Geology and Tectonic Evolution of Bird Head Region Papua, Indonesia: Implication for Hydrocarbon Exploration in the Eastern Indonesia*

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Abstract

The Bird Head Region is located in the western part of Papua Island and is one the most geological complex regions in the eastern part of Indonesia. This region is known as one of the most hydrocarbon prolific areas in Indonesia. Two major oil and gas producing basins were discovered in the region namely the Salawati and Bintuni Basins. Numerous work and publications have been done in the area to ramification geologic history of the region. However, the geology and structural evolution of the region are poorly known due to limited data over the region, particularly in relation to hydrocarbon distribution. In addition, several recent results of exploration drilling have generated major disappointment for continuity of future exploration in the region. One of the main problems is related to the origin and tectonic evolution of the Bird Head Region. This paper is presenting results of the ongoing study in ramification of the problems using tectono-straigraphy approach generated from integrated fieldwork and subsurface data evaluation (2D seismic and well data).

There are several different published proposed models of the origin of the Bird Head Region. However, most of the models were not supported by enough subsurface data. Understanding stratigraphy from various different locations within the region and detail structural evolution is one of the most important tasks in solving the origin of Bird Head. Our newly proposed model generated from conducting numerous 2D and 3D palinspatic reconstructions from several different locations in the regions using integrated surface and subsurface geological information. It is clear that deformation of the region varies from area to area indicating that the region experienced several translations and rotations during their history. Using structural reconstructions we developed several

representative paleogeographies of the region showing distribution of Jurassic and Tertiary reservoirs including their petroleum system. Hopefully, our new model can help in locating new exploration target areas.

Selected References

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GEOLOGY AND TECTONIC EVOLUTION OF BIRD HEAD REGION PAPUA, INDONESIA: IMPLICATIONS FOR HYDROCARBON EXPLORATION IN THE EASTERN INDONESIA

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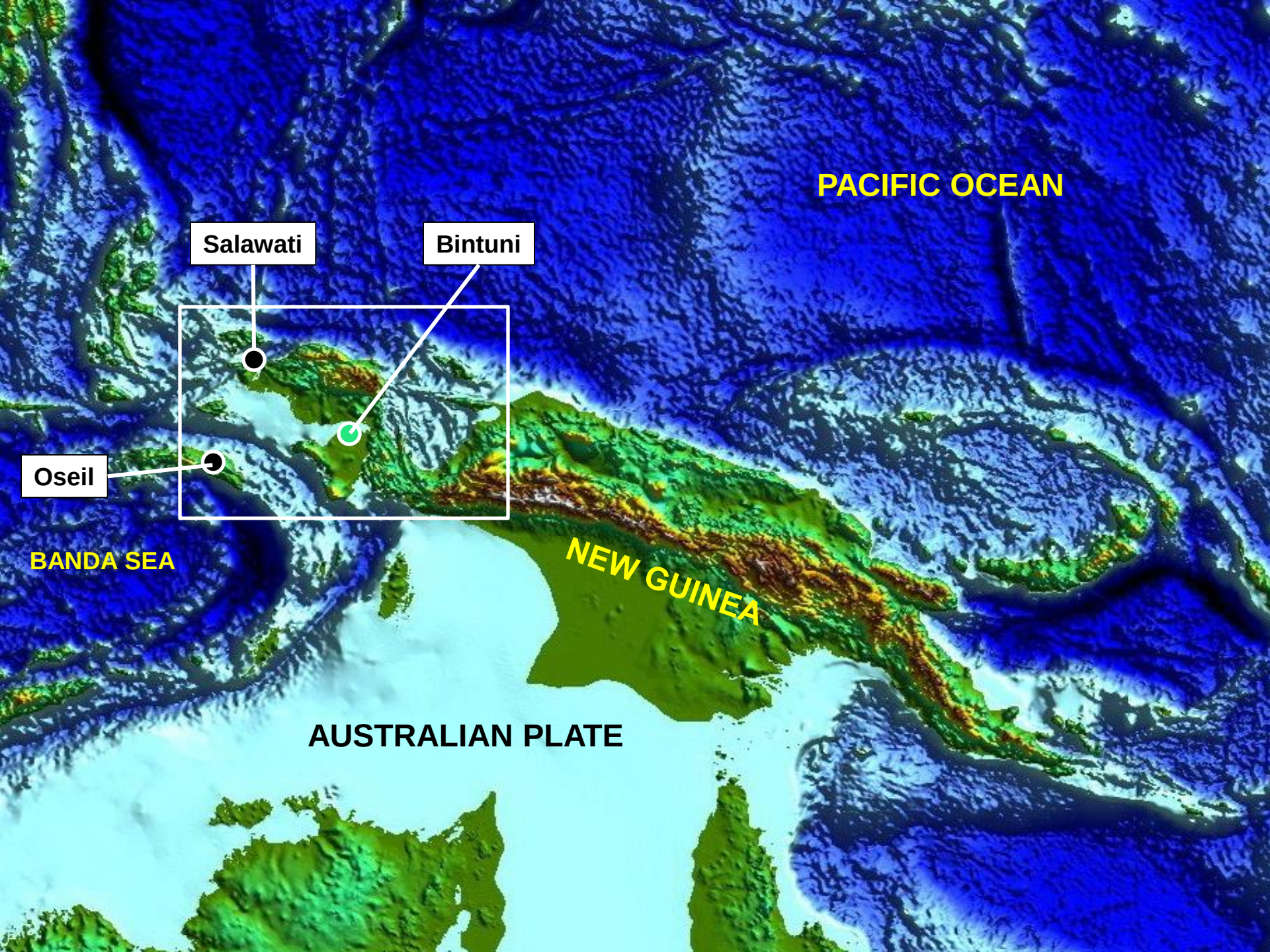

PACIFIC OCEAN
Salawati
Bintuni
Oseil
BANDA SEA
NEW GUINEA
AUSTRALIAN PLATE

Overview of Problems

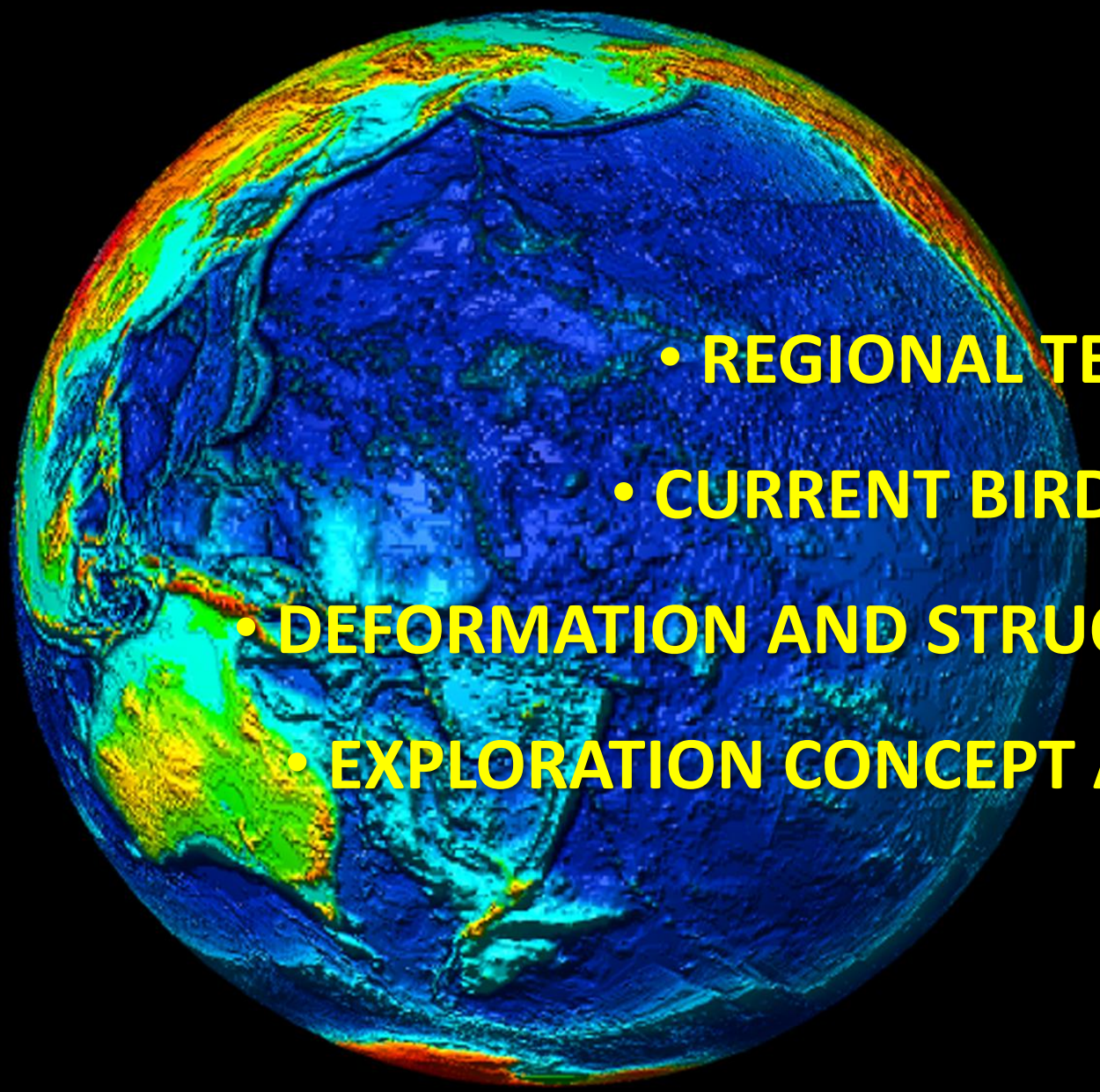
- **Eastern Indonesia is tectonically and structurally extremely complex, comprising slivers of continental blocks, arc fragments and trapped ocean basins.**

- **Many potential petroleum basins are recognized; however geologically poorly understood.**

- **Origin of Bird Head ? (*Micro-continent*)**

- **The origin peculiar triangular deep embayment of the Cendrawasih Bay (Basin) are still growing debate.**

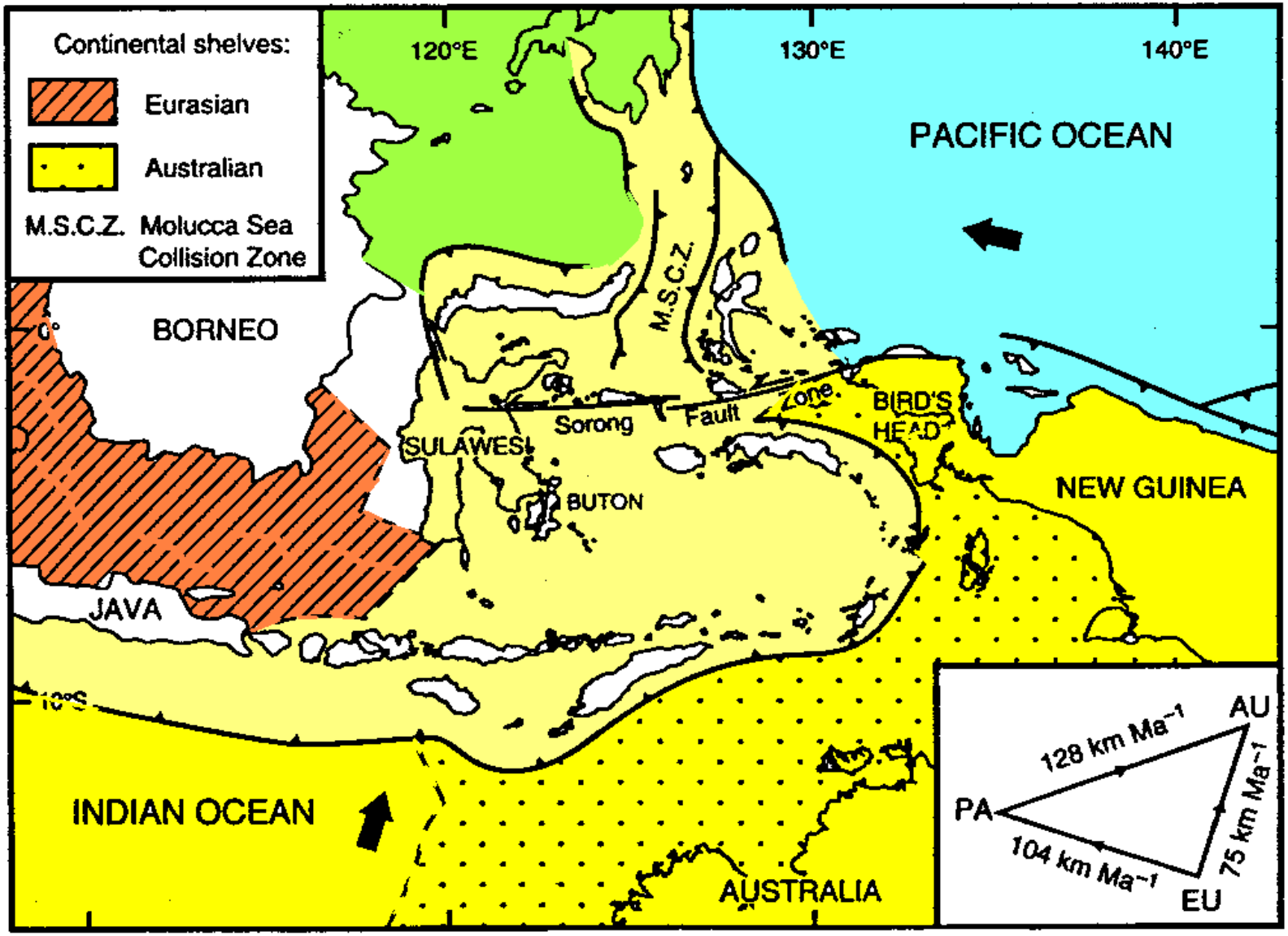
TECTONIC EVOLUTION - PALEOGEOGRAPHY



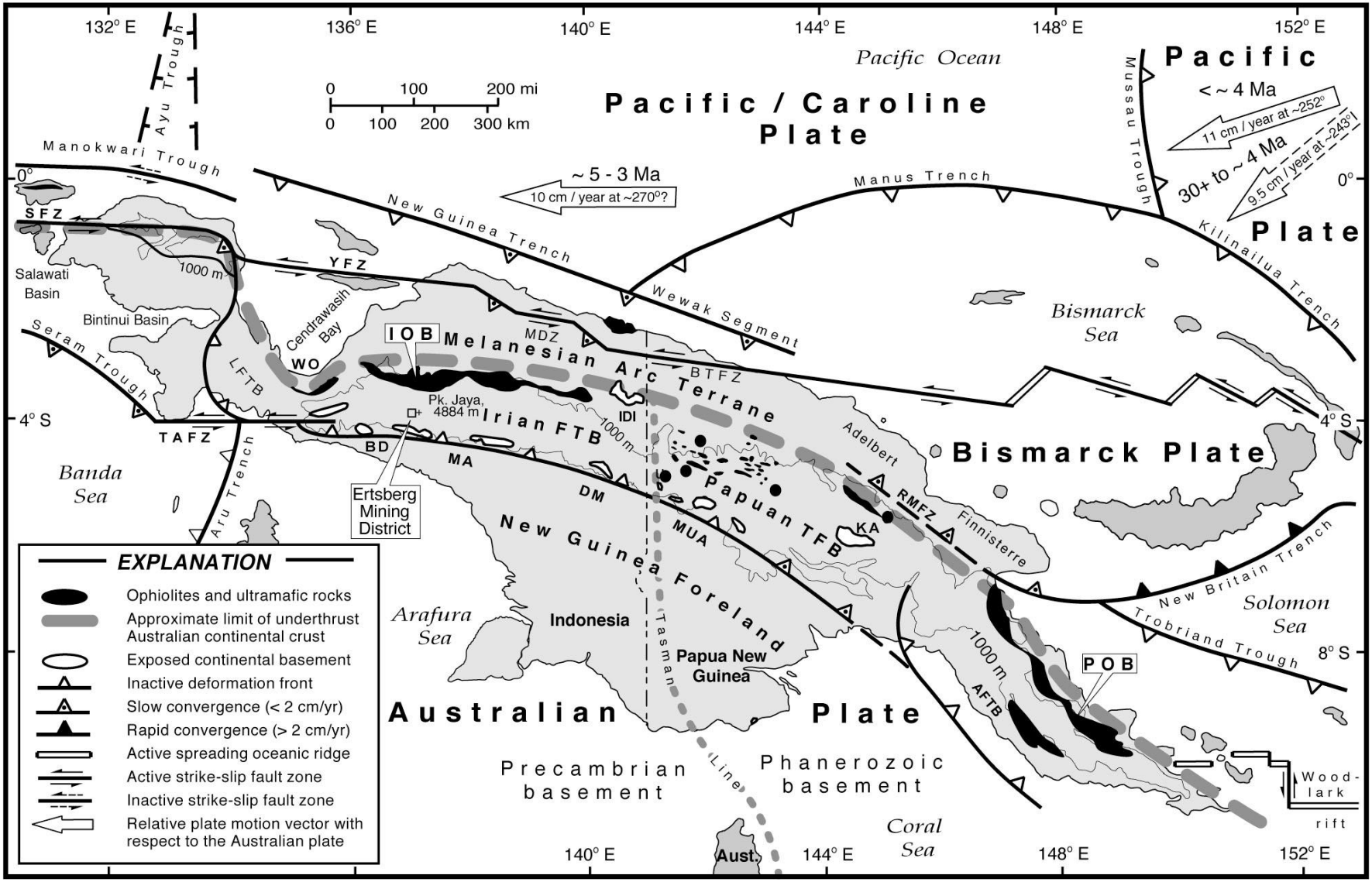
OUTLINE

- REGIONAL TECTONIC SETTING
- CURRENT BIRD HEAD GEOLOGY
- DEFORMATION AND STRUCTURAL PATTERN
- EXPLORATION CONCEPT AND DIRECTIONS
- CONCLUSIONS

