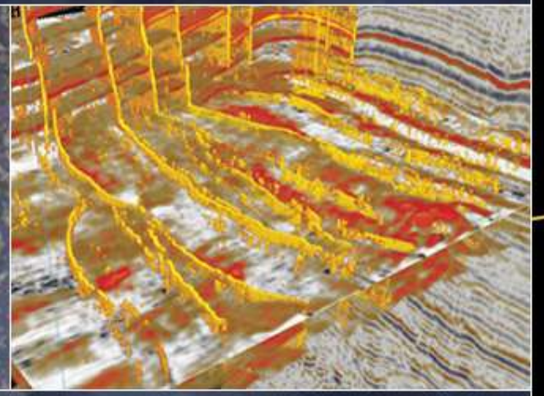
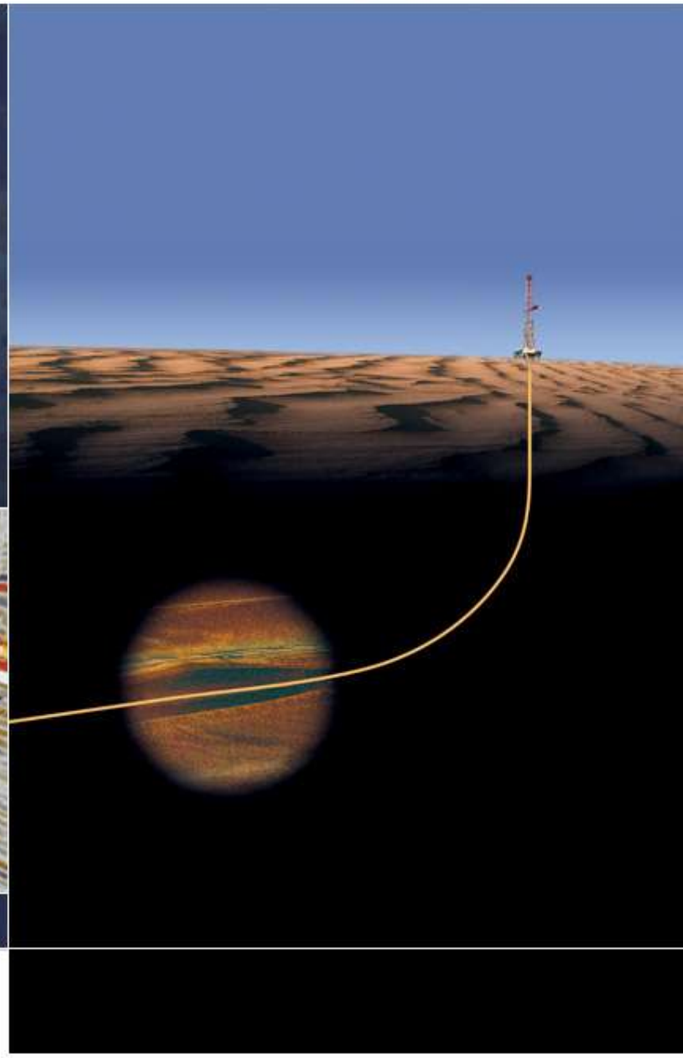
Enhancing Global Energy Security, Role of Technology in the Petroleum Sector

Carbon Management in E&P Operations
A Way Forward for Sustainable Future

Mahmut Sengul
Schlumberger Carbon Services, MEA
Riyadh , December 15 , 2008



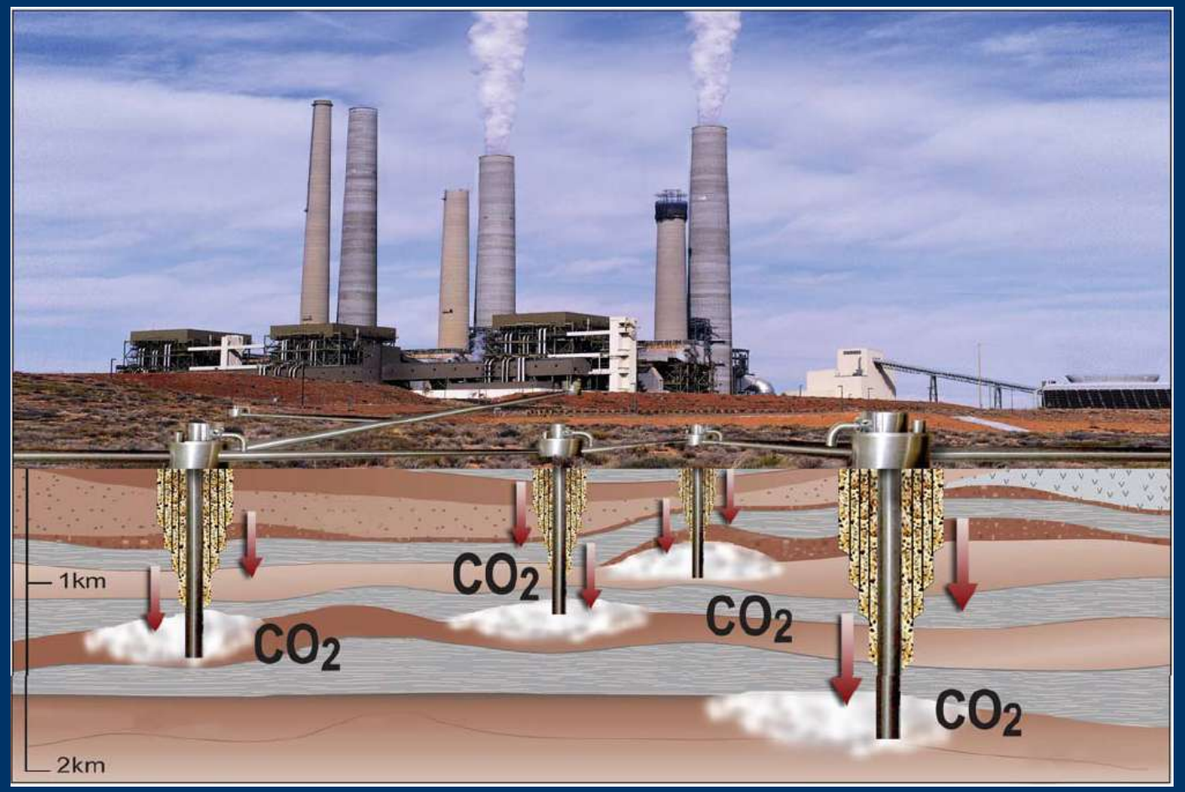



Schlumberger Carbon Services Middle East and Asia

Schlumberger

Overview

- Global warming and GHG
- Stabilizing CO_2
- Carbon Capture and Storage
- CCS Research
- Early case studies
- Summary



