

# SPE Distinguished Lecturer Program



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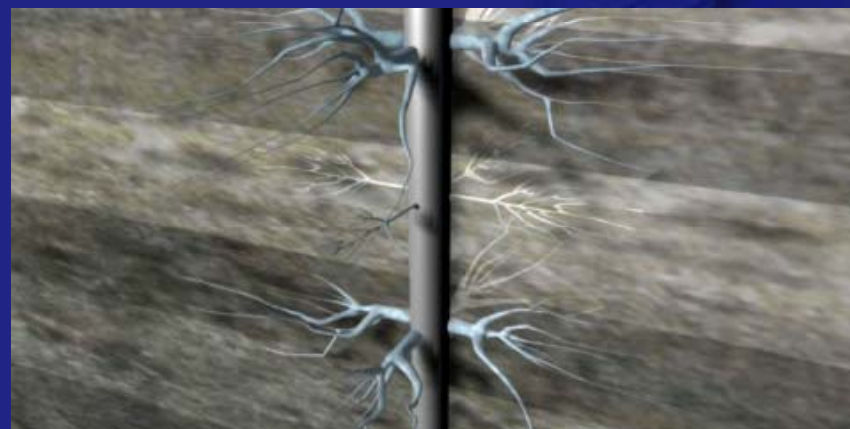
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Additional support provided by AIME



# Successfully Stimulating Complex Carbonate Reservoirs

**Ernie Brown**  
**Schlumberger**



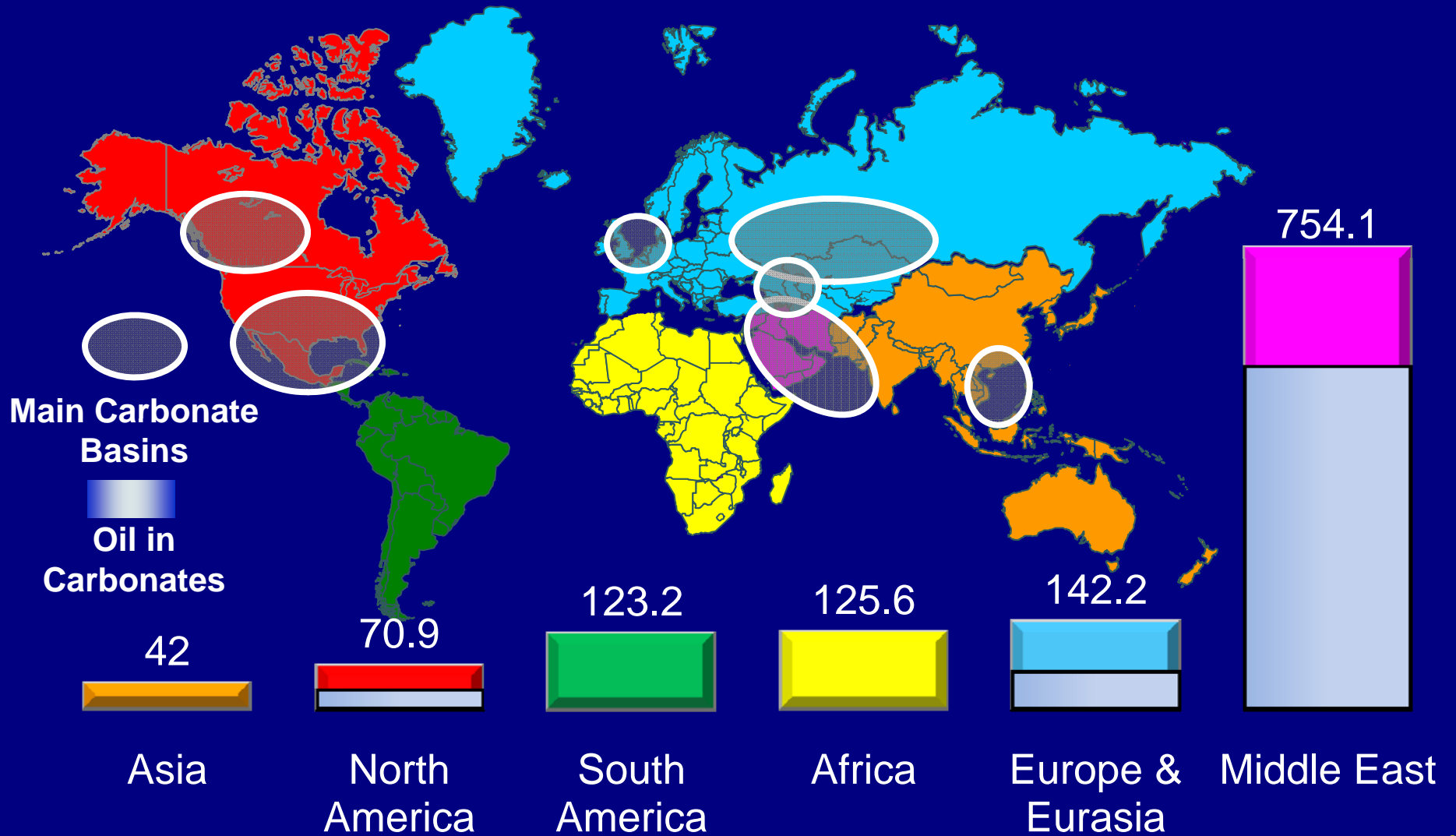
Society of Petroleum Engineers  
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[www.spe.org/dl](http://www.spe.org/dl)

