



Teknik Geofisika ITS & MGMP Geografi
Jatim mempersembahkan :

Webinar

“EVOLUSI GEOLOGI JAWA TIMUR”

Sabtu
7 Okt 23 13.00 s.d
15.30 WIB

Zoom ID : 4654-4005-85

Sebagai Moderator:



Nanin Kusuma, M. Pd
Kabid Humas dan Kerjasama
MGMP Geografi Jatim

Sebagai Host :



Dra. Artini Inderawati
Ketua MGMP Geografi Jawa Timur



Dr. Amien Widodo
Dosen Teknik Geofisika ITS



ANDANG BACHTIAR
Geolog Independent
Evolusi Geologi
Jawa Timur



C. PRASETYADI
Teknik Geologi
UPN Veteran
Yogyakarta
Sesar Rembang-
Madura-Kangean-
Sakala



**RULLY
HERMANSYAH**
BMKG Jatim
Update Sesar Aktif
Jatim

Kunjungi its.ac.id/admission untuk pendaftaran
perkuliahan S1 Reguler dan Internasional di
Teknik Geofisika ITS

its.ac.id/tgeofisika

Teknik Geofisika ITS

[teknik_geofisika_its](https://www.instagram.com/teknik_geofisika_its)

Teknik Geofisika ITS



Sesar RMKS (Rembang- Madura-Kangean-Sakala): Tinjauan berbasis data seismik

Carolus Prasetyadi

Jurusan T Geologi - UPN Veteran Yogyakarta

PEMBAHASAN



- **PENDAHULUAN**
- **DATA & METODA**
- **HASIL ANALISIS**
- **KESIMPULAN**

PEMBAHASAN



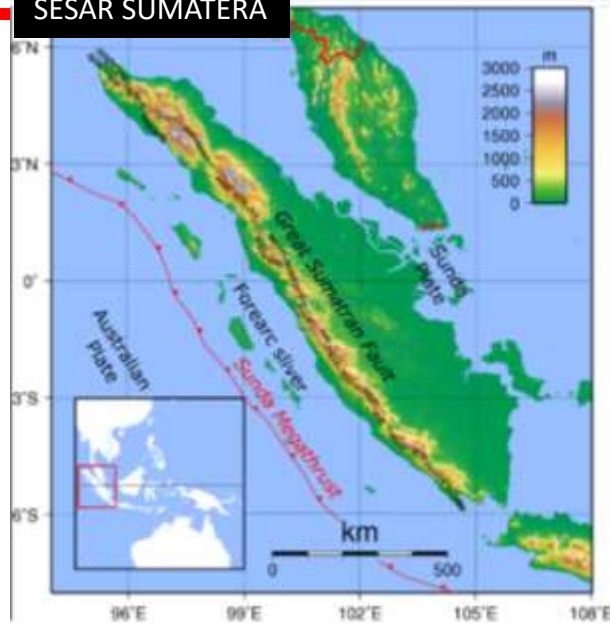
- **PENDAHULUAN**
- DATA & METODA
- HASIL ANALISIS
- KESIMPULAN

PENDAHULUAN

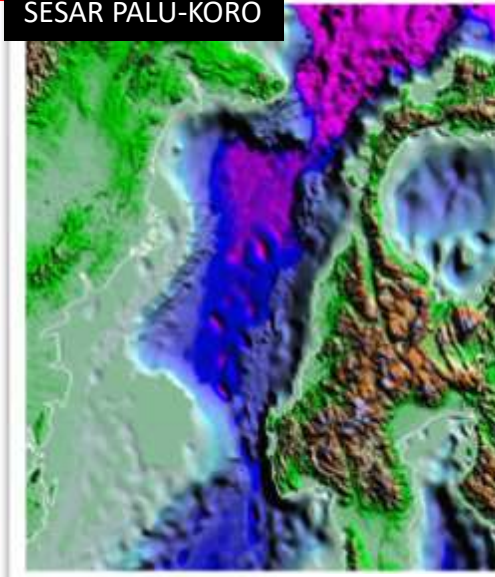
SESAR-SESAR UTAMA DI INDONESIA



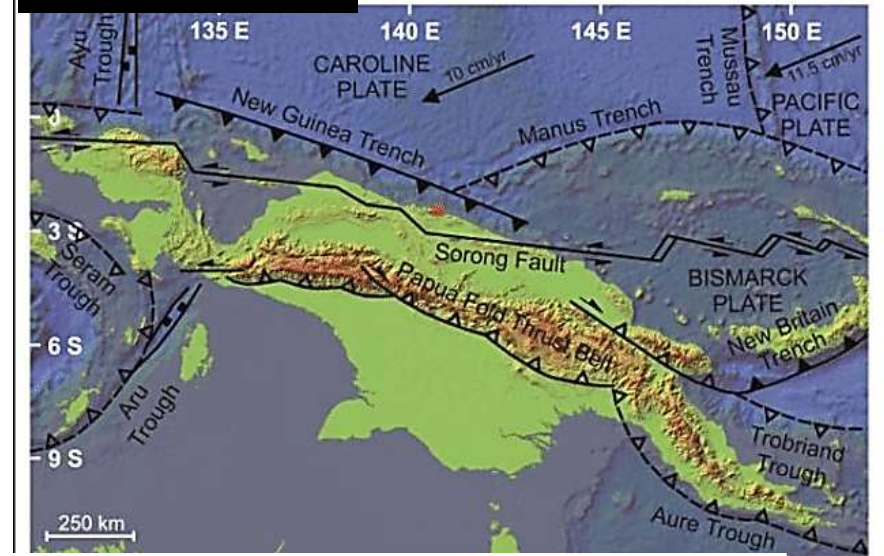
SESAR SUMATERA



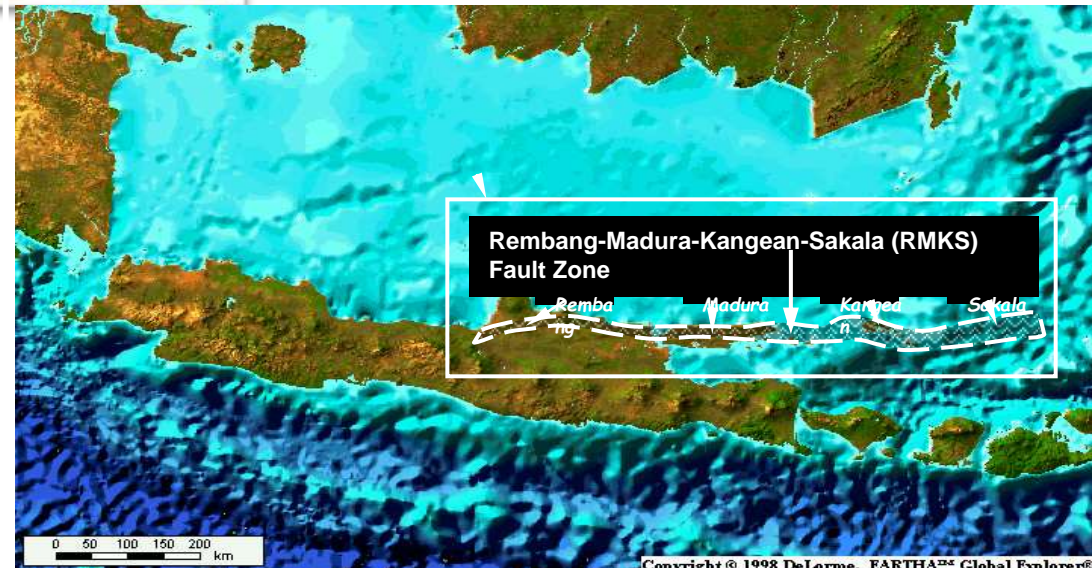
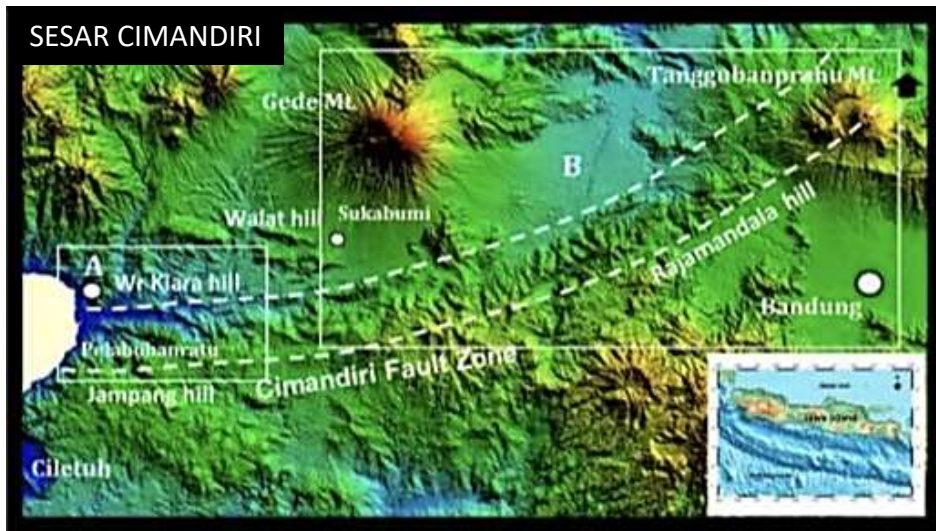
SESAR PALU-KORO



SESAR SORONG-YAPEN



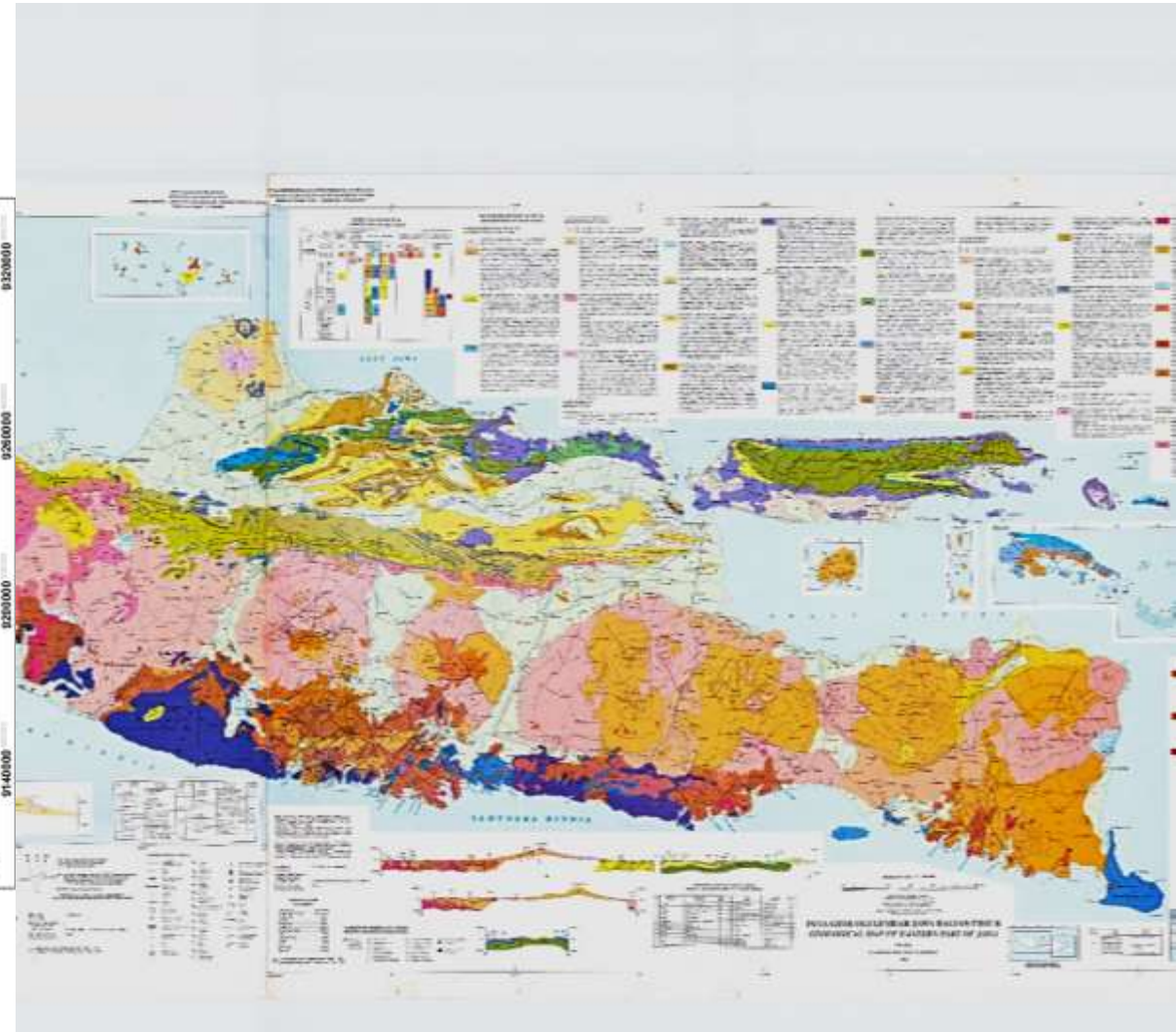
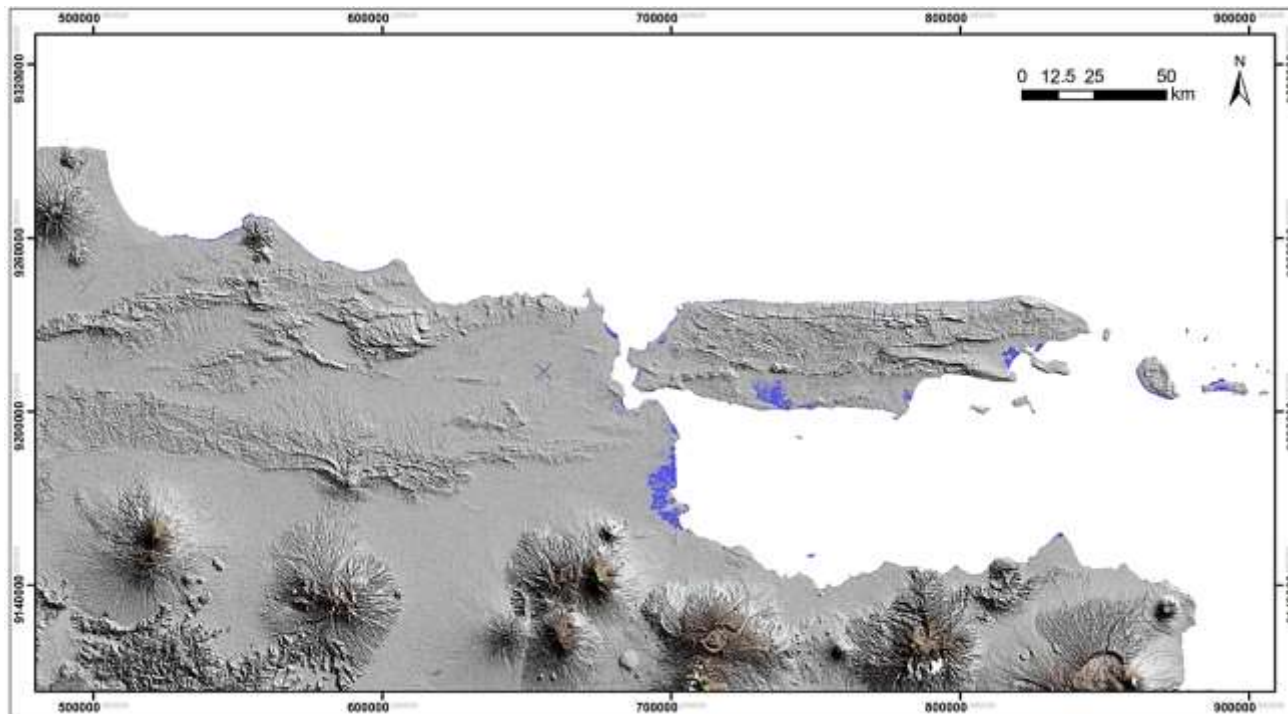
SESAR CIMANDIRI



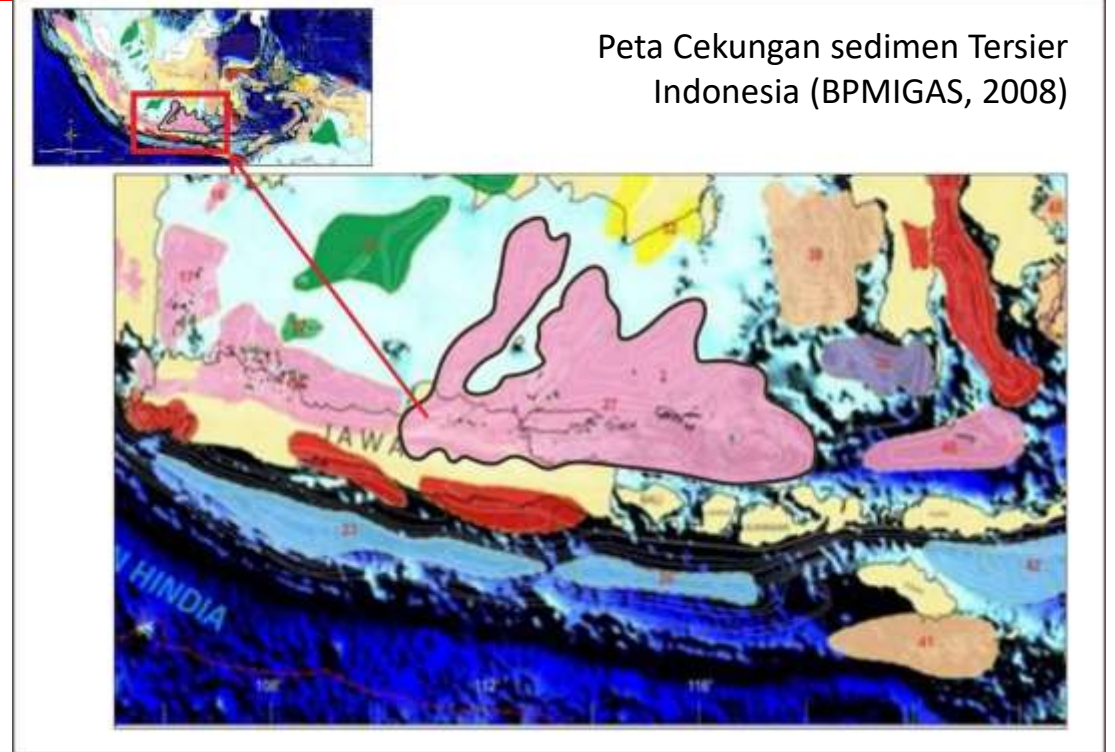
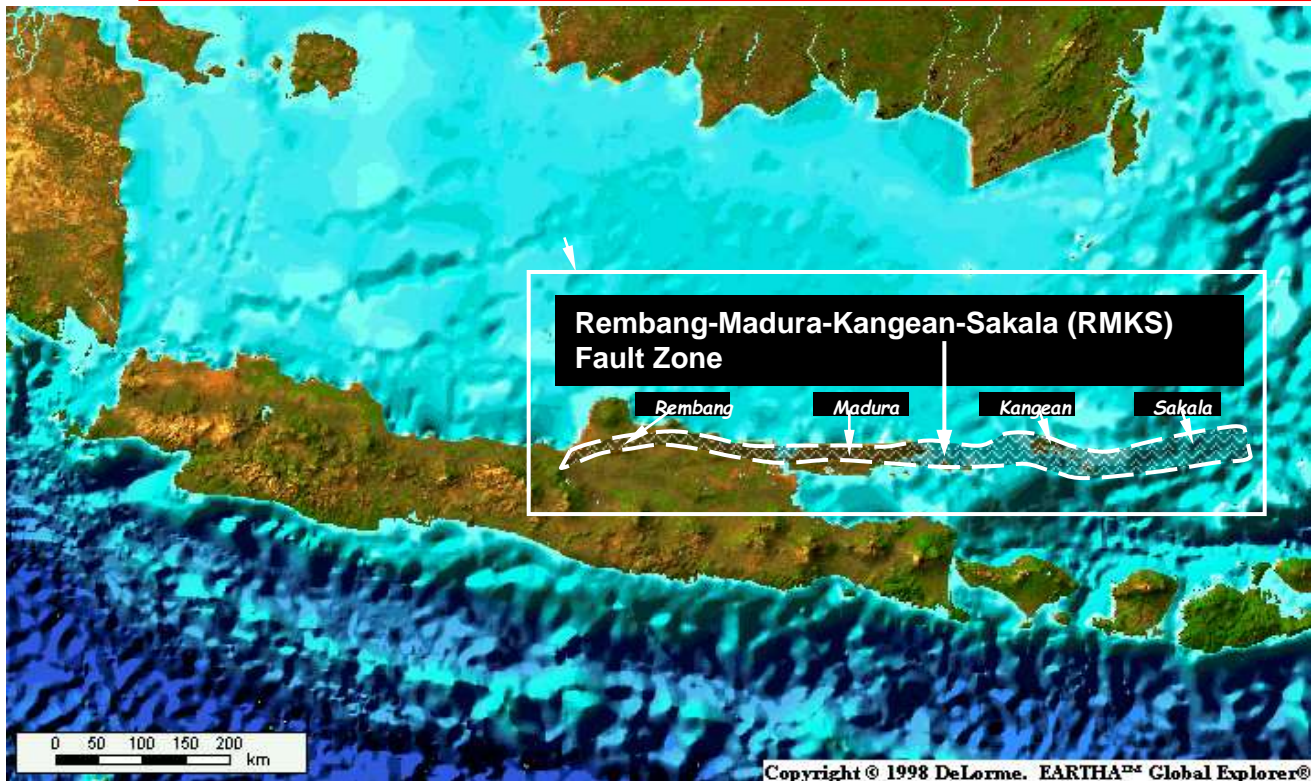
PENDAHULUAN

Gelogy Map: RMKS FZ not recognized

RMKS FZ = Surface expression not clear



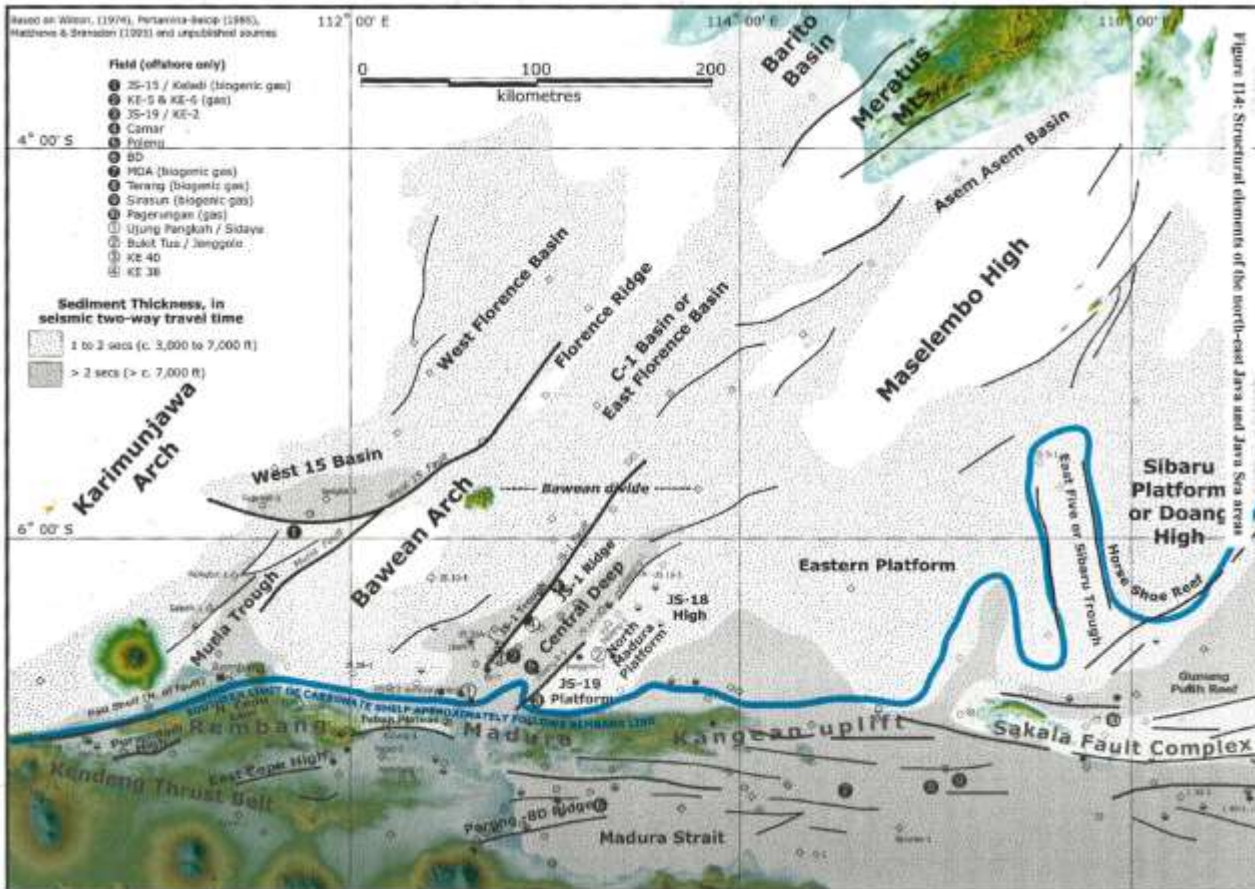
PENDAHULUAN



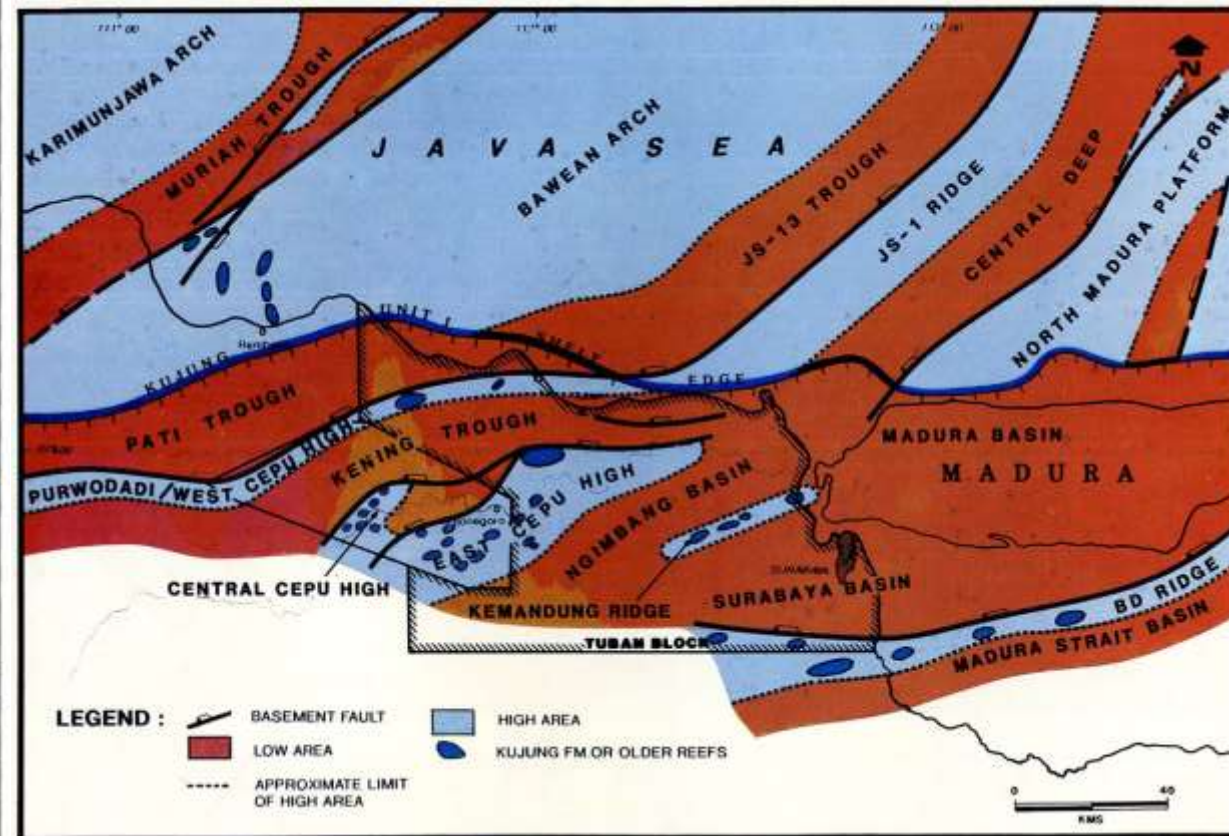
Satyana et al 2004

- Sesar RMKS berlokasi di Cekungan Jatim Utara
- **Sebagai cekungan penghasil HC**, Cekungan ini mrpk salah satu area eksplorasi yg paling aktif.

