Structural Traps and Hydrocarbon Resources of the Papuan Basin: An Overview*

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Abstract

Papua New Guinea has become one of the world's most exciting exploration regions, with significant hydrocarbon potential. The key geological element that controls hydrocarbon accumulation evolved over the initial Permian−Triassic basement rifting and post-sedimentation inversion folding and faulting largely due to the S−SW propagation of the Pacific plate toward the stable Australian craton. In this study we categorize the larger Papuan basin into four main geological areas based on hydrocarbon exploration, discovery, development, and production. Recent seismic data acquired by Searcher Seismic over the Gulf of Papua (GoP) has revealed exciting new structural potential for hydrocarbon accumulation. High quality seismic data revealed a more comprehensive play identification in deep to shallow waters of GoP. Basement rifting structural plays with post-rift carbonate and turbidite siliciclastic deposition are the key reservoir plays. Pasca, Pandora and Uramu gasfield discoveries were made on Miocene reefal carbonate build-ups on faulted basement highs. The carbonate and siliciclastic plays are estimated to have a combine resource of up to 306MMboe–gas/condensate. The Aure fold thrust belt (AFTB) has a complex structural zone where regional thrust change orientation from NW−SE to N−S. Onset of Tertiary transpressional deformation of the AFTB cross-cuts older structures developed by arc-continental collision in the Papuan fold thrust belt (PFTB). Shallow thrust detachment faults in the upper Ieru formation were reactivated by basement faults during the persistence compressive tectonics in Pliocene. The thrusted platform slope and reefal Miocene carbonates become the primary reservoir plays in the region. The region is estimated to have a potential resource of 2,225MMboe–gas/condensate. The Papuan foreland basin structures are fairly very simple because extensional faulting of Paleozoic granitic basement during Triassic−Early Jurassic has created low relief faulting anticlinal structural closures. Sediment draping over structural highs are also potential plays in the foreland. Reactivation of basement faults during the Late Cretaceous eastern Australia extension has played significant role in configuration of the structural plays. Late Jurassic–Early Cretaceous marine siliciclastic reservoirs are the primary play targets. Potential resources for the foreland region are estimated at 582MMboe–gas/condensate. The PFTB structural play styles were influenced by extension of basement in the Triassic−Jurassic and compression in Late Miocene. Seismic imaging and well dataset imply changes in structural styles across the PFTB. Thin-skinned southwest directed emergent thrust faults and ramp anticlines are associated with the Kutubu producing fields. Toward the northwest in the Muller range structural styles are associated with basement involvement and northeast directed fold and thrust structures. Large-scale structural changes and associated structural complexities reflect on the structural controls on the deformation and the influence on

both the trapping style and distribution of hydrocarbon within the PFTB. The overall estimated resources (produced, undeveloped and yet to find) for the region is 2,867MMboe–oil/gas/condensate.

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Any errors are accidental and the responsibility of the authors.

This is a geological and technical presentation and is not comprehensive.

Scope of Presentation

Introduction:

- Regional tectonic evolution of Papuan Basin
- Tectonic elements and stratigraphy

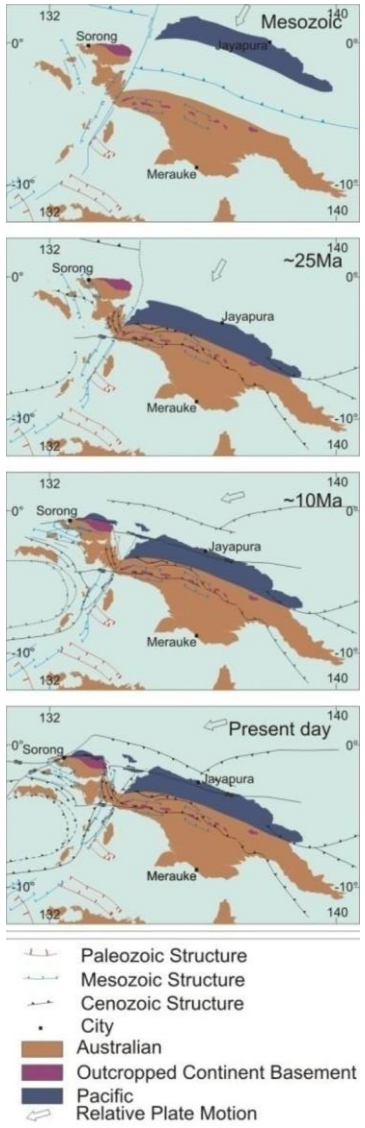
Structural Styles:

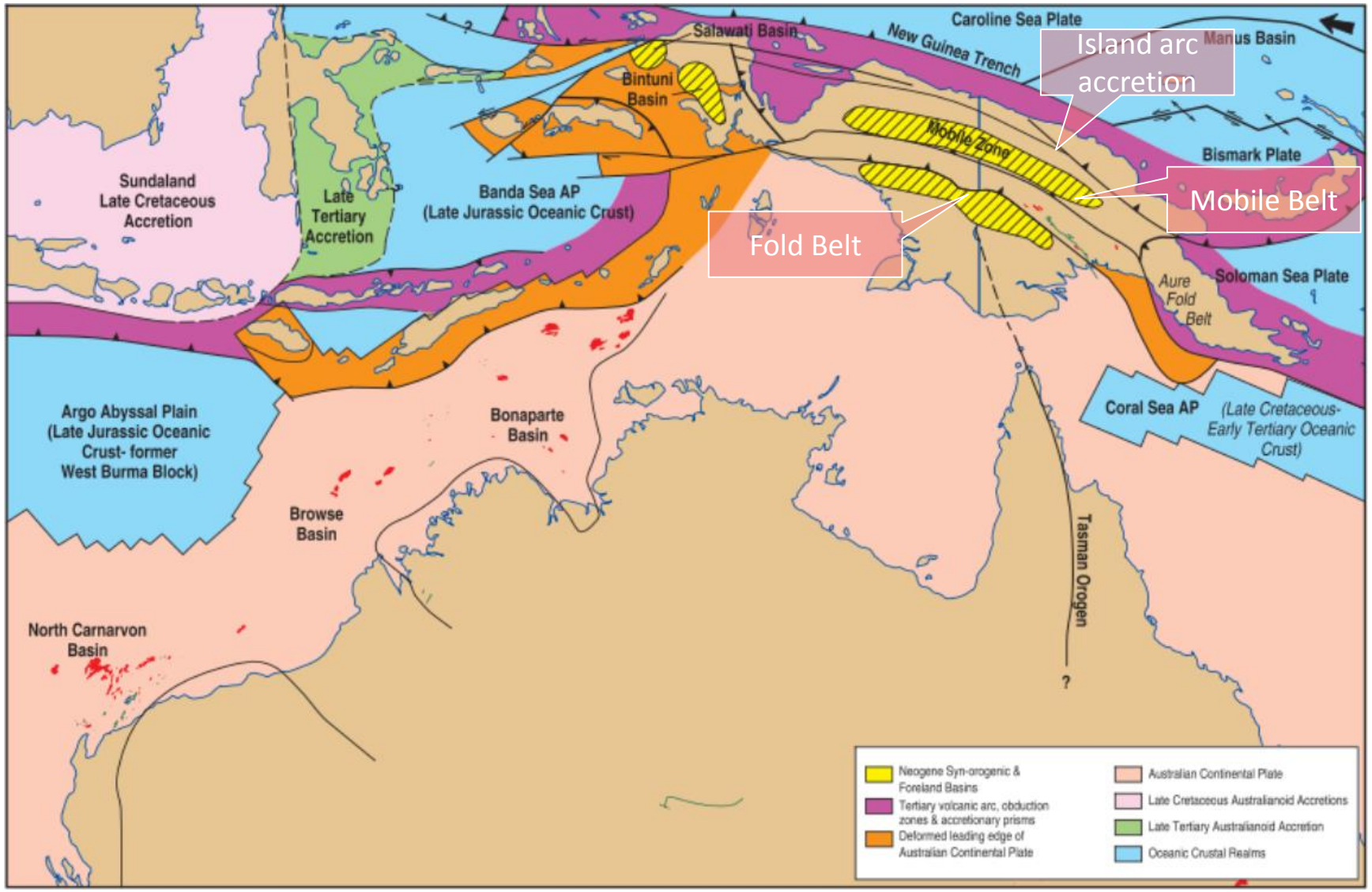
- Papuan Fold Thrust Belt
- Papuan Foreland
- Aure Fold Thrust Belt
- Gulf of Papua