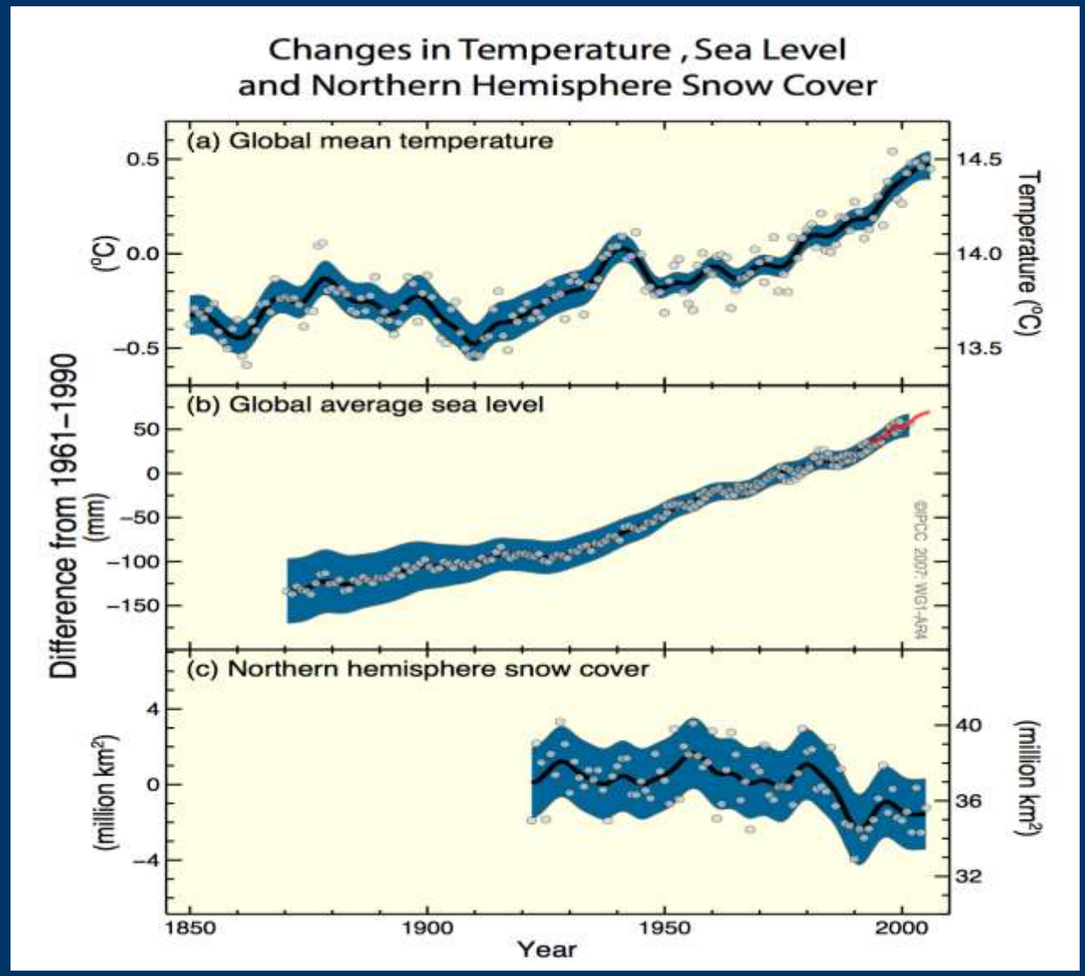
Schlumberger

Direct Observations of Recent Climate Change

Global mean temperature

Global average sea level

Northern hemisphere snow cover



Schlumberger

Carbon Mitigation Options

Continued use of fossil fuel in a carbon constrained world will require:

- Moderating demand by improving energy efficiency
- Developing low / no-carbon energy sources
- Implementing large scale carbon capture and sequestration

Schlumberger

Emission Reduction Opportunities in Oil and Gas Operations

CO_2 Emissions

- Power Generation
- Ageing Fields Power Demand
- Improve Turbine Efficiency
- Carbon Capture

Non CO_2 Emissions

VOC

- Tanker Loading
- VOC Recovery System

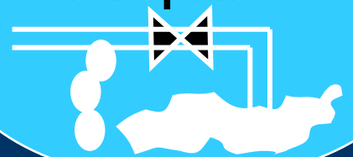
SOx

- Rich Gas Flaring
- Vapor Recovery

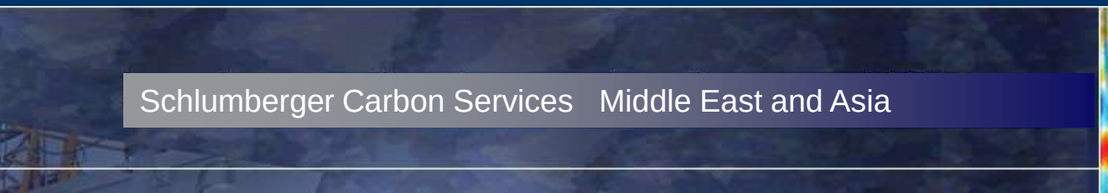
Gas Flaring

- Closed Burning Open Flaring
- Existing Fields: Review
- New Projects: Incl. in Design
- Vapor Recovery