# Summary

- Importance of production from carbonates
- Basic challenges of carbonate reservoirs
- Need for a multi-disciplinary approach
- Stimulation methodologies
- Developing carbonate stimulation technologies

# Proved Reserves for Conventional Oil

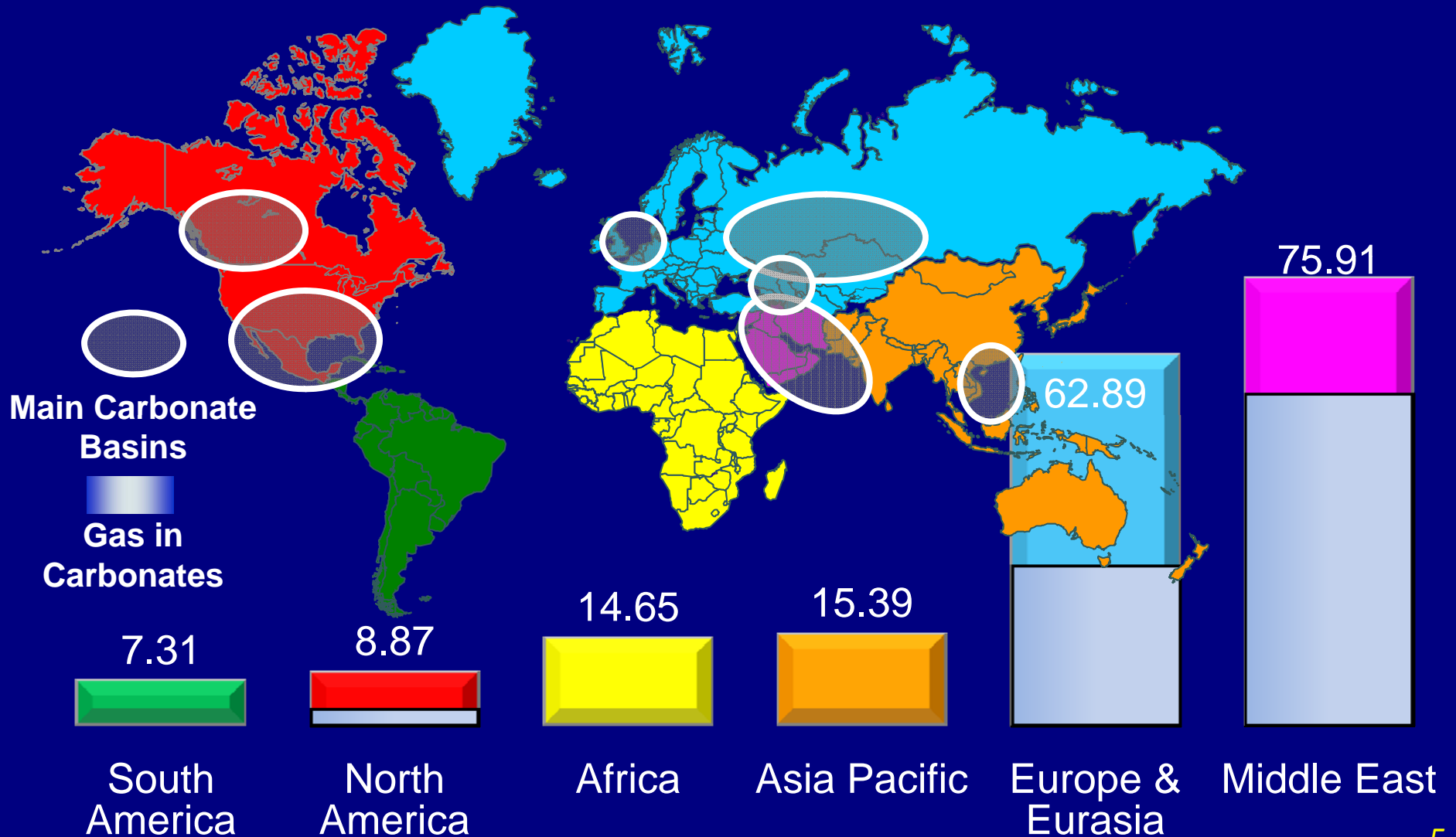
(Billion bbl)



