



Challenges and Opportunities for Oil exploration in Cyprus: the Role of the University

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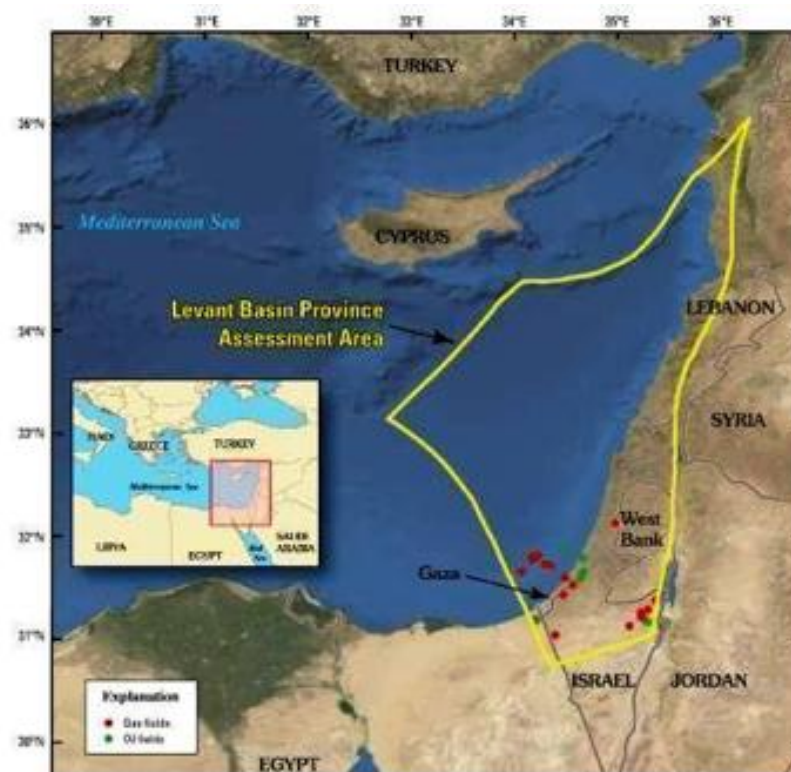
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Outline

- Challenges in Levant basin
 - Political challenges
 - Economic challenges
 - Technical challenges
 - Environmental challenges
- Management issues
- University-Industry relations
- Research in Petroleum Geomechanics