Oil spills

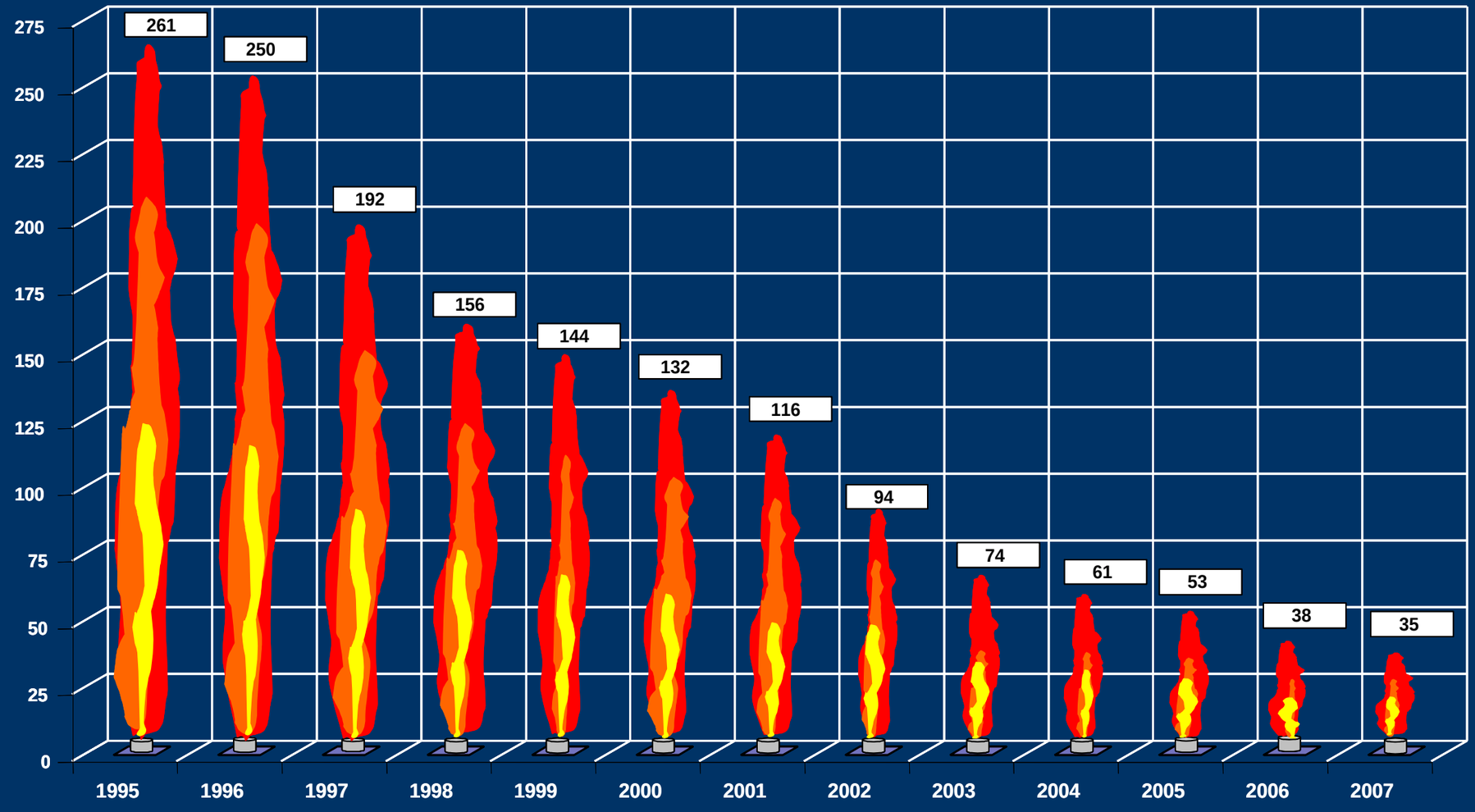


- Flow Line Leaks
- Clean-Up Guidelines
- Fast Response
- **Corrosion MS**
  - FL Corrosion Data
  - FL Replacement Project
  - Best Corrosion Protection Methods

