Springer
SPRINGER NATURE

Paper number:
392

Facies analysis, sequence stratigraphy and hydrocarbon habitat prospectivity of the Pindiga Formation and Fika Shale, Gongola sub-basin, northern Benue trough, Nigeria

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2ND CONFERENCE OF THE ARABIAN JOURNAL OF GEOSCIENCES (CAJG)
25–28 NOVEMBER 2019, SOUSSE, TUNISIA
www.cajg.org

AJG Springer SPRINGER NATURE
25-28 November 2019, Sousse, Tunisia

Background

- Nigerian economy depends on oil and gas derived from the Niger Delta Basin
- Seven frontier basins are either unexplored or under explored
- Gongola subbasin of the NBT is a prime target

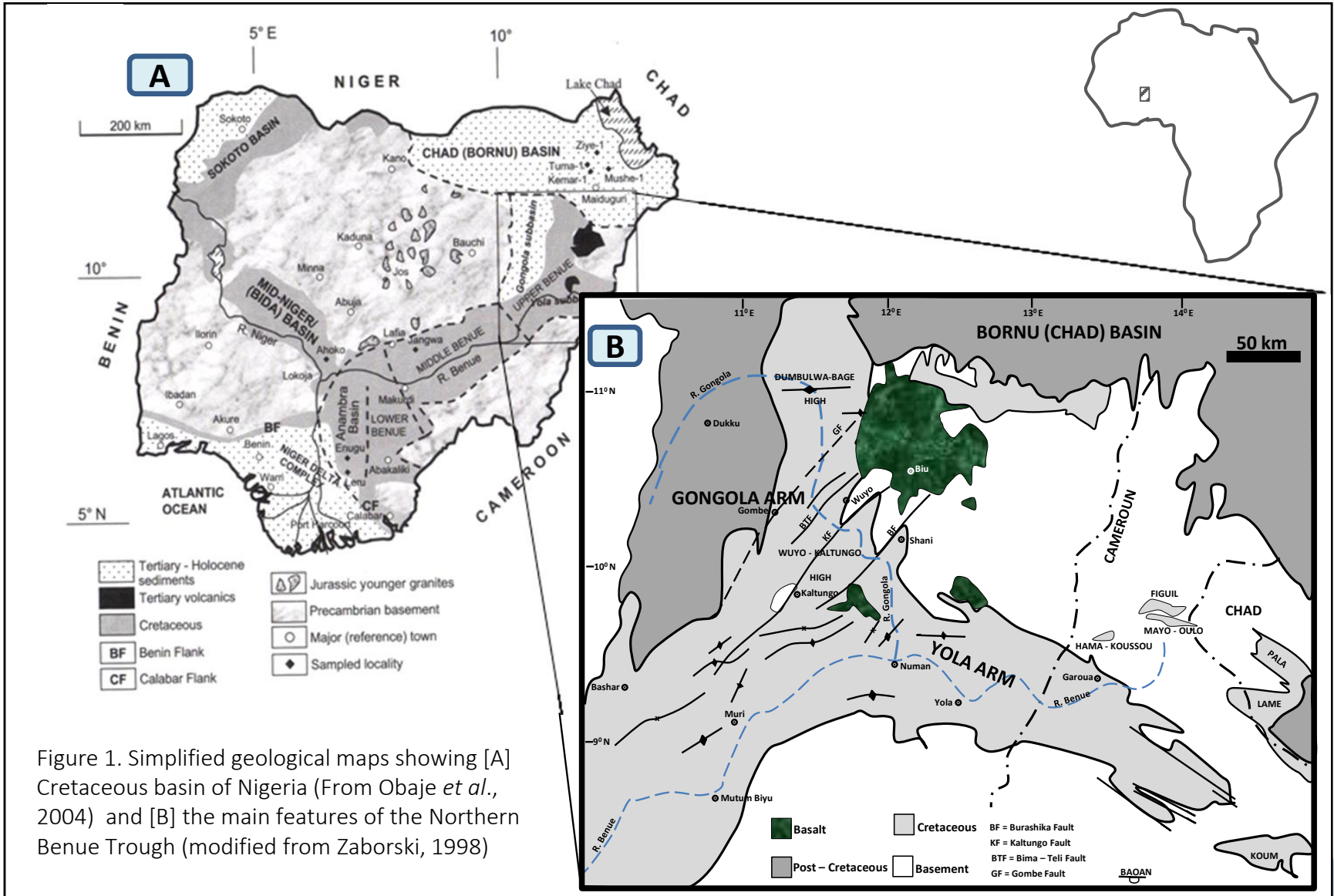


Figure 1. Simplified geological maps showing [A] Cretaceous basin of Nigeria (From Obaje *et al.*, 2004) and [B] the main features of the Northern Benue Trough (modified from Zaborski, 1998)

Background

- Drilling of three wells led to the discovery of hydrocarbon in the Gongola sub-basin
  - Kolmani-1-Well with reported discovery of sub-commercial oil (SHELL, 1997)
  - Nasara-1-Well - dry
  - Kuzari-1-Well – dry
  - Kolmani-II-Well – ongoing

- In order to effectively explore for hydrocarbon in the Gongola sub-basin, adequate understanding of the genetic evolution of the sedimentary packages of Pindiga Formation and Fika Shale using sequence stratigraphic technique is critical due to its predictive nature

