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
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)
- Petroleum/Reservoir Engineer; Shell Petroleum Development Nigeria Limited (2004/2014)
- Manager/Lead Engineer Subsurface; Seven Energy Nigeria Limited (2014/date)

Industrial Interest
- Member SPE (a certified SPE Petroleum Professional)
- Member Nigeria Society of Engineers (COREN Registration)
- Member & Director Lagos Oil Club
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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: Geological Framework
Synopsis of Nigeria Petroleum Resource Base

Nigeria Sedimentary Basins: Tectonic Framework

- Depths of Basins & Presence/Patterns of Faulting

Source: D.K.Amogu, 2010
Synopsis of Nigeria Petroleum Resource Base

Overview of Geological/Petroleum Engineering Exploration Screening Process

- GEOLOGICAL MODELING
- BASIN MODELING
- PLAY MAPPING & ANALYSIS
- TECHNO-ECONOMICS & RISKING
Synopsis of Nigeria Petroleum Resource Base

Overview of Geological/Petroleum Engineering Exploration Screening Process

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 geogic, well, facilities, production, reserves, etc )

Other key regulatory government agencies include; Min of Environment, Nigeria Nuclear Regulatory Agency, Nigeria Police, Nigeria Content Agency, etc
Introductions/Seminar Objectives

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Q & A
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 = \(7758 \times A \times h \times Soi \times (1/Boi)\).
- GIIP = \(43560 \times A \times h \times Sgi \times (1/Bgi)\).

- Evaluating each of \(A, h, \alpha, Sgi, Soi, Bgi,\) 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 of UNCERTAINTIES.
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}
An estimation of what fraction of the STOIIP/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 on the level of Asset/Reservoir Development.

Good practice to use more than one method to estimate recoverable volumes.

**RECOVERABLE VOLUMES**

- Increasing level of reservoir development
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]
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.
Technical Aspects of Exploration, Appraisal, Field Development and Production

RANGE OF UNCERTAINTY

- Uncertainty range can be determined through probabilistic or deterministic methods

<table>
<thead>
<tr>
<th>Deterministic</th>
<th>Probabilistic</th>
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<tbody>
<tr>
<td>Low</td>
<td>At least a 90% probability (P90) that recoverable volume will equal or exceed the low estimate</td>
</tr>
<tr>
<td>Best</td>
<td>At least a 50% probability (P50) that recoverable volume will equal or exceed the best estimate</td>
</tr>
<tr>
<td>High</td>
<td>At least a 10% probability (P10) that recoverable volume will equal or exceed the high estimate</td>
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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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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
- Academia/Industry Divergence/Convergence
Thank You

Questions!