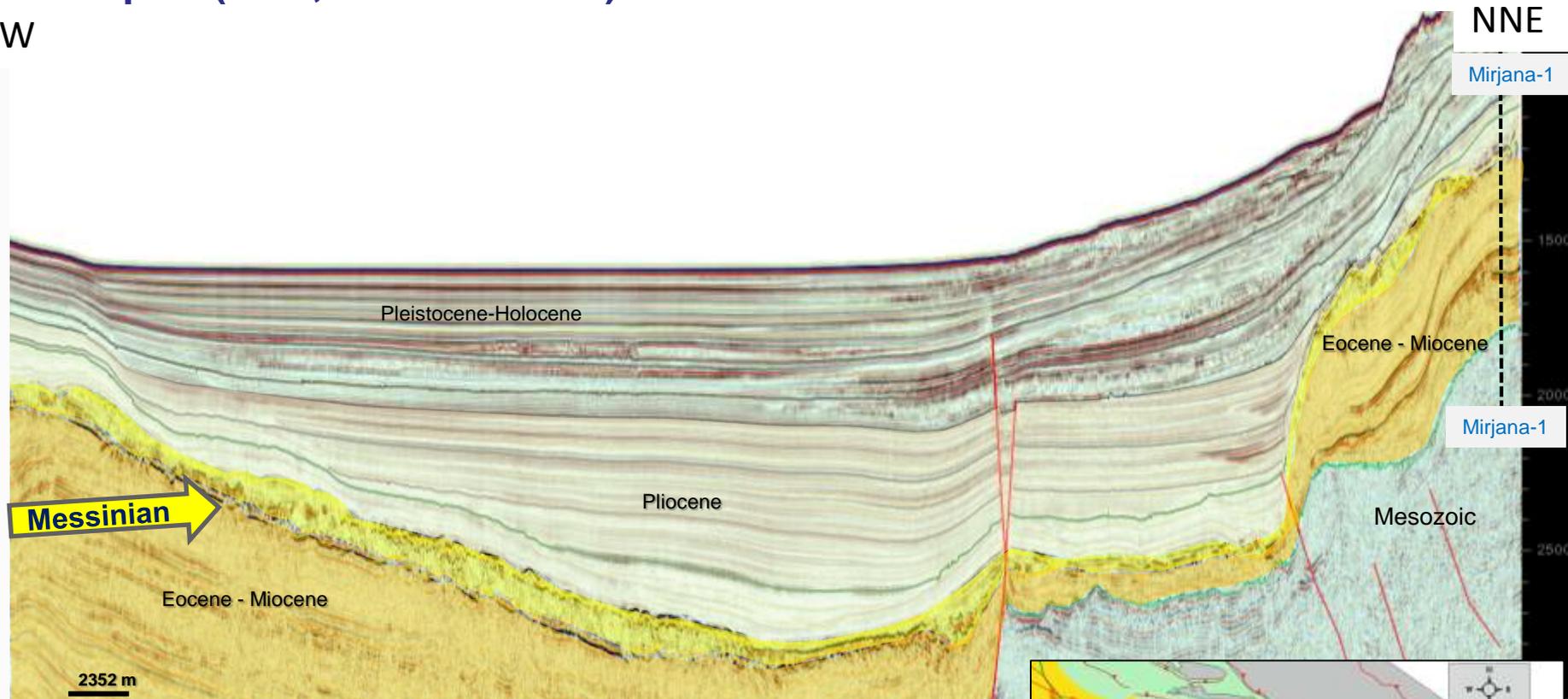
Northwest area (AHS and DTB)



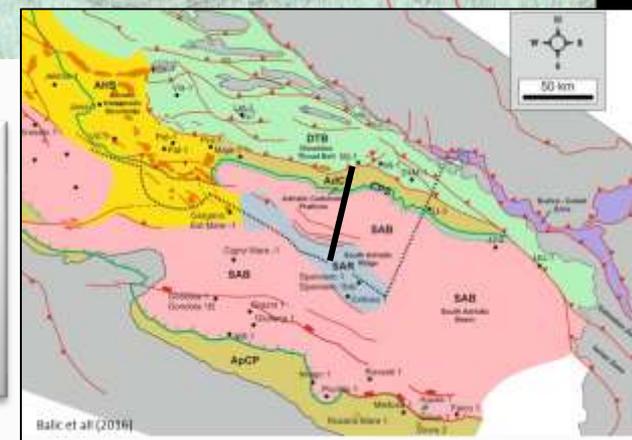
- ❑ Thickness: from 40m (Palagruza-1) to 130m (estimated from seismic)
- ❑ Lithology: limestone, marl, evaporite
- ❑ Permo-Triassic halocinetic divided in two mini basins
- ❑ Chaotic seismic facies of Messinian unit

Central part (SAR, SAB and DTB)