Concluding Summary:

- Changes in structural style and traps across the different tectonic regimes of the larger Papuan Basin and their potential for future discoveries

Regional Tectonic Evolution Of Papuan Basin





Sapiie *et al*. (2009)

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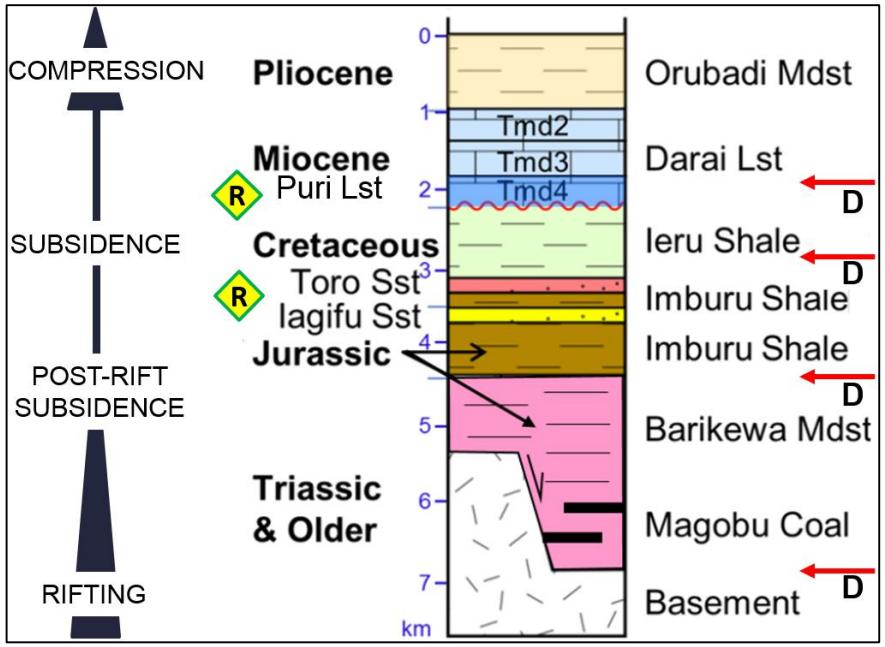
Papuan Basin Stratigraphy and Main Tectonic Areas

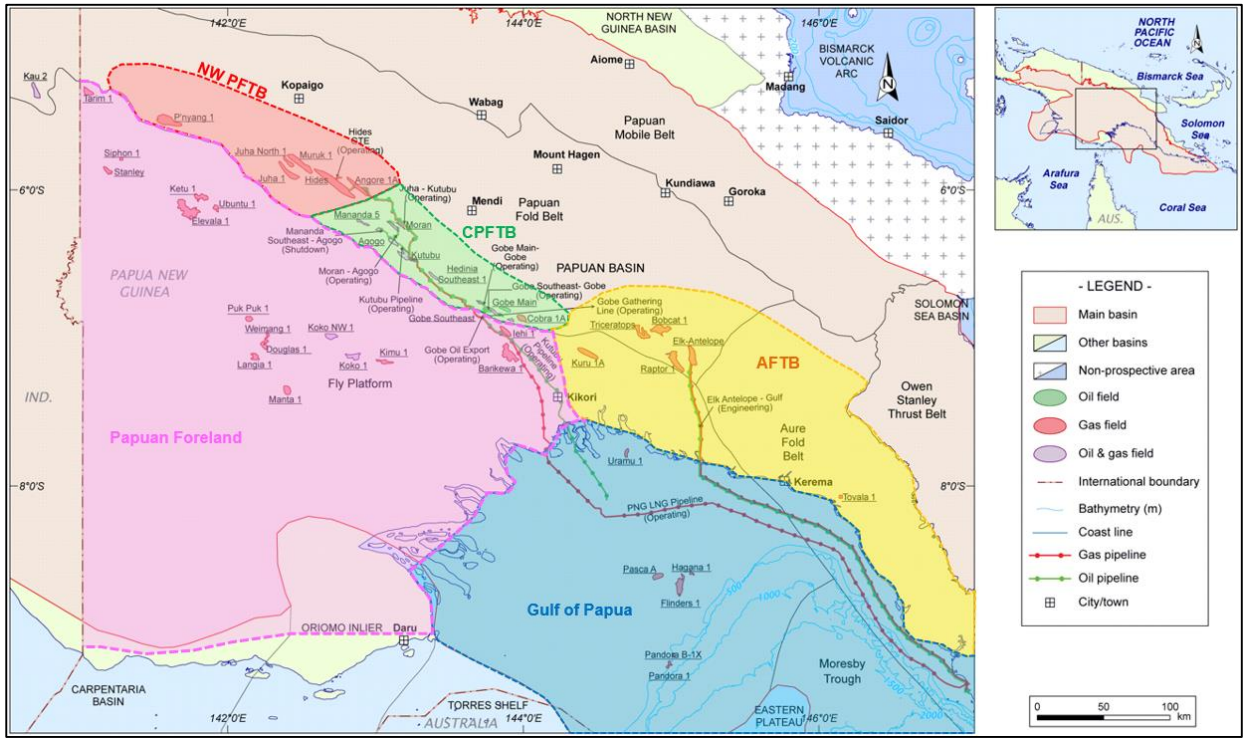
Papuan Basin Stratigraphy (simplified)



» **Simplified stratigraphy showing:**

- ages and thicknesses of sediments
- regional tectonic activities
- detachment horizons (D)

