

Town/Gown Departmental Seminars Department of Petroleum Engineering. Covenant University

Topic:

Nigeria Oil & Gas Exploration & Production Value
Chain; Opportunities for Graduate Engineers &
Researchers

By:

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Outline

- ▶ Introductions/Seminar Objectives
- ▶ Synopsis of Nigeria Petroleum Resource Base
 - ▶ Overview of Nigeria's Sedimentary Basins
 - ▶ Overview of Geological/Petroleum Engineering Exploration Screening Process
 - ▶ Overview of Government & Regulatory Industrial Oversight
- ▶ Synopsis of Petroleum Exploration, Appraisal, Development and Production; The Nigeria Value Chain
 - ▶ Technical Aspects of Exploration, Appraisal, Field Development and Production
 - ▶ Commercial & Regulatory Aspects of Exploration, Appraisal, Field Development and Production
- ▶ Key Issues & Challenges in the Industry: Opportunities for Research/Value Creation
 - ▶ Reservoir/Field Exploitation Efficiency
 - ▶ Facility/Asset Integrity Management
 - ▶ Petroleum Resource Processing/Utilization
 - ▶ Data Acquisition, Analysis, Storage, Utilization and Commercialization
 - ▶ Academia/Industry Divergence/Convergence
- ▶ Q & A

Introduction

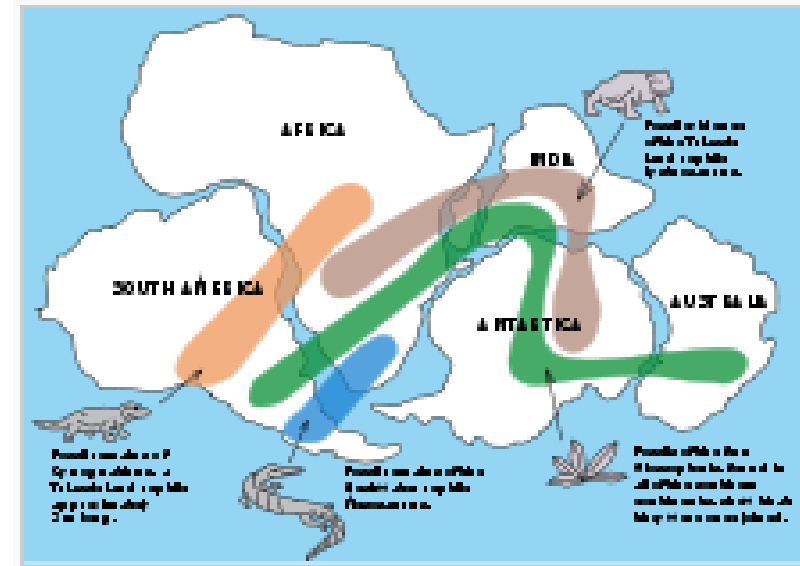
- ▶ Name: Collins A Onyeukwu, a petroleum engineer with 16 years oil and gas industry experience.
- ▶ Academic Background:
 - ▶ B. Eng Chemical Engineering (1998), University of Port Harcourt, Port Harcourt
 - ▶ M. Sc Petroleum Production Engineering (2010), Robert Gordon University, Aberdeen
- ▶ Oil & Gas Industrial Experience:
 - ▶ Derrick Man/Mud Technician Assistant (SWIES); Global Offshore Drilling Ltd (1996)
 - ▶ Production Operations Engineering Assistant (NYSC); Mobil Producing Nigeria UnLtd (1999/2000)
 - ▶ Chemical/Thermal Process Engineer; Boskel Nigeria limited (2000/2002)
 - ▶ Petroleum/Reservoir Engineer; Shell Petroleum Development Nigeria Limited (2004/2014)
 - ▶ Manager/Lead Engineer Subsurface; Seven Energy Nigeria Limited (2014/date)
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 - ▶ Member Nigeria Society of Engineers (COREN Registration)
 - ▶ Member & Director Lagos Oil Club

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Synopsis of Nigeria Petroleum Resource Base

Sedimentary Basins



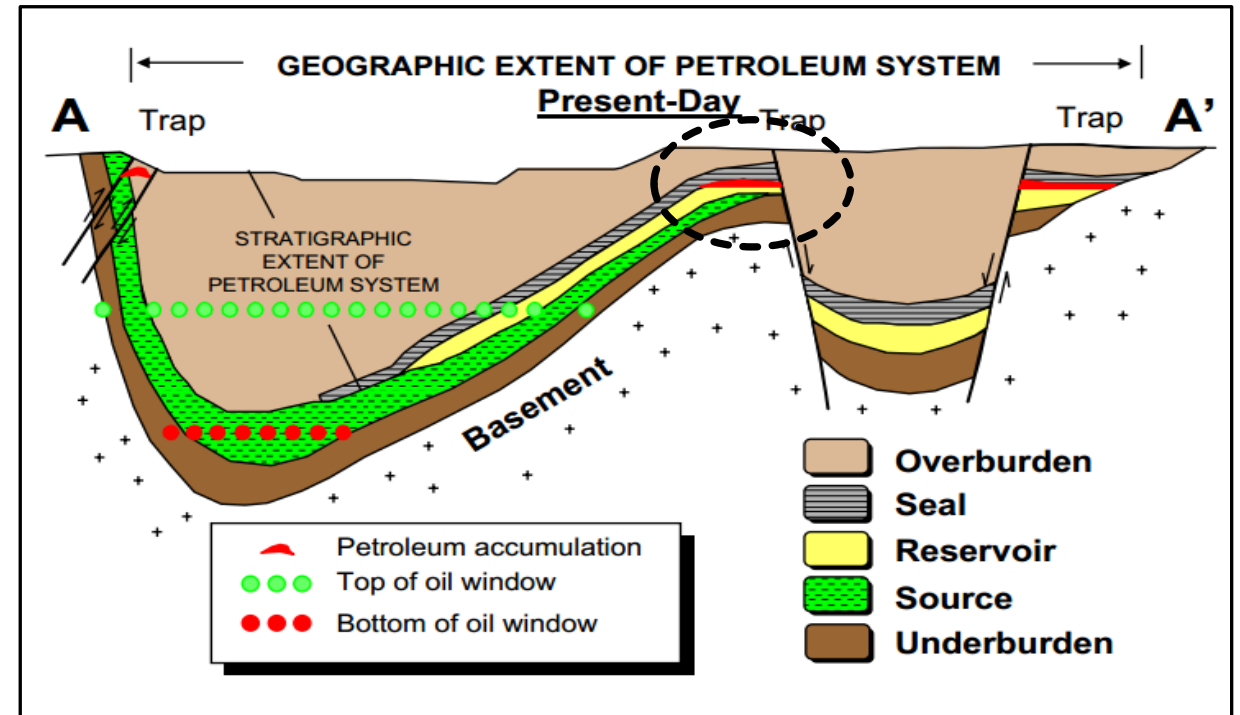
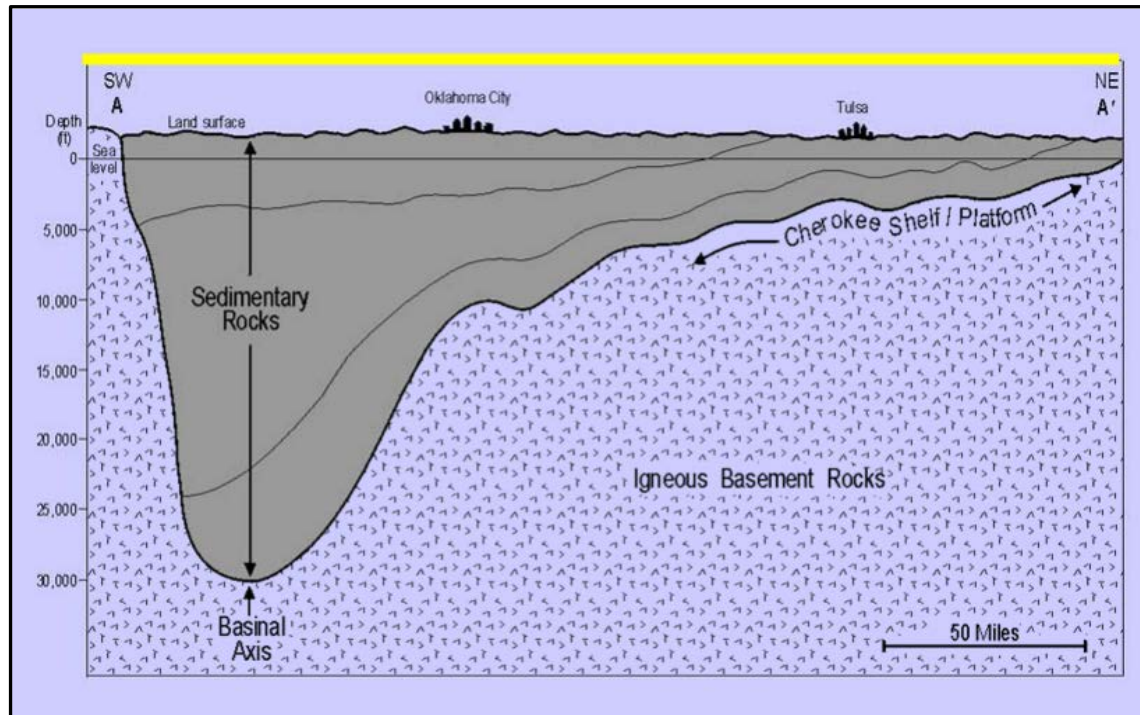
- In the 'beginning' (180 - 500 million years ago), earth scientist postulate that the earth consist of as one supercontinent 'Pangaea'.
- Scientist claimed that tectonic forces initiated and caused the drifting apart of continents to their current locations now.