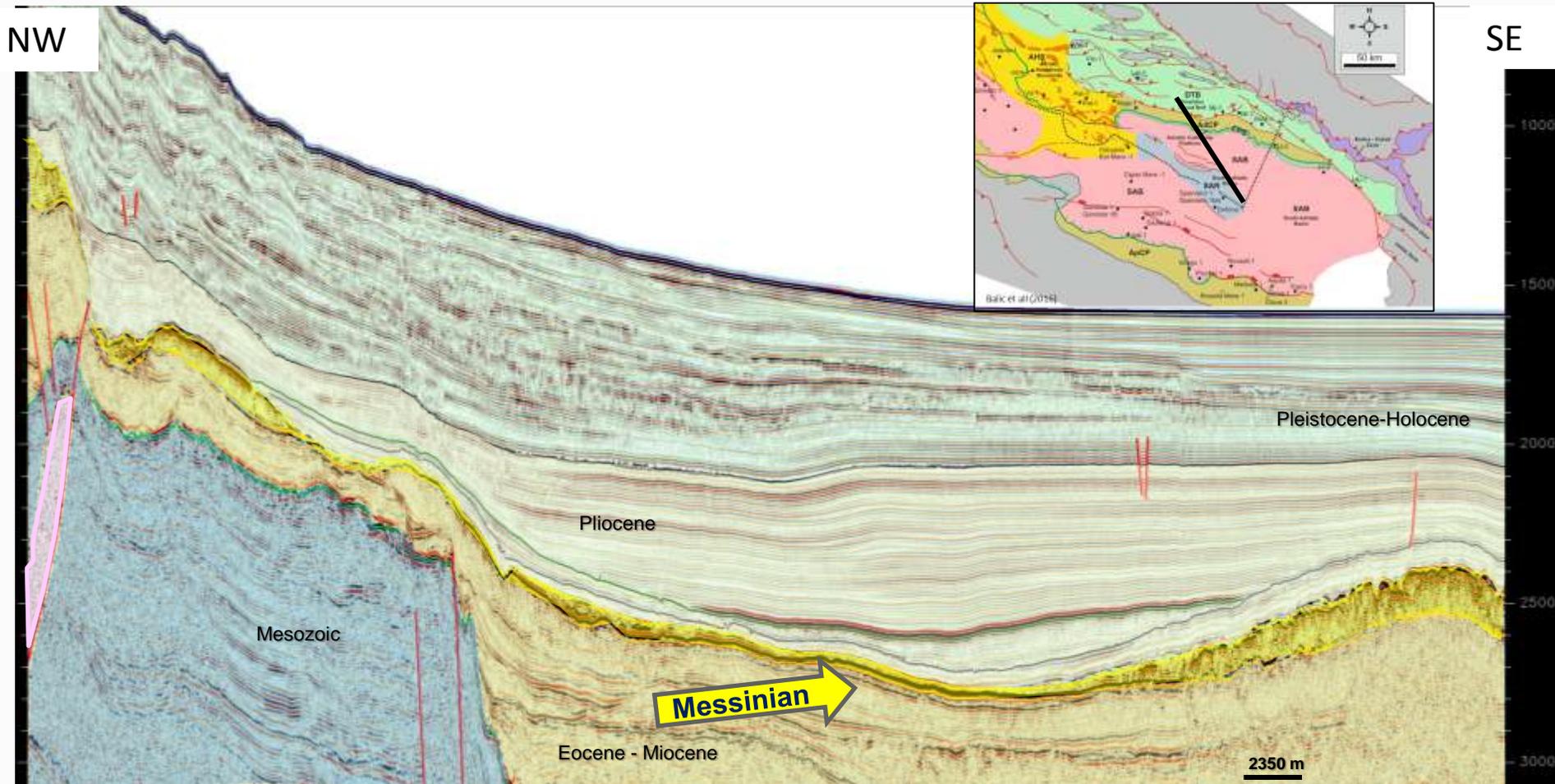
SSW



- ❑ Absence of Messinian deposits on Mirjana-1 well (Middle Miocene)
- ❑ Thickness increases southwards ~ 250m (seismic data)
- ❑ Lithology: limestone, marl, evaporite
- ❑ Permo-Triassic halocinetic influence weaker

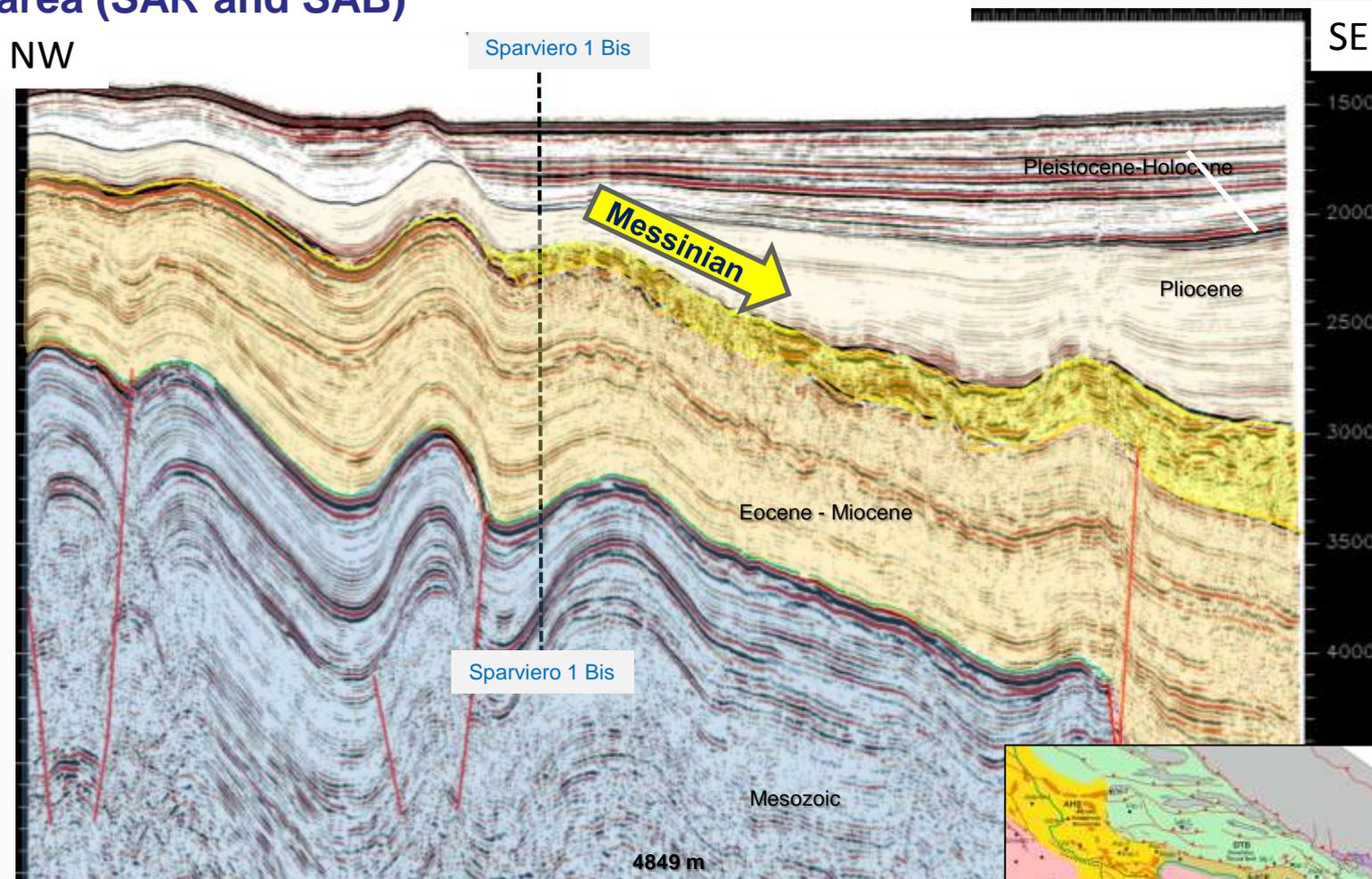


Central part (DTB, AdCP and SAB)