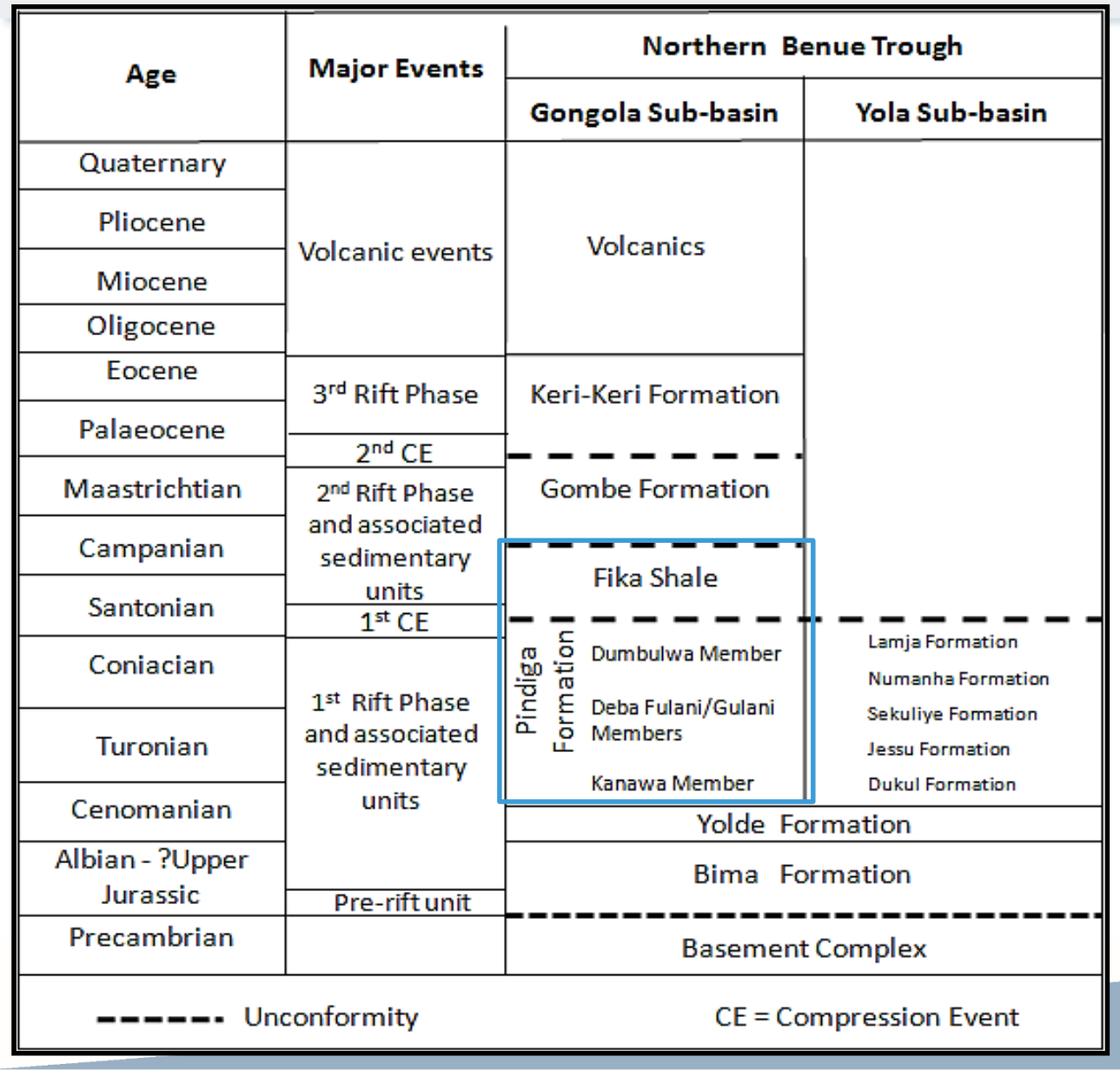
- The present work provides detailed outcrop facies, facies associations, facies successions, sequence stratigraphic framework and hydrocarbon play potentials of the approximately 600 m thick Pindiga Formation and Fika Shale

- This offers a good and refined understanding of the geology of the basin to minimize exploration and production risk

Outline

1. Study area
2. Methodology
3. Results
4. Discussion
5. Conclusions

1. Study area



- Of importance to this presentation is the Pindiga Formation
- Zaborski et al. (1997) described the Pindiga Formation as consisting of:
  - shale and limestone dominated Kanawa Member,
  - the laterally equivalent sandstone dominated Gulani, Deba Fulani and Dumbulwa members and
  - the Fika aaaMember mudstones/shales of the Fika Member

Figure 2. Lithostratigraphic successions in the Northern Benue Trough (Data from Genik, 1992; Guiraud, 1993; Zaborski et al., 1997 Zaborski, 1998; Abubakar *et al.*, 2014).