NE-SW ridges and half grabens in the NE Java basin

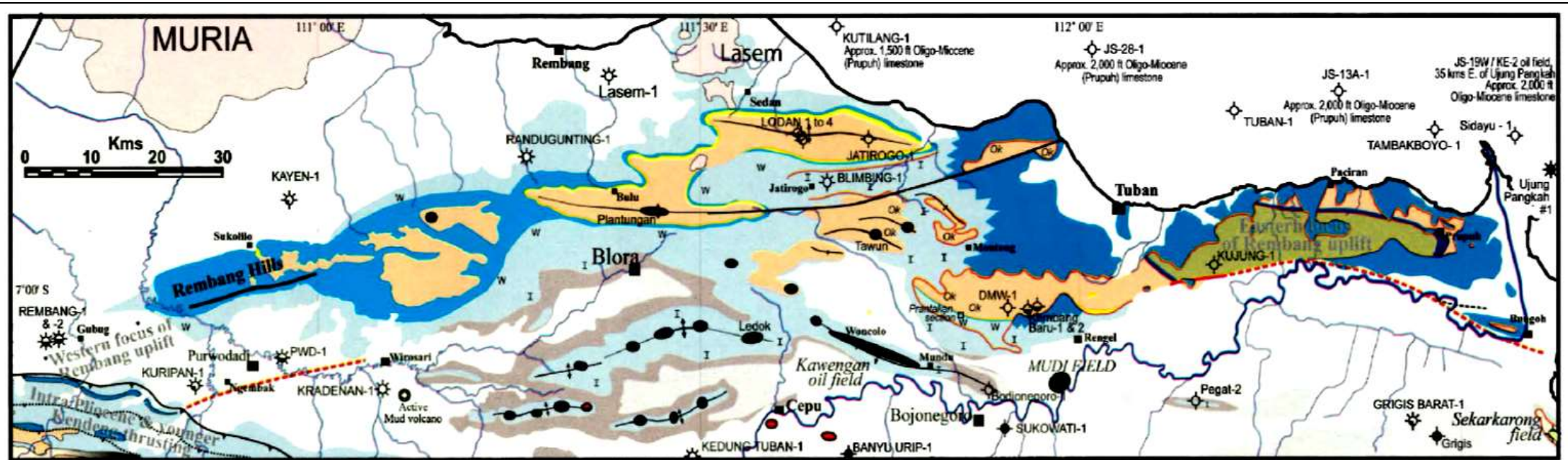


Lunt, 2013

















Ardhana 1993

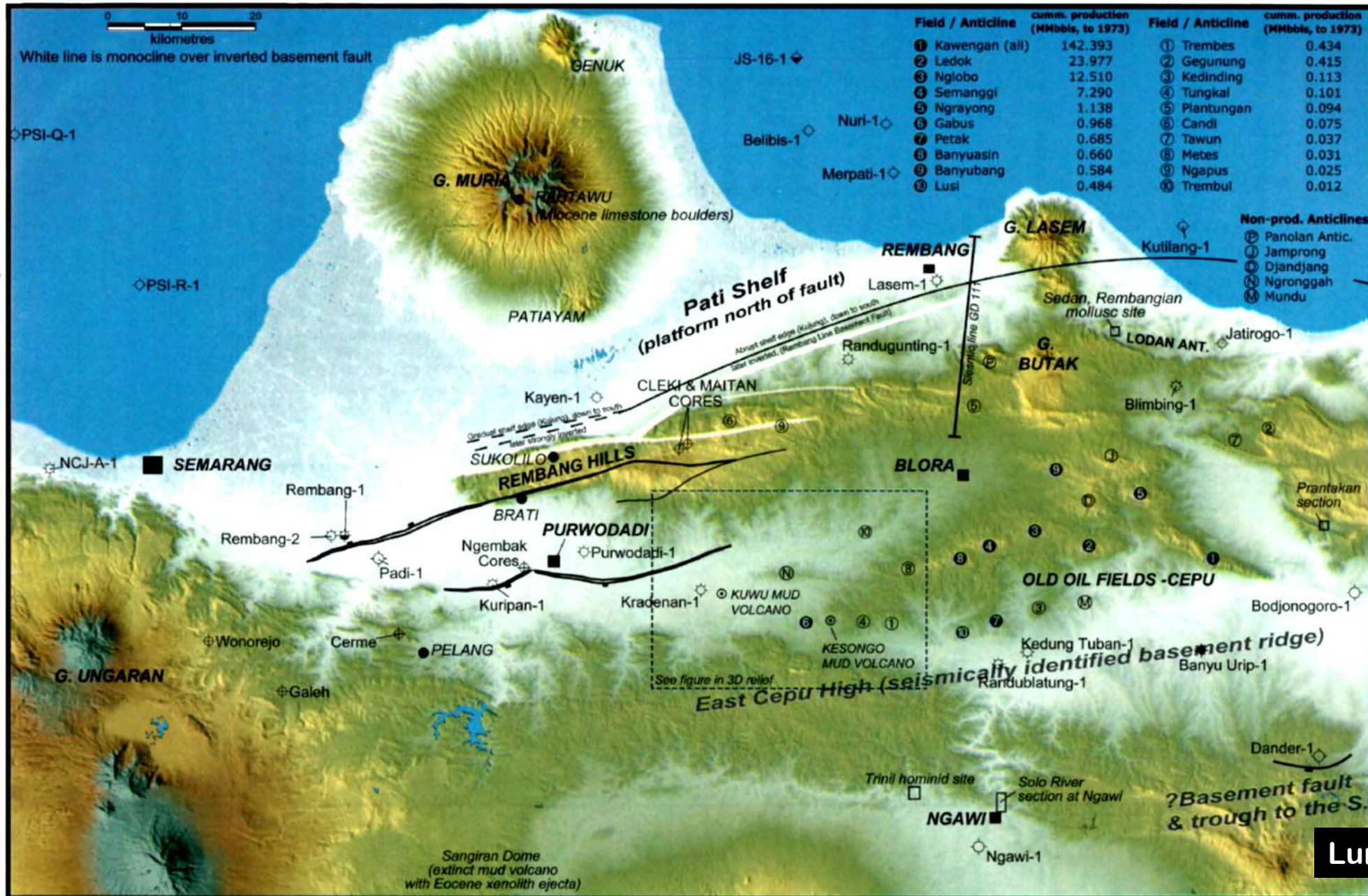
Simplified geological map of the Rembang - Madura uplift in NE Java



Southern bounding fault of Rembang Zone uplift (c 8 Ma) in Red, other faults in black

-  Alluvium
-  Quaternary volcanics
-  Latest Pliocene & younger, fluvial clastics
-  Late Pliocene Marine Clastics.
-  3.5 ma. Unconformity
-  **Karren Limestone (east) - Kapung Limestone (west)** Deposited after transgression onto Late Miocene Rembang Zone uplift.
-  E. Pliocene chalky facies. (**Cipluk Beds** in W). Lt Mioc. and Ey Plioc., initially burst of reworking of sediments from Rembang Uplift (**Ledok Sands**), followed by increasingly starved sedimentation (chalks & marls; **Mundu Fm.**).
-  **c. 8 ma. Rembang Uplift**
-  Marly clastics undiff. **Wonocolo Beds**, prior to unconformity, in deep marine setting.
-  **Platen Limestone** at base, reefal along palaeoshelf edge
-  **c.12 ma. Regional tectonic event**
-  **Ngrayong Sst.** prograding highstand sands overlying clays of **Tawun / Tuban Beds**.
-  Orbitoid Kalk (OK) a local prograding limestone facies.
-  **c. 20 ma. Regional tectonic event**

Location map of wells and topography, Semarang to Rembang



Location map of wells and topography, Rembang to Surabaya



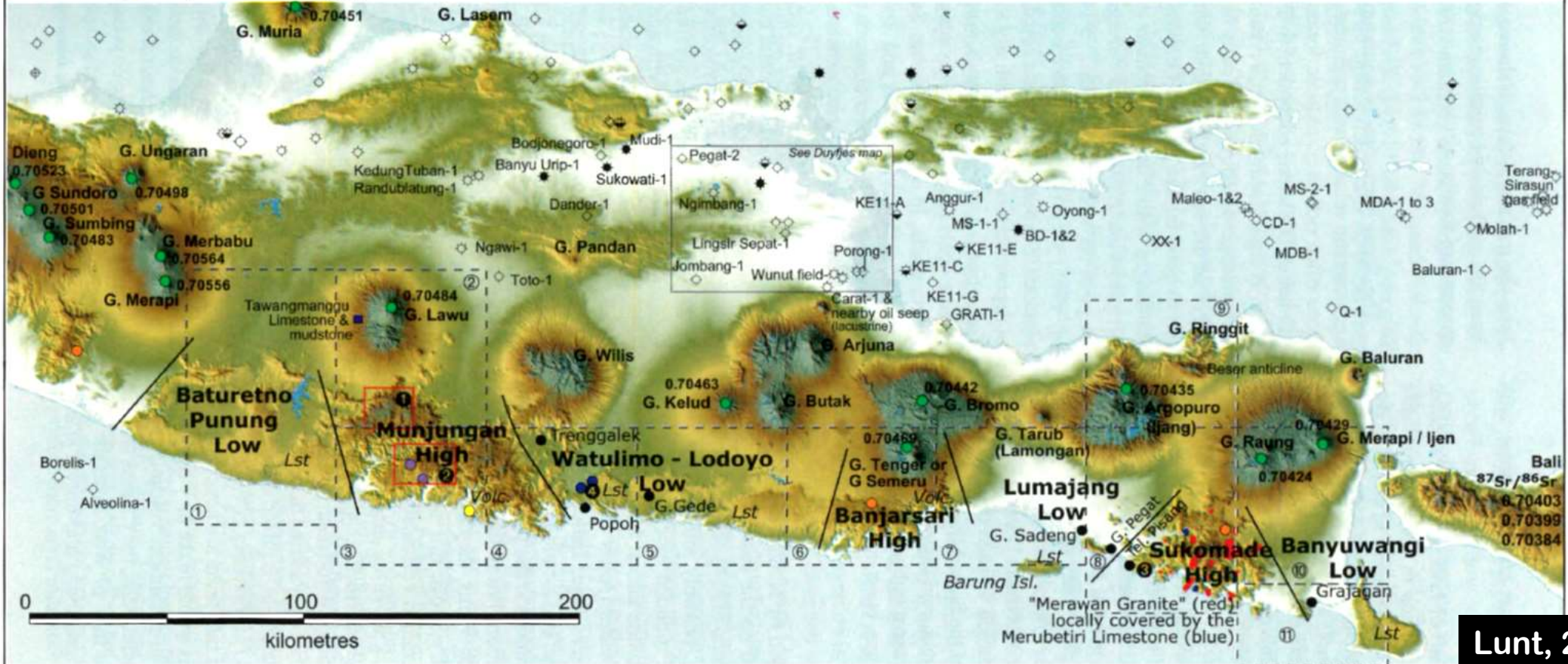
Lunt, 2013

Locations

- ① -Dawuhan area (van Bemmelen, volume 2, p.134). Gold bearing quartz veins in propylitized Old-Andesite breccias and andesite.
- ② -Kasihah, Domasan & Brungkah area, (van Bemmelen, volume 2, p.135). Gold bearing quartz veins in propylitized Old-Andesite breccias and andesite.
- ③ -Batu Ulu area, (van Bemmelen, volume 2, p.135). Quartz veins, possibly mineralised in propylitized Old-Andesite.
- ④ ● -Campurdarat Limestone, type location

Mapping quadrangles (1:100,000) of the GRDC

- ① Surakarta & Giritontro
- ② Ponorogo
- ③ Pacitan
- ④ Tulungagung
- ⑤ Blitar
- ⑥ Turen
- ⑦ Lumajang
- ⑧ Jember
- ⑨ Besuki
- ⑩ Banyuwangi
- ⑪ Blambangan



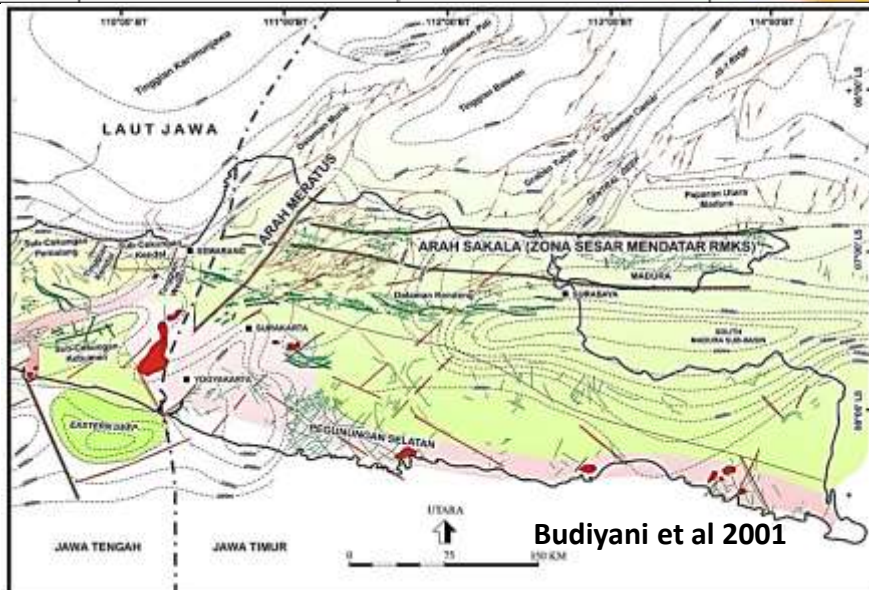
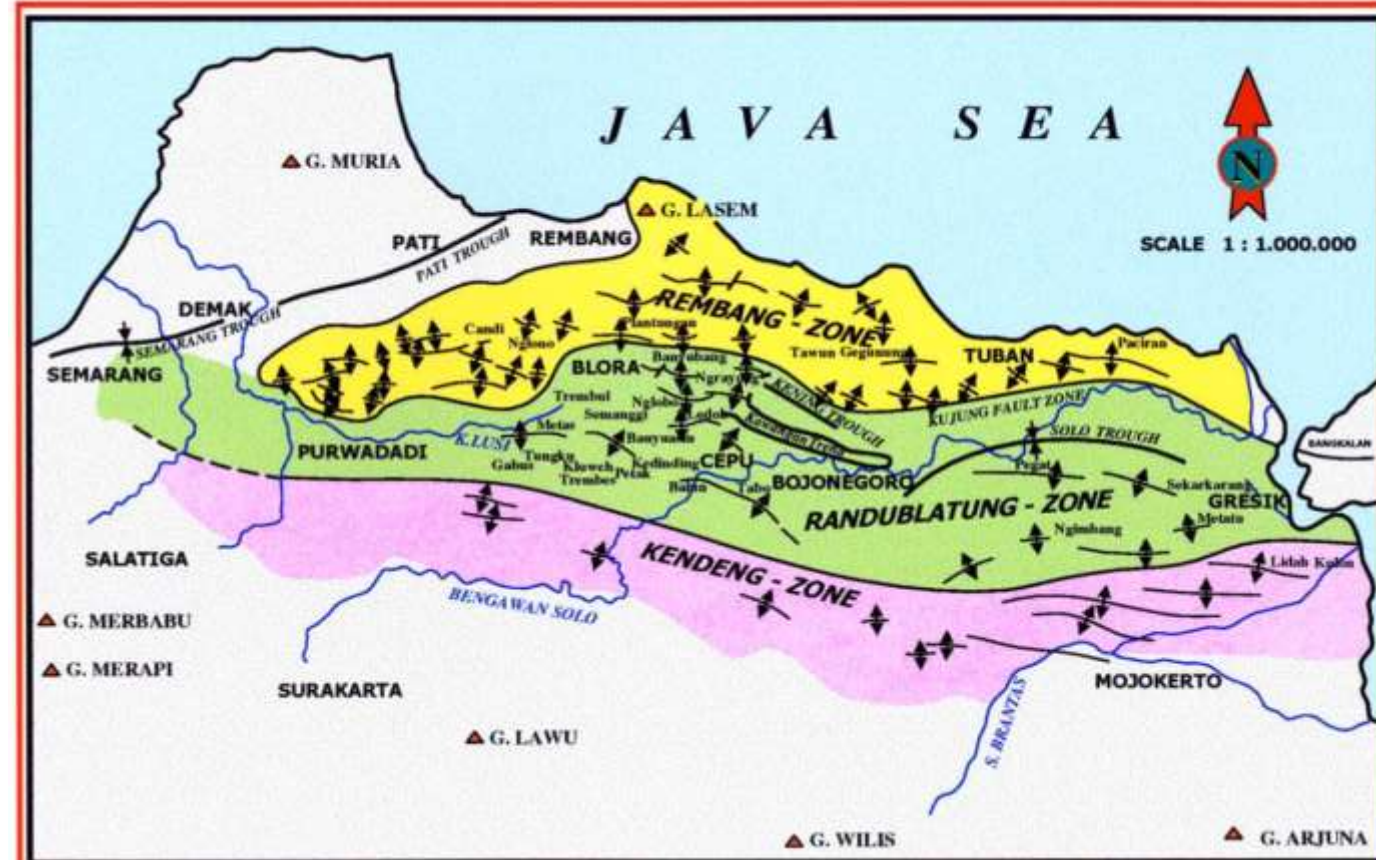
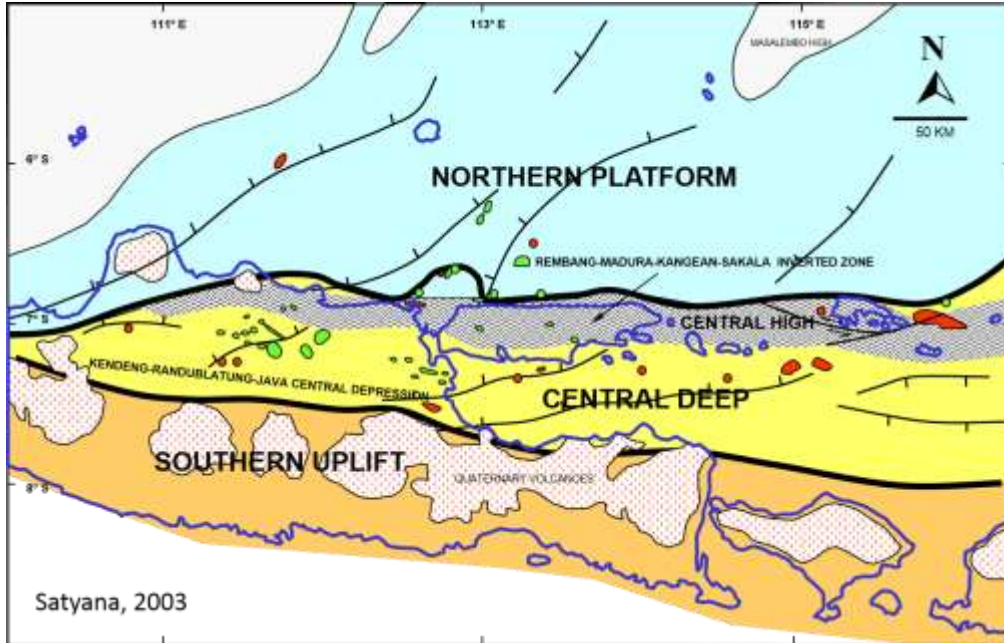
Lunt, 2013

Location map for south-eastern Java

- Strontium isotopic values ($^{87}\text{Sr}/^{86}\text{Sr}$) from Whitford (1975), averaged for each location, showing reducing values towards Bali. Whitford shows that island arc subduction below continental crust results in contamination by sialic Sr and ratios typically above 0.7040 - as seen across Java, while subduction of oceanic crust under oceanic crust has ratios around 0.7036 to 0.7038. Also the occurrence of highly siliceous magmas in many parts of the Southern Mountains, e.g. the "Merawan Granite" indicates the presence of sialic crust below these locations
- Jaten Fm. near Pacitan. The samples illustrated in Smyth et al 2003 of concentrations of volcanic (beta) quartz crystals
- Oligo-Miocene intrusions at Nanggulan, Turen and Jember of Smyth et al (2003) containing zircons with pre-Cambrian ages (500 to 3200 MYBP)
- Panggul Marble location

PENDAHULUAN

Structure of NE Java Basin

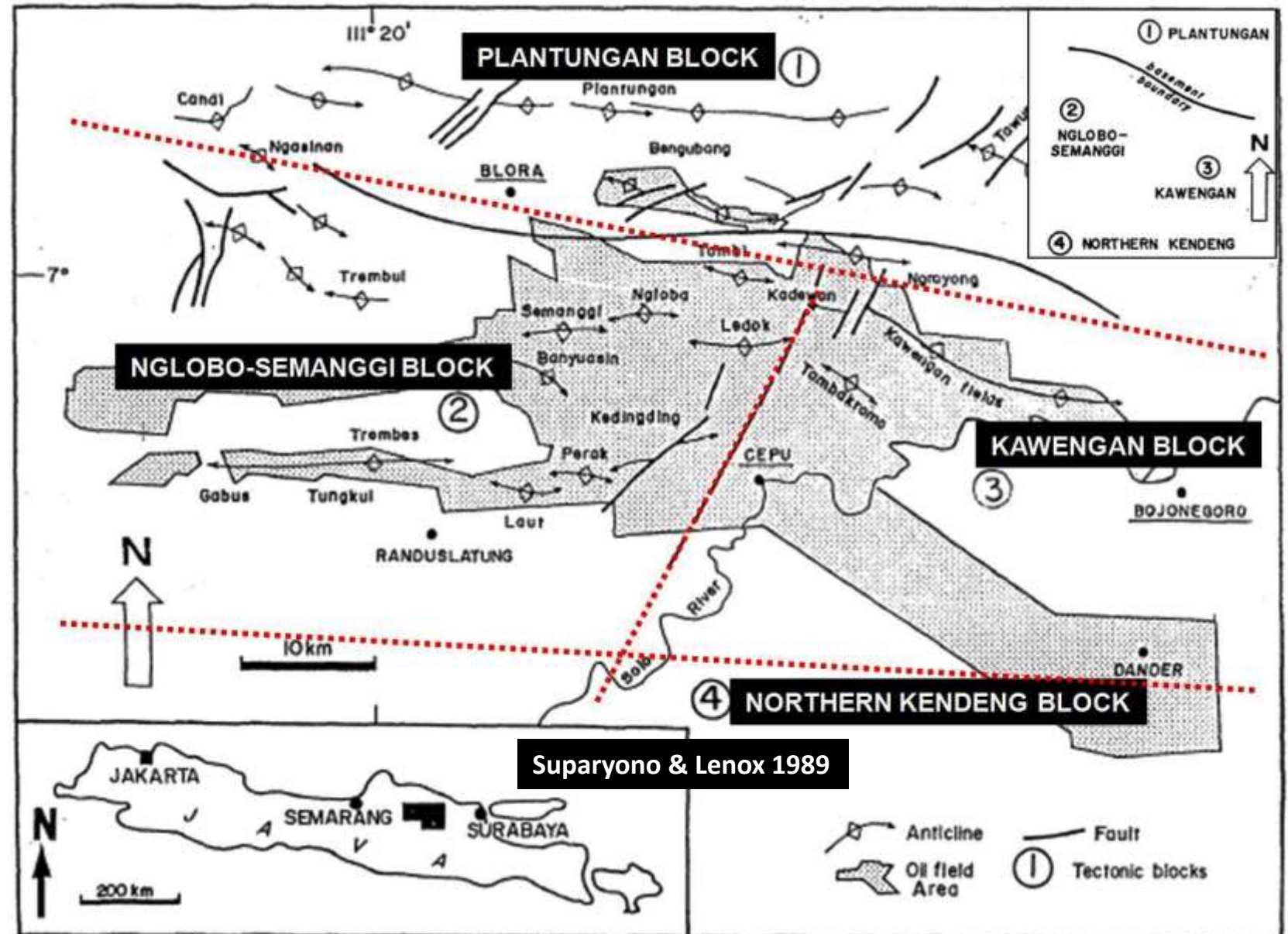


Three structure maps

Musliki, 1991

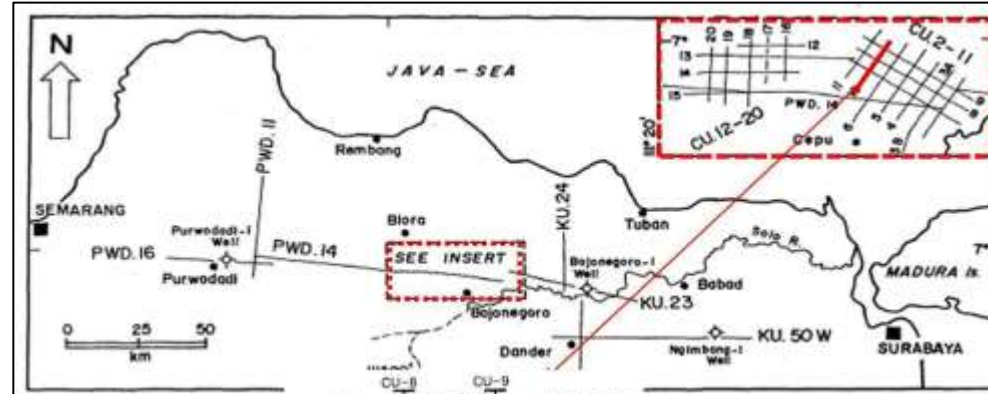
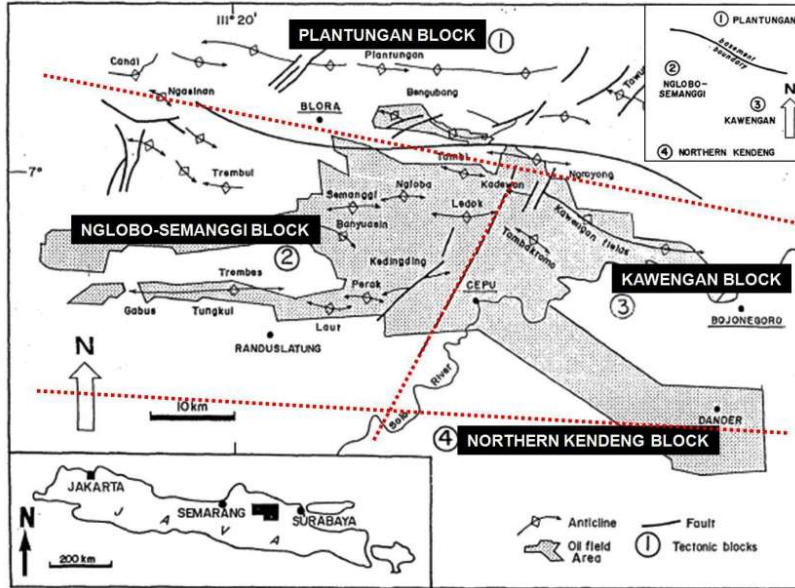
PENDAHULUAN

Previous study: Part of RMKS in Cepu Area (1)

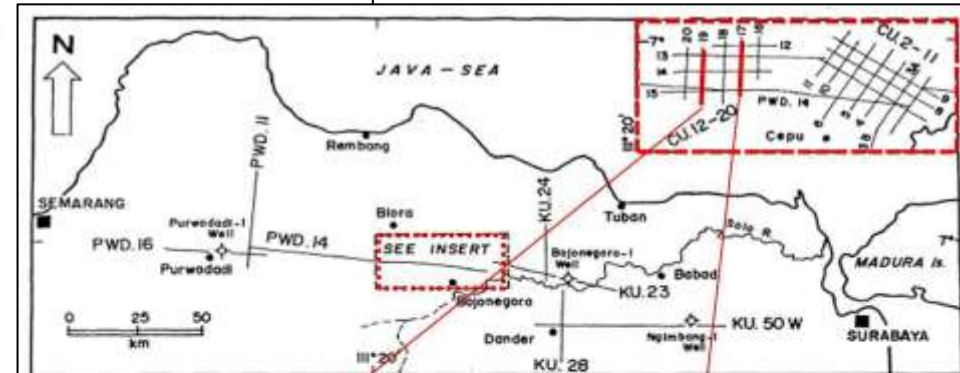
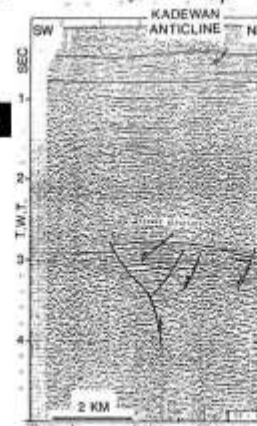


PENDAHULUAN

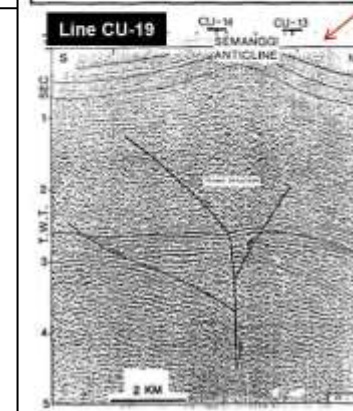
Previous study: Part of RMKS in Cepu Area (2)



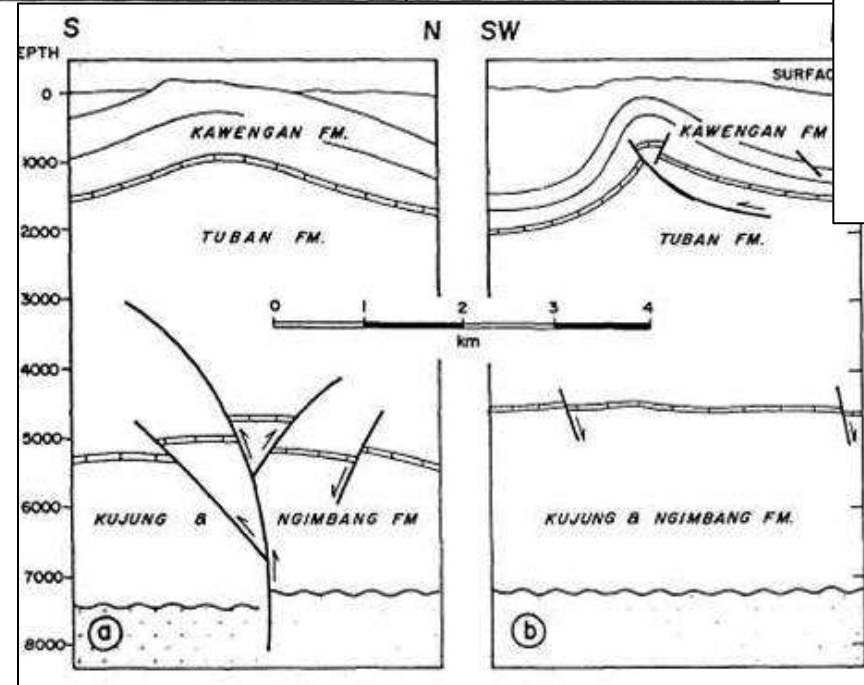
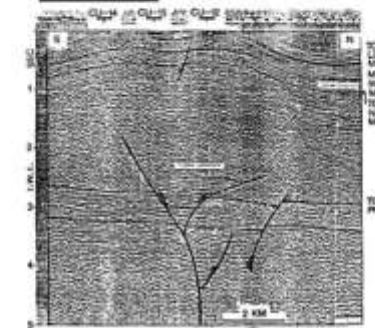
Line CU-10



Line CU-19



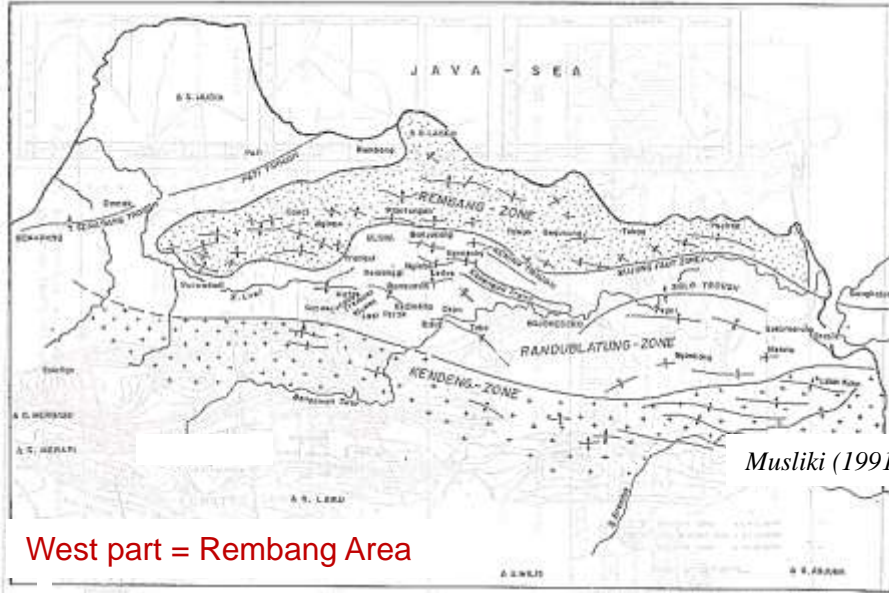
Line CU-17



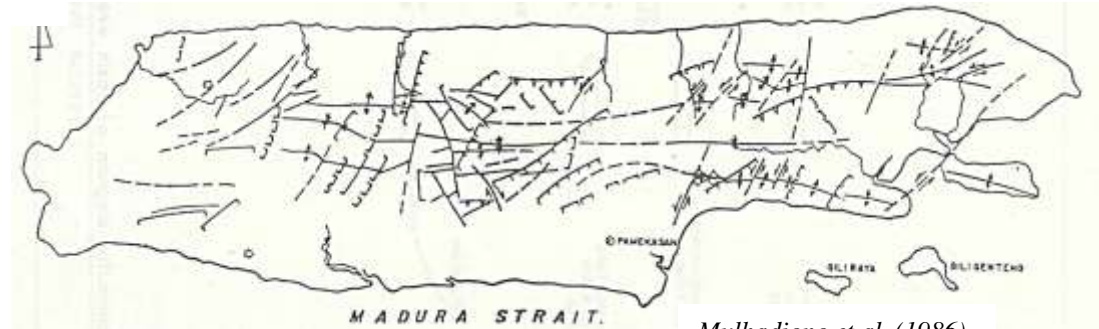
Suparyono & Lenox 1989

PENDAHULUAN

Previous Studies: Parts of RMKS Fault System

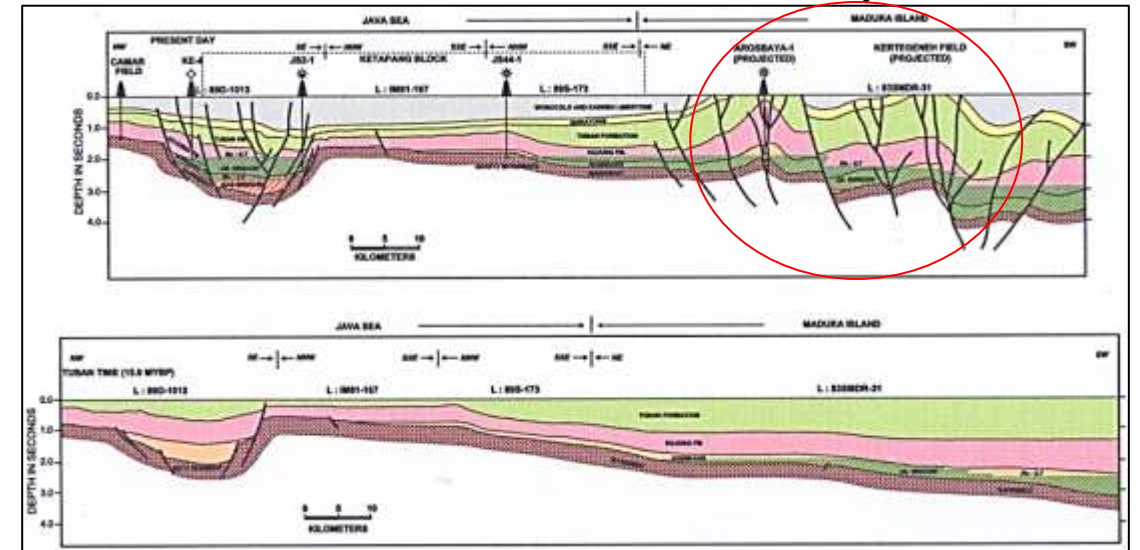


West part = Rembang Area

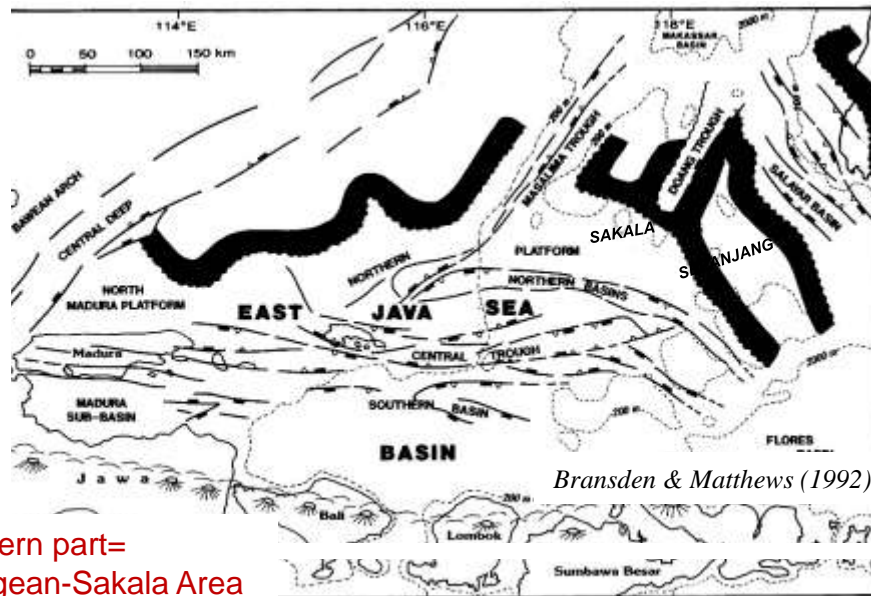


Central Part = Madura Area

Mulhadiono et al. (1986)