Source: BP Statistical Review of World Energy June 2009

# Proved Reserves for Natural Gas

(Trillion m<sup>3</sup>)



Source: BP Statistical Review of World Energy June 2009

# Carbonate Reservoirs are Unique

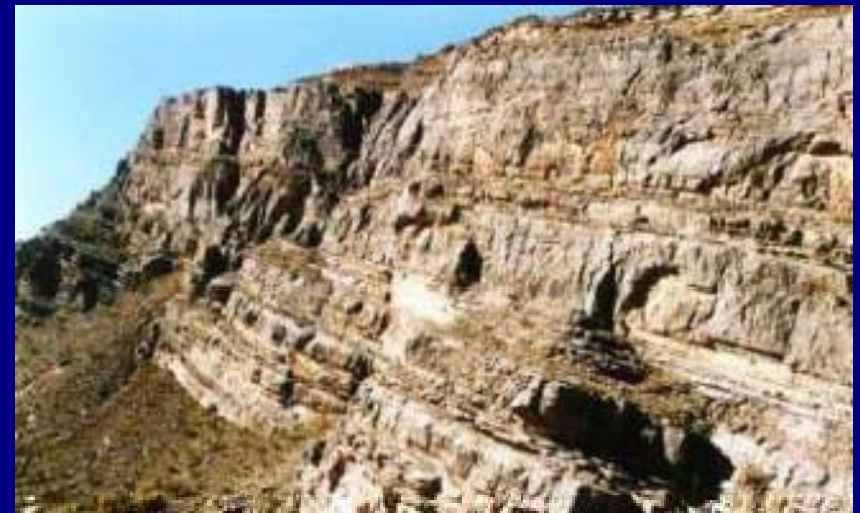
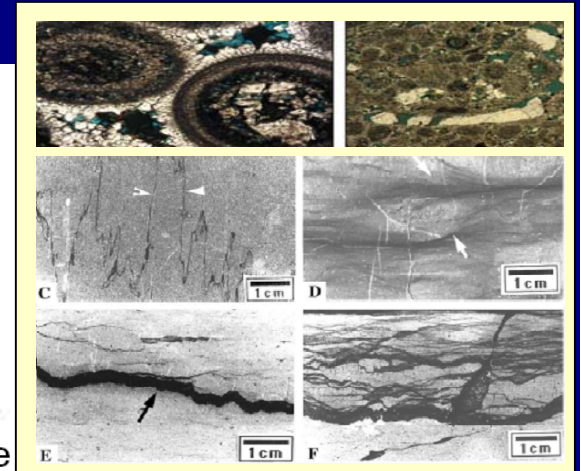
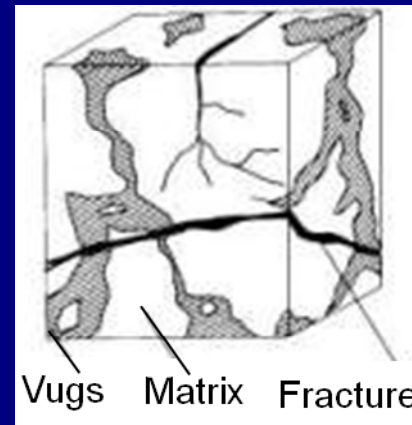
Three levels of porosity: The rock matrix, “vugs” and fractures