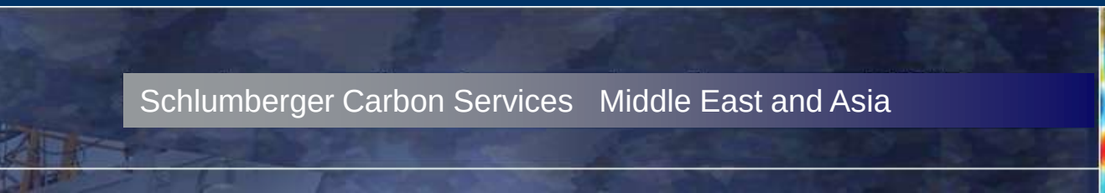


Schlumberger

Abu Dhabi Flare Reduction Performance

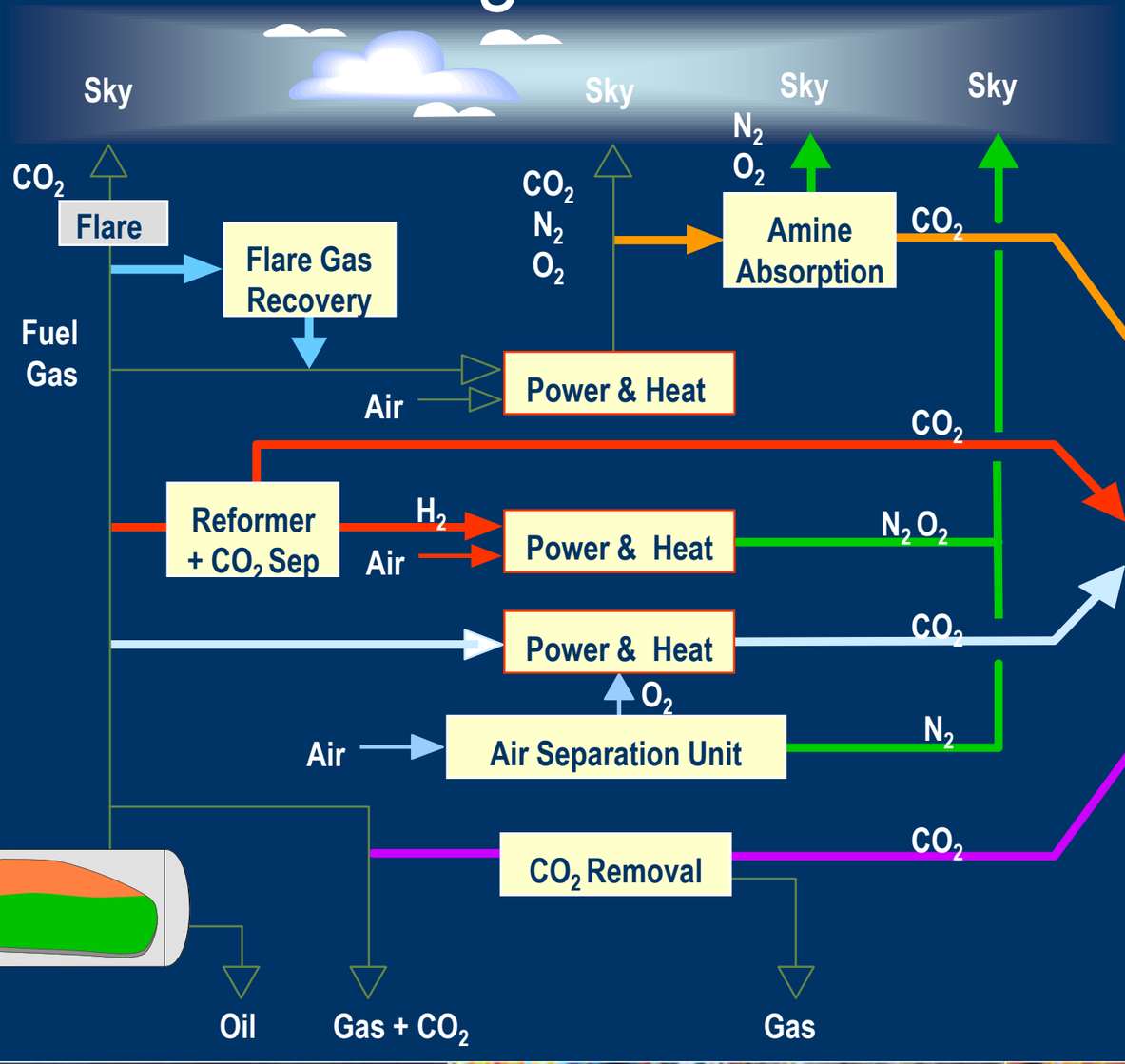


Courtesy of ADNOC



Schlumberger

Carbon Capture and Storage in E&P



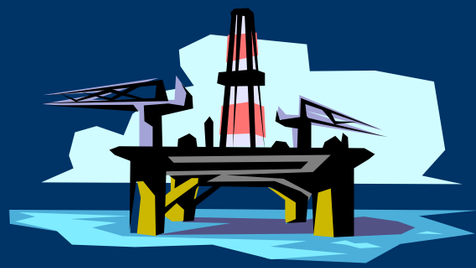
Flare Gas Recovery

Flue Gas Scrubbing

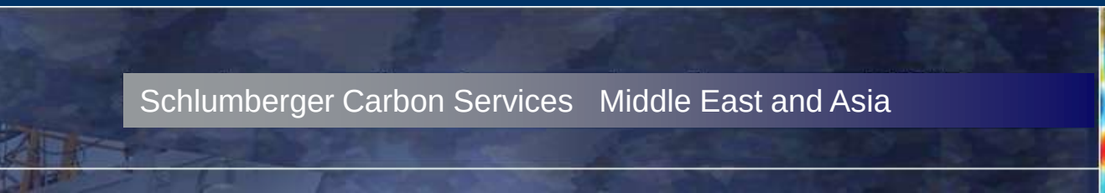
Precombustion Decarbonisation

Oxyfuel

Acid Gas Removal



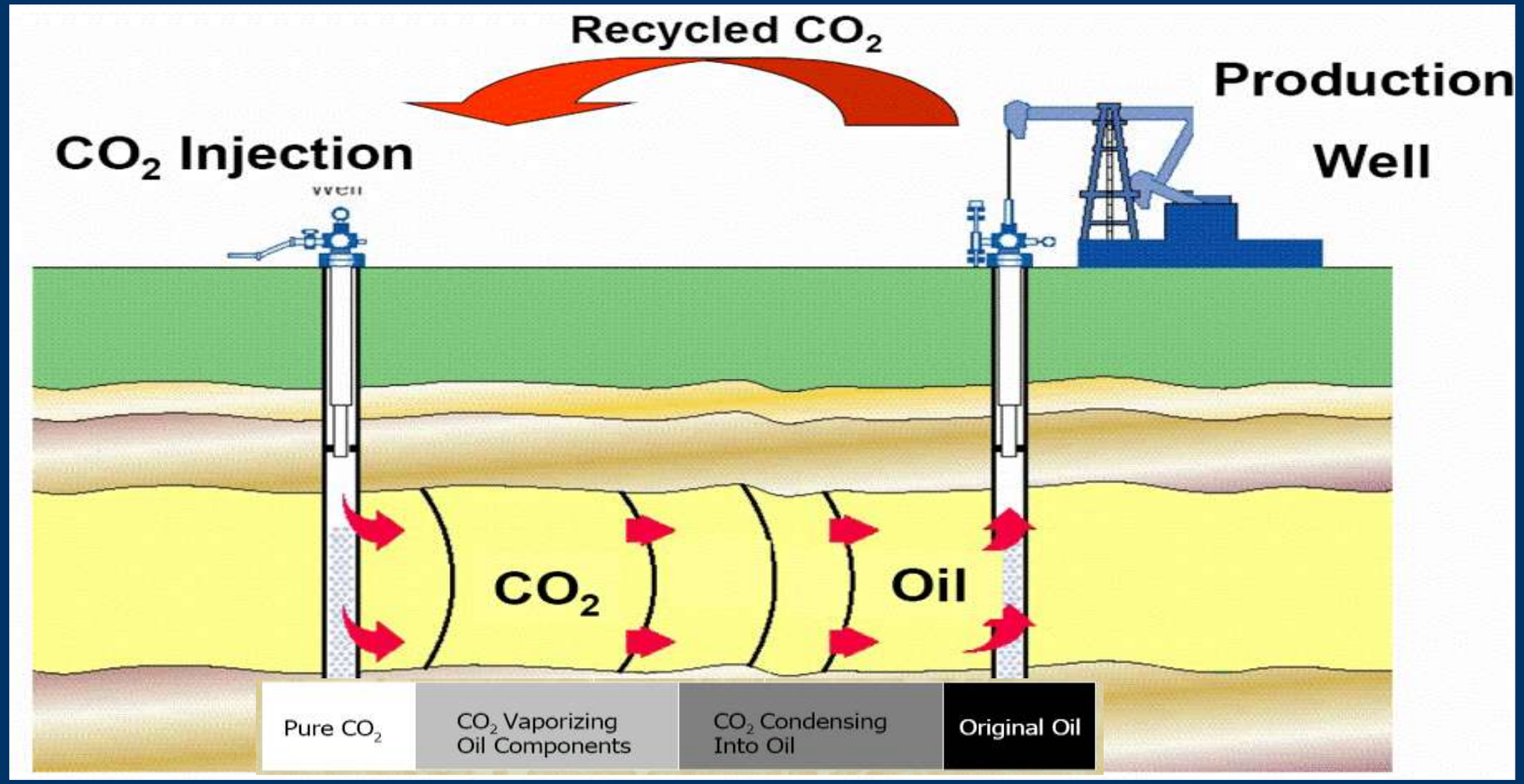
- Enhanced Oil Recovery
- Enhanced Coal Bed Methane
- Old Oil/Gas Fields
- Saline Formations



