Advancing Reservoir Performance

Mature Field Optimisation

Rich Ruggiero

VP Field Development

Reservoir Development Services

Baker Hughes Incorporated



Reservoir Development Services

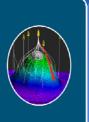




















400+ technical professionals with a broad range of in-depth capability

Exploration Basin Studies

- management · Play fairway mapping
- Trap/charging analysis
- Decision/risk analysis
- VSP interpretation • Portfolio management
 - (faults, tops)

inversion

AVO, thin bed

Geophysics

Seismic acquisition

Attribute Analysis

Geology/ Reservoir Characterization

- Structural Geology
- Stratigraphic studies Seismic processing and

 - Geocellular modelling

- Data analysis and geostatistics

Reservoir Performance Analysis

- Reservoir simulation
- Field Development
- Decline curve, MBE
- design of stimulations

Production TechnologyPro duction Chemistry

- Planning
- Well testing
- Evaluation and
- Integrated Asset
 Modelling
- Production Optimisation
- Artificial Lift
- Flow Assurance Management
- Scale evaluation
- Corrosion assessment
- Phase separation
- Hydrates
- Water Injection

Geomechanics

- 3D Geomechanical modelling
- Wellbore stability
- Pore Pressure
- Sand production prediction
- Fracture Stimulation
- Fault sealing and activation
- Subsidence
- Critically Stressed Fractures

Well Engineering and Operations

- Mechanical completion design
- Well Surveillance
- Well testing and stimulation
- Drilling engineering
- Completion design through stimulation

Certification, Strategic Advice

Evaluation.

- Transportation, supply and storage
- · GTL, LNG projects etc.
- Refining, processing and downstream studies
- Supporting transactional and financing activities
- Analysis and advice to clients on development

alternatives,

- Business entry or exit
- New business plans. bidding, M&A, etc

Fiscal Advice and Assistance

- · Analysis and support to NOCs and governments
- Impacts of tax, regulatory, etc, decisions
- Support in negotiations
- Support of technical/managerial capabilities

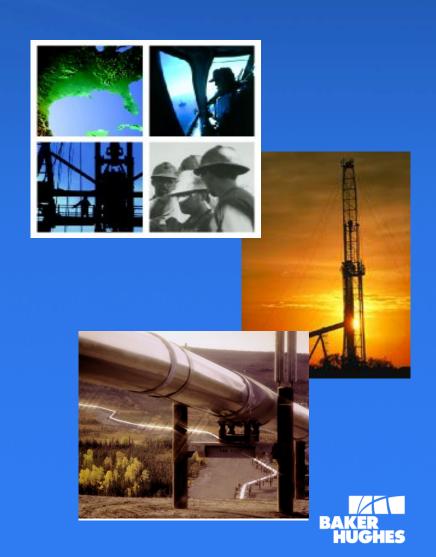
Dispute resolution

- 3rd party expert advice
- · Reserves, development plans, work programs
- Best practices advice and opinions
- Economic analysis and valuation
- · Application of fiscal terms
- Impact of decisions and actions and the value or cost of such



Real-World Experience from All Angles

- Multiple Perspectives
 - Government & Oil Company
 - Operator & Non-Operator
 - Buyer & Seller
 - Lender & Borrower
 - Private Sector & Public Sector
 - Upstream, Midstream & Downstream
 - Greenfield/Brownfield