- Tectonic force balance caused the 'stretching' of continental landmass leading to depressions 'basins'.
- Continental drift happened at different times, different rates and it is currently happening as we speak.
- Scientist uses various methods to study trends of continental tectonics; eg study of fossils, shapes of facing sides of continents, presence of similar sediments and minerals

Synopsis of Nigeria Petroleum Resource Base

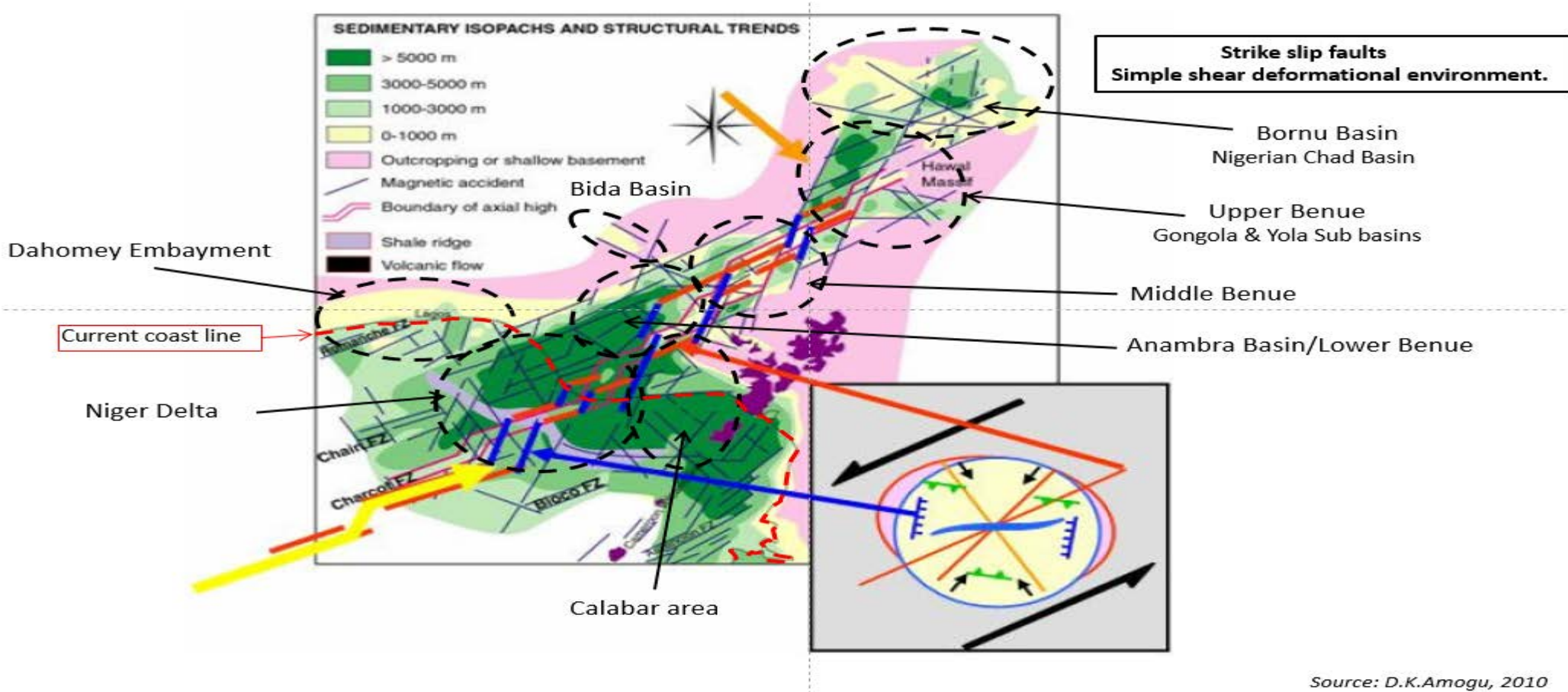
Sedimentary Basins

- Tectonic force effects is one of the key causes of basin formation and deposition of sediments and evolution of a petroleum system
 - Petroleum System: (Source, Generation, Migration, Trap, Reservoir).