1. Study area

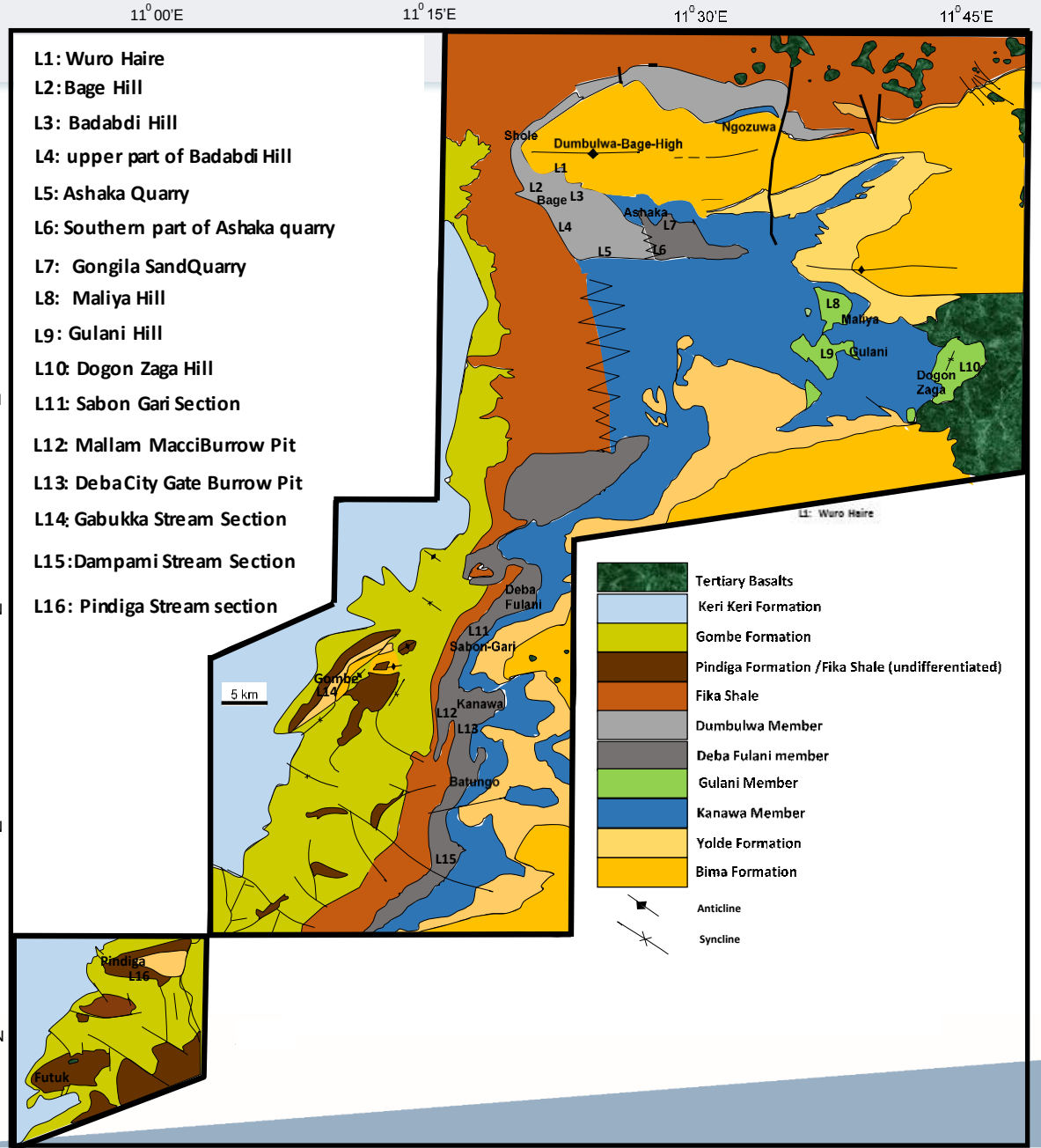
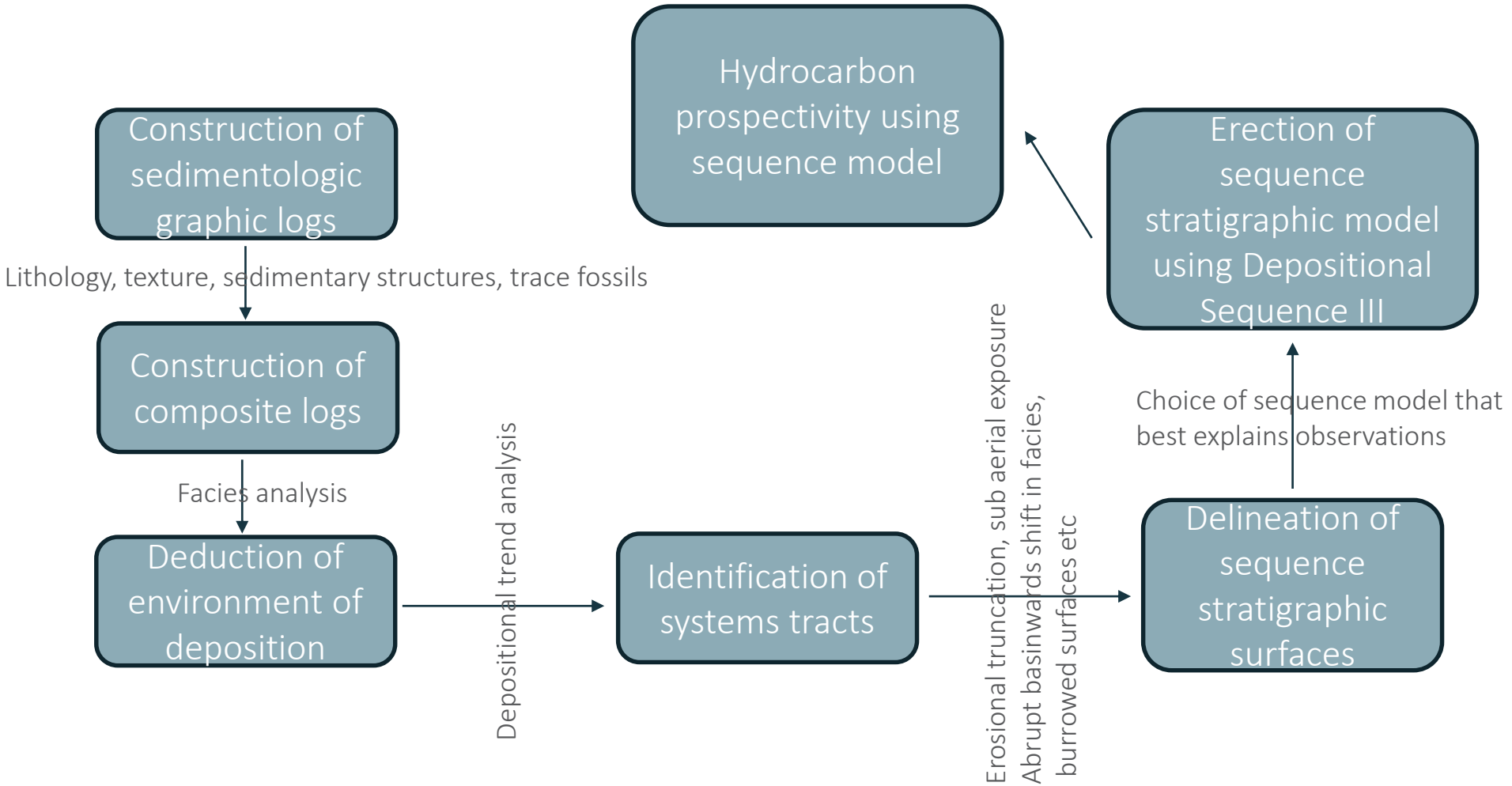


Figure 3. Geological map of the Gongola Sub-basin (modified from Zaborski *et al.*, 1997) showing approximate positions of the logged sections in the study area (L1 to L16).