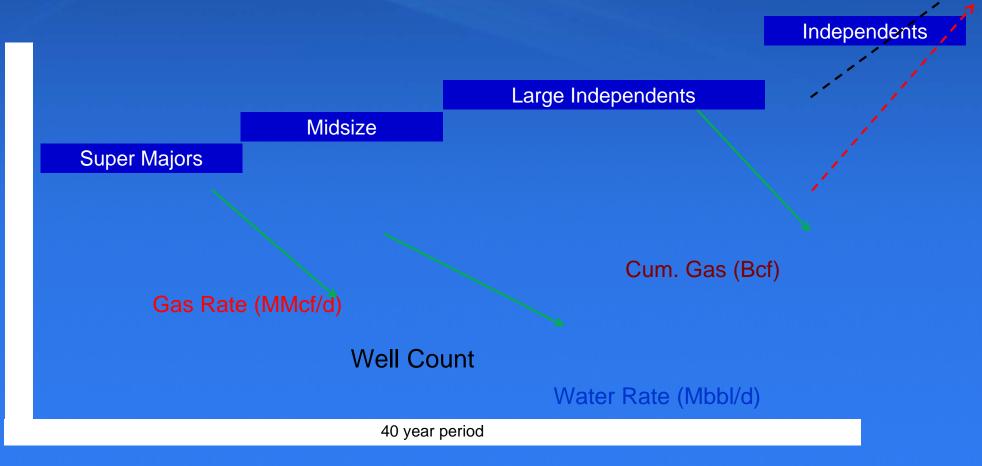


Optimizing Production Over Time

- 'Based on our experts' analyses oil and gas will run out in [pick a number] years'
 - Trace that back as long ago as pre WWII
 - Every decade or so we hear the same thing, just a few more years until supplies get dangerously low
 - Challenged, the oil industry has learned to adapt and grow
- Changing limits to find new hydrocarbons
 - Drill deeper (vertical, water depth); drill longer (horizontal)
 - Operate under ever increasing pressure, temperature
 - Real time data gathering and processing while drilling
 - Evaluation tools that 'see' deeper, further away from the wellbore
 - The 'Independent' approach vs. the 'Super Major' approach



The Natural Order of Things



Entrepreneurship? Different Risk Profile? Technology?
or
The 'Pygmalion' Effect

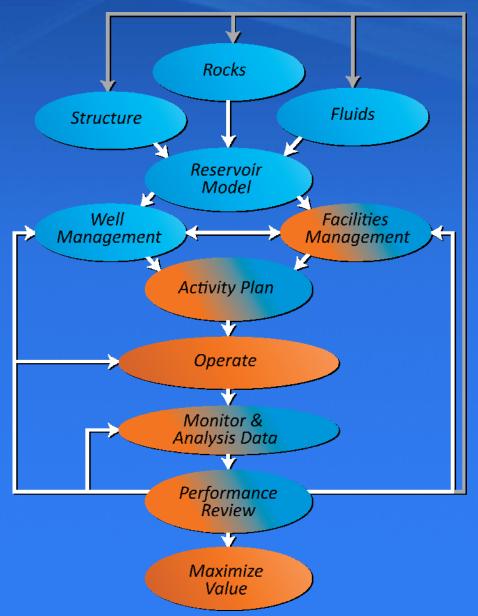


Optimizing Production Utilizing Technology

- "Old School" Technologies still very much applicable
 - Review the data, ALL data
 - Challenge assumptions bring in a new set of eyes
 - Know your physical set-up
 - Understand laws, regulations and contracts
- "New" Technologies can be game changers
 - 3D Visualization
 - Geology to Reservoir to Market linked models/simulations
 - Horizontal drilling
 - Fracture stimulation
 - Real time pore pressure



Process to Maximizing Asset Value



Integrated Study and Technology solutions enhance owner value by:

- Improving reservoir understanding
- Improving reservoir management
- Accelerating production
- Accessing bypassed oil
- Optimizing facilities
- Deferring abandonment
- Appling proper EOR solutions
- Managing market dynamics



Improving Decision Cycle Time

Long Term Reservoir Depletion

Management ta for operational

Reservoir

Well Management

Operations

Project and Corporate data for portfolio management and decision making to deliver improved asset performance