Heterogeneity at all scales

Most carbonate reservoirs have mixed wettability

Reservoir description is challenging, especially permeability

Oil recovery factors can be significantly lower than average



Fractured carbonates - Wadi Bani Kharus, Oman

# Stimulating Carbonate Production

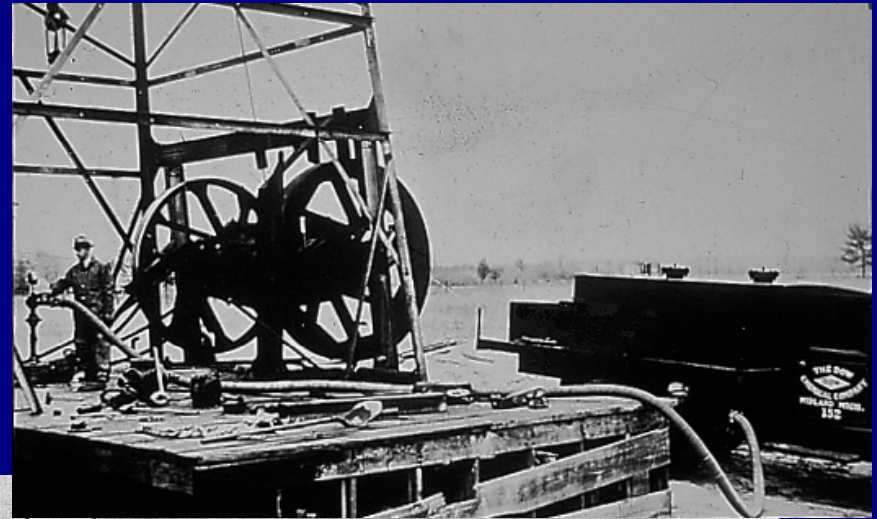
Carbonate acidizing first successfully used in 1895

Patented process in 1896

Corrosion problems limited broad application

Inhibited HCl patented in 1932

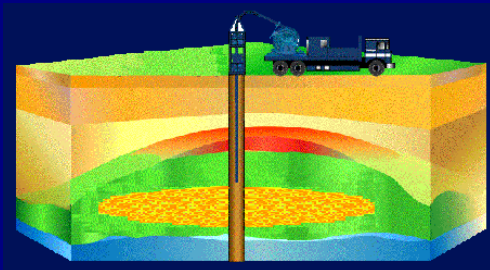
>6000 wells treated by 1935



# The Dichotomy of Acid Stimulation

## Simple acid stimulation treatments often have positive results

- Acid bull-heading, acid washes and perforation clean up treatments
- Production and recovery not optimized