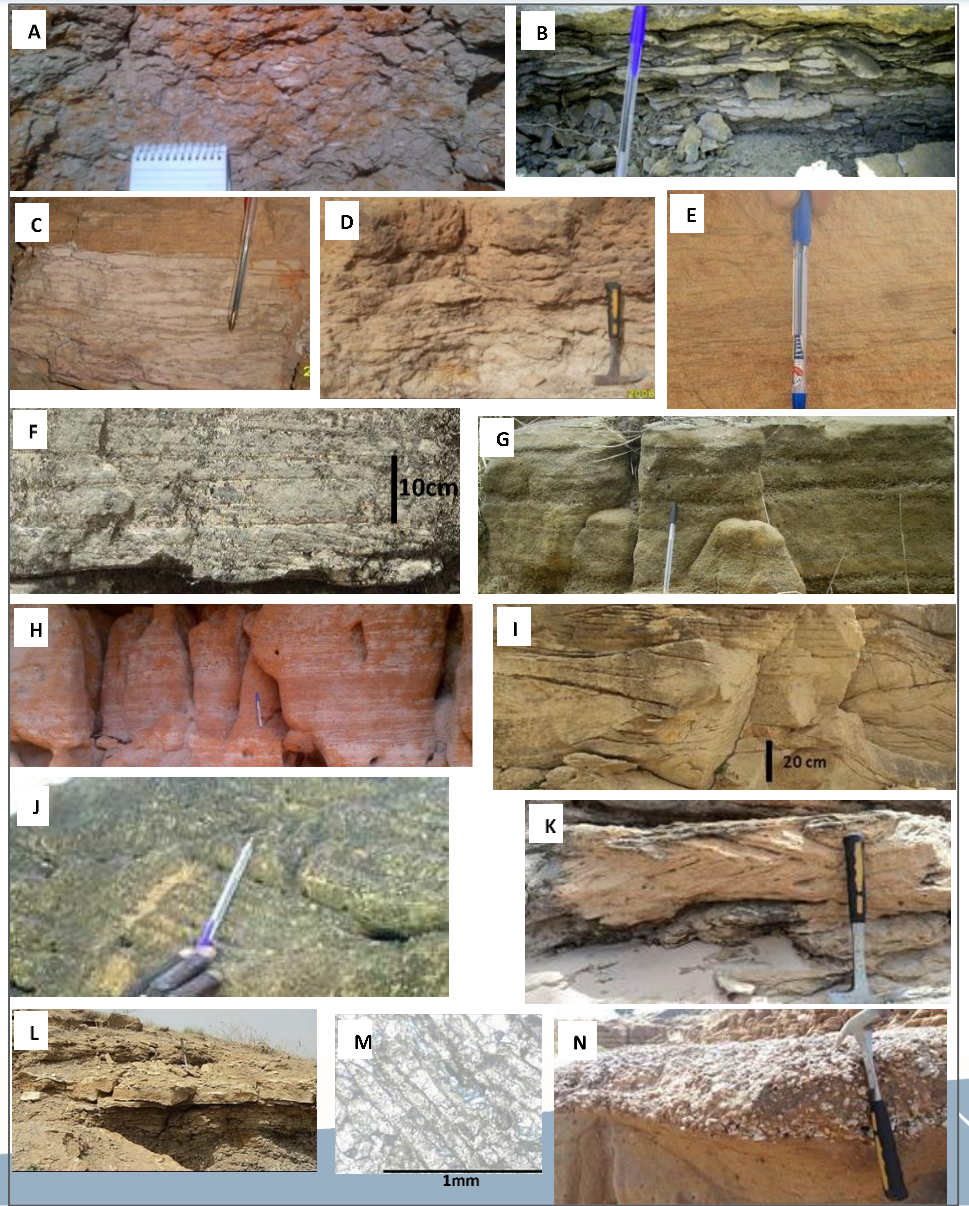
2. Methodology



3. Results (Lithofacies)

Kanawa Member

Sandy Members



Fika Shale

- 21 outcrop lithofacies were identified
  - Kanawa Member: K1, K2
  - Sandy Members: S1-S14
  - Fika Shale: Fk1-Fk5

3. Result (Facies associations)

Facies Association	Code	Lithofacies Present
Kanawa Member		
Outer ramp	FA1	K1, K2
Mid-ramp	FA2	K1, K2
Sandy Members		
Wave/storm-dominated prodelta to delta front	FA3	S1, S2, S4, S6, S9, S14
Wave/storm-dominated shoreface to nearshore	FA4	S1, S7, S8, S9, S11, S12
Offshore to offshore transition	FA5	S1, S9
Tide influenced fluvial channel	FA6	S4, S10, S11, S12, S13
Tidal bar	FA7	S2, S3, S4, S11, S12, S13
Bayhead delta	FA8	S1, S4, S6, S10, S12,S13
Tidal channel	FA9	S4, S12, S13
Central bay	FA10	S1, S5
Estuary mouth	FA11	S1, S2, S4, S7, S8, S9, S12, S13
Fika Shale		
Prodelta facies association	FA12	Fk1, Fk2, Fk3
Delta front facies association	FA13	Fk1, Fk3, Fk4, Fk5

