Fractured Carbonate Reservoir of Tiaka Field, Eastern Sulawesi, Indonesia (T-3 Carbonate Cores)*

Deddy Hasanusi[1], Dian Kurniawan[1], RM Iman Argakoesoemah[2], and Windi Darmawan[2]

Search and Discovery Article #20145 (2012) **
Posted May 28, 2012

*Adapted from oral presentation given in Bali, Indonesia at the Geoscience Technology Workshop (GTW) on Reservoir Quality of a Fractured Limestone Reservoir, 15-17 February 2012

[1]JOB Pertamina-Medco E&P Tomori Sulawesi (deddy.hasanusi@medcoenergi.com)
[2]PT Medco E&P Indonesia

Field Characteristics

- Discovered: 1985
- Play Type: Miocene Thrust Structure
- Reservoir: Miocene Carbonate of Tomori Fm.
- Reservoir depth: 6800-8700 ft TVDSS
- Total wells: 10 wells
- Avg Por & Perm: 7 % & 5 md
- Type Hydrocarbon: Oil
- Initial Pressure: 3776 psi
- Current Production Rate: ~1500 BOPD (from 6 wells)

Stratigraphic Requisites for Accumulation:

Source Rock
- Lower-middle Miocene Tomori Formation
- Middle Miocene Matindok Formation

Reservoir
- Lower-middle Miocene Tomori Formation
- Middle-upper Miocene Minahaki Formation and
- Upper Miocene-Pliocene Mantawa Member

Seal

• Middle Miocene Matindok Formation
• Pliocene Kintom Formation (Sulawesi Group)

Summary

- Structural trap in the Tiaka Field is characterized by NE-SW low-angle thrust fault.
- Reservoir characteristic is tight, fractured carbonate reservoir dominated by muddy facies.
- The depositional environment of this carbonate is interpreted as shallow restricted marine environment.
- Evidence of fractures can be identified and interpreted from core, log, thin-section and well-test data.
- Fracture distribution and characteristic modeling utilized conceptual approach controlled by well data.
- The image log run in T-7ST2A indicates that the dominant orientation is to the NW-SE with a mean of fracture dip of 30°-40° toward the southwest.
- T-3 Core Summary
    - Quality is generally poor (only the dolomitized zone displays moderate- good quality).
    - Coral reef facies are poorly developed.

Reference

Nandang, H., A. Nawawi, S. Anwar, M. Abdullah, B. Mertani, A. Kohar, C.V. Ponto, H. Darman, W. Ardana, C.A. Caughey, A. Bachtiar, and D. Natanegara, 1996, Petroleum Geology of Indonesian Basins: Principles, Methods and Applications: Pertamina, BPPKA (Foreign Contractors Ventures Development Body), v. VI., irregular pagination.

JOINT OPERATING BODY
PERTAMINA-MEDCO E&P TOMORI SULAWESI

FRACTURED CARBONATE RESERVOIR OF TIAKA FIELD, EASTERN SULAWESI, INDONESIA

(T-3 CARBONATE CORES)

By :
Deddy Hasanusi[1], Dian Kurniawan[1],
RM Iman Argakoesoemah[2], Windi Darmawan[2]

(1) JOB Pertamina-Medco E&P Tomori Sulawesi
(2) PT Medco E&P Indonesia

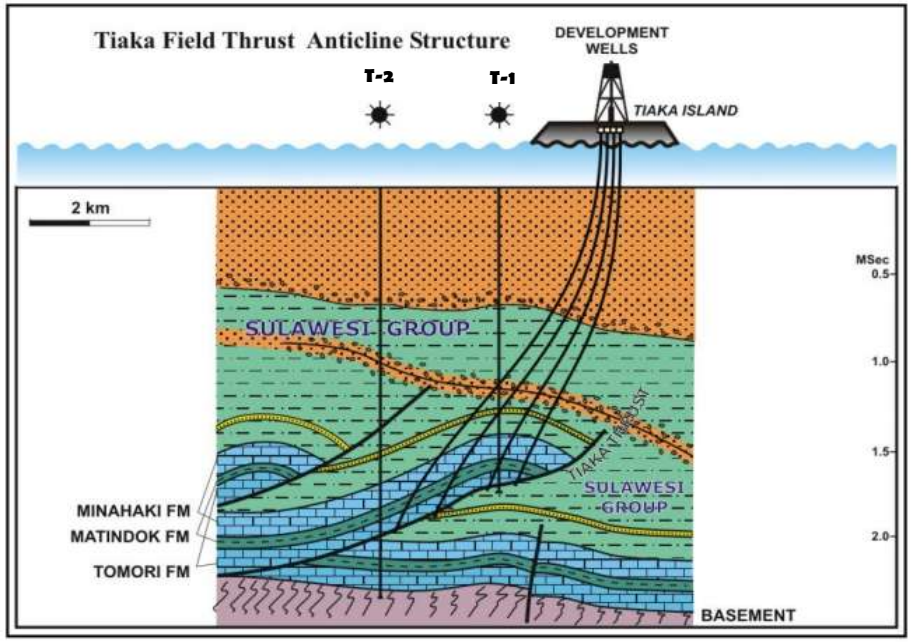
Outline

- Introduction
- Regional Geology
- Fracture Identification
- Summary

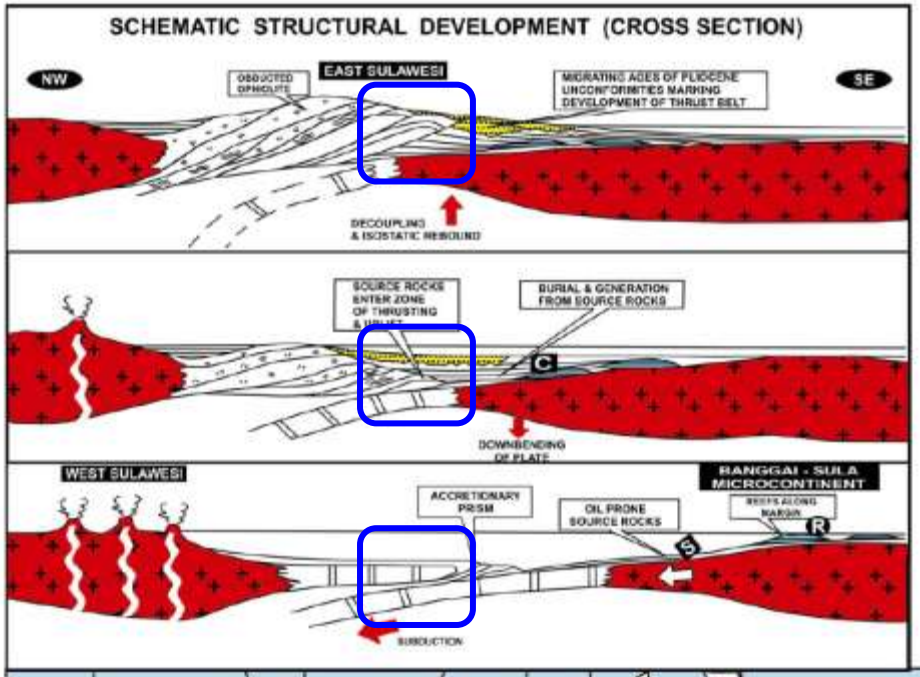
Field Location

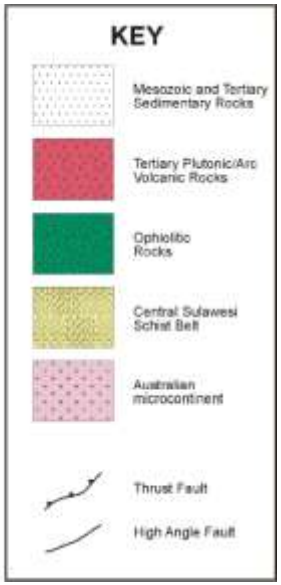
Tiaka Field Summary

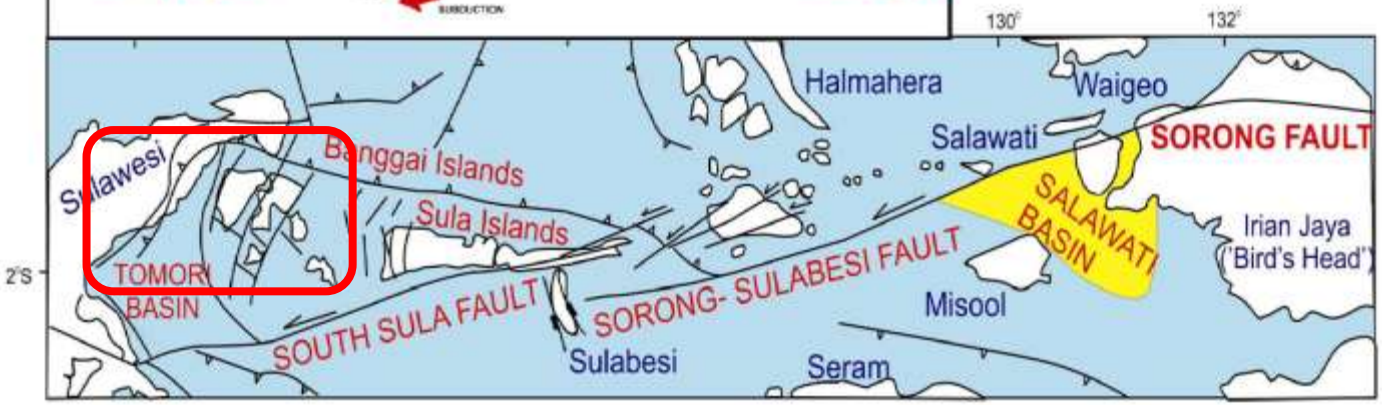
- Discovered : 1985
- Play Type : Miocene Thrust Structure
- Reservoir Objective : Miocene Carbonate of Tomori Fm.
- Reservoir depth : 6800 – 8700 ft TVDSS
- Total well drilled to date : 10 wells
- Average Por & Perm : 7 % & 5 md
- Hydrocarbon : Oil
- Initial Pressure : 3776 psi
- Current Production Rate : ±1500 BOPD (from 6 wells)