REGIONAL TECTONIC SETTING

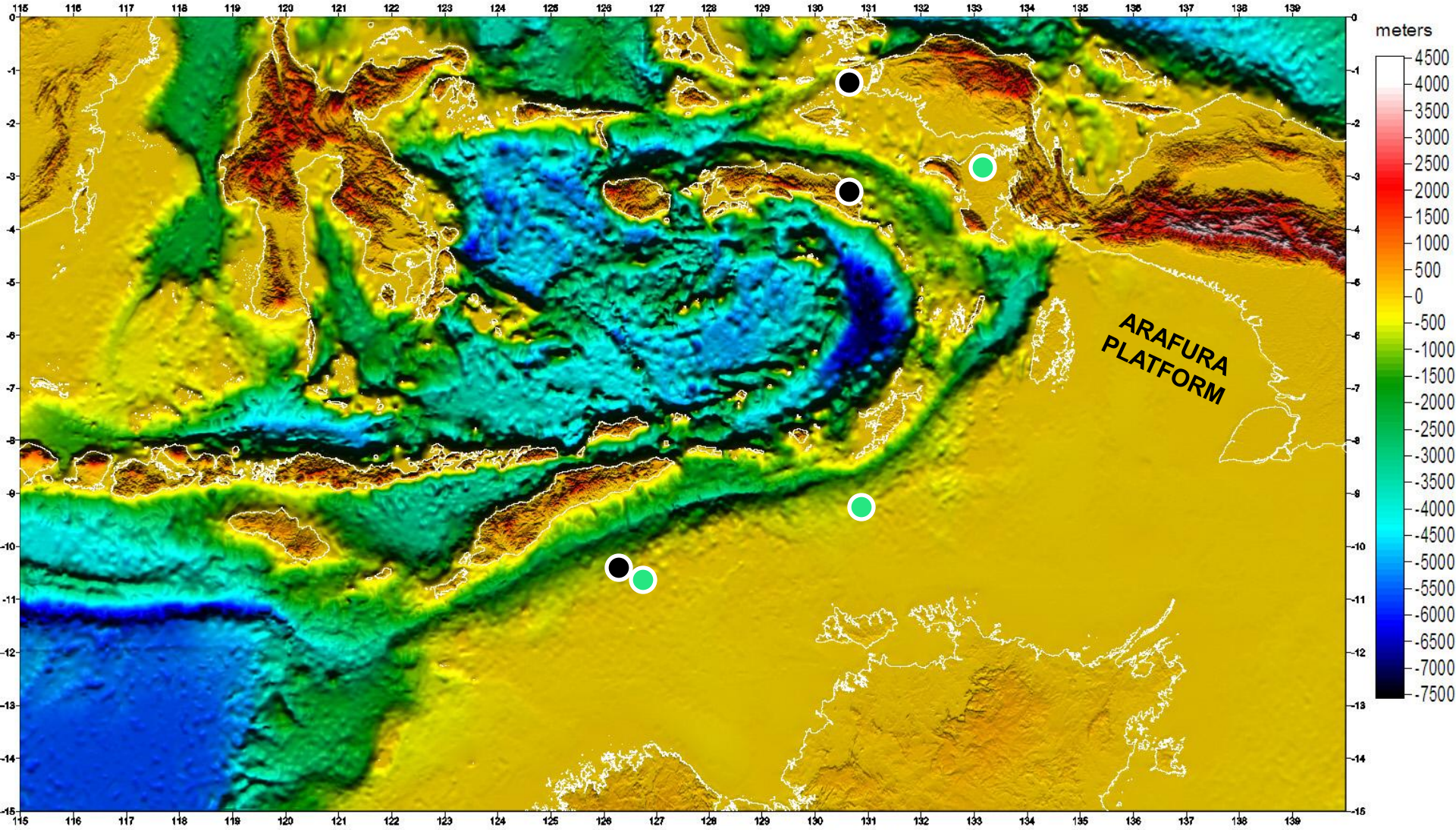


Tectonic Map of New Guinea



Sapiie (1998)

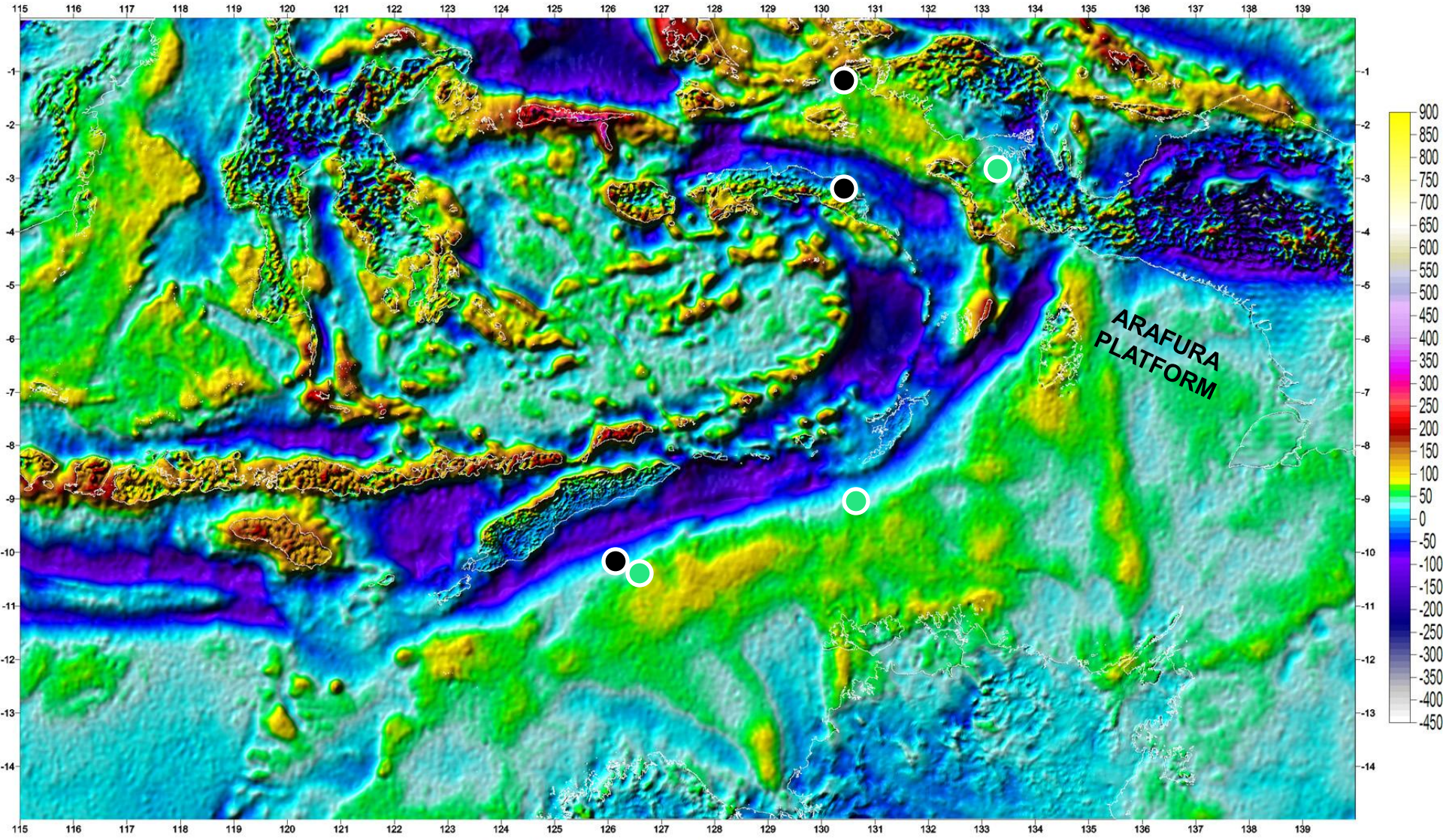
EASTERN INDONESIA TOPOGRAPHY AND BATHYMETRY



Banda Area Elevation 3D Surface.

BANDA ARC GEOPHYSICS (2011)

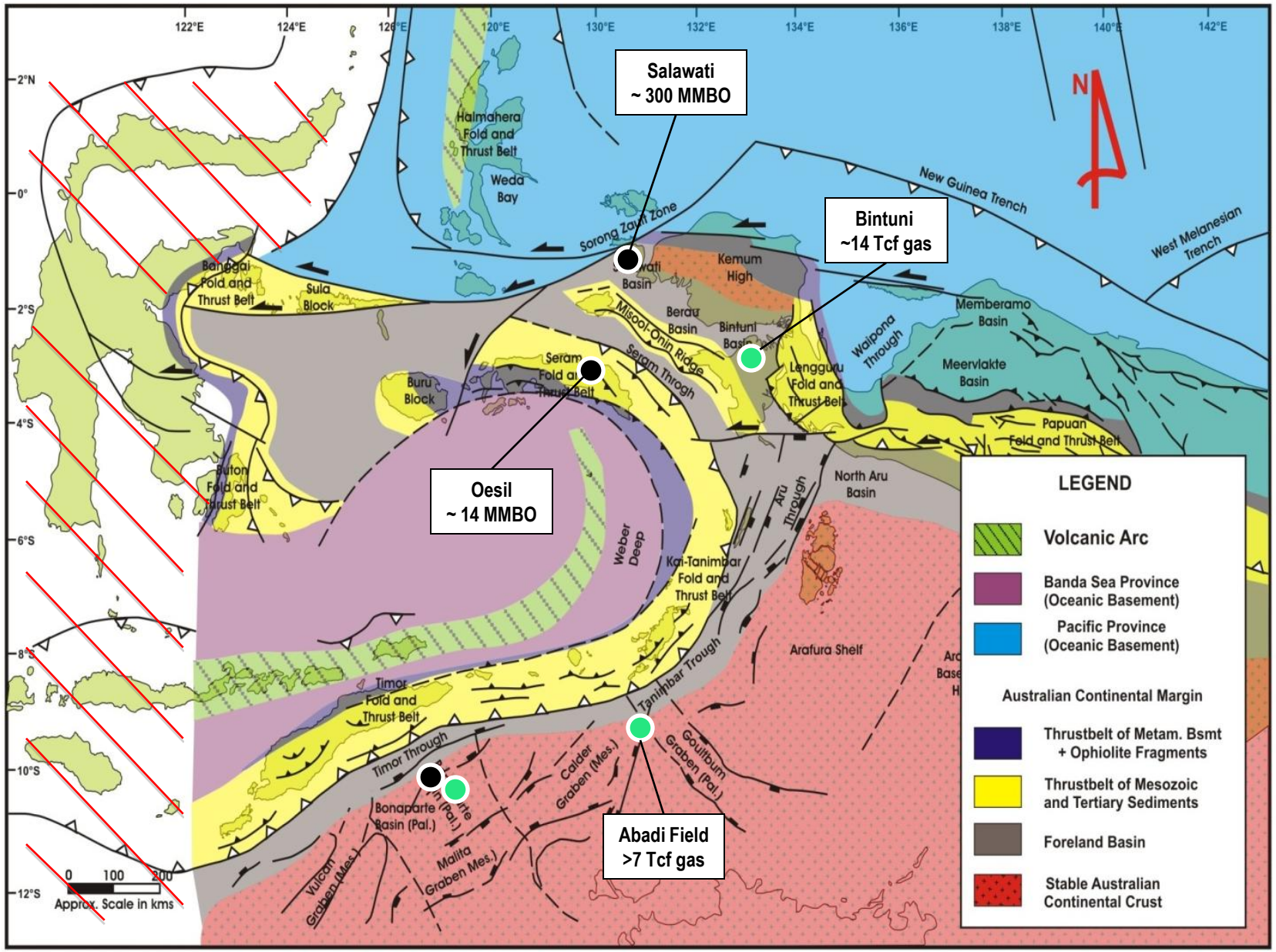
REGIONAL GRAVITY ANOMALY



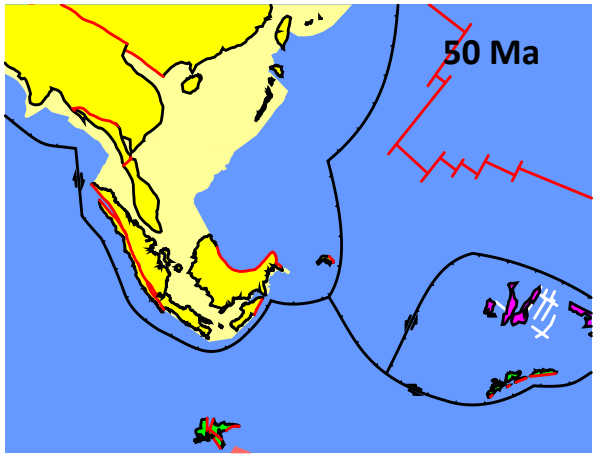
Banda area complete Bouguer anomaly on-shore,
height correction anomaly off-shore, mGals.
3D image sunlit from the NW at 45 degrees.

BANDA ARC GEOPHYSICS (2011)

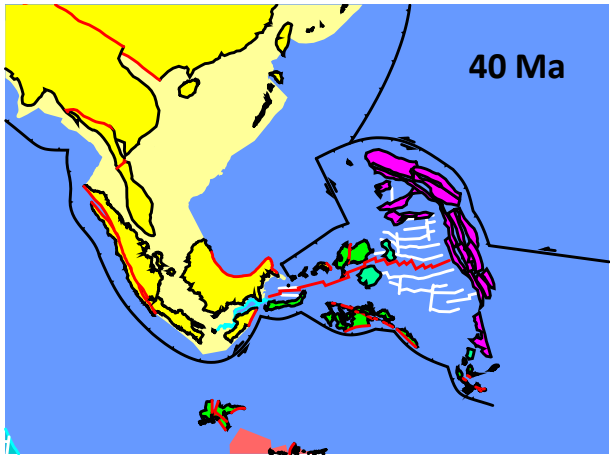
REGIONAL GEOLOGY AND HC OCCURENCES



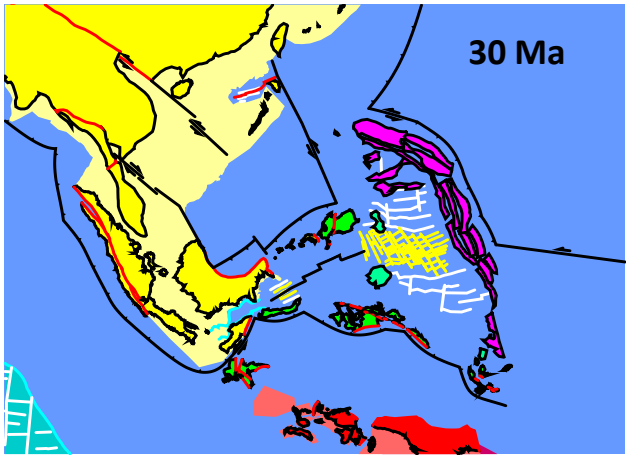
SE ASIA: Cenozoic Tectonic Reconstruction (Hall, 2004)