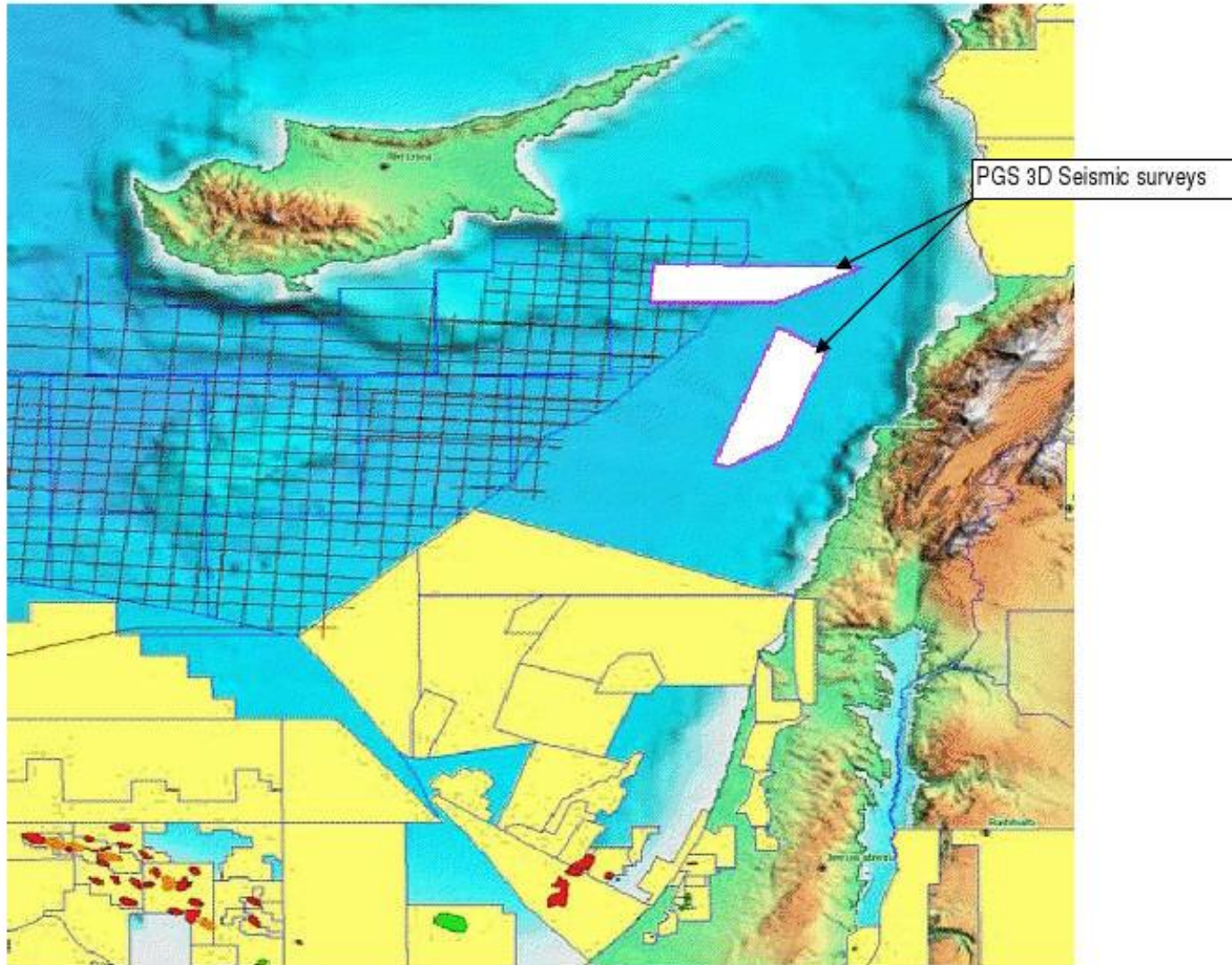
USGS: 1.7bn Oil, 122 tcf gas

Political Challenges

- How the oil companies decide to invest in a region
 - the economic risk, the technical risk, the political risk
 - the political risk (disputes and unsolved problems with neighbouring countries)
 - Lebanon and Israel disputes on the boundary of the EEZ
 - Cyprus and oil companies face intervention and threats by Turkey
- The higher the risk, the higher is the return on the investment for the Oil Companies and lower are the benefits for the countries
- Much more benefits from the development of oil industry in the wider-region with sharing of common infrastructure, equipment, technology and knowledge

Political problems in Levant Basin

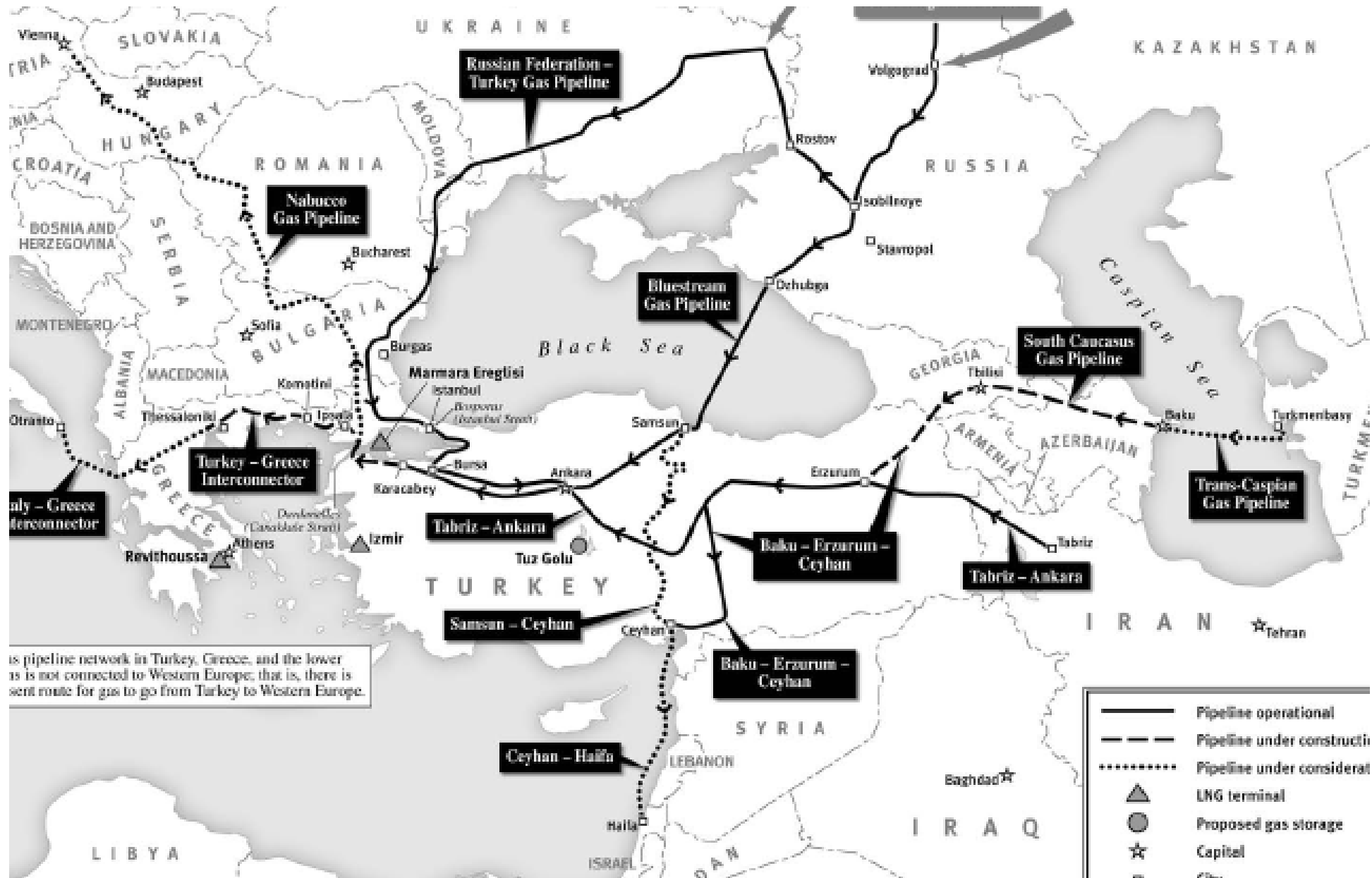
East Mediterranean - Two 3D surveys offshore Cyprus and Lebanon