Tectonic Setting and Regional Structure





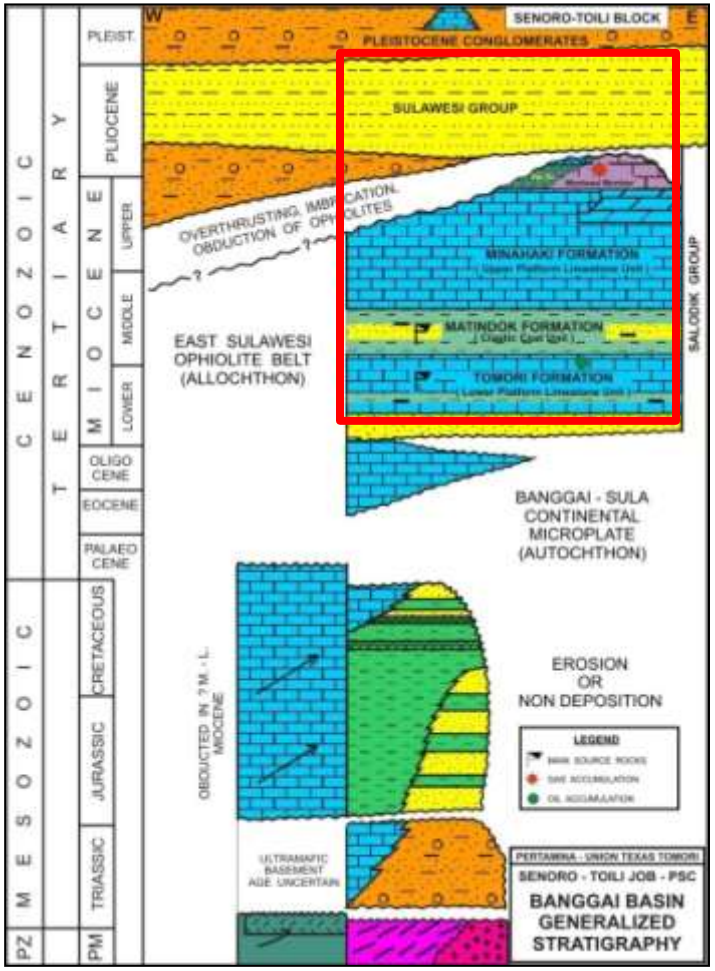


Regional Stratigraphy

Source Rock:
- Tomori Formation
- Matindok Formation

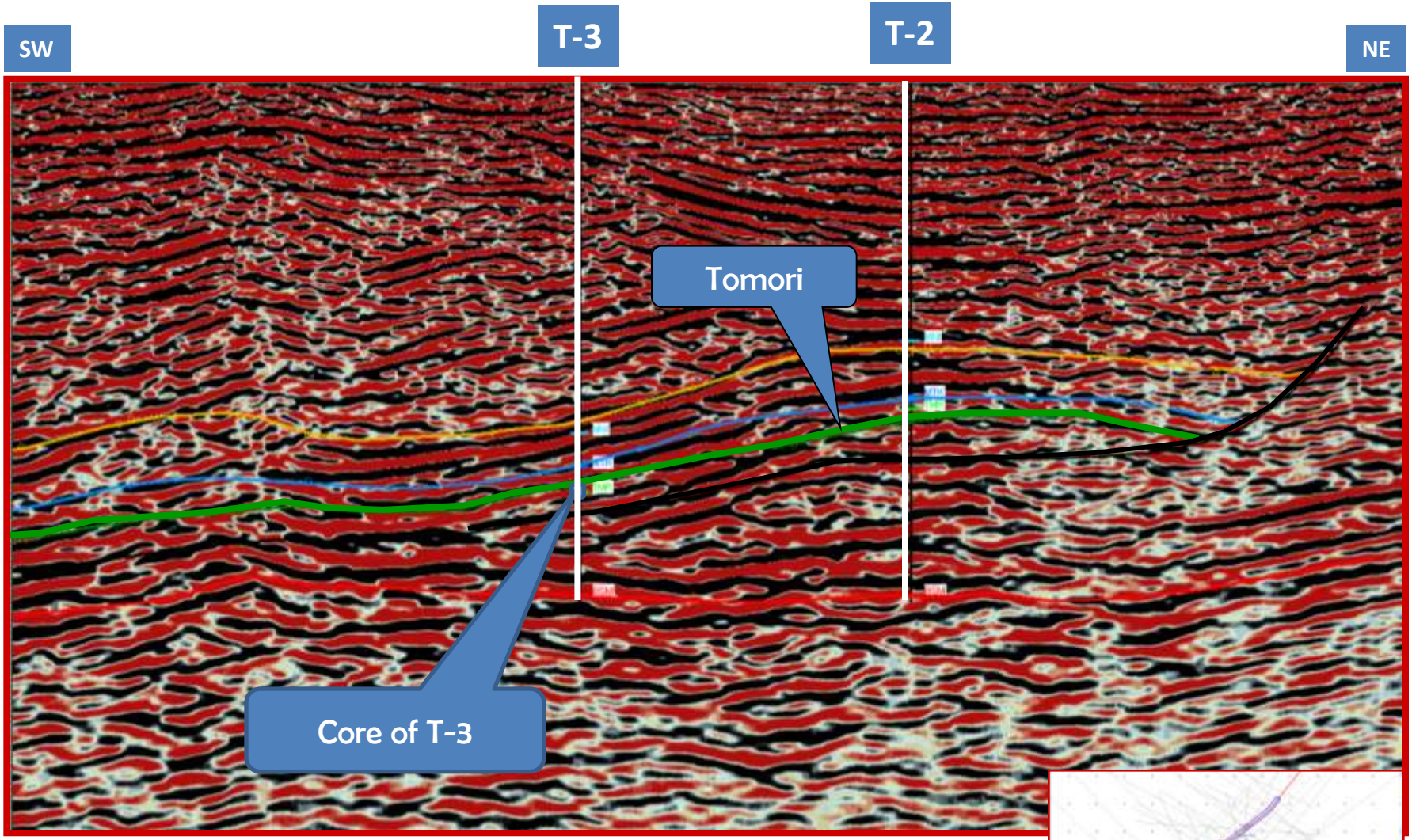
Reservoir:
- Tomori Formation
- Minahaki Formation and Mantawa Member

Seal:
- Matindok Formation
- Kintom Formation (Sulawesi Group)