Map of Papuan Basin

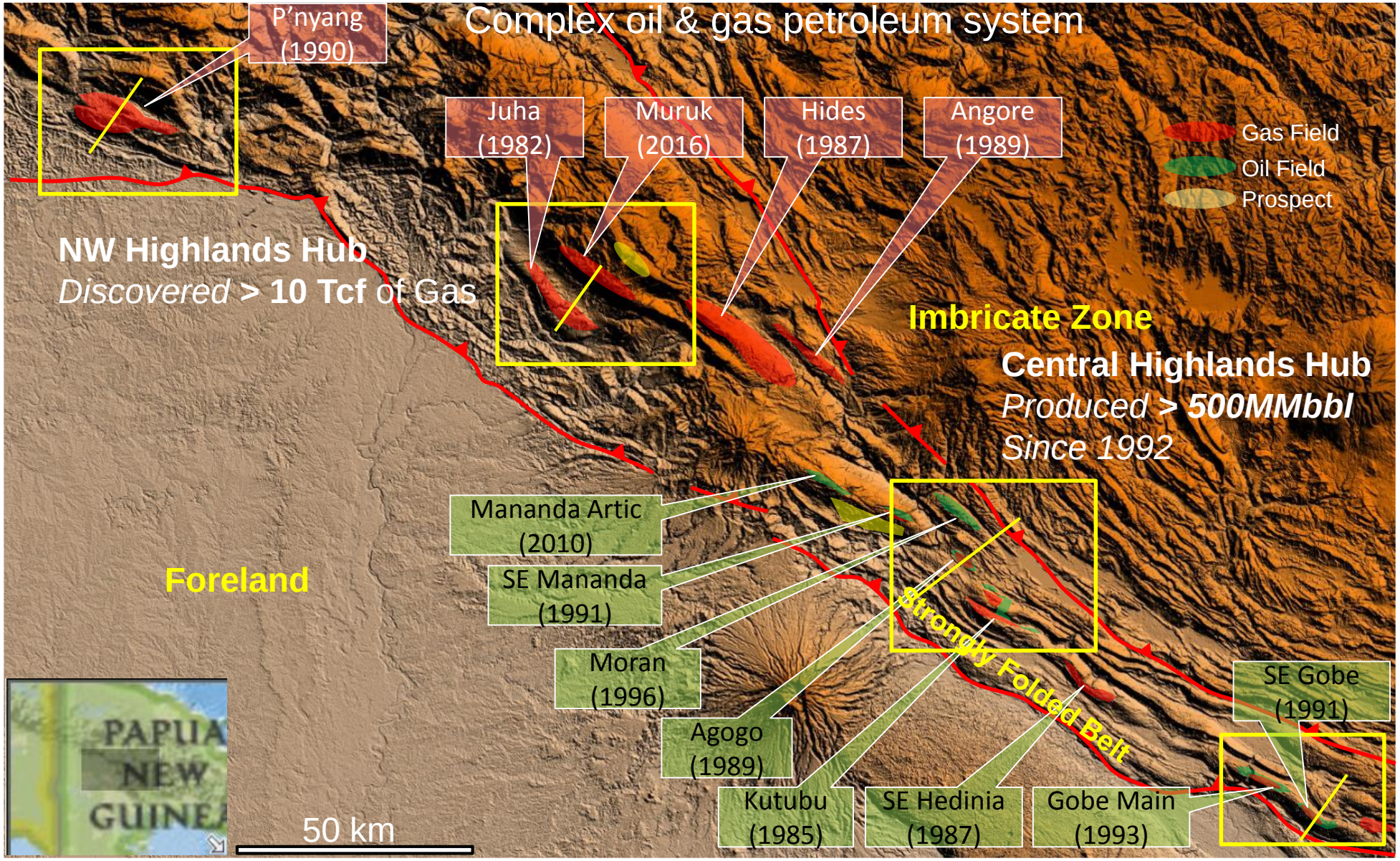


After IHS

» **Four main geological areas:**

- Papuan fold thrust belt (PFTB)
- Papuan foreland
- Aure fold thrust belt (AFTB)
- Gulf of Papua (GoP)

Papuan Fold Thrust Belt (PFTB) – DEM (Digital Elevation Model)



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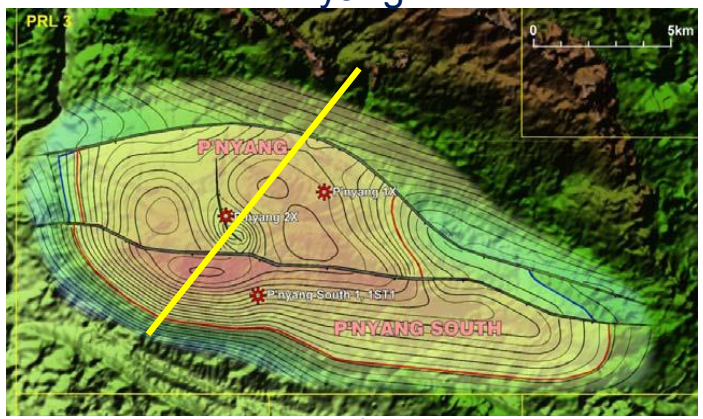
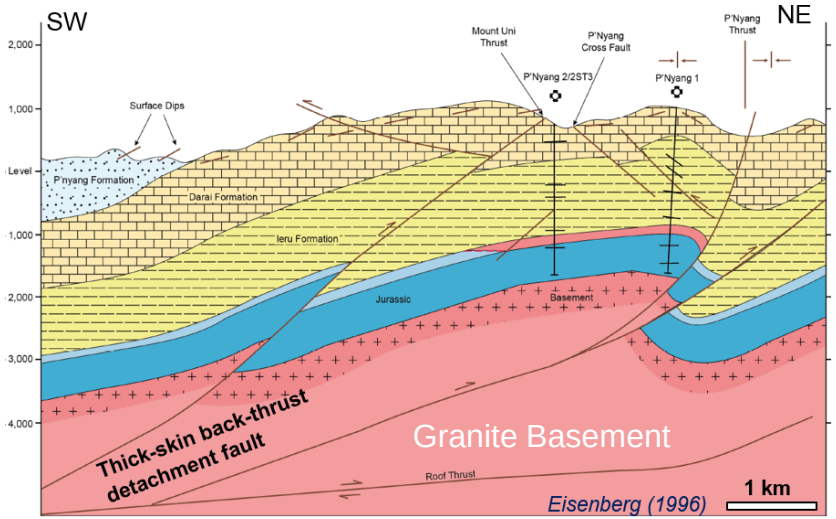
North West PFTB – P'nyang and Muruk Field Structures