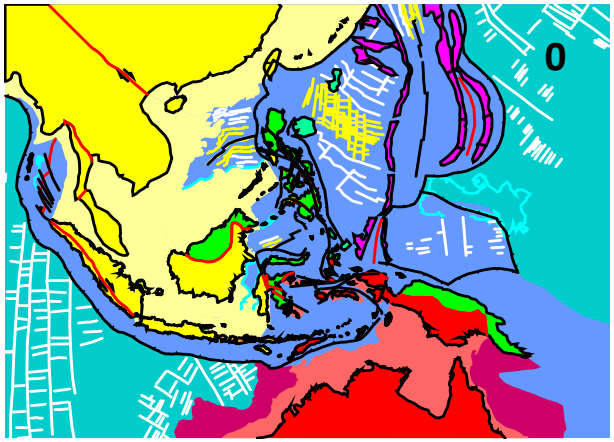
middle Eocene



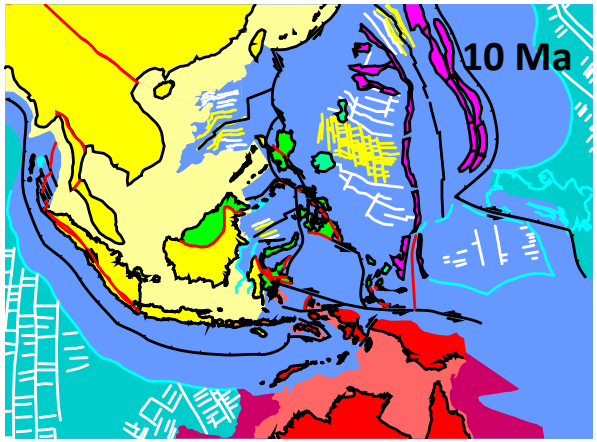
late Eocene



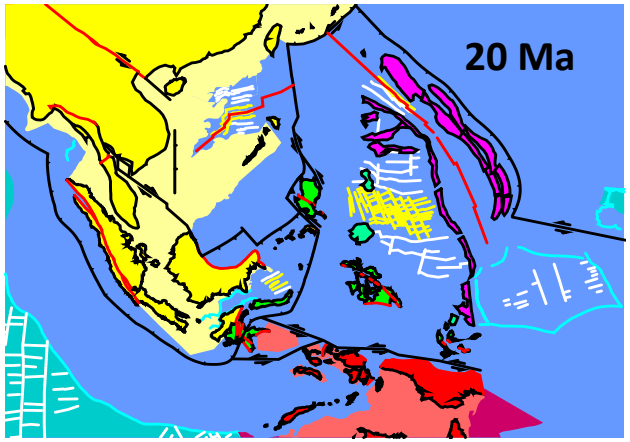
mid - Oligocene



Present

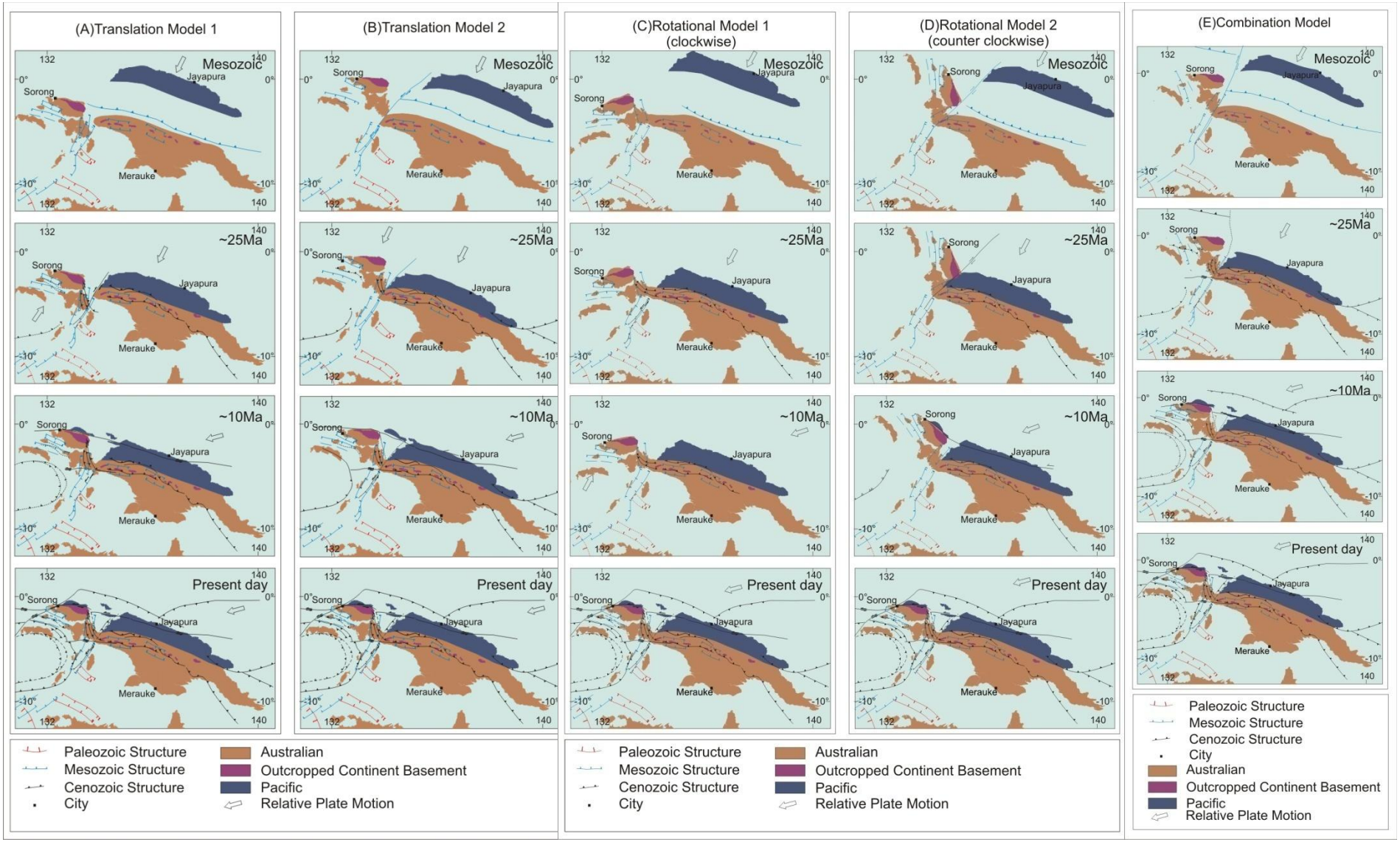


late Miocene



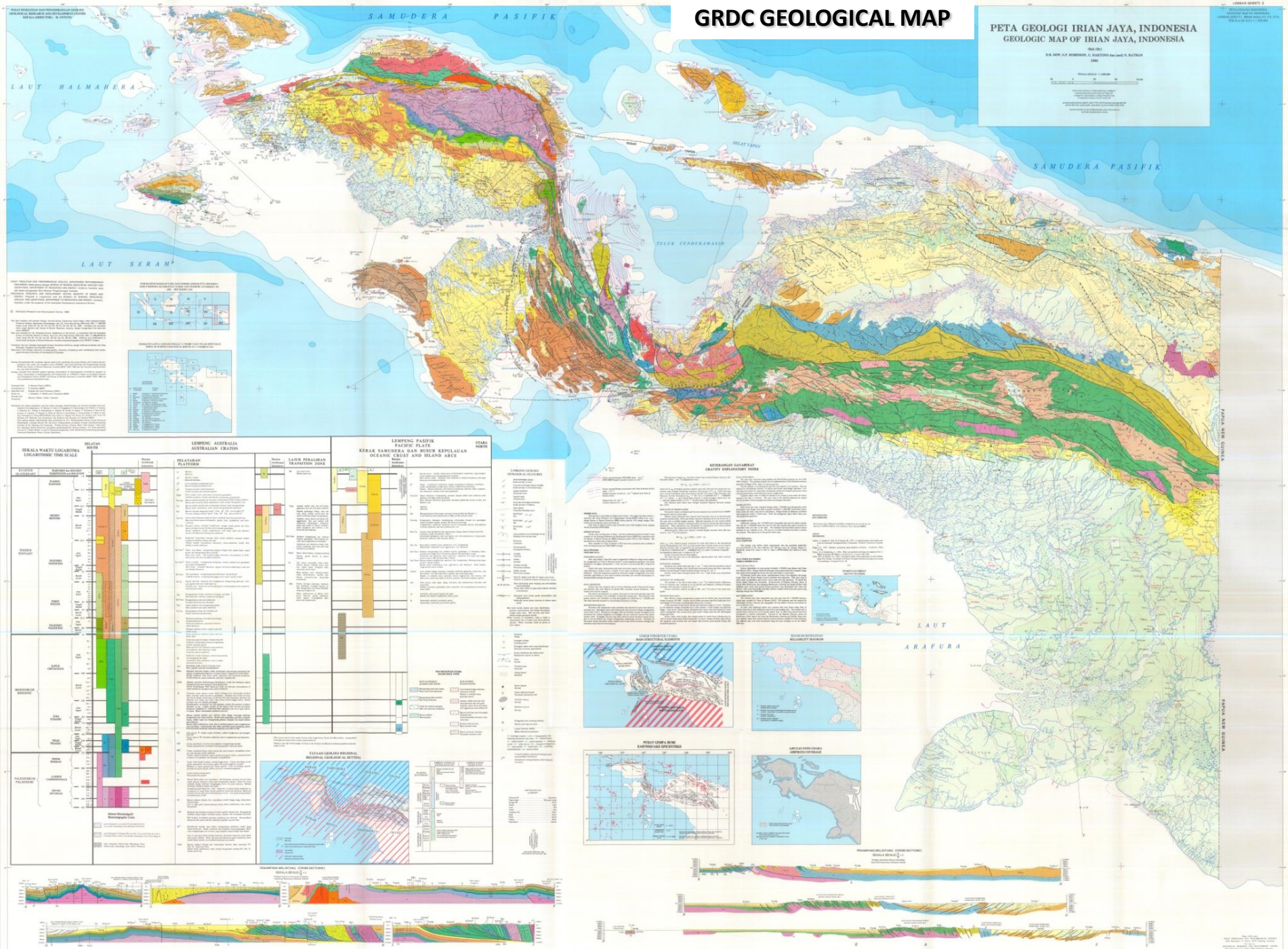
early Miocene

TECTONIC EVOLUTION OF BIRD HEAD REGION

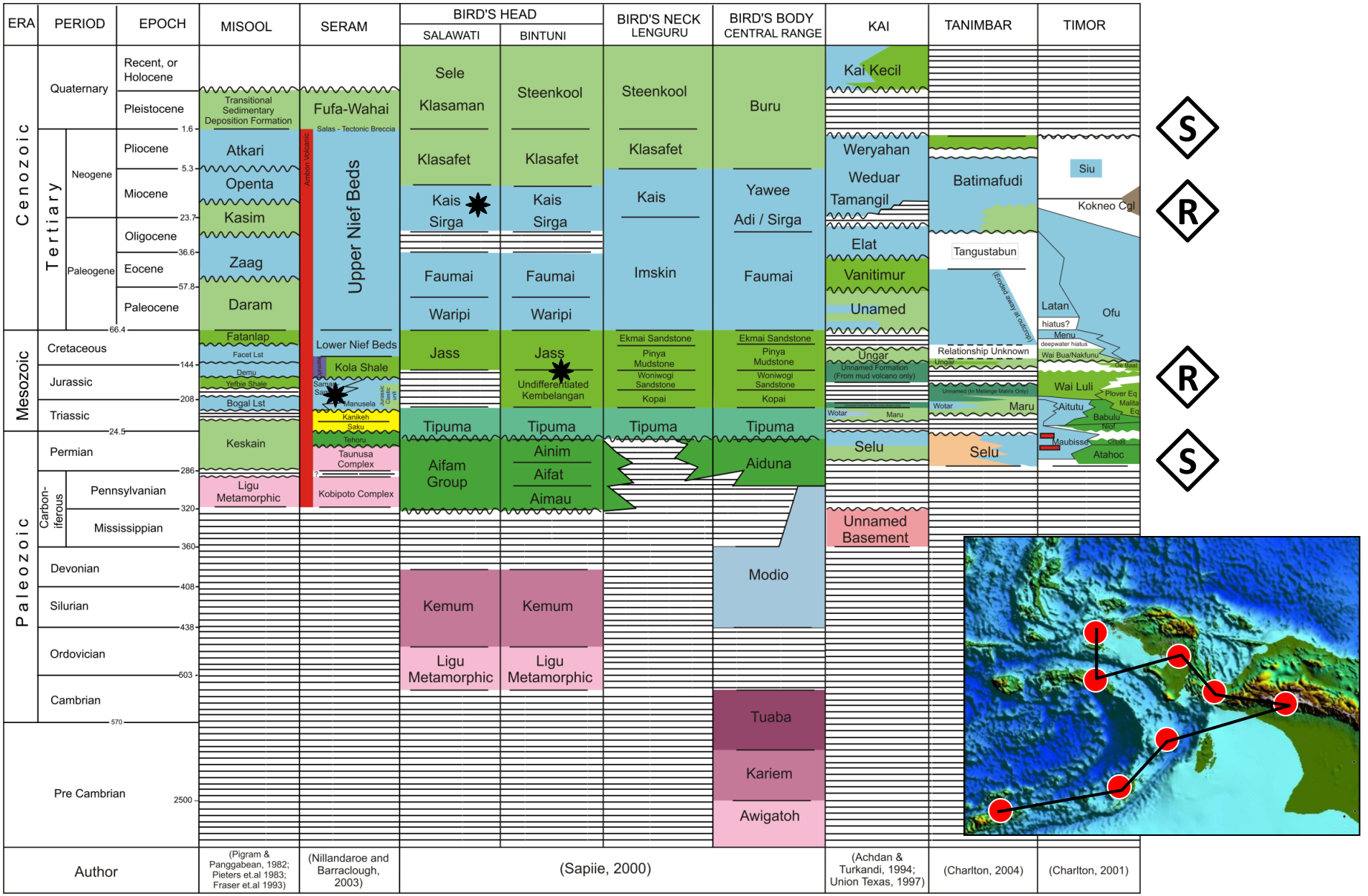


Sapiie, et. al. (2009)

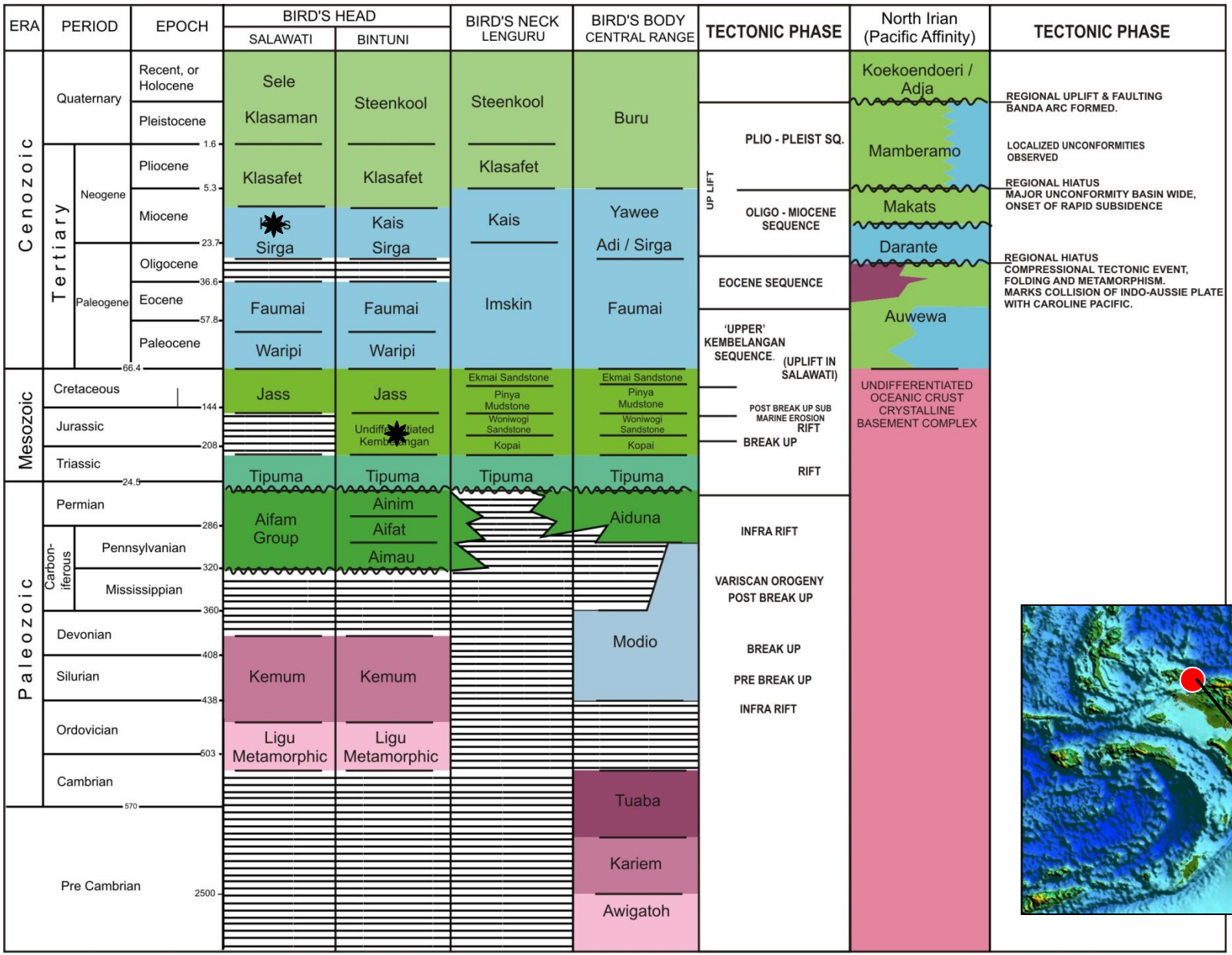
GRDC GEOLOGICAL MAP



REGIONAL LITHOSTRATIGRAPHY NOMENCLATURES



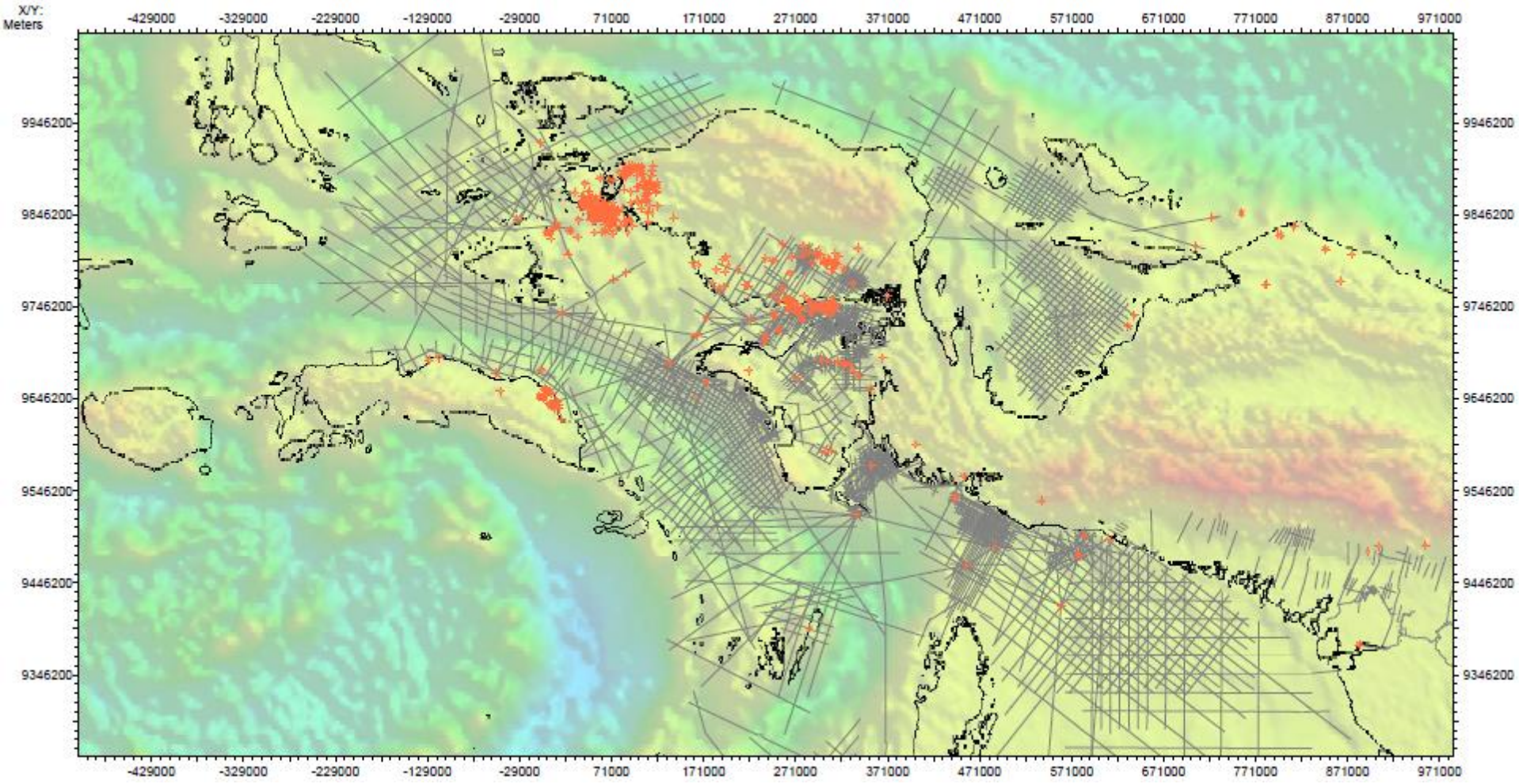
STRATIGRAPHY COMPARISON BIRD'HEAD – NORTHERN PAPUA/CWB?