- ❑ Thickness: from 100m to 400m
- ❑ Lithology: marl, sandy levels, evaporite
- ❑ Halocinetic in basin area bit different

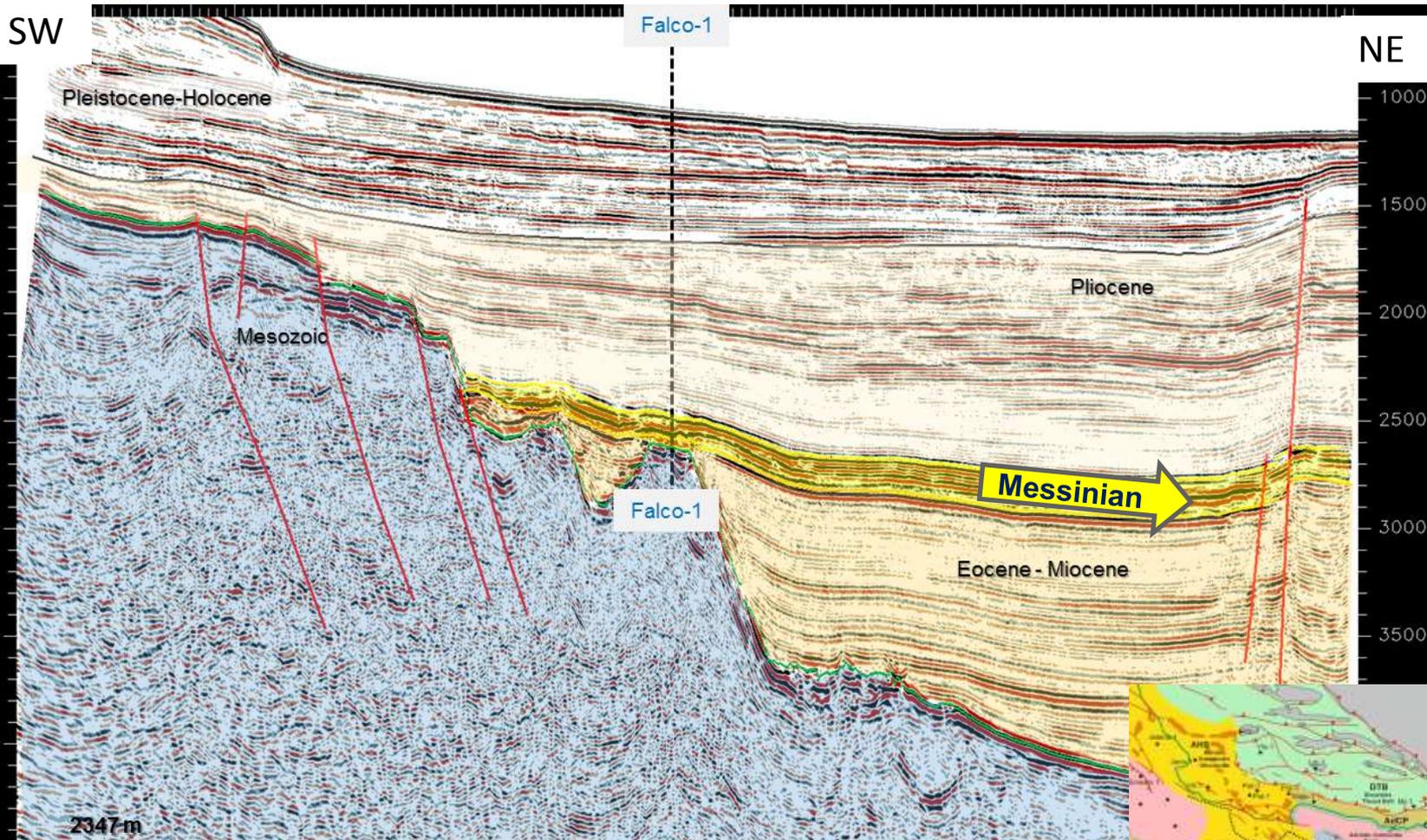
Central area (SAR and SAB)



- ❑ Become thicker toward South (350m), much thicker in SAB
- ❑ Lithology: marl, sandy beds, evaporite
- ❑ Halocinetic strongly present in SAR
- ❑ Absence of Messinian deposits toward west



South part (ApCP and SAB)