Economic Challenges

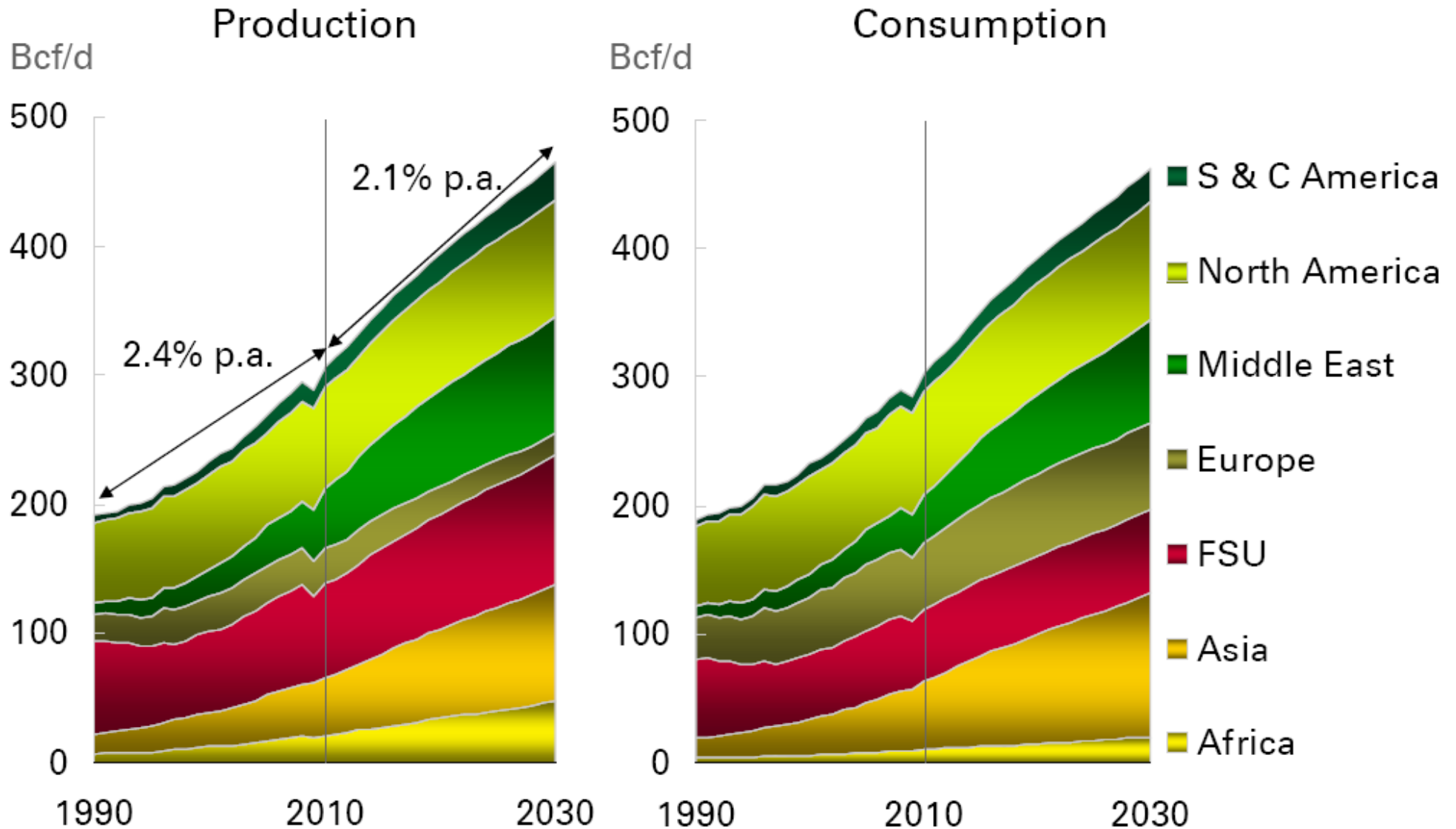
- Manage the cost, minimize unproductive time, minimize time to reach the markets
- Create the infrastructure for the gas to reach the markets
 - Pipes (political problems, technical challenges)
 - LNG export facilities (environmental concerns, difficult projects)
- European market shall be the main target
 - Low risk to fill the gap in Europe with gas from unconventional gas recourses (shale gas)