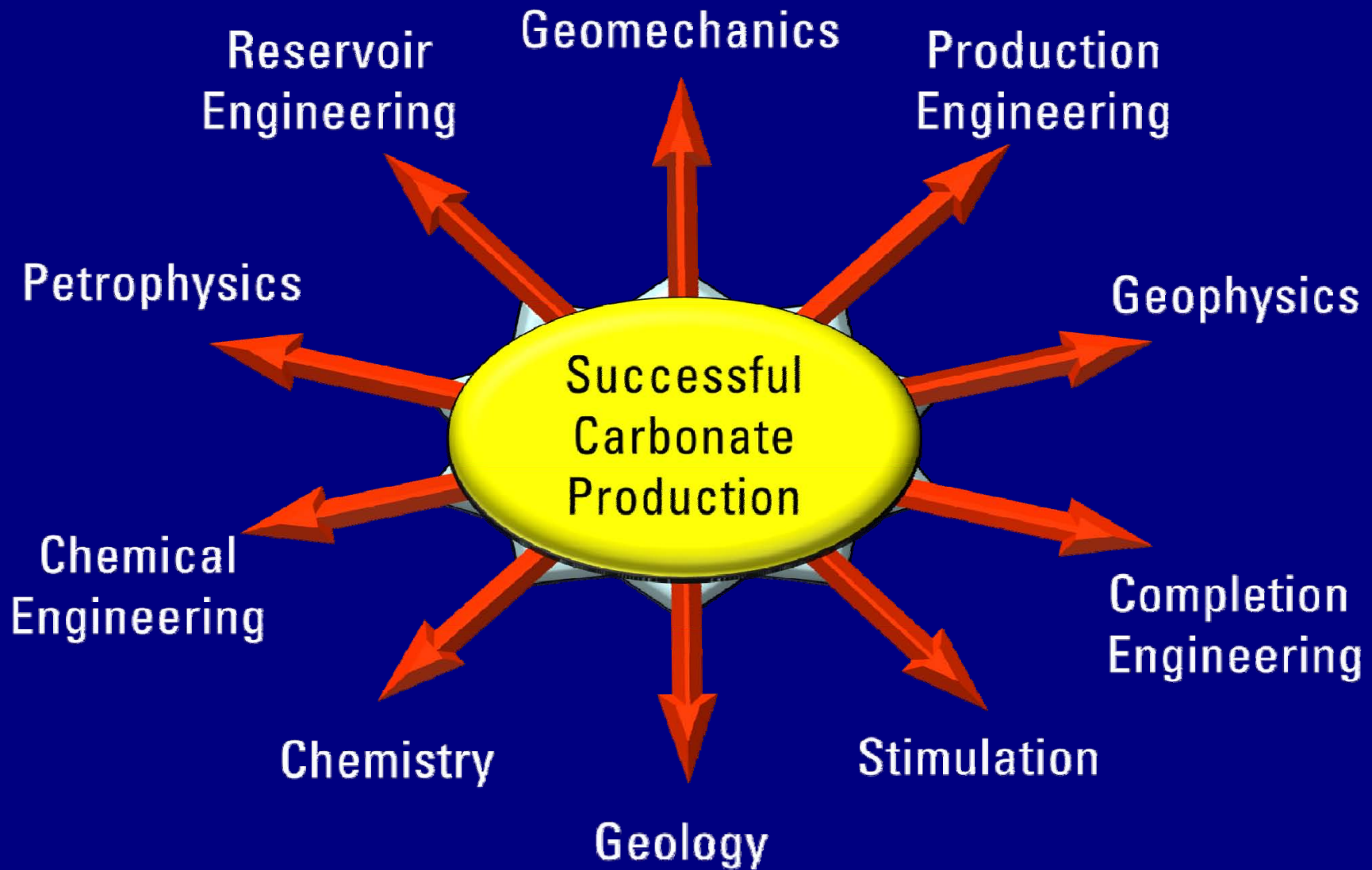


## Proper technical designs and solutions are demanding

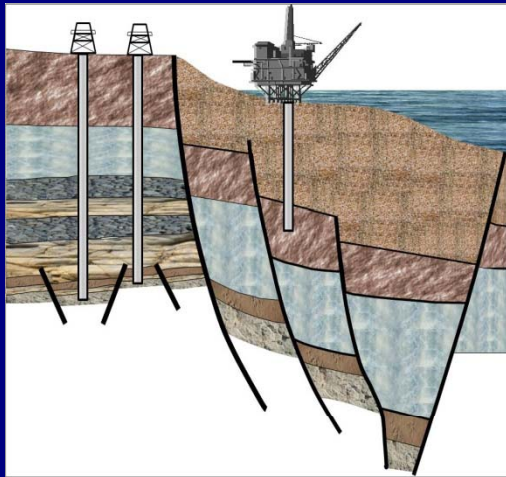
- Very complex reservoirs and processes
- Requires teamwork across many disciplines
- Greater production and recovery



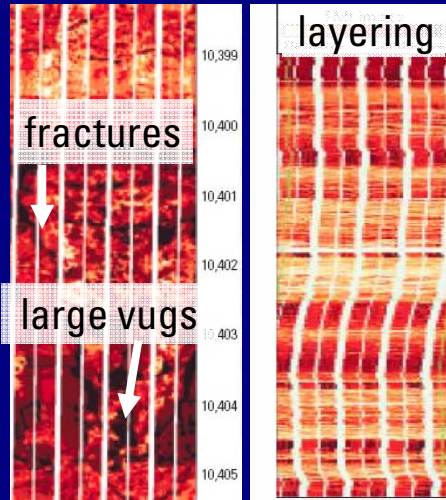
# What Disciplines are Required ?



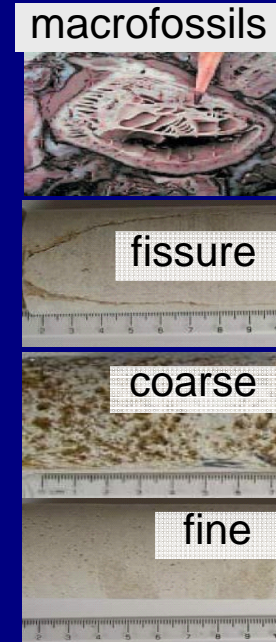
# Heterogeneity at all scales ...



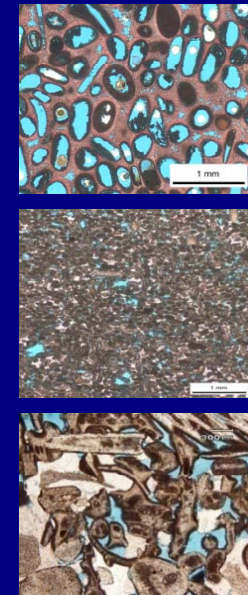
10m-1000m



10cm – 10m



1cm – 10cm



10 $\mu$ m – 10mm

# Better Characterization - Better Production

Most carbonate reservoirs are naturally fractured

Accurate characterization of fractured reservoirs through data integration:

- Cross-discipline measurements
- Geological models incorporating fractures
- Dual permeability flow simulation