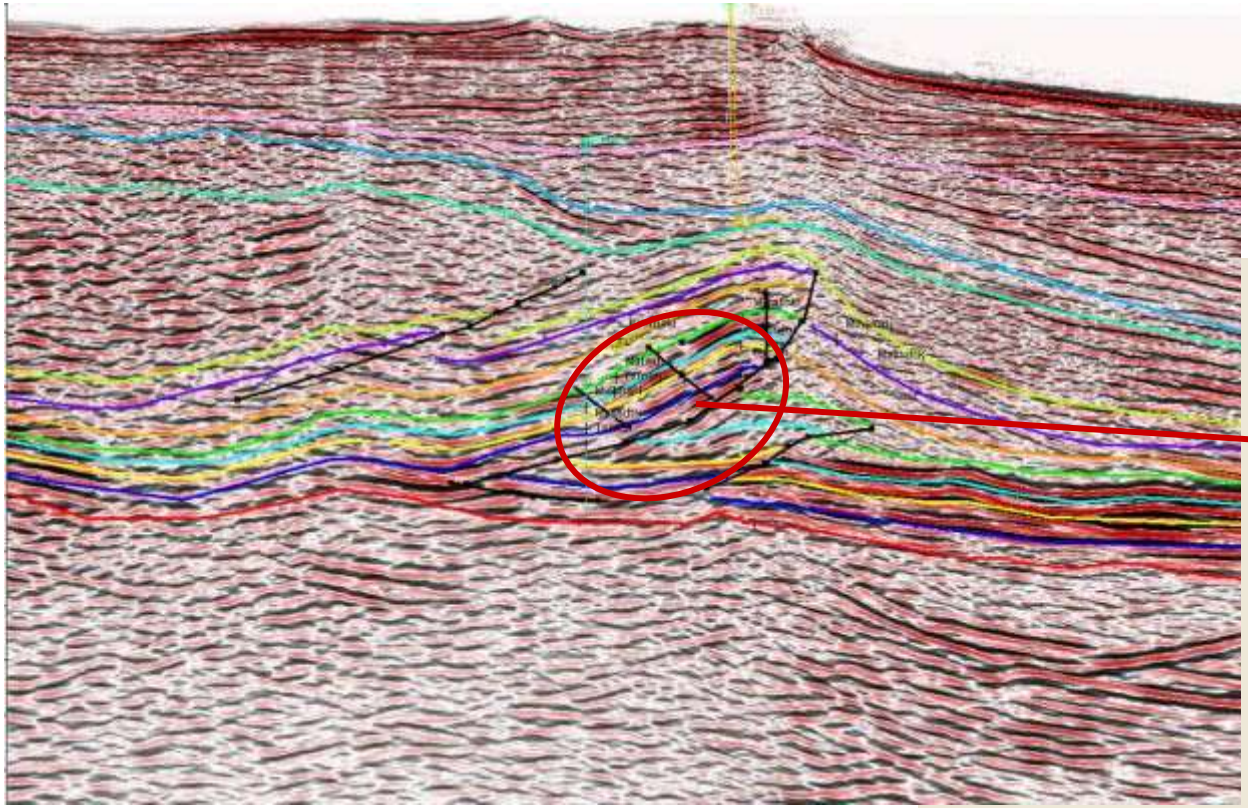


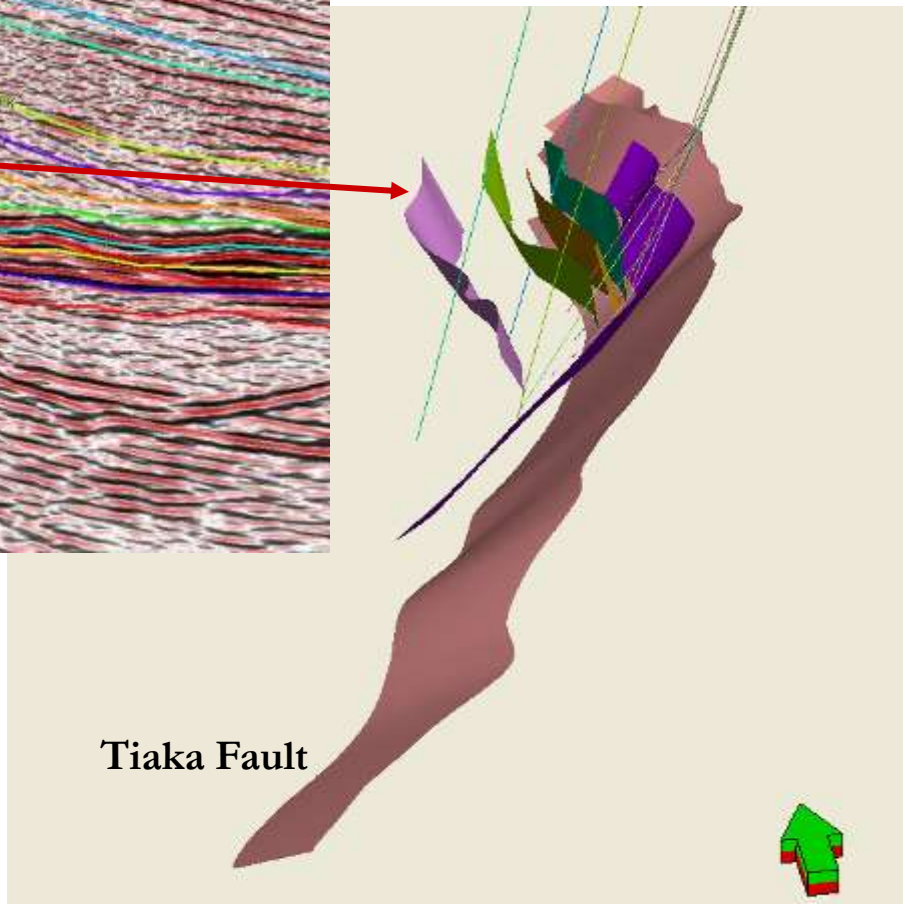
Pertamina BPPKA, 1996

Seismic Section

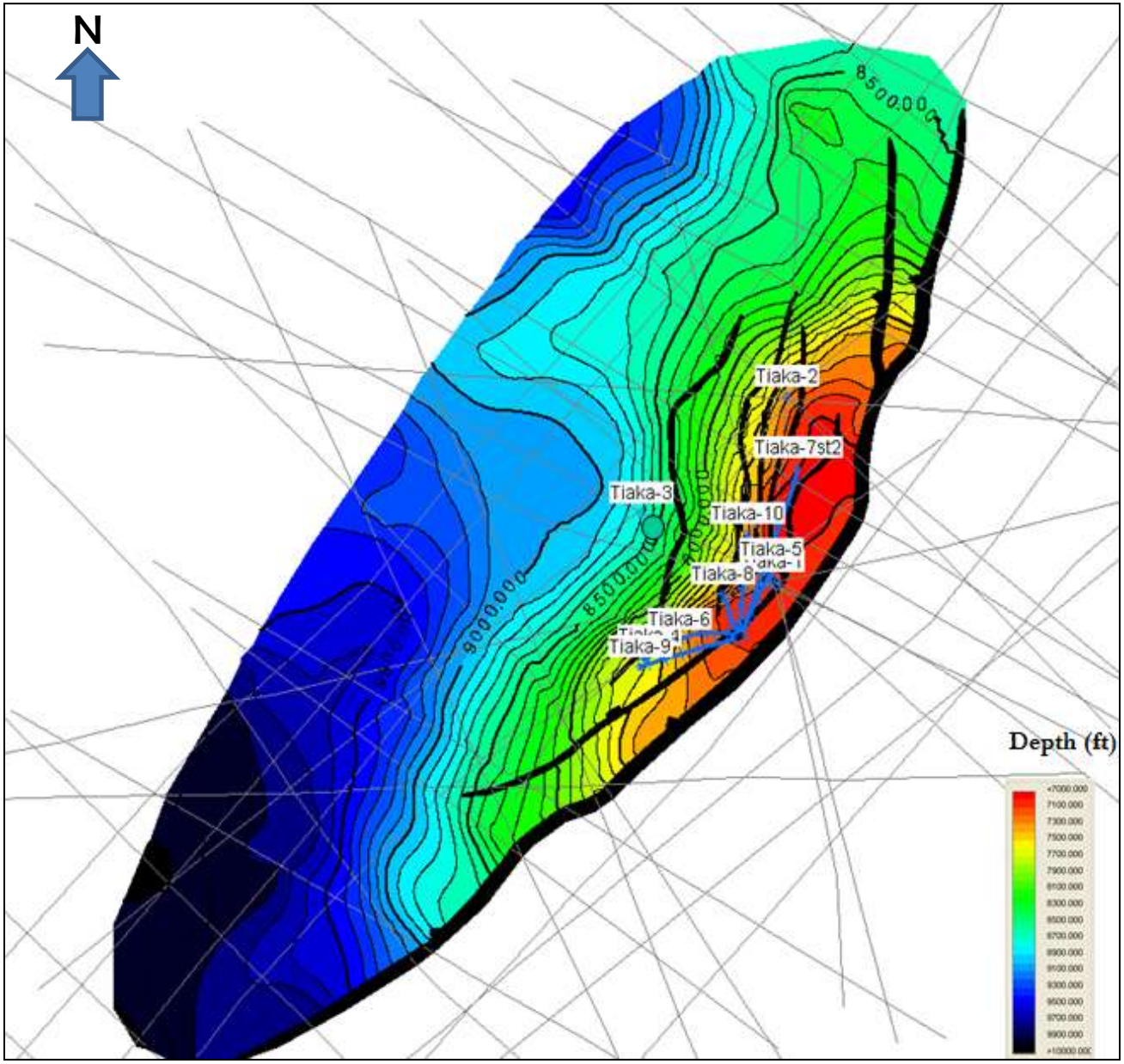