Pipelines in the area



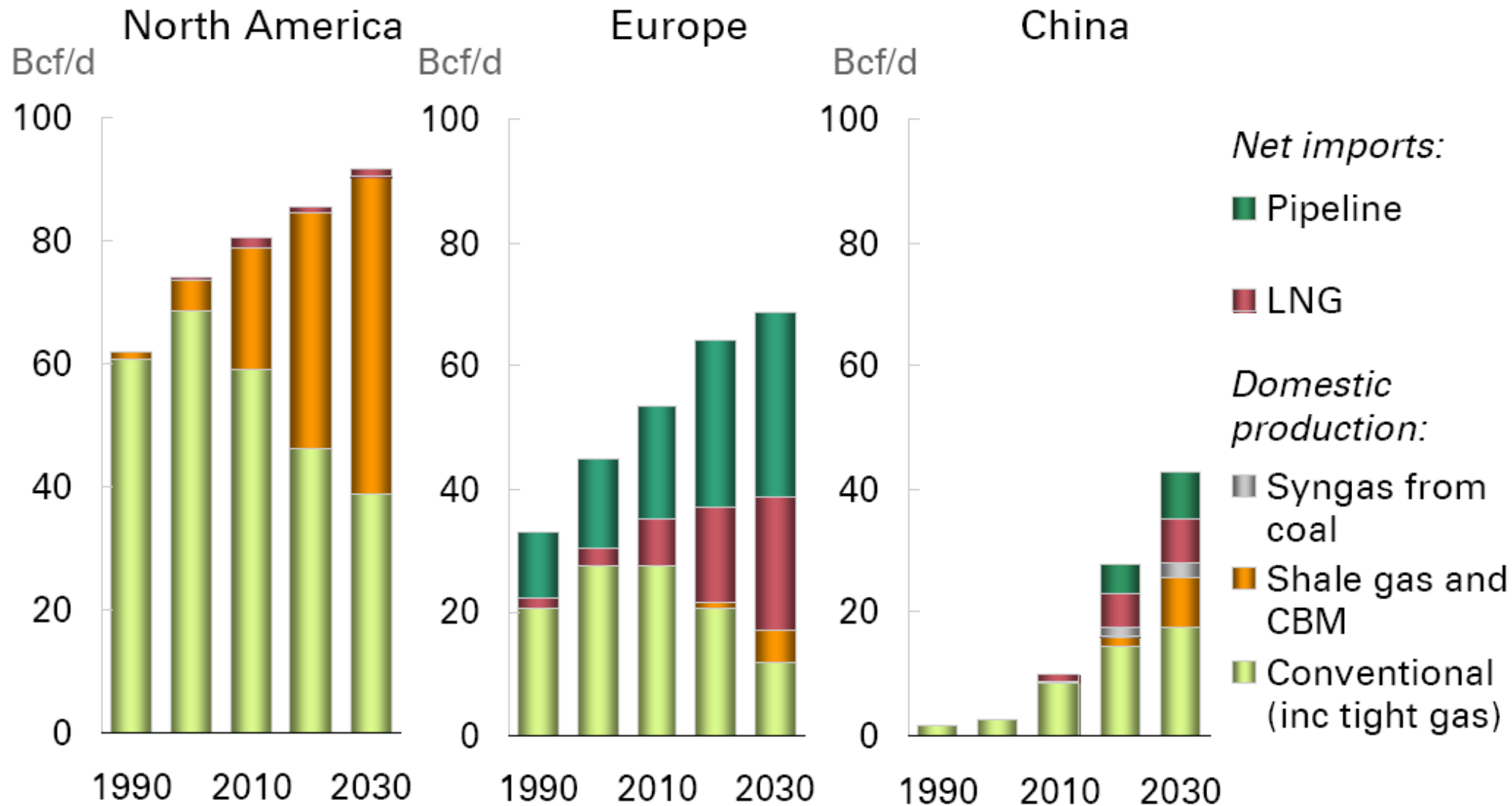
Gas production and consumption

(source BP)



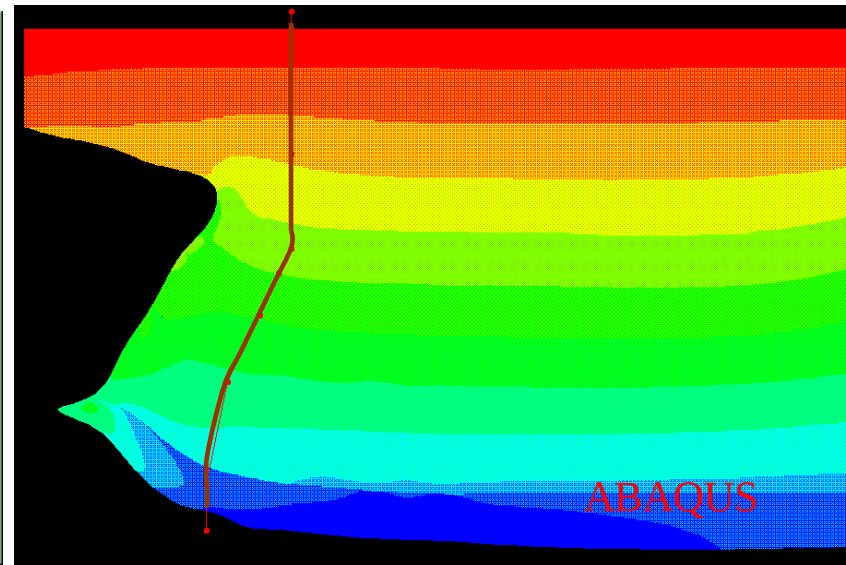
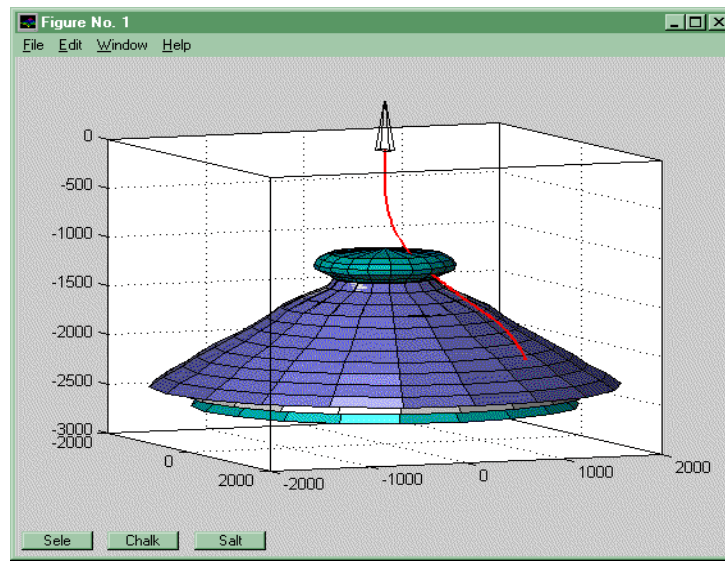
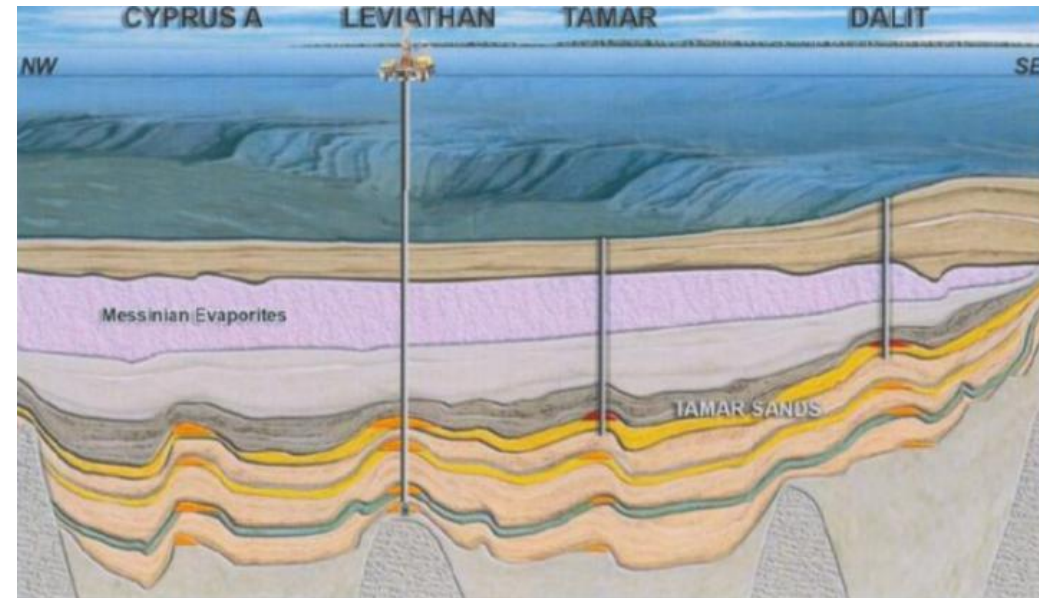
Gas type by region