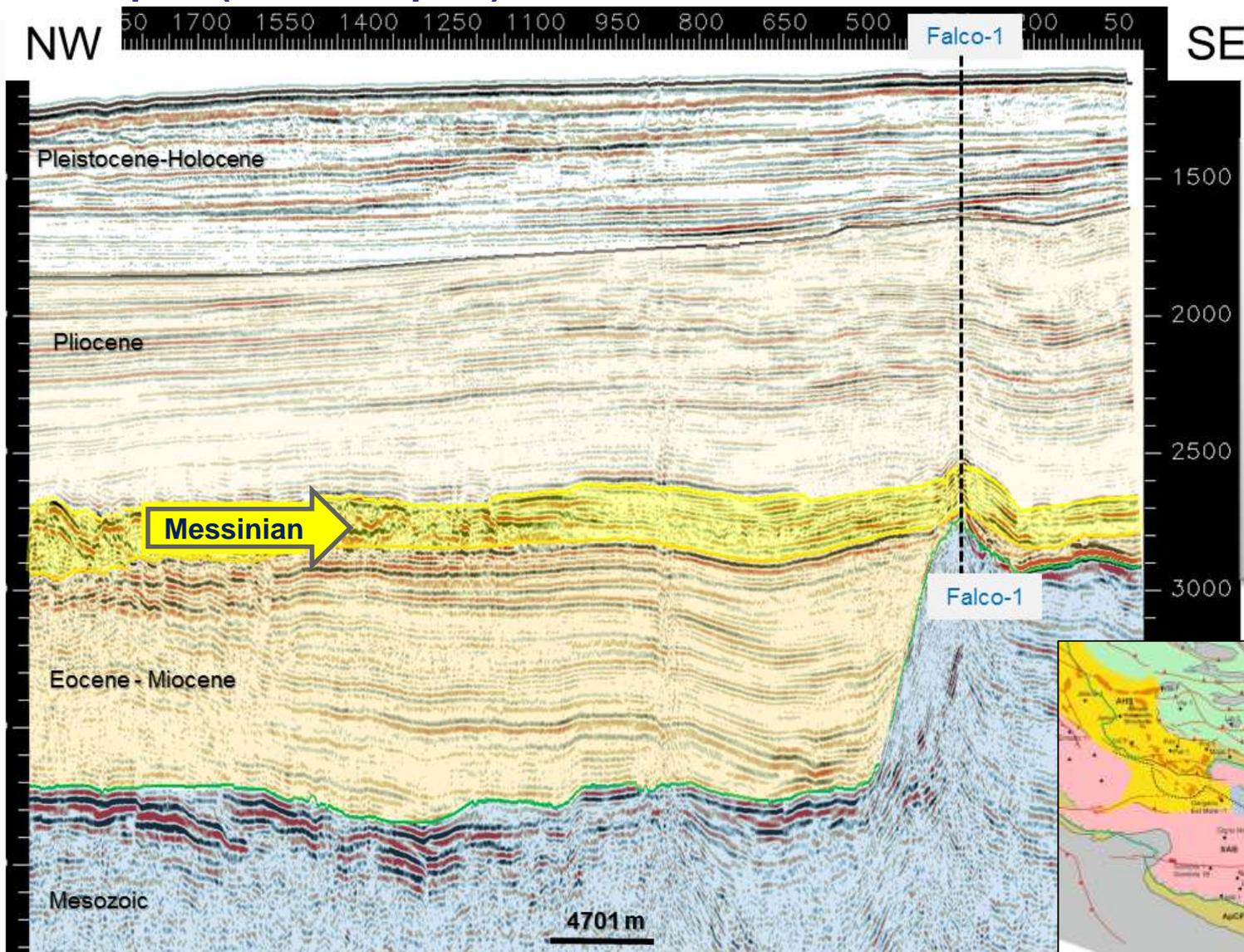


- ❑ Falco-1 well margin of ApCP, thick Messinian deposits
- ❑ Lithology: limestone, marl, evaporite
- ❑ Relatively more continuous seismic facies
- ❑ No Permo-Triassic halocinetic

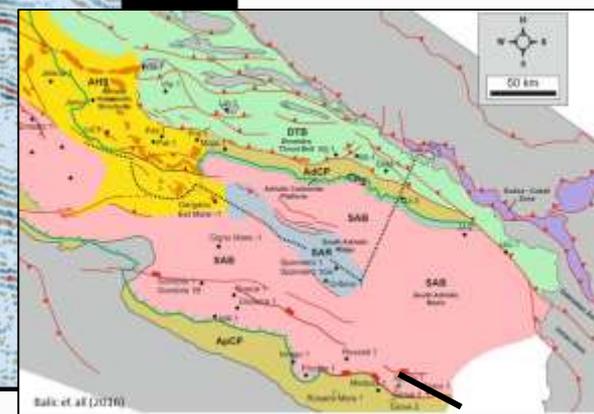


Seismic interpretation

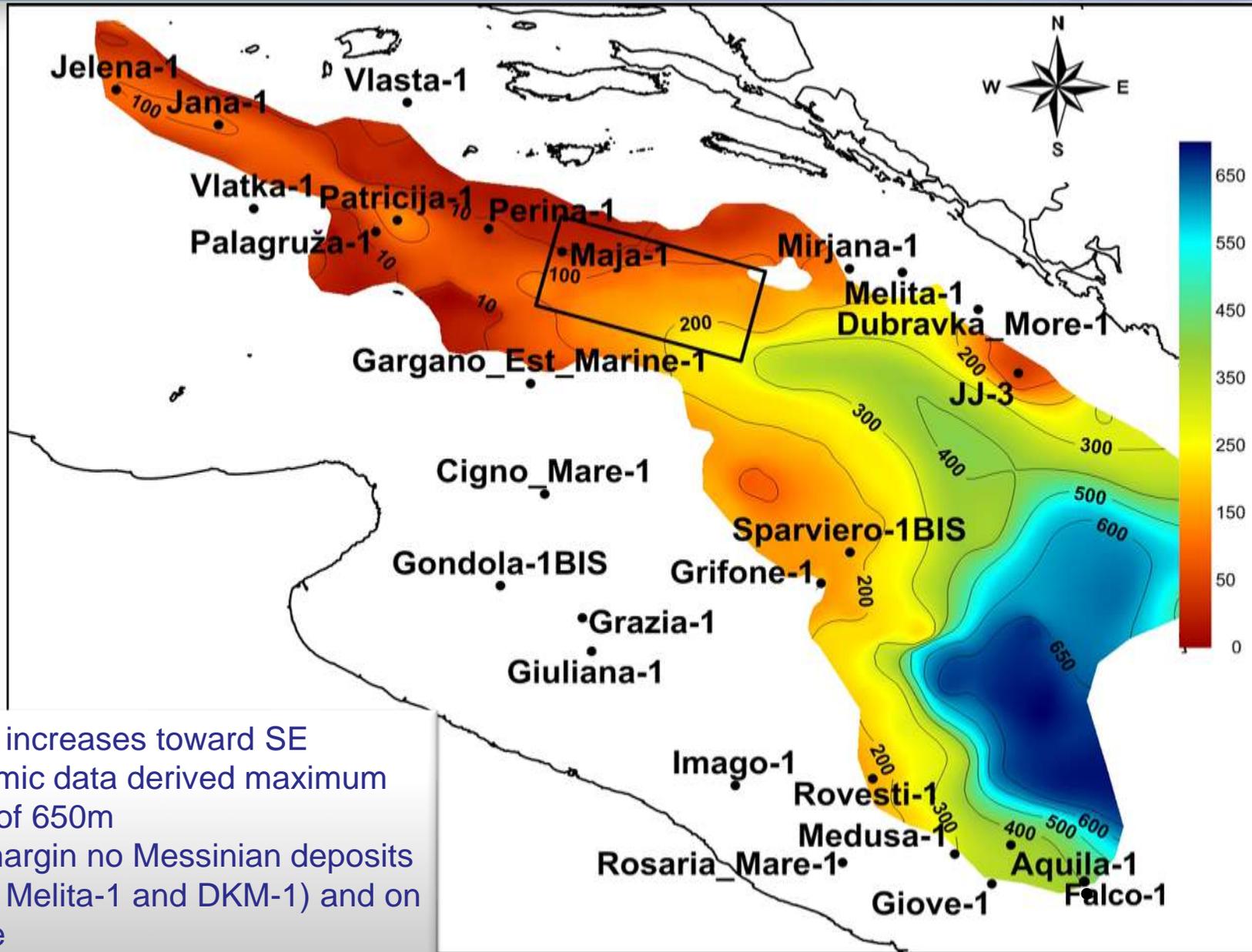
South part (SAB an ApCP)