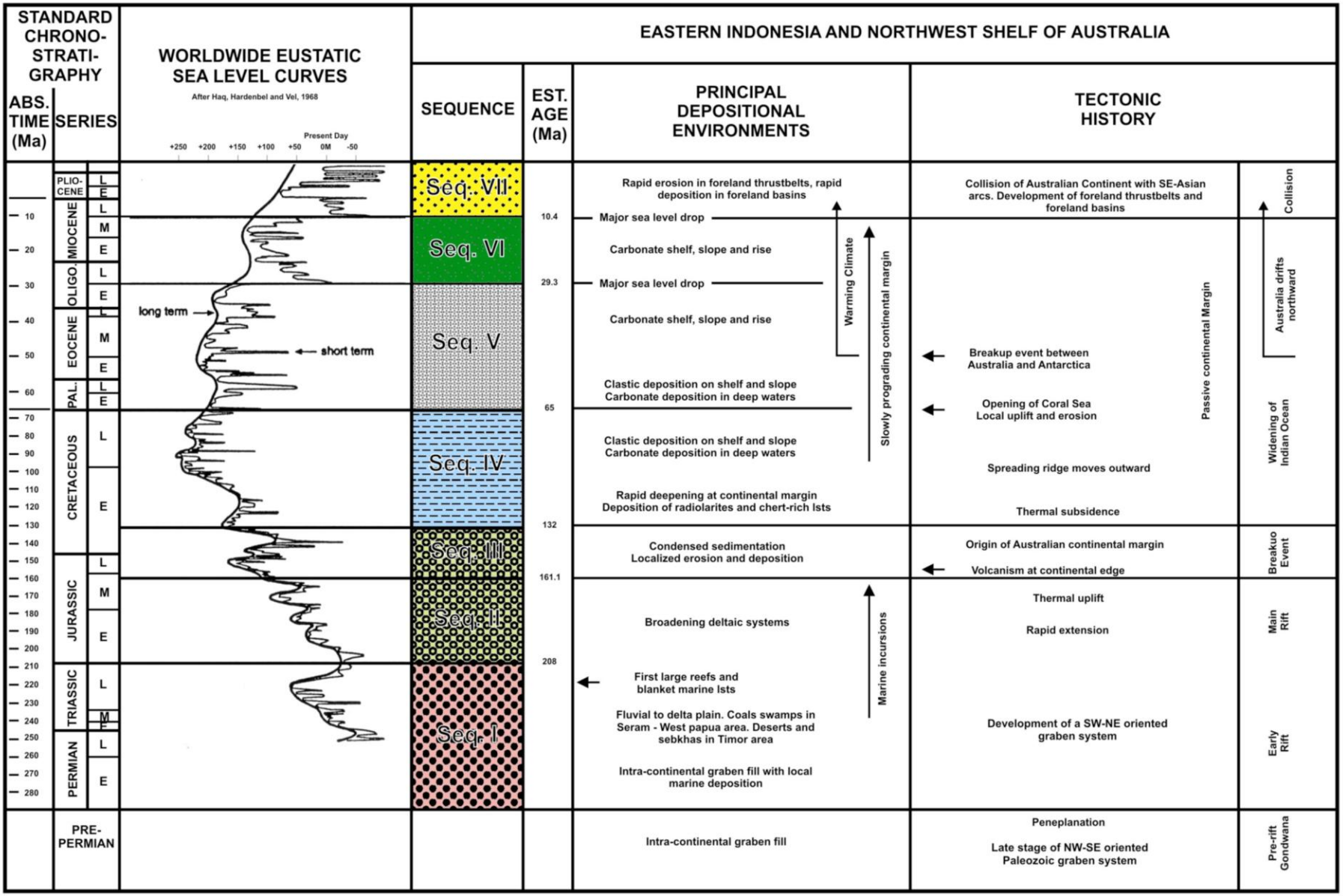
(Sapiie, 2000)

(McAdoo dan Haebig, 1999)