(source BP)



Technical Challenges

- Deep water environment
 - Transfer of technology and knowledge from other regions, e.g. Gulf of Mexico, offshore Angola
- Tectonic, near salt-dome stress fields (drilling problems, type of completion, production management)



Environmental challenges

- Very sensitive natural environment
 - tourist and recreational industries
 - Cyprus has the cleanest beaches in Europe
- Improve environmental performance
- Macondo accident presses
 - for Engineers certified for the deepwater environment
 - employ specific refine processes
 - provide technologies with the required performance
- Concern on the tender process for equipment and services



Proposal for management mechanisms

- Cyprus Petroleum Directorate
 - Governmental, specialist, advisory, regulatory, administrative, management
- National Oil/Natural Gas Company
 - joint ventures with Oil Companies
- Cyprus Oil/Natural gas fund
 - to facilitate the long-term management of the government's petroleum revenues

Universities - Industry relation

- Recruitment

- According to SPE the next five years a big number of experienced engineers will retire
- Oil and gas industries must consider the recruitment of local young Engineers (contract requirement?)
- highly educated population (near 1000 graduate Engineers every year)

- Research programs

- World class research
- Training through research programs

University of Cyprus (1992)

- Engineering School (2003)
- Departments
 - Civil & Environmental Engineering
 - Mechanical & Manufacturing Engineering
 - Electrical & Computer Engineering
 - Architecture
- Research Centers
 - Nanotechnology Research Center (MME)
 - KIOS Research Center for Intelligent Systems and Networks (ECE)
 - International Water Research Center (CEE)
 - **Proposal for Geosciences**
- 50 faculty members (23 vacant positions),
- 754 undergrad. 134 Master, 94 Ph.D.



Achievements

- Manage to attract faculty members from very good Universities or Research Centers
- Develop and offer 20 modern programs of undergraduate and graduate studies.
- Created teaching and research infrastructure, hard working research culture
- Attracted external funding for research support of budget 30million Euro. 17 million from abroad
- Good international visibility, organization of conferences, cooperation, editorial duties etc. Published 700 Journal papers cited more than 2500
- Department evaluations by international Committees made of professors from the best Universities