3D Fault Model

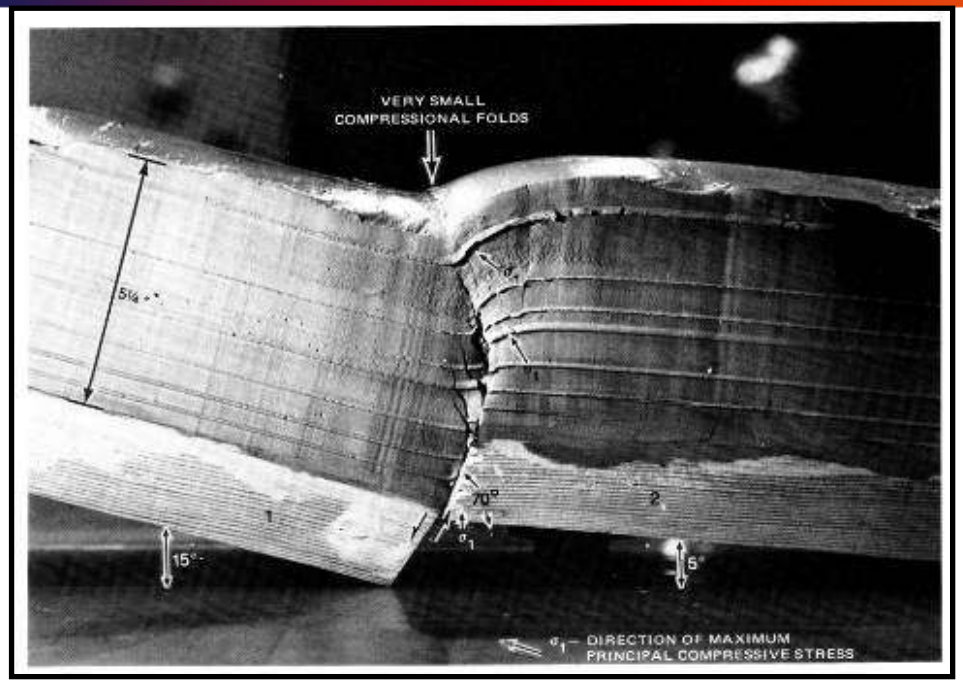




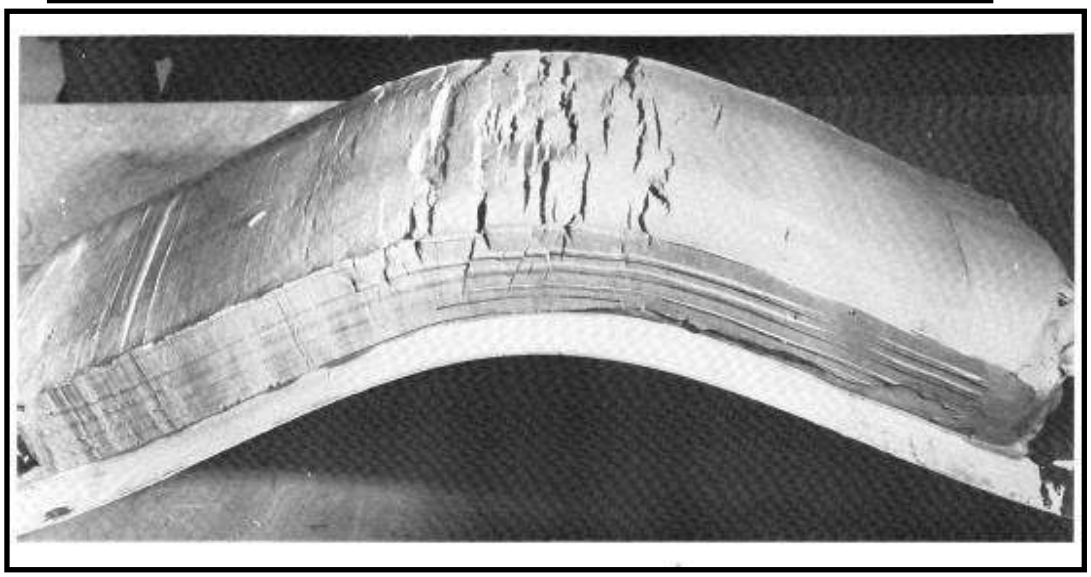
Depth Structure Map of Top Tomori Fm.