SUBSURFACE DATABASE OF BIRD HEAD REGION

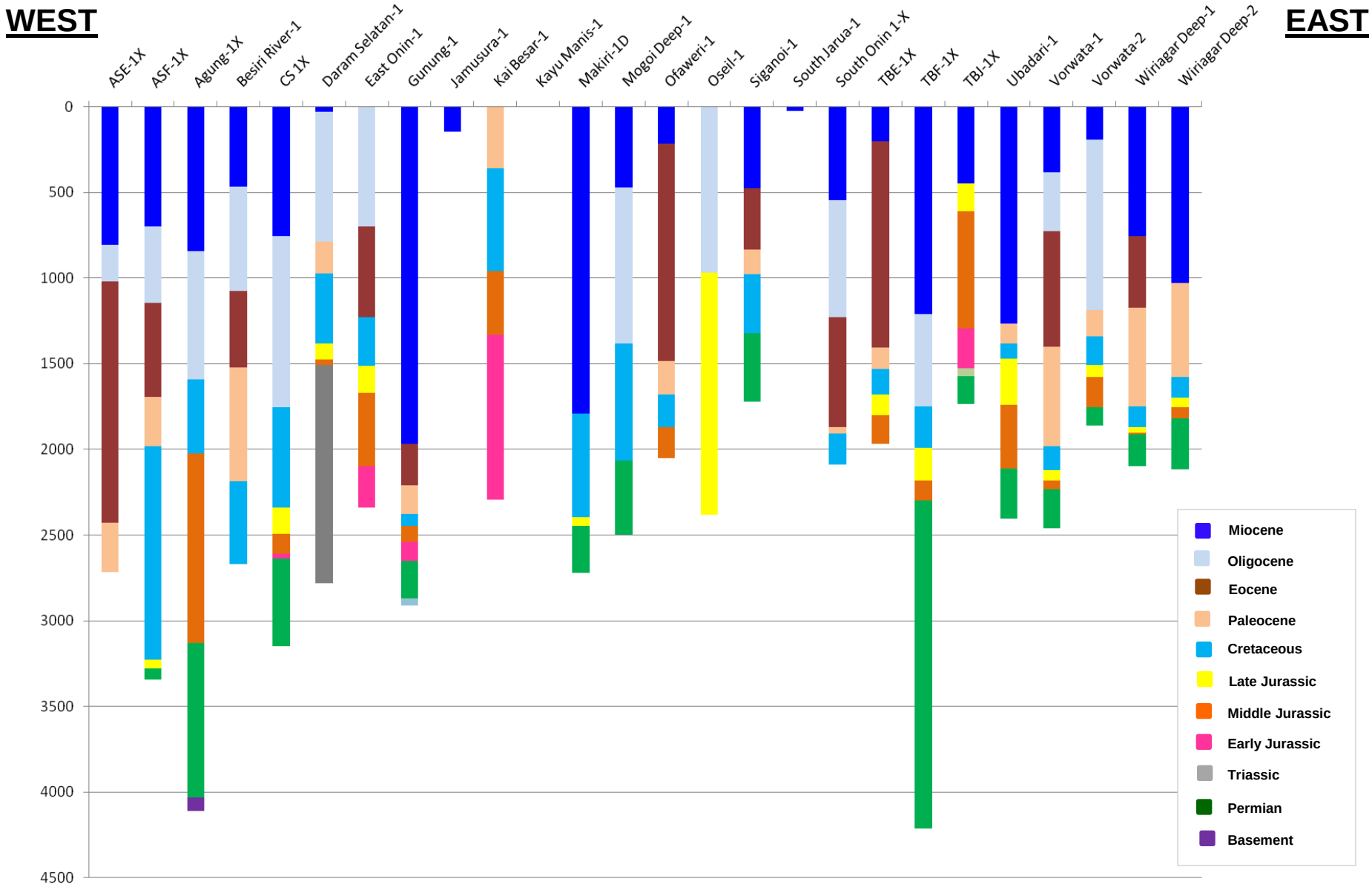


Sequence Scheme Eastern Indonesia & NW Shelf of Australia

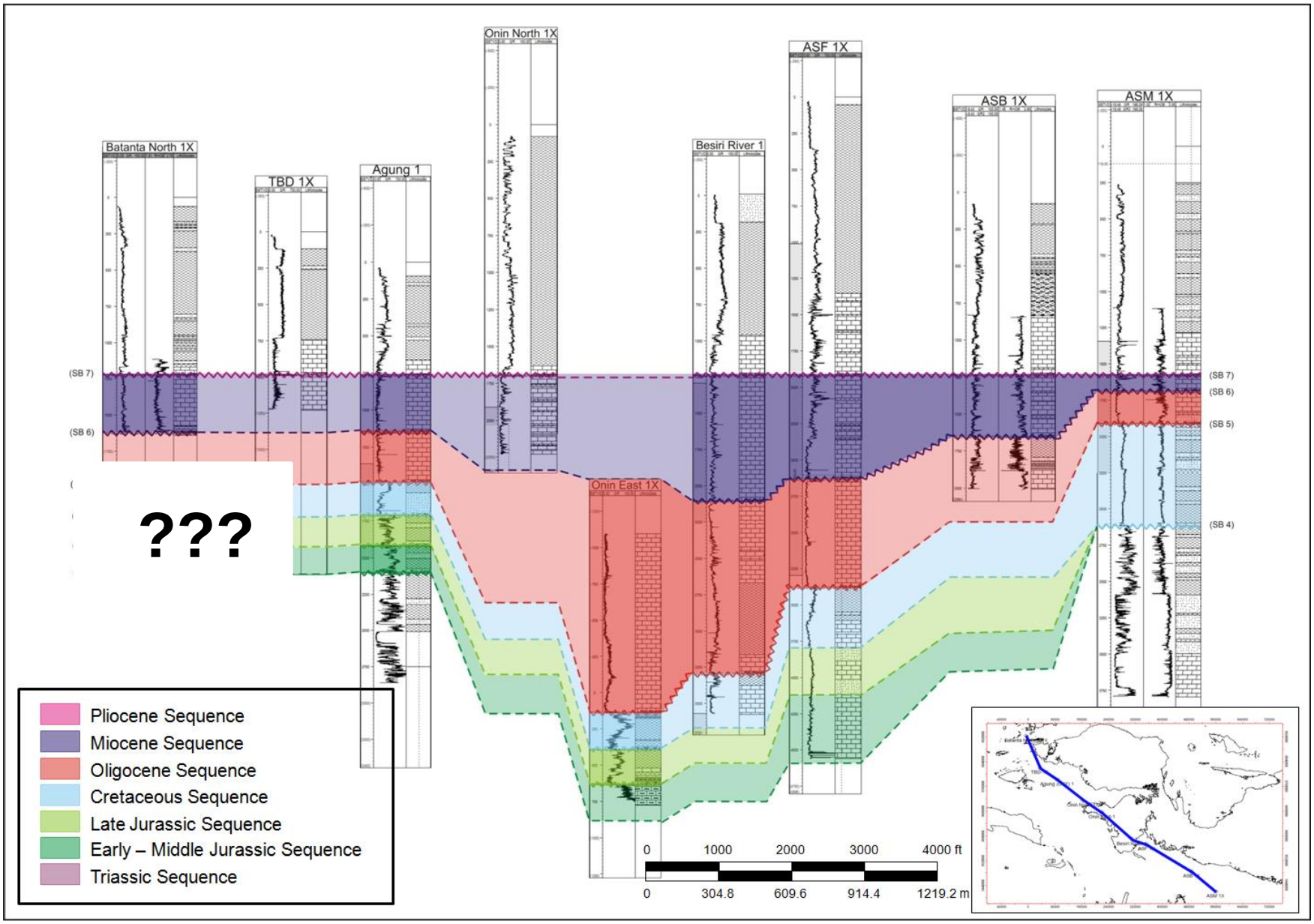


Core Laboratories / Pertamina Sequence Scheme - East Indonesia

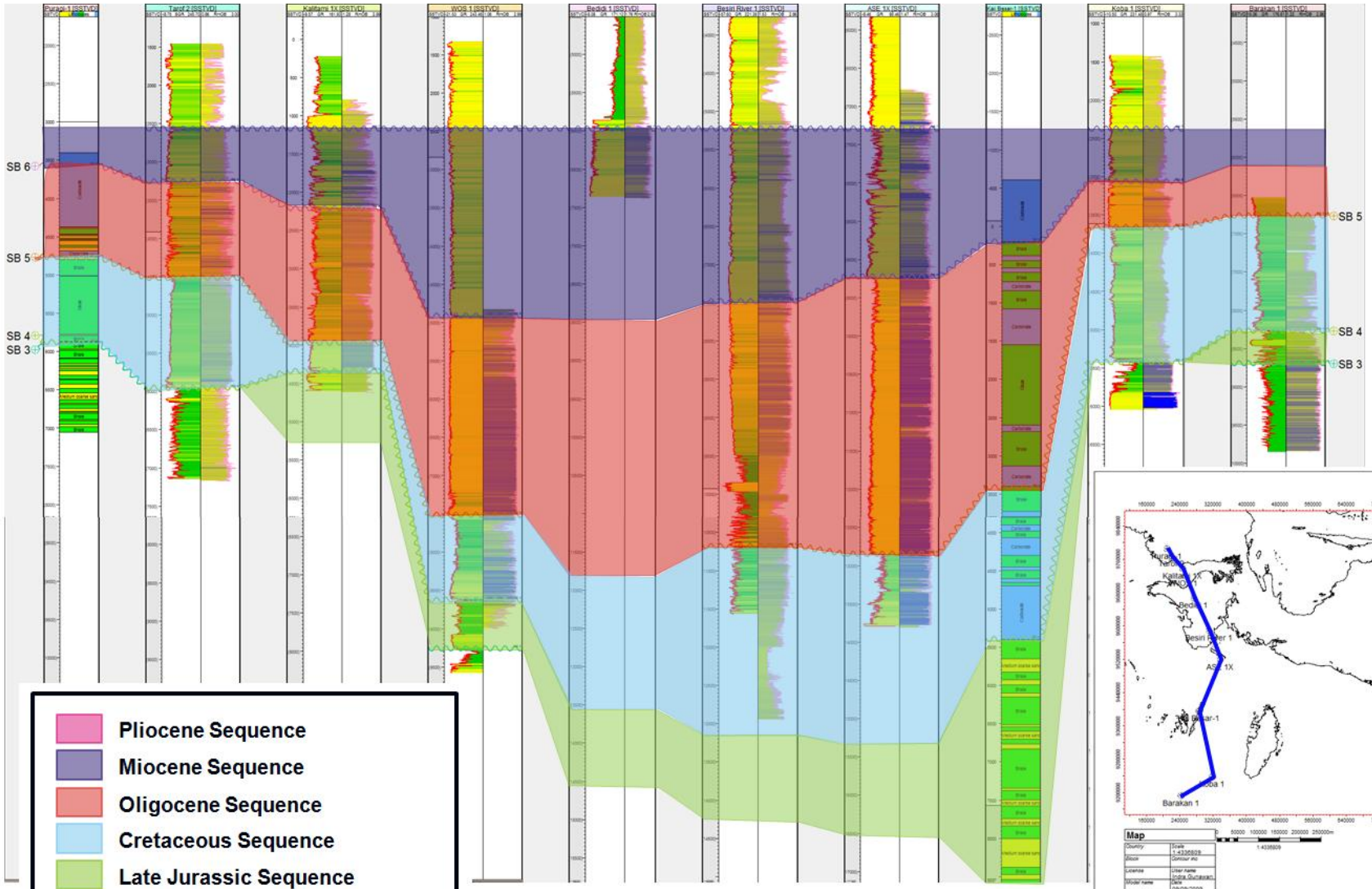
LITHOLOGY DISTRIBUTIONS IN WELL DATA



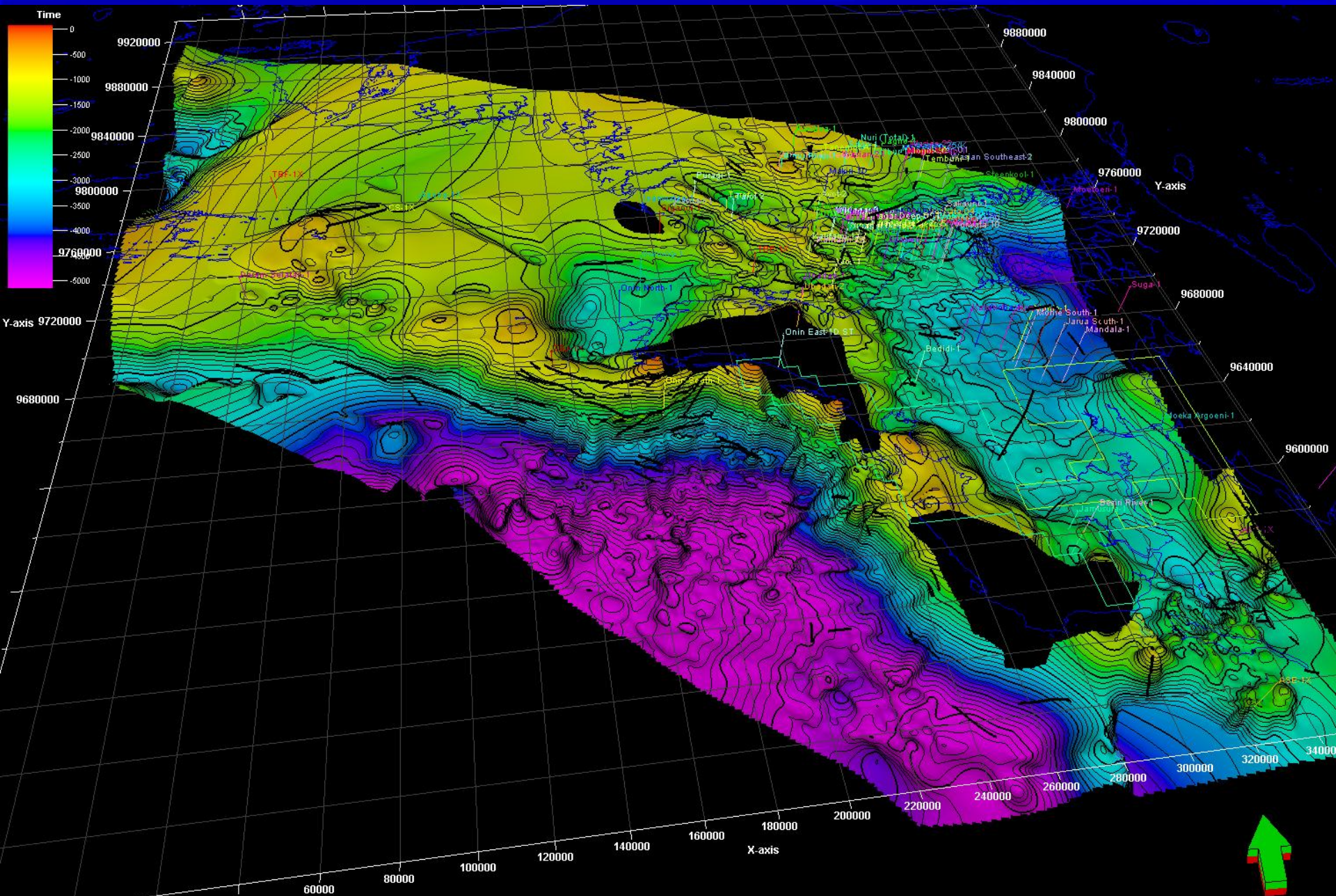
Regional Correlations



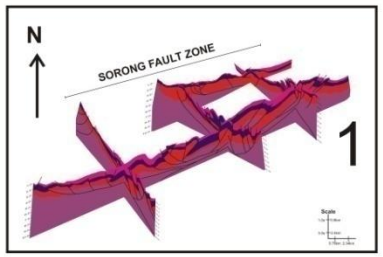
Regional Correlations

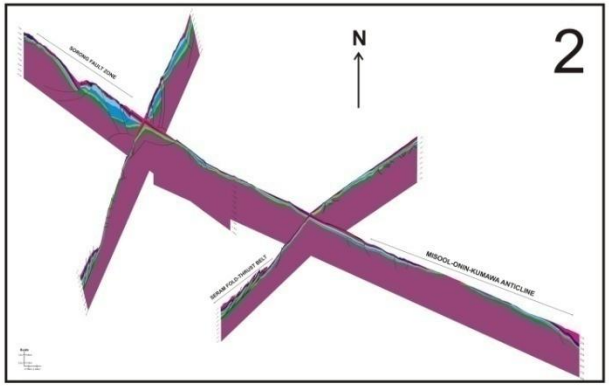


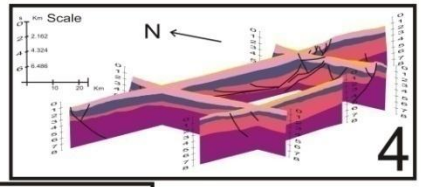
REGIONAL TIME STRUCTURE MAP – TOP JURASSIC

