

New evidences for the formation of and for petroleum exploration in the fold-thrust zones of the central Black Sea Basin of Turkey

By: Ivy Hodgkinson

Abstract

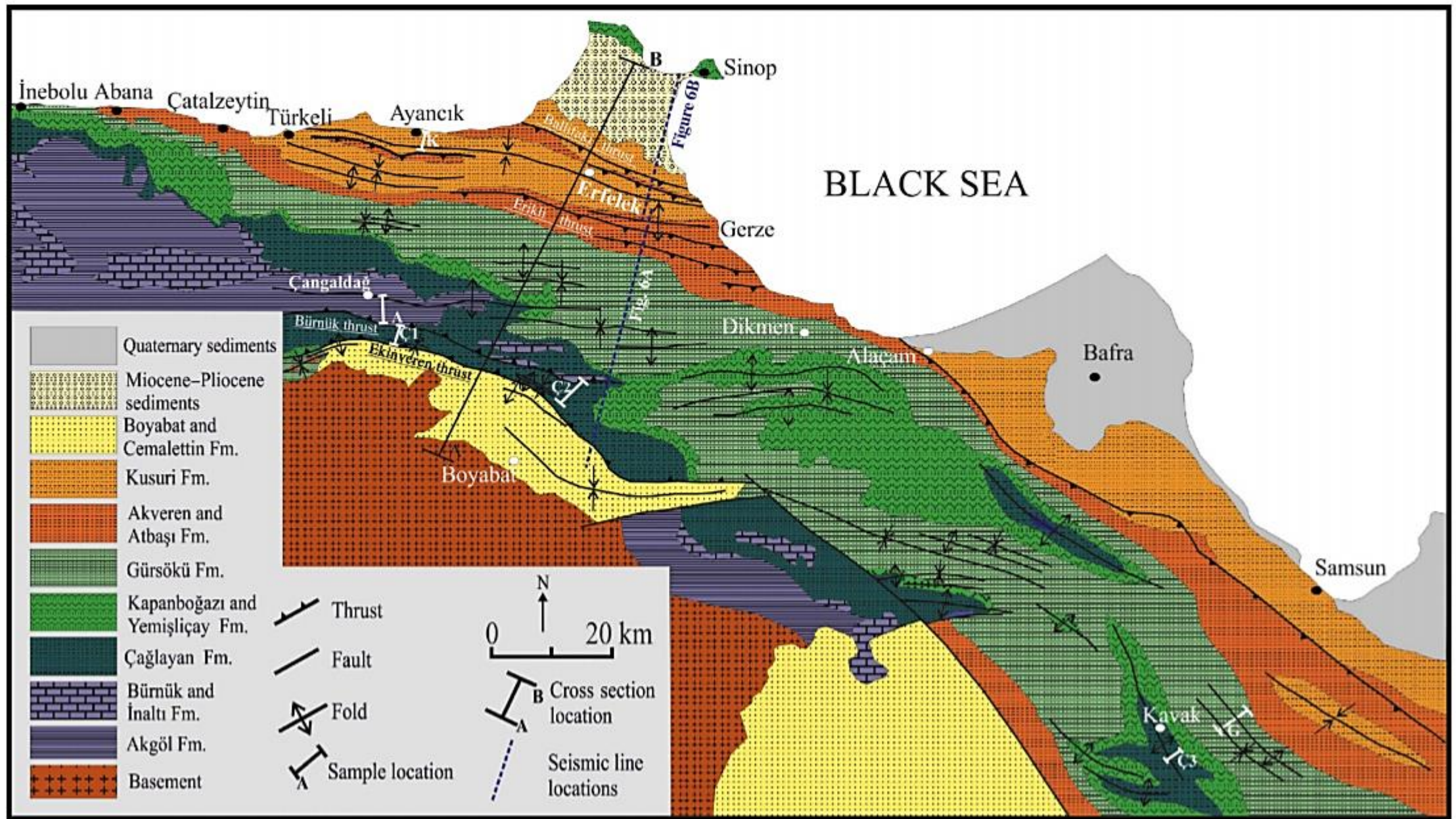
- The central Black Sea Basin of Turkey has a complex history; first the basin was a rift basin then transitioned into an arc basin and eventually formed into a retroarc foreland basin.
- There are many large structures that are associated with extensional and compressional tectonics. Researches believe that there might be a good source for hydrocarbon accumulation.
- 15 onshore and 3 offshore exploration wells were drilled in the Black Sea Basin, but none of the wells has commercial quantities of hydrocarbons.
 - Even though the wells were drilled near structural traps where there are oil and gas seeps, the drilling results showed that the wells were not drilled deep enough.