Schlumberger Carbon Services Middle East and Asia

Schlumberger

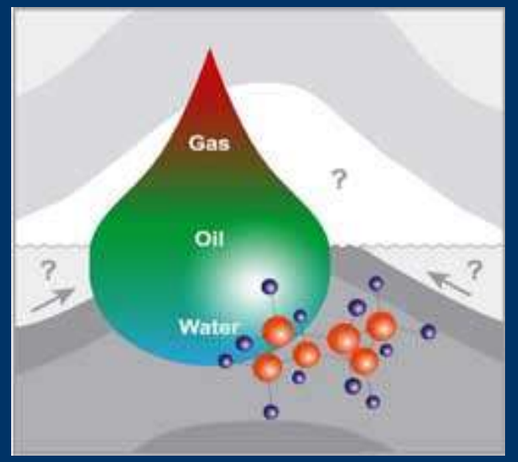
CO_2 EOR



Schlumberger

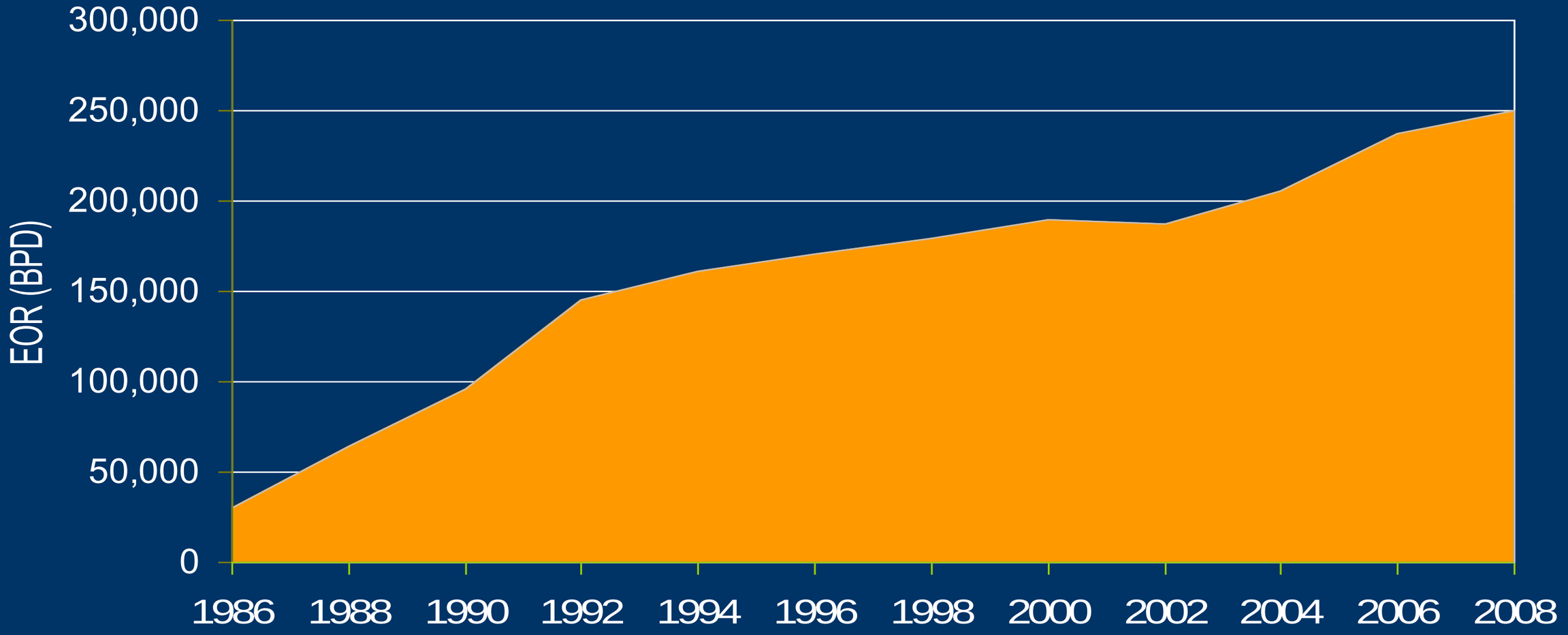
Oil Displacement in CO_2 EOR

- Swelling the crude oil
- Reducing oil viscosity
- Reducing oil density
- Reducing the gas-oil interfacial tension
- Solubility process
- Vaporizing (extracting) lighter hydrocarbon in crude oil
- Generating miscibility by the multiple contact process if the pressure is sufficiently high



Schlumberger

US CO_2 EOR Production



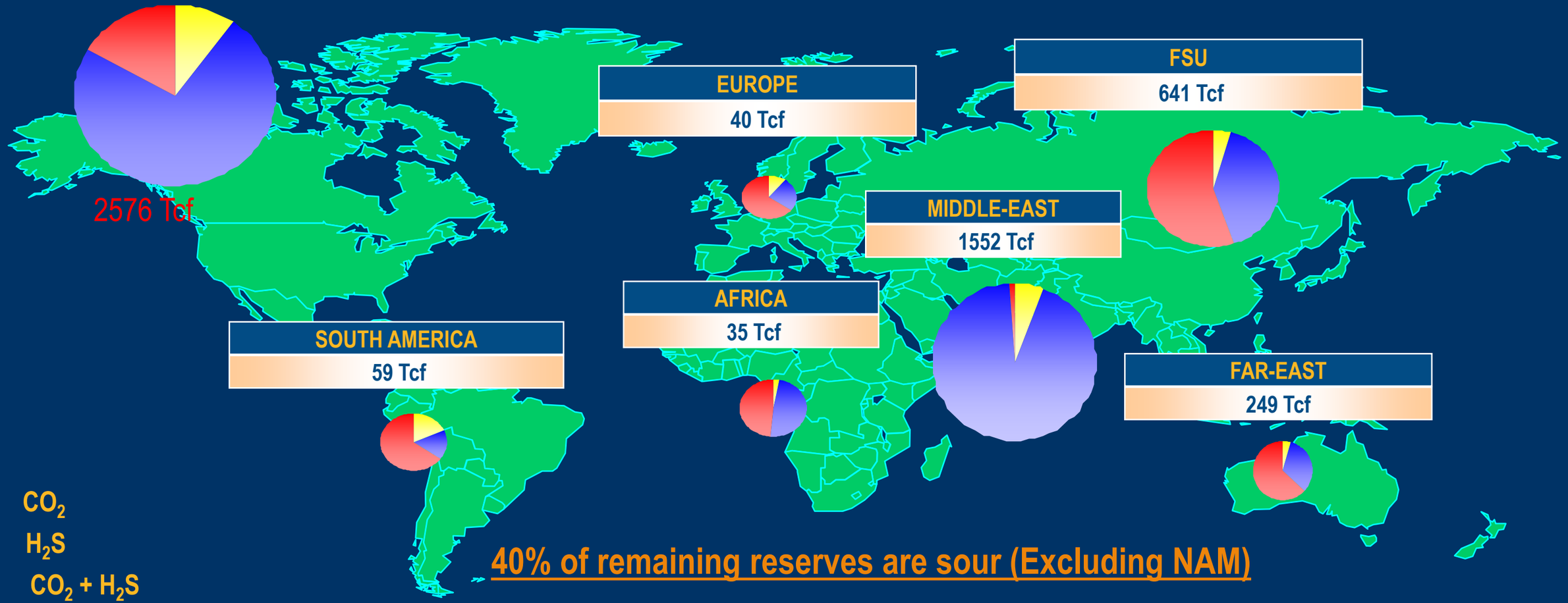
Schlumberger

Issues with CO_2 EOR

- CO_2 availability
- Recovery estimates
  - Relative permeability end point values
  - Slim tube MMP experiments
  - Timing of CO_2 EOR
  - CO_2 Utilization
- Reservoir / well integrity issues

Schlumberger

Remaining Gas Reserves with CO_2>2% and/or H_2S>10ppm



40% of remaining reserves are sour (Excluding NAM)