Synopsis of Nigeria Petroleum Resource Base

Nigeria Sedimentary Basins: Tectonic Framework

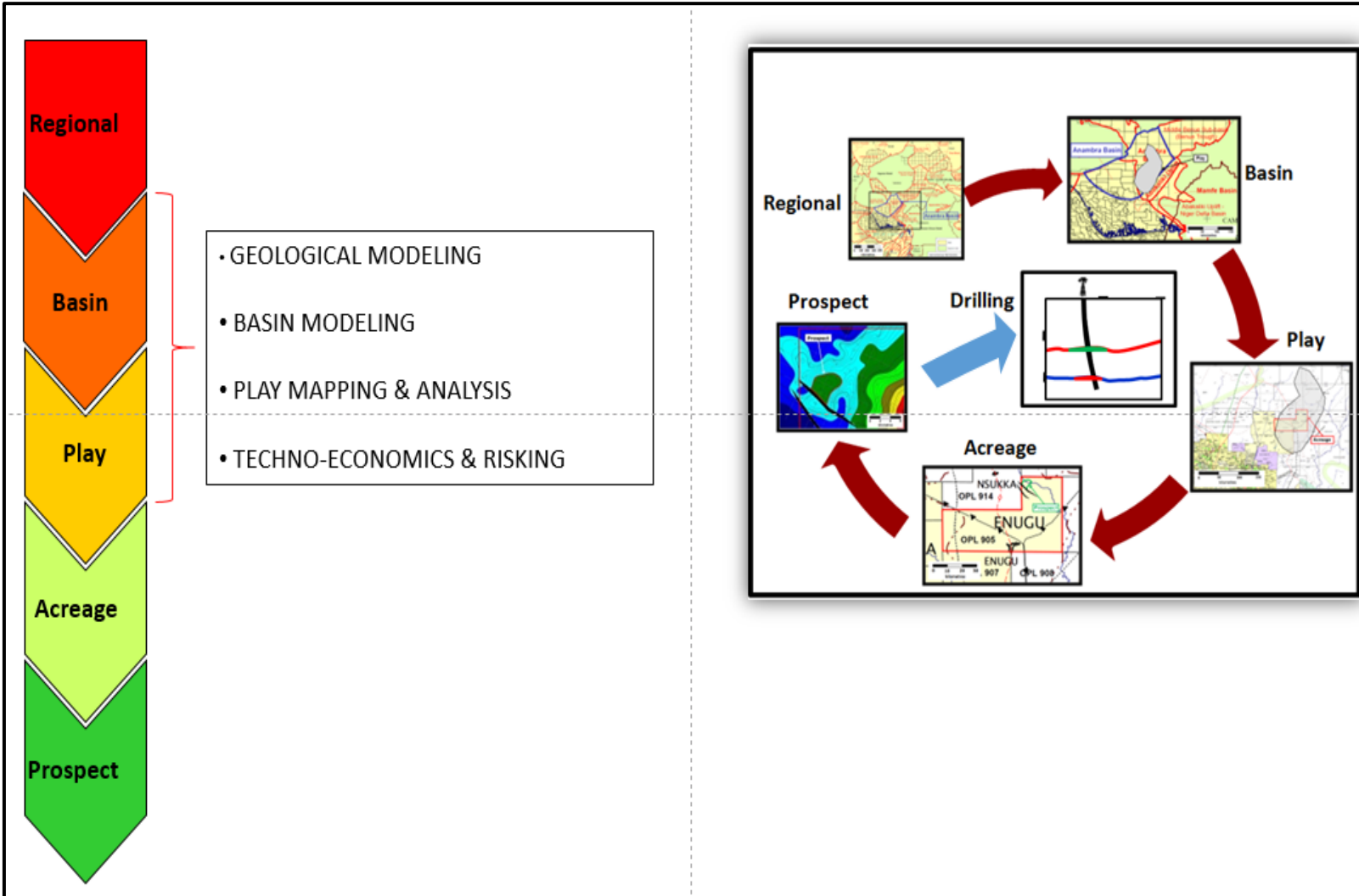


Source: D.K.Amogu, 2010

➤ Depths of Basins & Presence/Patterns of Faulting

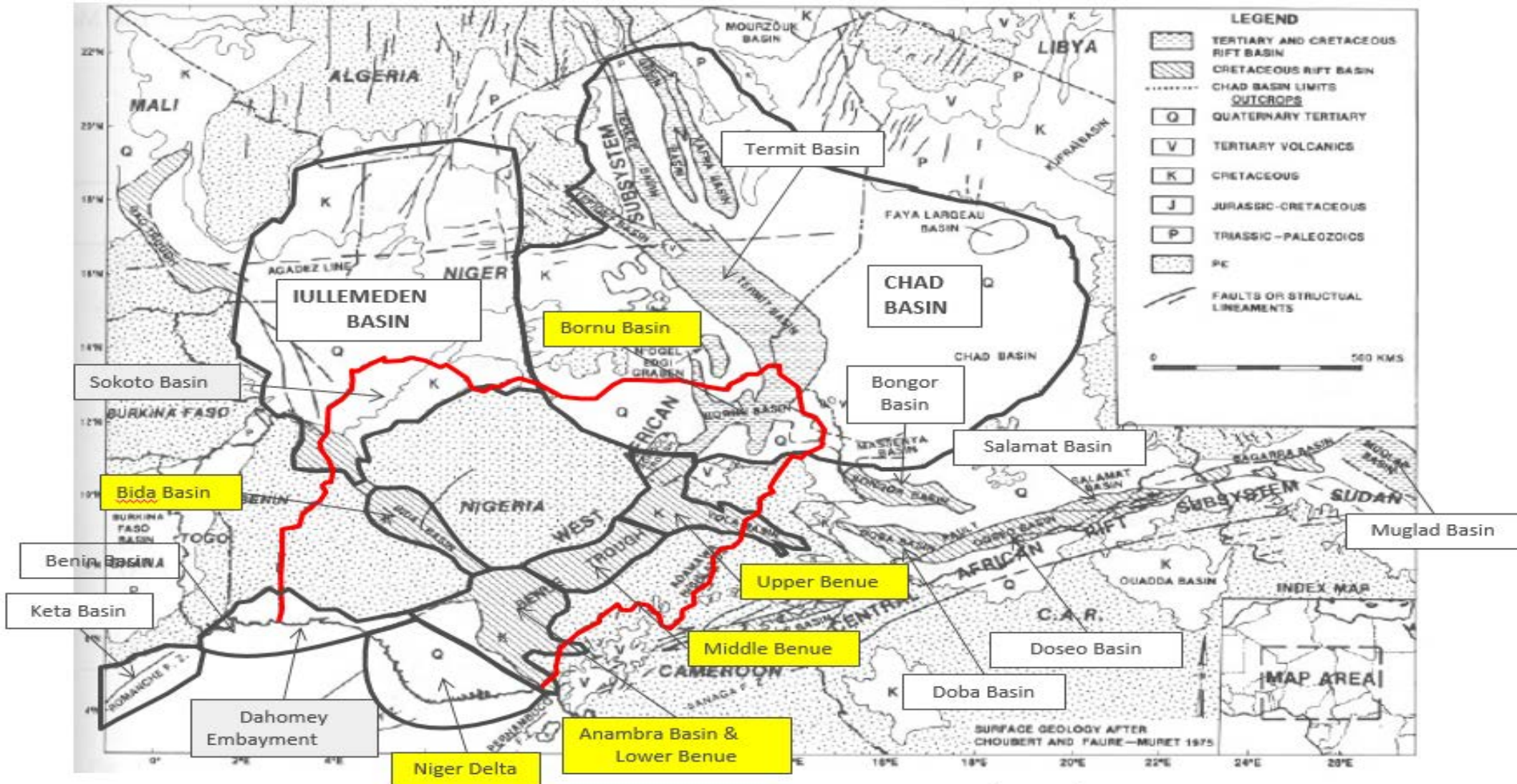
Synopsis of Nigeria Petroleum Resource Base

Overview of Geological/Petroleum Engineering Exploration Screening Process



Synopsis of Nigeria Petroleum Resource Base

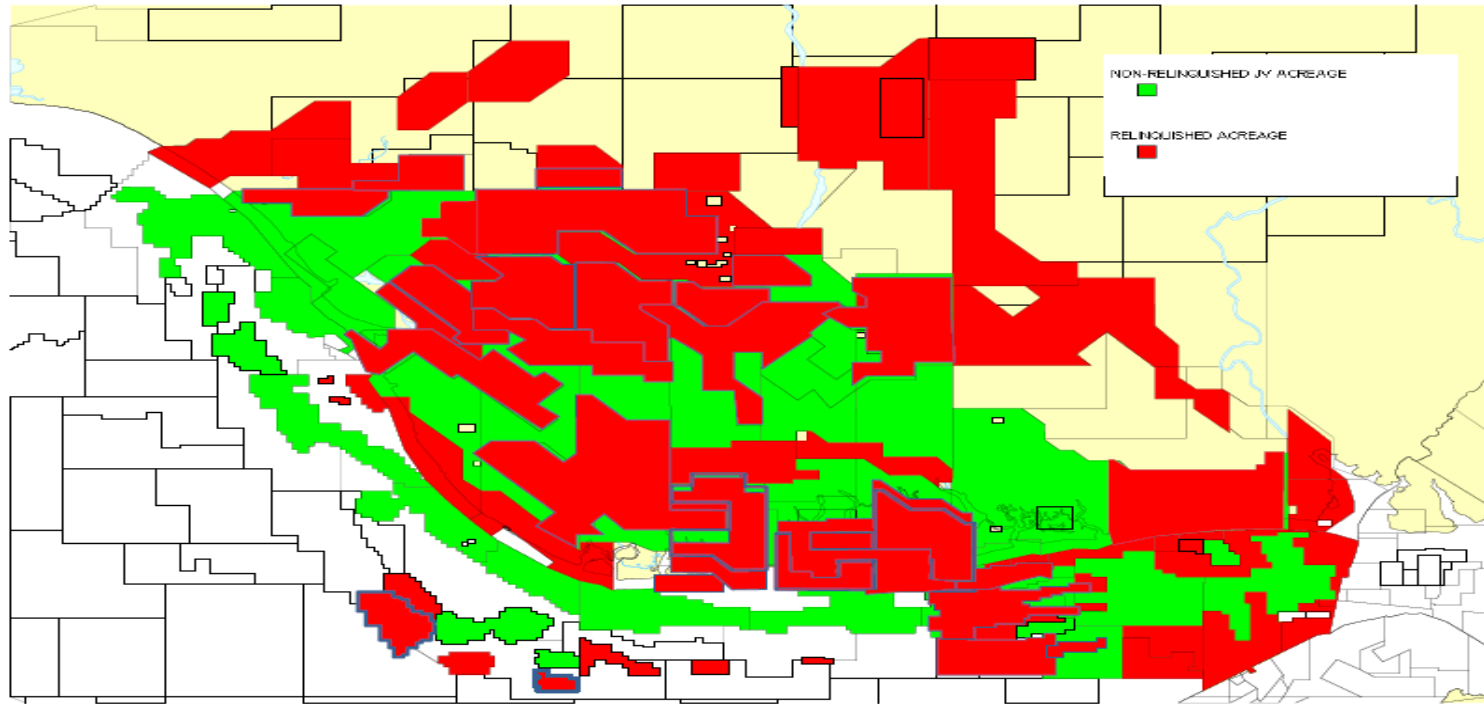
Overview of Geological/Petroleum Engineering Exploration Screening Process



Source: from Genik, 1992.

