International Workshop on Offshore Geologic CO_2 Storage

CCS Initiatives from Malaysia's perspective: A Pioneering Offshore Carbon Sequestration-Kasawari

By:
Haylay Tsegab[1*], Monera Adam[1], Abdulrasheed Ibrahim Yerima[1], Mirza Arshad[2], and Ana Widyanita[3]

[1]Southeast Clastic and carbonate Research Laboratory, Universiti Teknologi PETRONAS
[2]Georesearch Solutions
Kuala Lumpur
[3]PETRONAS Research Sdn Bhd

*haylay.Tsegab@utp.edu.my

UNIVERSITI TEKNOLOGI PETRONAS
energising futures

17 September 202

SEACARL
SOUTH-EAST ASIA CARBONATE RESEARCH LABORATORY

OUTLINE

- Introduction
- Geological Setting
- Subsurface structure
- Technological advancement
- Opportunities and Challenges
- Conclusion
- Acknowledgement
- Reference

Why CCS?

- The global warming is a global challenge that needs global thinking but local action.
- Malaysia is one of the signatories of the Paris Agreement.
- We have gas fields that contained big percentage of CO_2.
- The geographic location of the country is optimum for the purpose.
- The country has visioned to be CCS-hub of the region.
- There are several maturing fields.
- Recently there is a huge consortium of companies to work on CCS (PETRONAS, Storegga, and ADNOC).
- Contributing to the solution of the global challenge.