XRD

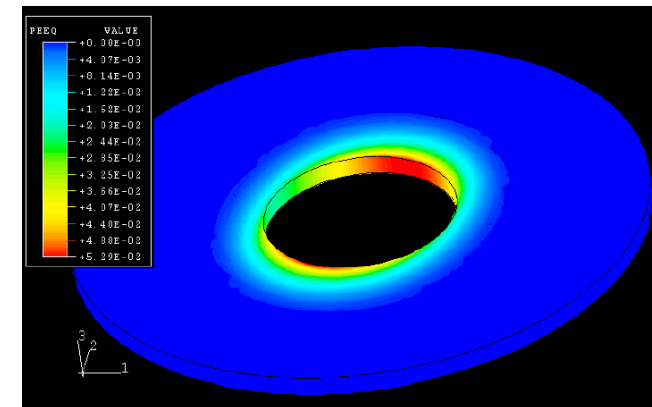
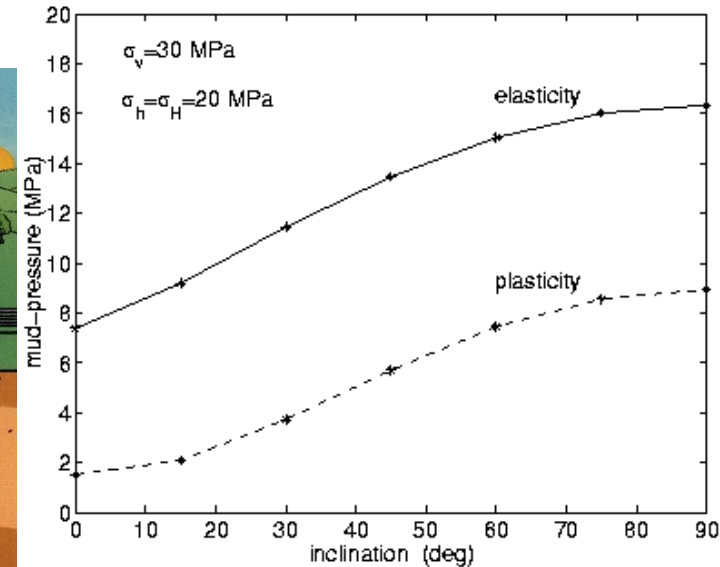
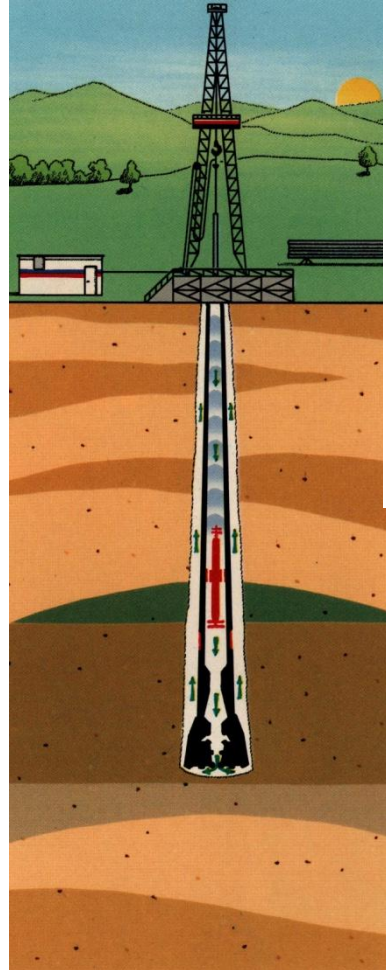


Scratch tool

Petroleum Geomechanics

Wellbore stability

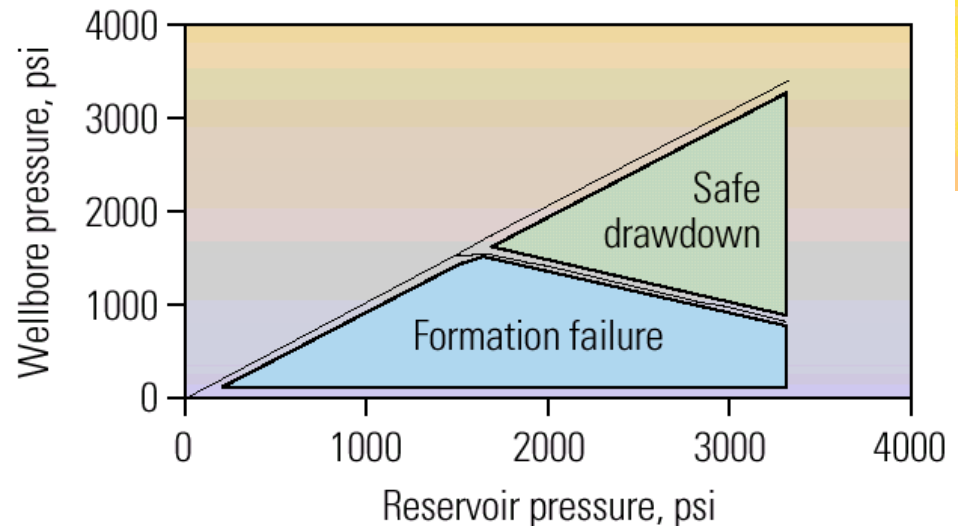
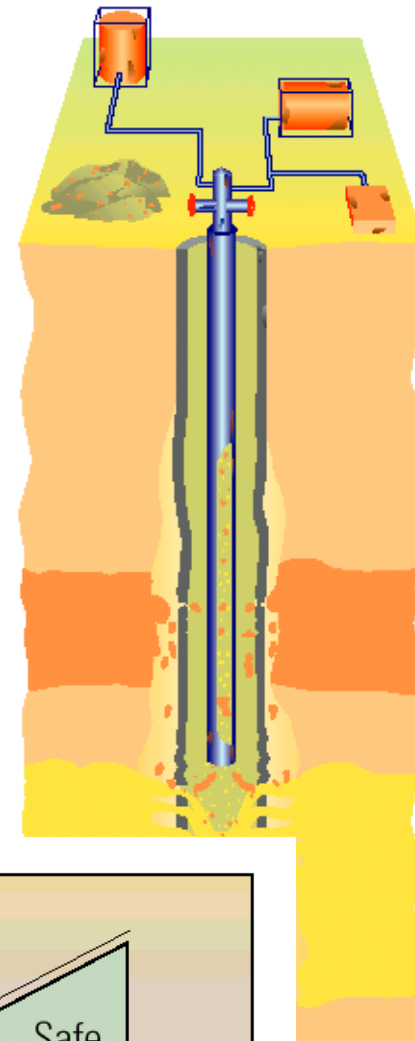
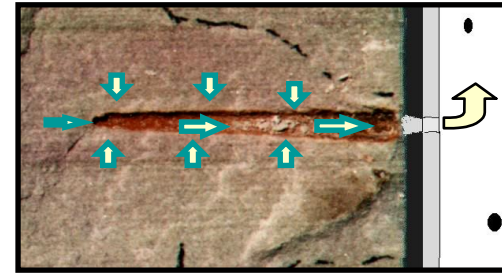
- Wellbore instabilities (\$6 billion +/-year)
- During drilling hole is supported by the mud-pressure calculated using mechanical models
 - low mud-pressure: hole collapse
 - high mud-pressure: formation fracturing, low rate of penetration
 - 3-D generalized plane strain FEM code