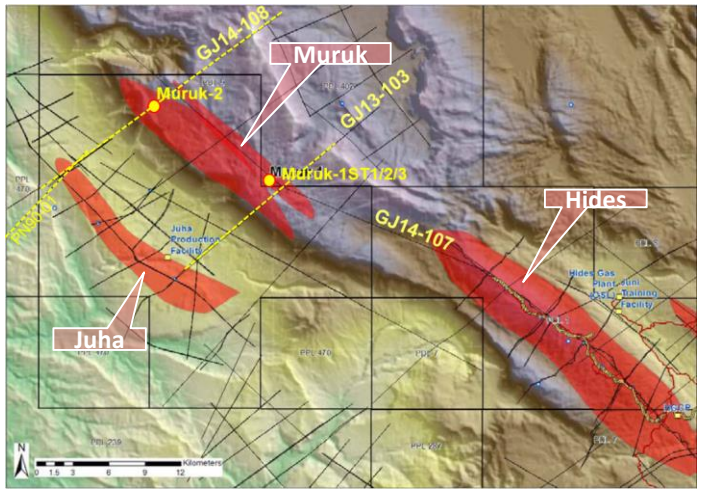
P'nyang

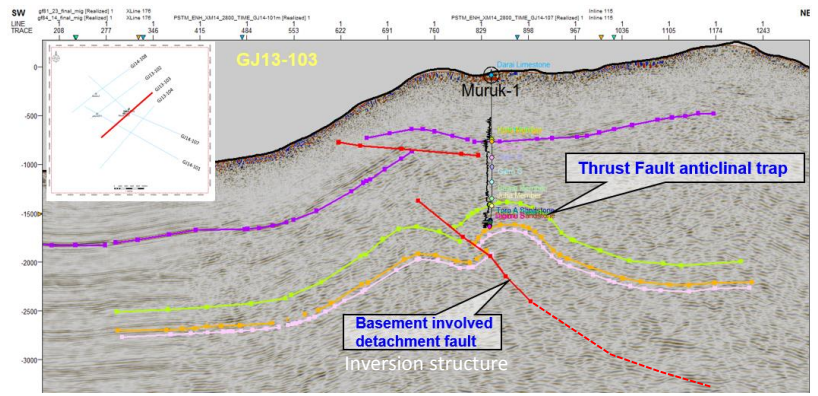


Data courtesy of PRL 3 CoV



Muruk





Data courtesy of PDL 9 & PPL 402 CoV

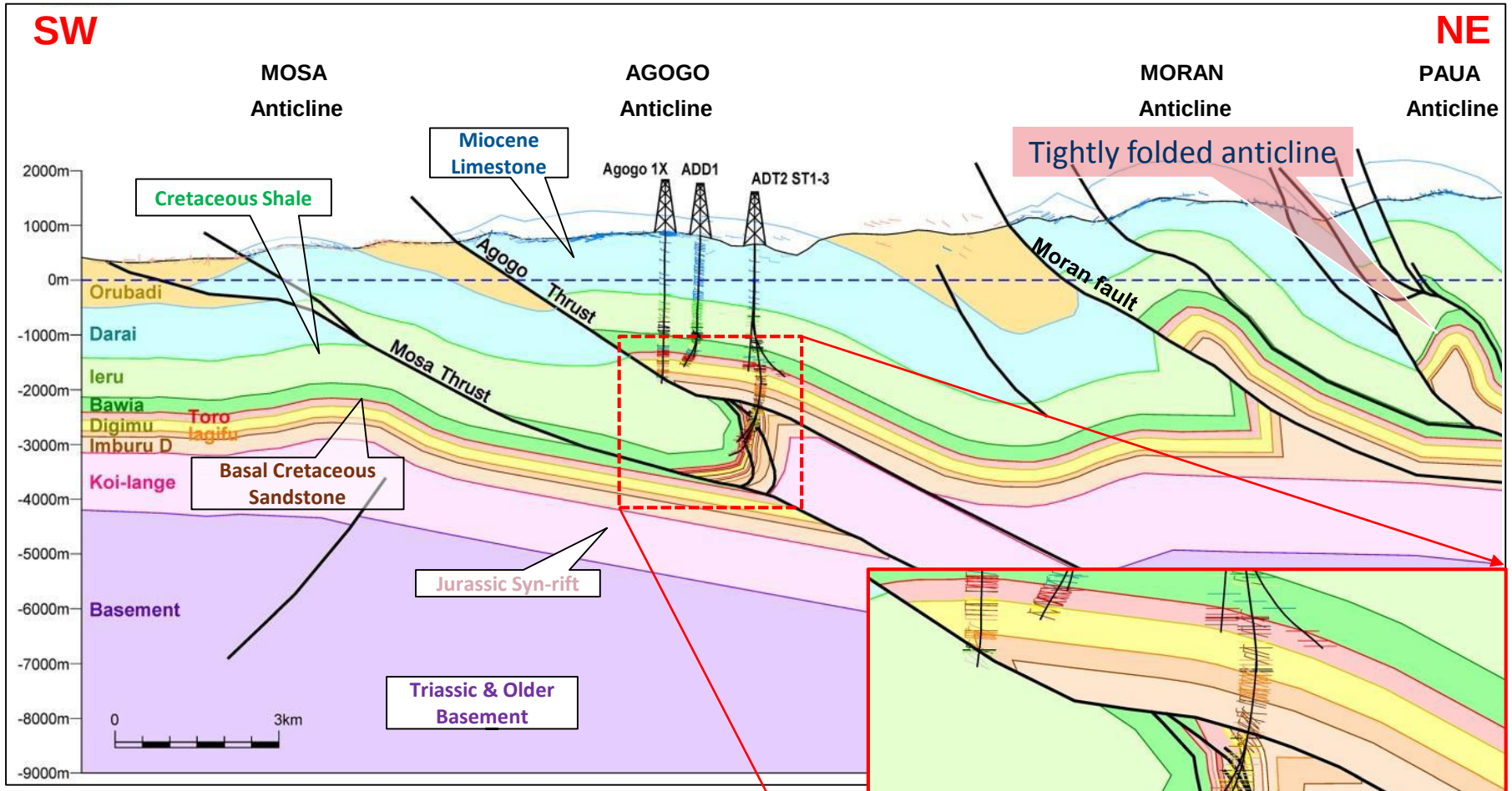
» Structural style

- **P'nyang**: SW-dipping basement involved back-thrust fault
- Intra Ieru Fomation detachment
- **Muruk:** NE-dipping basement involved detachment fault
- **Frontal Foldbelt:** Low angle NE-dipping fault detachment occur above Toro reservoir unlikely to establish structural closure

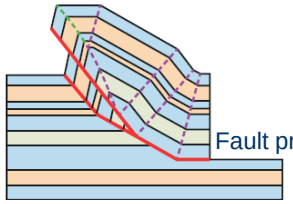
» Reservoirs

- Toro – gas
- Digimu – gas/water
- Emuk – water wet (P'nyang)

Central PFTB – Paua-to-Agogo Structures



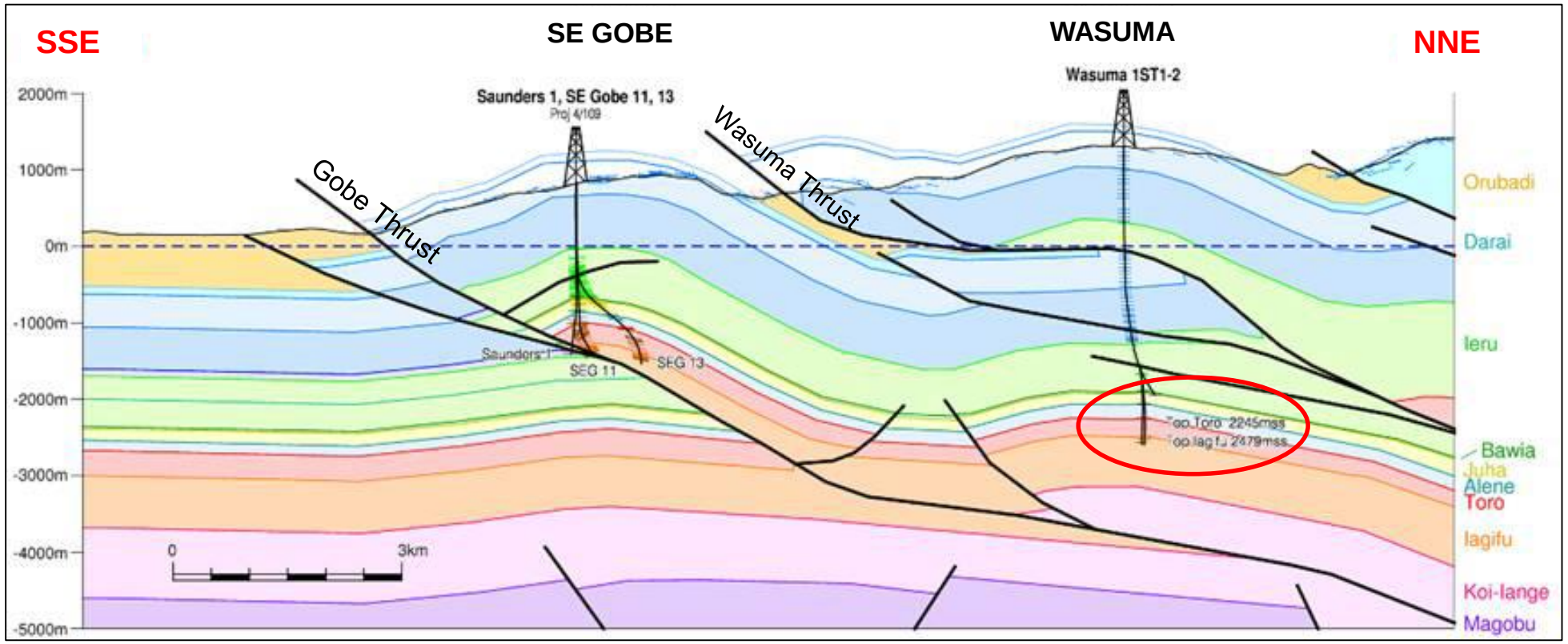
Parish (2015)

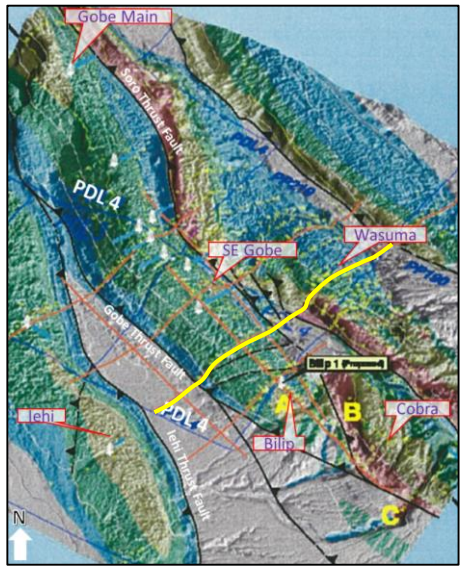


Fault propagation folding model

- Near vertical forelimb with folded & overturned back-thrusts
- Similar forelimb structural styles are present from Mananda in NW to Hedinia in SE
- Structural Trap Types Tested:
  - Hangingwall √
  - Forelimb √
  - What's next, footwall?
- Toro, Digimu & Iagifu: Hydrocarbon bearing