Daily data for operational planning, further optimisation and re-forecasting

"In the day" operational data for daily production optimisation

High frequency data for operational monitoring and control



Decision Making

Strategic

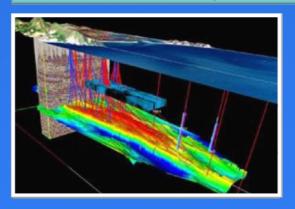


Tactical



Operational

Recovery Performance





Operating Performance





Old School West Texas Example: Increasing Production and Adding Reserves

Over a 3 month period:

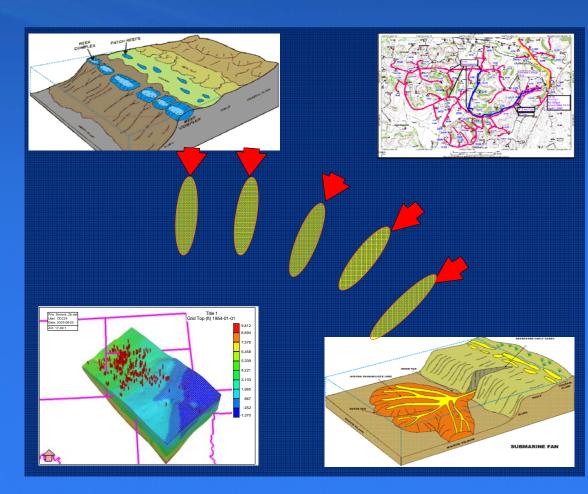
Digitized logs & production history for over 4000 wells. Built multi-mile cross sections for 7 reservoirs

Developed an in-depth understanding of completions, surface facilities, processing and markets

Built new geological and reservoir models

Identified a series of production optimization and drilling options

This included accessing new/bypassed hydrocarbons, infill drilling, horizontal re-drills, multi-stage fracs (before this was the norm) and facility reconfigurations

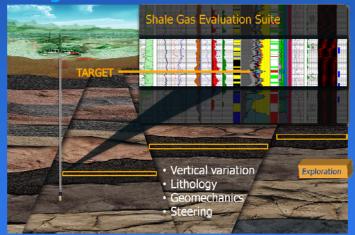


These results were delivered on a collection of fields which were thought to have been played out and under "care and maintenance" operations

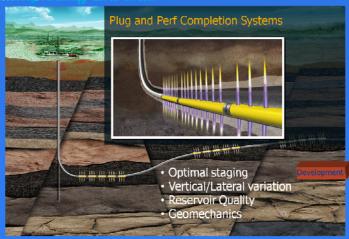


New School Shale Example: Technology Addressing the Challenges

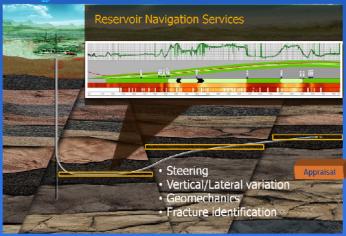
Landing the well



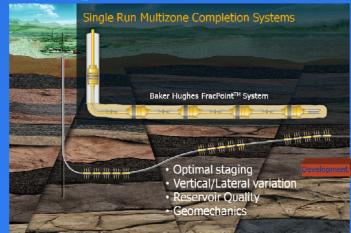
Completing the well



Placing the well

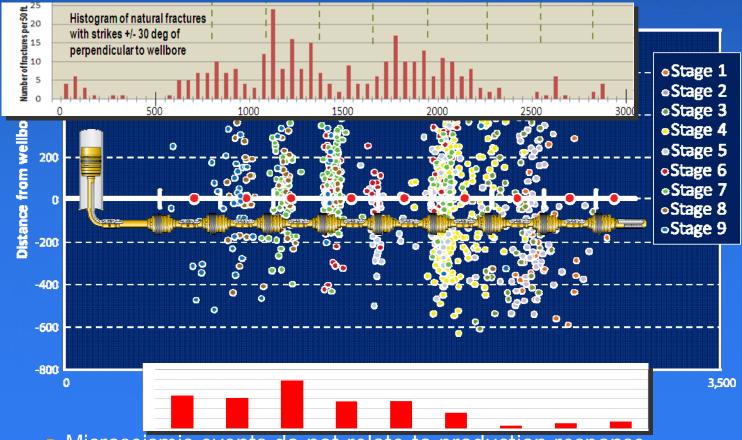


Completing the well





New School Shale Example: Understanding the production Source



- Microseismic events do not relate to production response
- Do all microseis Rates emeasured 5 months later?
- Production seems dependent on natural fractures



