Mature Assets – Challenge and Opportunity

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Mature Fields

70% Amount of worldwide oil & gas production from mature fields

35% Average worldwide recovery factor for oil

1% Recovery factor increase needed for additional two year, global oil and gas supply
A Mature Field is Not Defined by It’s Age
... but Where It is Relative to Peak Production
Untapped Opportunity…The Right Side of the Curve

Primary Recovery

Thousand Barrels Per Day


Mature Field

Original Decline Curve

Economic Limit
Untapped Opportunity...The Right Side of the Curve

- Primary Recovery
- Secondary Recovery

Secondary Decline Curve

Mature Field

Economic Limit
Untapped Opportunity…The Right Side of the Curve

Primary Recovery
Secondary Recovery
Improved Recovery

Mature Field
Tertiary Decline Curve
Economic Limit

Thousand Barrels Per Day
Untapped Opportunity…The Right Side of the Curve

- Primary Recovery
- Secondary Recovery
- Improved Recovery
- Enhanced Oil Recovery

![Graph showing the decline curve of oil production over time with labels for different recovery stages and key points such as mature field and economic limit.]

Thousand Barrels Per Day

Why Mature Fields?
Consumption is Outpacing Reserve Additions
Why Mature Fields? New Discoveries are Fewer and Smaller

Total Volume of Discoveries has been decreasing since the 1960’s

Average Volume per Discovery has also been decreasing

Source: Deutsche Bank, Wood Mackenzie
Mature Field Challenges
Reservoir and Field Productivity Challenges

- Re-assessment and planning
  - Hydrocarbon sweep efficiency
- Excessive water production
- Pressure depleted
- Increase field productivity
  - Accessing bypassed reserves through infill drilling
- Optimizing enhanced oil recovery strategies
- Reducing water production
- Reducing or eliminating scaling
Drilling and Completions Challenges

- Improve well productivity
  - Re-perforating the mature wellbore
  - Sand control in producer wellbores
  - Reduce unwanted fluid production
- Maximize reservoir contact and production
  - Stimulation
  - Multi-laterals
  - Horizontal wells
- Identifying, analyzing and remediating wellbore mechanical integrity
- Minimizing formation damage
- Well abandonment
**Objective**

**Mature Field Challenges at a Glance**

<table>
<thead>
<tr>
<th>Critical Factors</th>
<th>Key Elements</th>
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</thead>
<tbody>
<tr>
<td>Identify New Reserves</td>
<td>Optimal Surface Facility Design</td>
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<tr>
<td>Producing Reservoir Capability</td>
<td>Sustainability</td>
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<tr>
<td>Maximize Reservoir Contact</td>
<td>Well Abandonment</td>
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<td>Maximize Well Productivity</td>
<td>Optimize Completion Efficiency</td>
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<tr>
<td>Optimize Drilling Efficiency</td>
<td>Optimize Long Term Reliability</td>
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</table>

### Critical Factors

- **Data Capture Strategy**
  - Prospects Drilling
  - Fluid Identification
  - Well Type
  - Well Placement
  - Pad Drilling
  - Fluid Identification
  - Long Term Reliability
  - Water Control
  - Define Objectives
- **Process Seismic Data Efficiently**
  - Reservoir Dynamic Model
  - Well Spacing
  - Frac Design
  - Well Placement
  - Sand Control
  - Efficient Production Infrastructure
  - Surveillance
  - Reservoir Parameters
- **High Resolution Seismic Acquisition**
  - Data Capture Strategies
  - Fracture Placement
  - Conductivity Endurance
  - Hole Quality and Cleaning
  - Zonal Isolation
  - Efficient Production Infrastructure
  - Water Disposal
  - Borehole Condition
- **Accelerated High Risk Appraisal Well Program**
  - Petrophysical & Reservoir Study – Static Model
  - Fracture Properties
  - Secondary/ Tertiary Recovery
  - Efficient Drainage Of Reservoir
  - Scale and Asphaltenes
  - Instrumentation
  - Reservoir Fluid
- **Exploit Understanding of Geomechanics**
  - Extended Laterals
  - Targets To Suit Multi-layered Reservoir
  - Directional Drilling Efficiency
  - Frac Staging Techniques
  - Instrumentation
  - Evaluation of Primary Cementing
- **Resolve Uncertainties With Data Obtained While Drilling**
  - Multilaterals
  - Prediction of Variable Reservoir Quality
  - Frac Equipment Utilization
  - Post Frac Cleanup
  - Artificial Lift
  - Secondary/ Tertiary Recovery
  - Review Existing Well Design
  - Sustain Production
  - Well History
  - Sustain Feedback
  - Abandonment Regulation Review
  - Ensure A Skilled and Trained Workforce
  - Pipe Recovery
  - Reservoir Pressure Maintenance
  - Cement Plug