From:
Satyana et al 2004

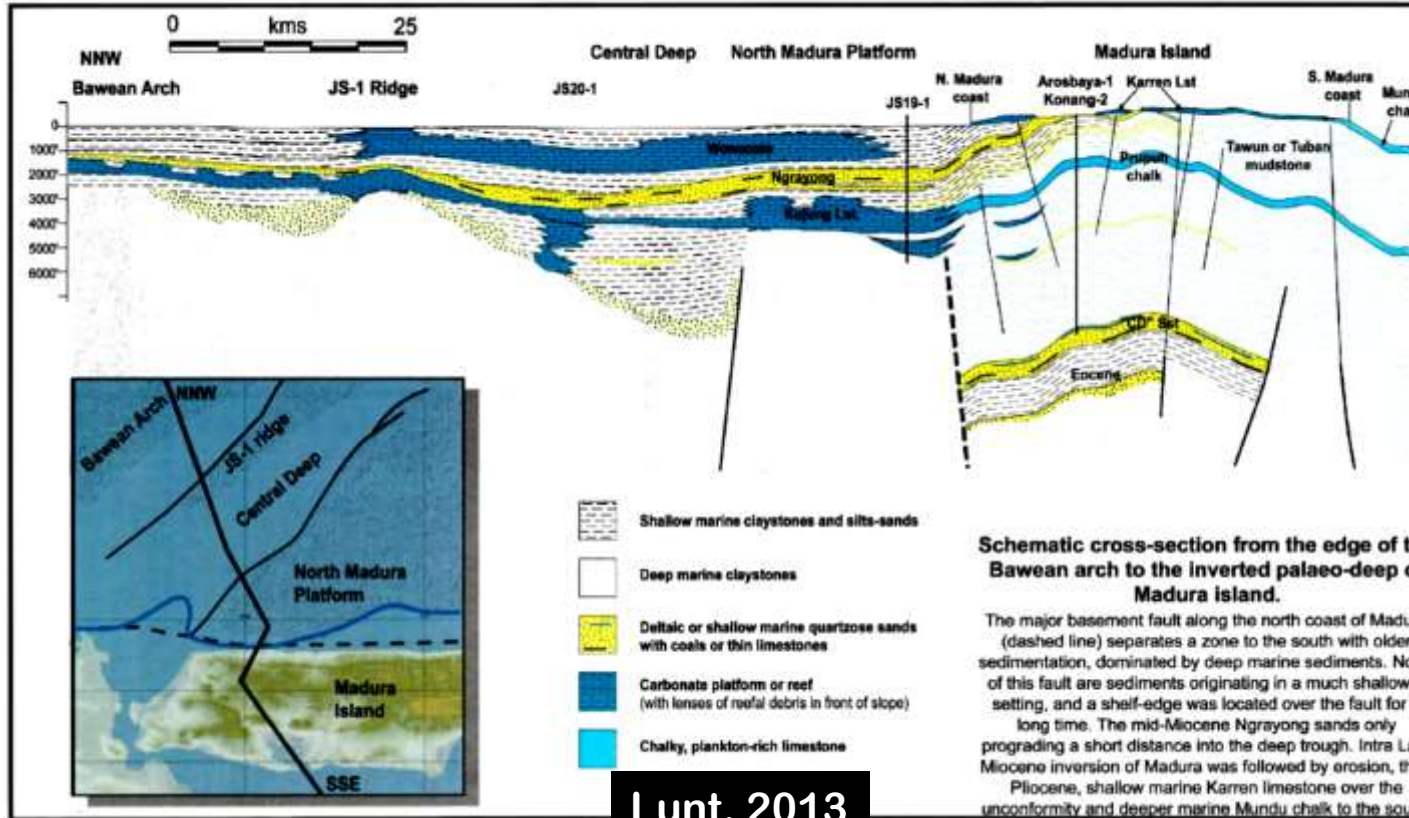


Eastern part=
Kangean-Sakala Area

Brandsen & Matthews (1992)

PENDAHULUAN

Previous Studies: Parts of RMKS Fault System

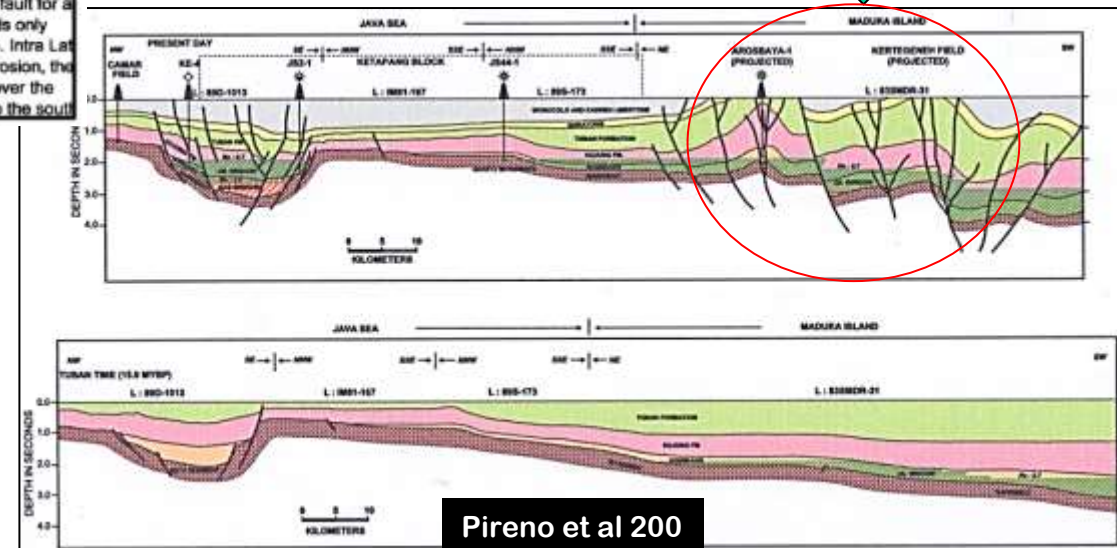


Lunt, 2013

Schematic cross-section from the edge of the Bawean arch to the inverted palaeo-deep of Madura island.

The major basement fault along the north coast of Madura (dashed line) separates a zone to the south with older sedimentation, dominated by deep marine sediments. North of this fault are sediments originating in a much shallower setting, and a shelf-edge was located over the fault for a long time. The mid-Miocene Ngrayong sands only prograding a short distance into the deep trough. Intra Lat Miocene inversion of Madura was followed by erosion, the Pliocene, shallow marine Karren limestone over the unconformity and deeper marine Mundu chalk to the south.

X-Section MADURA ISLAND



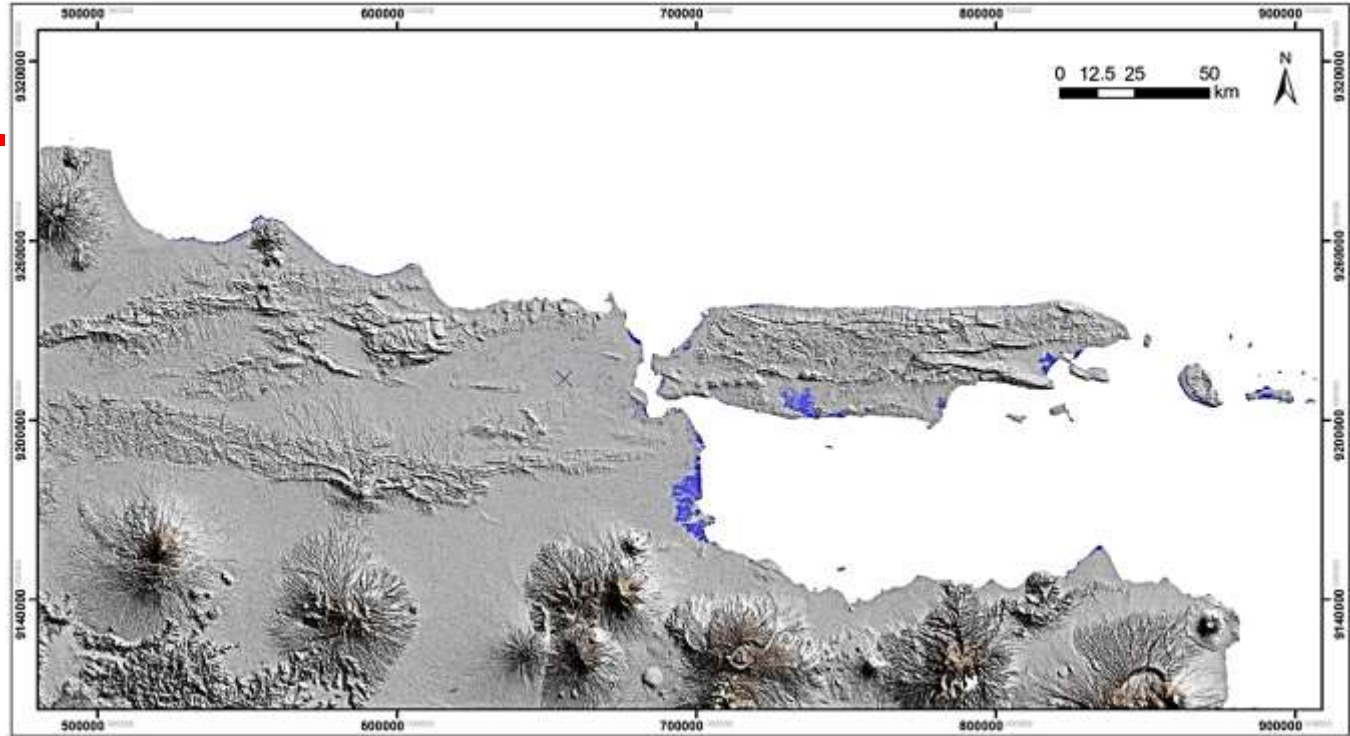
PENDAHULUAN

Sistem Sesar Mendatar & Sesar RMKS

En Echelon Folds

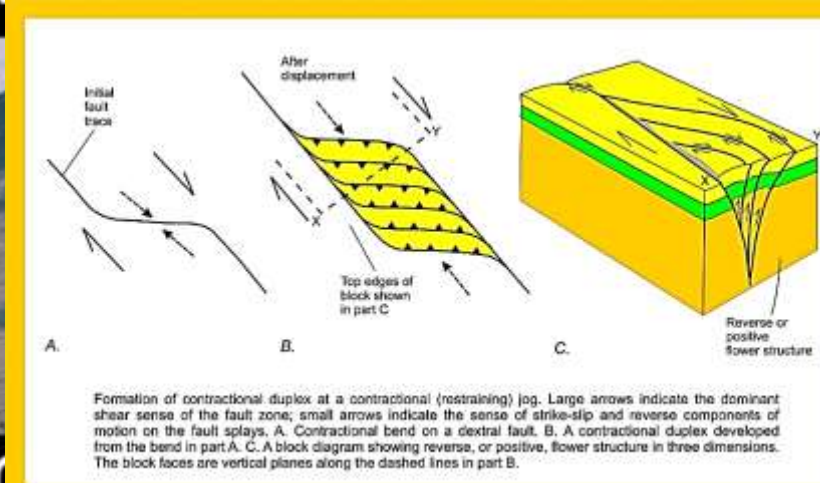
A. INCIPIENT WRENCH ZONE

Simple Shear deformation

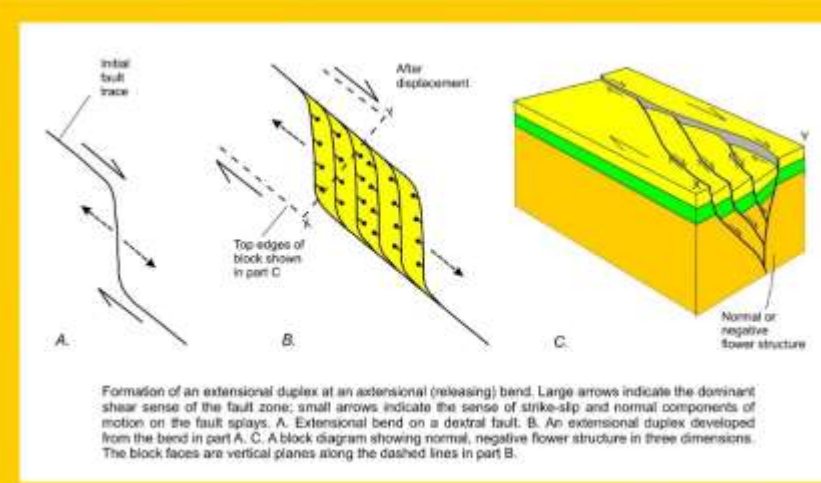


En Echelon Folds

A. INCIPIENT WRENCH ZONE



Formation of contractional duplex at a contractional (restraining) jog. Large arrows indicate the dominant shear sense of the fault zone; small arrows indicate the sense of strike-slip and reverse components of motion on the fault splays. A. Contractional bend on a dextral fault. B. A contractional duplex developed from the bend in part A. C. A block diagram showing reverse, or positive, flower structure in three dimensions. The block faces are vertical planes along the dashed lines in part B.



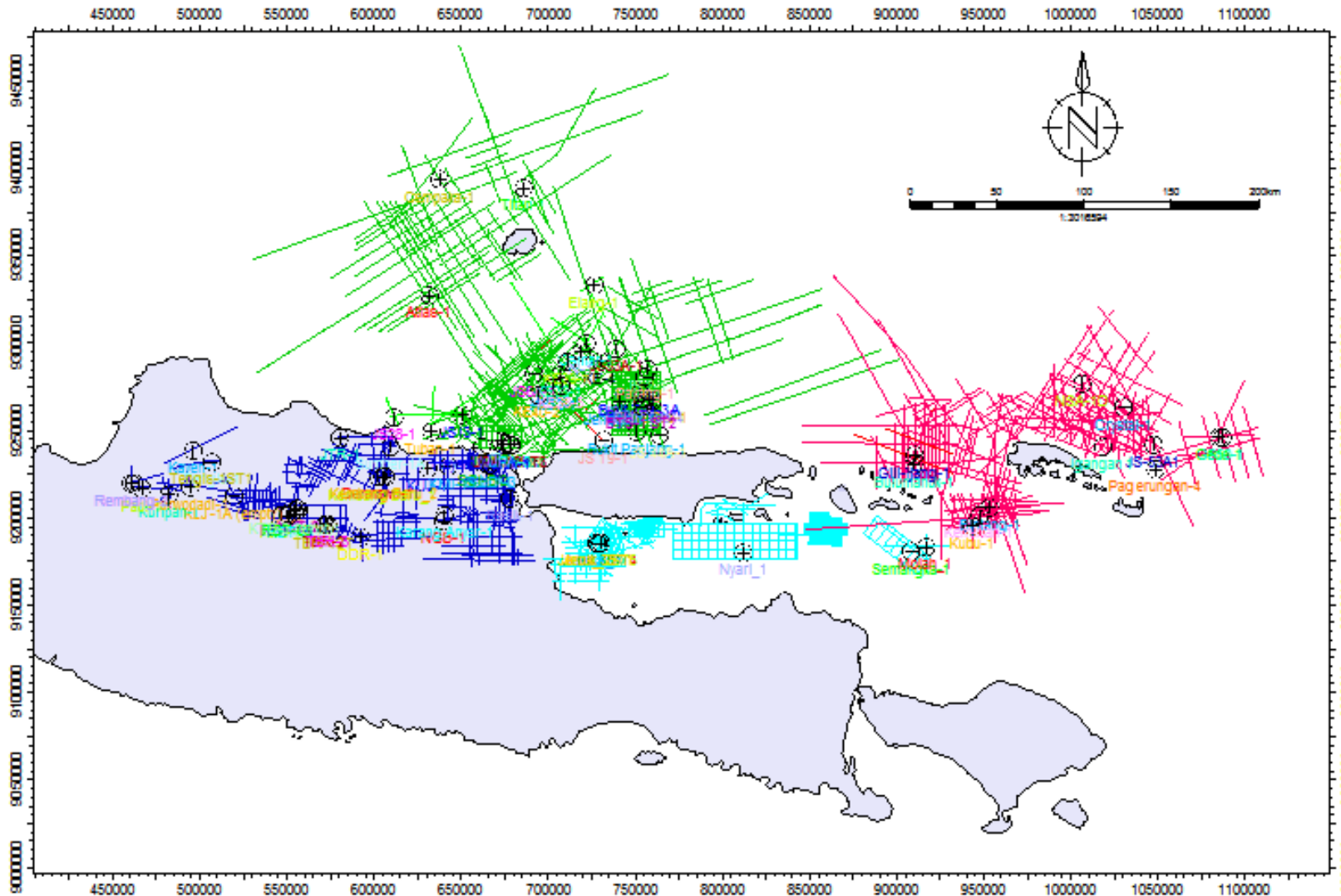
Formation of an extensional duplex at an extensional (releasing) bend. Large arrows indicate the dominant shear sense of the fault zone; small arrows indicate the sense of strike-slip and normal components of motion on the fault splays. A. Extensional bend on a dextral fault. B. An extensional duplex developed from the bend in part A. C. A block diagram showing normal, negative flower structure in three dimensions. The block faces are vertical planes along the dashed lines in part B.

PEMBAHASAN



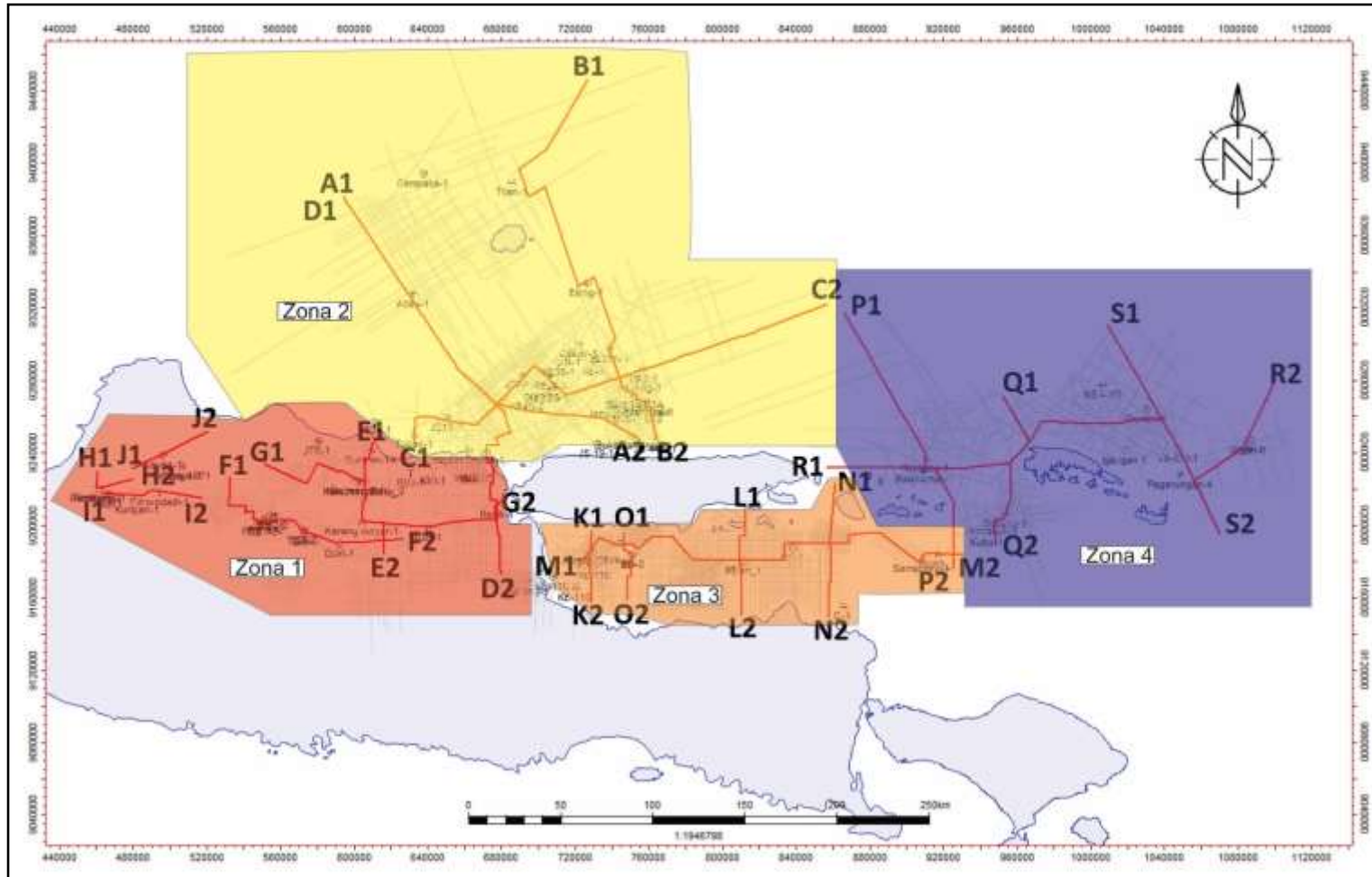
- PENDAHULUAN
- **DATA & METODA**
- HASIL ANALISIS
- KESIMPULAN

DATA & METODE



- 115 well data
- 766 lines 2D seismic
- 8 cubes 3D seismic

DATA & METODE



Red lines= regional seismic lines

- 115 well data
- 766 lines 2D seismic
- 8 cubes 3D seismic

PEMBAHASAN



- PENDAHULUAN
- DATA & METODA
- **HASIL ANALISIS**
- KESIMPULAN

HASIL ANALISIS

(INTERPRETATION OF LINE A1-A2)



Northern Platform

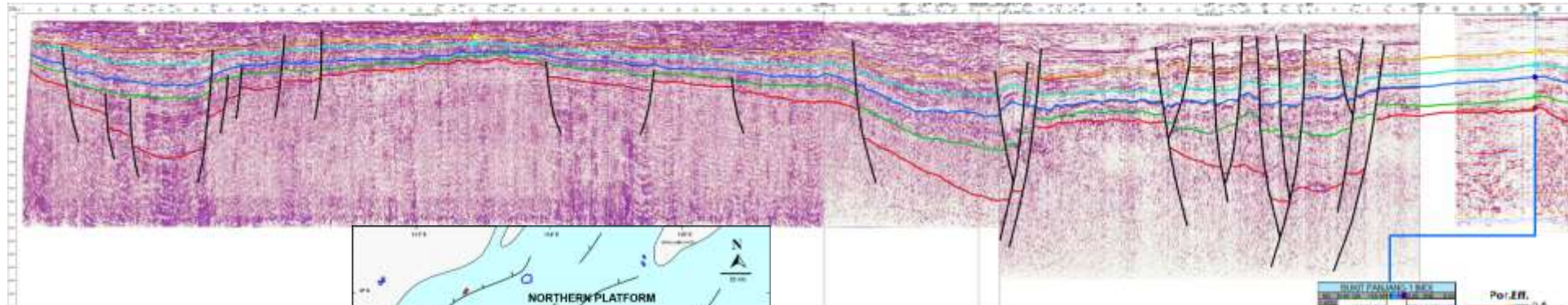


West **A1**

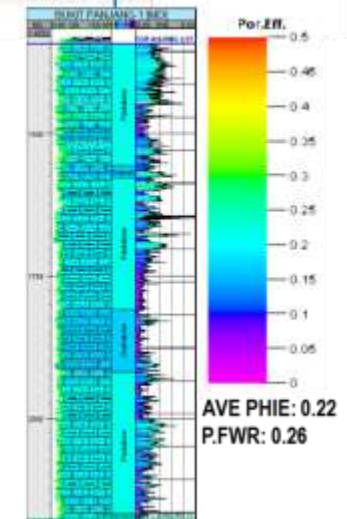
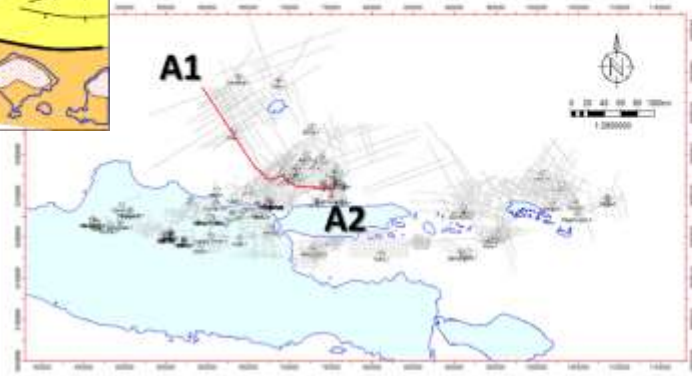
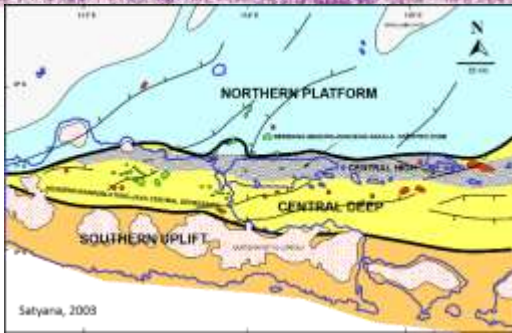
A2 East

Atlas-1

Bukit Panjang-1



- Legenda**
- Formasi Ngrayong
 - Formasi Rancak
 - Formasi Kujung
 - Formasi Ngimbang
 - Basement
 - AVE PHIE Porositas Efektif rata-rata
 - P.FWR Porositas dari Final Well Report

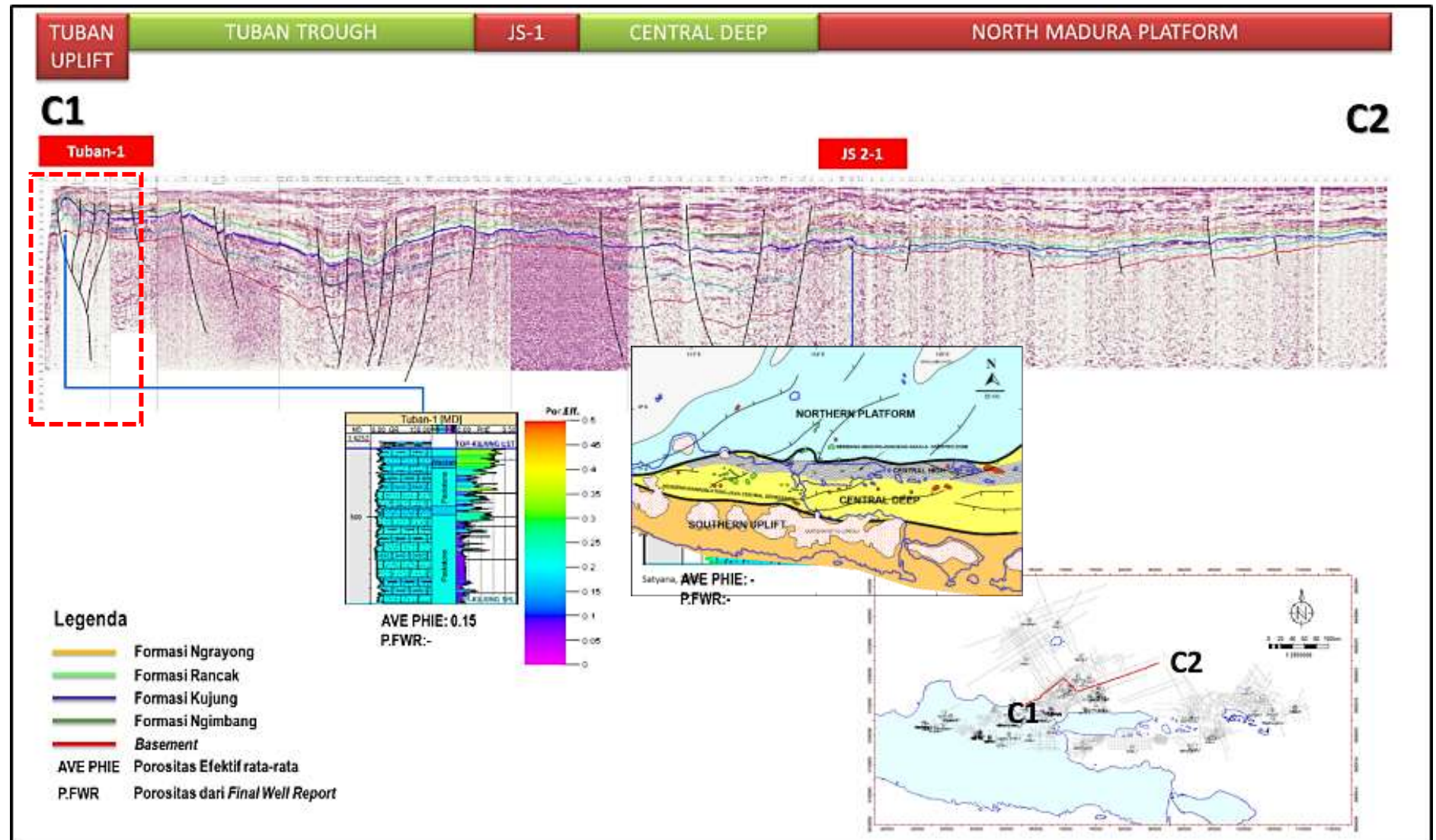


HASIL ANALISIS

(INTERPRETATION OF LINE C1-C2)