SE PFTB – Gobe Field Structure





OSL

- Valid Hangingwall trap
- Deeper Footwall trap
  - Toro/Iagifu: water bearing (Gobe Footwall-1)
- No valid Hangingwall trap
- Footwall trap valid (Wasuma Deep)
  - Iagifu sandstone charged
- Potential Reservoirs
  - Iagifu – oil/gas
  - Toro
  - Digimu
  - Hendinia
  - Koi-Iange

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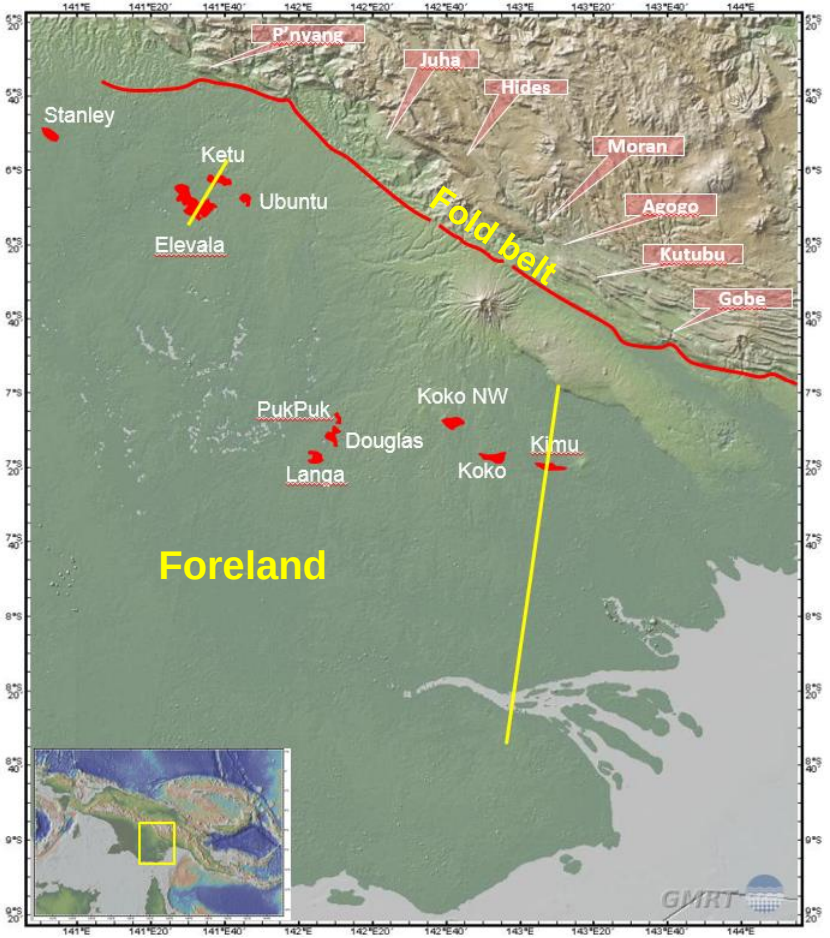
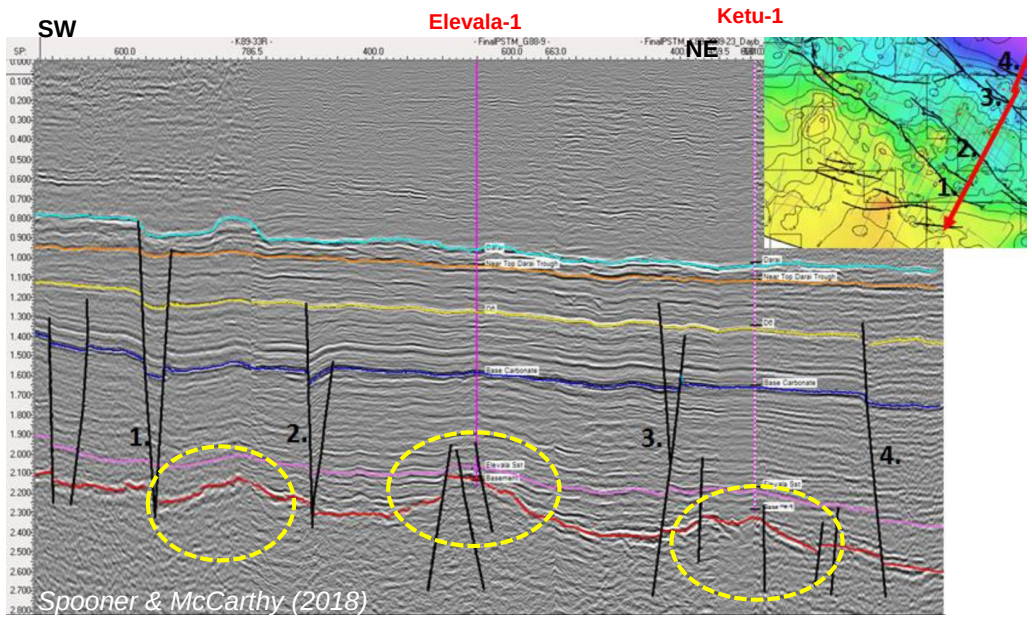
Papuan Foreland – NW and SE Gas Field Structures



GeoMapApp (http://www.GeoMapApp.org)

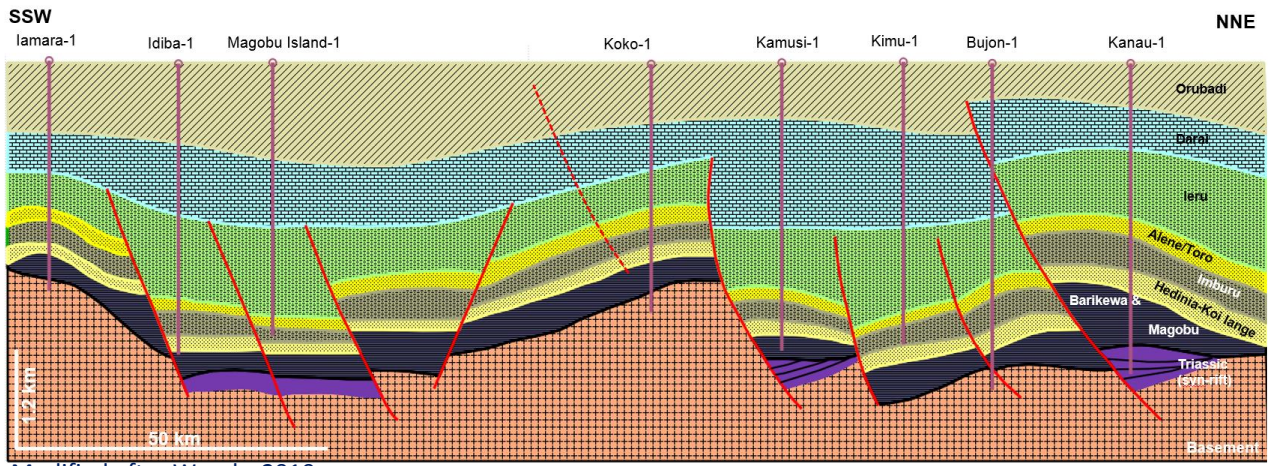


Structural style

- Low relief faulting anticlines
- Onlap Pinchout structure?
- Roll-over anticlines?