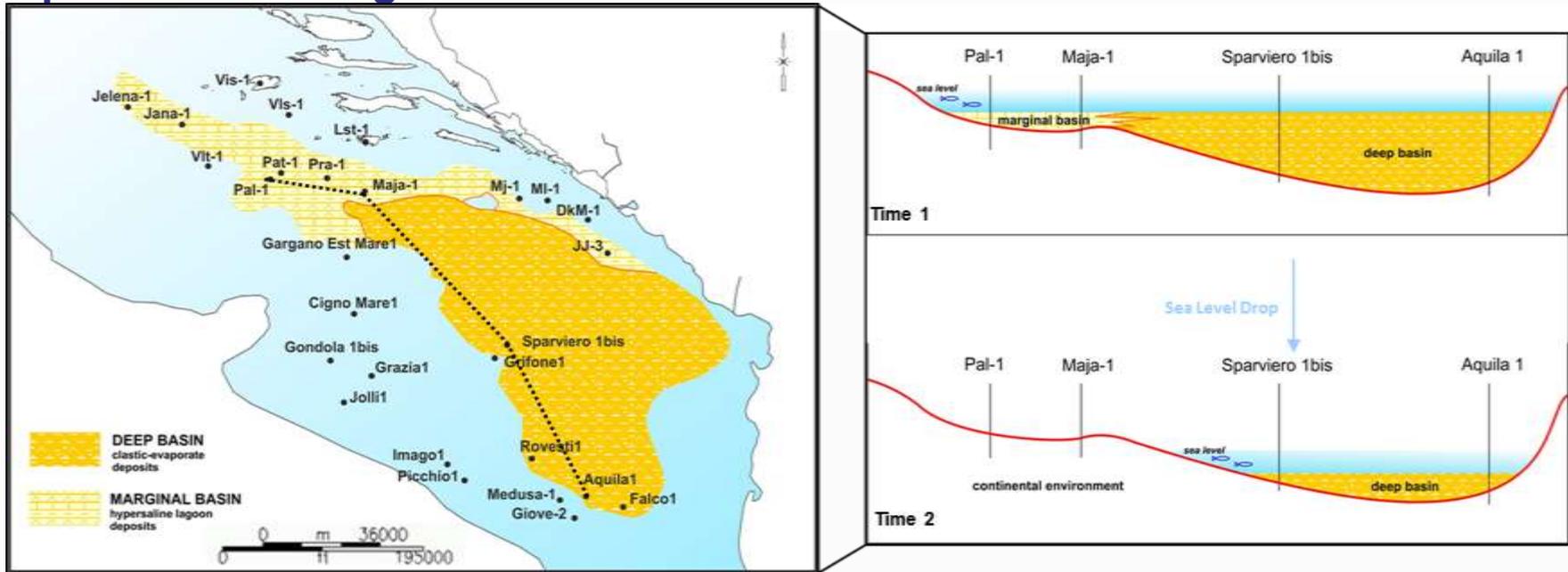
- Edge of ApCP
- Thick Messinian deposits,
- Lithology: limestone, marl, evaporite
- Chaotic seismic facies
- Halocinetic weak



Thickness map of Messinian deposits



Depositional setting of Messinian unit



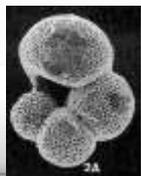
Marginal Basin

- Carbonate-evaporite succession, interbedded limestone, gypsum and mudstones were deposited
- Fossil assemblage (benthic foraminifers – *Rectuvigerina/Bolivina*, gastropods, molluscs, ostracods) indicate deposition in a shallow lagoon complex with hypersaline conditions