Synopsis of Nigeria Petroleum Resource Base

Overview of Government & Regulatory Industrial Oversight



DEPARTMENT OF PETROLEUM RESOURCES

- Federal Govt (through Department of Pet. Resources) delineates the country's sedimentary basins into blocks and award license for petroleum prospecting to companies/organisations.
- Oil prospecting license are usually awarded under 2 broad fiscal regimes; Concession (Joint Ventures) & Contract (PSCs).
- DPR is the key regulator of the industry in Nigeria (awards oil blocks, issues drilling, development, etc guidelines and permits, keeps records and database of all geologic, well, facilities, production, reserves, etc)
- Other key regulatory government agencies include; Min of Environment, Nigeria Nuclear Regulatory Agency, Nigeria Police, Nigeria Content Agency, etc

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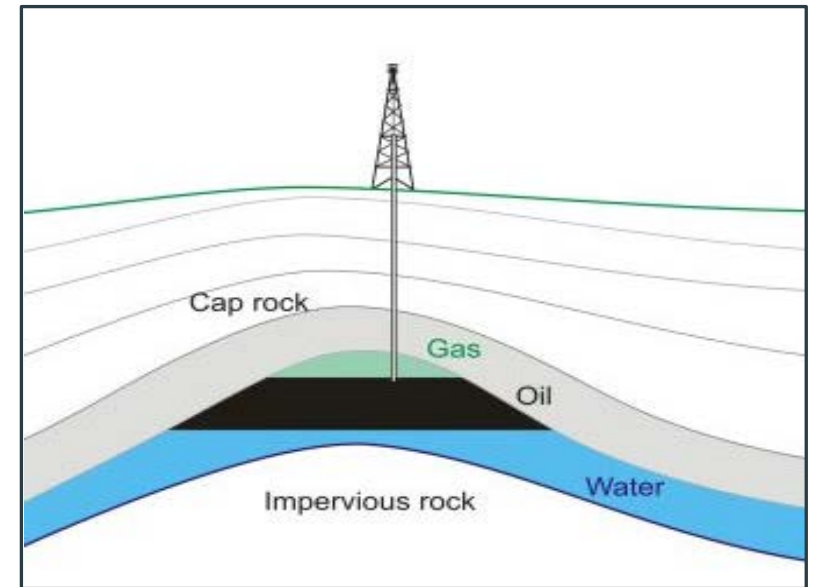
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Technical Aspects of Exploration, Appraisal, Field Development and Production

- Identify likely prospective basin to explore for hydrocarbon (Presence of a Petroleum System/Basin Analysis).
- Apply to Fed Government (via DPR) for Oil Prospecting License (OPL); typically conducted via scheduled bidding process.
- On successful bid, explore for hydrocarbon presence and on success estimate **oil and gas in place**. Establish commercial producibility in acreage, estimate ranges of In-place and recoverable volumes, evaluate if volume recoverable can support a development project (economic & fiscal terms and conditions) develop a field development plan and apply for field development permit (via DPR FDP approval), raise financial capital for field development (via combination of equity & debt), produce field and after 10 year period conversion of OPL to OML
- **Finding HC, estimating volumes, developing field and production to abandonment in a SAFE, ENVIRONMENTAL acceptable manner and to return FINANCIAL PROFIT to all stakeholders**

FINDING & Estimating THE IN-PLACE VOLUMES

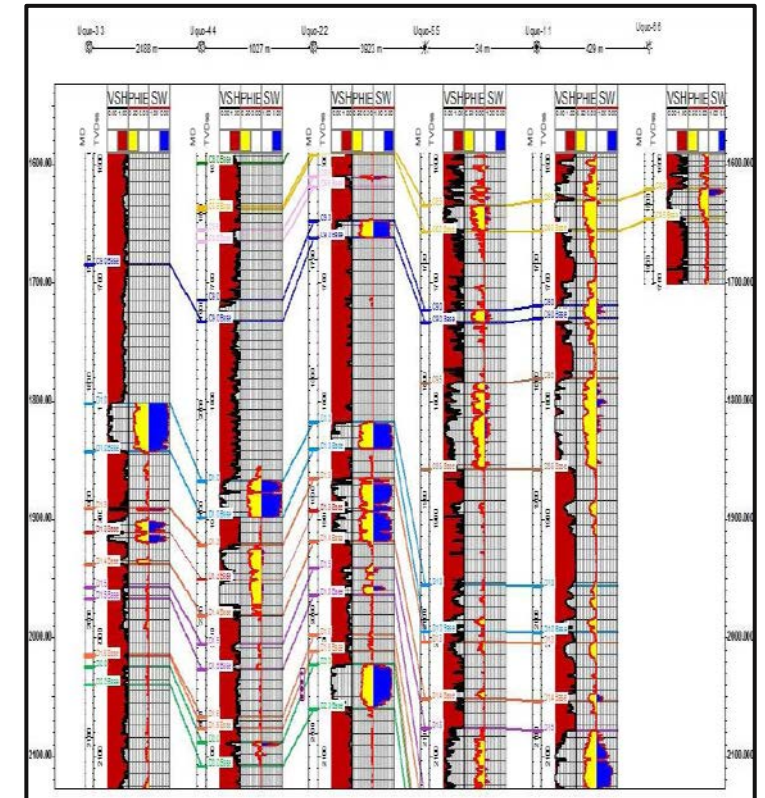
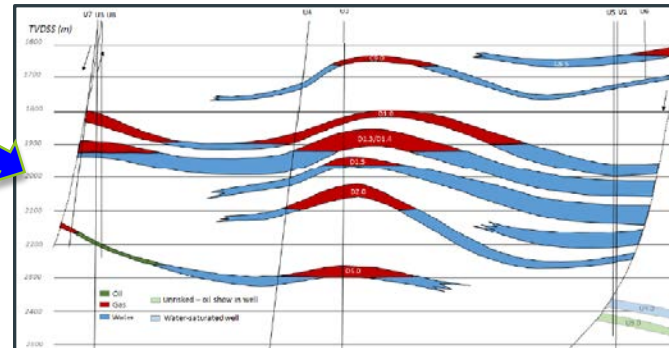
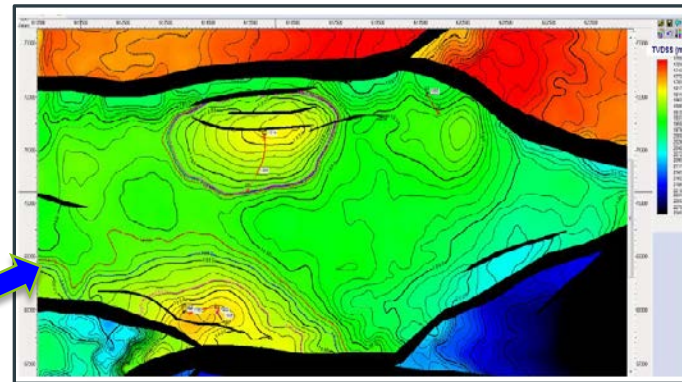
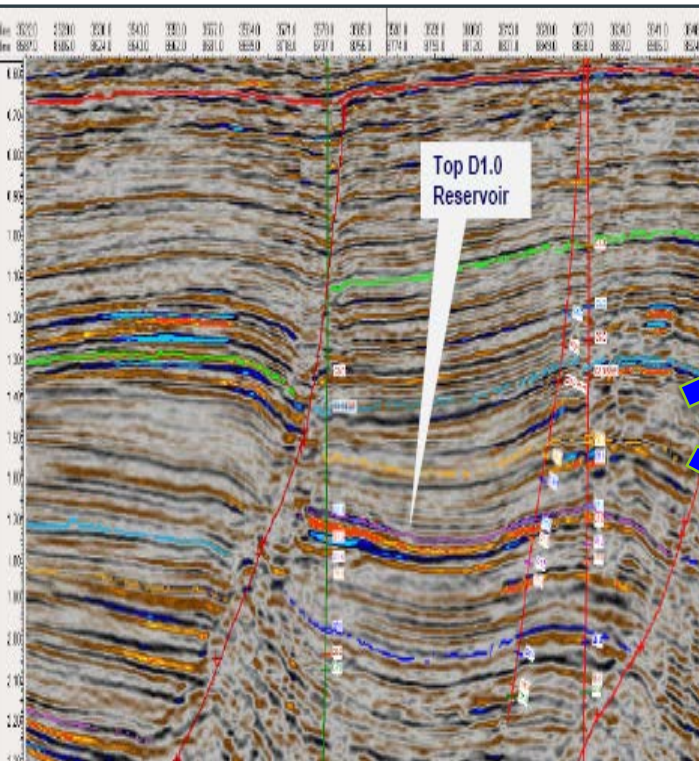
- $STOIIP = 7758 * A * h * \phi * Soi * (1/Boi)$.
- $GIIP = 43560 * A * h * \phi * Sgi * (1/Bgi)$.
- Evaluating each of **A**, **h**, **ϕ** , **Sgi**, **Soi**, **Bgi**, and **Boi** parameters involves a combination of seismic acquisition, time/depth conversion, horizon mapping, well logging, reservoir fluid sampling, etc.
- Each of these techniques are largely an INDIRECT measurement and are entrenched with lots **UNCERTAINTIES**.