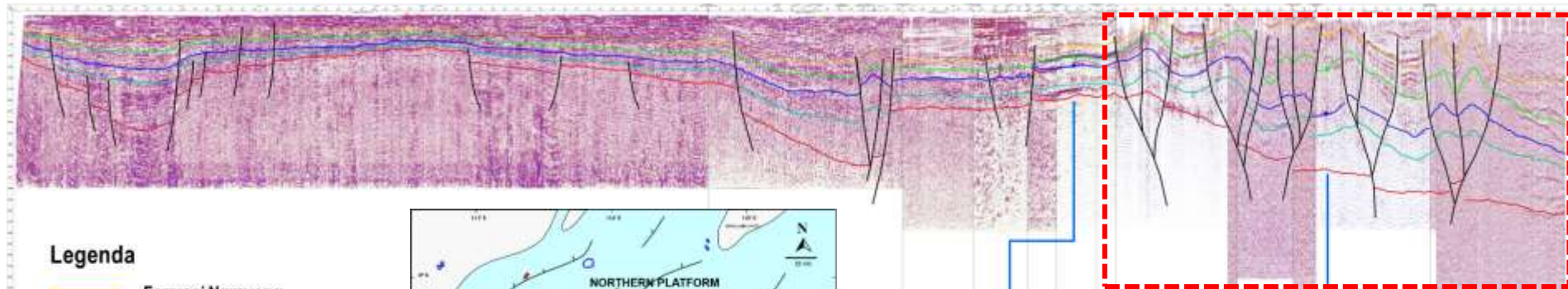


Northern Platform



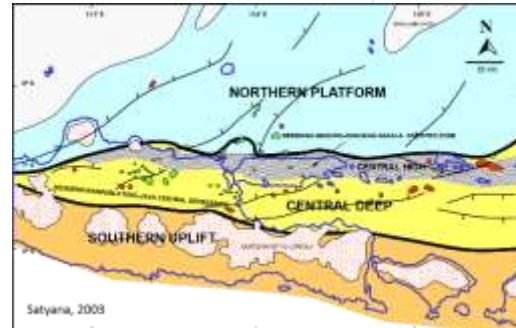
HASIL ANALISIS

(INTERPRETATION OF LINE D1-D2)



Legenda

- Formasi Ngrayong
- Formasi Rancak
- Formasi Kujung
- Formasi Ngimbang
- Basement
- AVE PHIE Porositas Efektif rata-rata
- P.FWR Porositas dari Final Well Report

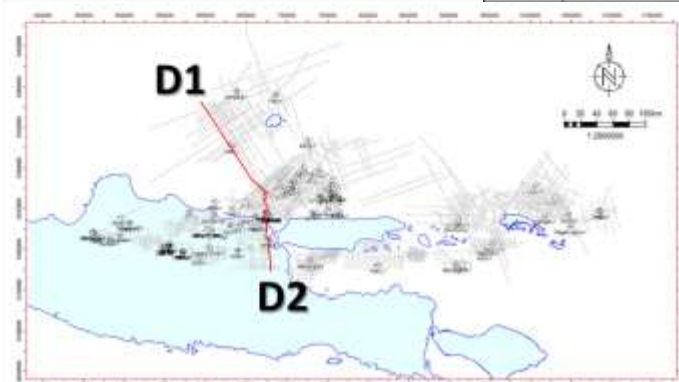
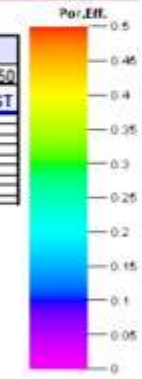


up-3 [MD]					
MD	0.00	GR	150.00	PHE	0.50
1.4252					
TOP-KUJUNG LST					
1500					

AVE PHIE: 0.13
P.FWR:-

Resik-1 [MD]					
MD	-1.45	GRST	96.95	PHE	0.50
1.33617					
TOP-KUJUNG LST					

AVE PHIE: 0.19
P.FWR:-



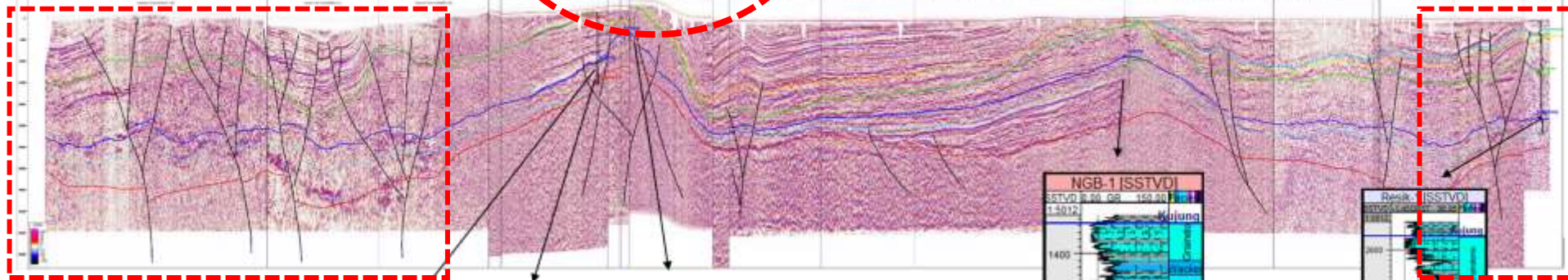
Central Part of RMKS FZ

HASIL ANALISIS

(INTERPRETATION OF LINE G1-G2)

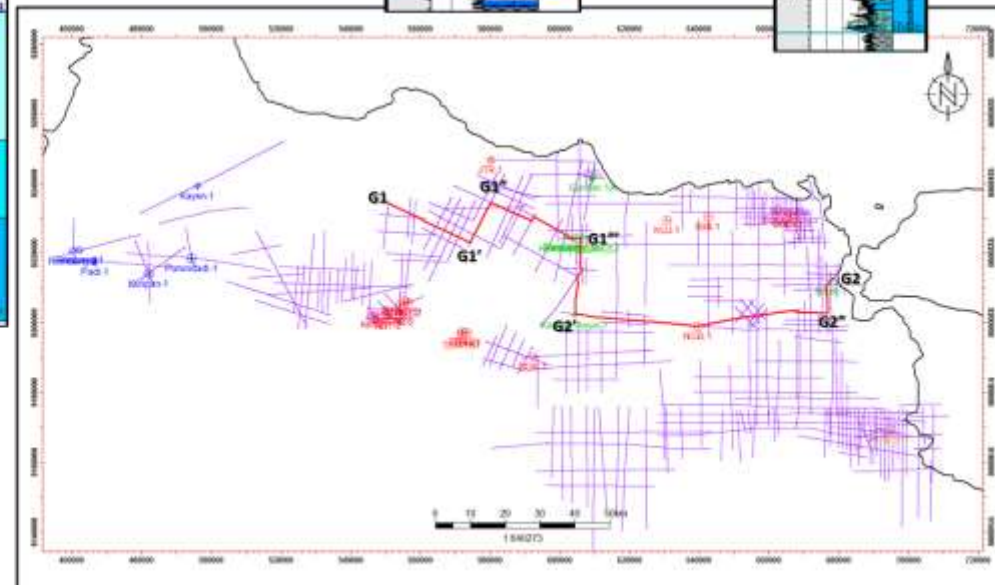
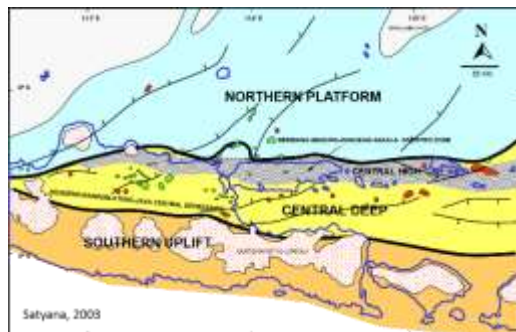
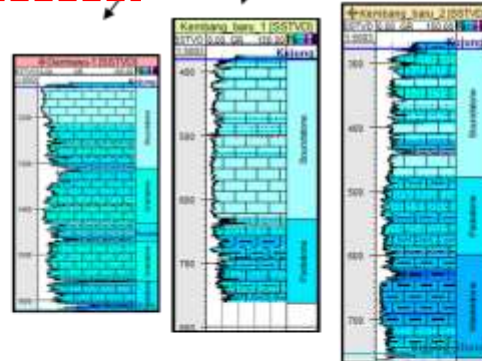


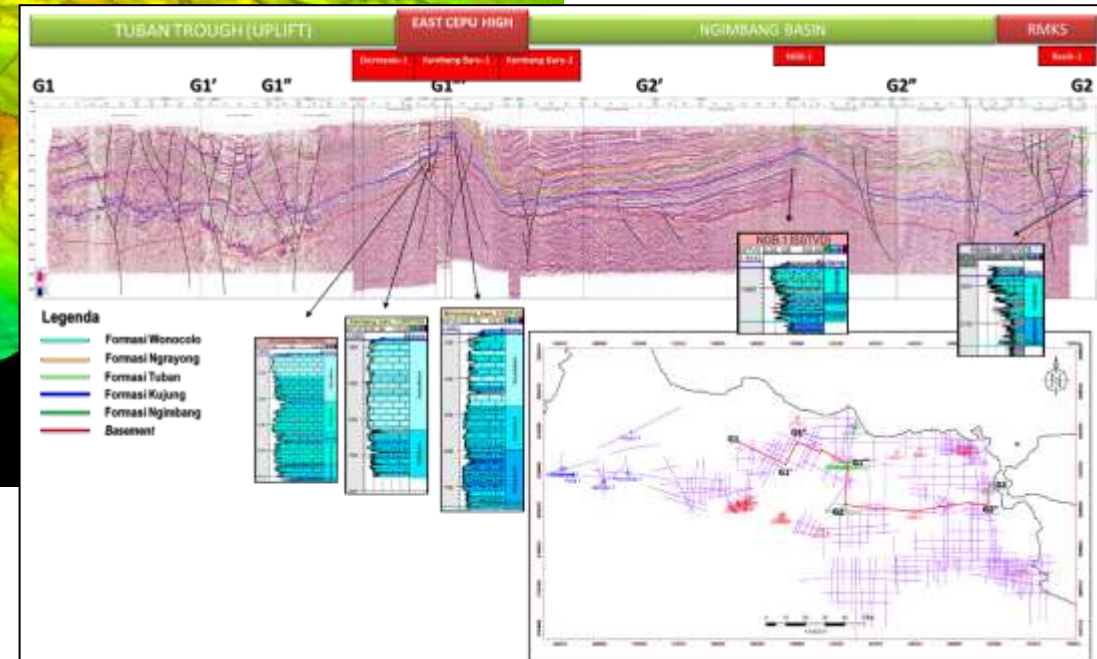
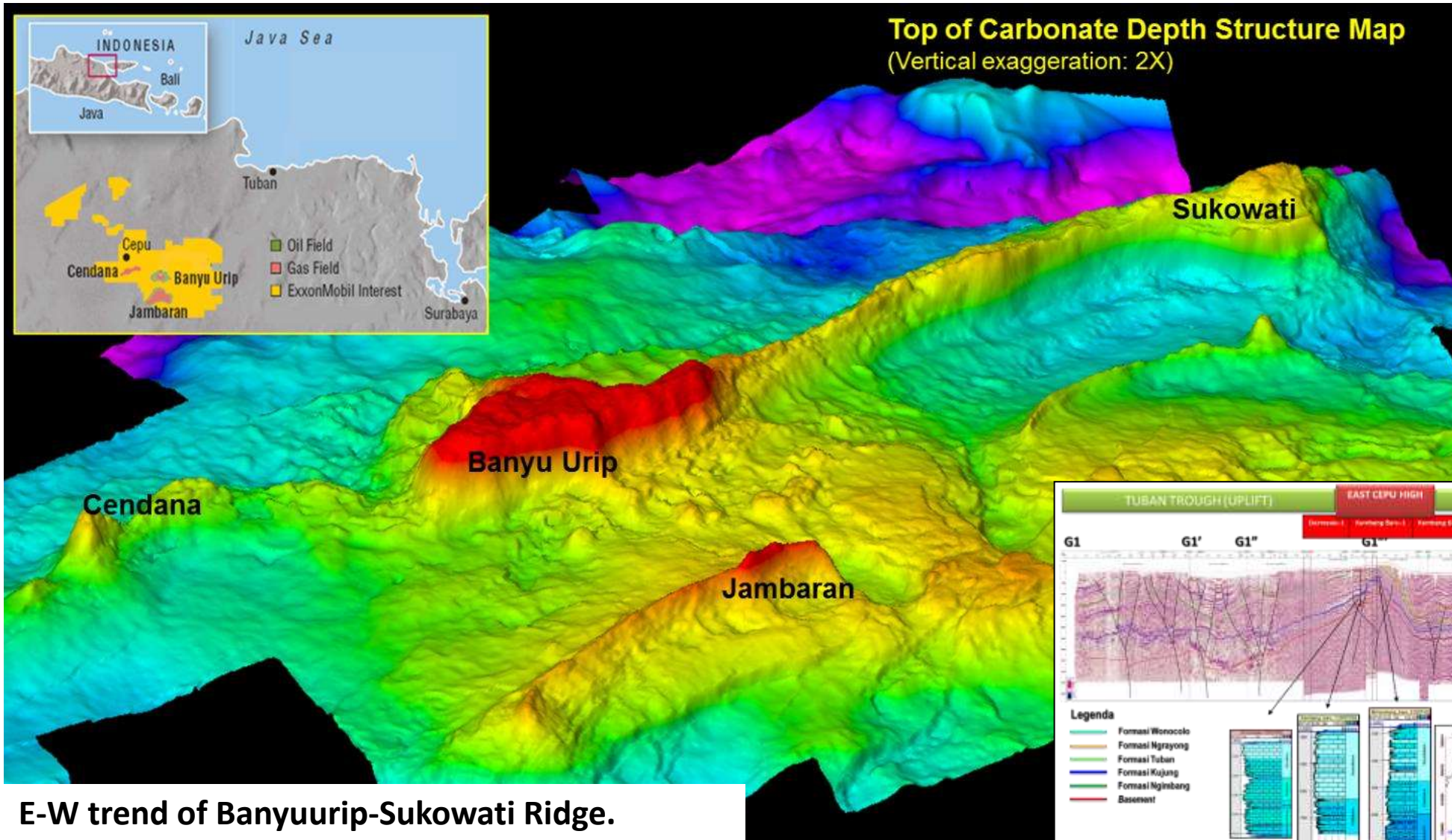
NE-SW or E-W trending ?



Legenda

- Formasi Wonocolo
- Formasi Ngrayong
- Formasi Tuban
- Formasi Kujung
- Formasi Ngimbang
- Basement





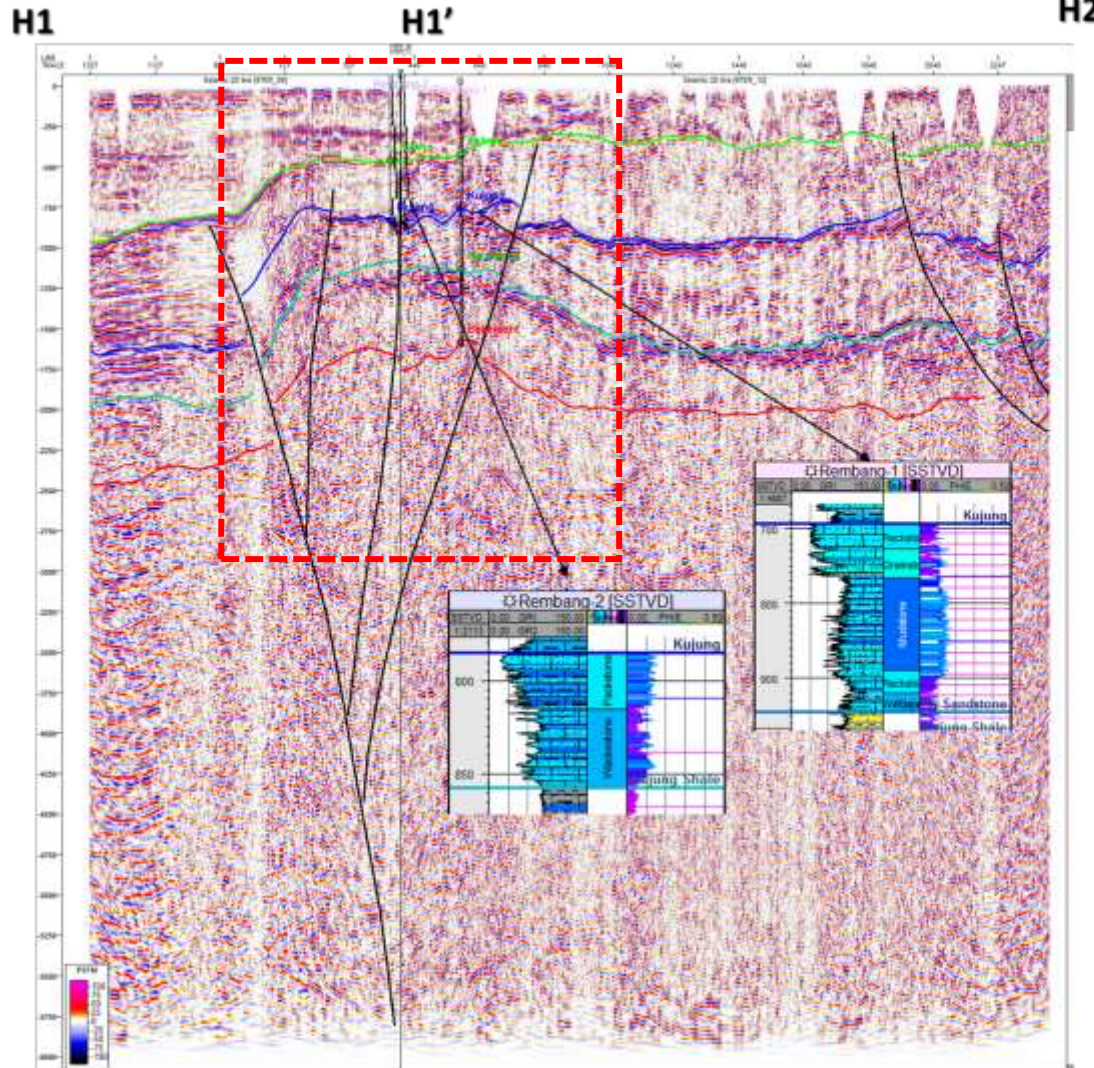
E-W trend of Banyuurip-Sukowati Ridge.
The ridge does not show Meratus trend (NE-SW) at the onshore of North East Java Basin (Hakiki; Musgrove, IPA-2015)

HASIL ANALISIS

(INTERPRETATION OF LINE H1-H2)



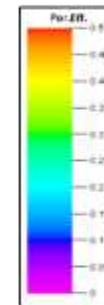
Western Part of RMKS FZ



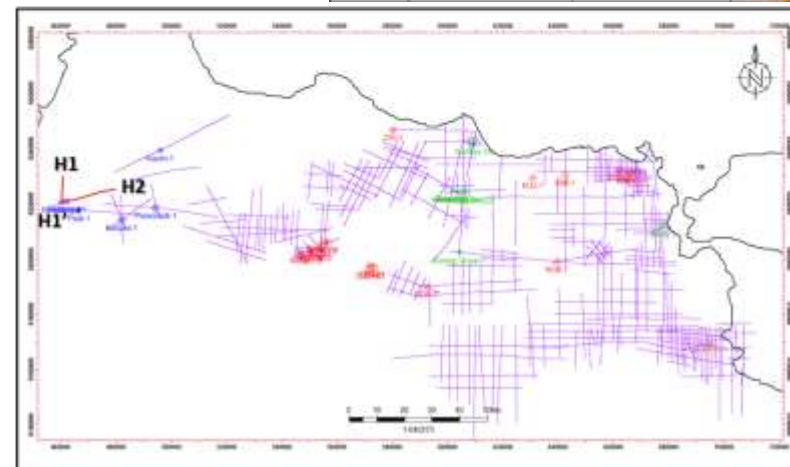
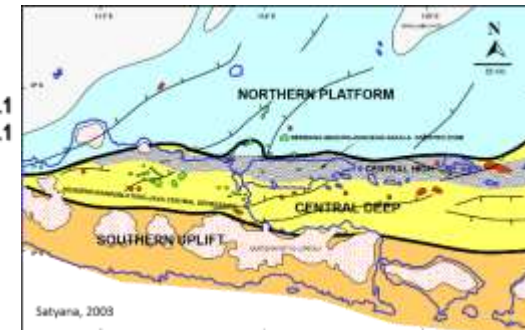
Legenda

- Formasi Tuban
- Formasi Kujung
- Formasi Ngimbang
- Basement

P. FWR Porositas dari Final Well Report



P. FWR
Rembang-1 : 0.1
Rembang-2 : 0.1

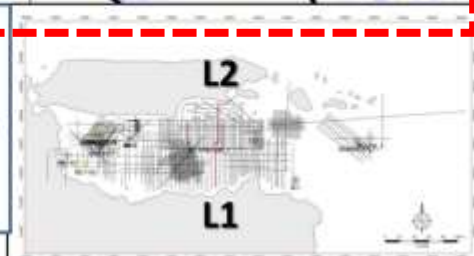
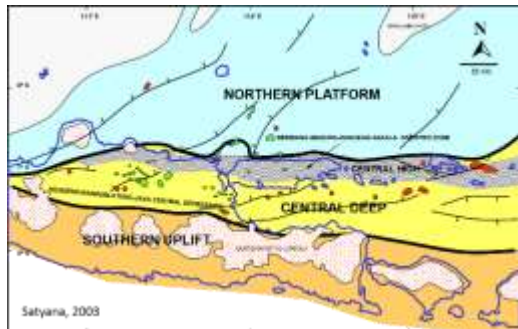
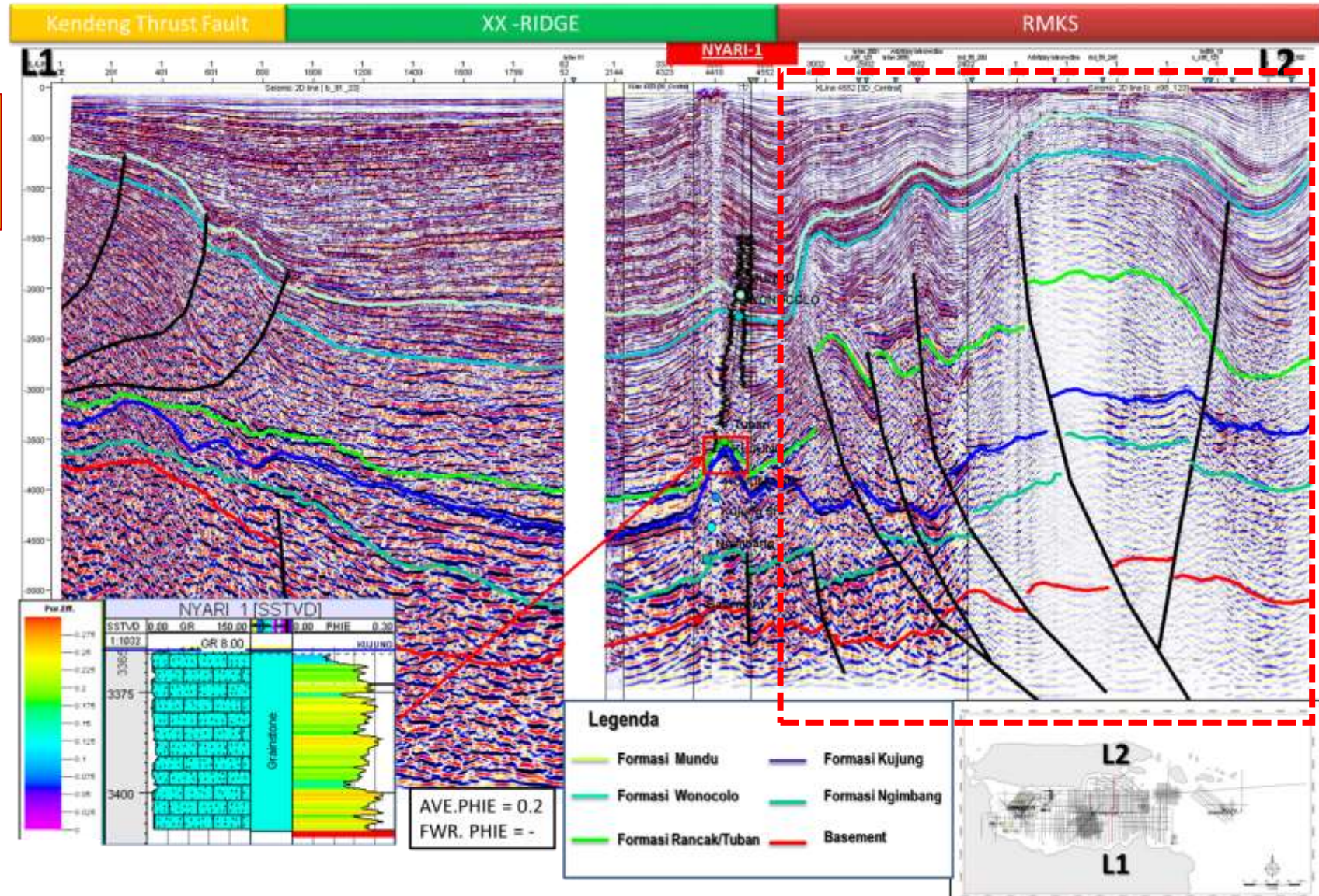


HASIL ANALISIS

(INTERPRETATION OF LINE L1-L2)



**SOUTHERN PART
OF RMKS FZ**

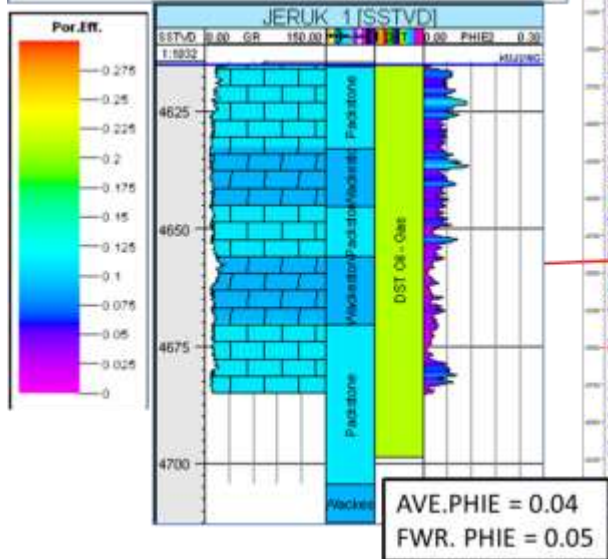
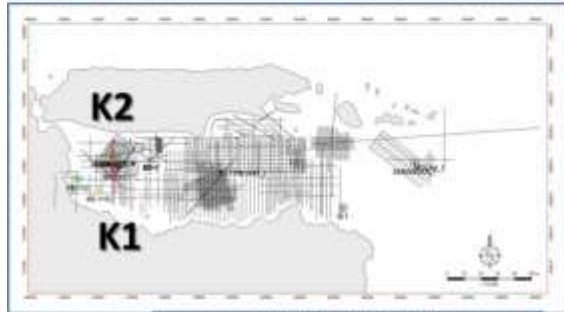
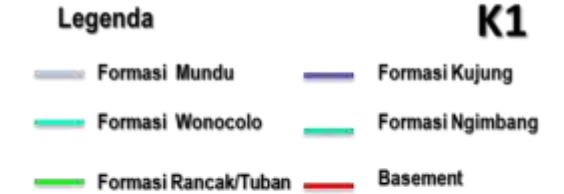
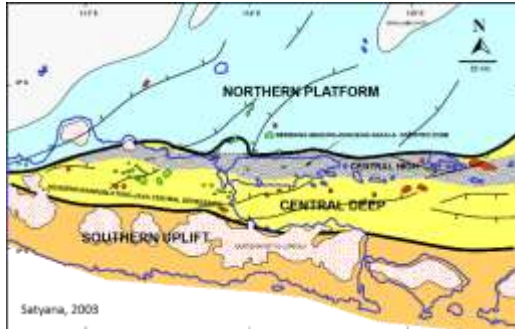


HASIL ANALISIS

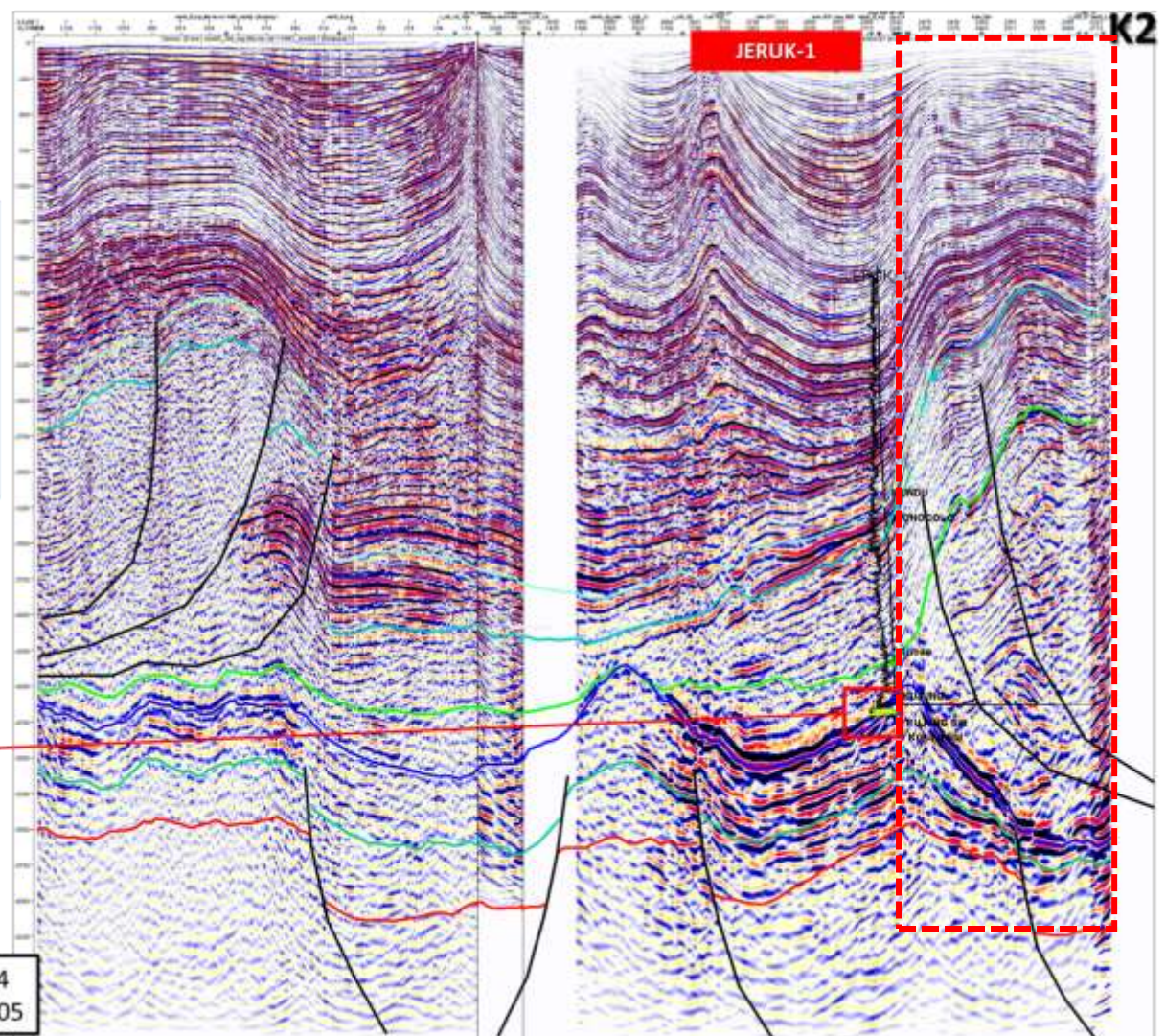
(INTERPRETATION OF LINE K1-K2)