Sand production and avoidance

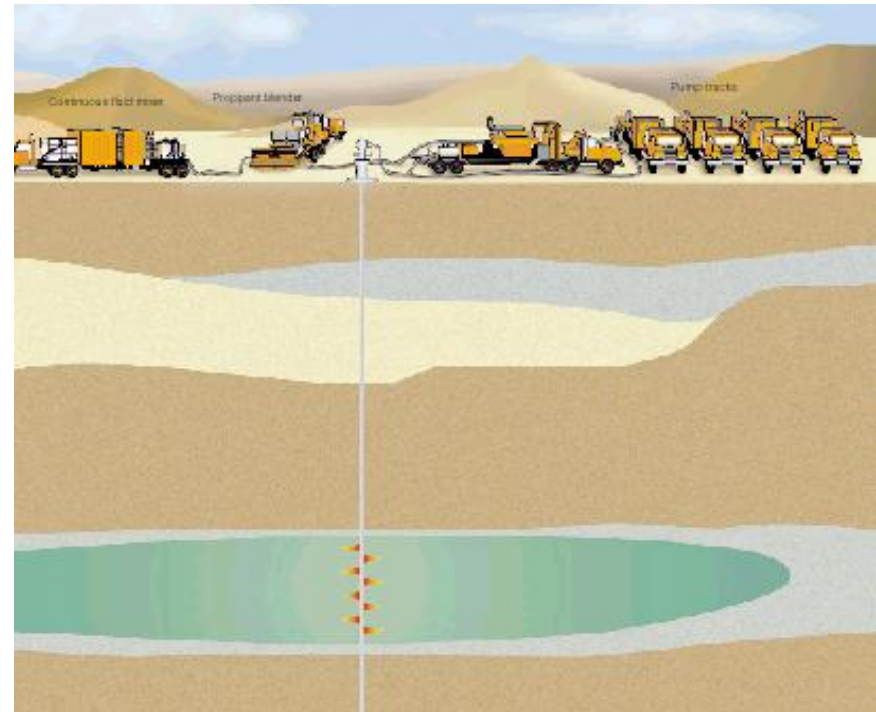
- Sanding problem (\$2 billion/yr)
 - blocks perforations, damages of equipment, requires separation from the oil and disposal
- Avoidance
 - gravel packing and screening, preferential perforating, fracturing
- Objective
 - develop models to predict sanding and optimum completion
 - 3-D elastic stress analysis, fluid flow term, apparent strength

Real perforation



Hydraulic fracturing

- Petroleum engineering
 - stimulate oil and gas reservoirs, cuttings re-injection
- High net-pressures ($p_{\text{net}} = p_{\text{frac}} - \sigma_{\text{min}}$)
 - high apparent fracture toughness: due to scale effect, confining pressure, heterogeneities and plasticity
 - flow behaviour near the tip: fluid-lag, rock dilation
 - underestimation of the closure stress (σ_{min})