Introduction

- Central Black Sea Basin is a prospective area for petroleum exploration.
 - Formations that are of interest
 - The Upper Triassic-Lower Jurassic Akgol Formation and Lower Cretaceous Caglayan Formation- have poor to good oil and gas source rock potential.
 - Eocene Kusuri Formation- has moderate gas source rock potential.
 - Thrust of Ekinveren and Burnuk- oil and gas seeps
 - Gas seeps- found NW of the Sinop Peninsula
- The basin has many potential structural traps in fold-thrust zones.

Prior Exploration Wells

- A period of drilling (1960s-1990s) onshore exploration wells showed no economical oil or gas accumulation.
- The purpose of this article is to show why well exploration has been unsuccessful and to provide new future exploration opportunities.
 - Describe the sedimentary and structural settings of the basin based on 4 years of field work and tons of seismic data.
 - Data from the 15 exploration wells are reinterpreted.
 - The petroleum geology of the basin is summarized based on basin modeling, oil to source analysis, reservoirs. Rock-Eval-Total carbon (TOC) analysis and organic petrographically data.



Regional Setting

Paleozoic

- The Pontide orogenic belt formed from the subduction and accretion during the closure of the Paleotethys and Neotethys oceans at the southern Eurasian margin.

Late Eocene

- The Neotethys Ocean was closed. It was between the Pontides and Anatolide-Touride and Kirsehir blocks.

Late Cretaceous

- The Neotethys ocean was closed due to northerly subduction, there was arc magmatism, an inner-arc basin, a back-arc basin, and a fore-arc basin that formed in the region. Subduction and arc development ended in the late cretaceous.