Fracture Distribution Model



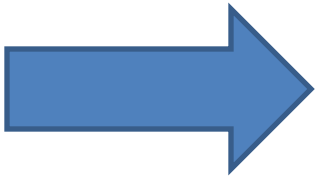
- Proximity to faults



- Maximum Curvature

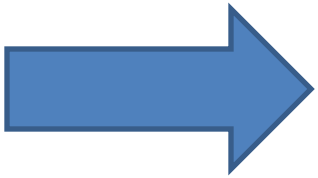
Fracture Identification

- Core
- Thin Section



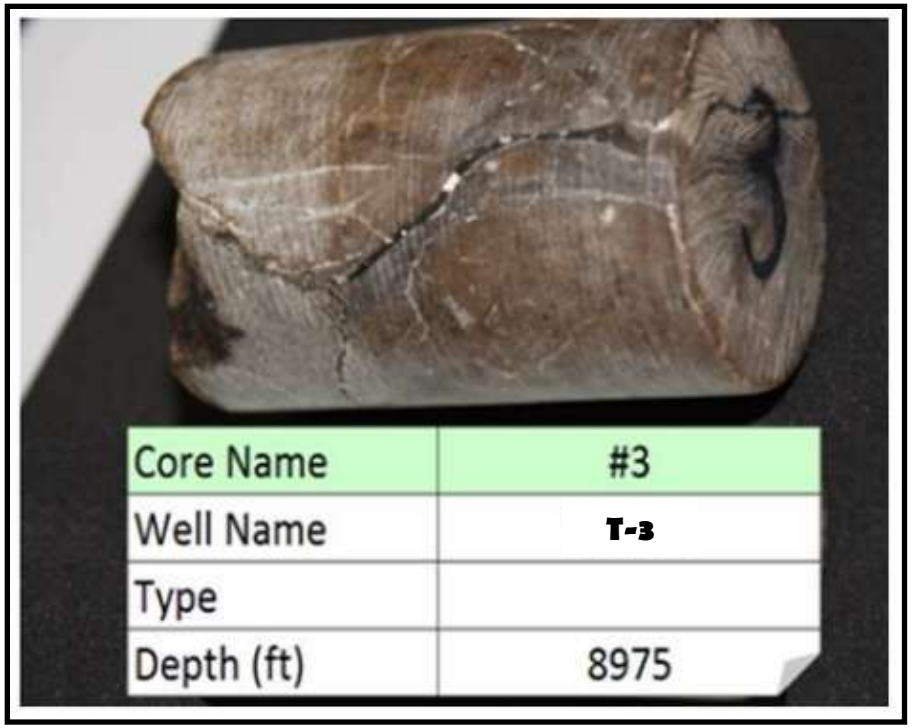
Direct Detection

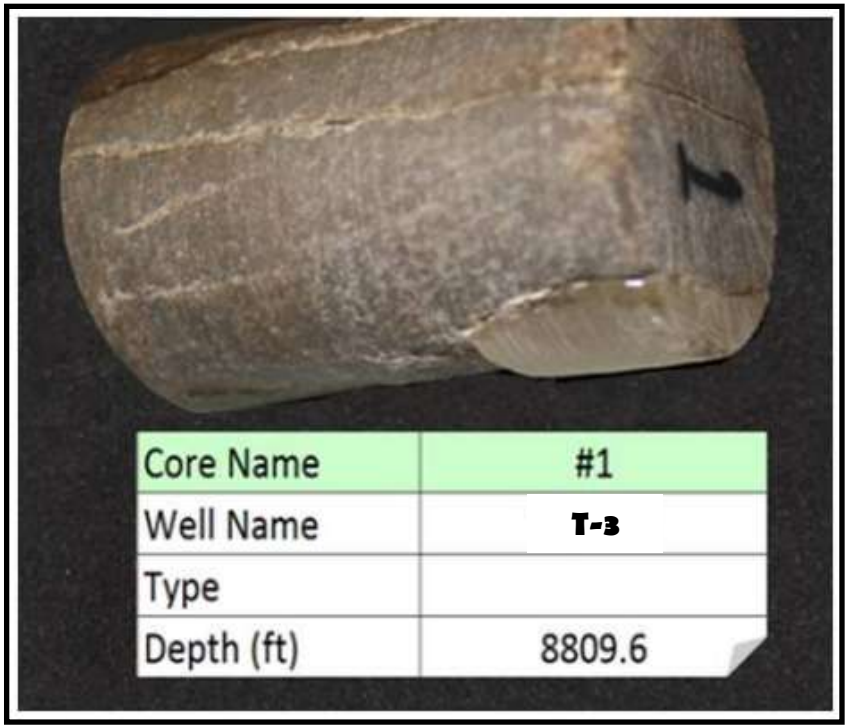
- Well-log Data
- Well Test Data



Indirect Detection

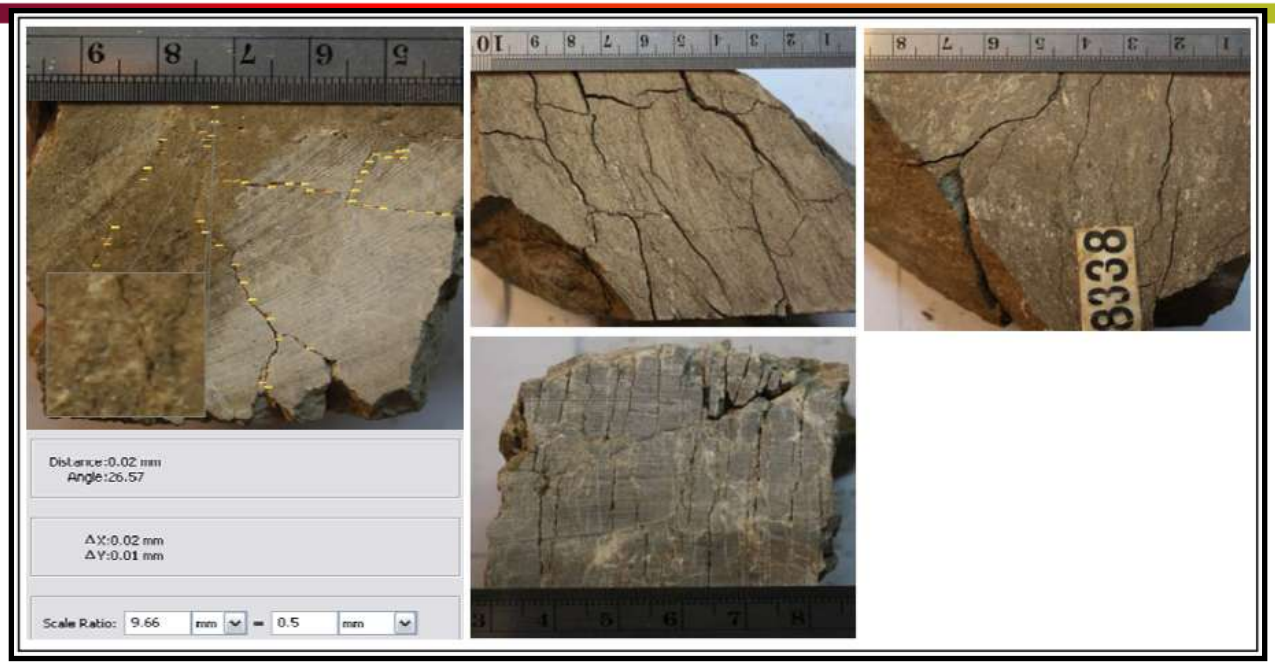
Fracture in Core Sample



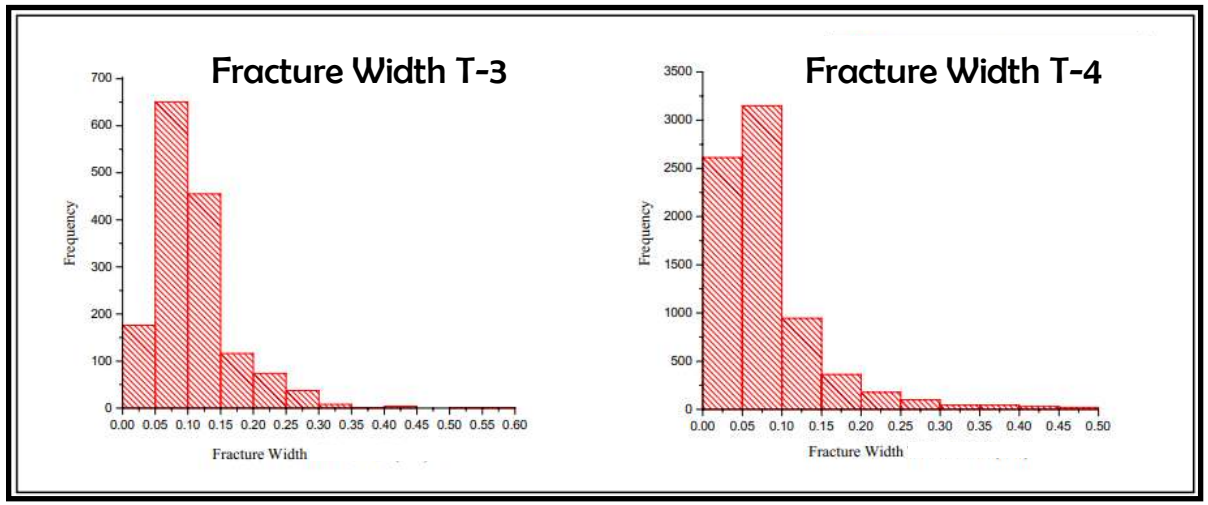


Fracture evidence in Core of T-3

Fracture in Core Sample

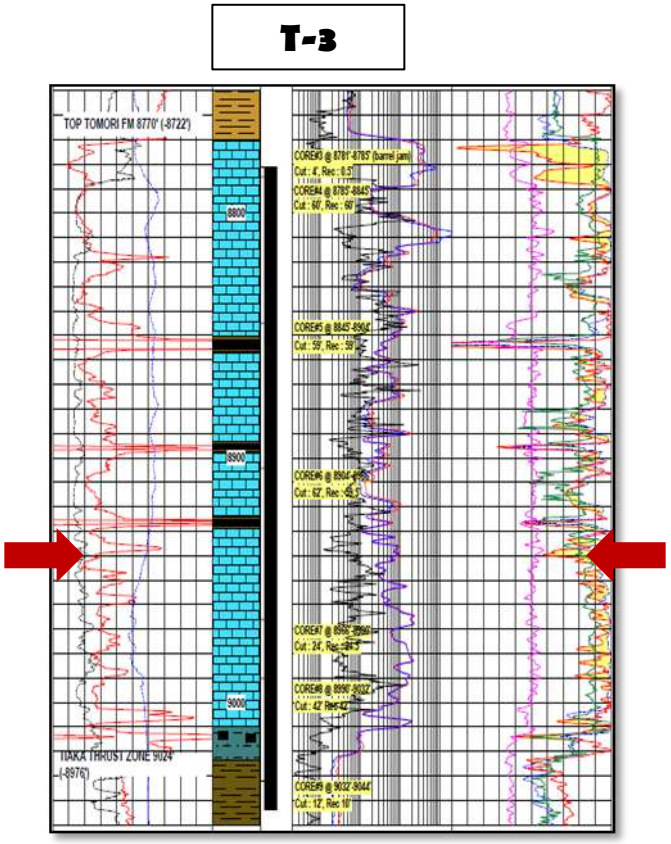


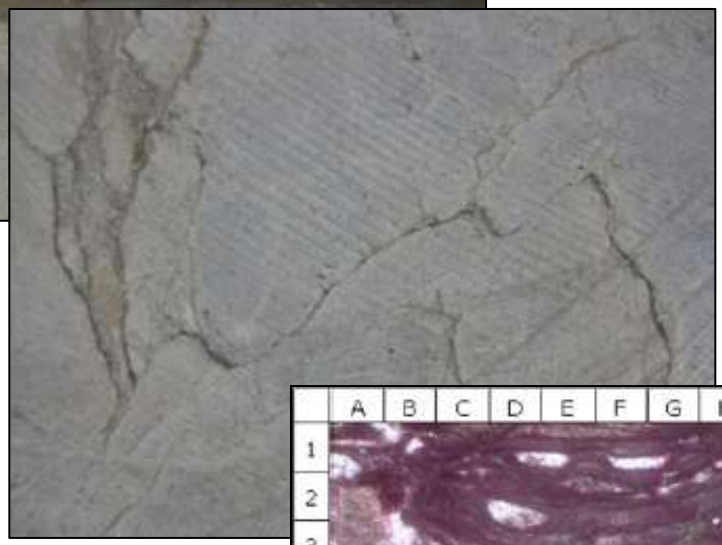
Fracture core observation for fracture width measurement