Discovery of the Kasawari

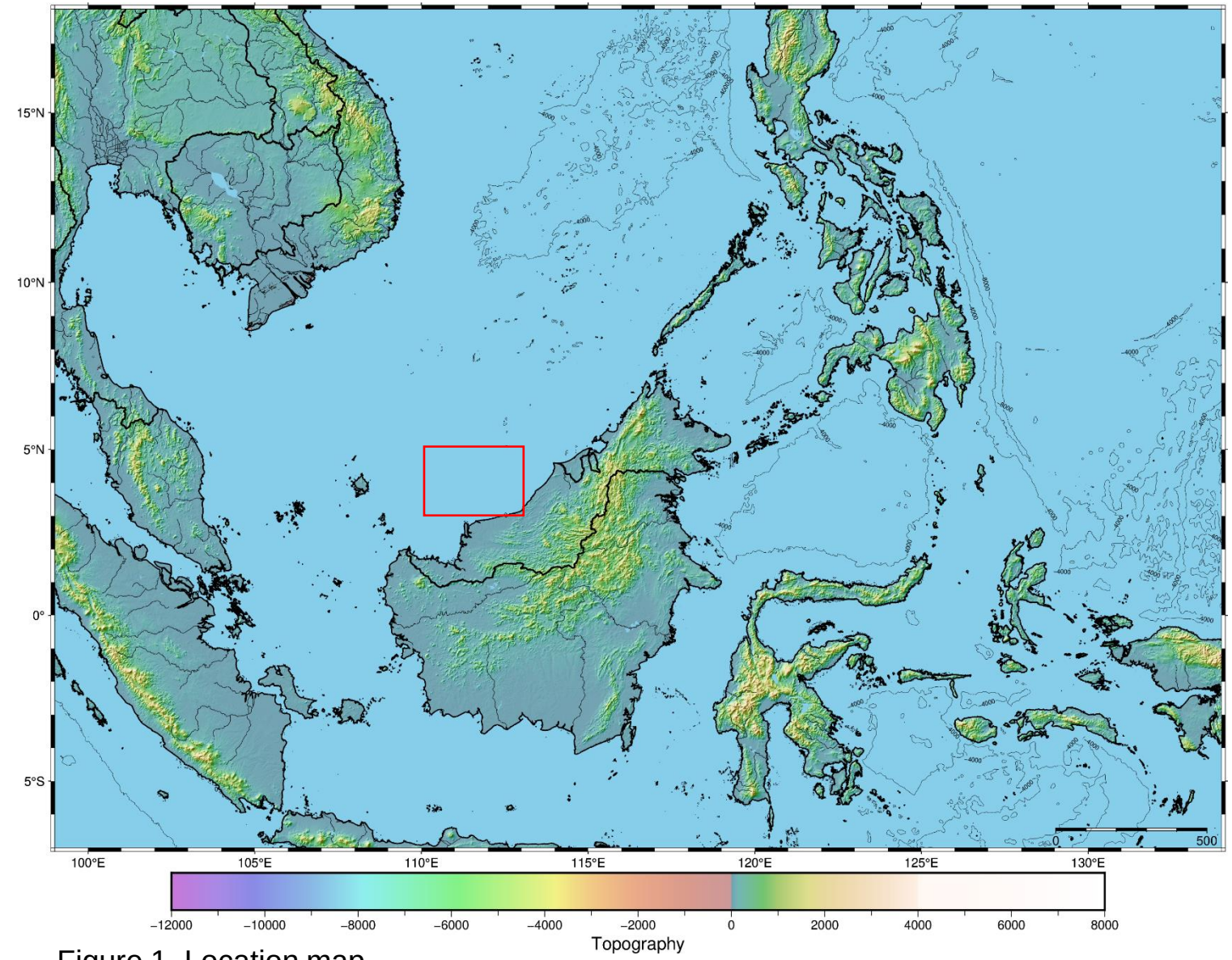


Figure 1. Location map

- The Kasawari gas field was discovered by PSCB in Nov 2011.
- It is in the Cycle IV/V Late Miocene carbonate build-ups.
- The field has a four-way dip conical closure.
- Kasawari field is estimated to contain approximately 10(TSCF) of recoverable gas resources.
- CO_2 ~22% and it has also H_2S.

The Central Luconia – Gas Fields

Figure 2. The Kasawari Gas Field Project, offshore Sarawak, Malaysia (NS ENERGY, 2022).

- The Central Luconia Province has natural gas reserve of about 65 TSCF, of which 27.32 tscf is CO_2 (Md Shah et al., 2018).
- Kasawari Carbon Capture and Storage (CCS) project is positioned as the world's largest offshore CCS up on its commencement by 2025.
- It is developed as the first CCS project by PETRONAS.
- The scale is significant as it represents 9% of global CCS operation (2021) and anchors PETRONAS' pathway for Net Zero Carbon Emission (NZCE) by 2050.