### Software

- **Reduction of Drilling and Completion Cycle Time**
- **Real Time Decision Capability**
Mature Field Opportunities
Creating the ‘Wedge’ to Extend the Life of the Field

- Process:
  1. Identify scenarios
  2. Rank/screen
  3. Choose optimal

- Scenarios:
  - Scenario A
  - Scenario B
  - Scenario Z

- The Wedge:
  - AbandonmentX
  - AbandonmentY

- Economic Limit

- Oil Production Rate
  - 1950 to 2030
  - 0 to 50
Mature Field Challenge – Re-Assessment and Planning: Realizing the Full Potential from your Mature Fields

- Using the latest software portfolios for
  - Reservoir characterization through life of field
  - Production optimization
  - Asset management
Mature Field Challenge – Re-Assessment and Planning:
Identifying Bypassed Zones and Determining Remaining Recoverable Fluids

- Using new logging techniques on old wells
- Reservoir Monitor Tool
- Through tubing C/O system
- Continuous passes
- Higher measurement resolution
Mature Field Challenge – Increase Field Productivity: Accessing Bypassed Reserves Through Infill Drilling

- Well extensions and multilaterals
  - Improved reservoir drainage
- Infill drilling
  - Access bypassed hydrocarbons
  - Identification
  - Using precise wellbore placement
Mature Field Challenge – Maximize Reservoir Contact and Production: Improve Connectivity with Acidizing and Real-Time Assurance

- Using the latest acidizing technology
  - Evaluate lost production reasons in well(s)
  - New levels of precision and cost-effectiveness
- New chemical techniques
  - Comprehensive acid treatment portfolio
  - Penetrate deep into lower-permeability rock
- Fiber optic real-time assurance
- Workflow Integration
Mature Field Challenge – Eliminating Scaling and Corrosion:
Production Chemicals

- H₂S issues
- Corrosion issues
- Mineral deposits
- Wax deposits

Production Chemical Treatments in EOR Operations

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<th>Region</th>
<th>Produced Water Flood</th>
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<th>Alkaline Surfactant Polymer Flood</th>
<th>CO₂ Flood</th>
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Customer Challenge – Pressure Depletion:
Increase Recovery and Prevent Lost Time and Premature Abandonment

- ESPs
- Linear lifts
- Gas bypass system
Mature Field Challenge – Well Productivity:
Prevent Production of Unwanted Fluids

- Using fluid dynamics

Inflow Control Device Completion
Mature Field Challenge – Well Productivity:
Predict and Shutoff Unwanted Fluids

Understanding the conformance Issues
- Understand fluid flow behavior
- Predict water influx problems
- Select candidate wells for water control treatments
- Average worldwide H$_2$O cut 75%

Common issues like coning and high perm streaks can be addressed with a conformance service.
Mature Field Challenge – Reducing or Eliminating Blockage: Pipeline Flow Assurance

Pipeline and Facility Integrity

- Mechanical cleaning
- Thermal cleaning
- Chemical cleaning
- Intrusive intervention techniques
Customer Challenge – Well Abandonment: Barrier Assurance

Packaged Services

- Consultancy
- LED Engineering
- Project Management
- LED Execution

Delivers
- Reduced uncertainty
- Technical risk management
- Innovation
- Multi-skilled crews
- Interface management

- Cementing
- Slickline and e-line
- HWO and tubular pulling
- Wellbore clean-up
- Specialist sub-contractors
- Fluids
- Completion tools
Panel
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Thank you. Questions?