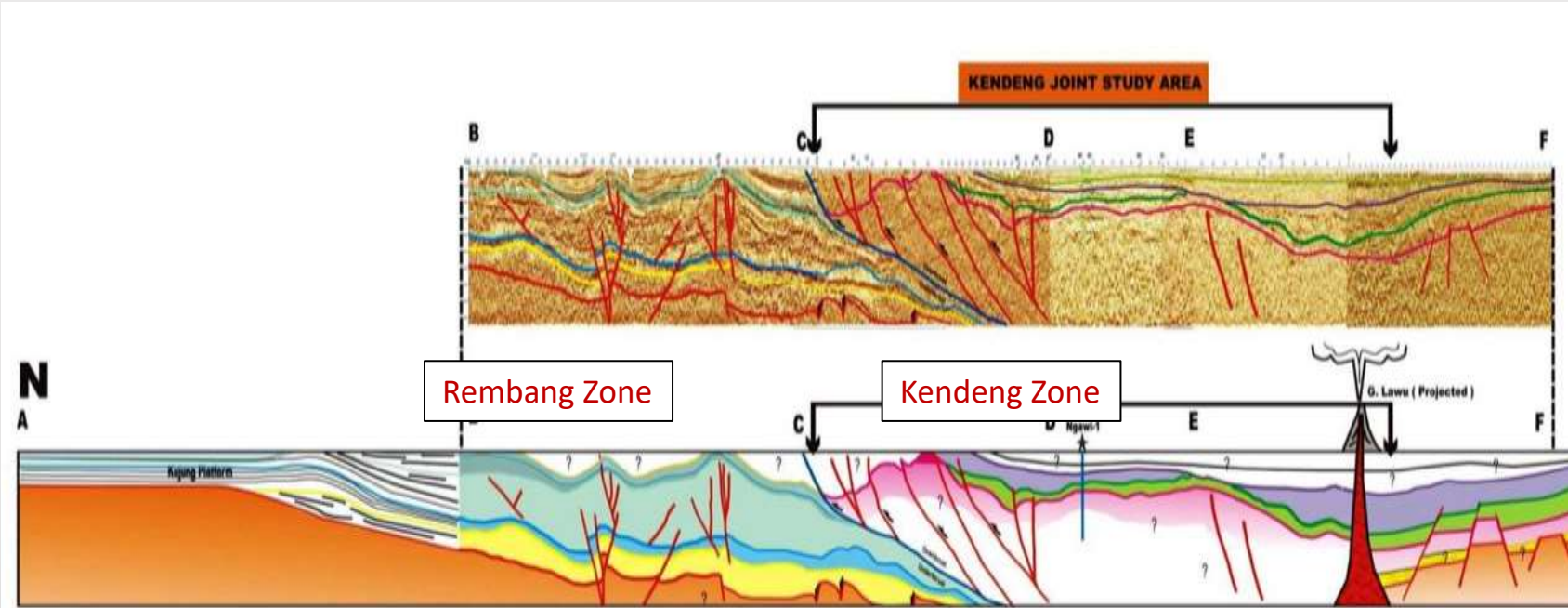
**SOUTHERN PART
OF RMKS FZ**



Kendeng Thrust Fault XX- RIDGE BD- RIDGE RMKS



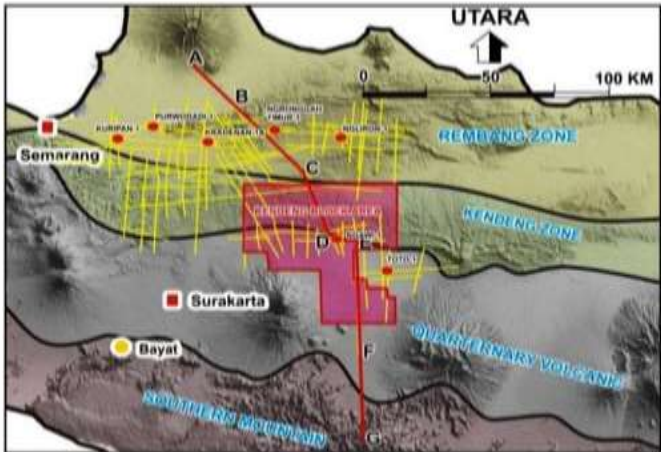
Regional N-S Cross Section: The Contact



KENDENG ZONE :

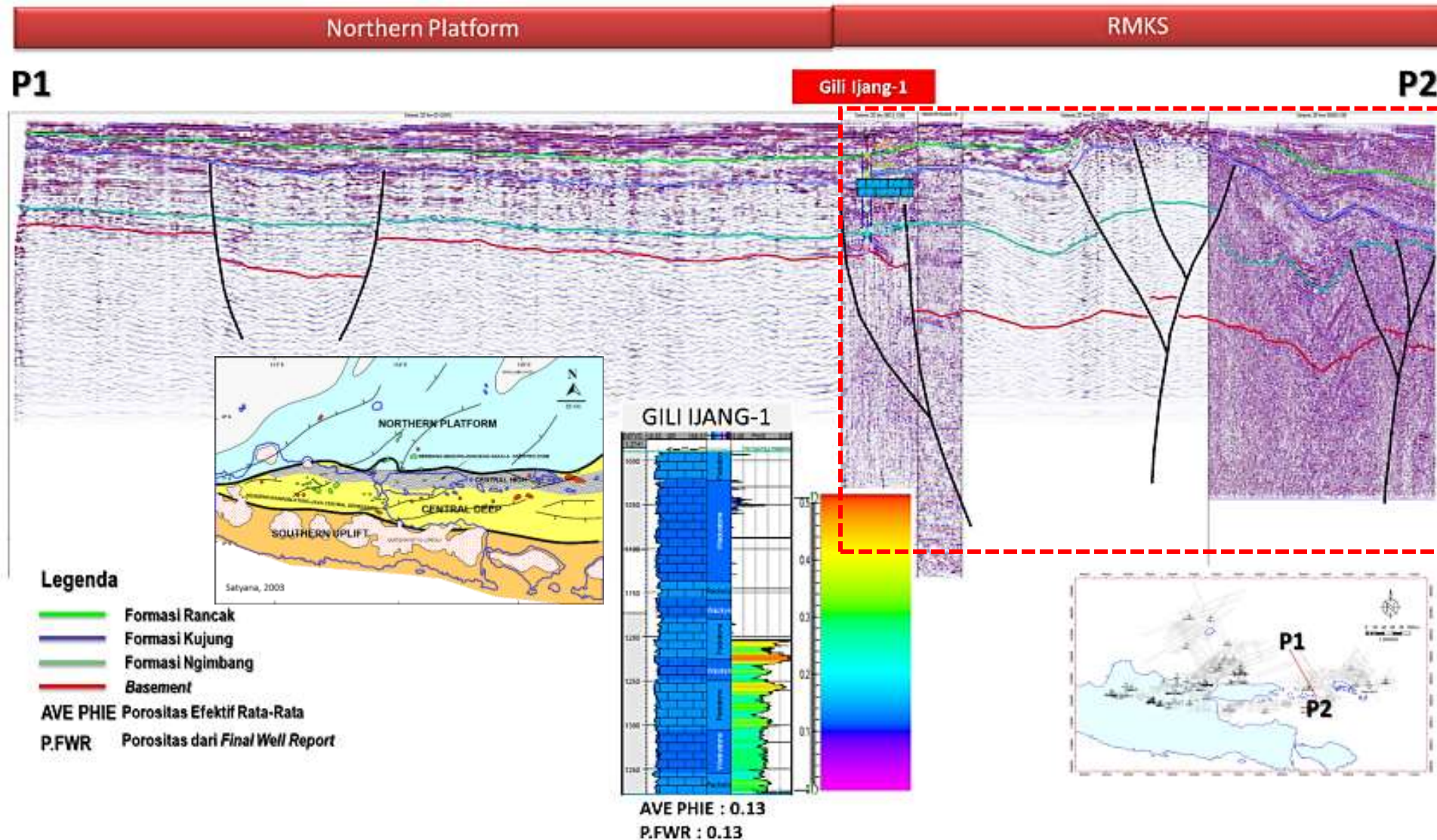
- = Top Ledok
 - = Top Wonocolo
 - = Top Tuban
 - = Top Tawun
 - = Top Tuban
 - = Top Kujung
 - = Top Ngimbang
 - = Basement
- = Top Kalibeng
 - = Top Banyak
 - = Top Kerek

Prasetyadi 2007



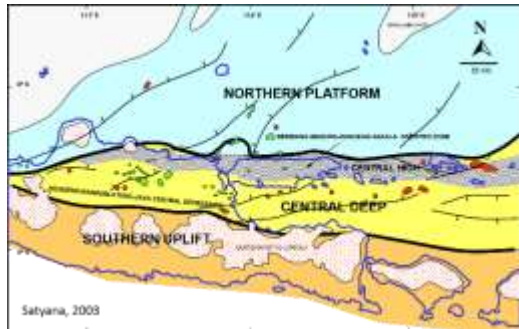
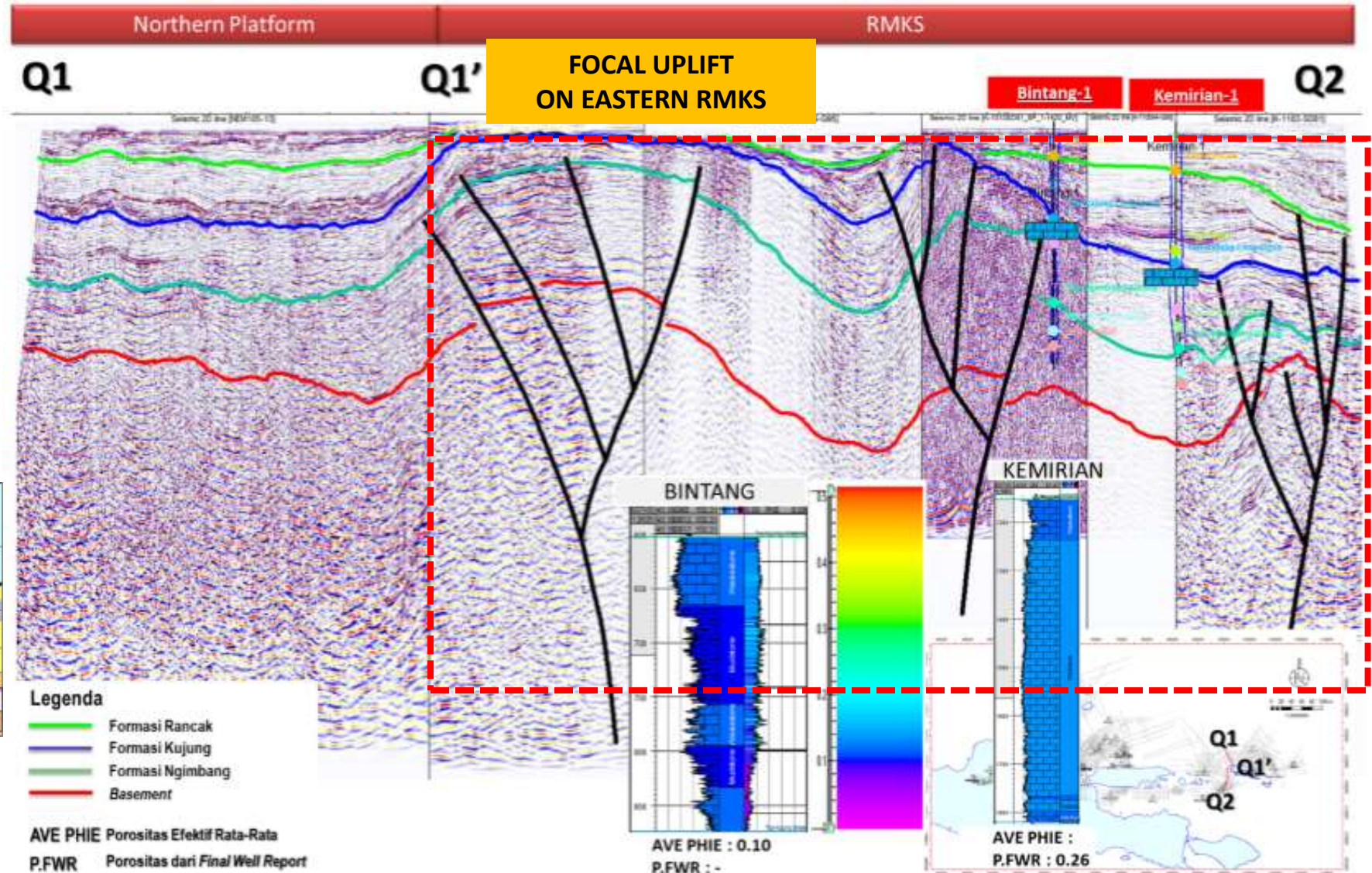
HASIL ANALISIS

(INTERPRETATION OF LINE P1-P2)



HASIL ANALISIS

(INTERPRETATION OF LINE Q1-Q2)

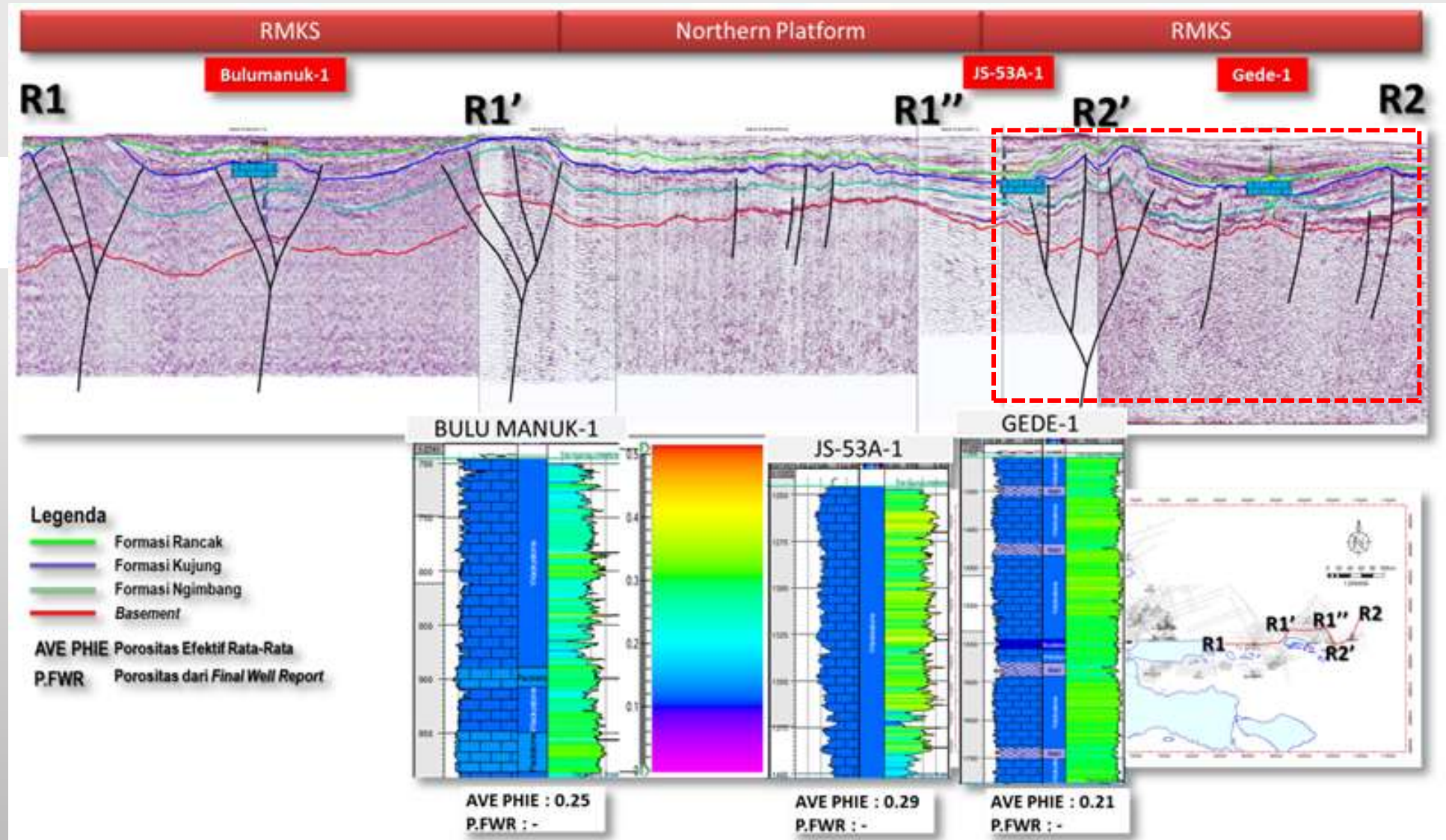


HASIL ANALISIS

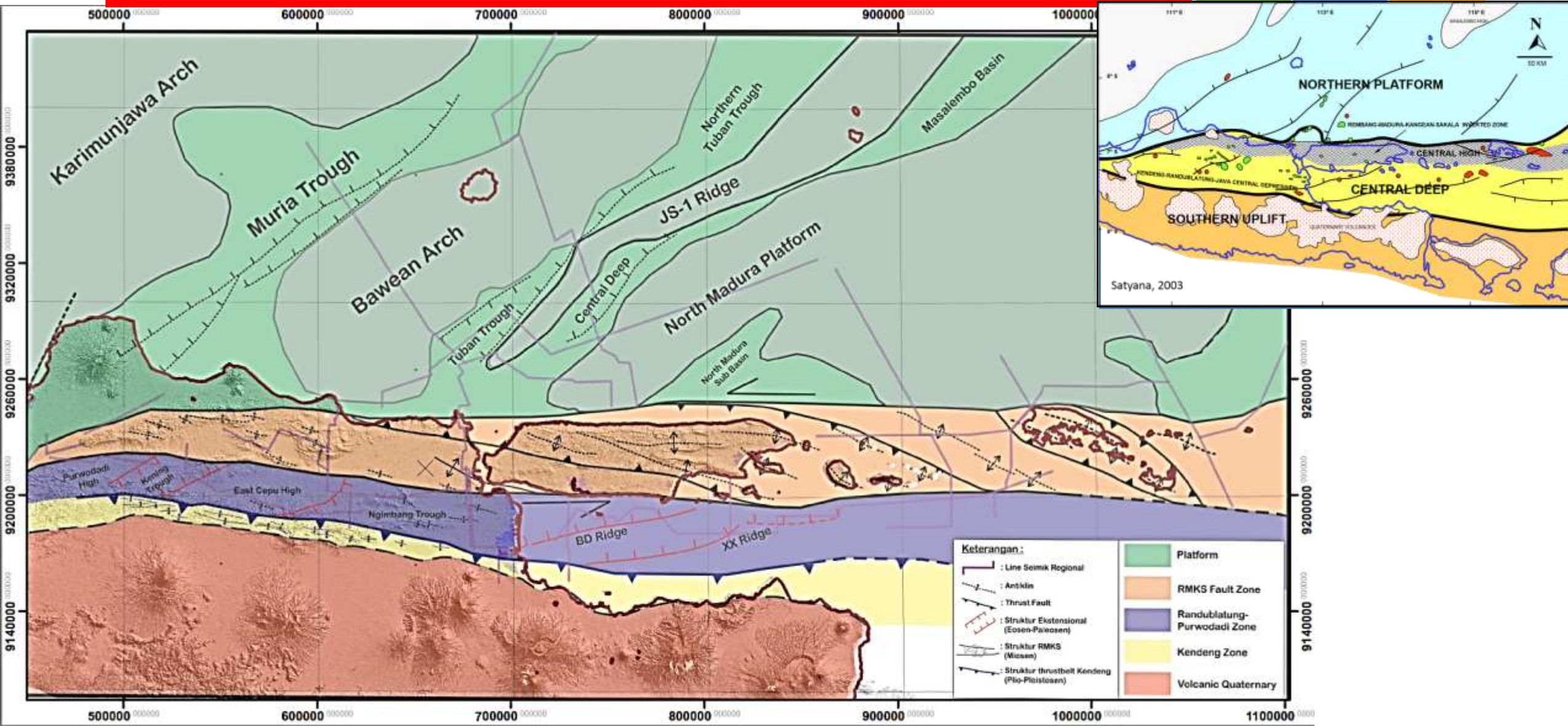
(INTERPRETASI LINE R1-R2)



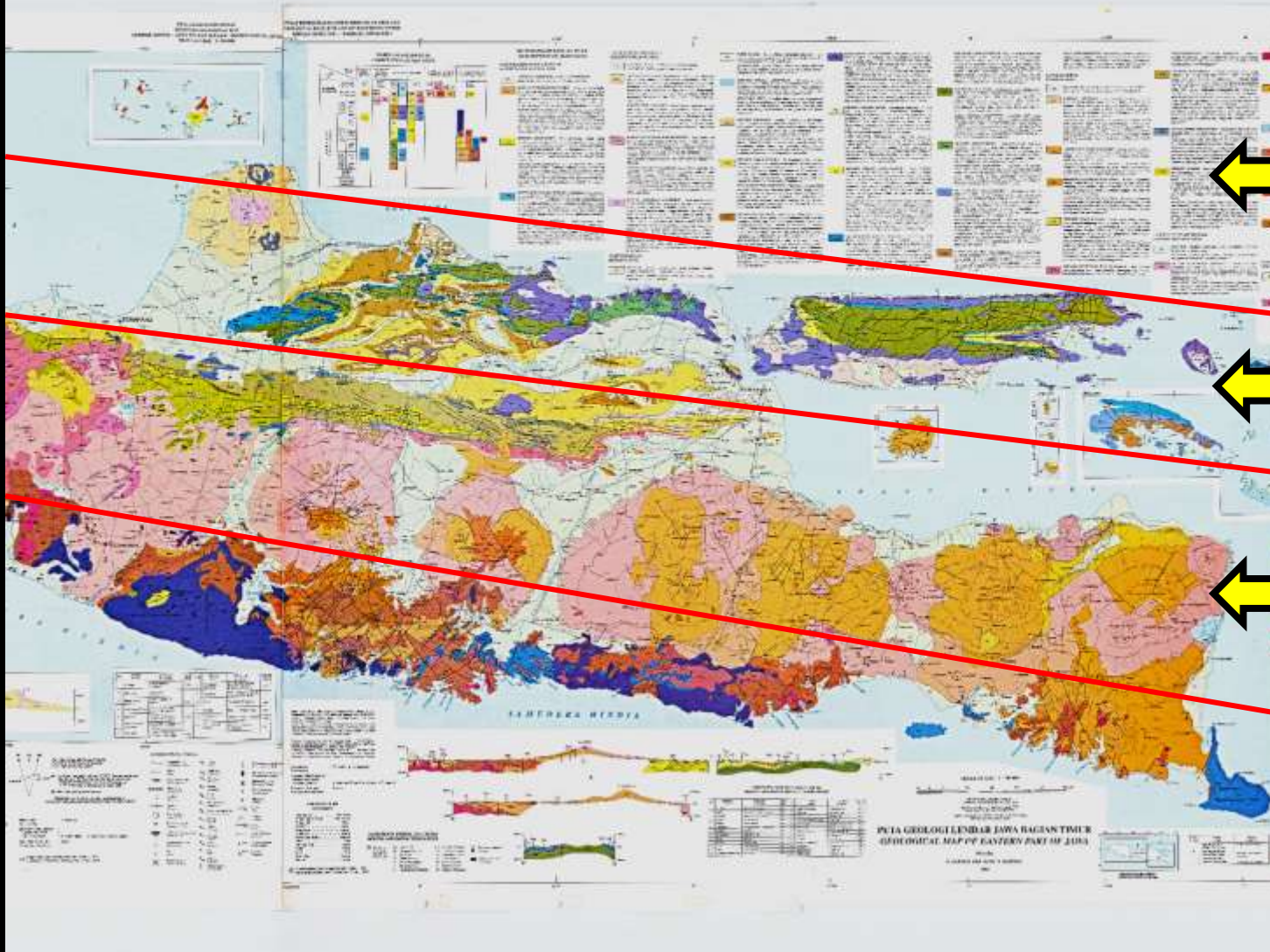
**EASTERN PART
OF RMKS**



RESULTED STRUCTURAL MAP



TERTIARY GEOLOGICAL PROVINCES OF JAVA



← SUNDALAND Region / NORTHERN PLATFORM

← Rembang Zone (+ RanduBlatung Zone)
(Foreland basin-EN ECHELON FOLD BELT/RMKS FZ)

← Kendeng Zone
(Back Arc basin-FOLD THRUST BELT)

← Southern Mountain
(Ancient/Oligo-Miocene Arc)

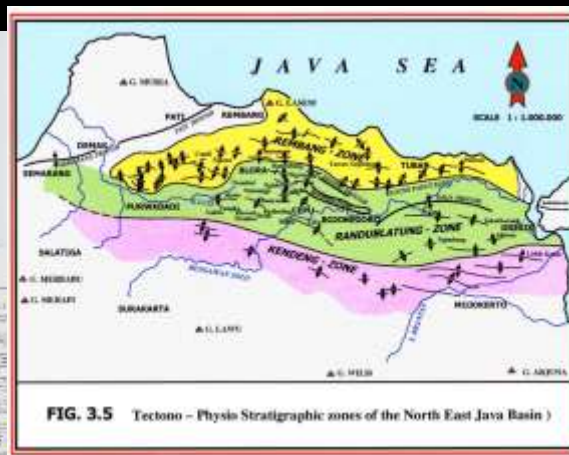
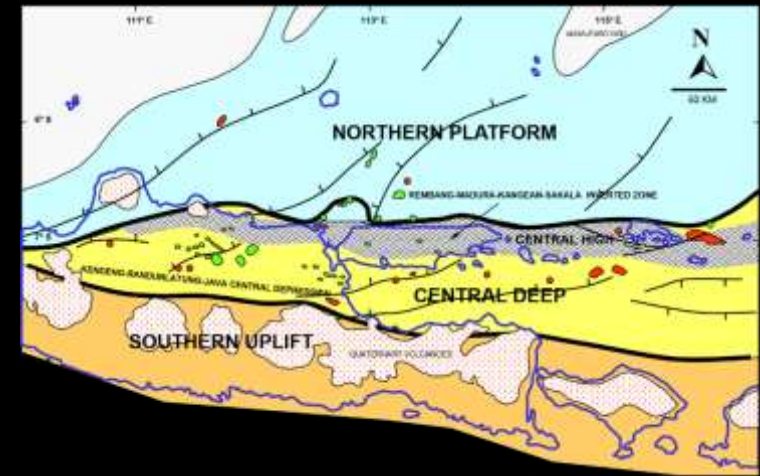


FIG. 3.5 Tectono - Physis Stratigraphic zones of the North East Java Basin)



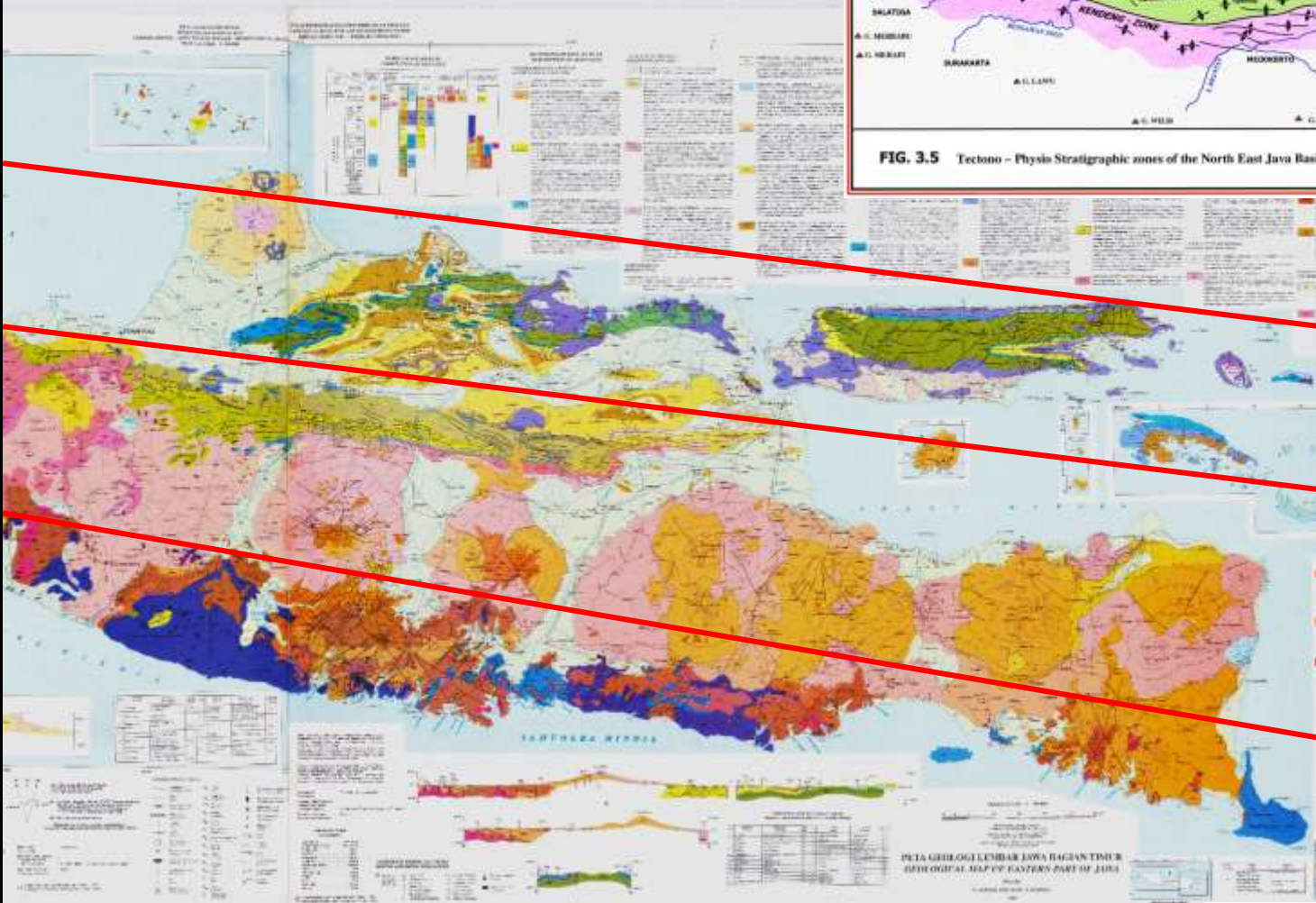
SUNDALAND Region / NORTHERN PLATFORM

Rembang Zone (+ Randublatung Zone)
(Foreland basin-EN ECHELON FOLD BELT/RMKS FZ)

Kendeng Zone
(Back Arc basin-FOLD THRUST BELT)