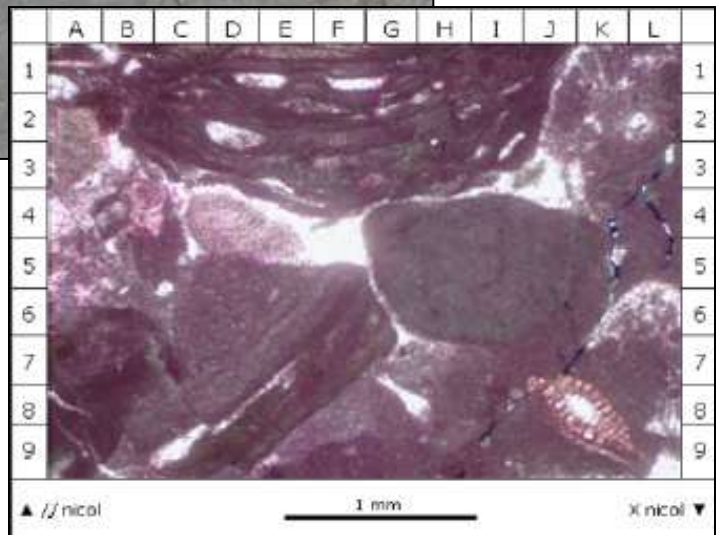


The probability of fracture width taken from core T-3 & T-4

Fracture in Core Sample



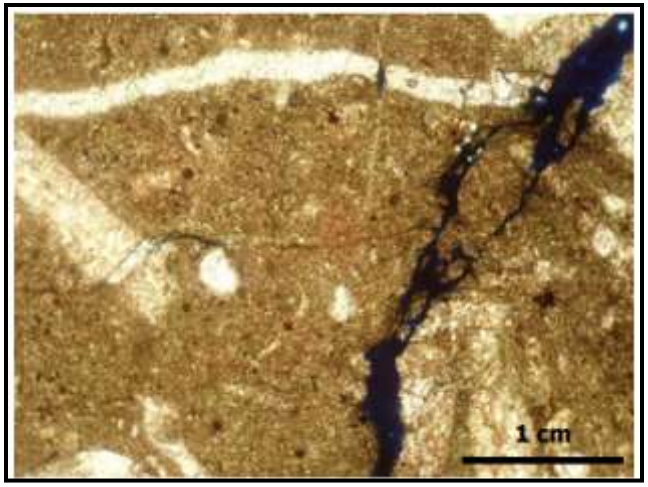




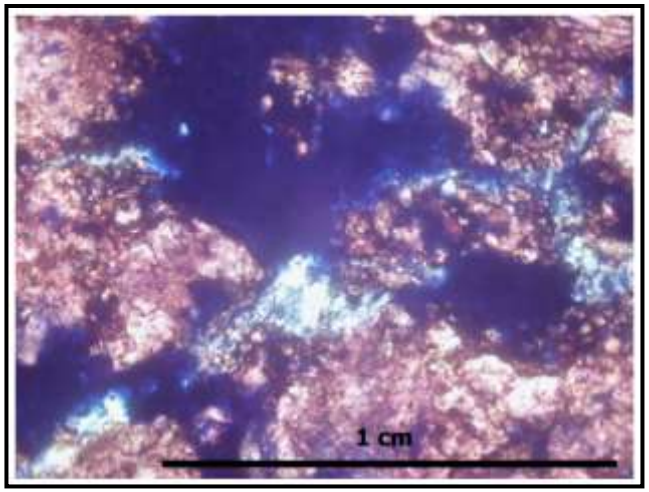
T – 3

Light to medium grey wackestone and packstone consisting of foram, echinoderm and gastropod. Extensive fractures sub-parallel to core axis are generally calcite-filled, suggesting restricted shallow marine environment.

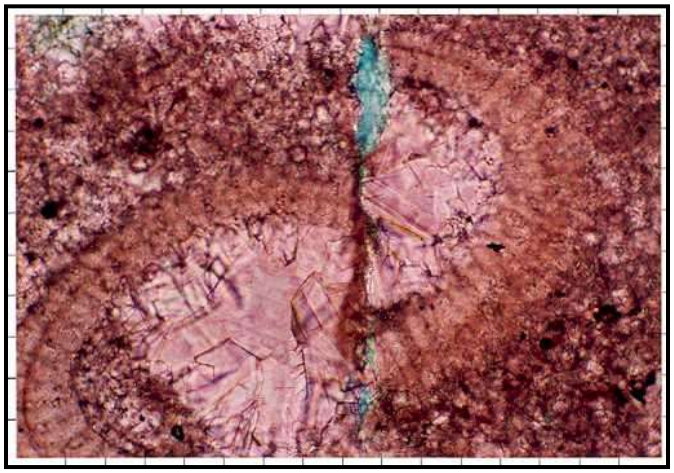
Fracture in Thin Section



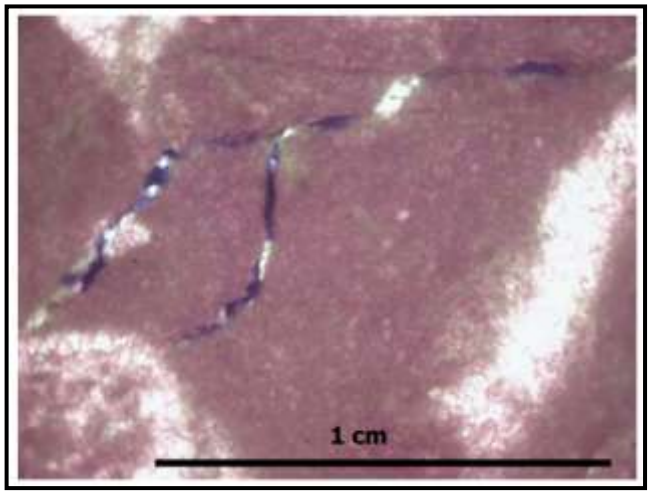
Fracture filled by calcite & cut by fracture porosity (T-2)



Vug & fracture porosity (T-4)



Fracture cross-cuts a skeletal fragment, intraskeletal cement and matrix, indicating that fracture event post-dated lithification & void-filling cement (T-2)

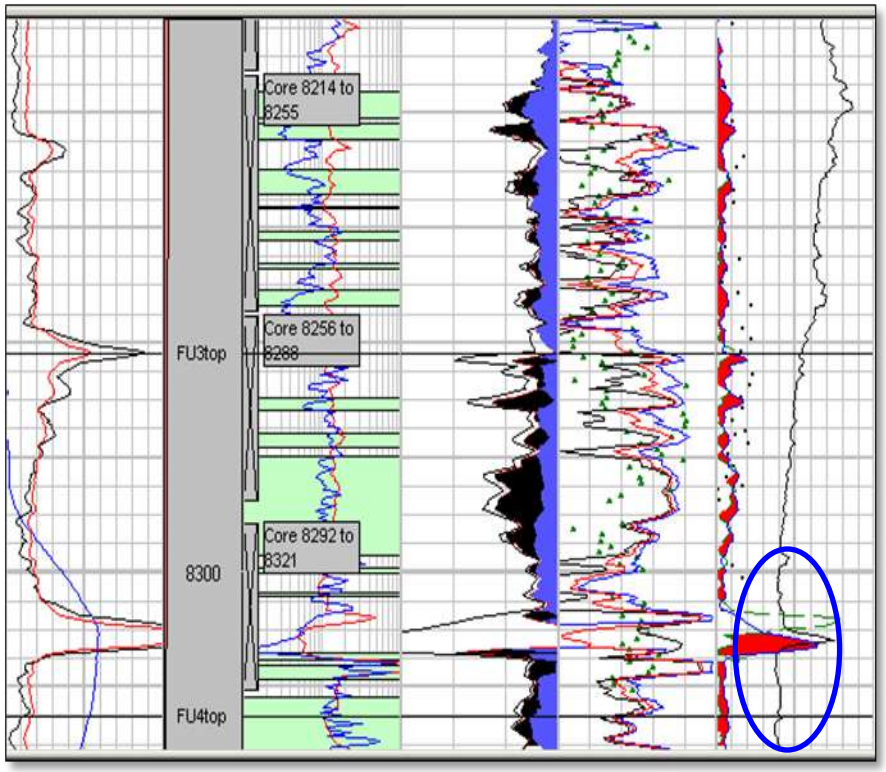


Fracture porosity, dolomitization (T-3)