Regional Geology

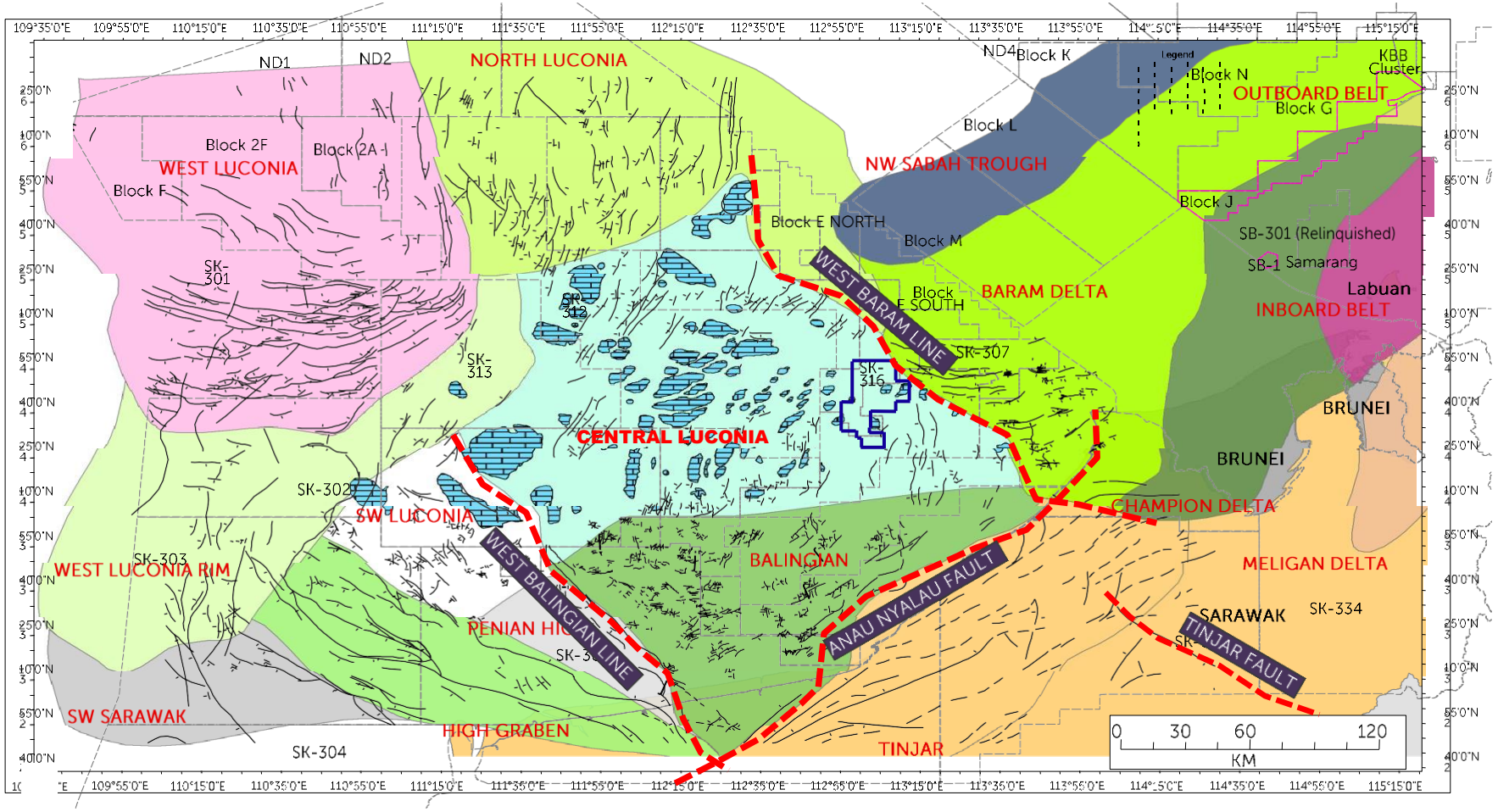


Figure 3. regional geology of the Sarawak Basin. Source: Petroleum Geology and Resource of Malaysia

- Located in SK316 block in the Central Luconia
- The Central Luconia is characterized by broad and stable continental shelf
- It hosts about 200 mapped carbonate build-ups.
- Extensional forces in the north and compressional forces in the south produces a series of hosts and gardens that served as anchor points for the Miocene.