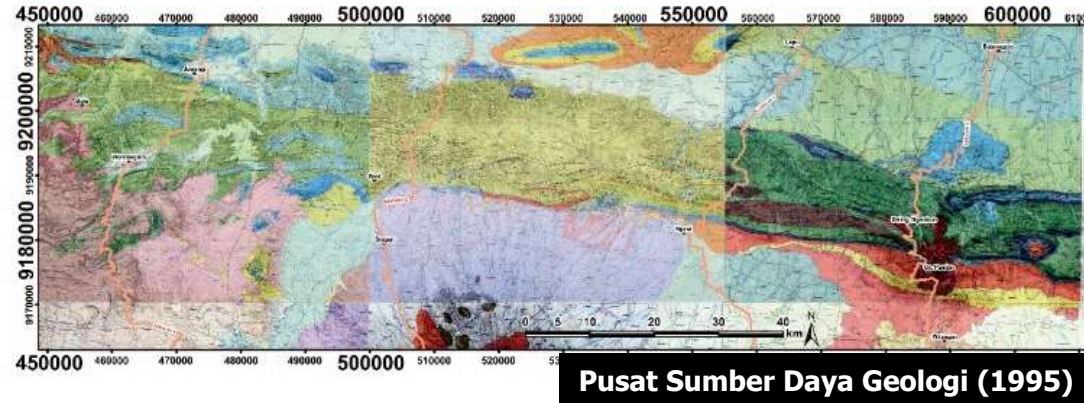
Southern Mountain
(Ancient/Oligo-Miocene Arc)

Unique → juxtaposition EN ECHELON FOLD BELT/RMKS FZ and FOLD THRUST BELT

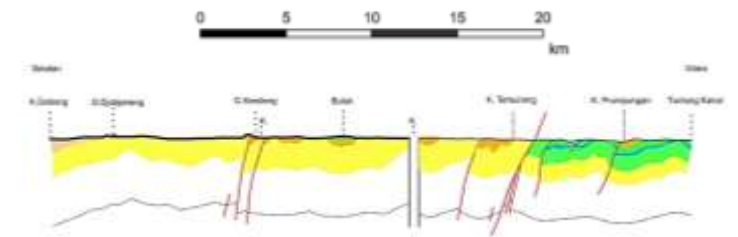


PREVIOUS STUDY: Kendeng Zone

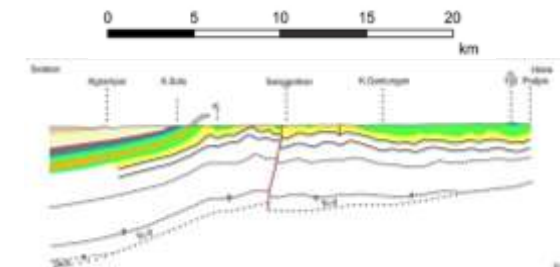
- Genevraye & Samuel (1972)
- Pusat Sumber Daya Geologi (1995)
- Prasetyadi (2007)
- Hall (2007) & Clements (2009)
- Hall & Nugraha (2012)
- Rachman (2016)



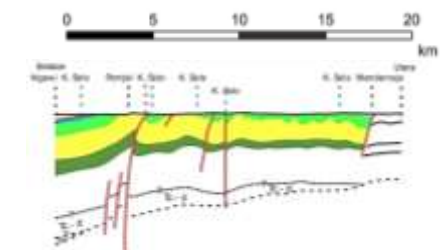
Penampang Lintasan 1



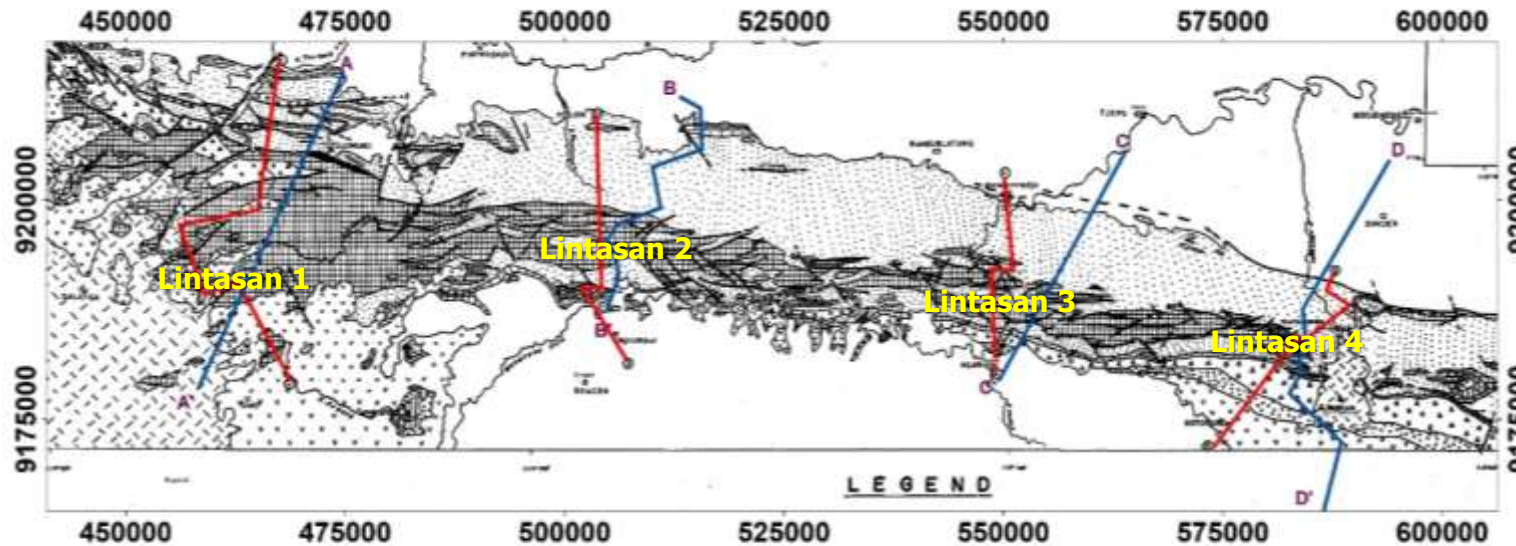
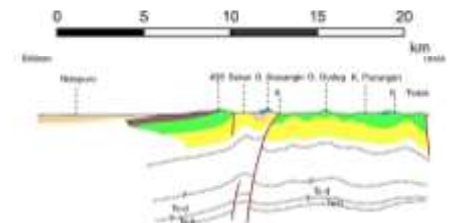
Penampang Lintasan 2



Penampang Lintasan 3



Penampang Lintasan 4



Keterangan

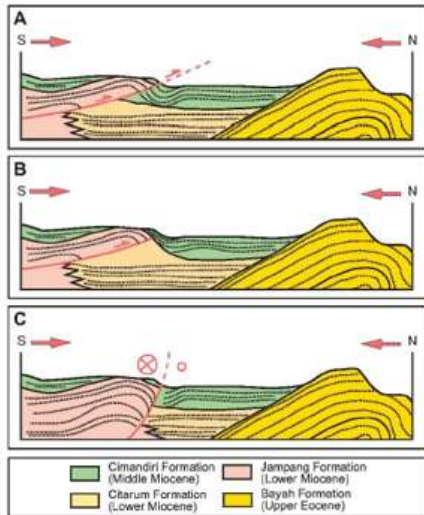
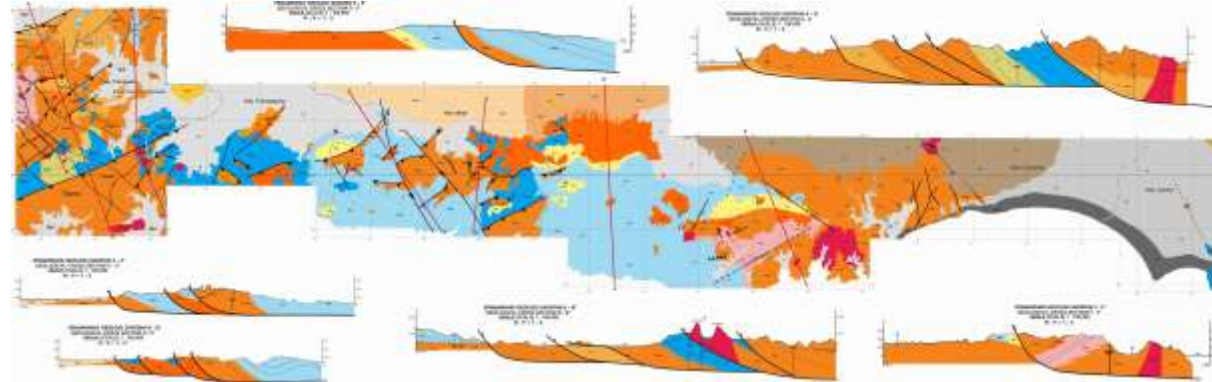
- Seyatan Geologi
- Seyatan Genevraye, 1972

Genevraye & Samuel (1972)

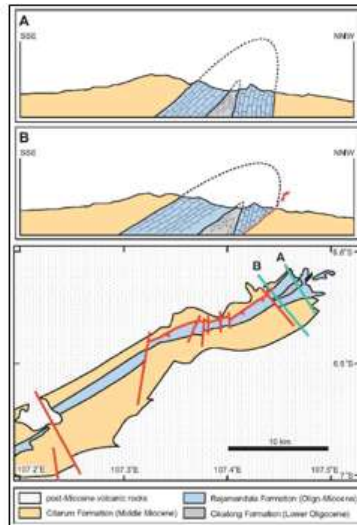
PREVIOUS STUDY: Southern Mountain

Rachman (2016)

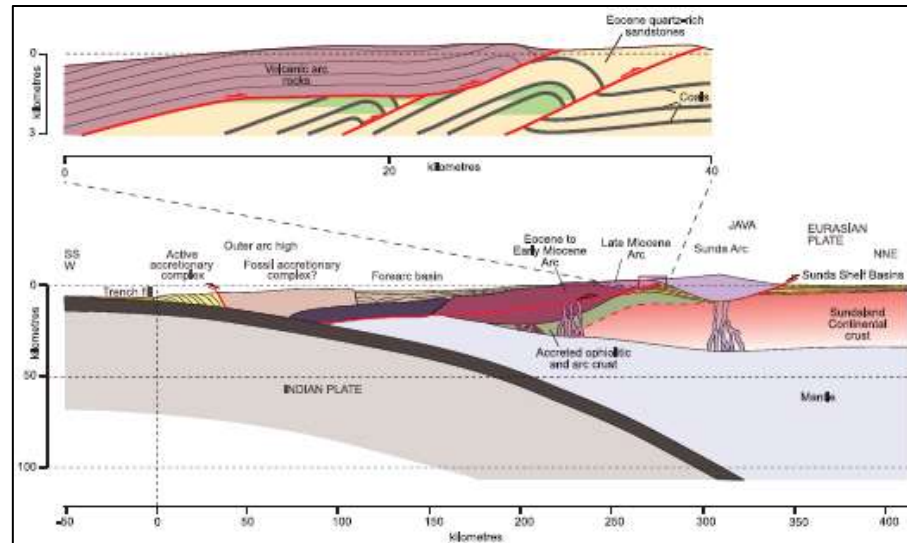
- Genevraye & Samuel (1972)
- Pusat Sumber Daya Geologi (1995)
- Prasetyadi (2007)
- Hall & Nugraha (2012)
- **Hall (2007) & Clements (2009)**
- **Rachman (2016)**



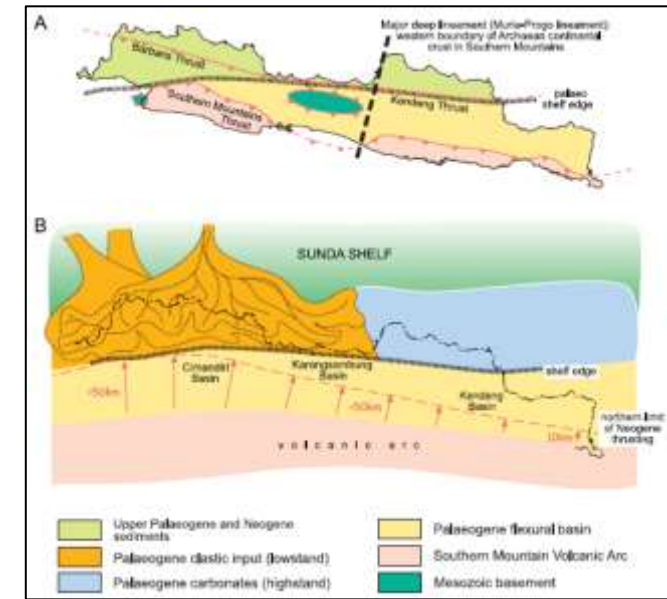
West Java, Cimandiri Valley: Cross sections showing three possible interpretations of field relationships. A: Thrusting postdates the Middle Miocene; B: Thrusting is Early Miocene; C: Cimandiri Valley is strike-slip fault (Hall, 2007).



West Java, Rajamandala Limestone: Map and cross sections showing folding and thrusting of limestones north of Bandung (Hall, 2007 and Clements, 2009).



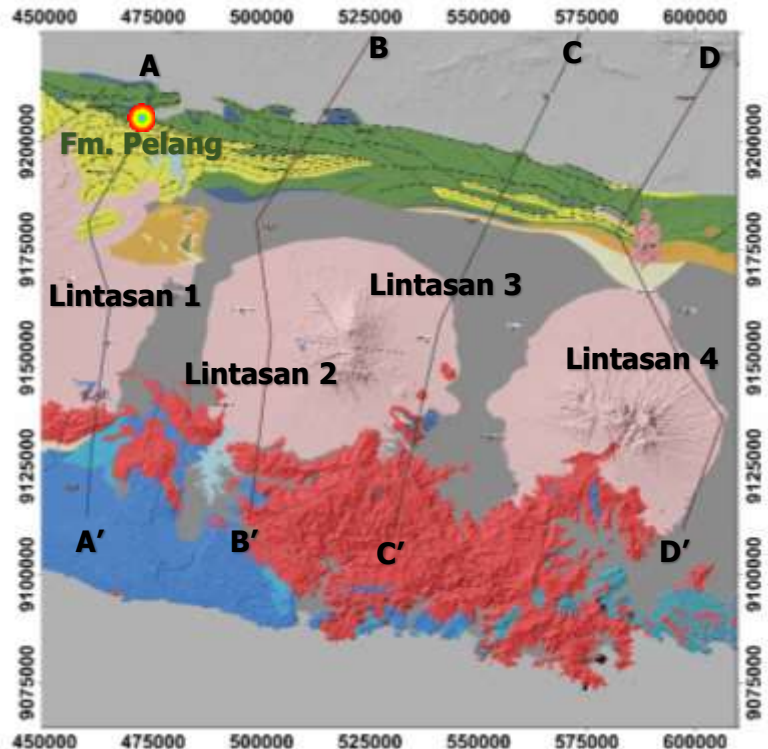
Regional cross-section through the West Java margin. Forearc structure is from Kopp *et al.* (2002). Estimates of crustal thickness are from Hamilton (1979). Inset is a schematic cross-section showing potential hydrocarbon plays (hypothetical accumulations shown in green) (Clements, 2009).



Java: Summary tectonic maps showing (A) present-day interpreted structure and (B) schematic pre-thrusting relationships inferred between the Sunda Shelf, the Palaeogene volcanic arc and sedimentary basins between them (Hall, 2007 and Clements, 2009).

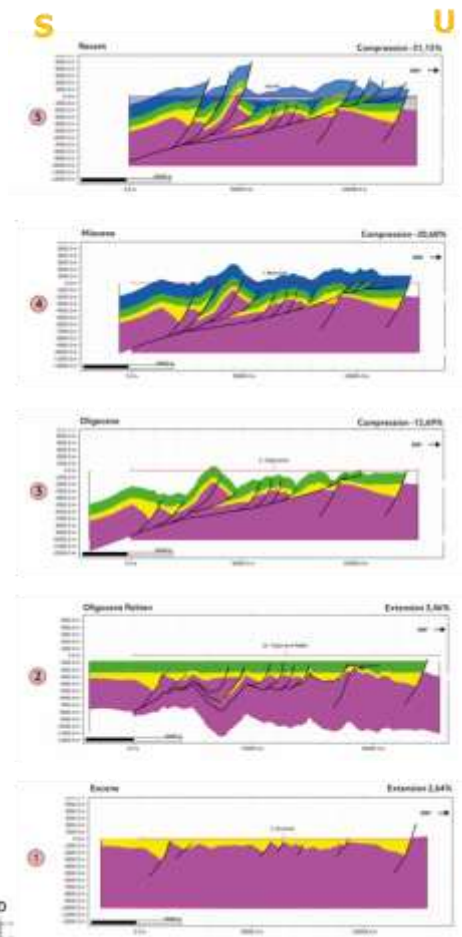
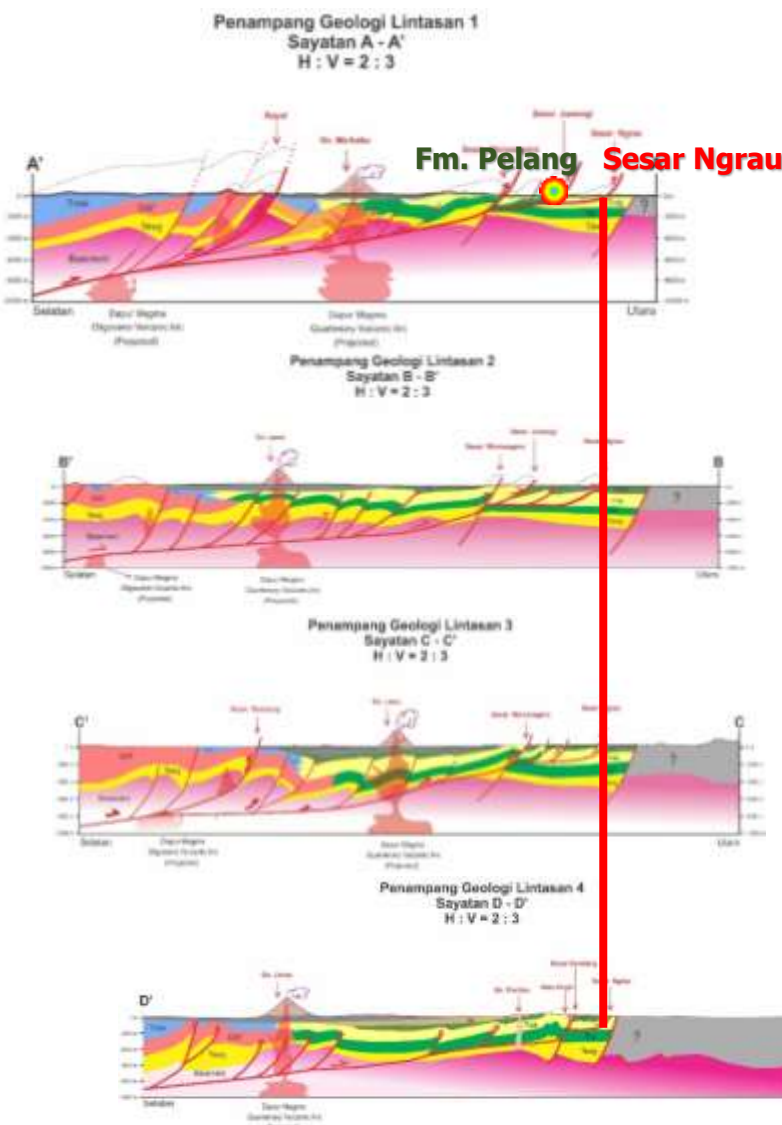
PETA GEOLOGI DAN MODEL GEOLOGI (KENDENG – PEG. SELATAN)

Rekonstruksi penampang seimbang Lintasan 1



Keterangan

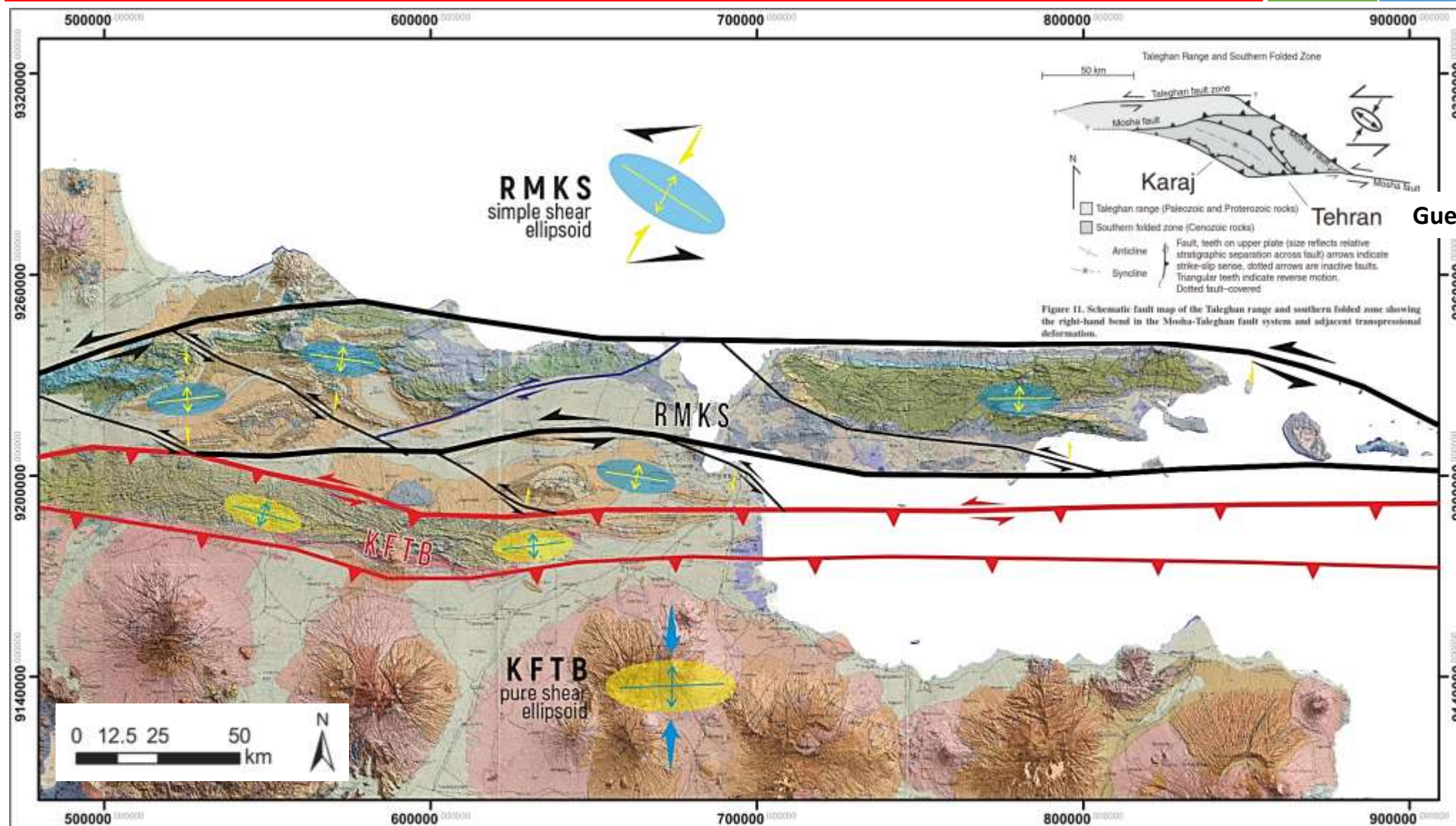
- Toponimi
- Endapan Aluvial
- Endapan Vulkanik Kuartar
- Endapan Vulkanik Pandan
- Fm. Atasangin
- Fm. Kabuh
- Fm. Notopuro
- Fm. Pucangan
- Fm. Kalibeng
- Batuan Terobosan
- Fm. Klitik
- Fm. Kalipucang
- Fm. Oyo
- Fm. Campurdarat
- Fm. Wonosari
- Fm. Sampung
- Fm. Sambipitu
- Fm. Kerek
- Fm. Pelang
- Old Andesite Formasi
- Batuan Malihan
- Rembang
- Waduk
- Sesar
- ▲ Sesar Naik
- Antiklin
- Sinklin
- Kelurusan
- Garis penampang geologi



Time	Length (m)	Time to Time	Time to Base-ment
5. Recent	100947	-10,55%	-31,15%
Kenampakan saat ini yang menyebabkan pembentukan sesar naik di daerah utara			
4. Mio-cene	112847	-7,92%	-20,60%
Kelanjutan rezim kompresi yang menyebabkan pengangkatan di utara Zona Kendeng			
3. Late Oligocen e	122548	-16,15%	-12,69%
Kemunculan awal sesar naik serta reaktivasi sesar tua, mengakibatkan <i>shifting</i> OAF ke arah utara.			
2. Oligo-cene Flatten	146143	0,82%	3,46%
Pembentukan <i>island arc</i> di pegunungan selatan dan kondisi <i>open marined</i> cek Kendeng.			
1. Eosen	144955	2,64%	2,64%
Fase ekstensi dengan trend tinggian berarah barat-timur.			
Lo	141228	0%	0%
Kondisi awal			

HASIL ANALISIS

RESULTED STRUCTURAL MAP



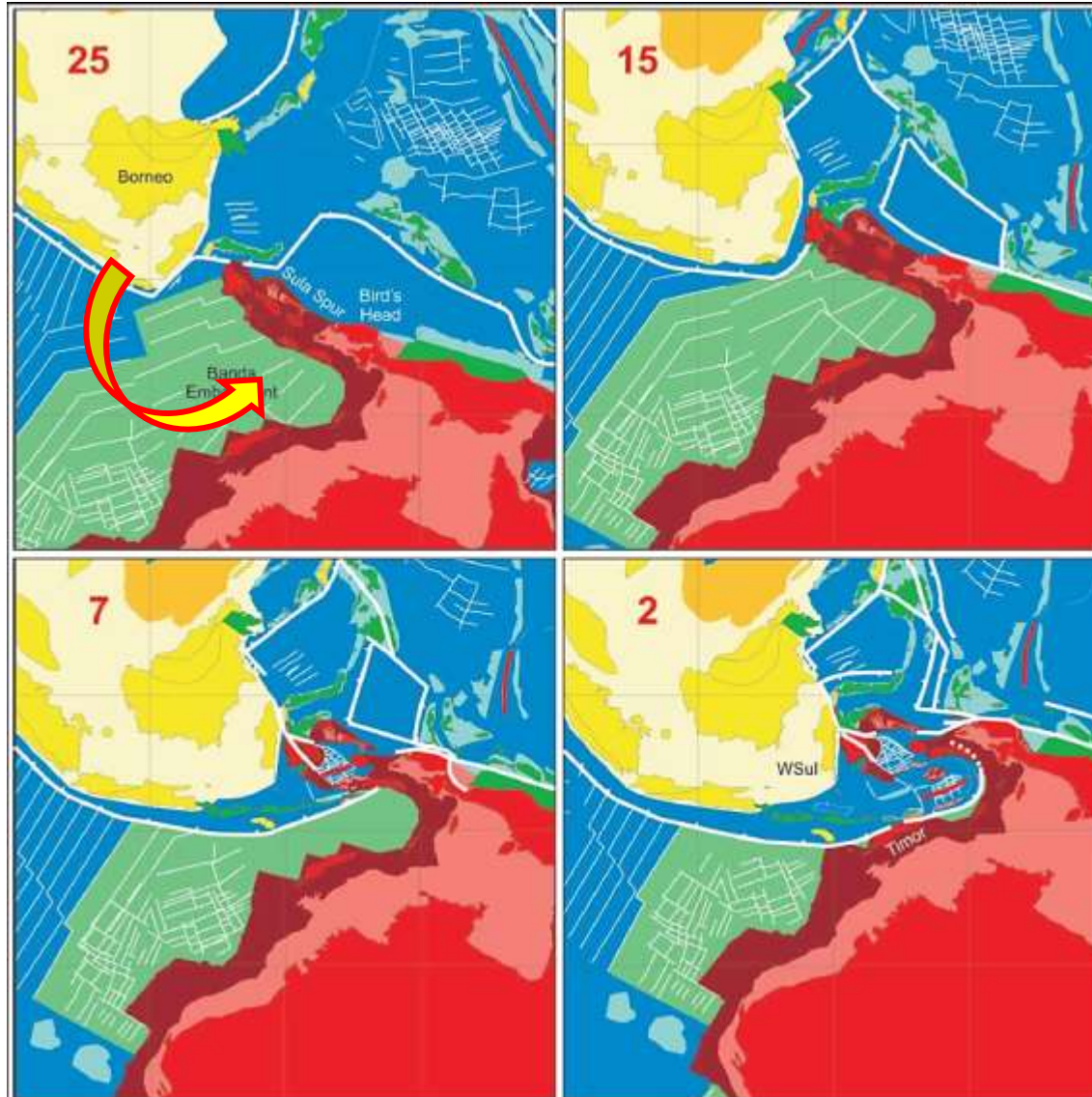
Guest et al., 2006

PEMBAHASAN



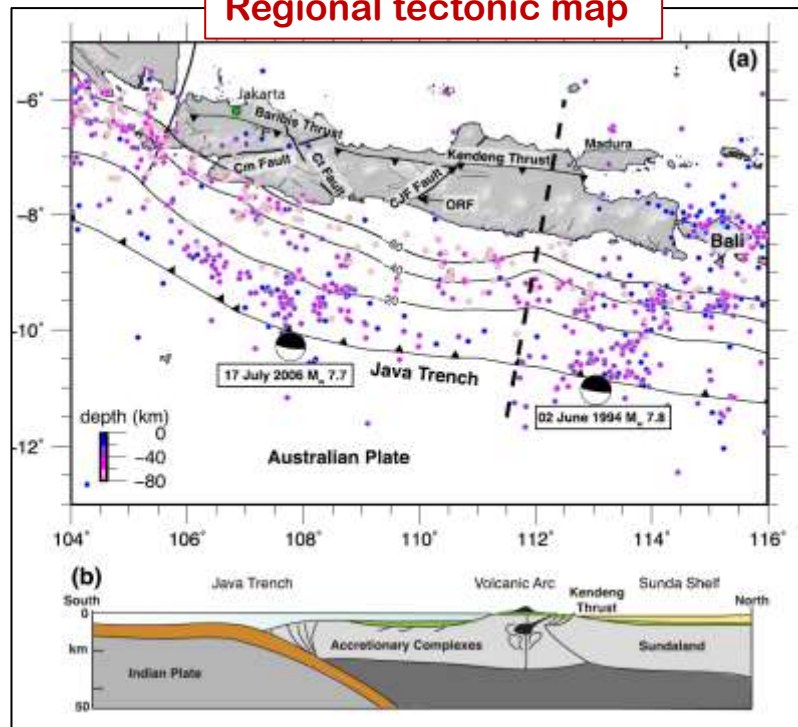
- PENDAHULUAN
- DATA & METODA
- HASIL ANALISIS
- **KESIMPULAN**

(RMKS FAULT ZONE: Schematic RECONSTRUCTION)