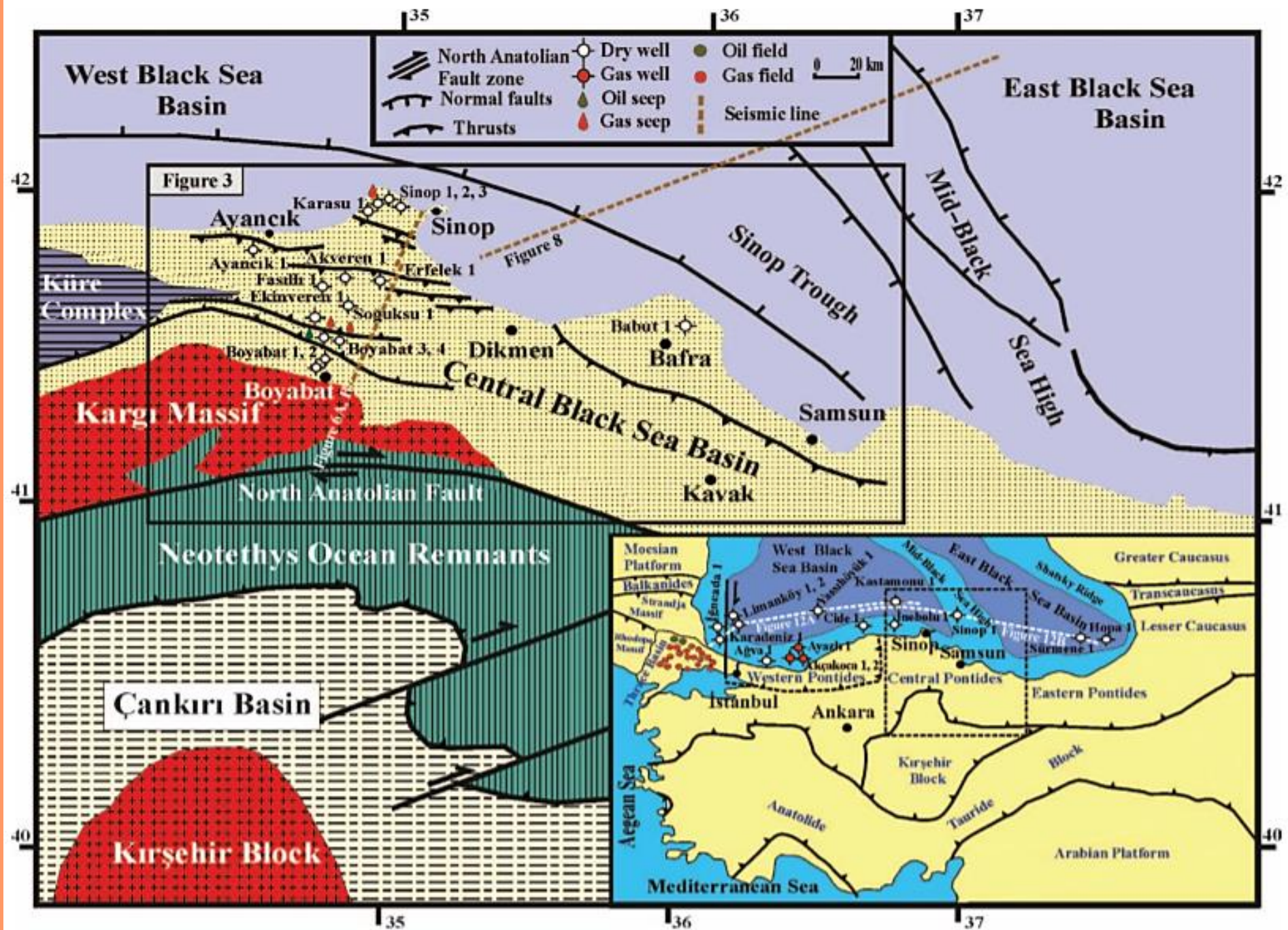
Regional Setting continued

Late Eocene

- Then there was a collision of the Pontides and the Kirsehir block that caused the magmatic arc region to deform into a fold-thrust zone. Within the basin there were multiple folds and thrust that developed by the final collision of the continents.

Pliocene

- The basin was cut by a major strike slip fault, the North Anatolian fault.



Structural features of the Central Black Sea Basin

- The main formation of the basin is a structure that contains two-fold-thrust zones (The southern Fold-Thrust Zone and The Northern Fold Thrust Zone) and the Cangal dag anticlinorium
- The offshore area of the CBSB contains sediment from the upper Eocene and Oligocene-Miocene to Pliocene-Quaternary
 - There are extensional faults that are located in the mid-Black Sea High where older sediments were found to be inverted and deformed by a late Eocene fold-thrust faults.
 - Flexural loading and regional subsidence caused undeformed sediments from the Oligocene-Miocene to Pliocene-Quaternary to form an abrupt basin subsidence.

Structural features of the Central Black Sea Basin

The Southern Fold-Thrust Zone

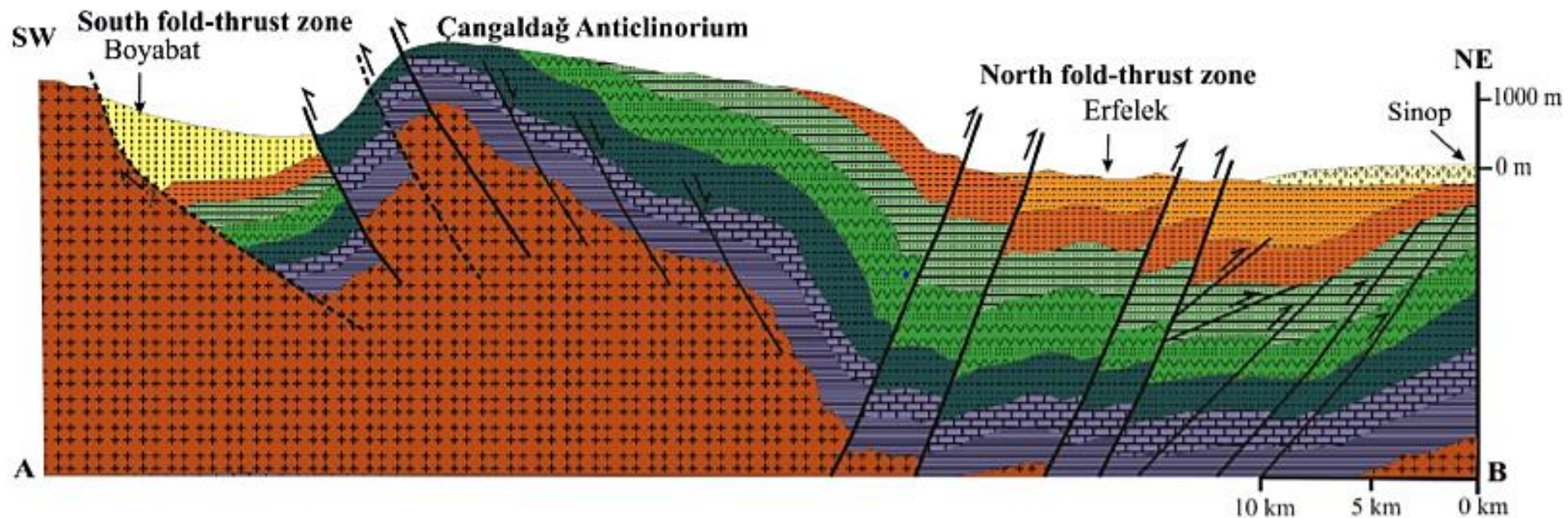
- The Ekinveren thrust was formed by the Caglayan formation thrusting over the Cemalettin Formation located in the Southern portion of the figure 3.
- The Burnuk thrust formed because the Inalti Formation was thrust over the Caglayan Formation during the middle Eocene. There were many anticlines and synclines formed because of this thrusting.
- The Southern fold-thrust cut into the southern flank of the Cangaldag anticlinorium