Petroleum Exploration, Appraisal, Development and Production; The Nigeria Value Chain

Technical Aspects of Exploration, Appraisal, Field Development and Production

- Seismic Interpretation & Mapping {time/depth conversion, etc}
- Reservoir Geometric Description {Traps, Spill points, Contacts, etc}
- Reservoir Parameters {thickness, net pay, porosity, saturation, Boi, Bgi}

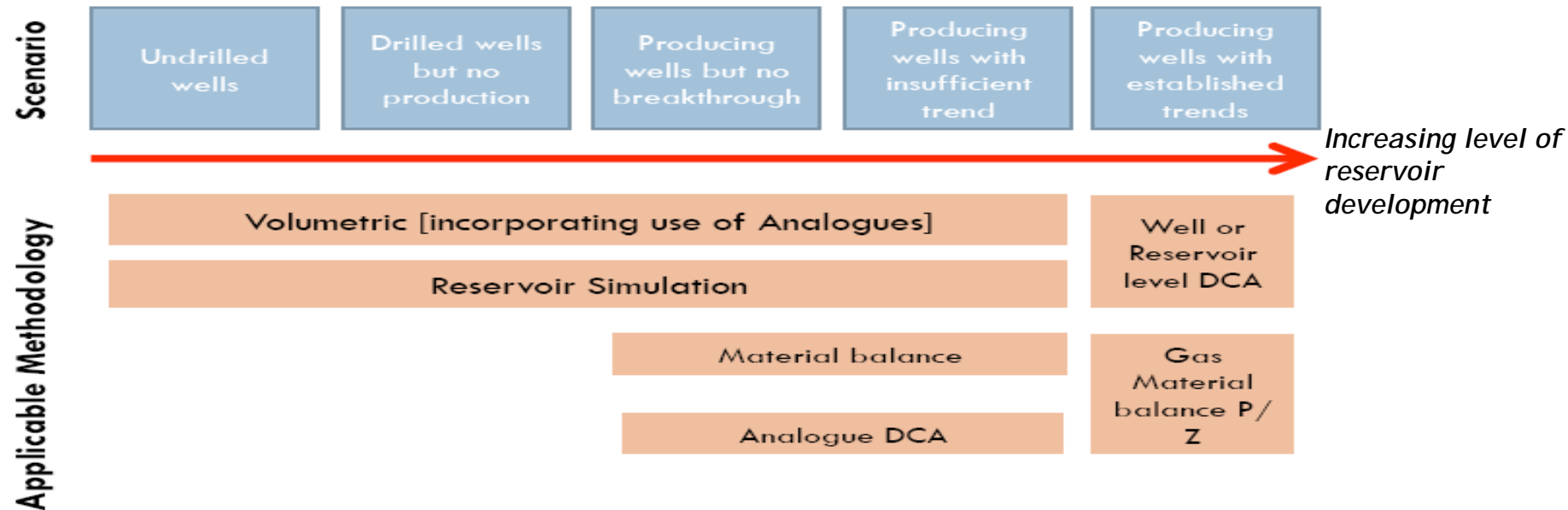


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Technical Aspects of Exploration, Appraisal, Field Development and Production

RECOVERABLE VOLUMES

- An estimation what fraction of the STOIP/GIIP is producible from the reservoir through the Wells, Processing Facilities, Pipelines to the point of sales [oil export terminal, gas powered electricity plant, industrial plant, etc].
- Various evaluation techniques exist, the type applied depends of the level of Asset/Reservoir Development.
- Good practice to use more than one method to estimate recoverable volumes

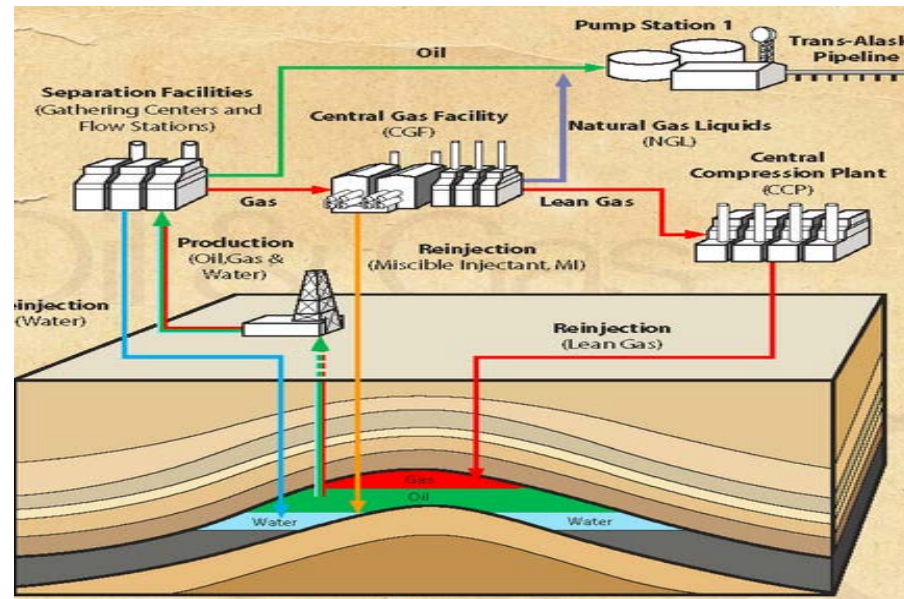
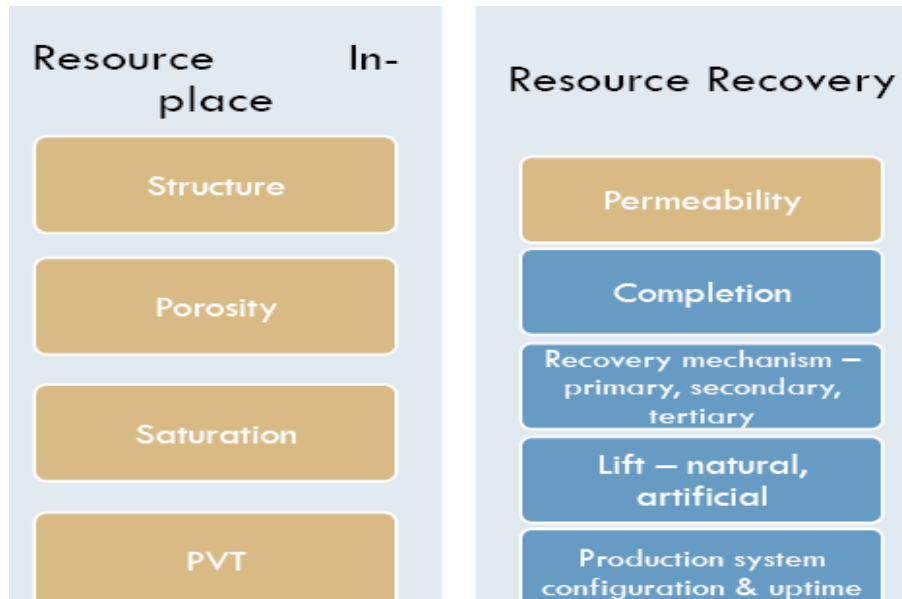