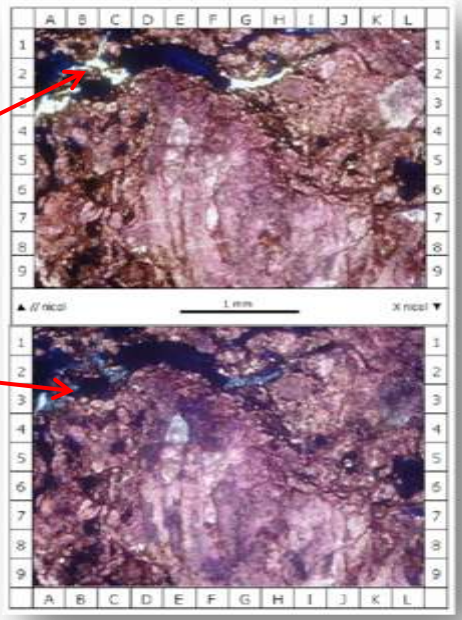
Fracture Property in Well-log

PERTAMINA MEDCOENERGI Oil & Gas

T-4



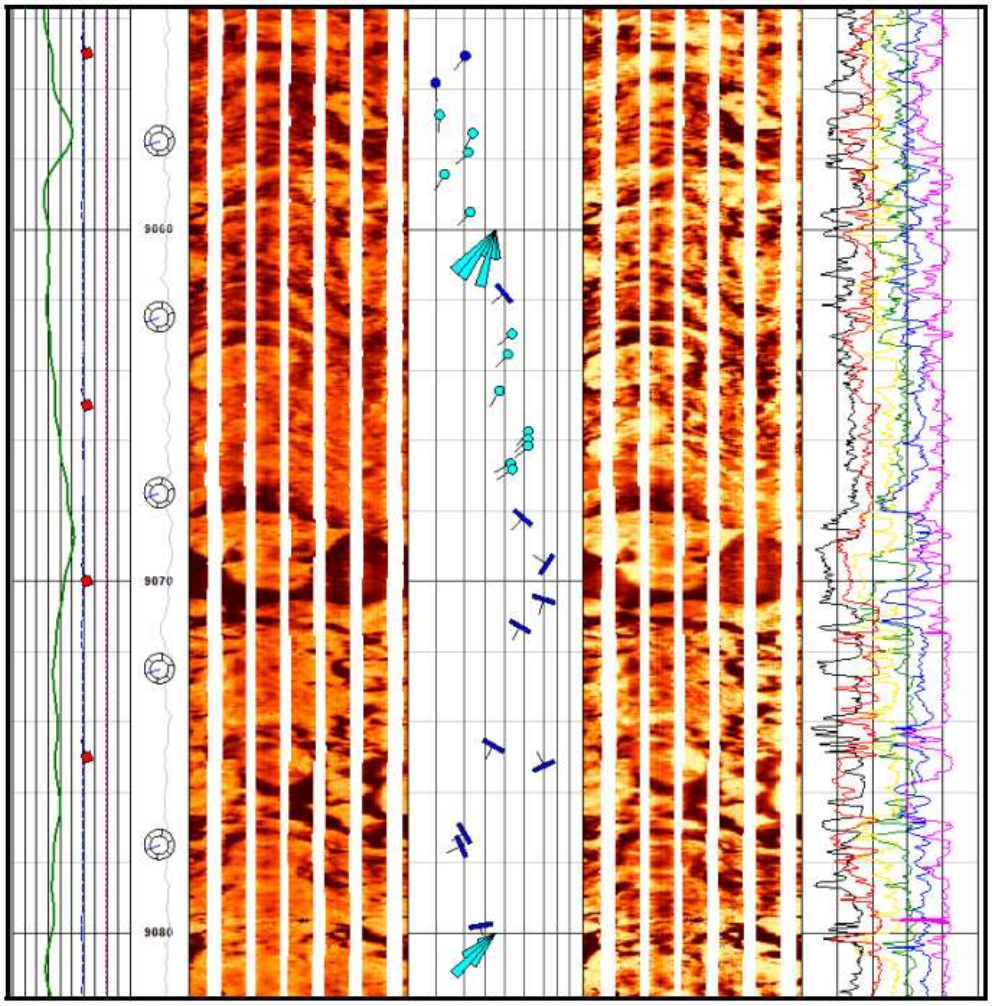
FRACTURE



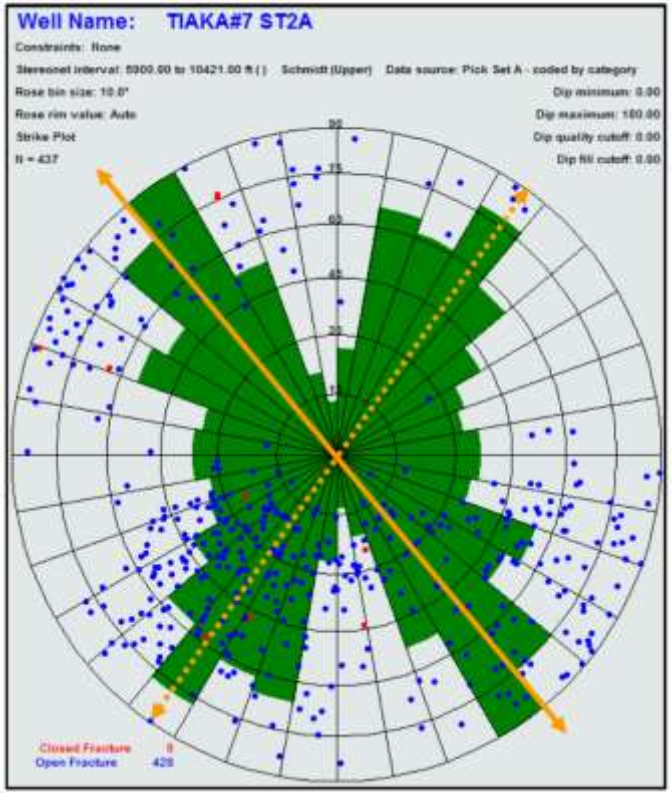
T - 4

Fracture evidence in the Tomori limestone is indicated by cross-over between apparent porosity and sonic porosity, consistent with core and thin-section descriptions.

Fracture Evidence in Image Log (T-7St2A)

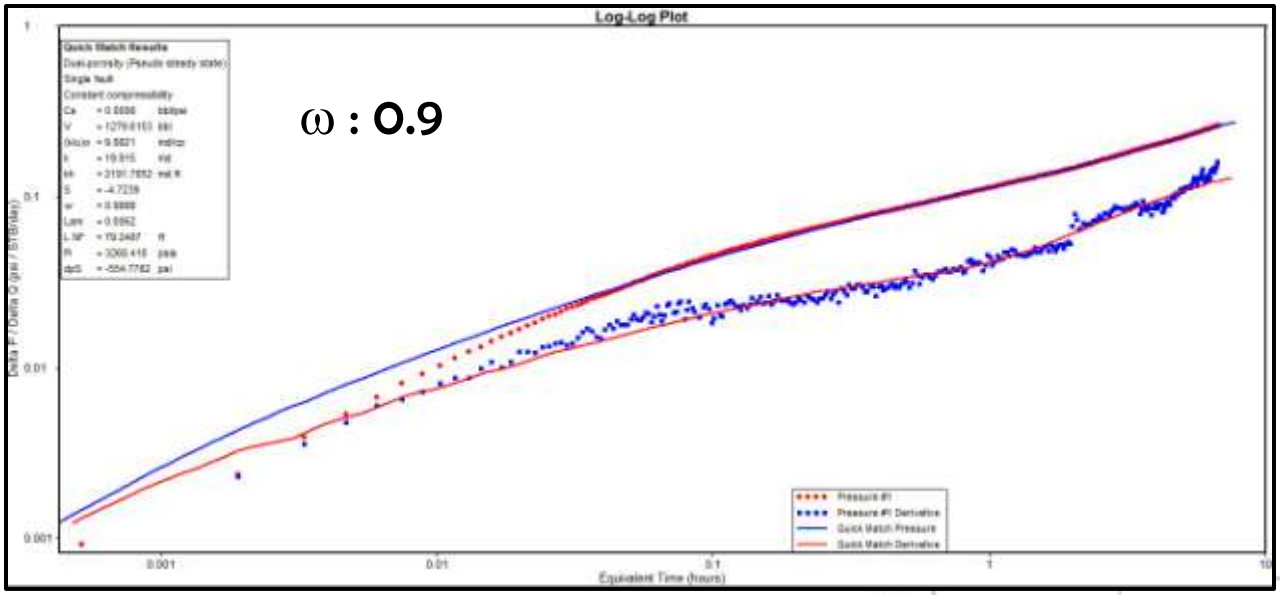


Example of natural open (conductive) fracture (blue fracpole)