Reservoirs

- Elevala
- Alene
- Toro
- Hendinia
- Kimu



Modified after Woods, 2010

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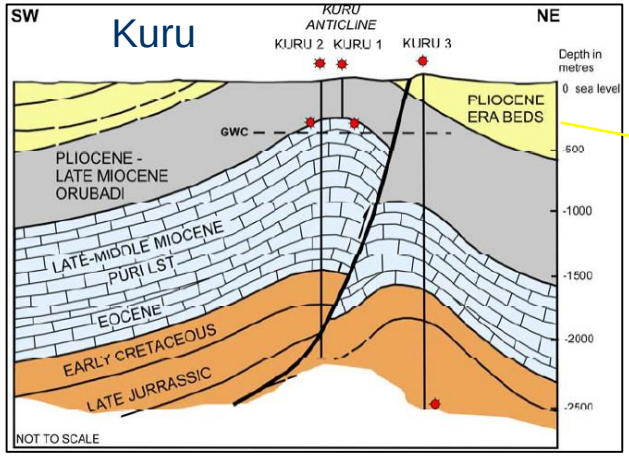
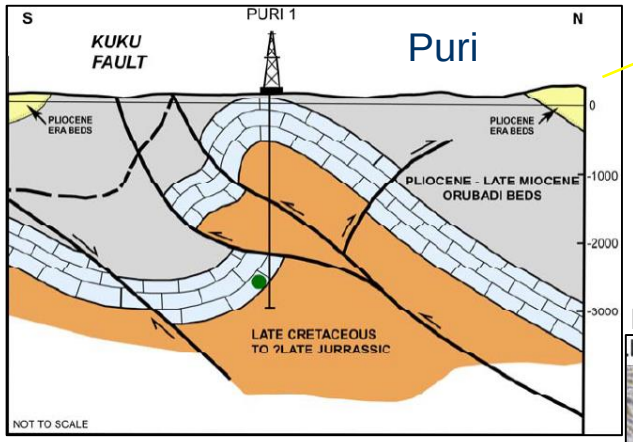
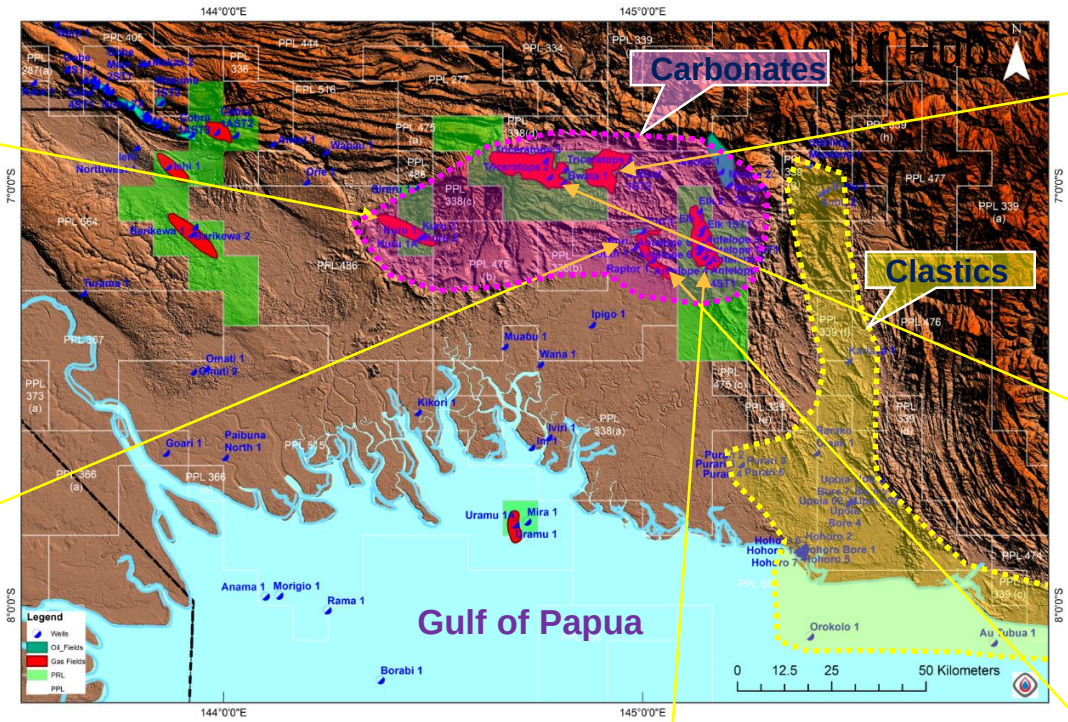
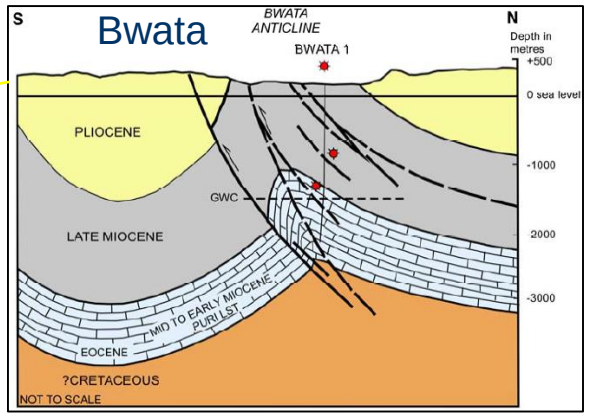
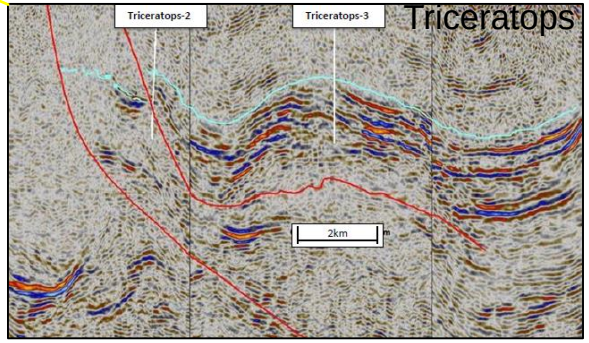
Aure FTB Hub Gas Fields Structures

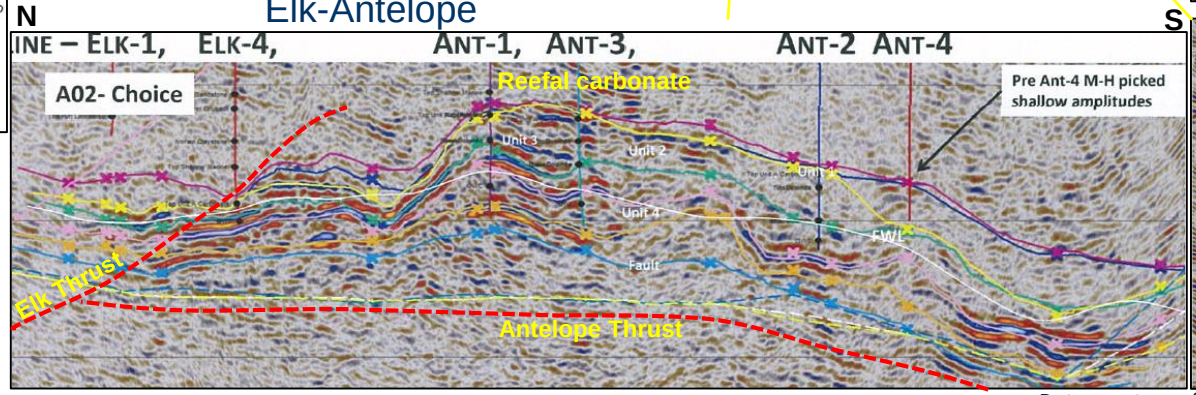


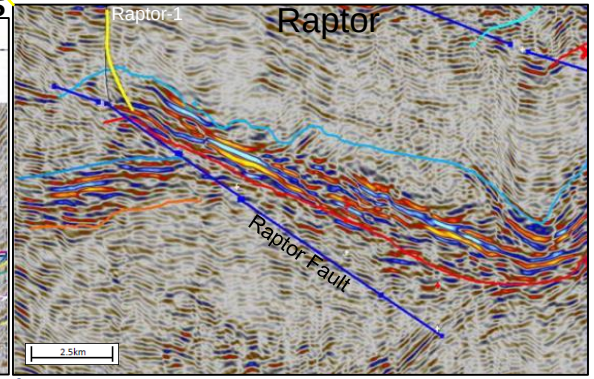












Data courtesy of PRL 15 CoV

» Structural style

- Thrust fault anticline traps common in NNW
- Miocene Carbonate plays
- M-L Miocene Clastic plays in SSE