The Northern Fold-Thrust Zone

- Zone is defined by the post-middle Eocene Erikki, Ballifaki, and few other minor thrusts.
- Thrust were formed when the Akveren and Atbasi Formations were thrust over the Kusurti Formation.
- Folds exist near the thrusts.

The Cangaldag Anticlinorium

- The Cangaldag area is located in the center of the basin and composed if a zone that measures tens of kilometers of multiple post-middle Eocene folds.



Formations of interest

Akgol formation

- Contains sandstone to shale ratios between 1:3 and 1:5
- show sediments have poor to fair source rock potential
- Sediments were overmature.

Caglayan formation

- Turbiditic sediments that contain sandstone and shale ratios between 1:2 to 1:5.
 - These samples show fair to good source rock potential.
- Sediments are mature to overmature.

Gursuku formation

- Consists of turbiditic sandstone, mudstone, and marl.
- Formation ranges from mature to overmature.
 - Over maturity may be related to the heating of volcanic rocks from the underlaying Yemislicay Formation

Kusuri Formation

- Made up of turbiditic sandstone and shale.
- Formation has very limited source rock potential
 - Sediments are early to middle mature.

Potential source rocks in the basin

- Inalti Formation thick carbonates
- Caglayan Formation turbiditic sandstones

Main potential seal rocks in the basin

- The Caglayan shales Formation.
- The Kapanbogazi micritic limestone Formation.
- The Yemislicay volcanic rock Formation.

Petroleum Prospects from older data

In the 1960s-1990s, 15 onshore exploration wells were drilled in the central Black Sea Basin.

- 12 wells suggest that the wells were not drilled deep enough to reach any potential reservoirs.
 - It was because of a thick >5000m section that overlays the Formations of Kusuri, Atbasi, Akveren, Gursoku, and Yemislicay.
 - These formations experienced thrusting and folding that resulted in them to become thicker.
- 3 wells did penetrate the potential reservoir of the Cagkayan and Inalta Formations
 - Wells: Boyabat 3 and 4, and Ekinveren 1
 - Oil and gas were found at wells Boyabat 3 and 4

The Fold traps near the eastern area where there are possible reservoirs, but no exploration wells have been drilled