Stratigraphy of the Central Luconia

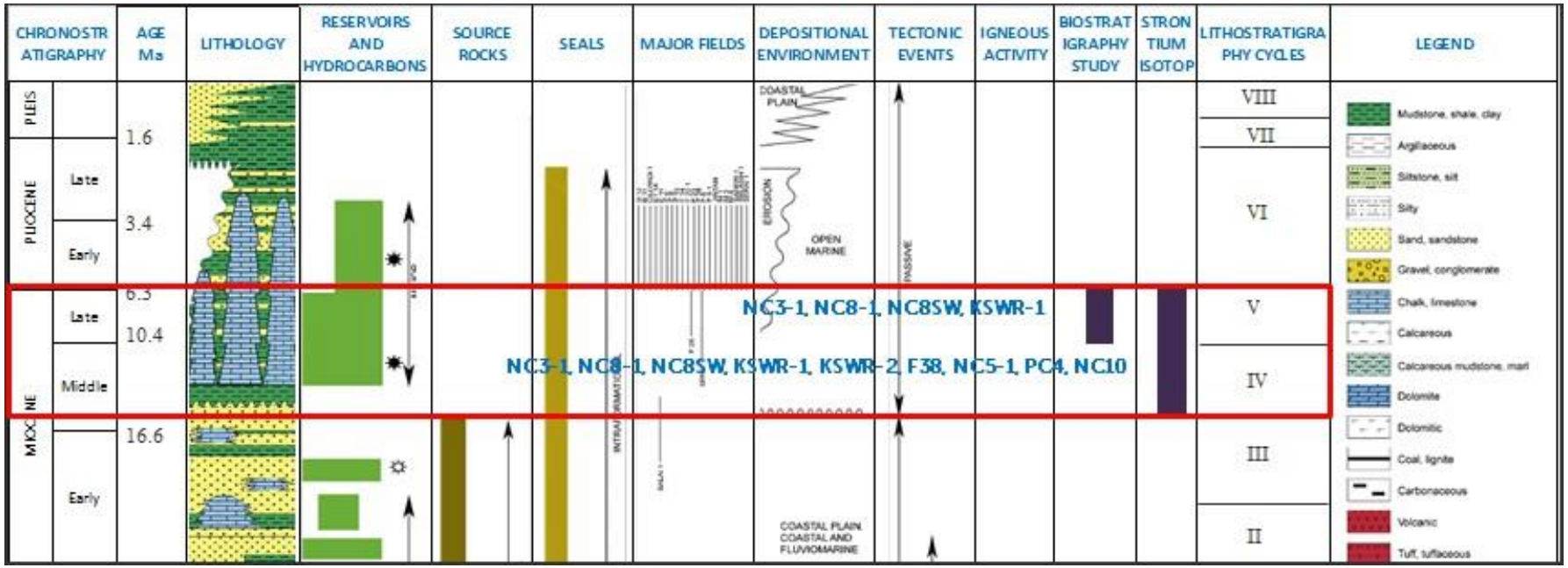
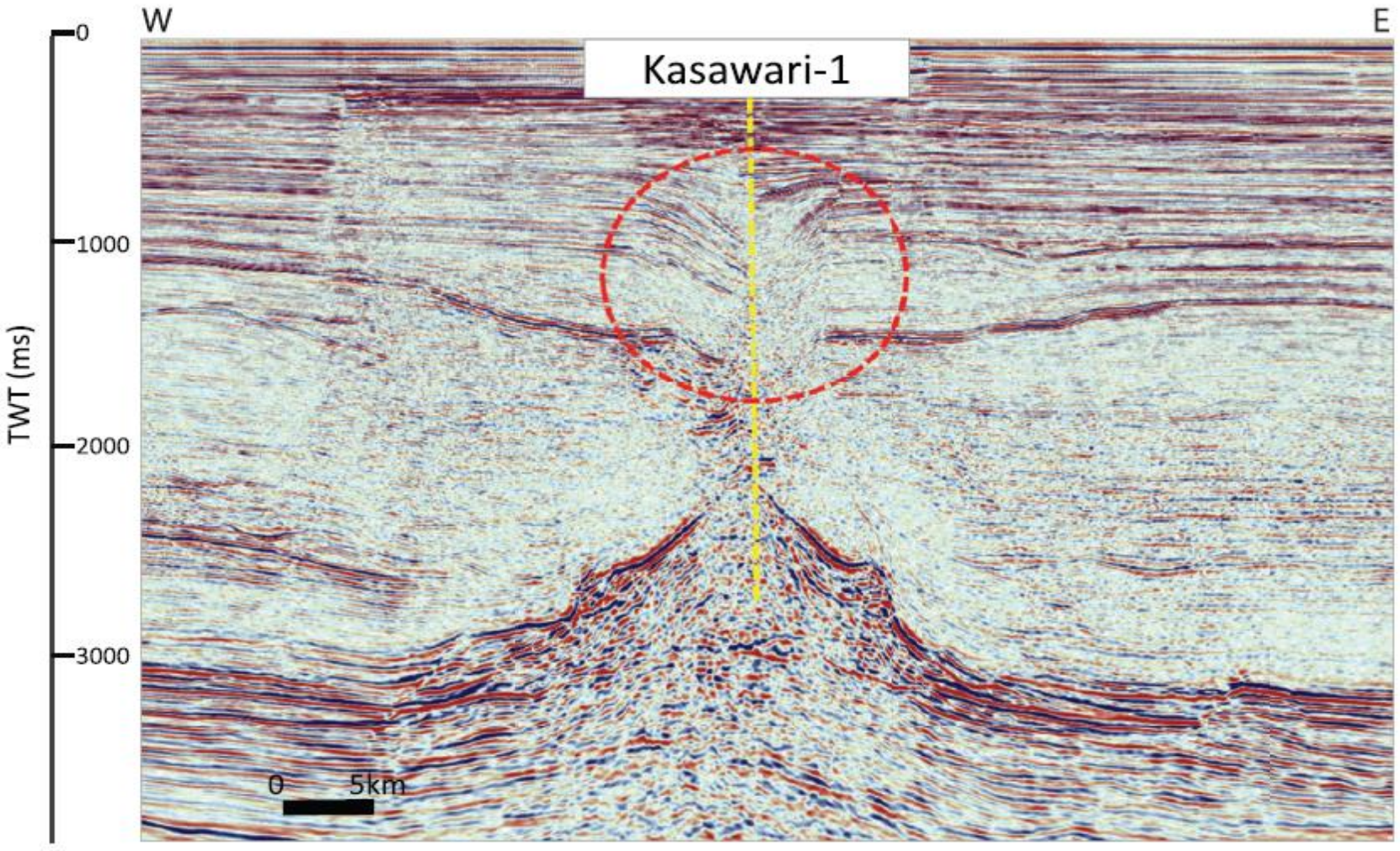


Figure 4. Regional Stratigraphy of Central Luconia (from Madon, modified after Hazebroek)

- Most of the carbonate build-ups are in Cycle IV/V.
- Dated to Middle to Late Miocene based on biostratigraphy and radiometric data.