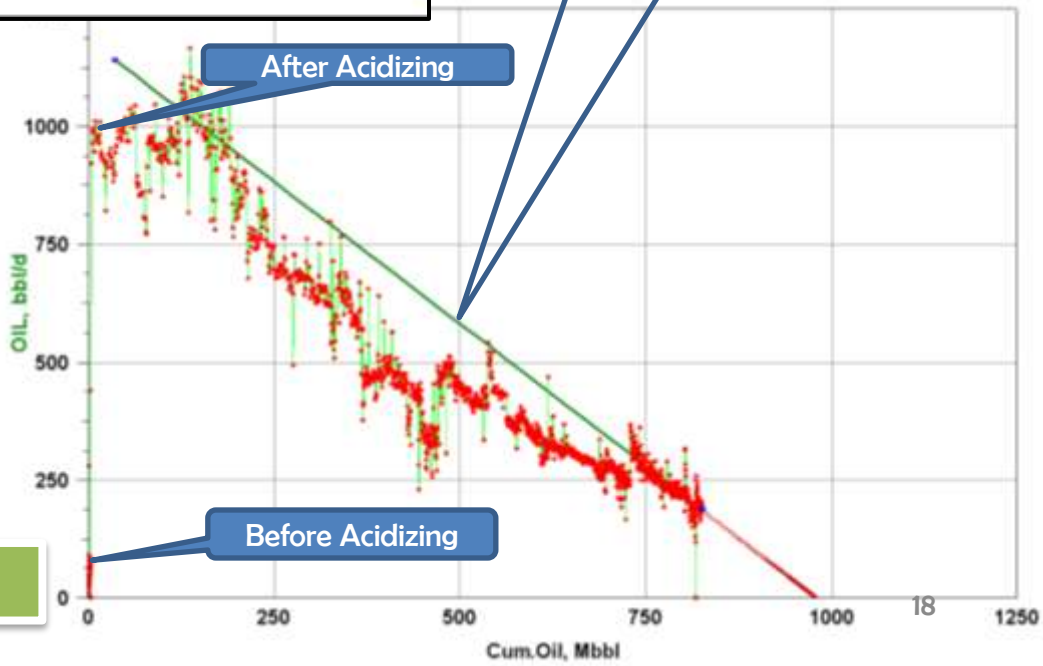


Stereo-plot representing all natural fractures in the well having dominant NW-SE strike (orange solid) and a secondary NE-SW strike (Orange dashed)

Well Test Data & Production Profile

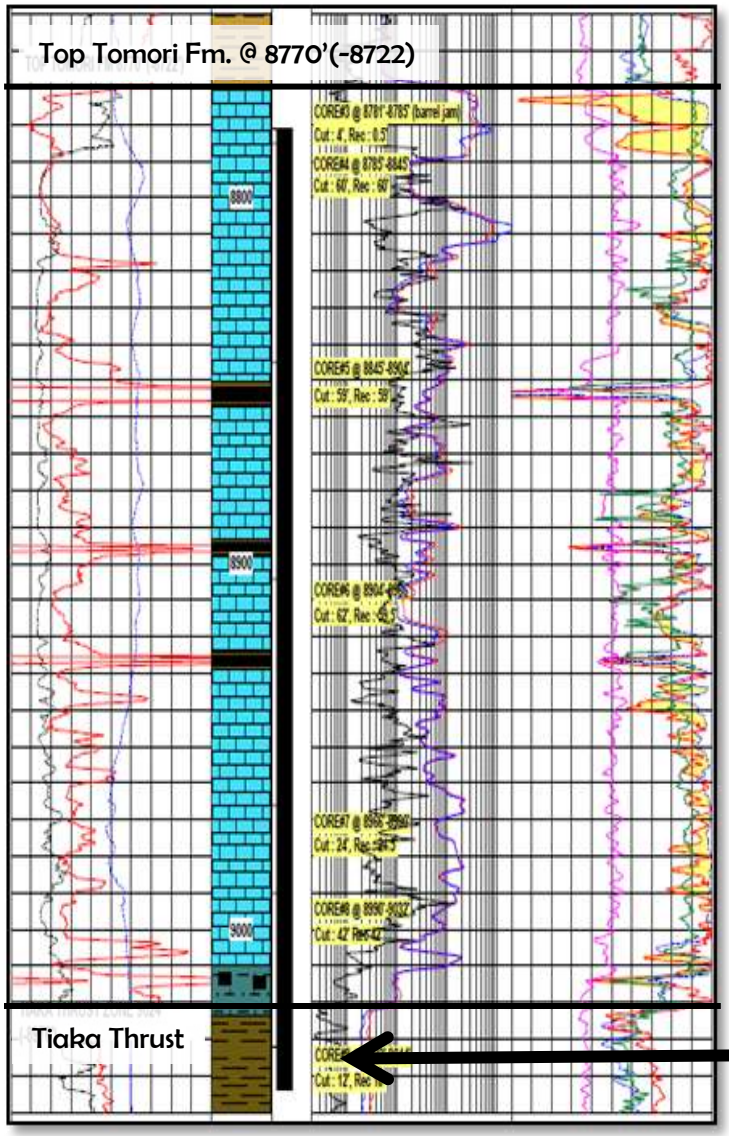


The Oil production is sharply declined and unstable



Tight Carbonate fractured reservoir

T-3 Carbonate Facies

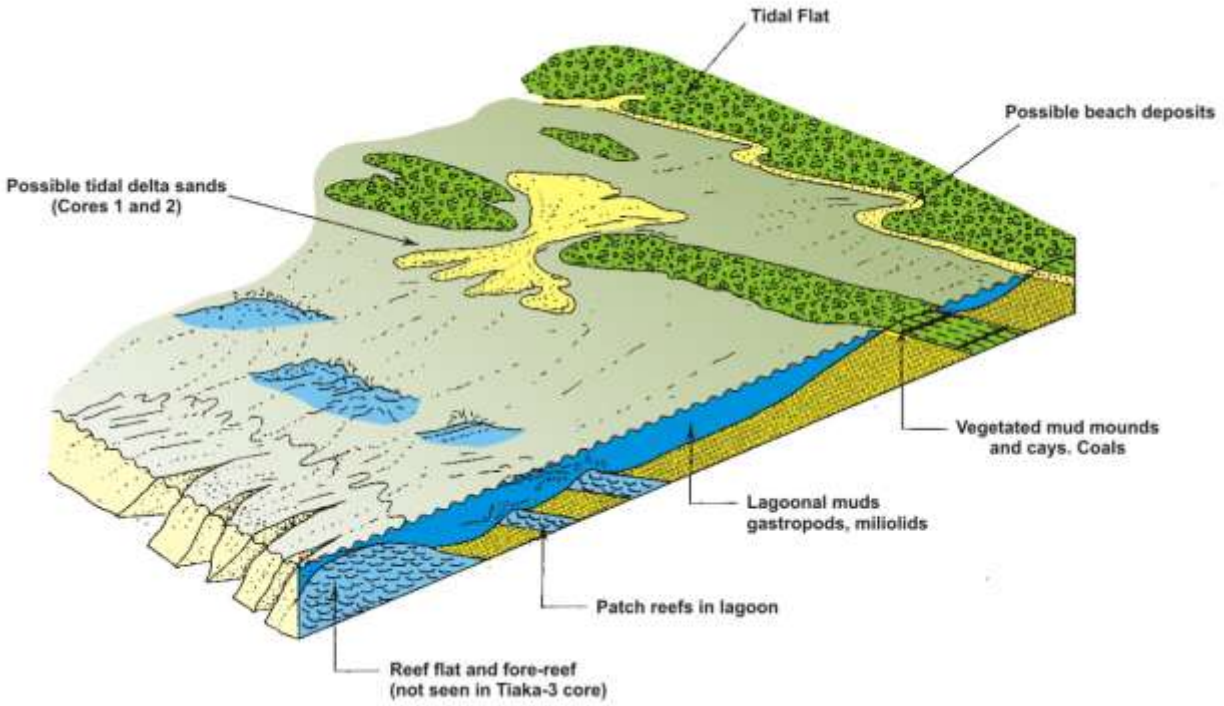


- 8787'-8800.5' :
  Coral Framestone and Interbedded Floatstone
- 8800.5' - 8814.5' : Intensely Fractured Lime Wackestone
- 8811', 8847', 8892', 8920' ; Coal
- 8814.5'-8830'; 8849'-8891'; 8947'-8969' :
  Bioturbated Lime Mudstone & Wackstone
- 8830'-8846' :
  Partially Dolomitized Wackestone & Packstone
- 8893'-8947' :
  Graded Lime Packstone & Wackestone w/ Interbedded Coals
- 8969'- 9010.5' :
  Argillaceous Stylolitic Lime Wackestone & Packstone

Slickensides in the Kintom caused by Tiaka Thrust Fault.

Depositional Environment

- The majority of cored sequence is composed of carbonate lithologies of mudstone-wackestone with streaks of coals and shale.
- Carbonate sequence deposited in the very shallow restricted marine environments as shallow lagoon and tidal flat that allowed periodic exposure of vegetation resulted in coals of both in situ and transported origins.
- Cycle sediment of lagoon and tidal flat sequence with vegetation is interpreted as an indication of intermittent transgressive and regressive episodes.



Schematic reconstruction of depositional environments in T-3 cored intervals

Summary

- Structural trap in the Tiaka Field is characterized by NE-SW low-angle thrust fault
- Reservoir characteristic is tight, fractured carbonate reservoir with muddy facies dominant
- The depositional environment of this carbonate was interpreted as the shallow restricted marine environment
- Fracture evidence can be identified & interpreted from core, log, thin section and well test data
- Fracture distribution and characteristic modeling used conceptual approach controlled by well data
- The image log run in T-7ST2A indicates that dominant orientation is to the NW-SE with a mean of fracture dip of 30°-40° toward southwest
- T-3 Core Summary :
  - Quality generally poor (only the dolomitized zone displaying mod- good quality)
  - Coral reef facies are poorly developed