3. Facies successions and depositional model

Kanawa Member

1. Carbonate platform (FA1, FA2)

Sandy Members

2. Wave/storm -dominated prodelta to delta (FA3)
3. Wave/storm-dominated offshore to nearshore (FA4, FA5)
4. Wave dominated estuary (FA8, FA9, FA10, FA11)
5. Tide dominated estuary (FA6, FA7)

Fika Shale

6. Prodelta to delta front

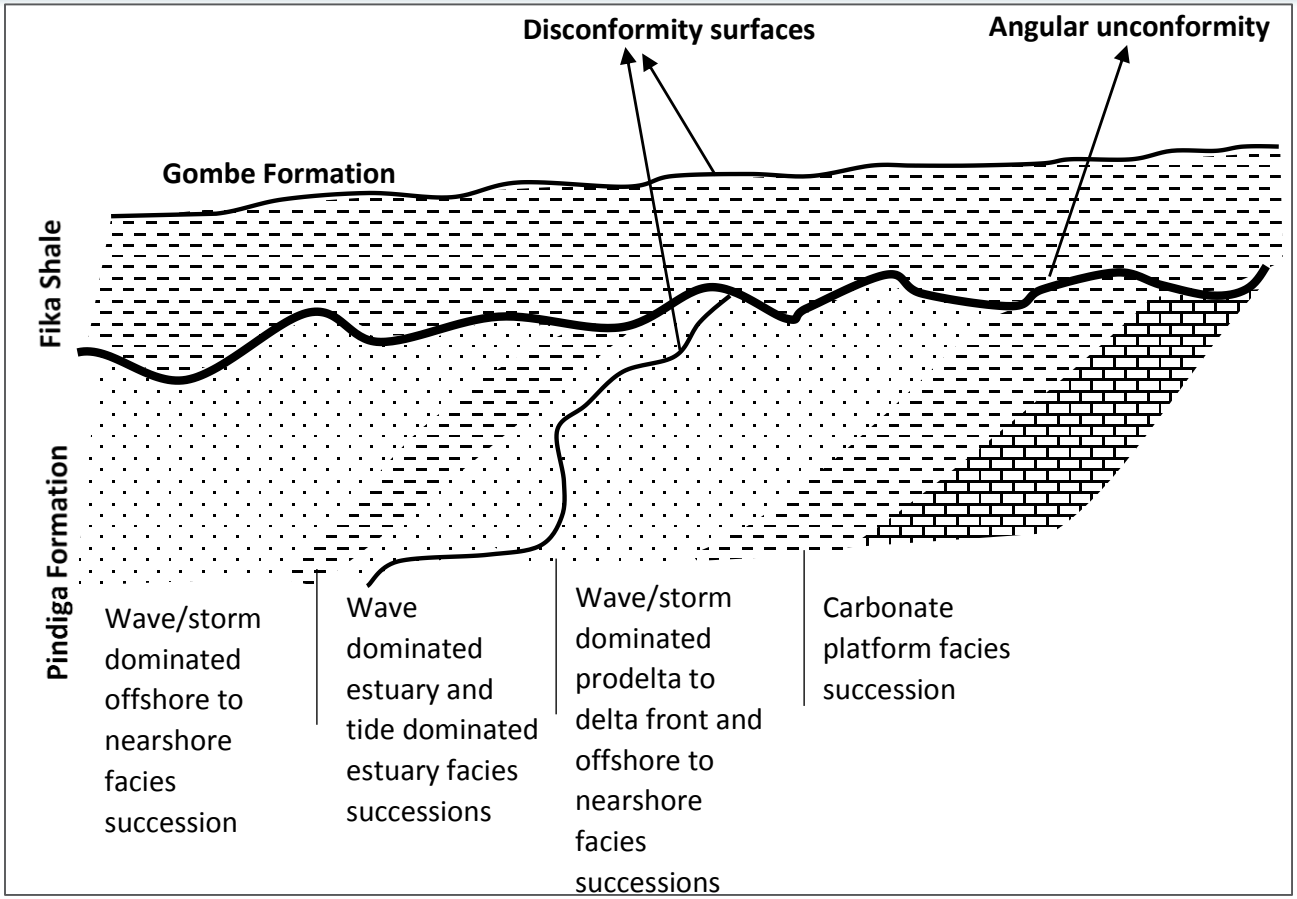
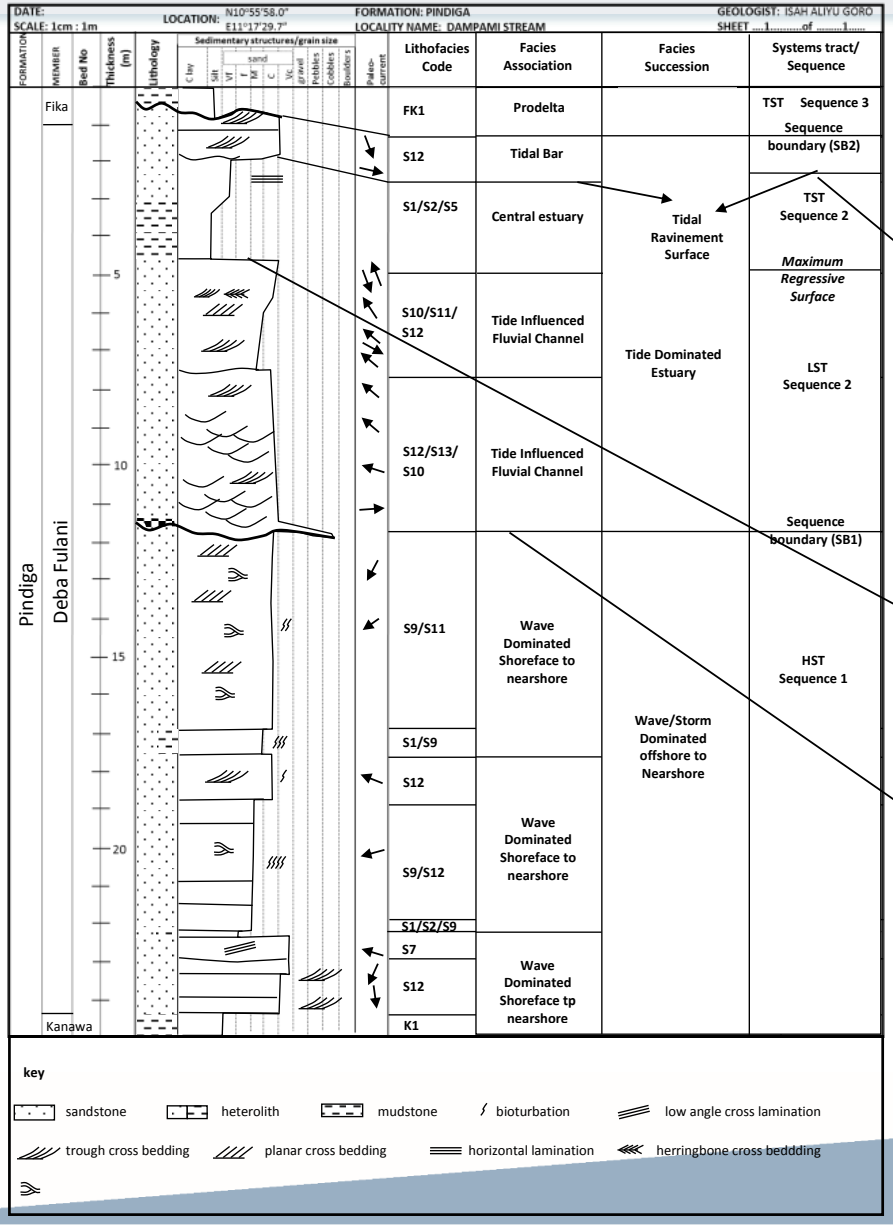
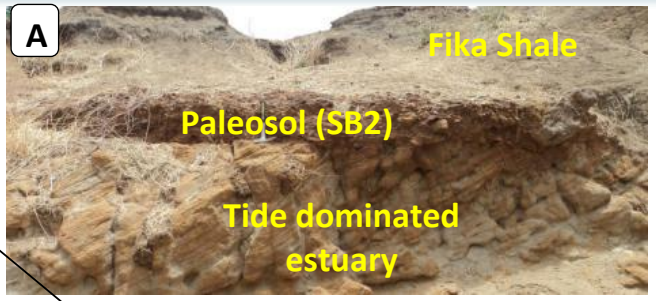