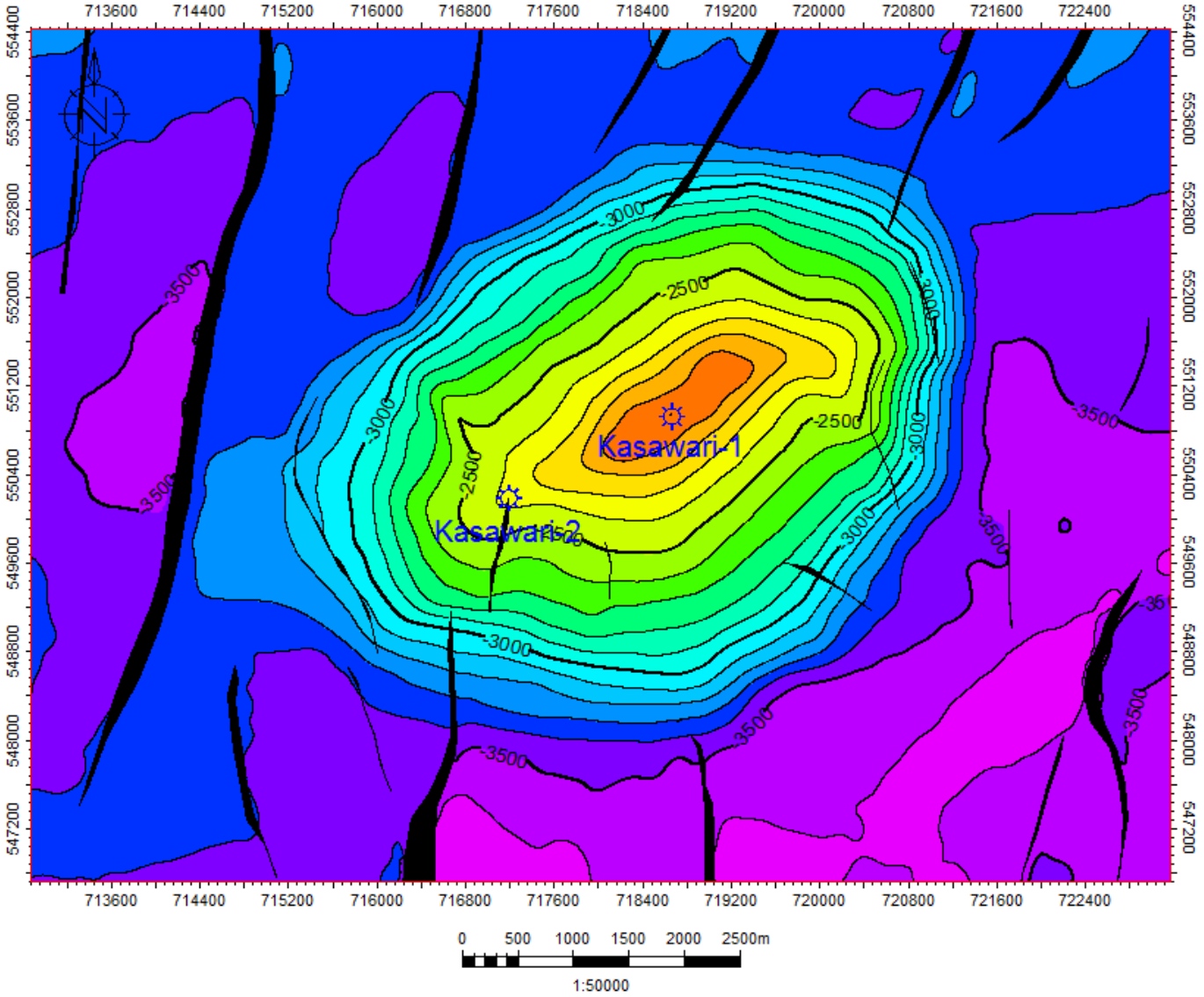
SEISMIC SECTION OF KASAWARI FIELD



- Concept of blown-trap had halted the exploration activity in the Central Luconia.
- However, the discovery of Kasawari, disproved the barrier and encourage others to look for the pinnacles.