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Technical Aspects of Exploration, Appraisal, Field Development and Production

RECOVERABLE VOLUMES

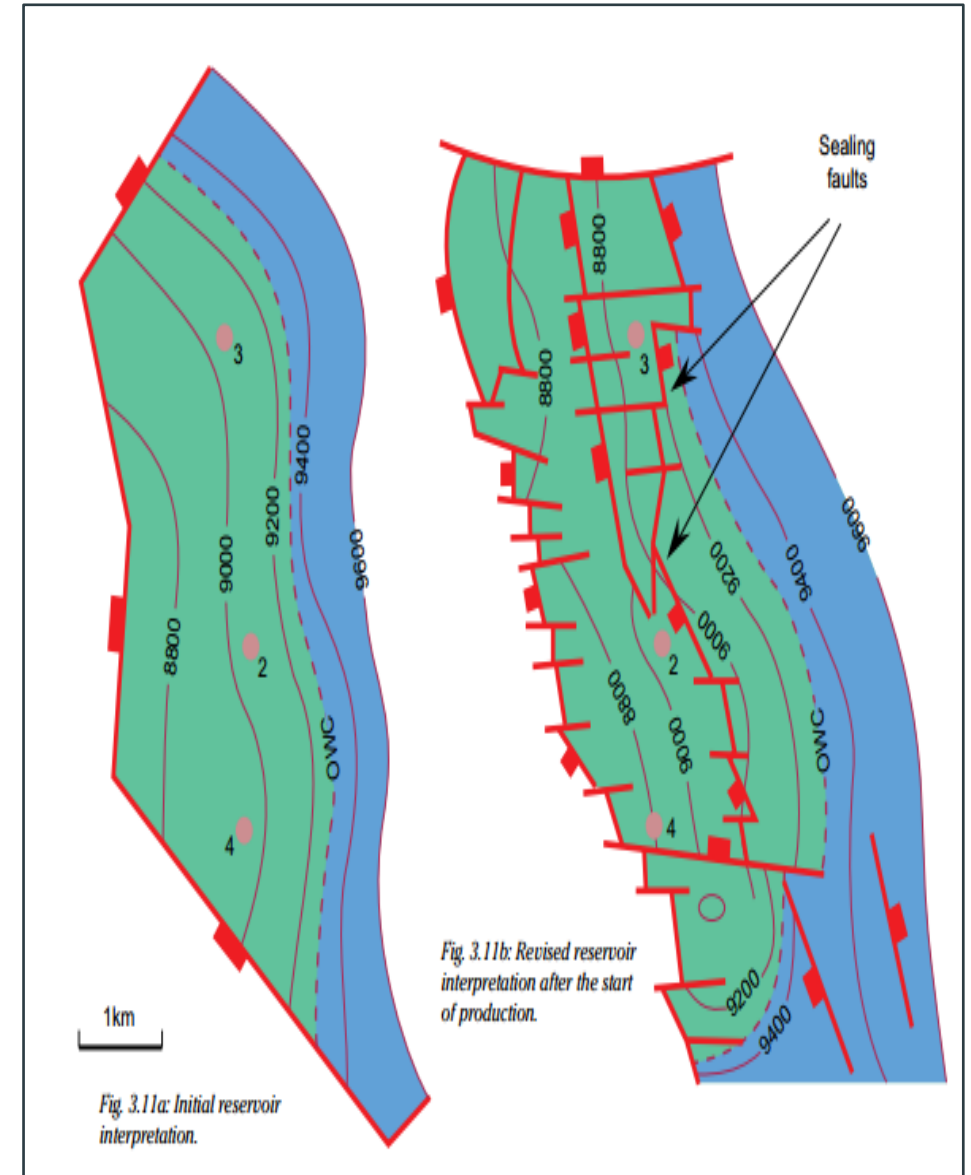
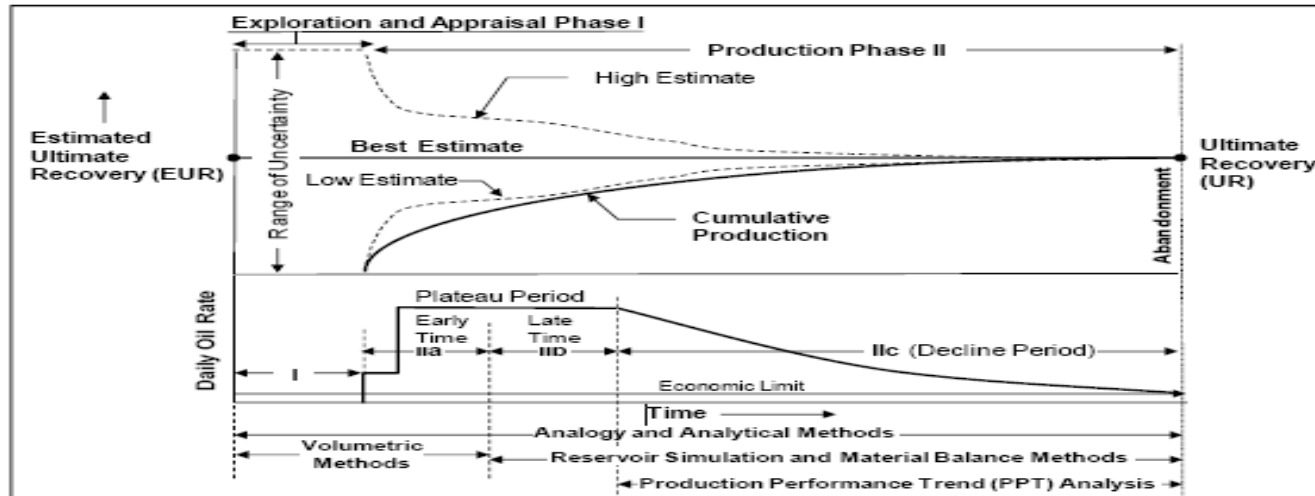
- Notwithstanding the recoverable volume estimation methodology adopted, lots of factors influence the volumes of oil and gas that can be produced from a reservoir.
- Influencing factors include; reservoir properties [pressure, permeability, fluid properties, etc], Wells [completions/tubing selection, completion efficiency/skin, artificial lift], Process facility/Engineering Design [flowline, process separator settings, compressor selection, pipeline design, etc]



Technical Aspects of Exploration, Appraisal, Field Development and Production

UNCERTAINTY MANAGEMENT

- Uncertainties exist in estimates of Reservoir in-place and Recoverable volumes; due to a combination factors such;
 - Limitation in seismic resolution
 - Limitation in well logs radius of inference
 - Inherent errors in tools and methods of data measurements
 - Limited understanding of the subsurface complexity, etc
- As mitigation; range of values (low, mid & high) values are utilised for each parameter. The variance btw these low case/mid case/high case dependent on data type & project life cycle, etc.