Infill Drilling: Doubling Daily Production and **Additional Reserves**

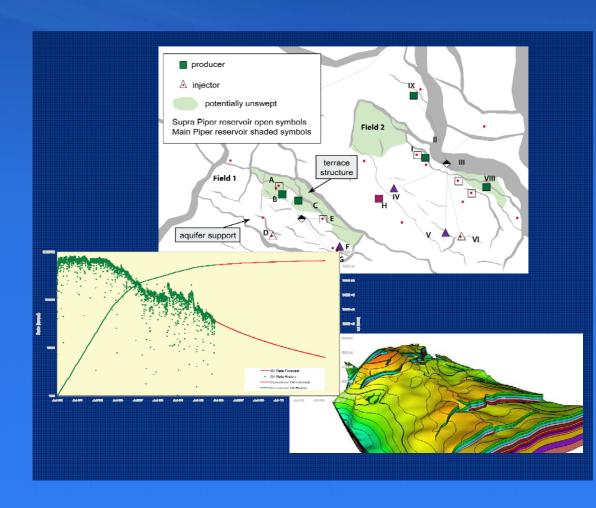
Provided a permanent subsurface team for client for 13-year period during significant asset divestiture

Developed an in-depth understanding of the subsurface architecture and field dynamic performance

Identified and developed a series of production optimization and investment opportunities on behalf of the client

This resulted in the client:

- Doubling daily production
- Accessing an additional 4 million bbls of reserves

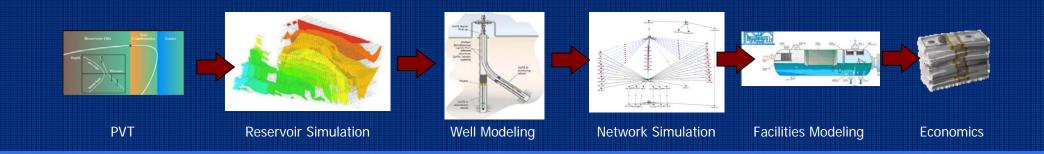


These results were for a field being prepared for abandonment!



The Business of Energy – The right tool at the right time

Optimized the field development planning and phasing of capital expenditure for international gas fields in order to meet local gas demands over the next 30 years



Built an integrated subsurface-to-facilities model linking the three reservoirs in question

The fully compositional model had to optimize the production profile against several reservoir management and field operating conditions:

- NGL, Gas, Injection/stripping
- Wide ranging CGR's
- Separate concession contracts
- Drawdown constraints to avoid Condensate drop out and Sand Production & Erosion
- Corrosion restrictions
- Development schedule

The client is now using the tool to optimize capital investment decisions to manage the production profile.



Baker Hughes Today

Energy Business Solutions

- Exploration to Abandonment
- Reservoir to Burner Tip
- Primary/ EOR
- Conventional/Unconventional

DRILLING and EVALUATION

Drill bits, directional drilling, formation evaluation





COMPLETION and PRODUCTION

Completion, intervention, intelligent well systems, artificial lift





FLUIDS and CHEMICALS

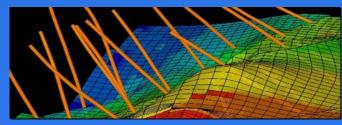
Drilling fluids, completion fluids, production chemicals





RESERVOIR TECHNOLOGY and CONSULTING

Reservoir Development Services Gaffney, Cline & Associates



PUMPING SERVICES

BJ Services





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