Source: Iris 21 database from IHS Energy -June 2004

Schlumberger Carbon Services Middle East and Asia

Schlumberger

High CO_2 Natural Gas - EOR Synergy

CO_2 Capture
High CO_2
Gas Reservoirs

Mature
Oil Reservoirs
Low RF

CCS + EOR PROCESSES

Natural Gas
LNG Sales

Incremental
Oil Recovery

CO_2 Storage

Schlumberger

Schlumberger Focus in CCS

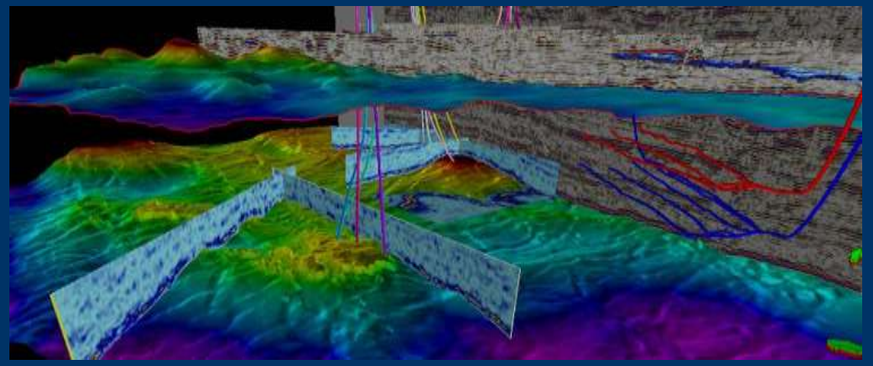
CO_2 Capture Services (Process)	CO_2 Transportation (EPC)	Reservoir Development Services (SLB-OFS)	Carbon Services	Reservoir Management Support (IPM-DCS-SIS)
✗	✗	✓	*Carbon Capture & Storage* *R&D* *Technical Consulting* ✓	✓

SCS works with customers to identify CO_2 Capture and Storage opportunities and recommend options for implementations.

SCS works closely with OFS segments and alliance partners to implement CCS projects

Schlumberger

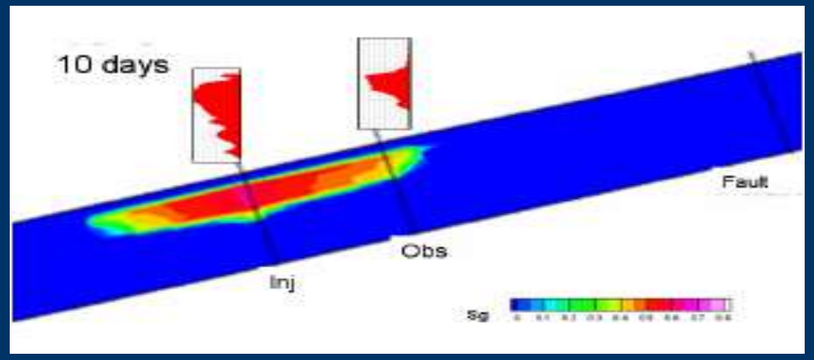
Current Research Activities

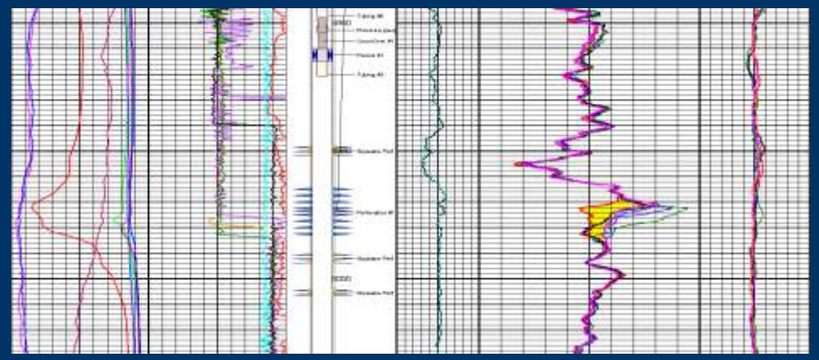


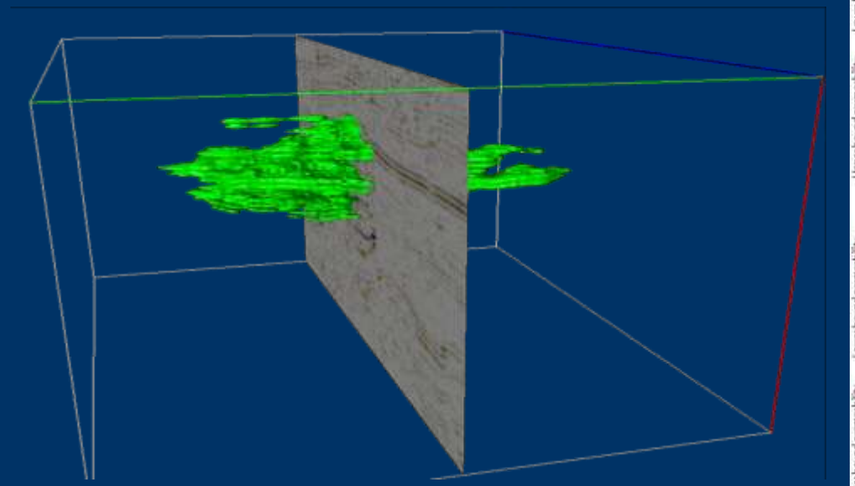
- Time lapsed 3D Seismic CO_2
- Eclipse for CO_2 Service
- Geochemical Simulator
- Geomechanical Simulator
- CO_2 resistant cement
- ESP / HPS for CO_2
- Next generation reservoir simulator
- Risk Assessment