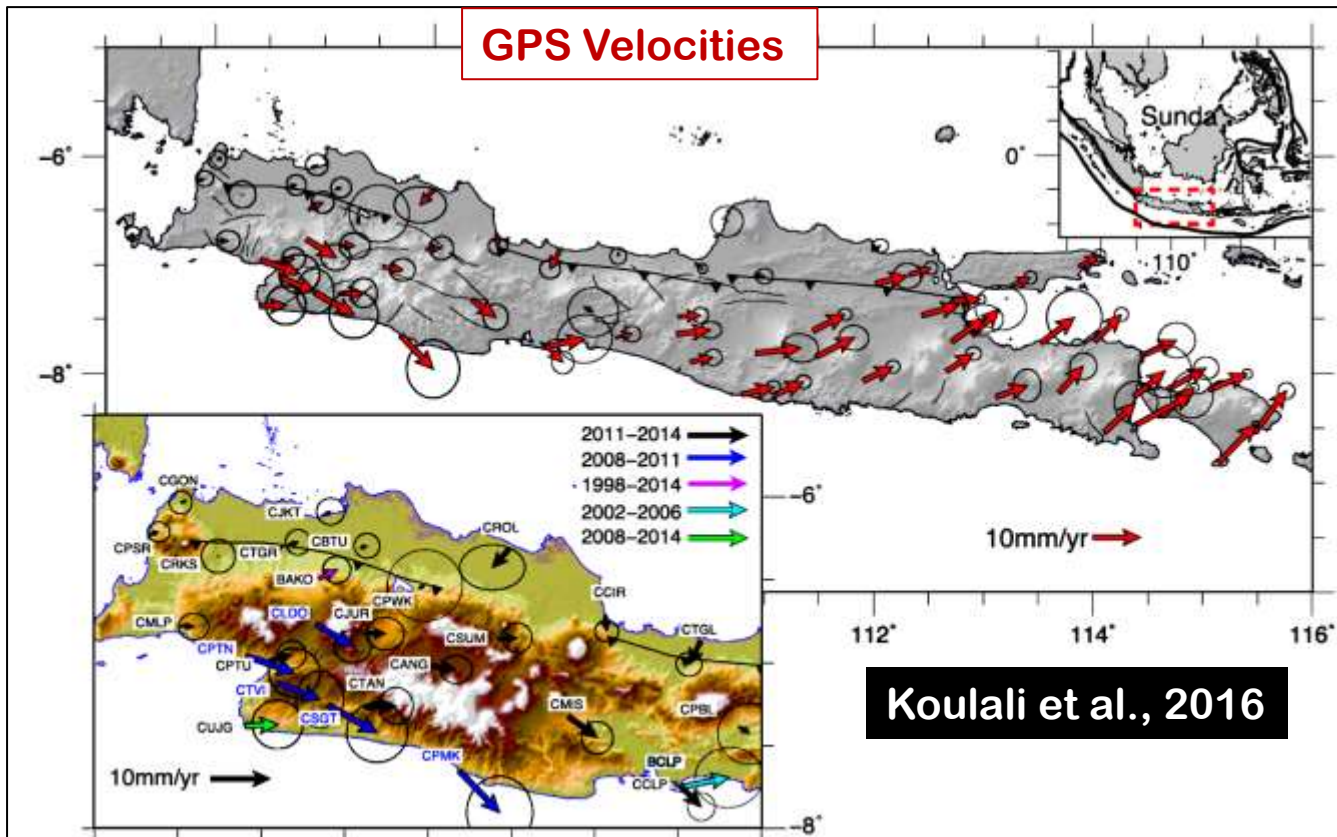


**Tectonic reconstruction:
Counter-Clock Wise Rotation due to
NW Australia collision**

Regional tectonic map

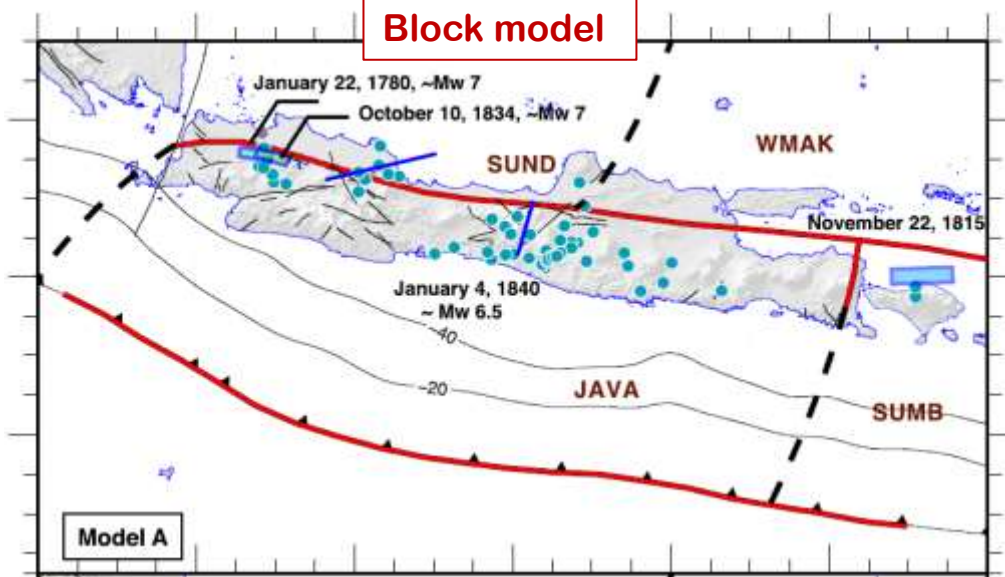


GPS Velocities

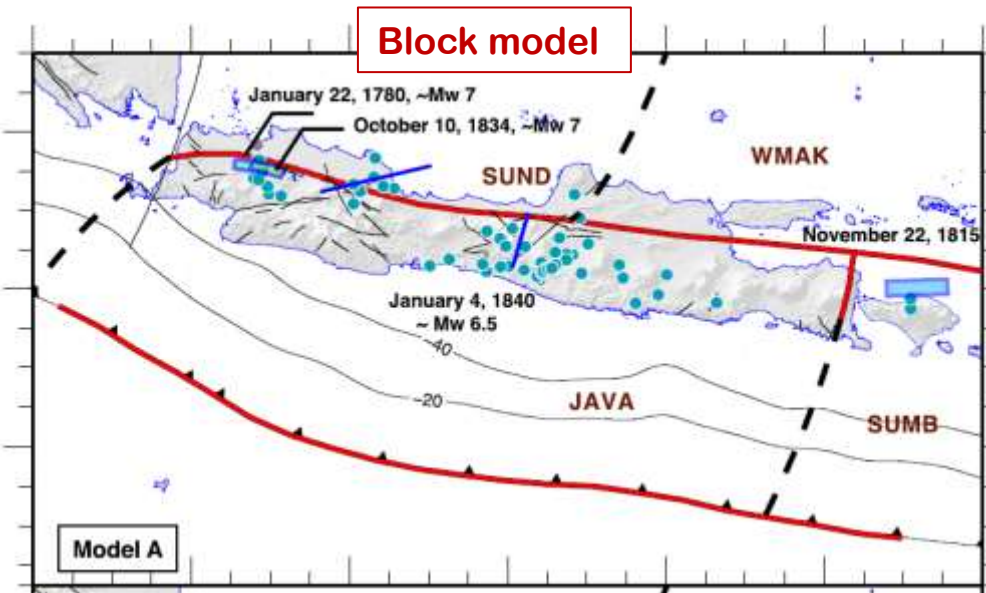


Koulali et al., 2016

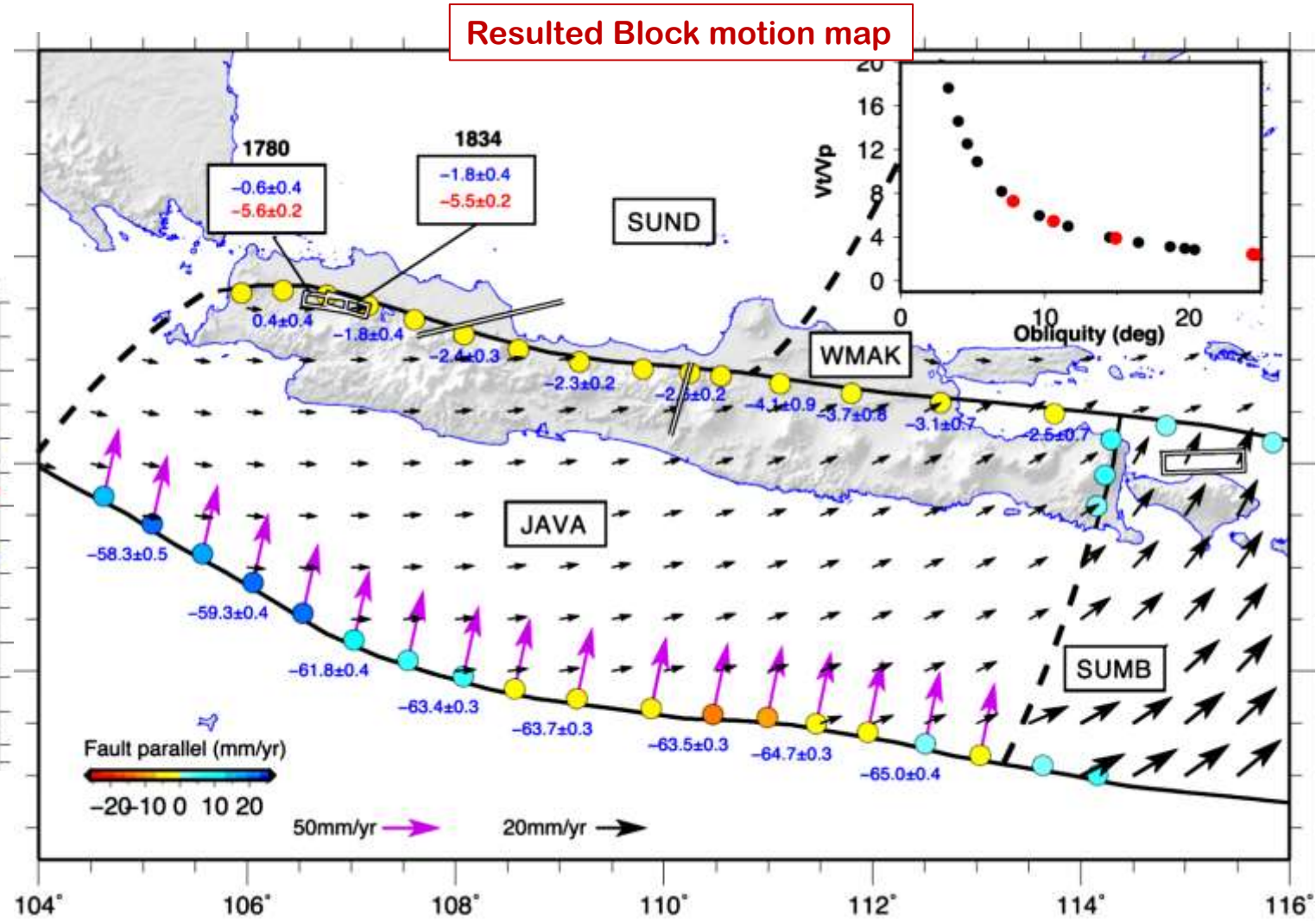
Block model



- The obtained velocity field shows a dominant counterclockwise rotation of the whole Java forearc with a rate increasing towards the E.
- The magnitude of the velocities vary from ~ 3 mm/yr in west Java to ~ 7 mm/yr in the East. This motion is consistent with the convergence direction between the Australian Plate and SE Asia (Tregoning et al., 1994; Simons et al., 2007).
- There is the northward decrease of velocities towards the Baribis thrust, indicating that the Java forearc is presently moving relative to Sunda Block, correlated with geological observations where Paleogene arc rocks have been thrust northwards towards the Sunda Shelf (Hall et al., 2007).

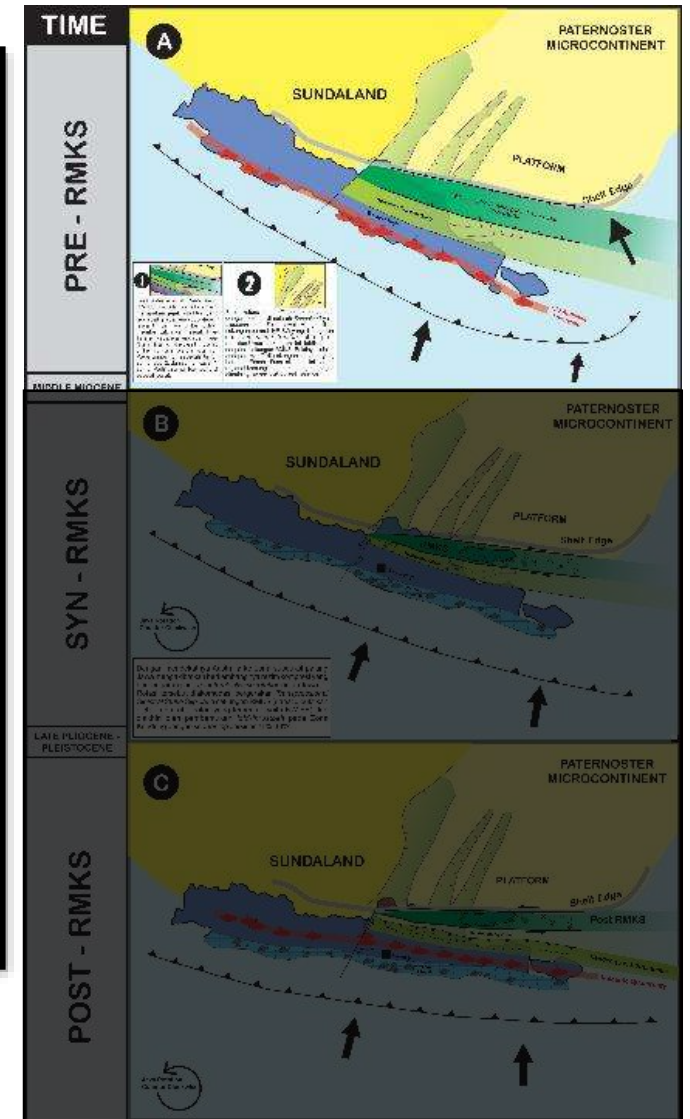
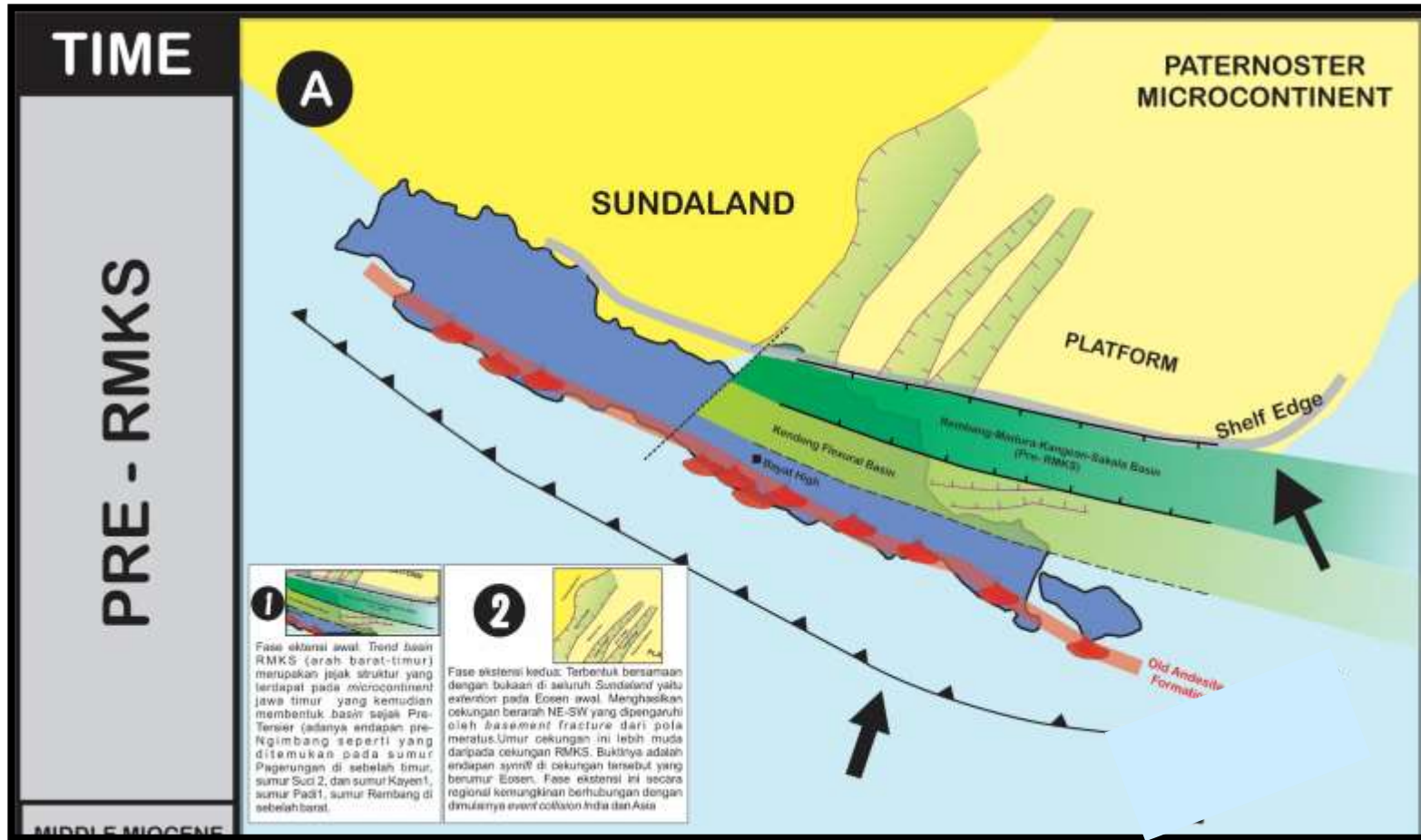


Koulali et al., 2016



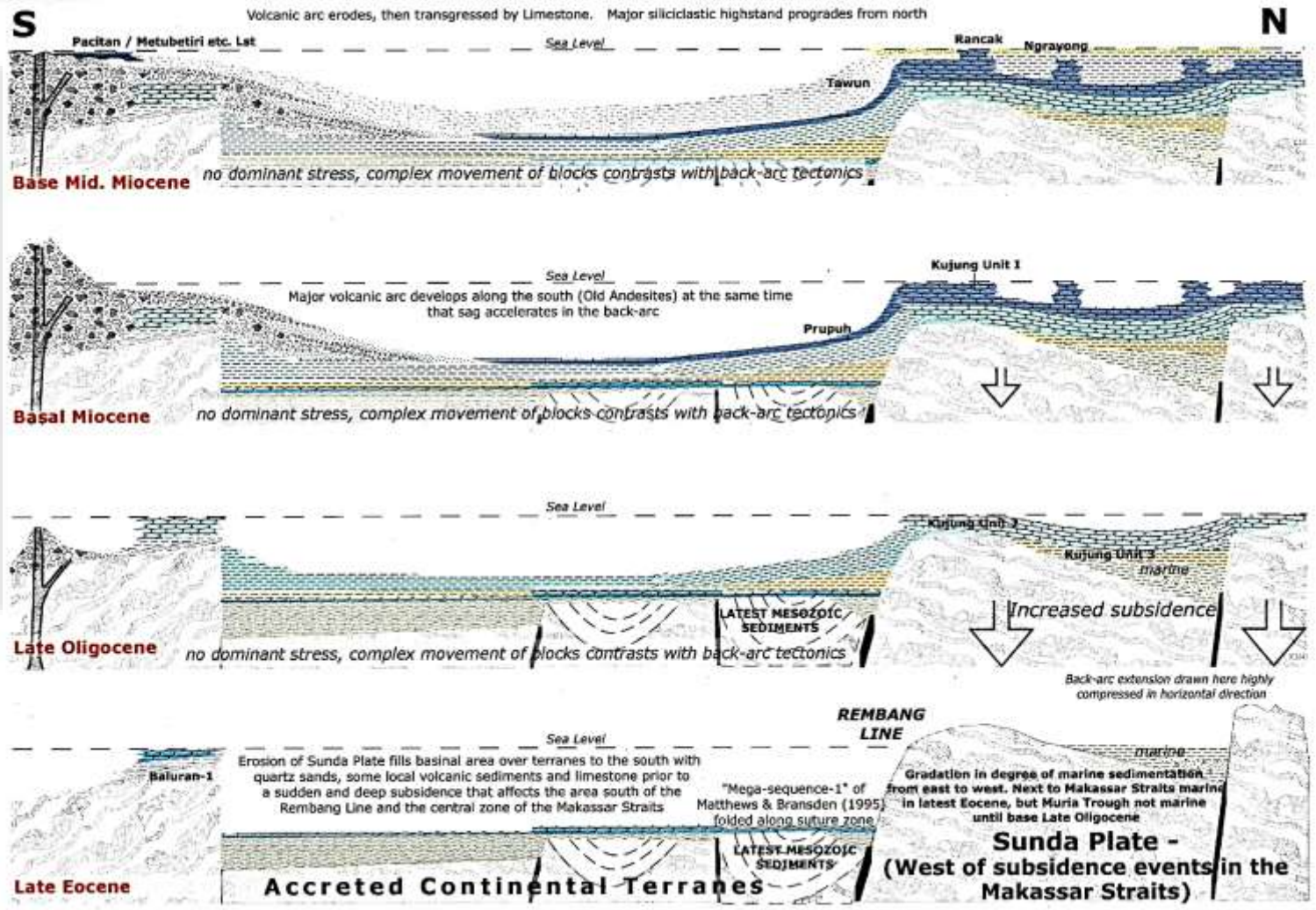
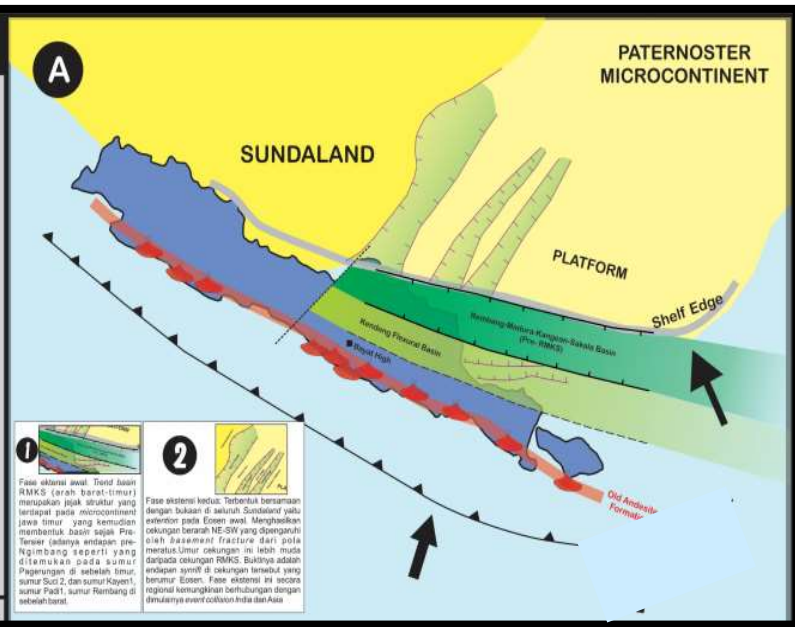
Black arrows represent the motion of the Java Block relative to Sunda Block, computed from the block model.

(RMKS FAULT ZONE: Schematic RECONSTRUCTION)

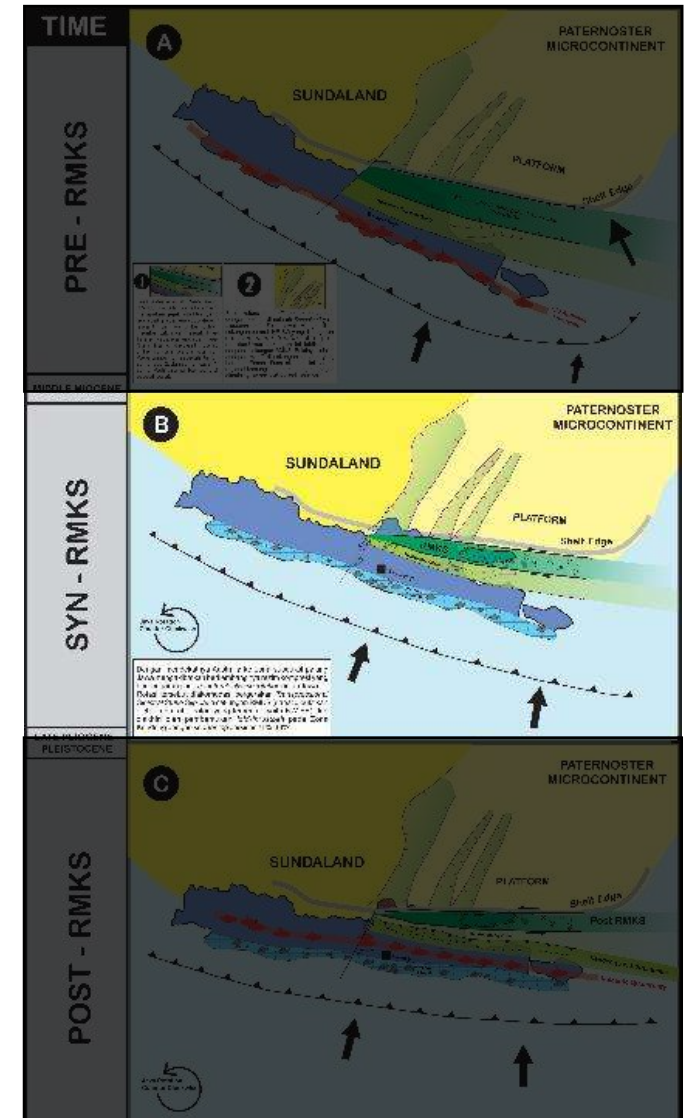
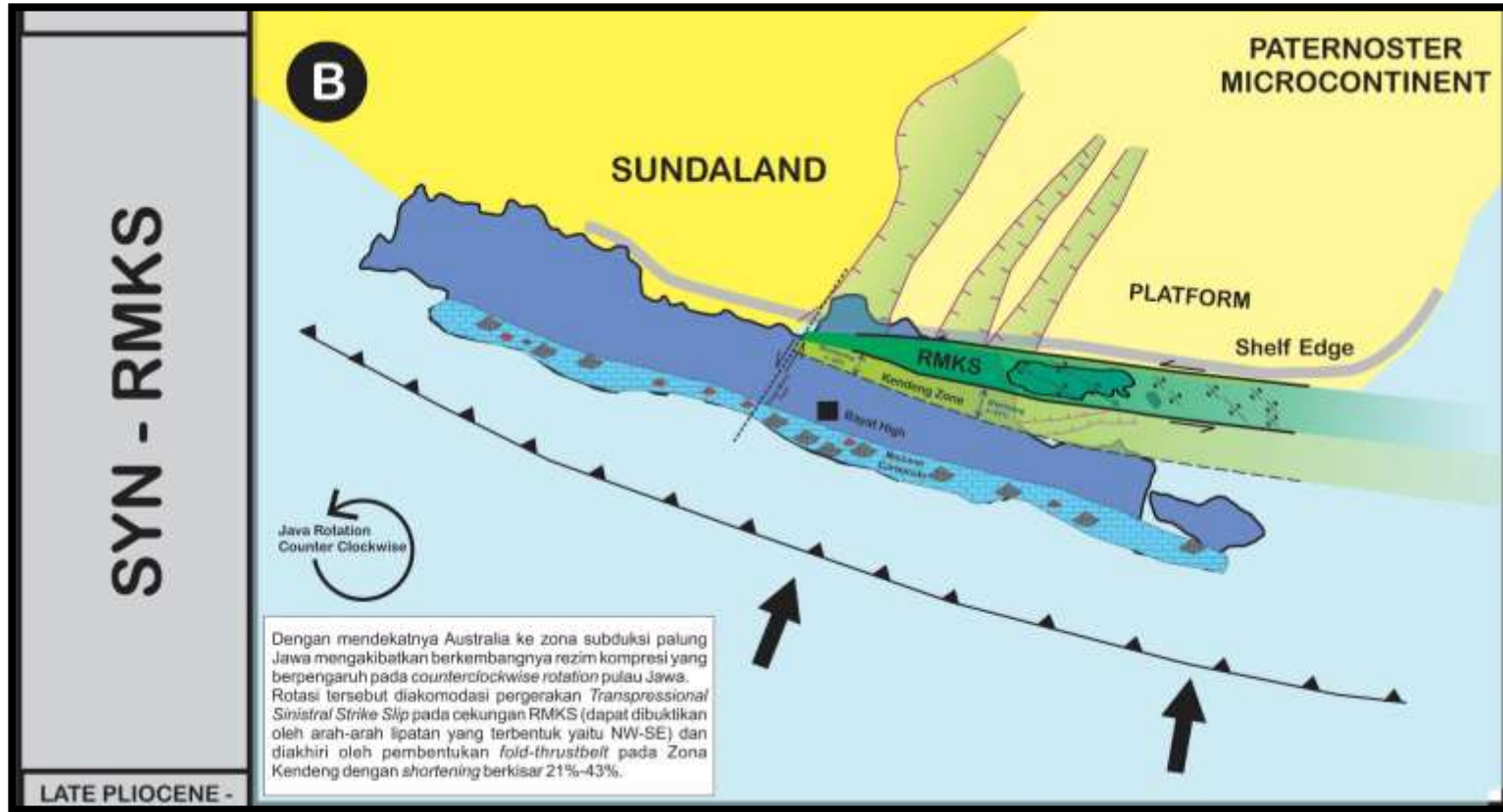


Schematic N-S X-sections across E Java from EOCENE to MID-MIOCENE times (Pre-INVERSION= Pre RMKS FZ)

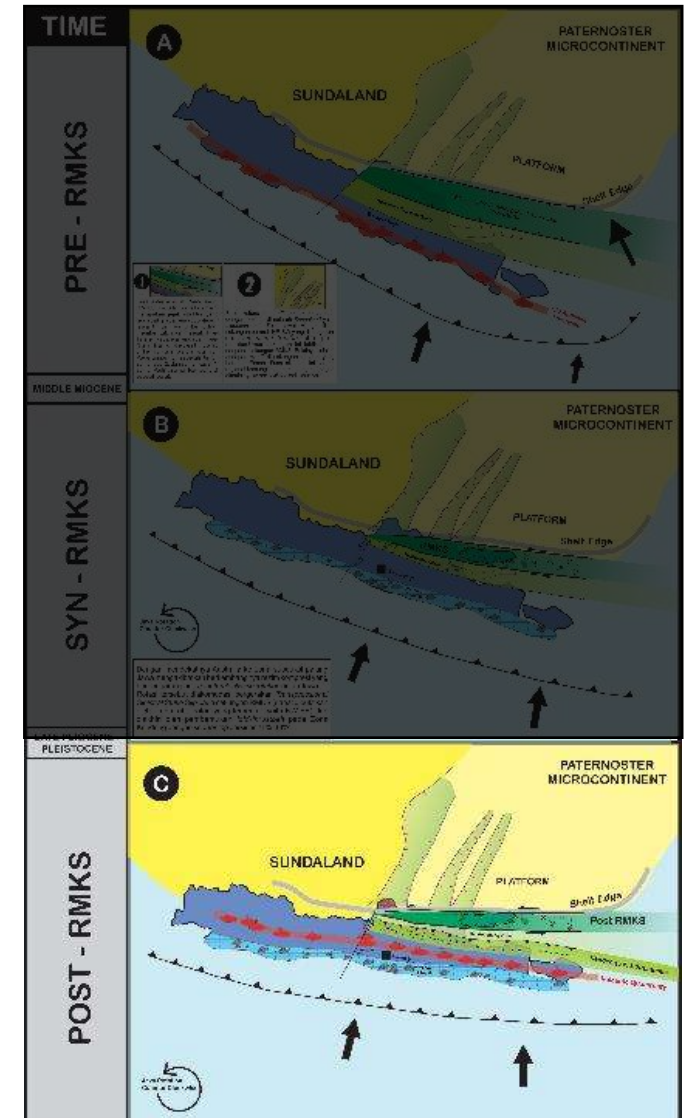
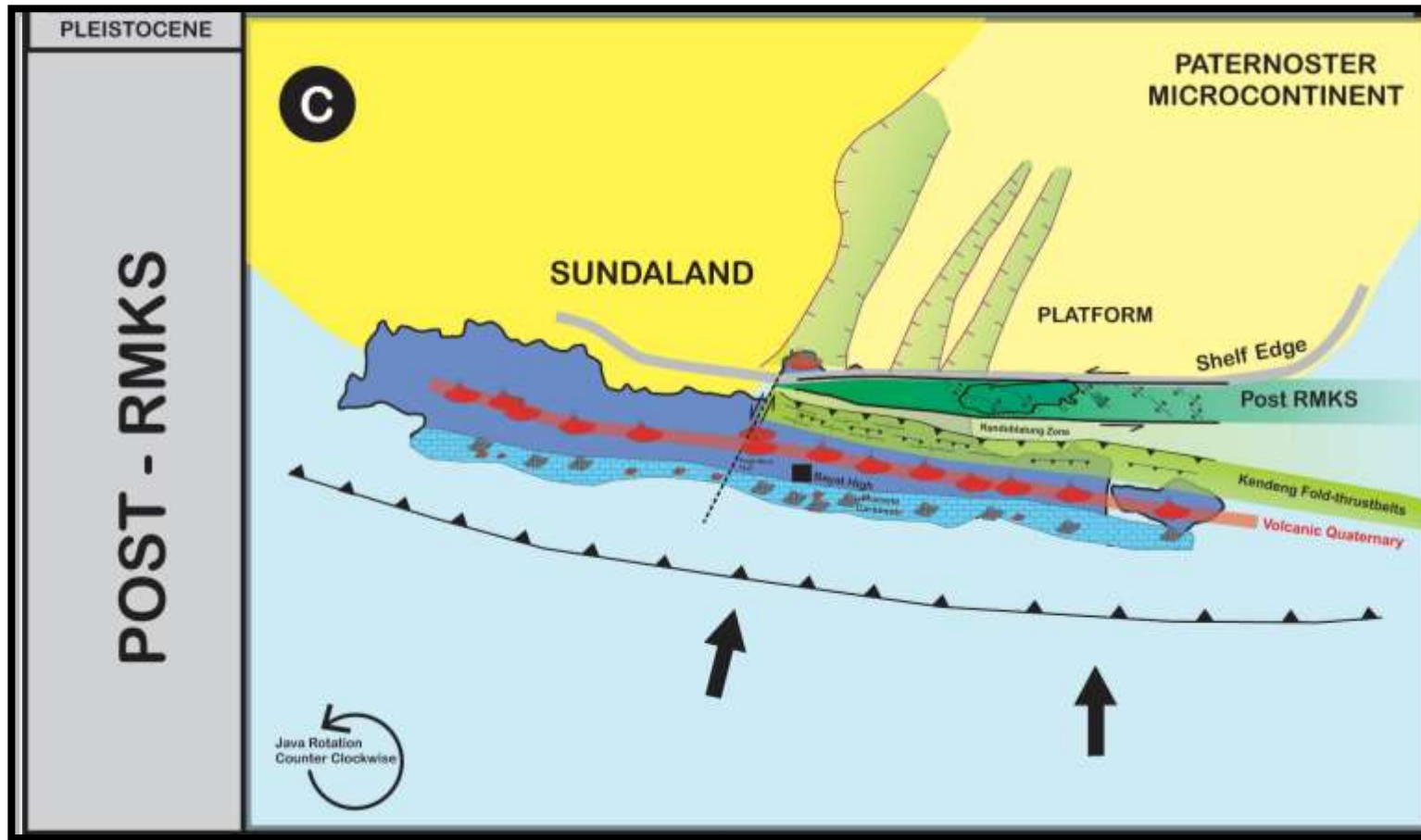
TIME
PRE - RMKS
MIDDLE MIOCENE