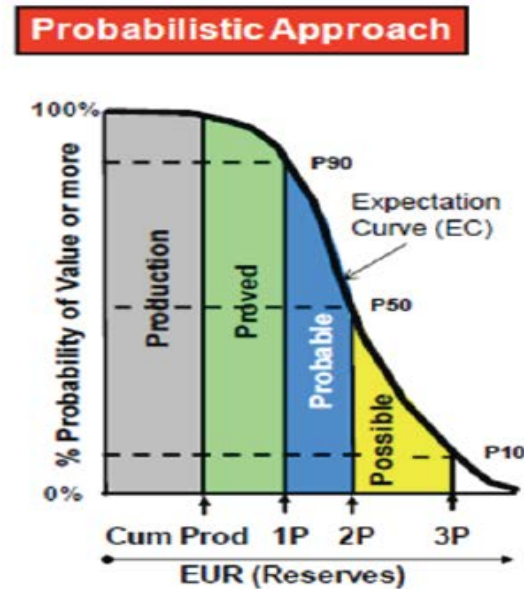
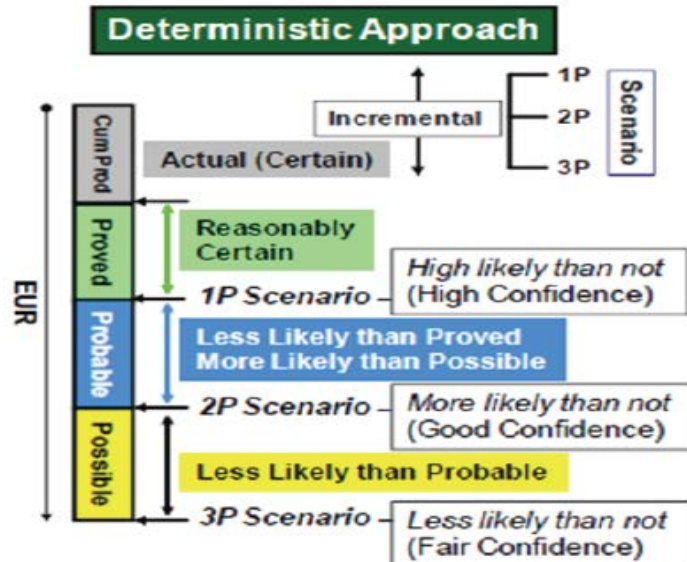
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Technical Aspects of Exploration, Appraisal, Field Development and Production

RANGE OF UNCERTAINTY

- Uncertainty range can be determined through probabilistic or deterministic methods

Deterministic	Probabilistic
Low	At least a 90% probability (P90) that recoverable volume will equal or exceed the low estimate
Best	at least a 50% probability (P50) that recoverable volume will equal or exceed the best estimate
High	at least a 10% probability (P10) that recoverable volume will equal or exceed the high estimate



Commercial & Regulatory Aspects of Exploration, Appraisal, Field Development and Production

- Estimate/establish conditions for field profitability and institute processes to produce field within economic conditions on behalf of venture partners.
- Fiscal Regimes, Tax policies, Legal & Joint Operating Agreements etc
- Regulatory interface
 - Commercial
 - Environment
 - Safety
 - Legal
 - Product market; terms/conditions/pricing/metering/fiscalisation etc

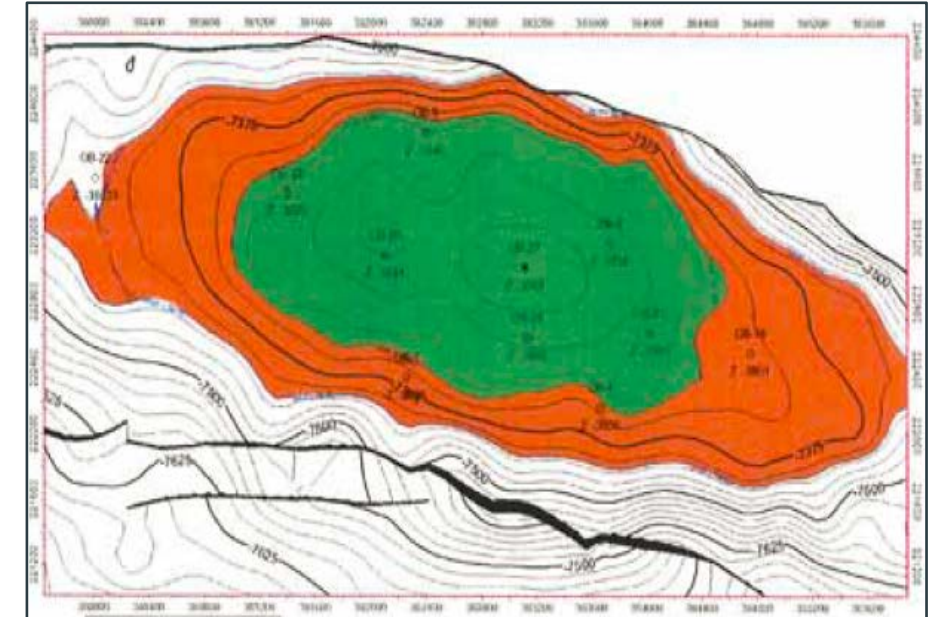
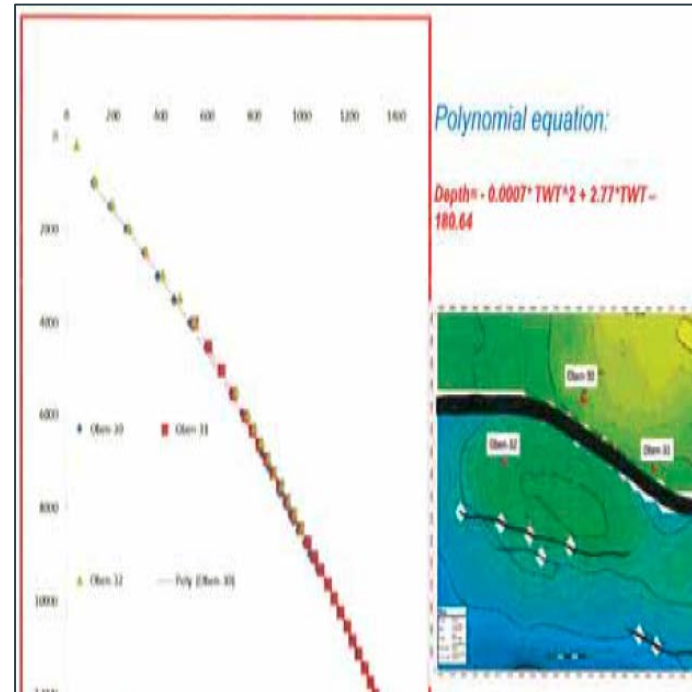
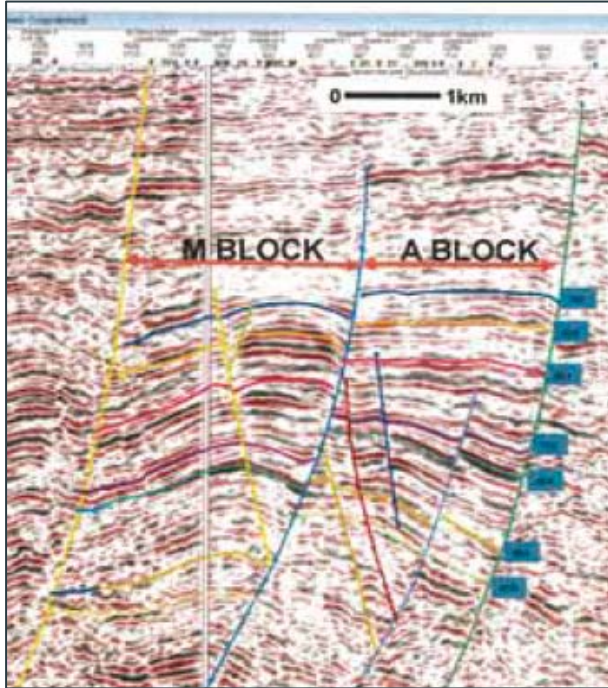
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Key Issues & Challenges in the Industry: Opportunities for Research/Value Creation

Reservoir Characterisation/Field Exploitation Efficiency

- Niger Delta Basin most matured (relatively) of the 5 petroleum basins in Nigeria hence opportunity exist for research to estimate correlations to use in characterisation for the remaining basins.