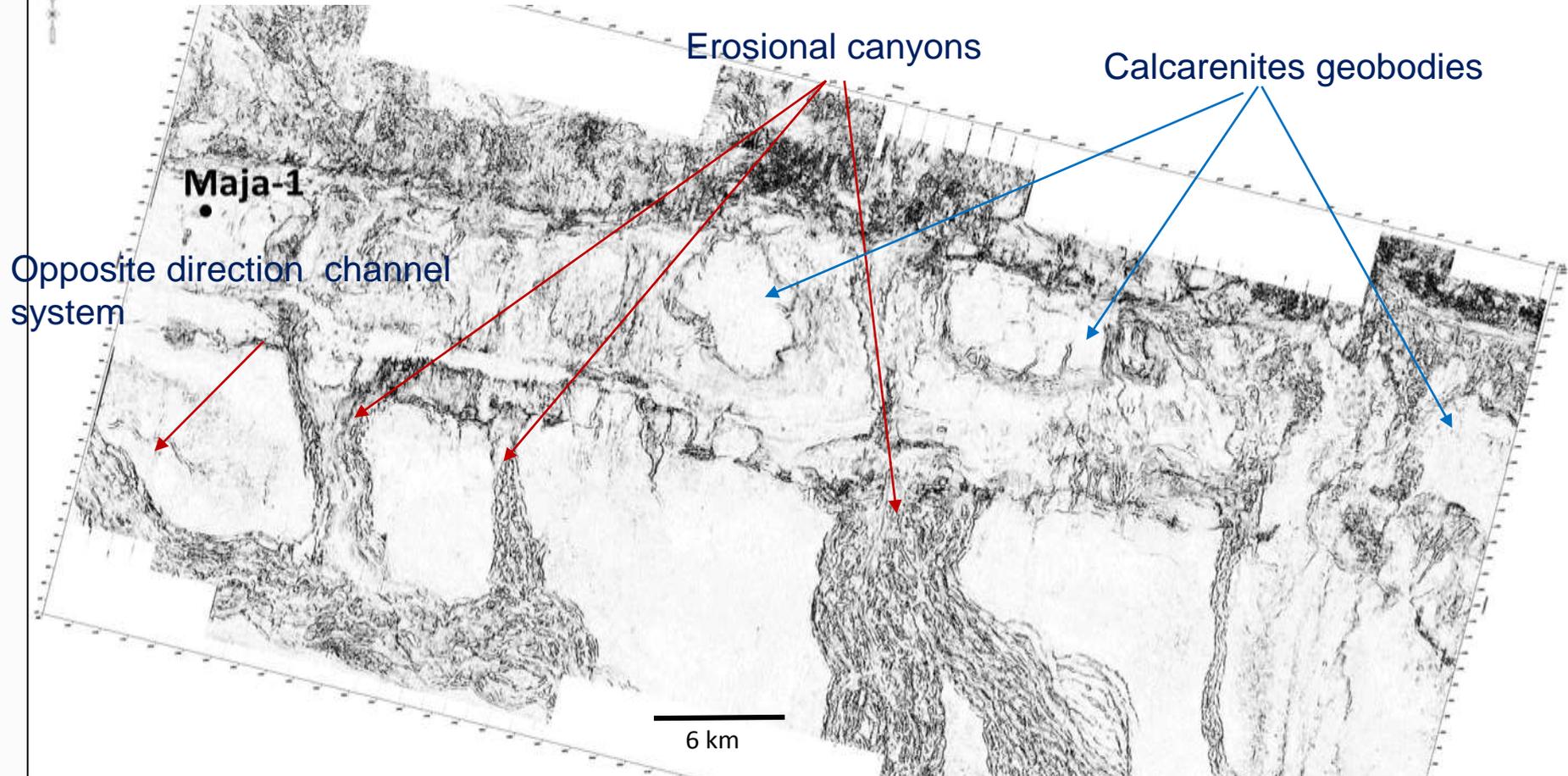
Deep Basin

- Clastic- evaporite sedimentation, clastic deposit (marls, sandy and silty layers) with anhydrites
- Deep water fossil assemblage (planktons forms prevail, *Globorotalia humerosa* zone)



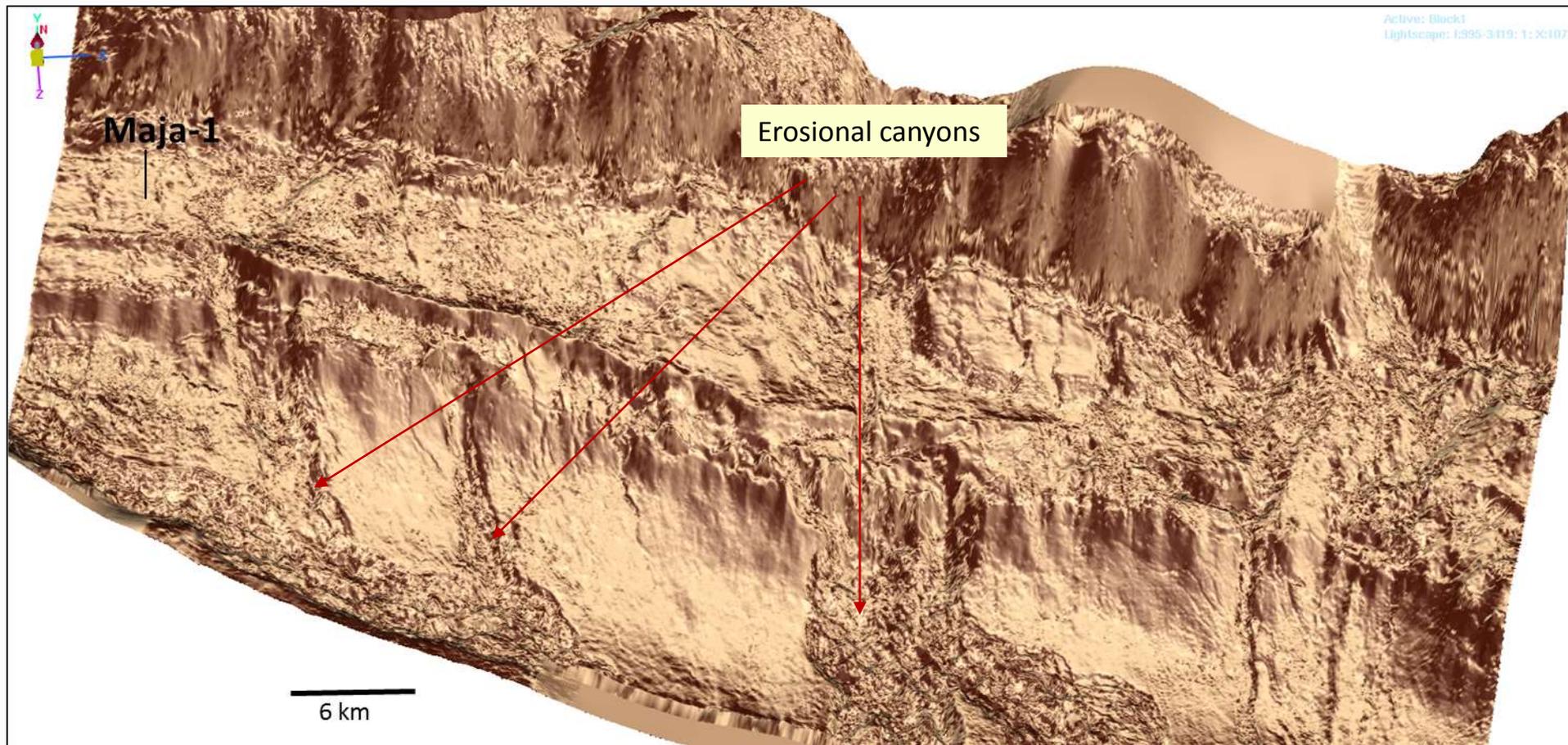
With sea level drops, lagoon environments grading into continental setting characterized by erosional channel forms. In deeper part of SAB the clastic-evaporite deposition prevails

