Salt Tectonics in the Sivas Basin (Turkey): Outstanding Seismic Analogues*

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See similar article Search and Discovery Article #30312 (2014)
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Abstract

The Sivas Basin in Anatolia is likely the world's finest open-air museum of salt tectonic structures. It is an elongated Oligo-Miocene sag basin that developed in an orogenic context above the complex Taurus-Pontides suture. From Late Eocene to Late Miocene salt deposition, salt tectonics, and salt reworking occur in a north-verging foreland fold-and-thrust belt setting north of the Taurus. The result is an intricate system of salt ridges, minibasins, salt sheets, and successive canopies. The orogenic continental setting is markedly different from the deep marine-passive margin environment of the petroleum rich salt basins such as Angola or the Gulf of Mexico, but close to the Pricaspian Basin setting.

Despite huge difference in content and evolution the Sivas Basin provides outstanding outcrops of the classic geometries associated to the development of diapirs, i.e. halokinetic sequences along diapir walls, and associated stratal deformations. The Sivas Basin also presents more exotic structures such as 4-ways closed minibasins, megaflaps (thinned sedimentary sequences pinching out on top of diapirs and overturned during glaciers later development), and evaporites allochtonous sheets. Such structures are only observed in thick and highly deformed salt basins, and are rarely seen at outcrop: only in the Axel Heiberg area (Northern Territories, Canada - hardly accessible) and the Flinders Ranges (Australia).

Striking geometric analogies between these outcrops and seismic images from the classic petroleum province controlled by salt tectonics will illustrate the extraordinary quality of the Sivas basin as field analogue for the Gulf of Mexico, the Brazilian, Angolan, and Congo Margins. Some comparisons with analog models under scanner will also be shown.
References Cited


SALT TECTONICS IN THE SIVAS BASIN (TURKEY): OUTSTANDING SEISMIC ANALOGUES

Jean-Claude RINGENBACH
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MARGIN’S GRAVITY TECTONICS SETTINGS

Gliding dominated (Angola)

Spreading dominated (GOM)

Two major petroleum provinces
Deep marine settings
WIDE AZIMUTH SEISMIC IS VERY GOOD BUT…

NEED FIELD ANALOGS AND MODELS

Important uncertainties
- Geometries against the salt walls
- Facies near the salt walls
- Sealing against/near the walls
- Diagenesis
- Fractures network…
A GEOLOGICAL FAIRY TALE

Subsalt GOM on Conventional 3D

Megaflaps: Ligurian, Heidelberg...

Pre-drill 2008

Analogue modeling

Sivas Field Analogue

WATS 3D

Post-drill 2009

TOTAL-UPPA
Structural Geology
Chair
Prof. JP Callot &

4 PhD students since 2012:
C. Ribes, C. Kergaravat
E. Legeay, A. Pichat

2008

2009

2010

2011

IFP for COBALT, Callot et al., 2016
AAPG ICE Melbourne  September 12-19, 2015

ILKINDI MB

EMIRHAN MB

ARPAYAZI MB

INCEYOL MB

Karayün - Fluvial

Karacaoeren - Marine

Karayün - Lacustrine

WNW

S

SW

Gypsum

Gypsum

Gypsum

Karayün - Fluvial

Karayün - Fluvial

ARPAYAZI MB

Gypsum

EMIRHAN MB

Gypsum

EMIRHAN MB

ILKINDI MB

Gypsum
THE NOW FAMOUS EMIRHAN AND KARAYÜN MINIBASINS

Kergaravat et al., submitted, 2016

GOM
HALOKINETIC SEQUENCES: HOOKS

Kergaravat et al., submitted

Giles and Rowan, 2012
THE NOW FAMOUS EMIRHAN AND KARAYÜN MINIBASINS

Kergaravat et al., submitted
COMPOSITE HALOKINETIC SEQUENCES AND FAULTS

From seismic to reservoir scale
Small faults and fractures

Two scales of faults and fractures
THE NOW FAMOUS EMIRHAN AND KARAYÜN MINIBASINS

**Explanation**
- Black: Evaporite
- Orange: Lower Eocene
- Blue: Upper Eocene
- Dark blue: Karsalan Fm.
- Light blue: Mid Lake Fm.
- Light purple: Lake Fm.
- Purple: Shale of upper Eocene
- Yellow: Karahmet Fm.
- Light yellow: Balcarka Fm.
- Green: Chalk and carbonates
- Greenish grey: Marine chalk
- Blackish grey: Marine chalk
- Black: Evaporite

**Figures**
- A1: NNW
- B1: NNW
- B2: ENE

- 1: Supra-salt MB
- 2: Salt Diapir
- 3: Salt Diapir
- 4: Salt canopy
- 5: WSW

**Scales**
- 1 km
- 2 km

**GOM**
MEGAHOOK AND UNCONFORMITY

[b]Pseudo-weld trajectory[/b]

Marine

Fluvial

Lacustrine

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AAPG/SEG International Conference & Exhibition 2016

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TOTAL
MEGAHOOK AND UNCONFORMITY
THE NOW FAMOUS EMIRHAN AND KARAYÜN MINIBASINS
MEGAFLAP EVOLUTION

Complex tip geometries
Visible only on the field and FMI

Without salt extrusion

With salt extrusion
Below canopy

Kergaravat et al., submitted

Rowan et al., 2016
SALT SHEETS AT VARIOUS SCALES

Kergaravat et al., submitted
GOCAD 3D MODEL: INCEYOL MINIBASIN

Collon et al., 2016

Kergaravat et al., submitted, 2016

Collon et al., 2016
THE SIVAS SALT MACHINE

Kergaravat et al., 2016
• Similarities with DO provinces:
  - Geometries and evolutions

• Differences with DO provinces:
  - Orogenic context vs passive margin context
  - Fluvial to very shallow marine sediments vs shelf to bathyal
  - Makes it difficult to compare facies distributions and diagenesis

• Large stock of evaporite is a strong driver whatever the tectonic system.
• Canopies act as a decoupling layer vs basement déformation
• Influence of tectonics context increases with salt withdrawal. Toward a typical Foreland FTB
A MOVIE: «salt tectonics + Sivas» in YouTube
COMING SOON: 3D Drone acquisition of the best outcrops

SALT TECTONICS IN THE SIVAS BASIN, TURKEY:
OUTSTANDING SEISMIC ANALOGUES FROM OUTCROPS
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