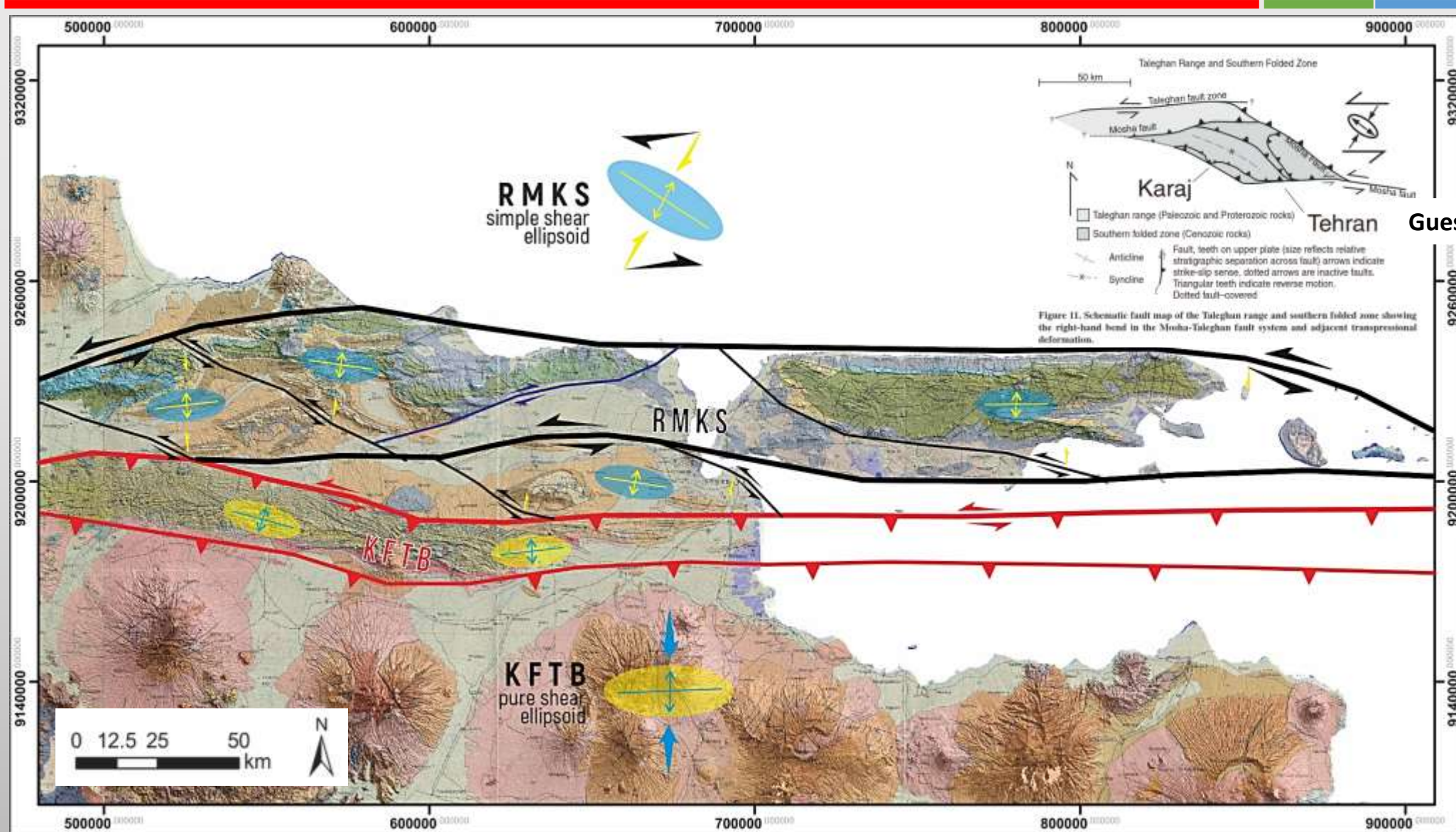
(RMKS FAULT ZONE: Schematic RECONSTRUCTION)



(RMKS FAULT ZONE: Schematic RECONSTRUCTION)

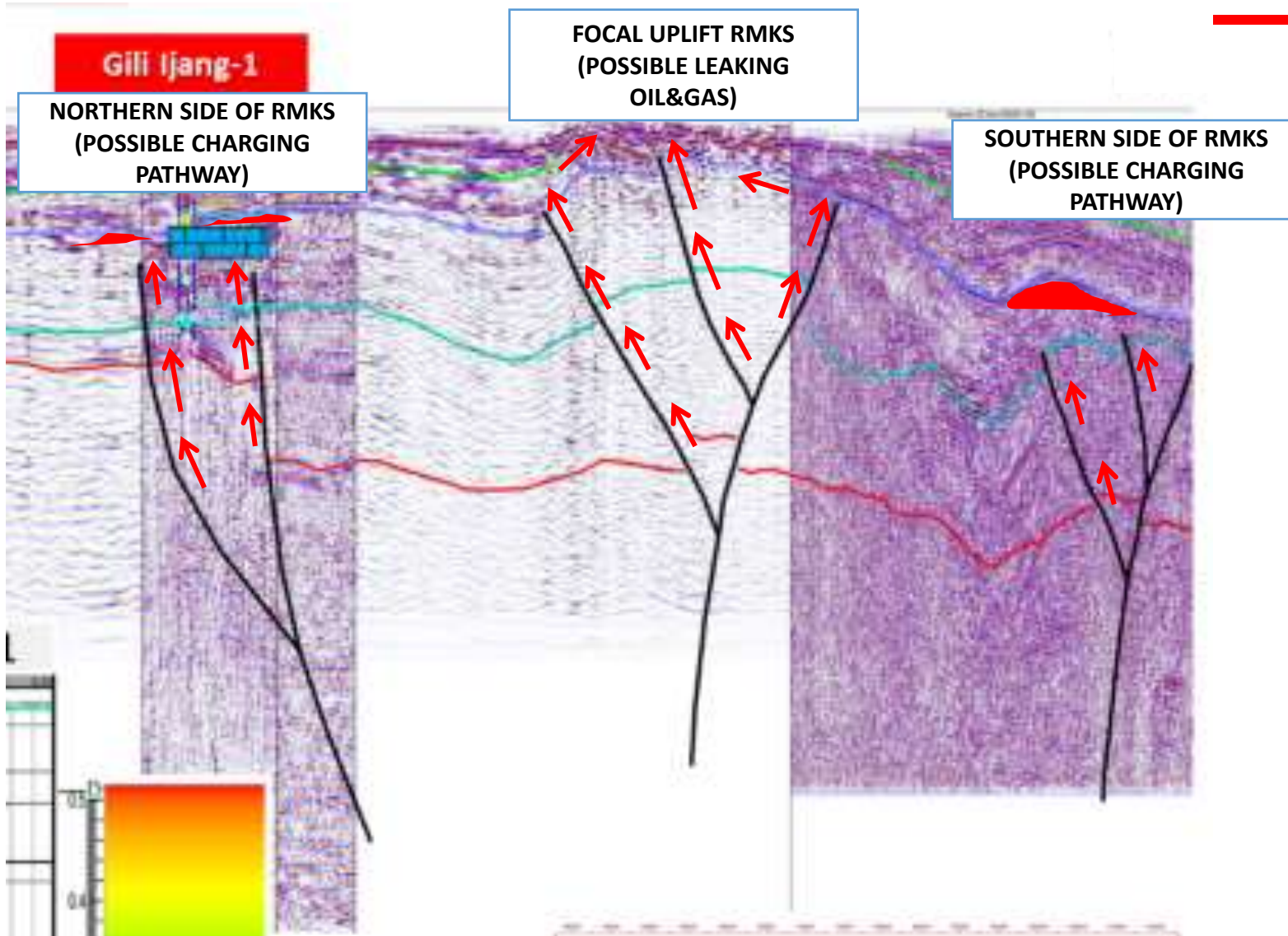


KESIMPULAN



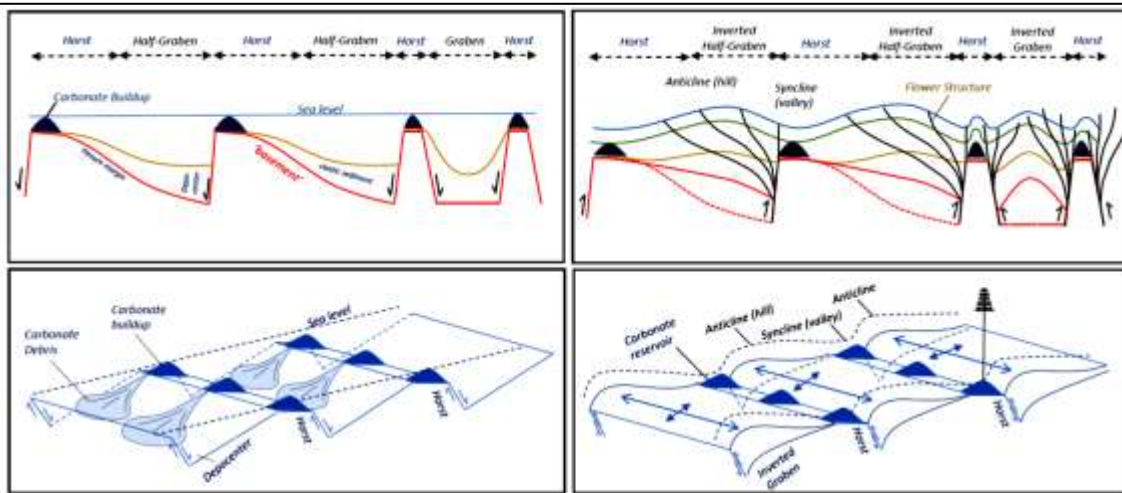
Guest et al., 2006

CONCLUSION: Related with HC migration



- ❑ RMKS FZ has a significant role, especially concerning the migration pathway.
- ❑ RMKS FZ crossing through depocenter and reaching the source rocks (Ngimbang F) could act as migration pathway.
- ❑ At the margins (side parts) of RMKS FZ, the migration pathways provide a good access for charging into the reservoir rocks (Kujung F) occurring at the basement highs.
- ❑ At focal point/central part of RMKS FZ mostly leaking.

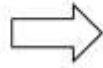
Implikasi Eksplorasi



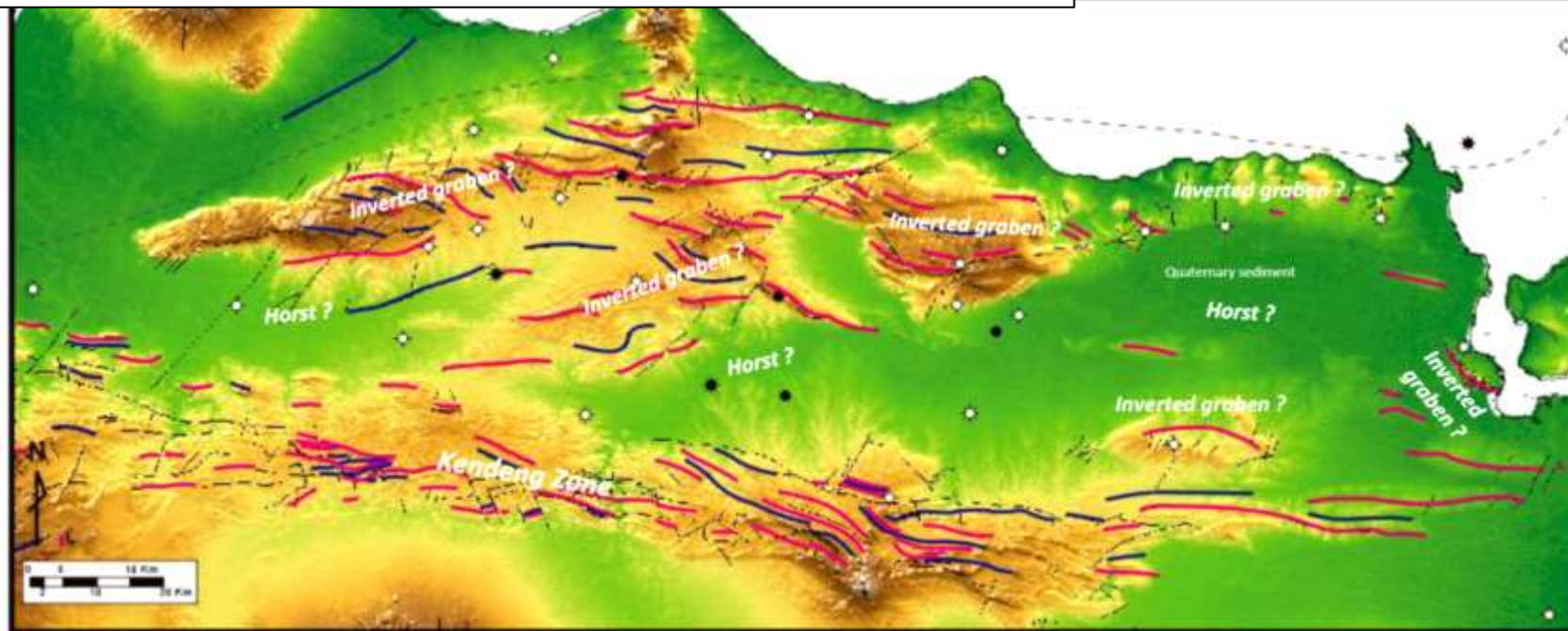
Inverted grabens

Quick Look:

- Oligo Miocene Carbonate Build up (well & seismic) → Horst
- Anticline = inverted half graben / inverted horsts (full graben)
- Syncline = near horst boundary



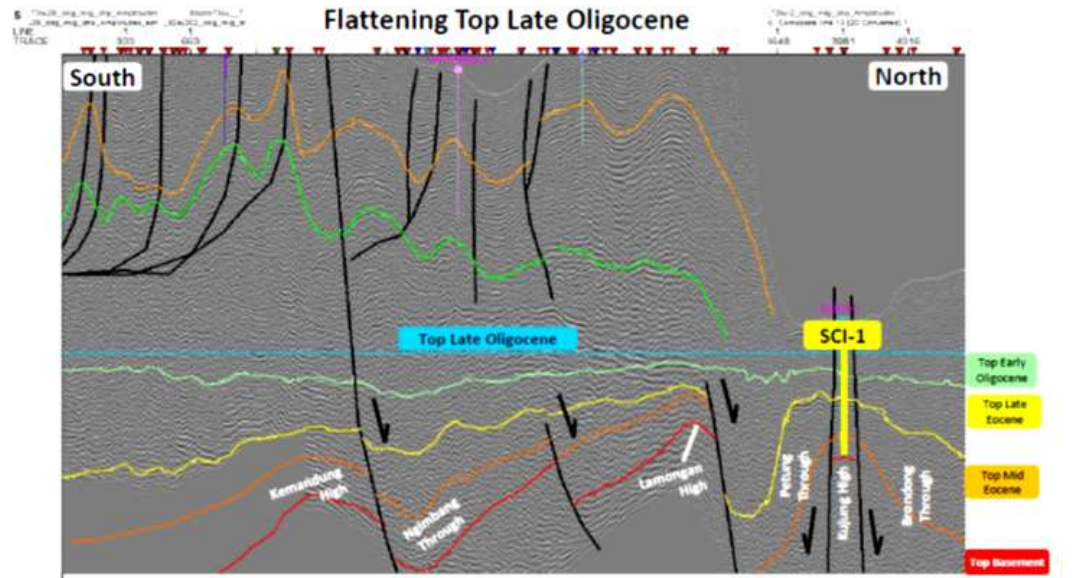
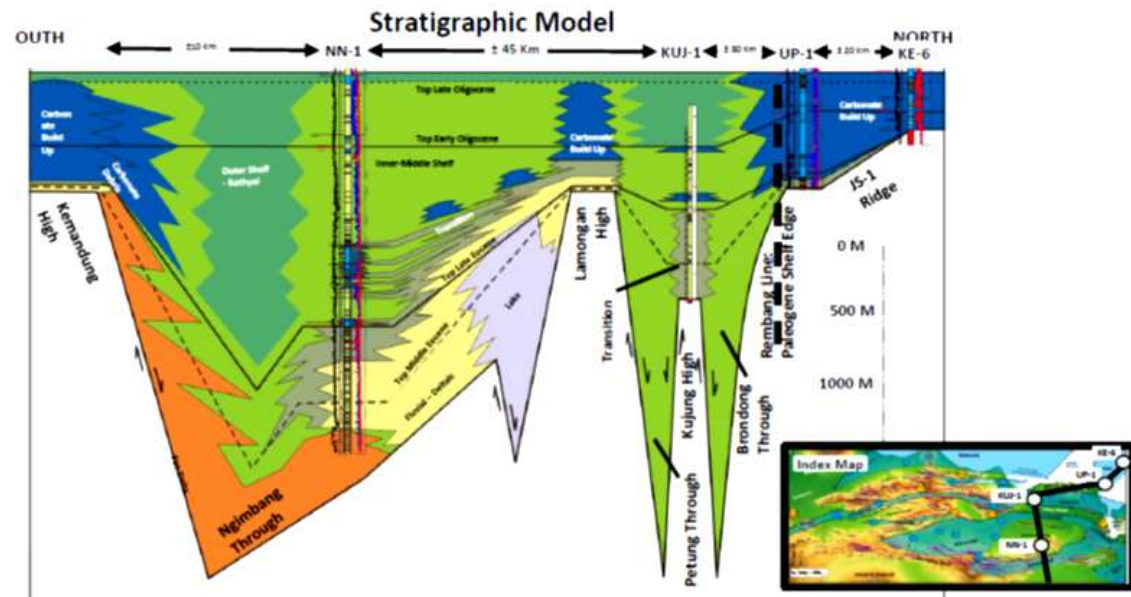
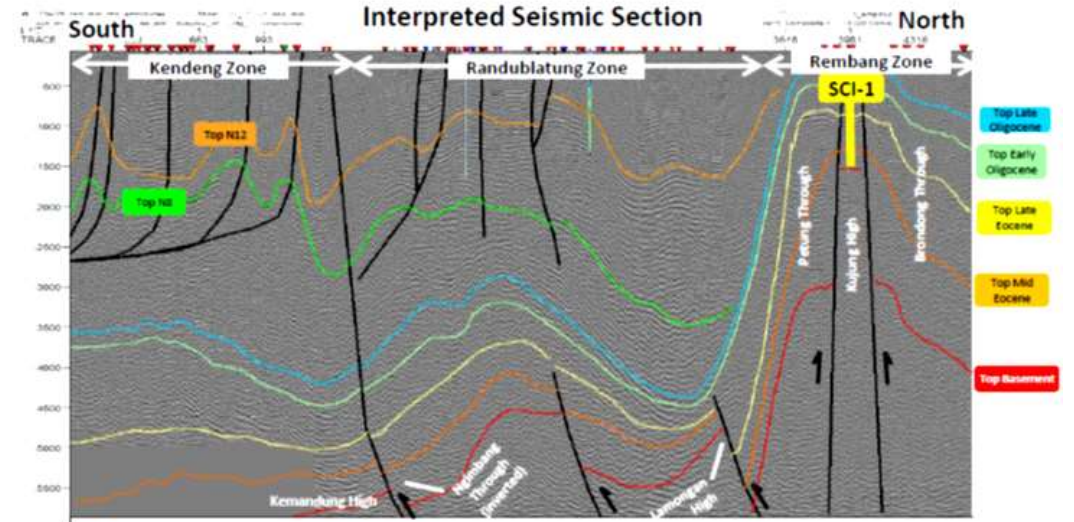
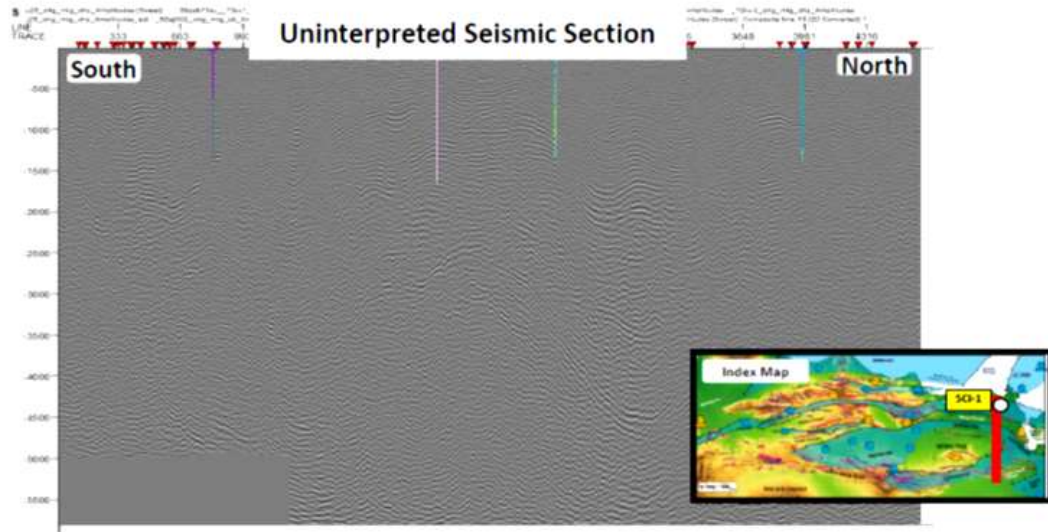
Fold at geological map reflect paleo structure (horst or graben)



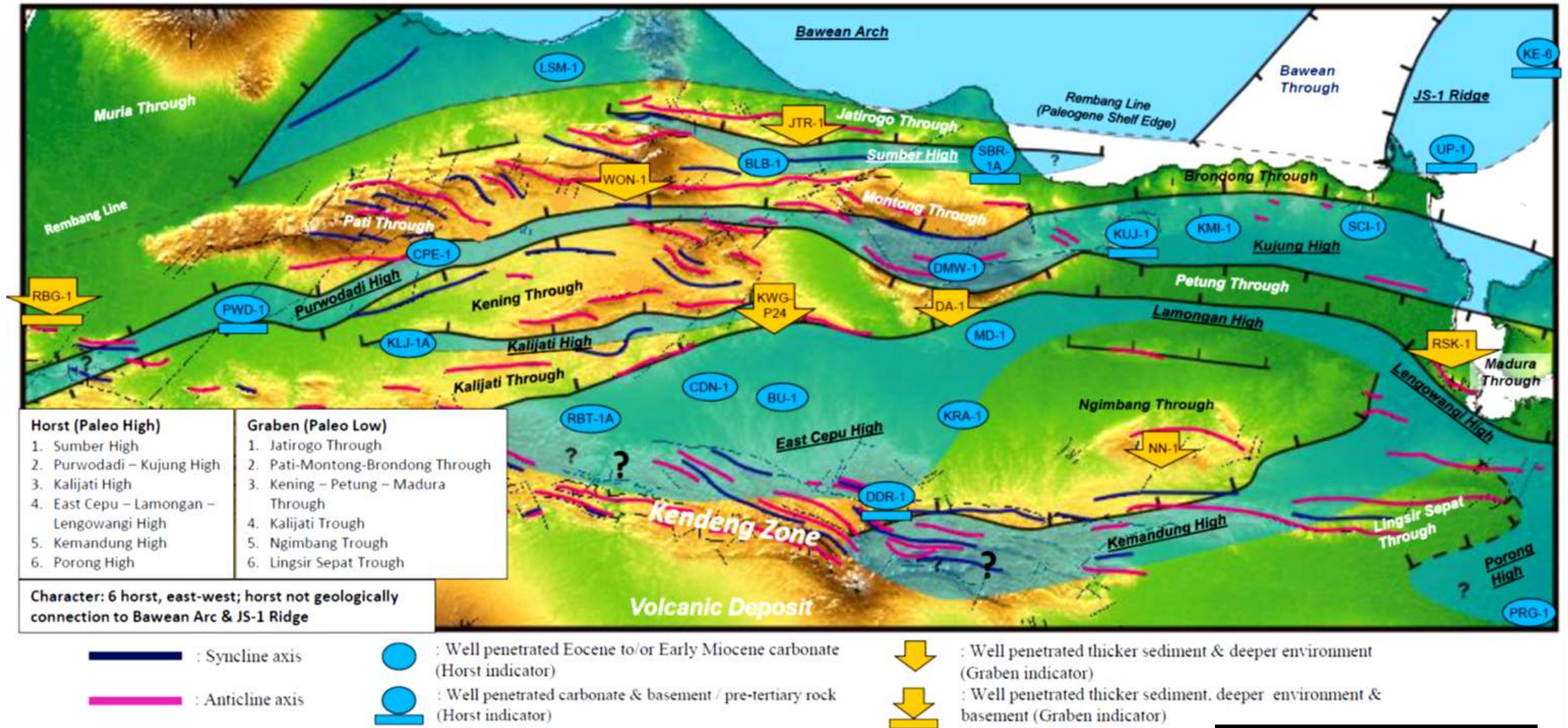
— : Syncline axis
— : Anticline axis



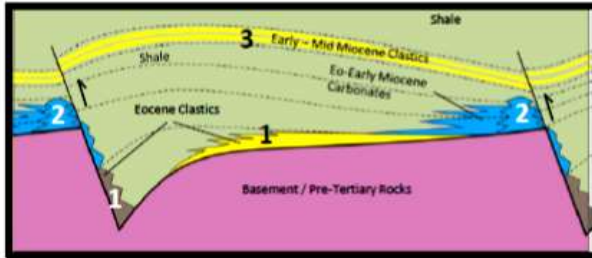
Seismic section & stratigraphy



New horst & graben map



New exploration opportunity



Play Concept:

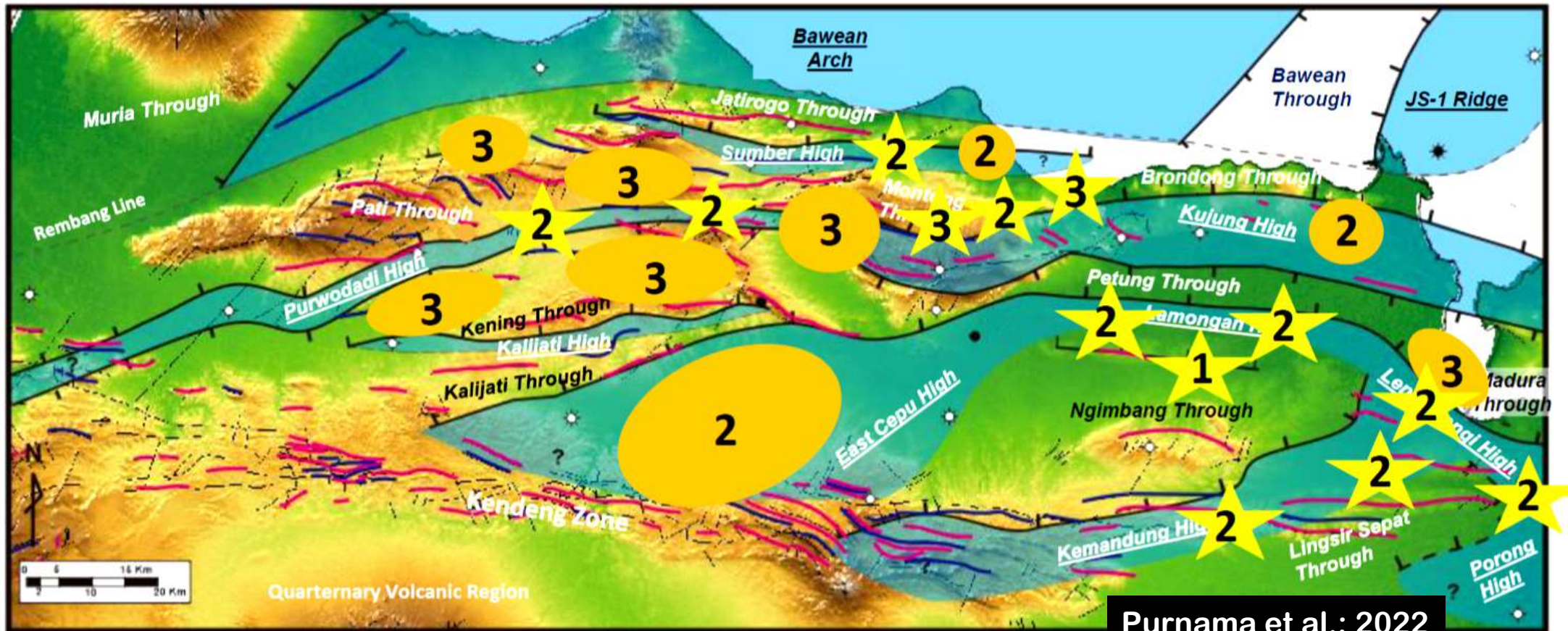
- 1) Eocene Clastics,
- 2) Eocene to Early Miocene Carbonates (incl. sub-thrust play)
- 3) Early to Middle Miocene Clastics



: Proven



: Opportunity





TERIMAKASIH

Acknowledgement

- **SKK MIGAS**
- **Pertamina**
- **Jurusan T Geologi UPN "Veteran" Yogyakarta**