„Coherence” seismic attribute of 3D seismic data



- ❑ From the margin of the Adriatic carbonate platform there are remarkable erosional canyons forming fans of chaotic sediments
- ❑ The thickness of these mass-transport deposits is several hundred meters, wedging-out at the base of tectonic slopes

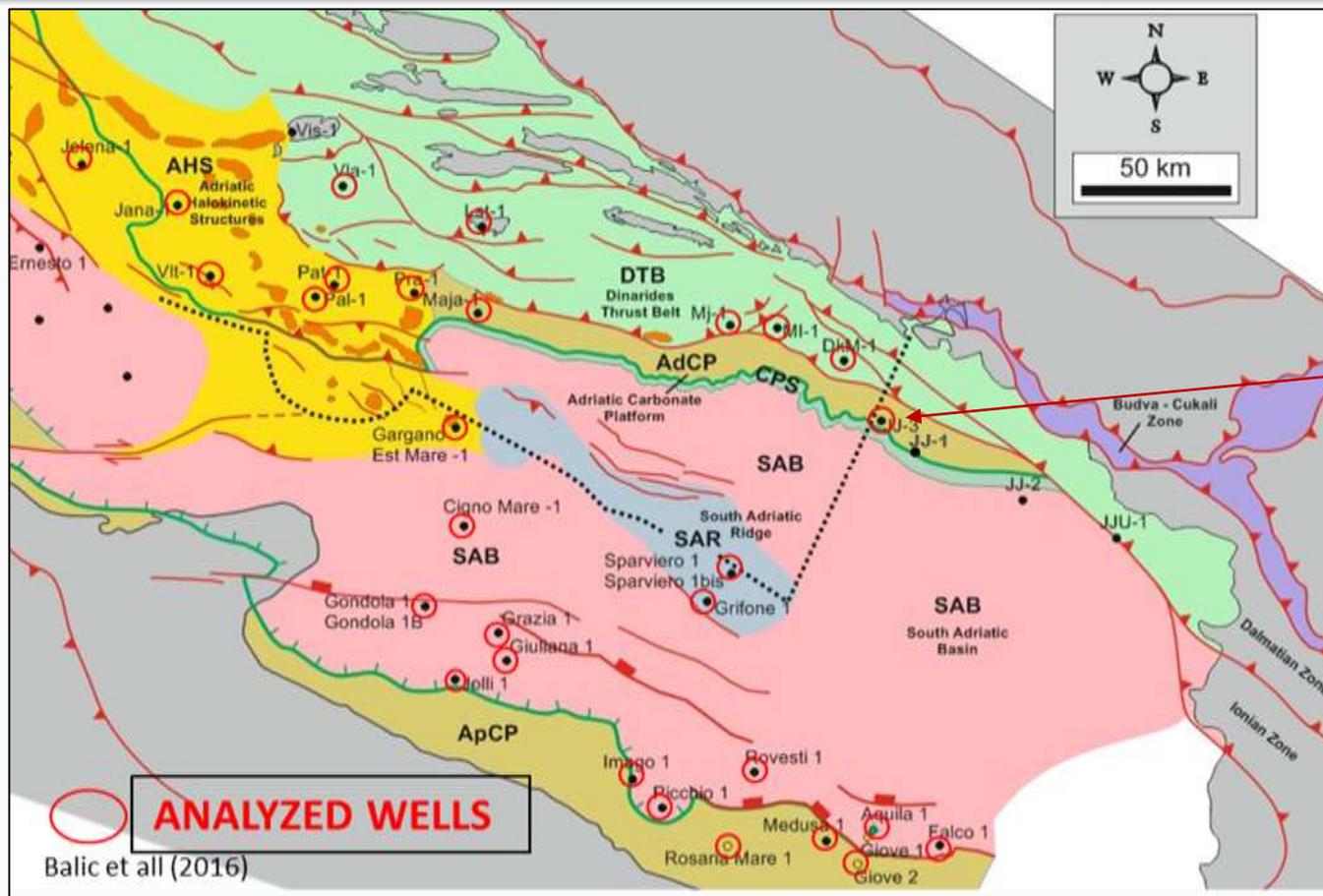
„Lightscape” seismic attribute



- The width of these mass-transport deposits reaches several hundred meters, even ten kilometres at the wedging-out at the base of the slopes

Possible Petroleum System Potential

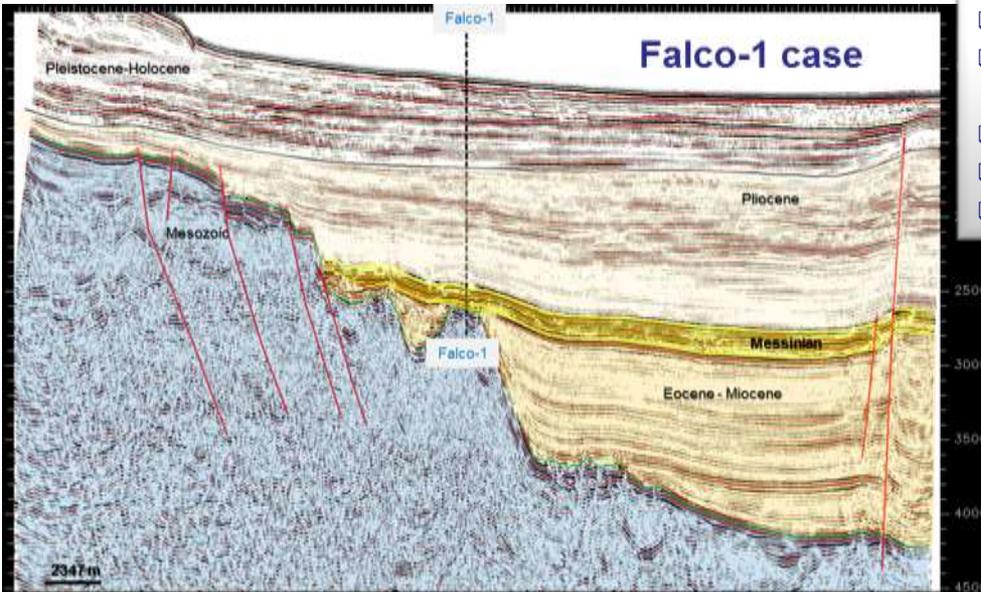
- ❑ Source rock: laminated deep water Miocene marls, Messinian unit without source rock potential
- ❑ Reservoir rock: deep water clastic deposits
- ❑ Seal: Pliocene marls
- ❑ HC shows: without HC shows in the available wells
- ❑ Proven play types: Biogenic gas accumulations in the Messinian post-evaporitic sequence (Falco-1 and A4-1X)