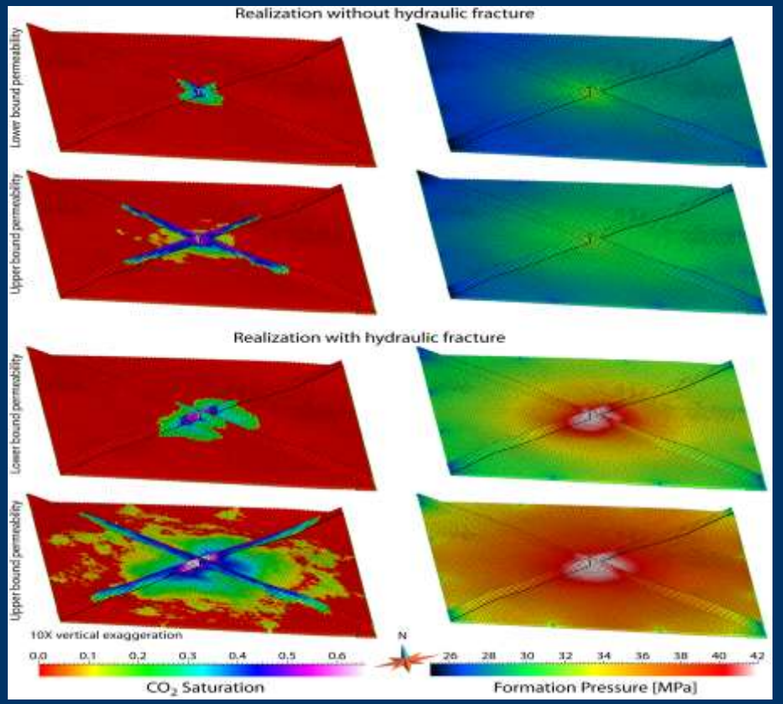
Schlumberger

Field Projects



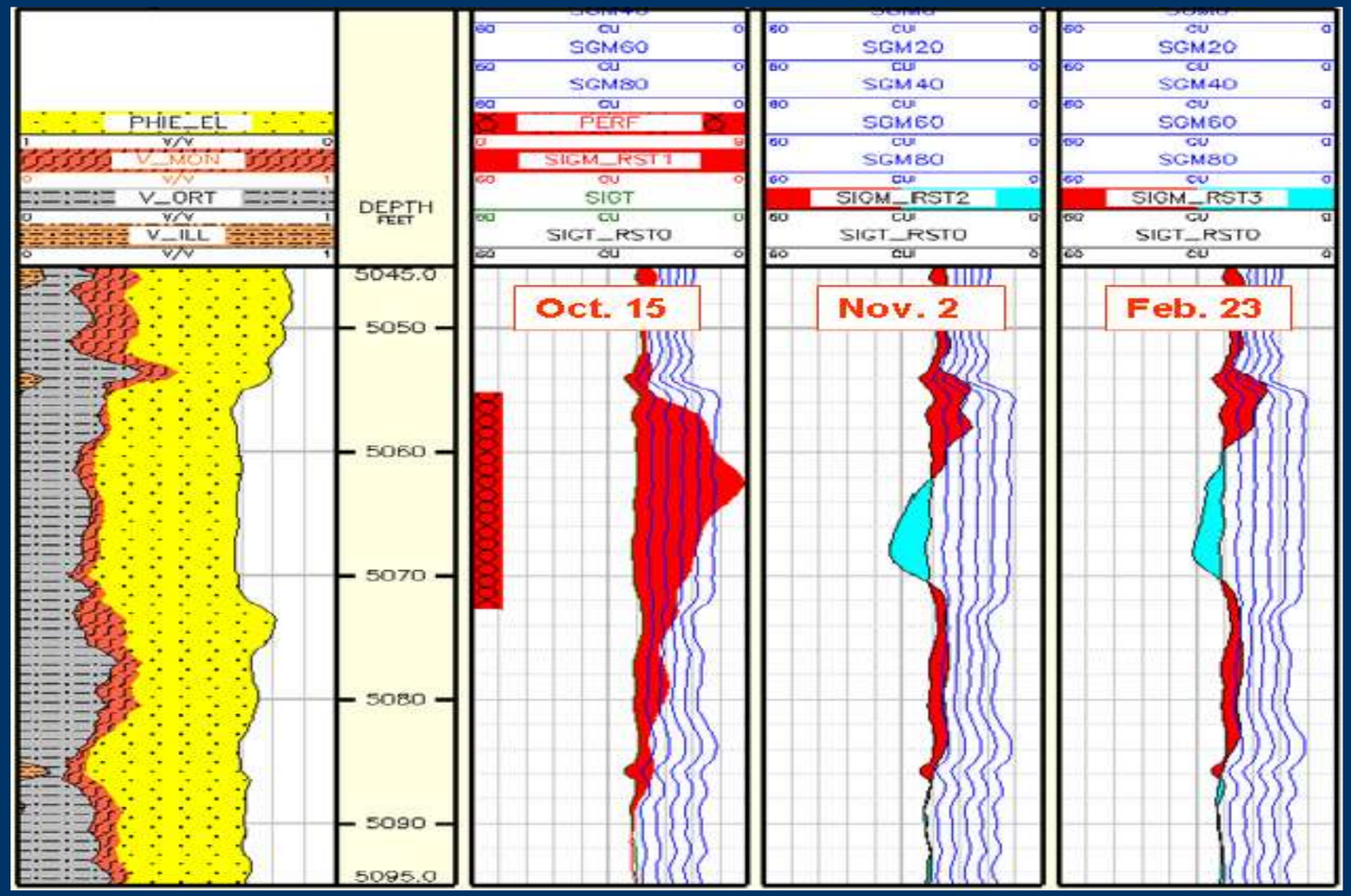






Schlumberger

Monitoring Using RST – Σ Measurement



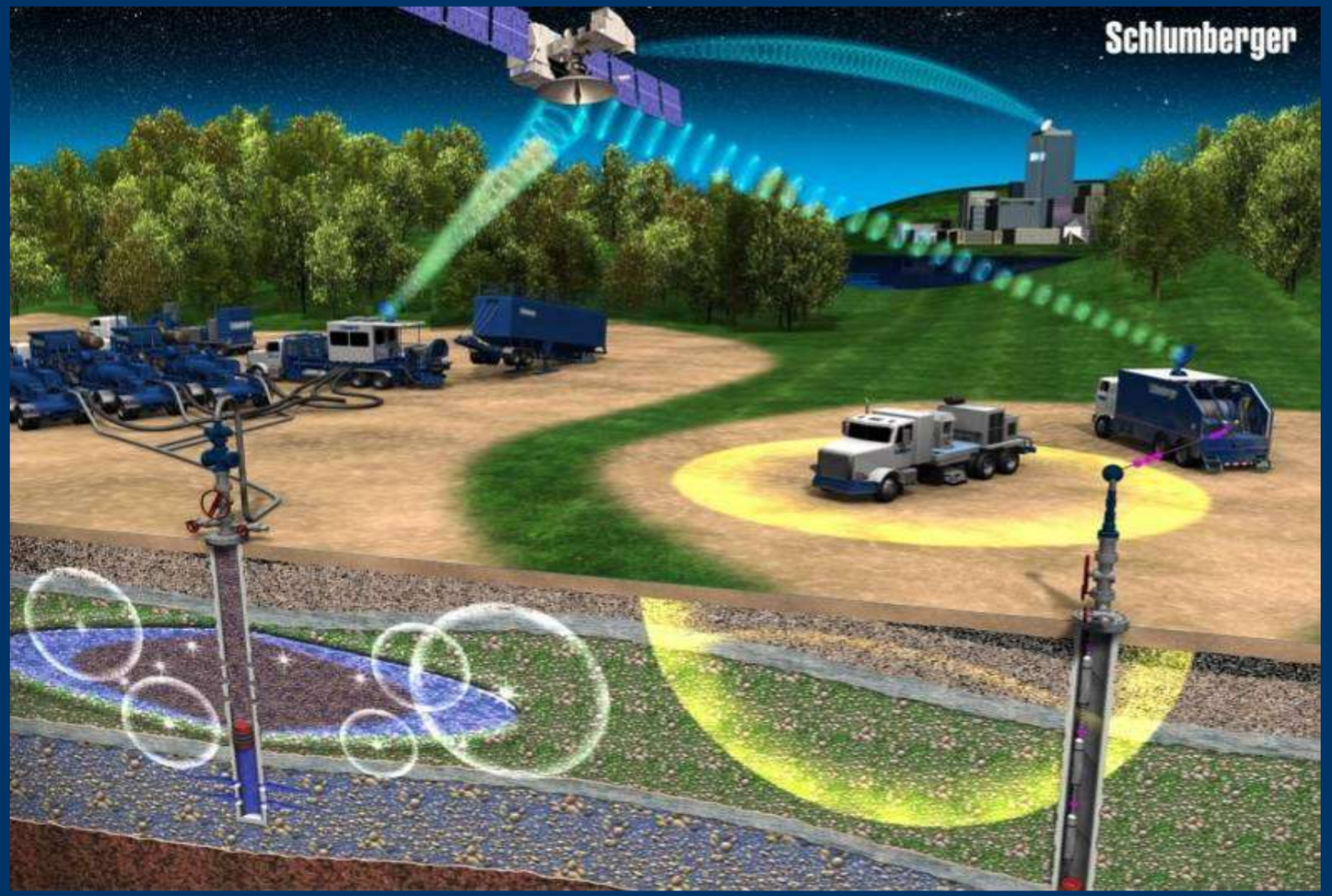
RST injection well

CO_2 Injection :
Start – Oct 4th / Stop - Oct 14th

(*) Sakurai et al. , SPWLA 46th – June 26-29th - 2005

Schlumberger

Microseismics

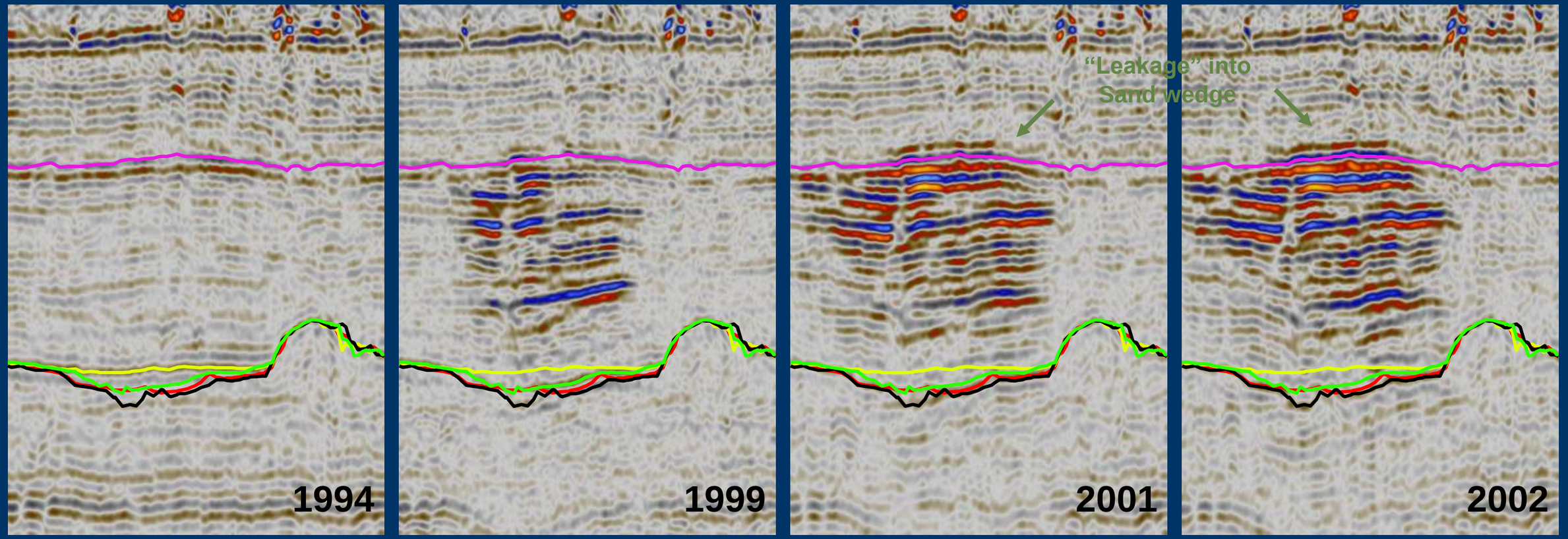


Main applications:

- Injection control
- Avoid fracturing cap rock
- Control CO_2 displacement
- Fault Re-activation

Schlumberger

Sleipner Seismic Monitoring Results



Courtesy SACS2

Schlumberger

Otway Basin Pilot Project - Australia

Schlumberger

Schlumberger Involved CO_2 Projects