Fig. 5. Kasawari found 5 TCF gas with >1 km of gas column, one of the 2011 giant discoveries.
The "blown trap" feature can be seen in the seismic section, circled in red. (**Adapted from Emeliana Rice-Oxley and Azli Abu-Bakar, 2022)**

Subsurface structure & storage capacity



- The field has a Four-way dip conical closure.
- Petrophysical properties:
  - Primary Porosity
  - Secondary Porosity

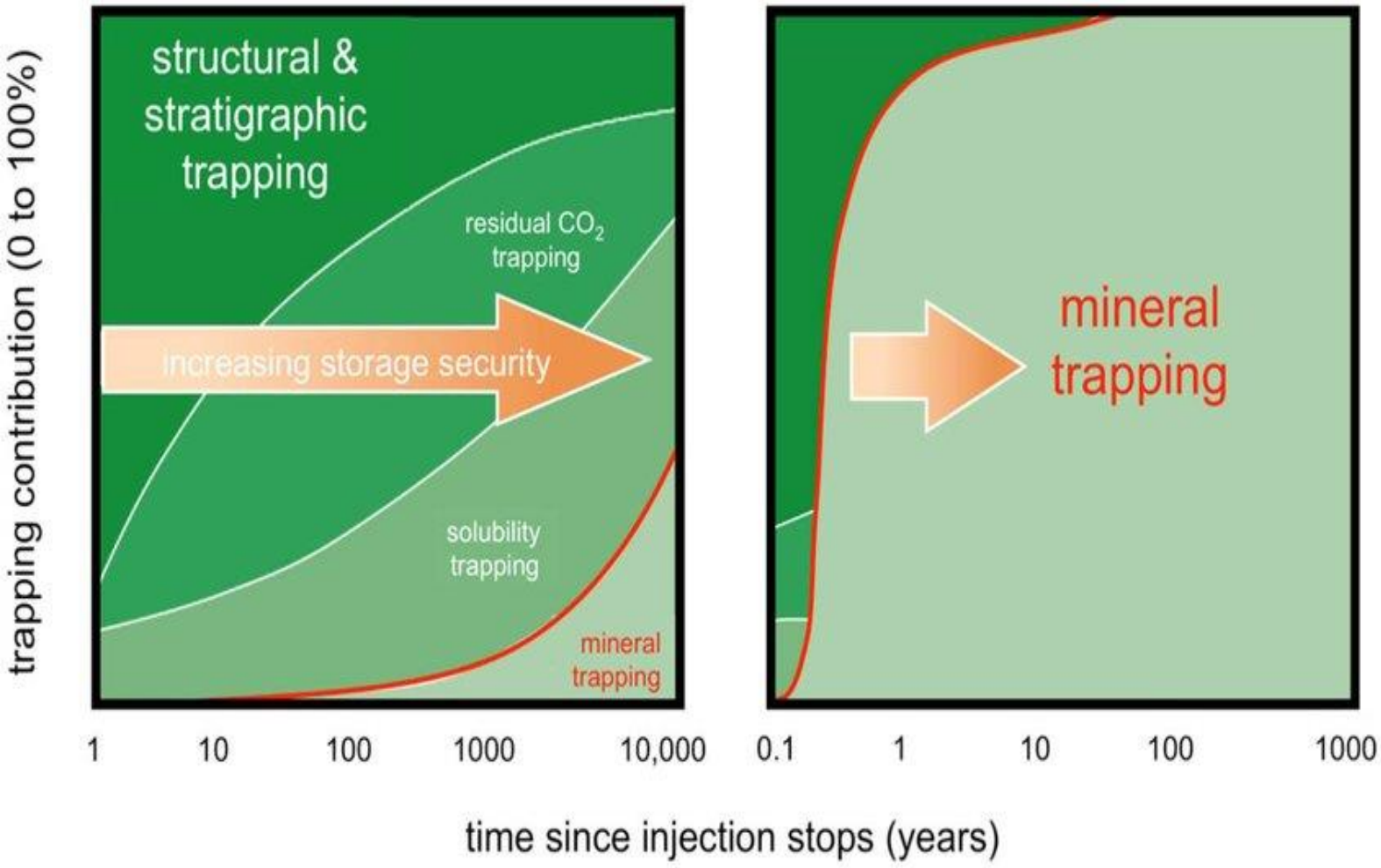
•Determines the volume of CO_2 that can be stored.

•The storage of the CO2 will be in a nearby depleted HC field (M1).