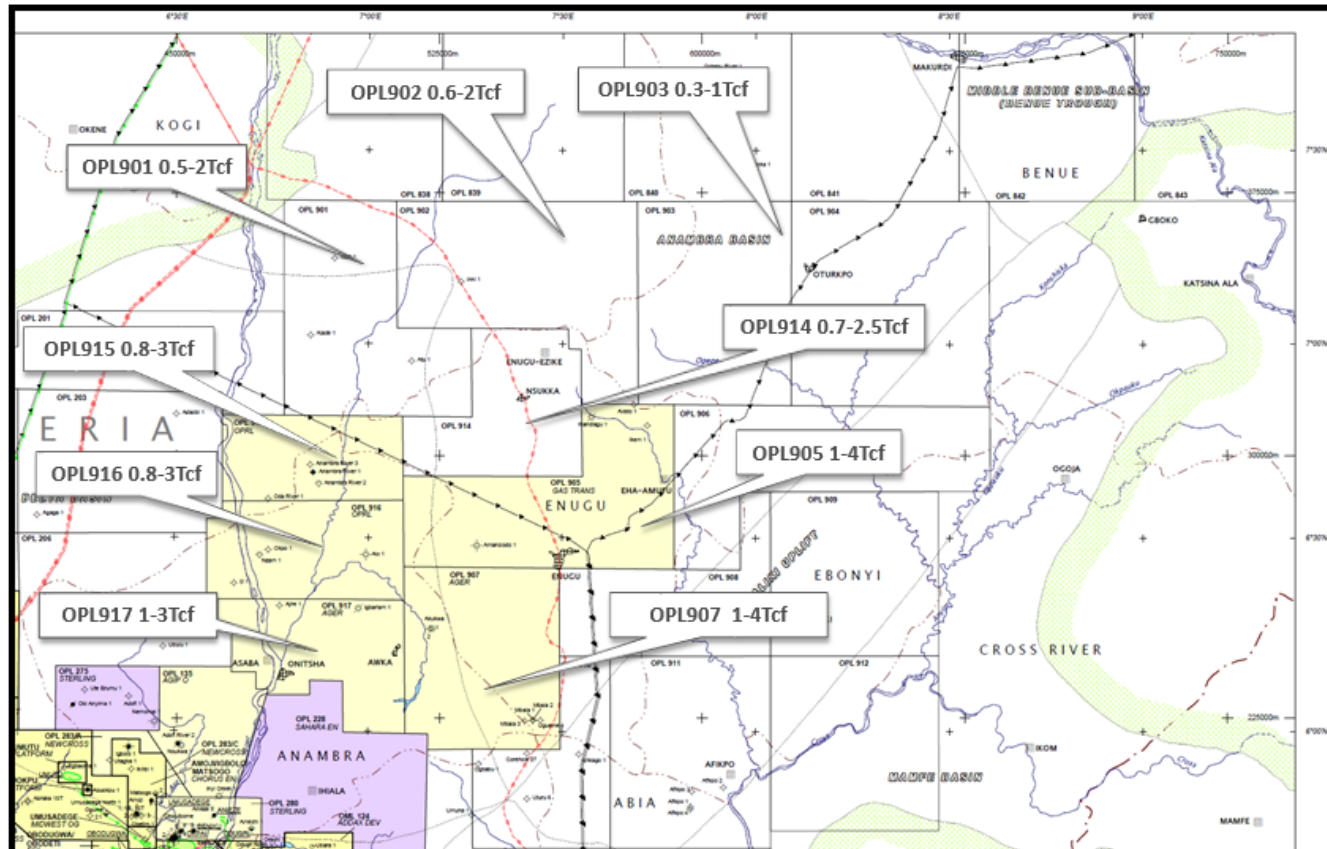


- Process of using seismic data to reservoir map requires a availability rock velocity data (variable dependent of formation density) within formation(s) transversed.
- Rock densities of Niger Delta formations are easily estimated using core/well data; while such correlation are lacking for Anambra and other basins.
- Opportunities for research for Time/Depth correlation for Anambra basin & others exist; likewise for FVF, Porosity, etc.

Key Issues & Challenges in the Industry: Opportunities for Research/Value Creation

Reservoir Characterisation (Anambra Basin)

- Opportunities exist for researchers to estimate more validated/robust correlation for virtually all reservoir characterisation parameters (Sw, Boi, Bgi, K, Por) for the Anambra basin formations.
- Anambra basin is the next frontier for gas exploration and development in Nigeria that will be lead by local Nigeria independents, hence Nigeria based institutions/researchers have an opportunity to participate and validate their research propositions.

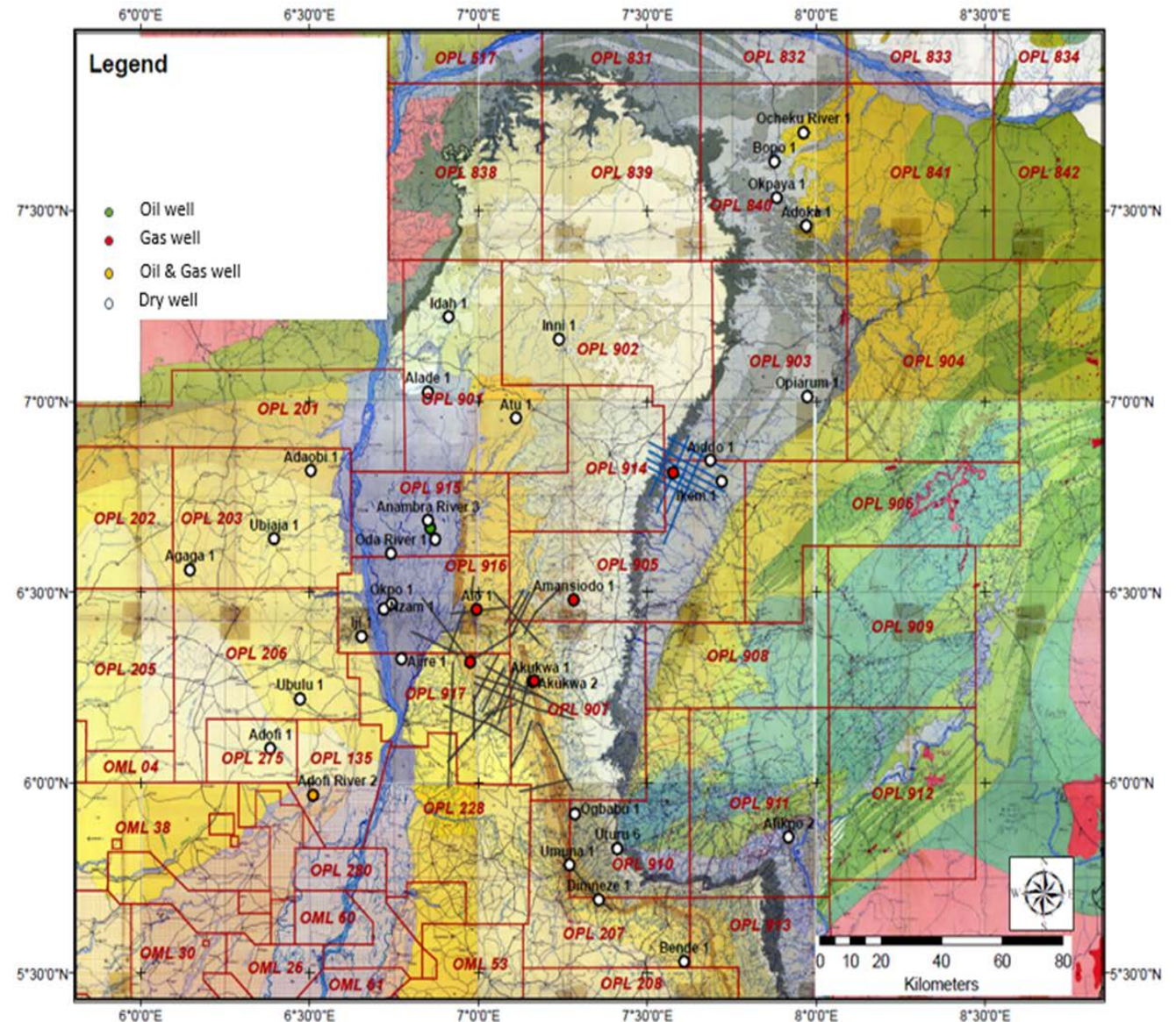


- Well inflow performance, fracking?
- Reservoir Performance correlations
- PVT/Fluid Correlations
- Pressure and Temperature trends
- Rock collapse/compressibility correlations
- Decline Curve Correlation for Tight sands
- Log Analysis
- Field Development guidelines
- Sand control
- Drainage radius
- Well completion designs, tubular specifications

Key Issues & Challenges in the Industry: Opportunities for Research/Value Creation

Facility Integrity Management/Resource Processing

- Facility integrity reliability
 - Pipeline specifications, material selection and classification
 - Right of way surveillance
 - Production accounting/metering/fiscalisation
 - Gas processing
 - CNG
 - Virtual pipeline
 - Produce Water Re-injection/Disposal standards/guideline
-
- ▶ Data Acquisition, Analysis, Storage, Utilization and Commercialization
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Thank You

Questions!