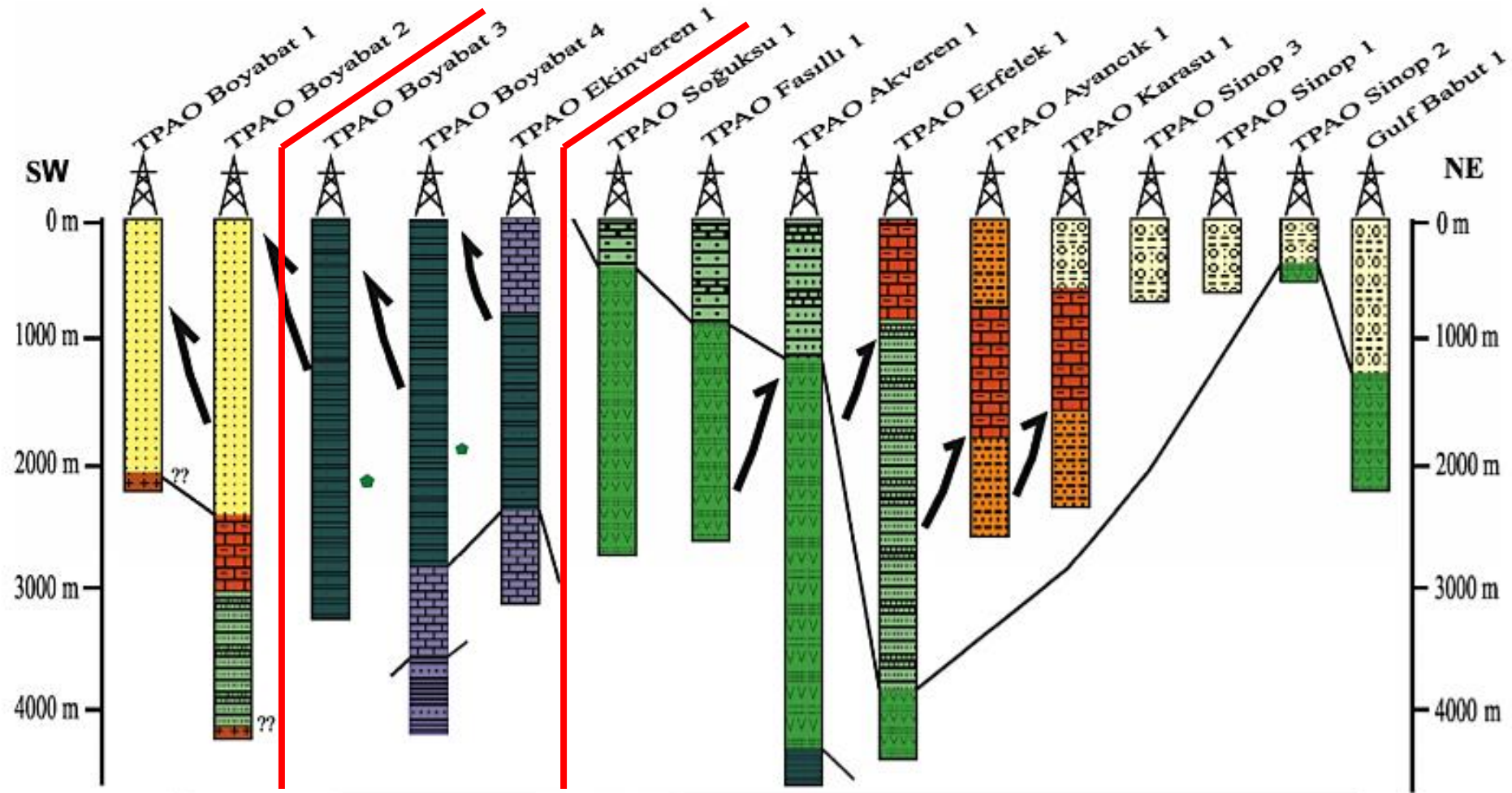
- This is because the Formations of Kusuri, Atbasi, Akveren, and Gursoku are thick formations where wells would need to drill down to great depths to reach hydrocarbon accumulations.

Petroleum Prospects from older data continued

- Basin modeling in 1995 showed hydrocarbon generation begin with the deposition of the Paleocene Akveren Formation.
 - By the time of deposition of the middle Eocene Kusuri formation the source rocks became overmature.
- The Basin model suggested that hydrocarbon generation from source rocks in
 - The Akgol Formation: Oil generation occurred between 122 and 84 Ma.
 - The Caglayan formation: Gas generation occurred between 98 and 78 Ma.
- The basin is still generating gas today.
 - Many potential traps in the S and N fold-thrust zones and the Cangalgad anticlinorium were formed post-middle Eocene (38Ma).
 - There was some hydrocarbon generation that have accumulated in these traps.

Petroleum prospects the results

- The Fold traps near the eastern area where there are possible reservoirs, but no exploration wells have been drilled
 - This is because the Formations of Kusuri, Atbasi, Akveren, and Gursoku are thick formations where wells would need to drill down to great depths to reach hydrocarbon accumulations.
- Future exploration wells in the eastern area:
 - Reservoirs of the Cagkayan and Inalta Formations and the seal rocks of formations Kapanbogazi and Yemislicay.
- Main traps in the basin were formed in the middle Eocene Southern and Northern fold-thrust zones and the Cangaldag anticlinorium Formations.
 - In the late Eocene is when source rocks began to start to generate oil and gas, but this was before the formation of the structural trap.



Conclusion

Formations that have poor to good hydrocarbon source rock potential.

- Upper Triassic-Lower Jurassic Akgol Formation and the Lower Cretaceous Cagayan Formation

Formations that have limited hydrocarbon potential.

- The middle Eocene Kusuri Formation

Potential seal rocks in the basin.

- The Caglayan Formation shales
- Kapanbogazi micritic limestone Formation
- The Yemislicay volcanic rock Formation.

Exploration wells drilled in the Black Sea Basin

- 15 on shore and 3 offshore
- Offshore wells no discovery of oil or gas

Drilling results suggests that.

- Wells were not drilled deep enough to reach the upper Jurassic-Lower Cretaceous reservoirs
- Only 3 wells reached potential reservoir intervals in the locations where major seal rocks were eroded and traps were disrupted by thrusts.
 - Future exploration targets: The eroded fold traps of Formations Caglayan and Inalta