•It targets to inject up to 4MTPA CO_2e for about 30 years of injection.

Figure 6. Depth structural map of the Kasawari field (Source: PETRONAS internal document)

MECHANISM FOR CO2 TRAPPING



- Trapping mechanism
  - Structural
  - Residual
  - Solubility
  - Mineral

Fig.7 Shows the contributions of the various CO_2 trapping mechanisms (Song and Wang, 2021).

Technologies

1. Advanced CO_2 Capture Technologies
   - PN-1™ Technology: PETRONAS developed this membrane technology to process and remove a wide range of CO_2 from natural gas.
2. Compression Solutions
   - State-of-the-art compression technology supplied by Baker Hughes for Malaysia's first CCS project
3. Emerging Technologies
   - Use of AI and advanced technologies to optimize storage capacity
4. Collaborative Efforts
   - Partnerships: PETRONAS has partnered with ADNOC, Storegga, and other international entities to develop CCS facilities and establish a regional CCS hub.
5. Research and Development
   - Ongoing studies and future prospects.
6. Storage Solutions
   - Exploration of saline aquifers for CO_2 storage, leveraging on existing geophysical and geomechanical models and reservoir simulations
7. Carbon Management Division (CMD)Integrated Approach
   - PETRONAS' CMD focuses on physical decarbonization and CCS across its operations, including upstream, downstream, and gas businesses.

Opportunities and Challenges

Benefits

1. Environmental benefits
   - Take away 3.7MTPA
2. Energy Security
   - EOR
   - Clean production
3. Many depleted fields

Challenges

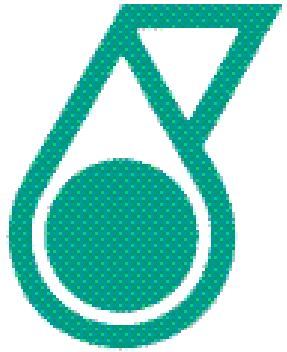
1. Technical Barriers
   - Complexity of CCS Technology
   - Infrastructure
2. Economic Constraints
   - High Costs
   - Funding and incentives
3. Regulatory and Policy Issues

Take away message

- Best practices from existing CCS projects will make future projects effective and efficient in terms of cost and time.
- The Kasawari CCS project is the largest CCS offshore platform in terms of injection rate and storage volume.
- It will significantly contribute to reduction of CO_2 emission into the atmosphere (represents 9% of global CCS as of 2011).
- It also helps in capacity building and Energy security.