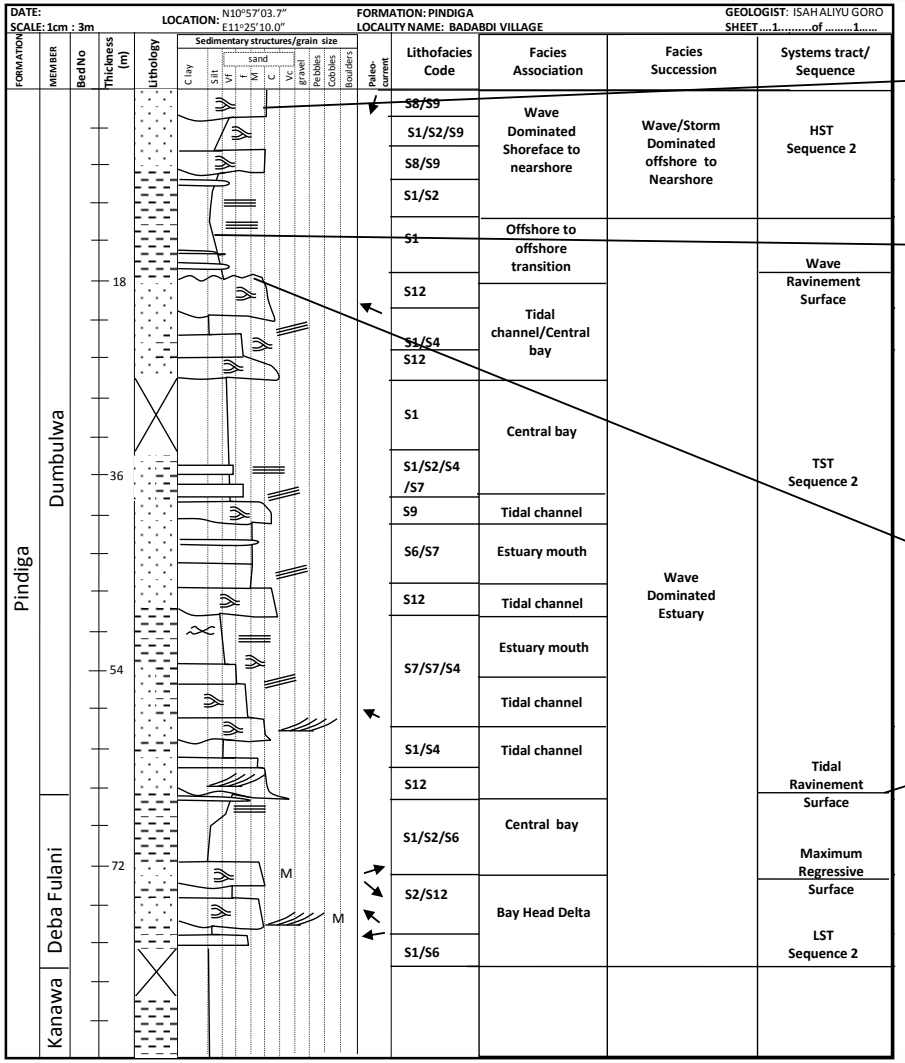
Figure 4. Schematic cross section of the Pindiga Formation and Fika shale, Gongola Sub-basin, Northern Benue Trough, NE Nigeria.