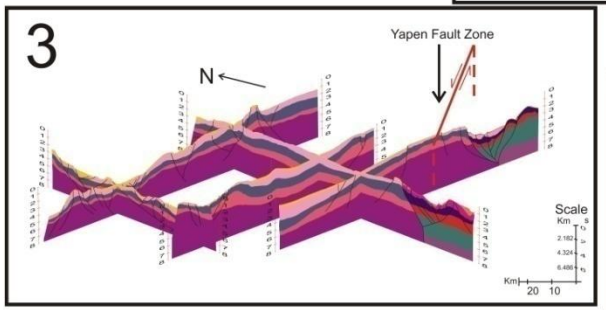


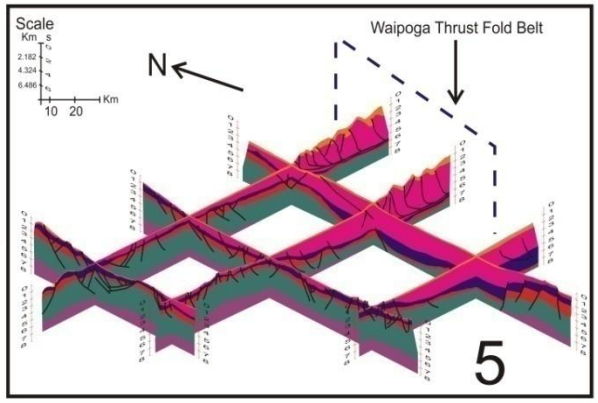
DEFORMATION OF BIRD HEAD REGION

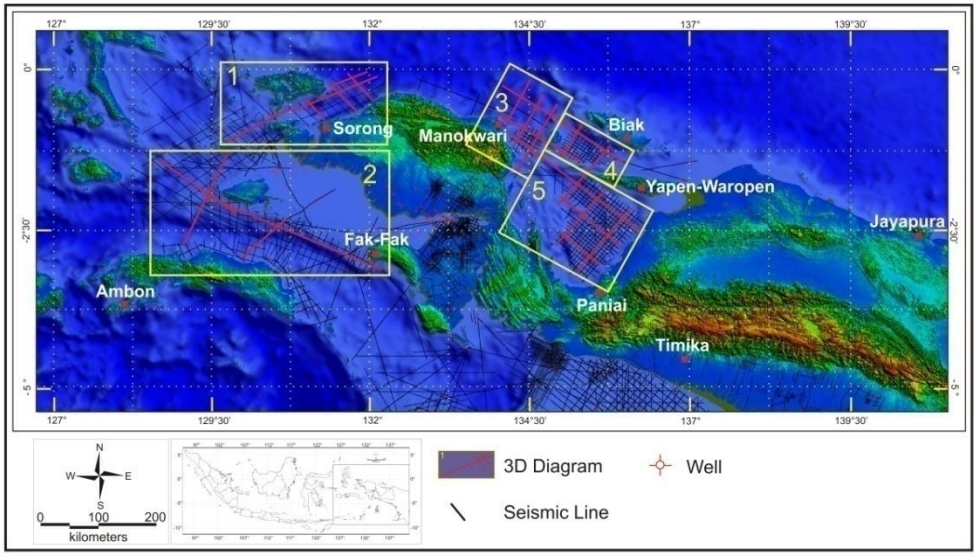


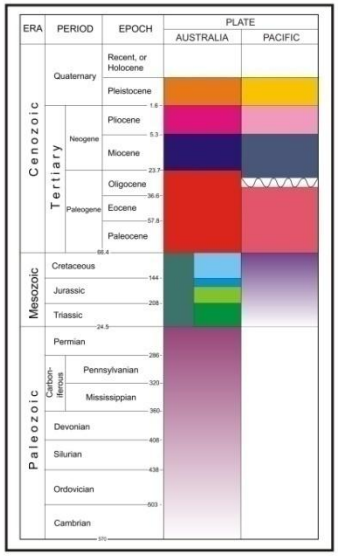




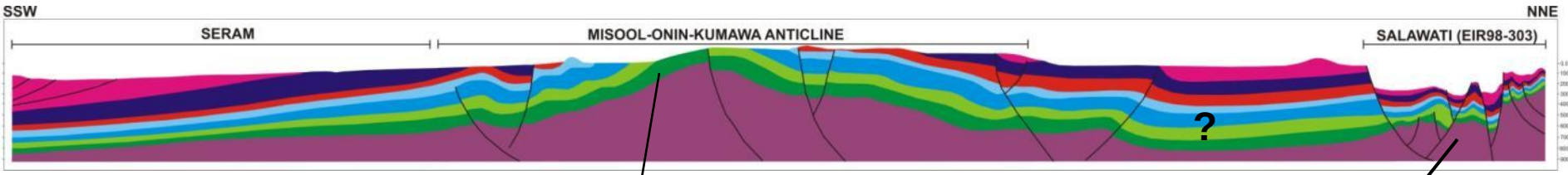


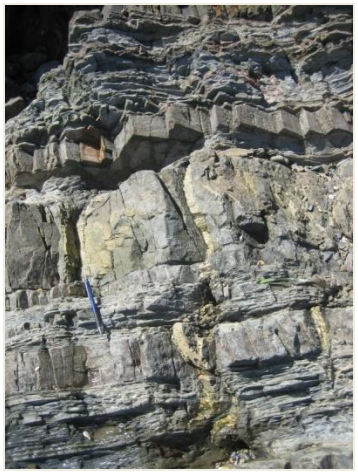


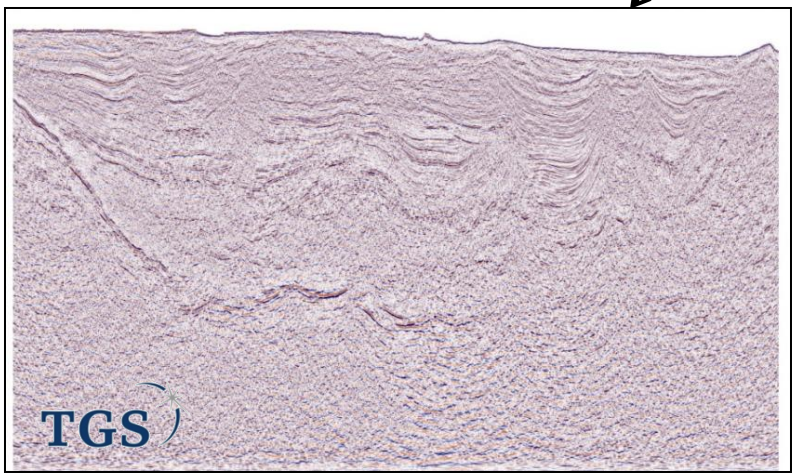


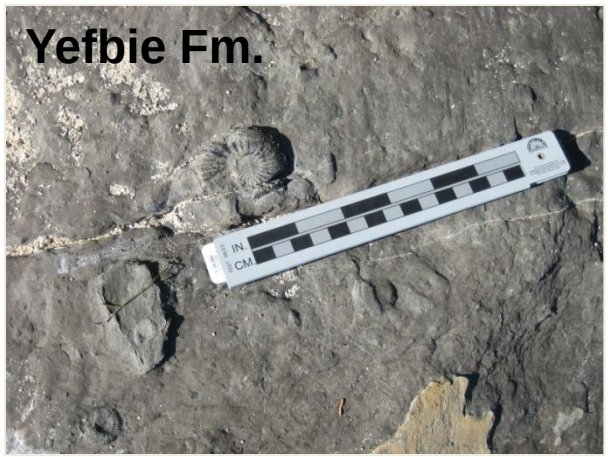


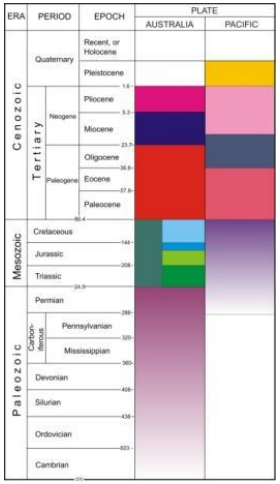
SALAWATI – MISOOL DEFORMATION

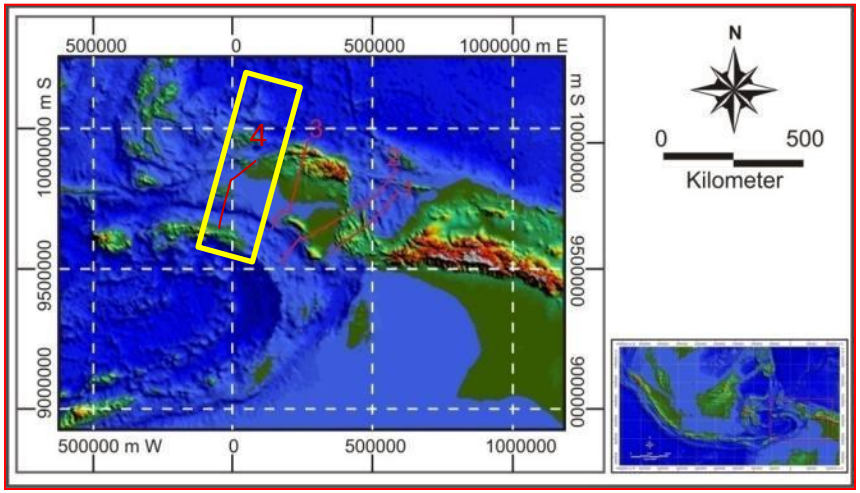




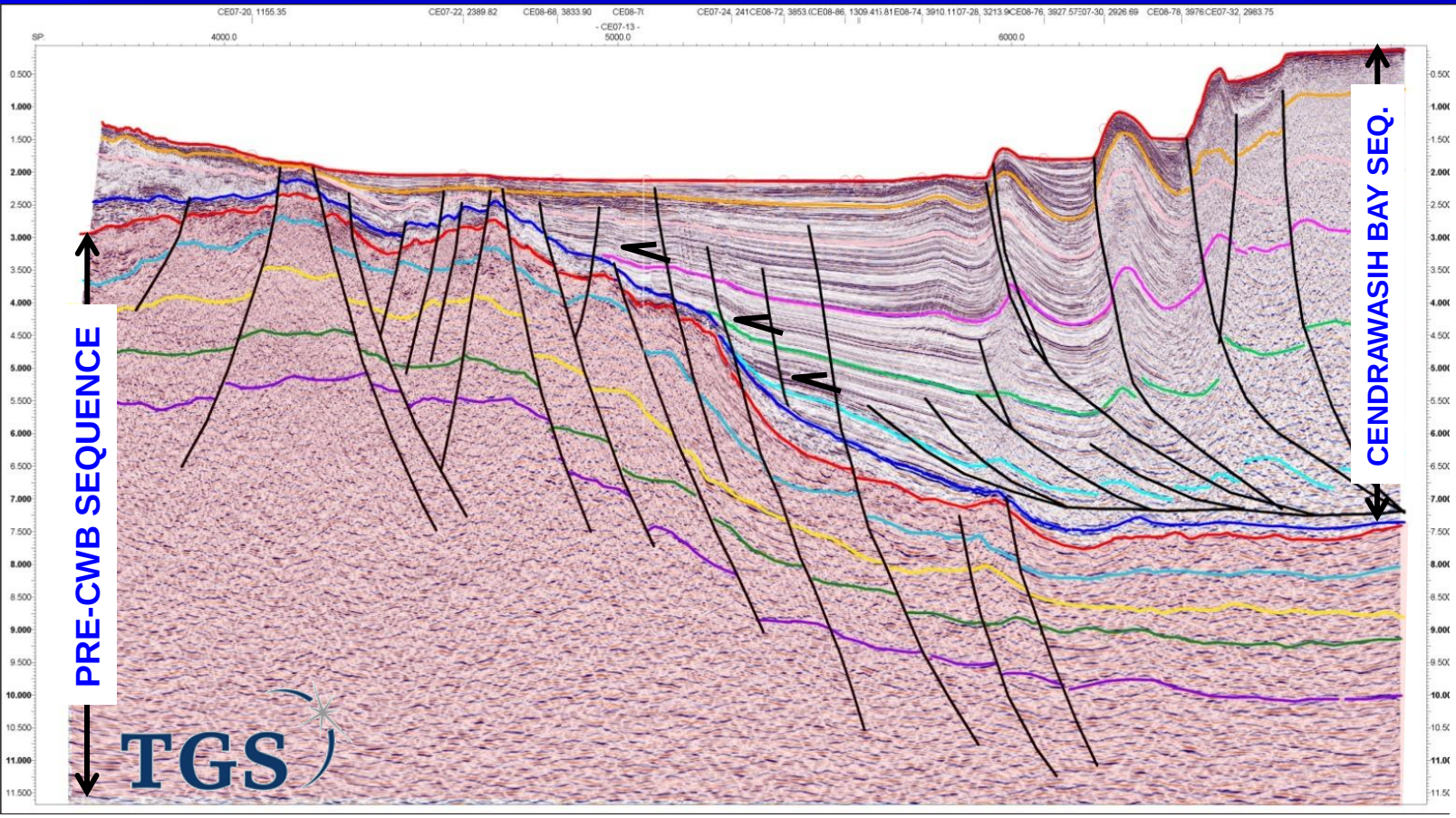


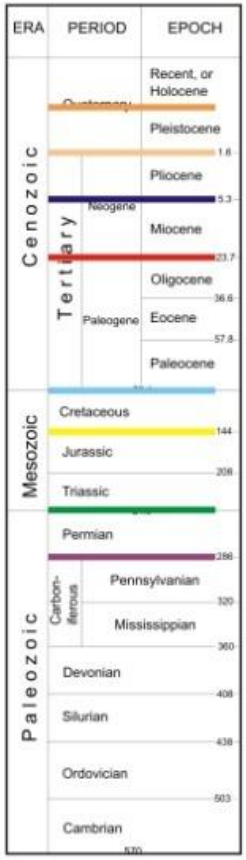




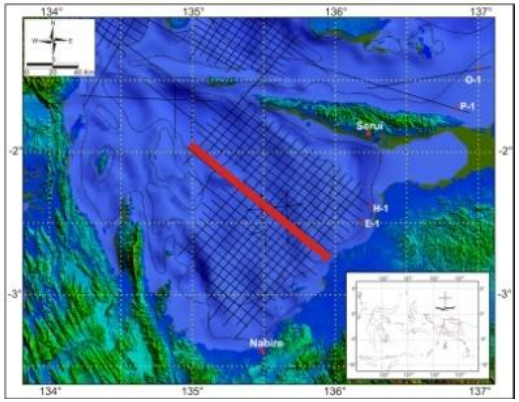


Seismic Interpretation of Cendrawasih Bay – *Basement Issue?*



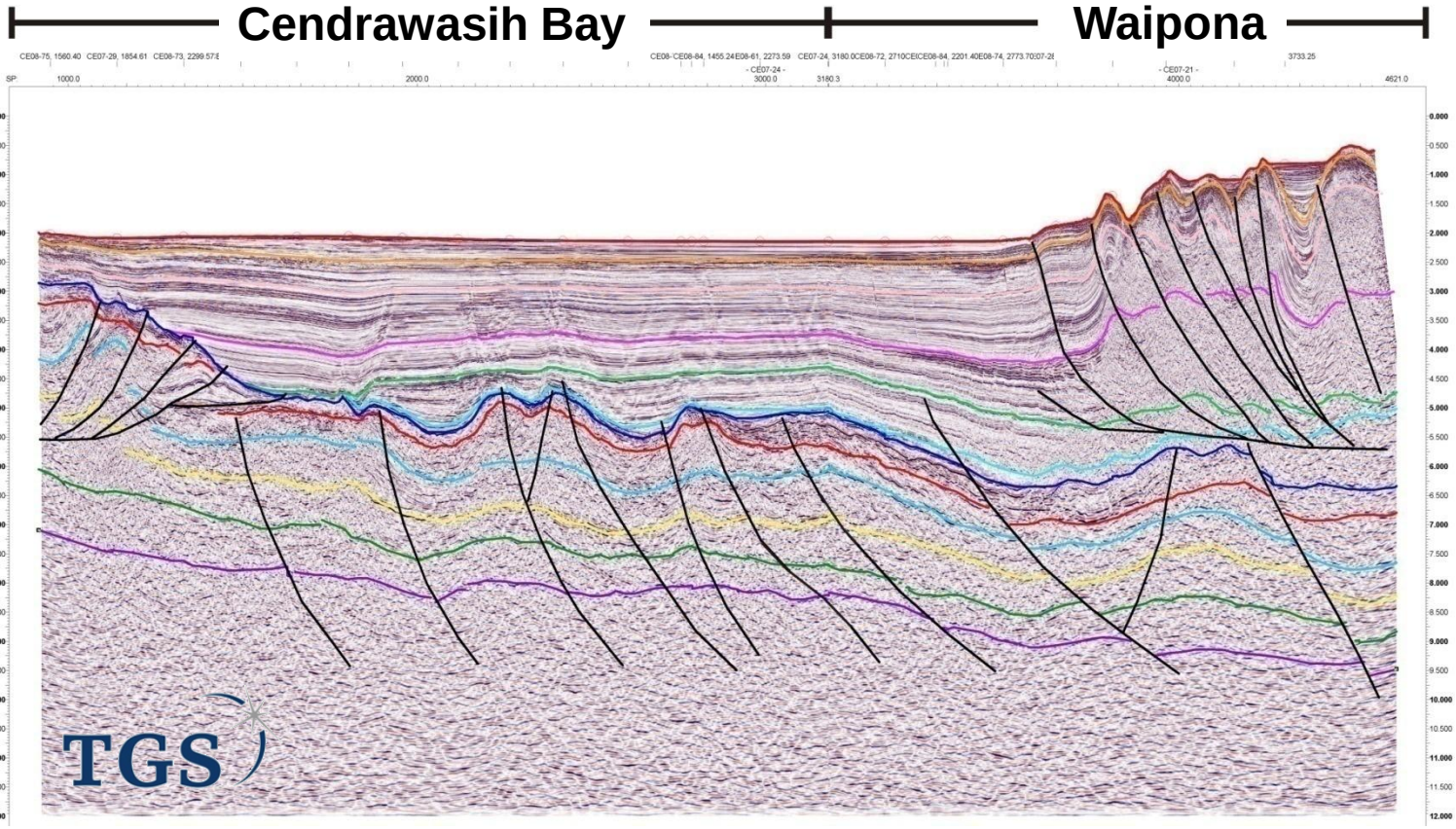


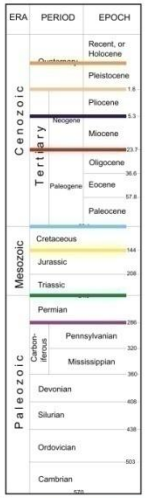
- Tied to O-1 well for Pliocene – Pleistocene
  - Divided into two major sequences
  - Angular unconformity relationship

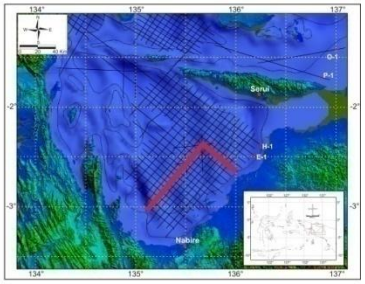


Sapiie, et al. (2007)

Seismic Interpretation of Cendrawasih Bay



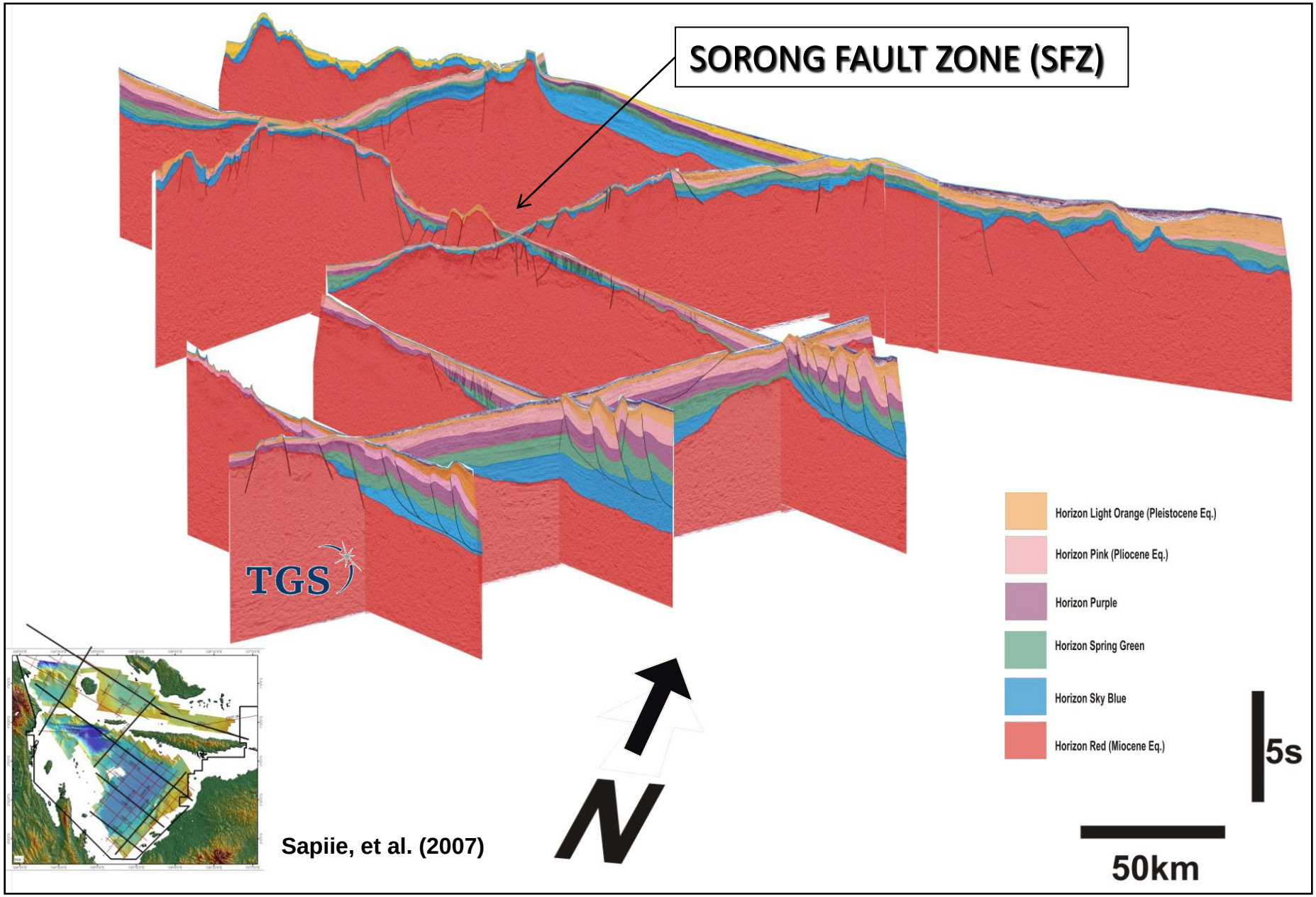




- Three Deformation Styles:
- Early normal faults
- Late Miocene (?) Thrust-Folds system
- Younger thin-skinned Thrust-Fold system

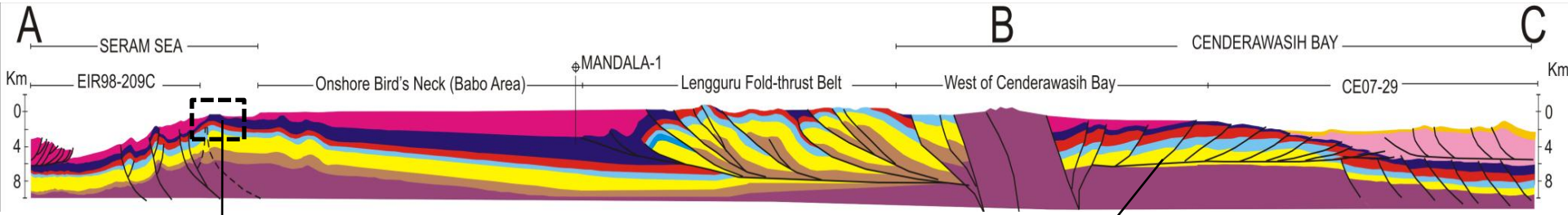
Sapiie, et al. (2007)

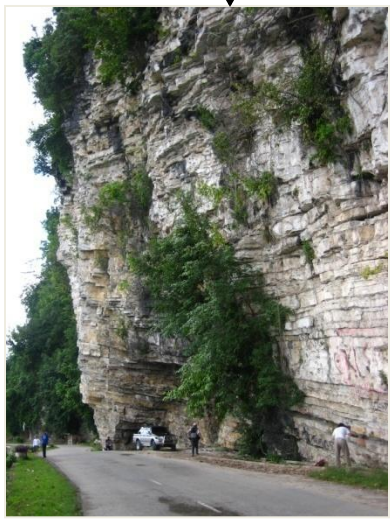
REGIONAL STRUCTURES - 3D VIEW – *continental vs. oceanic basement?*



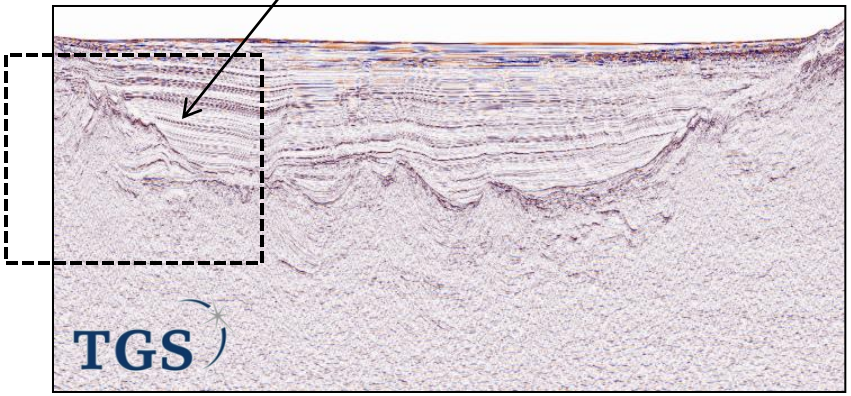
Sapiie, et al. (2007)

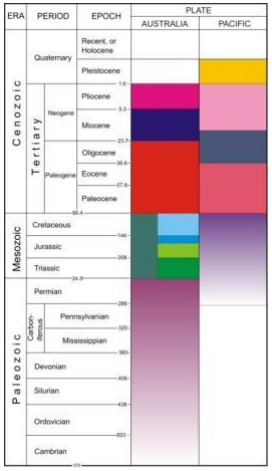
LENGGURU FTB – CENDRAWASIH BAY DEFORMATION

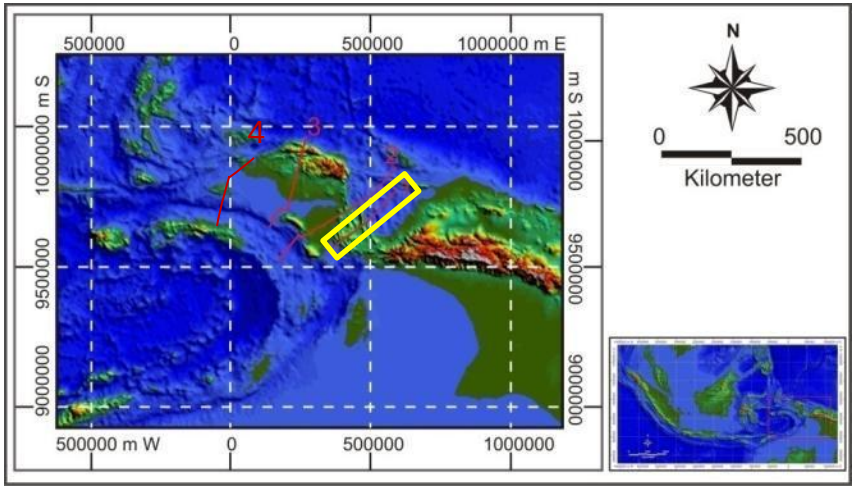




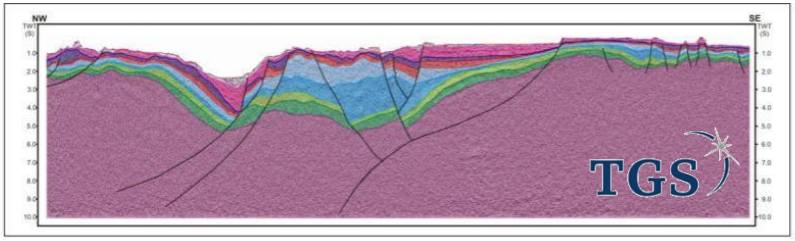
Sapiie, et al. (2007)