Acknowledgment

International Workshop on Offshore Geologic CO_2 Storage



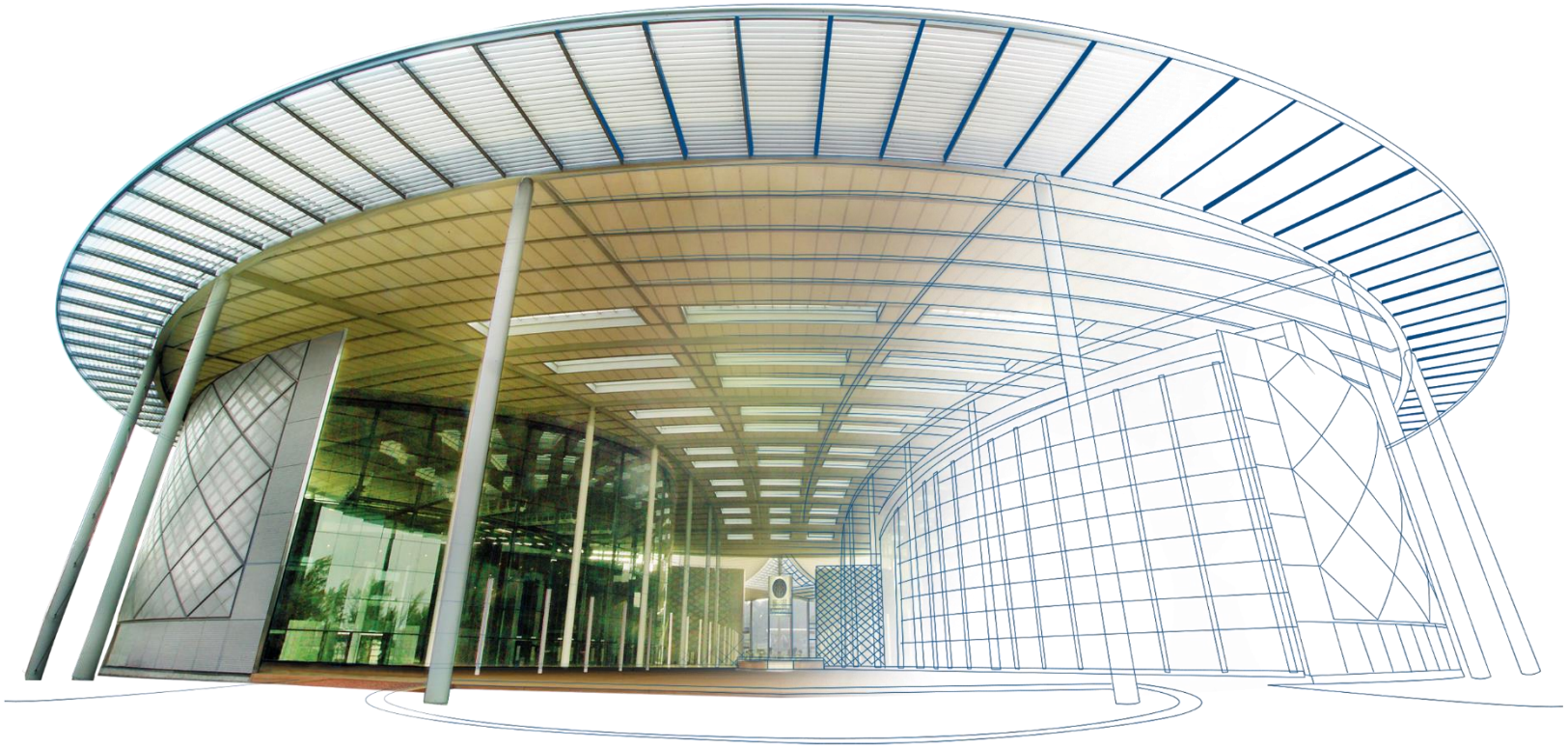
UNIVERSITI TEKNOLOGI PETRONAS

IEAGHG

CARBON CAPTURE, UTILIZATION & STORAGE
ACCELERATING CCUS TOGETHER
AN INITIATIVE OF THE CLEAN ENERGY MINISTERIAL

References

1. Morley, R.J., et al., *Sequence biostratigraphic framework for the Oligocene to Pliocene of Malaysia: High-frequency depositional cycles driven by polar glaciation*. Palaeogeography, Palaeoclimatology, Palaeoecology, 2021. **561**: p. 110058.
2. Nasir, E. and Y.I. Go, *Carbon capture and storage at Malaysia power plants: Evaluation of its feasibility and requisite enablers*. Journal of Cleaner Production, 2024. **469**: p. 143173.
3. Rahman, A.H.A., D. Menier, and M.Y. Mansor, *Sequence stratigraphic modelling and reservoir architecture of the shallow marine successions of Baram field, West Baram Delta, offshore Sarawak, East Malaysia*. Marine and Petroleum Geology, 2014. **58**: p. 687-703.
4. Madon, M., C.L. Kim, and R. Wong, *The structure and stratigraphy of deepwater Sarawak, Malaysia: Implications for tectonic evolution*. Journal of Asian Earth Sciences, 2013. **76**: p. 312-333.
5. Rice-Oxley, E. and A. Abu-Bakar, *Historical and emerging super basins of Southeast Asia*. AAPG Bulletin, 2022. **106**(3): p. 633-653.
6. Mohamed Najib, M.A., et al. *Kasawari Carbon Capture and Storage (CCS): Unfolding the Largest Offshore CCS Project Realization*. in *International Petroleum Technology Conference*. 2023. IPTC.
7. Morrison, K. and W.C. Lee, *Sequence stratigraphic framework of Northwest Borneo*. 2003.
8. Balakrisnan, M., et al. *Methodological Engineering Approach in Designing Injector and Observation Wells Incorporating MMV Requirements in Carbonate CCS Project in Offshore Malaysia*. in *Abu Dhabi International Petroleum Exhibition and Conference*. 2022. SPE.
9. https://www.offshore-technology.com/news/petronas-adnoc-storegga-ccs-partnership/?cf-view
10. https://globalenergyprize.org/en/2022/12/02/malaysia-approves-worlds-largest-offshore-ccus-project/



THANK YOU

Get Connected with

UTP

www.utp.edu.my | UTPOfficial