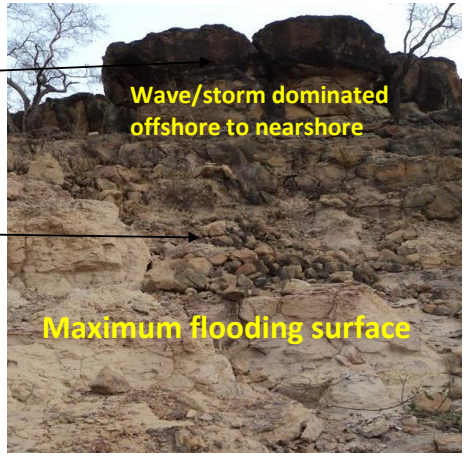
4. Depositional sequence 1 and 2

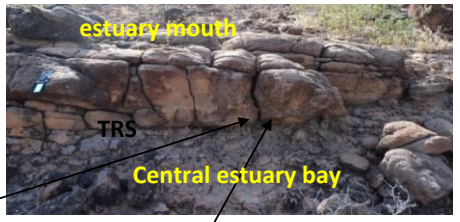




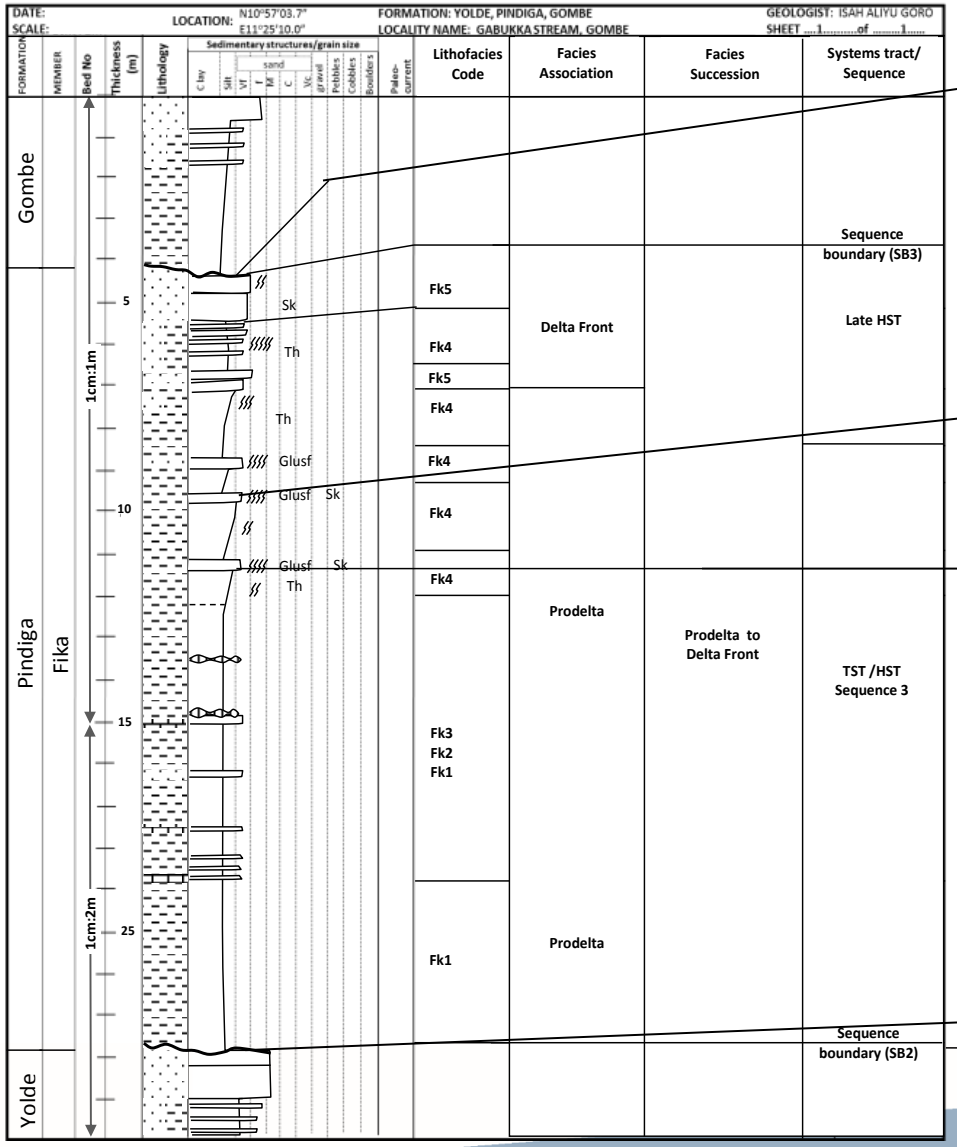
4. Depositional sequence 2

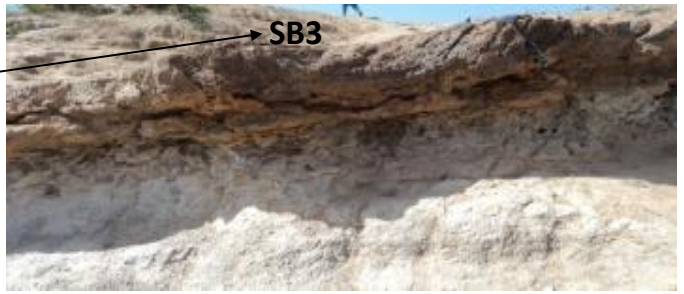


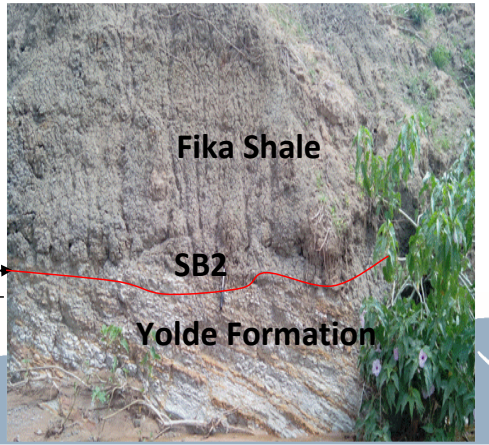




4. Depositional sequence 3







5. Sequence stratigraphic framework and hydrocarbon prospectively

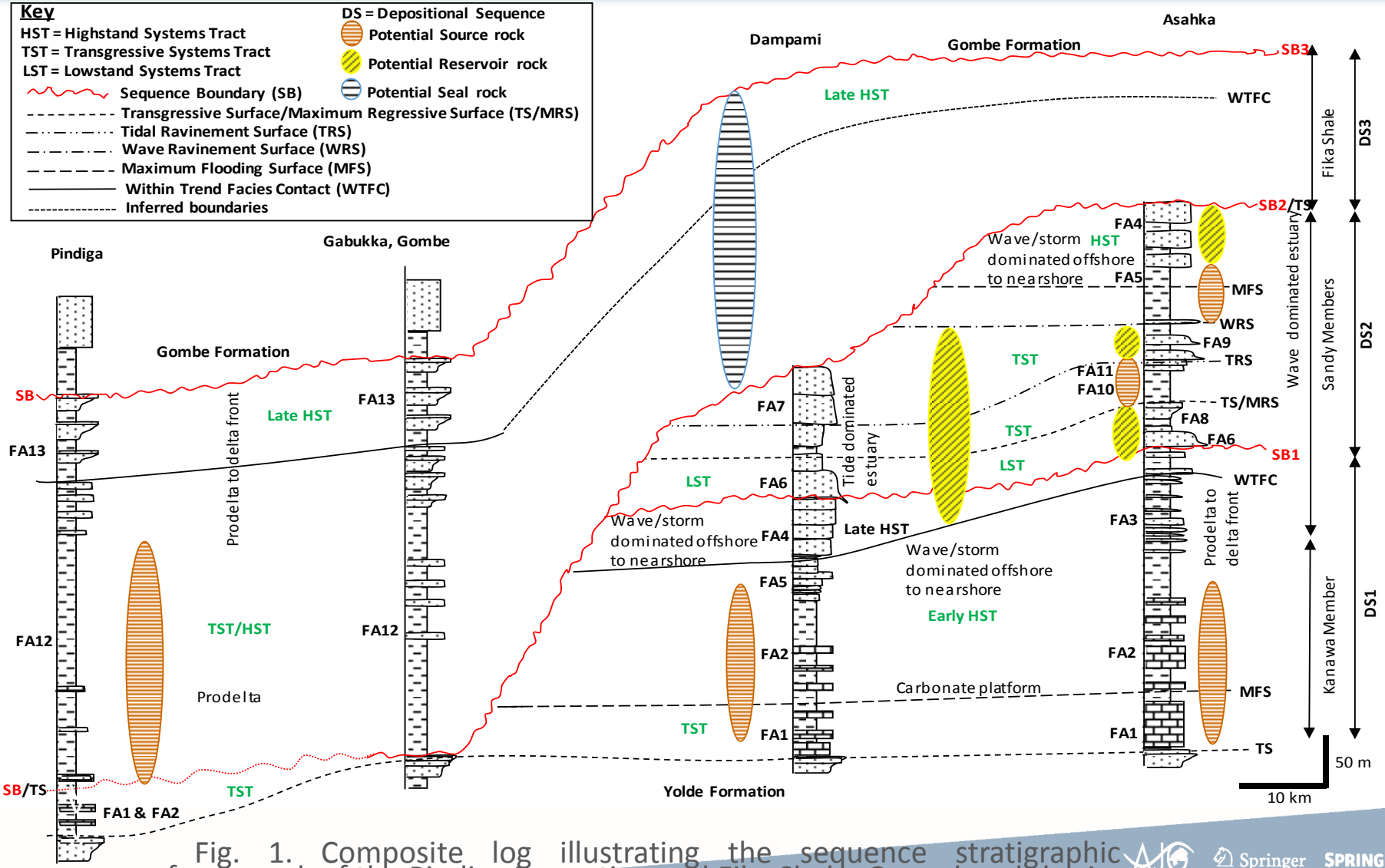


Fig. 1. Composite log illustrating the sequence stratigraphic framework of the Pindiga Formation and Fika Shale, Gongola sub-basin, Northern Benue Trough, Nigeria

Conclusions

- The purpose of this study was to use sequence stratigraphic approach to predict the hydrocarbon habitat of the Pindiga Formation and Fika Shale in the Gongola sub-basin of the northern Benue trough, Nigeria
- This study has identified one partial and two complete depositional sequences
  - The lower depositional sequence comprises a TST and HST with potentials for source and reservoir rocks respectively
  - The middle depositional sequence contains LST overlain by TST and HST
    - This sequence has great potential for reservoir Lithofacies provided by fluvial and tidal channels, tidal bar and shoreface to nearshore sandstones of the sandy members
  - Potential regional seal rock is provided by the laterally extensive, approximately 200 m thick upper depositional sequence represented by the Fika Shale
- Our study helps to better understand the stratigraphic evolution and hydrocarbon prospectivity of the Pindiga Formation and Fika Shale to minimize exploration and production risks in the basin and other related basins

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Thank you!

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