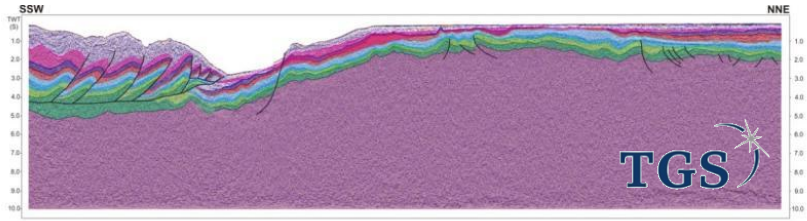


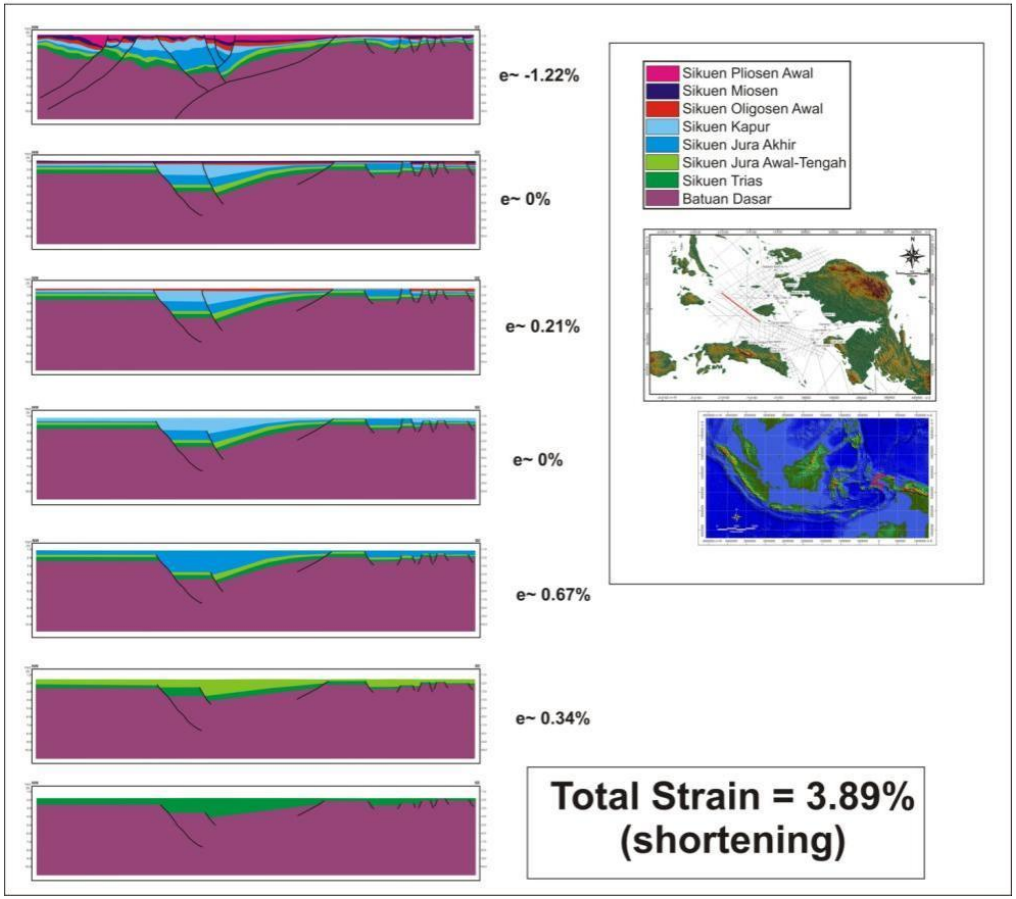


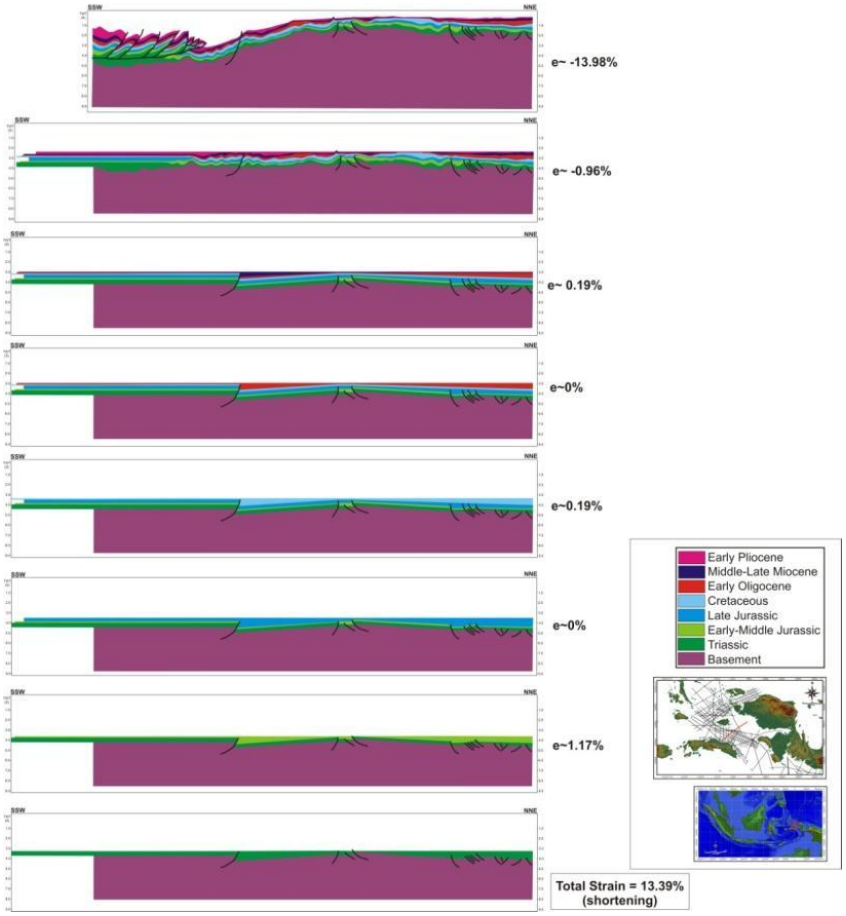


PALINSPATIC RECONSTRUCTIONS – *BALANCING CROSS-SECTION*

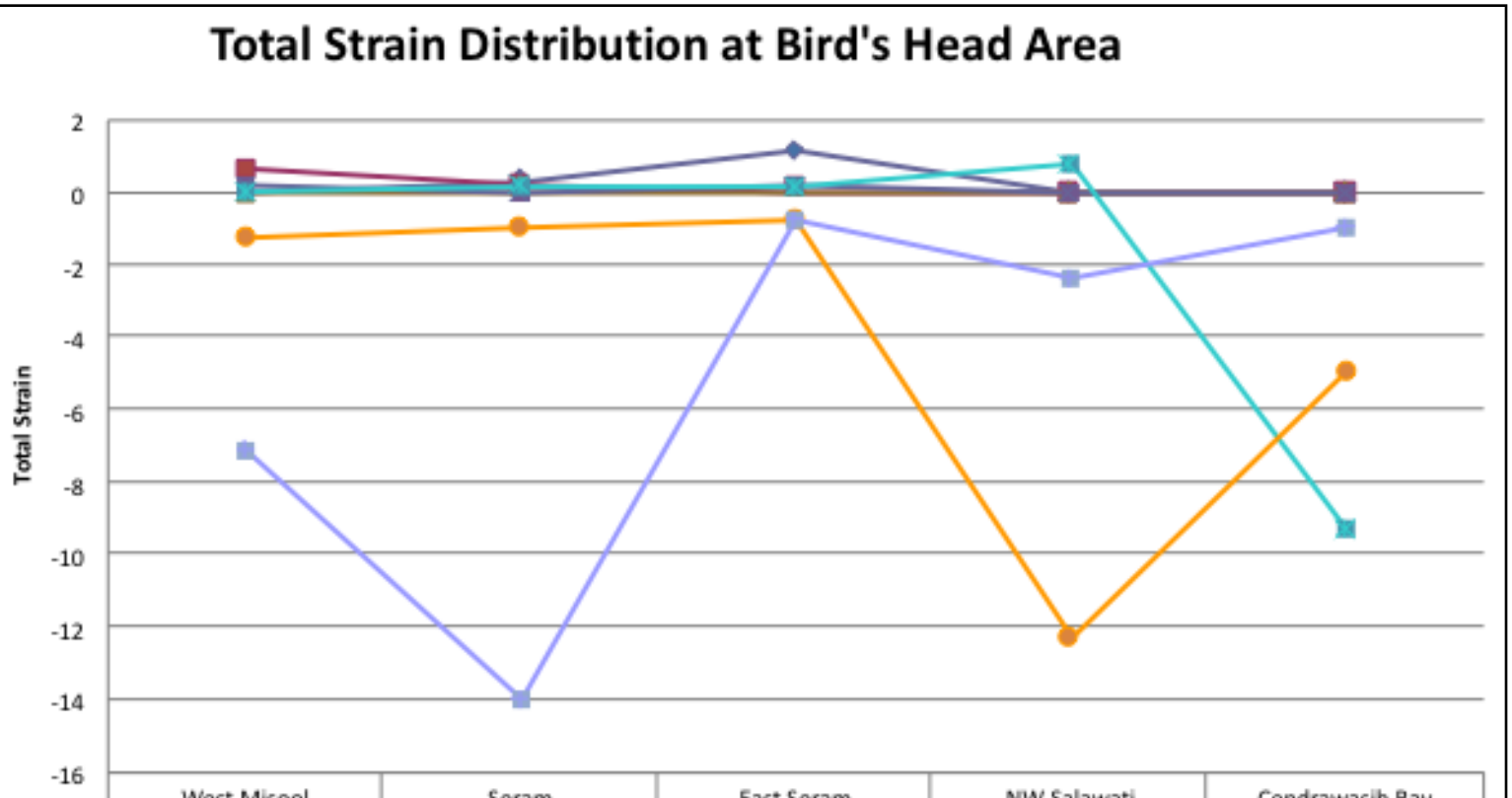






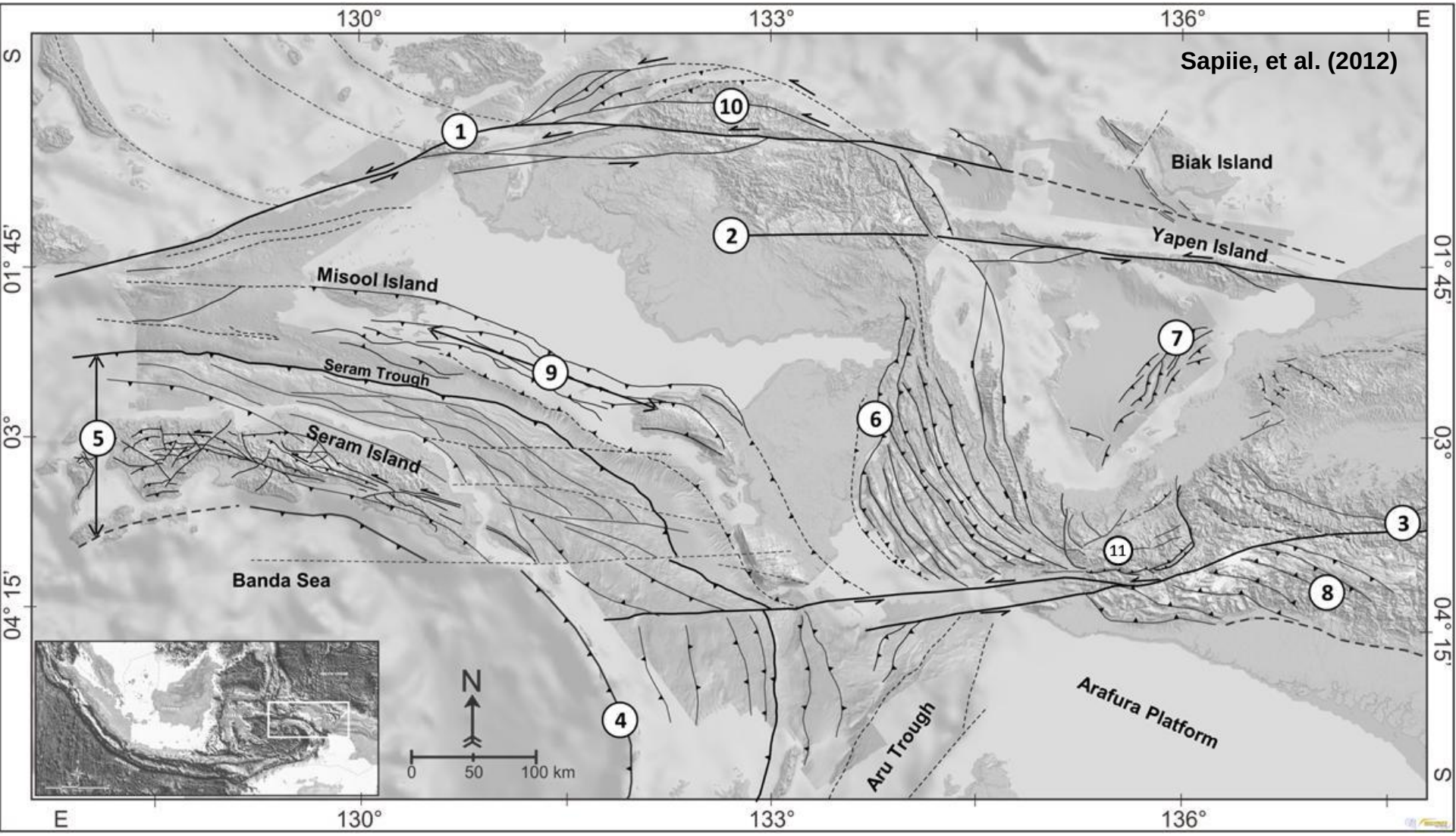


PALINSPATIC RECONSTRUCTIONS – *BALANCING CROSS-SECTION*



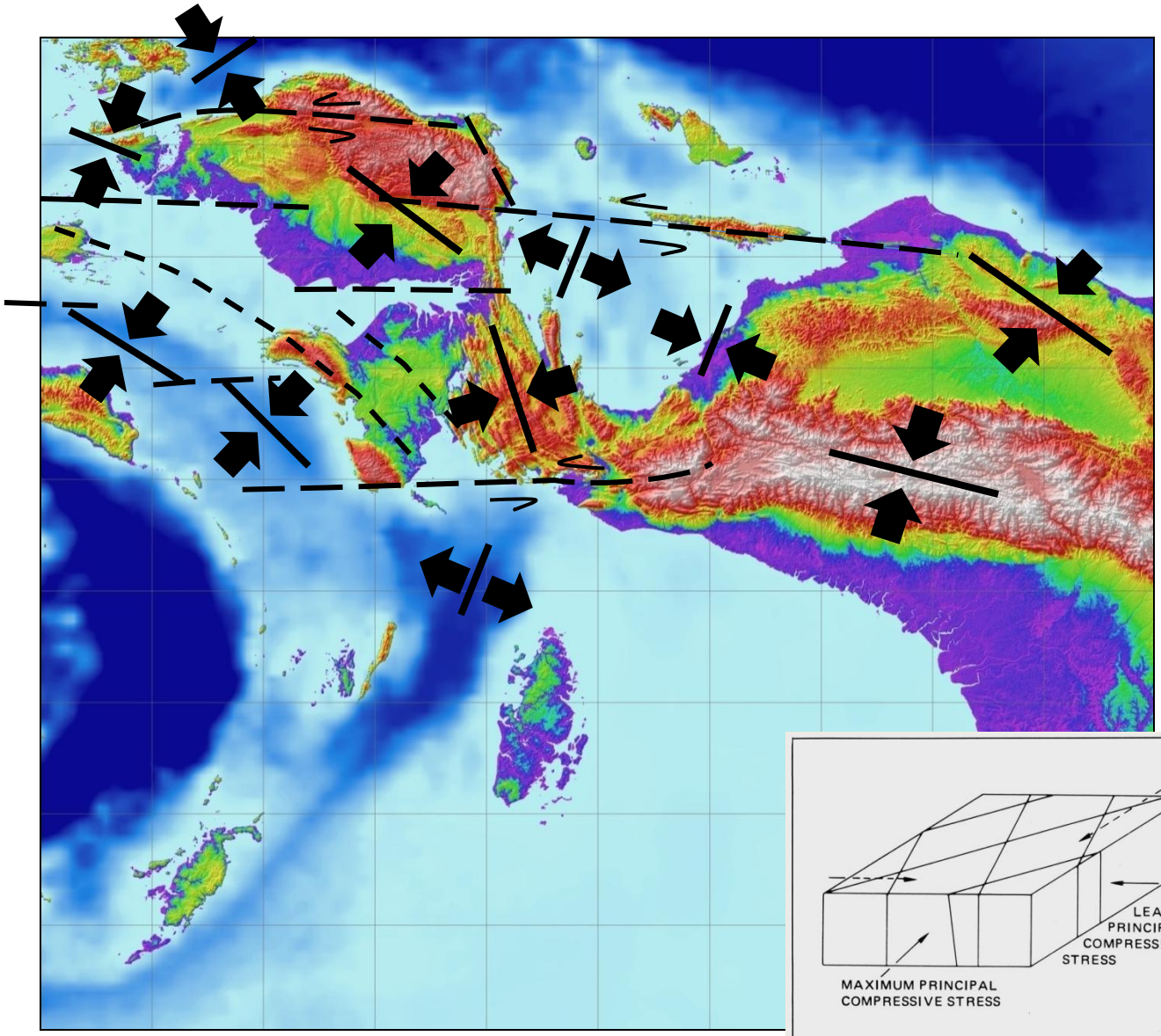
	West Misool	Seram	East Seram	NW Salawati	Cendrawasih Bay
Triassic-Early Jurassic	0.2	0.34	1.17	0	0
Early-Late Jurassic	0.67	0.25	0.15	0	0
Late Jurassic-Cretaceous	0	0.19	0.15	0	0
Cretaceous-Early Oligocene	0.21	0.07	0.19	0	0
Early Oligocene-Miocene	0	0.19	0.15	0.8	-9.27
Miocene-Early Pliocene	-1.22	-0.96	-0.75	-12.28	-4.97
Early Pliocene-Present	-7.09	-13.98	-0.75	-2.37	-0.98

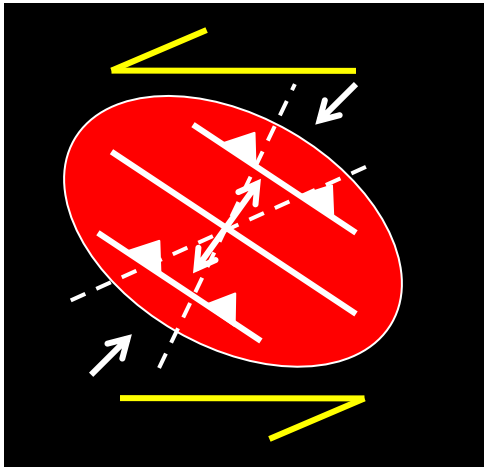
DEFORMATION PATTERN AND FAULT STYLE

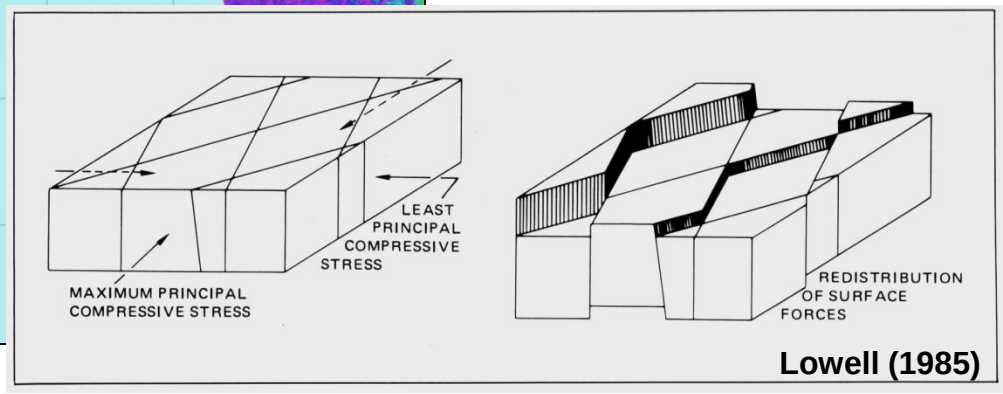


1. Sorong Fault Zone (SFZ), 2. Yapen Fault Zone (YFZ), 3. Tarera-Aiduna Fault Zone (TAFZ), 4. Banda Trench, 5. Seram Fold-Thrust-Belt (SFTB), 6. Lengguru Fold-Thrust-Belt (LFTB), 7. Cendrawasih Bay Fold-Thrust-Belt (CBFTB), 8. Central Range Fold-Thrust-Belt (CRFTB), 9. Misool-Onin-Kumawa Ridge (MOKR), 10. Kemum High, 11. Weyland Overthrust.