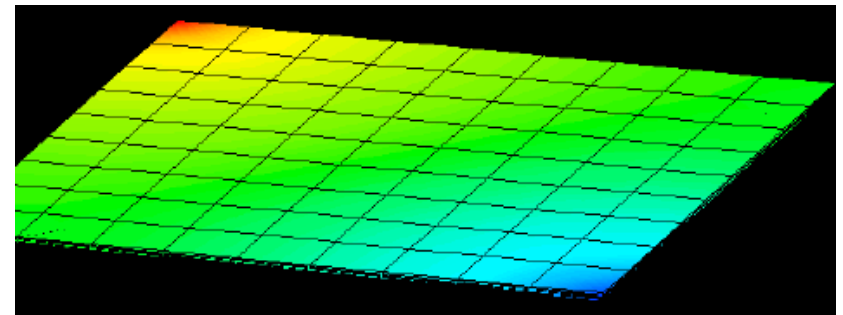
Reservoir geomechanics

- Reservoir simulations

- Multi-phase fluid-flow coupled with rock deformation

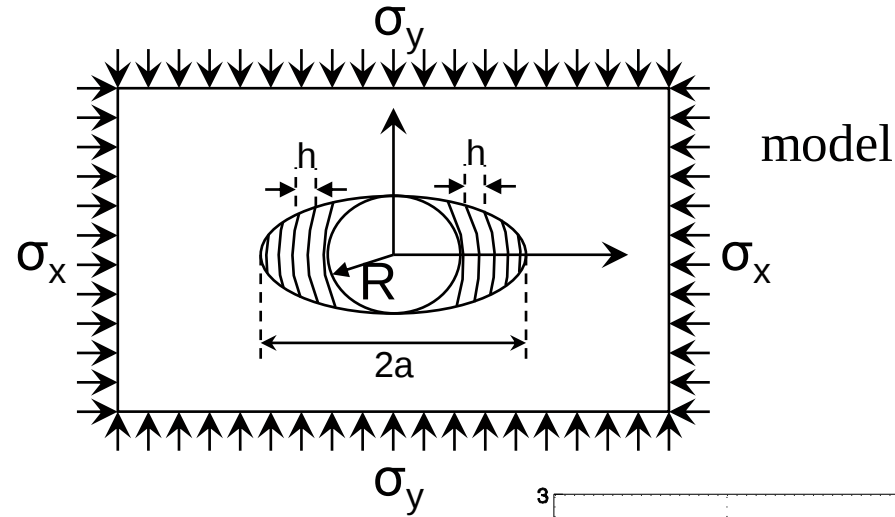
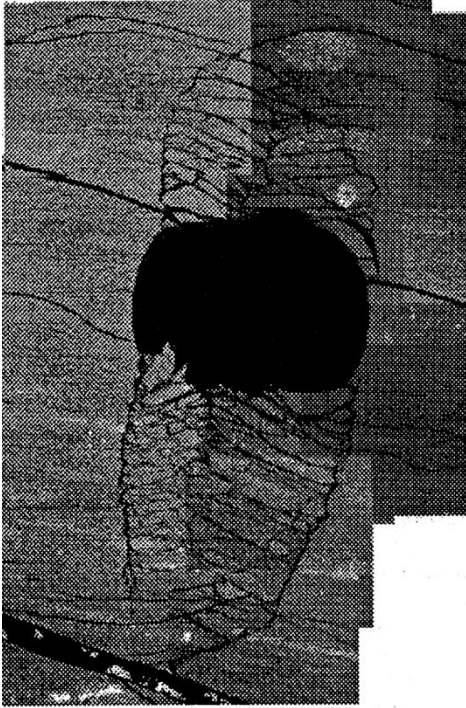
- Applications

- compaction drives production, stress-dependent permeability, direction of water-flooding, 4-D seismic interpretation
- surface subsidence, fault activation, small earthquakes, casing collapse, optimum well placement

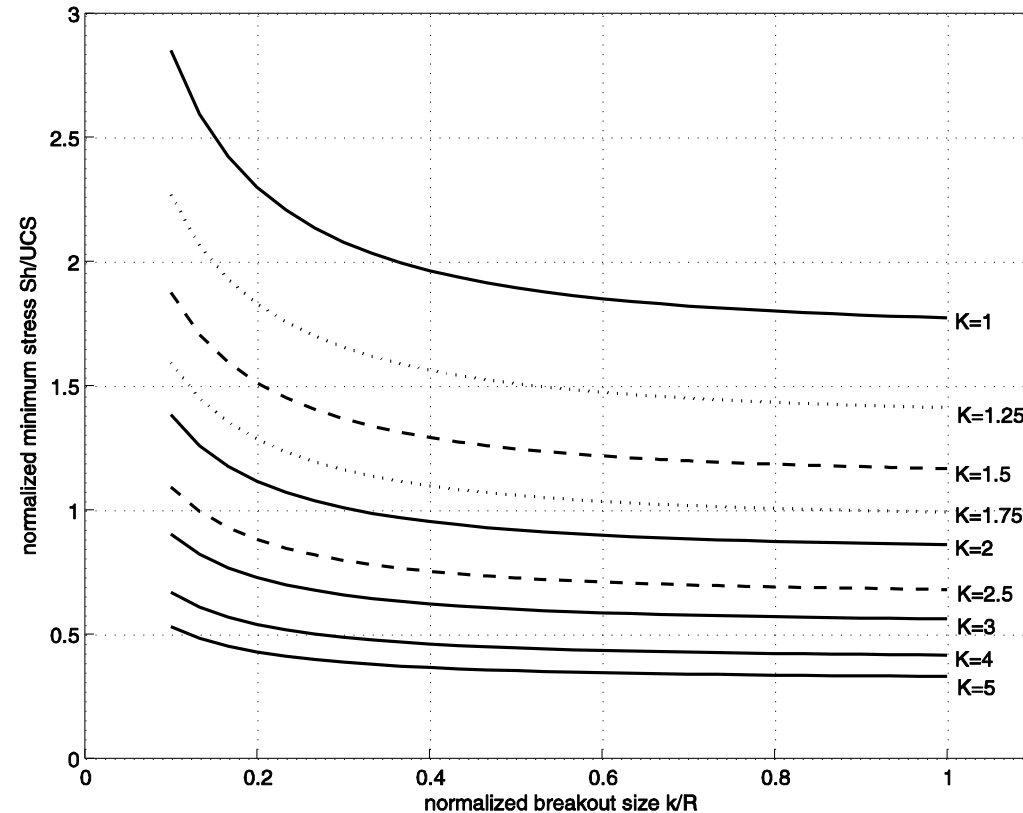
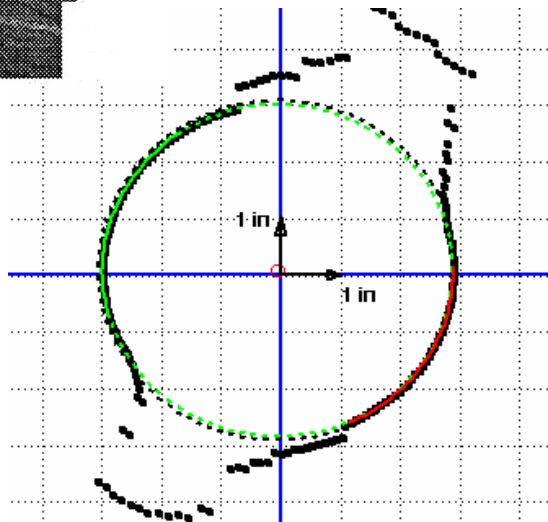


ECLIPSE

In situ stress determination



$$K = S_H / S_h$$



field image of a breakout (Desroches 2006)