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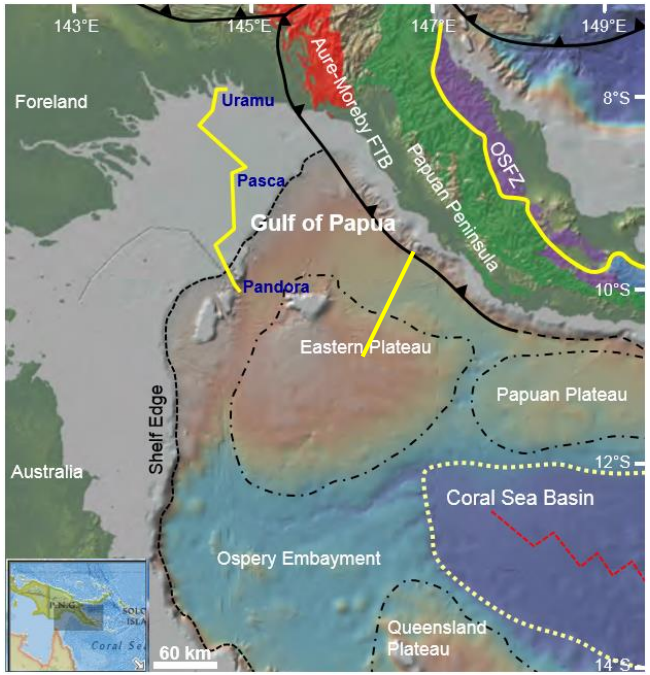
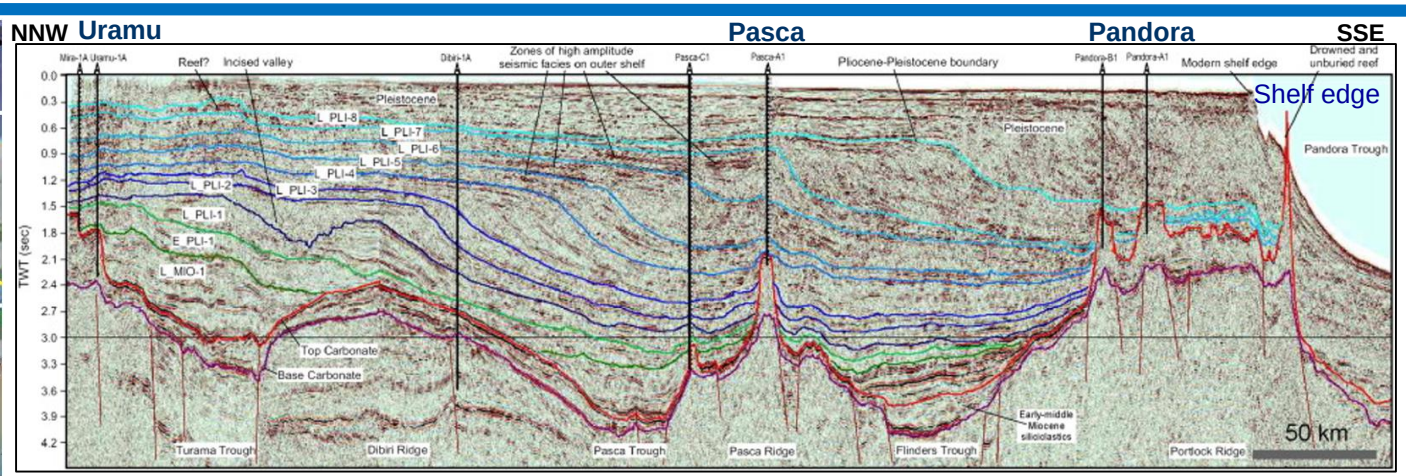
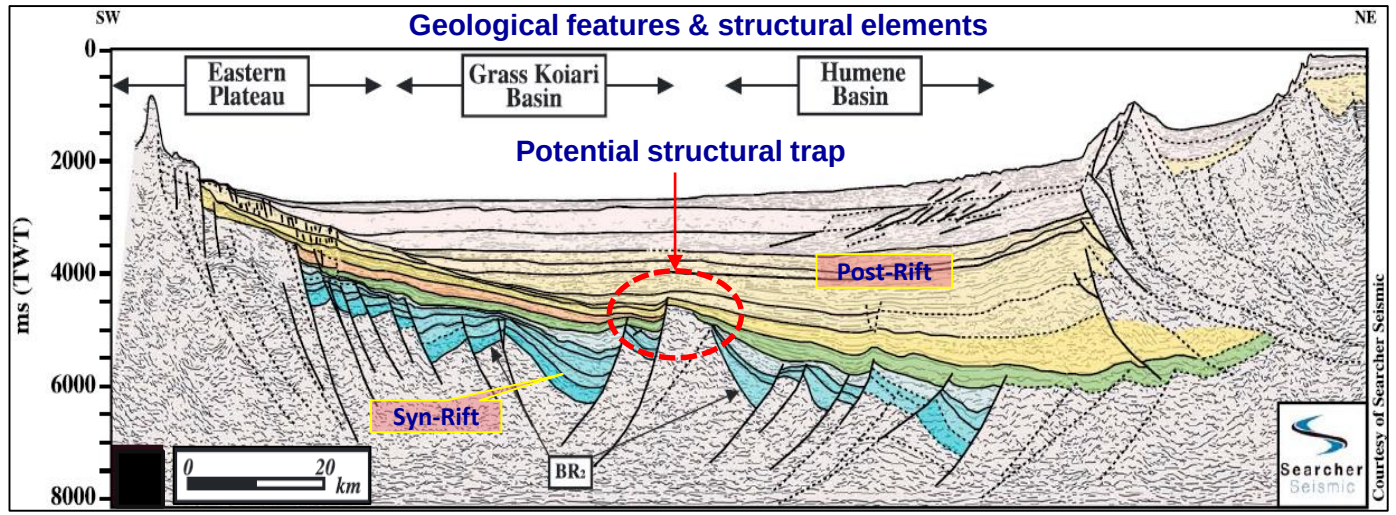
Gulf of Papua – Shallow and Deep-Water Structures

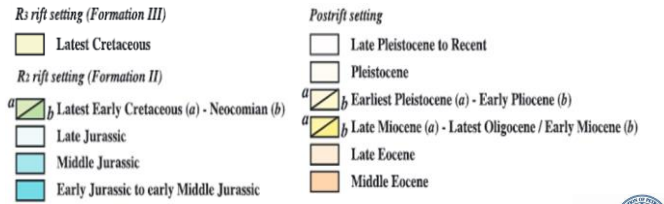


GeoMapApp (http://www.GeoMapApp.org)





Bulois *et al*. (2017)



» Robust faults and structural style present in the deep-water

» **Structural style**

- Miocene reefal carbonate build-ups on faulted basement highs
- Potential for other structural plays to exist – yet to identify (e.g. faulted carbonates, onlap/unconformity structures)

» **Reservoir play types**

- Reefal & Platform Carbonates – Miocene
- Turbidite clastics -– Pliocene-Pleistocene