STRAIN ANALYSIS BIRD REGION – *STRIKE SLIP DEFORMATION*

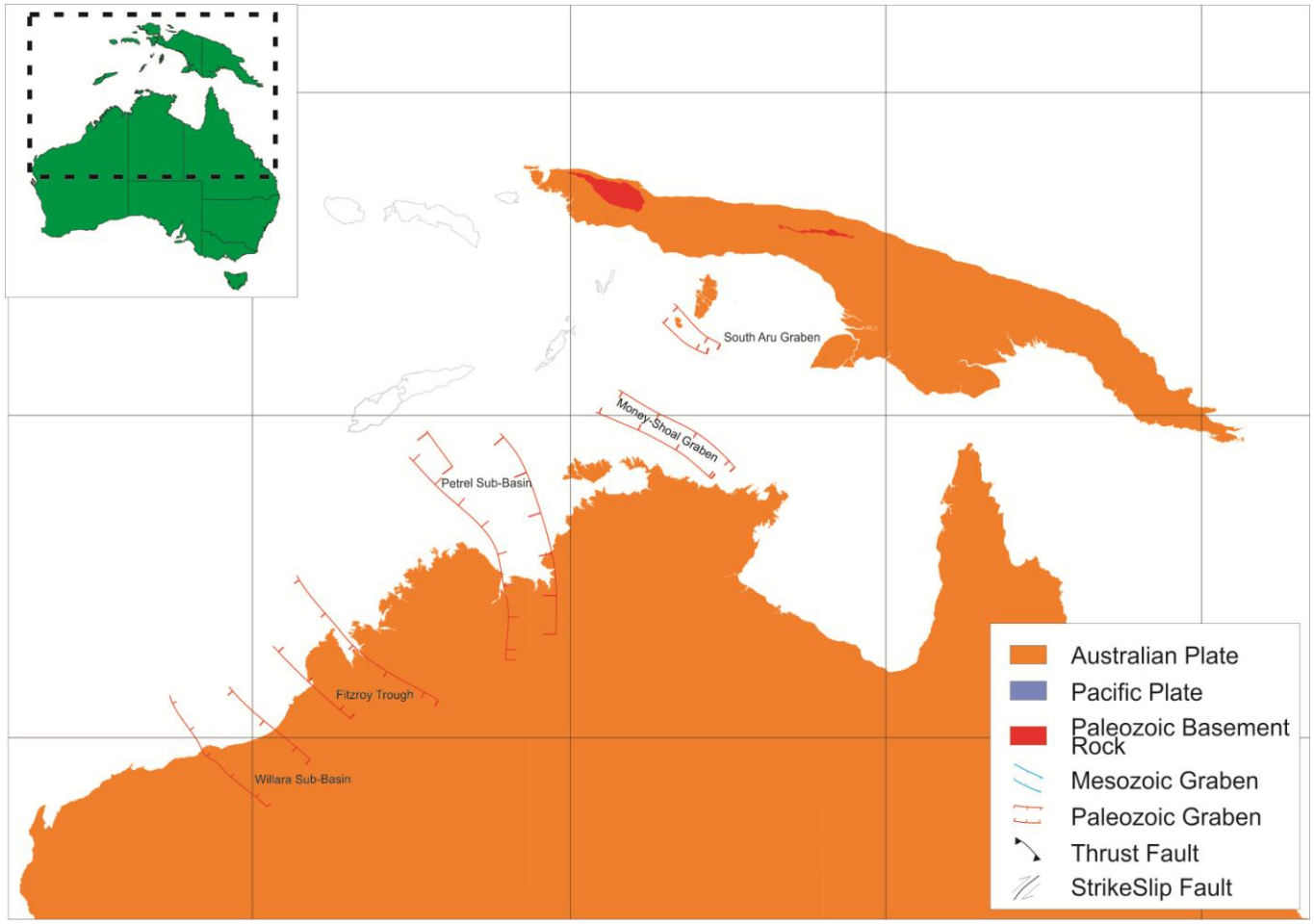




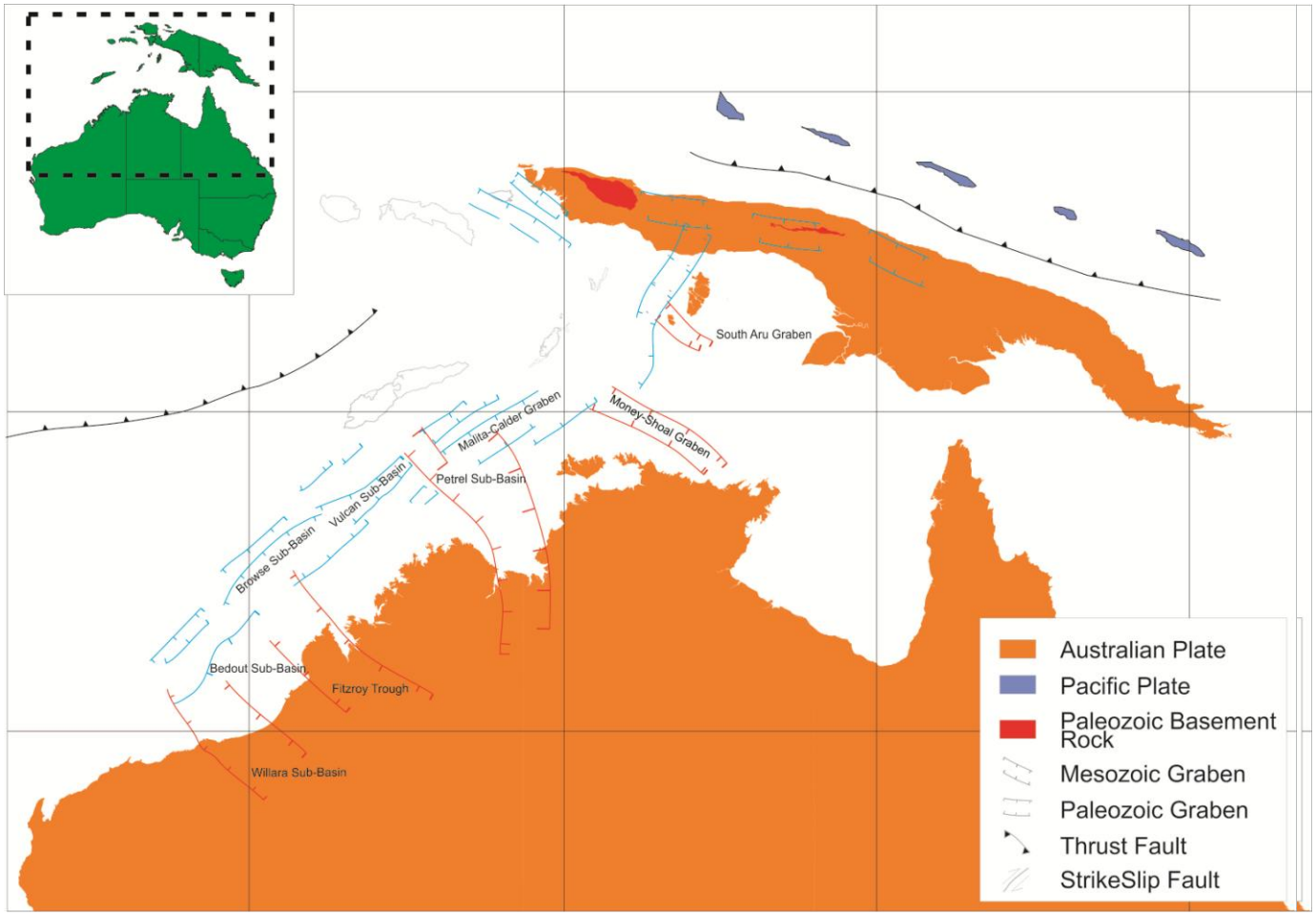


Lowell (1985)

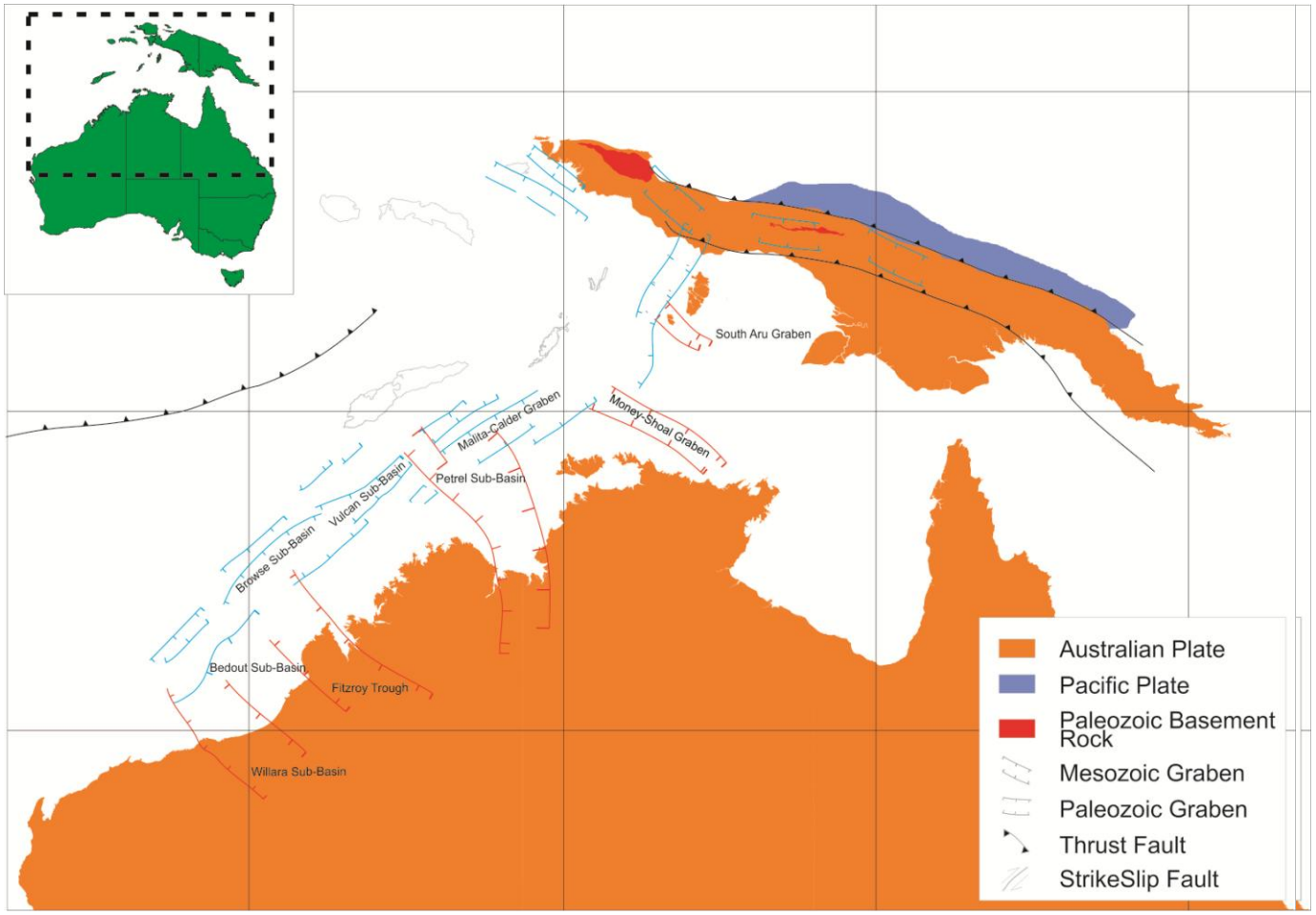
BIRD HEAD RECONSTRUCTIONS



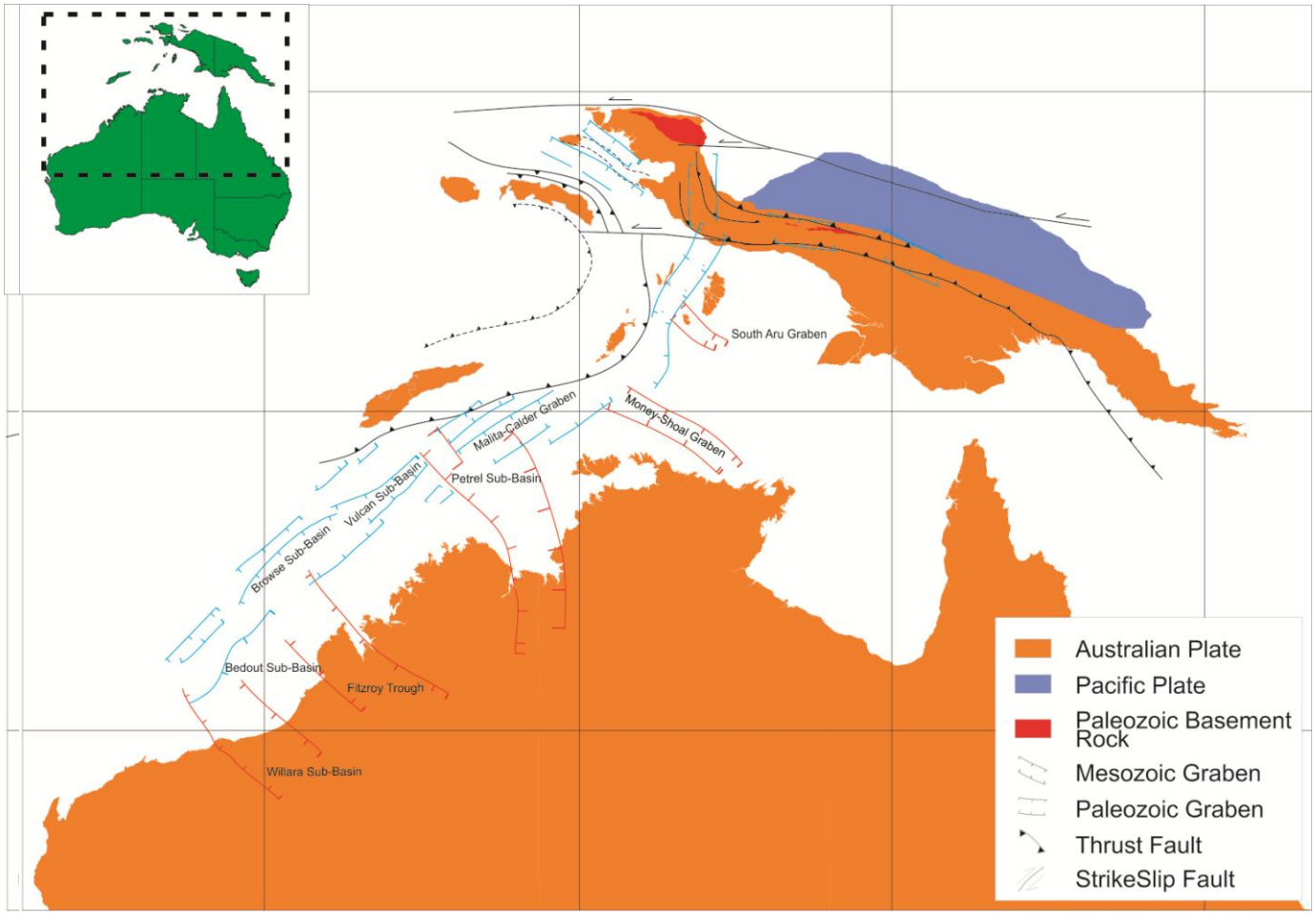
BIRD HEAD RECONSTRUCTIONS



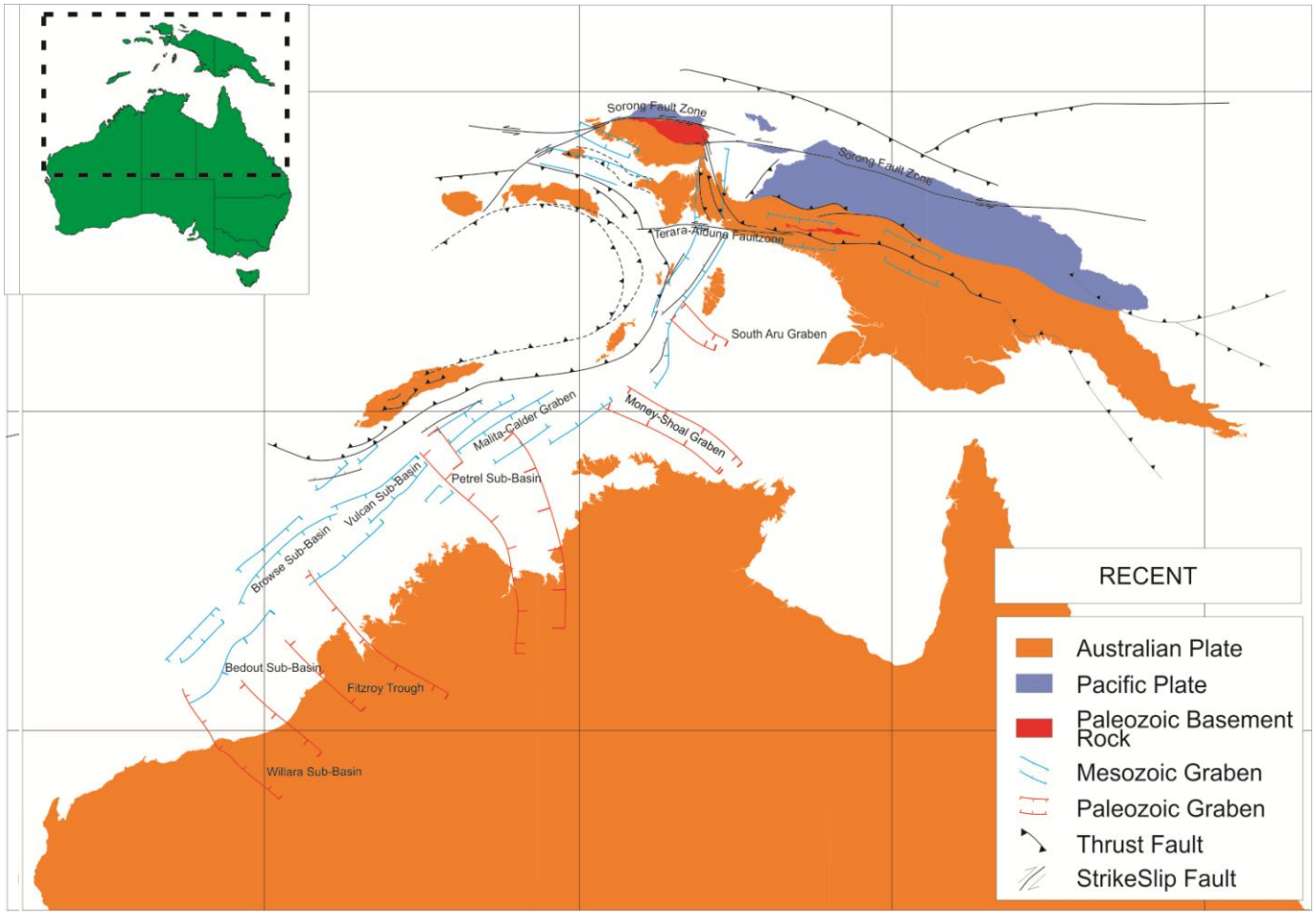
BIRD HEAD RECONSTRUCTIONS



BIRD HEAD RECONSTRUCTIONS



BIRD HEAD RECONSTRUCTIONS



CONCLUSIONS OF BIRDHEAD REGIONS

- BIRD HEAD REGION IS VERY COMPLEX STRUCTURES AND KINEMATICS AT PRESENT-DAY IT MOVING AS PART OF GREAT PACIFIC PLATES.

- DEFORMATION WITHIN CENDRAWASIH, SALAWATI AND SERAM BASINS IS CONTROLLED BY ACTIVITY OF SORONG FAULT ZONE.

- COMPLEX GEOMETRY OF SORONG FAULT ZONE CONTROLLED BY PRE-EXISITNG FAULT SUCH AS LEFT OR RIGHT-STEPPING CAUSED LOCAL ASYMETRY DEFORMATION PATTERN RESULTED IN SHORTENING AND EXTENSION WITHIN CENDRAWASIH BAY AND SURROUNDING BIRD HEAD REGION.

- *SIMPLE SHEAR MECHANISM INVOLVING RIGID BODY with TRANSLATION AND ROTATION AS THE MAIN MECHANISM*

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