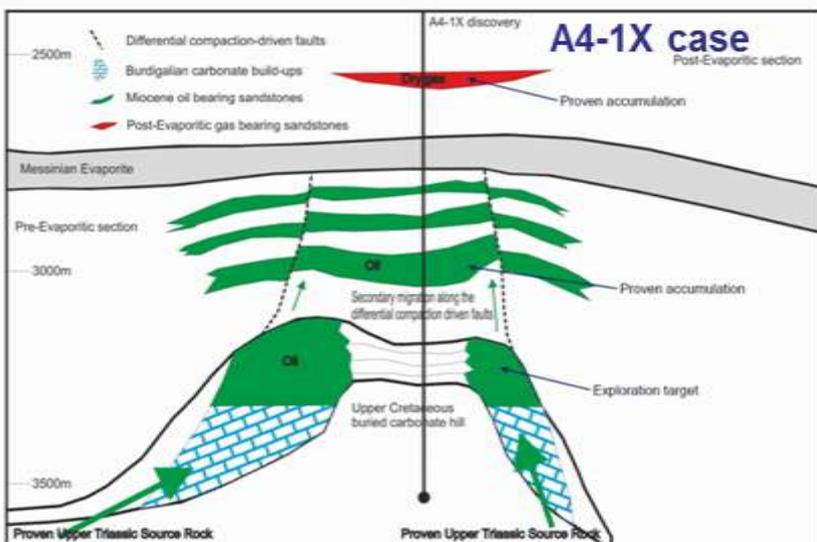
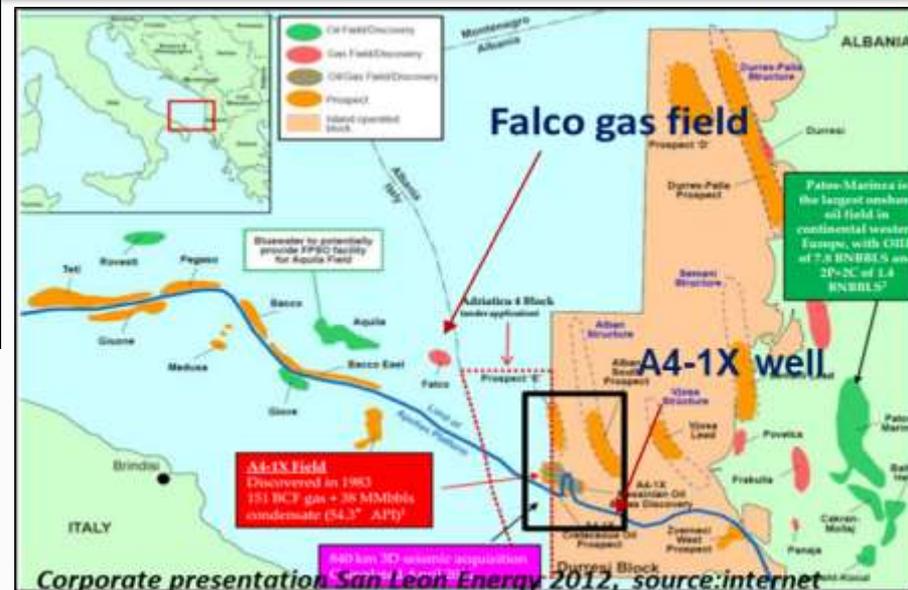
- ❑ JJ-3 – laminated Miocene marls below Messinian level, Corg 2%, estimated oil window (0,5%Ro) 2600 m

Possible Petroleum System Potential

Evidences for effective gas system in SAB; A4-1X well case



- ❑ The first well in Italy that test Miocene sandstone of the SAB
- ❑ Play type: Biogenic gas accumulations in the Messinian post-evaporitic sequence
- ❑ 51m perforated interval and cumulative rate of 36 MMcf/d
- ❑ OGIP 45 MMboe, Recov. 33.33 MMboe
- ❑ Source rocks: marls of Serravallian to Pliocene age (*IHS*)



- ❑ Gas/oil field SE from the studied area on Duresi Block
- ❑ Play type I: Biogenic gas in the Messinian post-evaporitic sequence
- ❑ Play type II: Messinian pre-evaporitic sequence charged from older source rocks
- ❑ Source rock: Upper Triassic
- ❑ Seal: Pliocene marls
- ❑ Reservoir rocks: thin-bedded distal turbidites
- ❑ 50 BCF gas accumulation

First attempt of more detailed Messinian deposition analysis in the SAB

Analyzed Messinian deposits in SAB generally fit into the picture of marginal part of Mediterranean Area during MSC

Messinian content reconstruction for deep part of SAB derived from seismic

Messinian depositional unit is characterized by both marginal and basinal facies

In margin part, carbonate-evaporite succession (interbedded limestone, gypsum and mudstones) were deposited. Fossil assemblage (benthic foraminifers predominates, microgastropods, moluscs, ostracods) indicate deposition in a shallow lagoon complex with hypersaline conditions

In basin part, clastic-evaporite sedimentation (marls, sandy and silty layers, gypsum) predominates. It is characterized by deep water fossil fauna (plancton f., *Globorotalia humerosa* zone)

Seismic facies of Messinian deposits is chaotic, reflex is rugous, thickness vary from 0-40 m in marginal part and 100m (NW) to 650m (SE) in basinal area

Weak evidences for potent petroleum system, possible only in deeper basin portion, evidence on SE where exist HC fields in the Messinian turbiditic level

Thank you!

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