» **Much of the region remains under explored**

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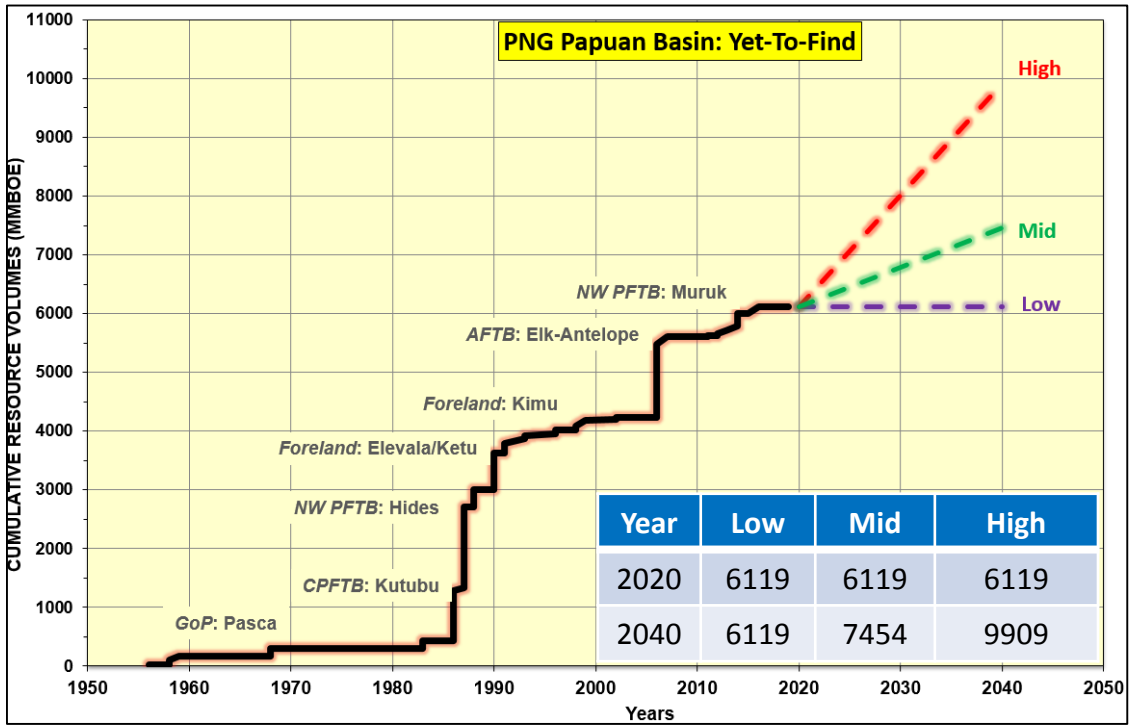
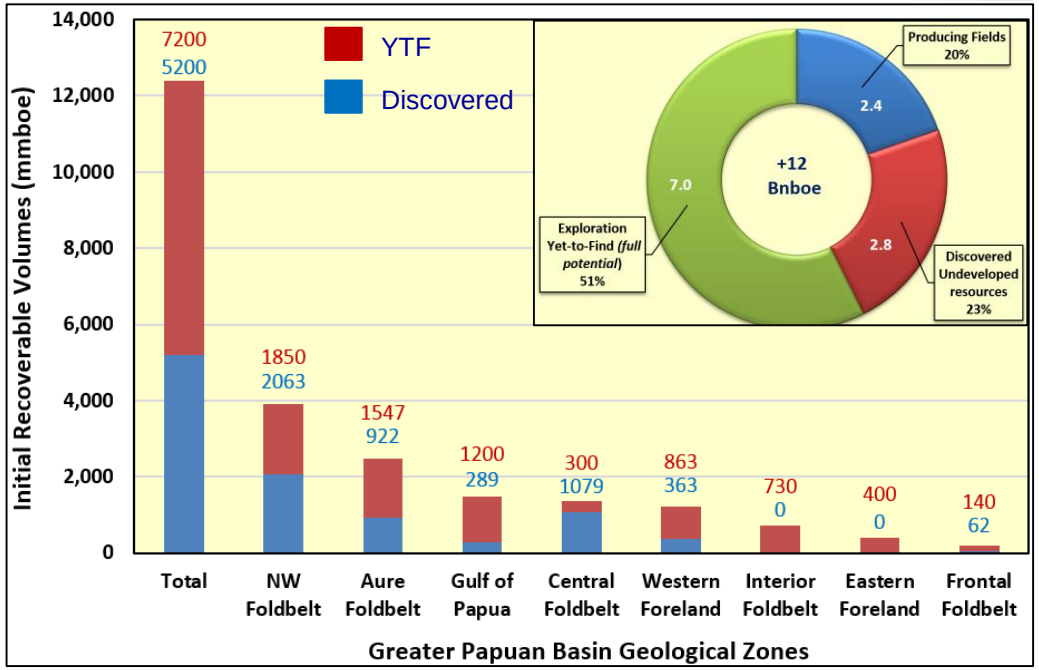
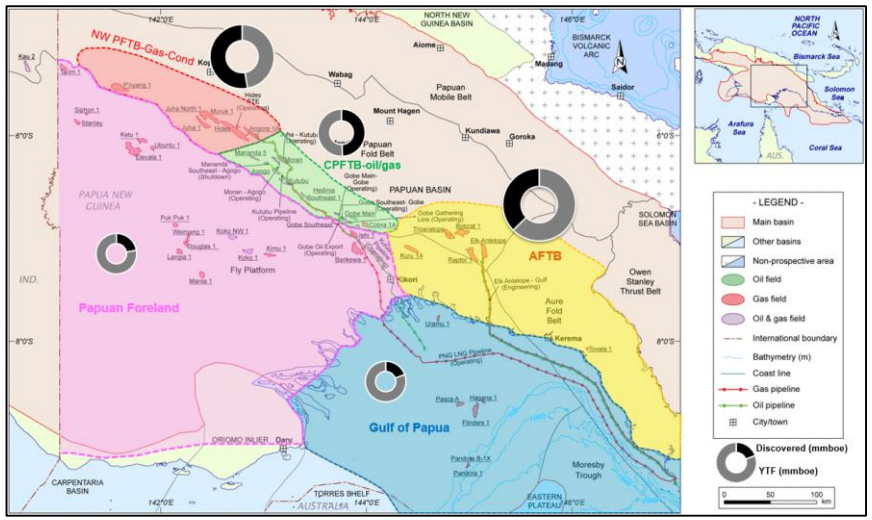
Papuan Basin Yet-To-Find ("YTF")



Year	Low	Mid	High
2020	6119	6119	6119
2040	6119	7454	9909



Data from OSL 2017



» **Potential for future Discoveries:**

- Fields of various sizes remain YTF
- Giant fields are likely

» **High Prospectivity in:**

- NW Fold belt
- Aure Fold belt
- Offshore
- Central fold belt

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Concluding Summary

- **Papuan FTB:**
  - Lateral changes in structural styles from P'nyang in NW to Gobe in SE
  - Hangingwall anticline traps are mostly successful
  - Forelimb overturned faulted blocks are valid traps in Kutubu Fields (Mananda–SE Hedinia)
- **Foreland:**
  - Basement involved low relief faulted anticline structural traps are common across the Papuan foreland
- **Aure TFB:**
  - Thrusted platform and reefal Miocene carbonates are the main reservoir plays in the NNW
- **Offshore GoP:**
  - Miocene reefal carbonate build-ups on faulted basement highs in the shallow waters
  - Pliocene turbidite clastic deposits
  - Robust faults and structural styles present in the deep-water
- **Potential for future Discoveries – YTF:**
  - Fields of various sizes remain YTF and changes of giant fields are likely
- **Exploration Upside high in:** NW Fold belt, Aure Fold belt and Offshore

Thank You

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