R&D Consortia and Projects

- GCEP Stanford University
- IPGP (France)
- CO2CRC (Australia)
- CO2ReMoVe (EU)
- COSMOS-1 (France-Germany)
- MOVECBM
- Battelle (US-DOE)
- Frio (US-Texas)
- Otway (Australia)
- CS Energy

Participation in international forums

- Zero Emission Fossil Fuel Power Plant (EU)
- Carbon Sequestration Leadership Forum
- IEA Greenhouse Gas R&D program

Schlumberger

CO_2 Sequestration Business - Challenges

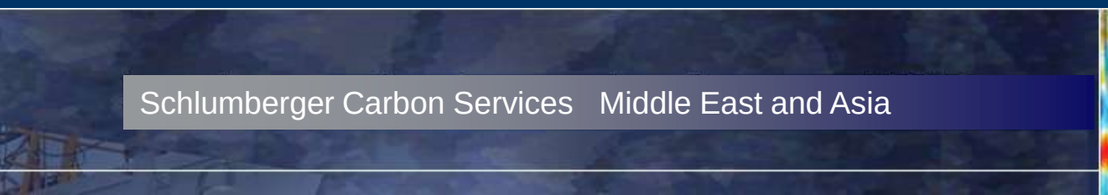
Upstream
Transportation
EPC, Gas processing
R&D Technology
Asset Ownership

PROJECT

Policies
Awareness
Economic Incentive
Will of people
Need

Technical Capabilities

Societal Factors



Schlumberger

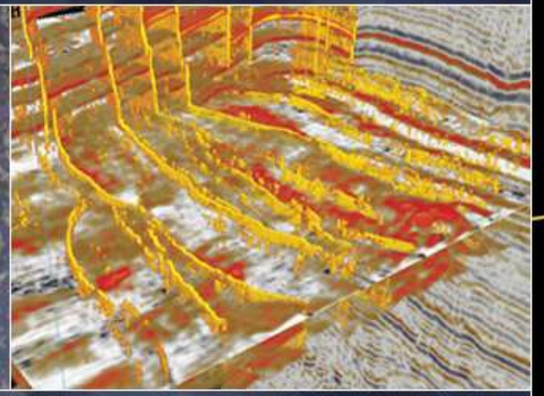
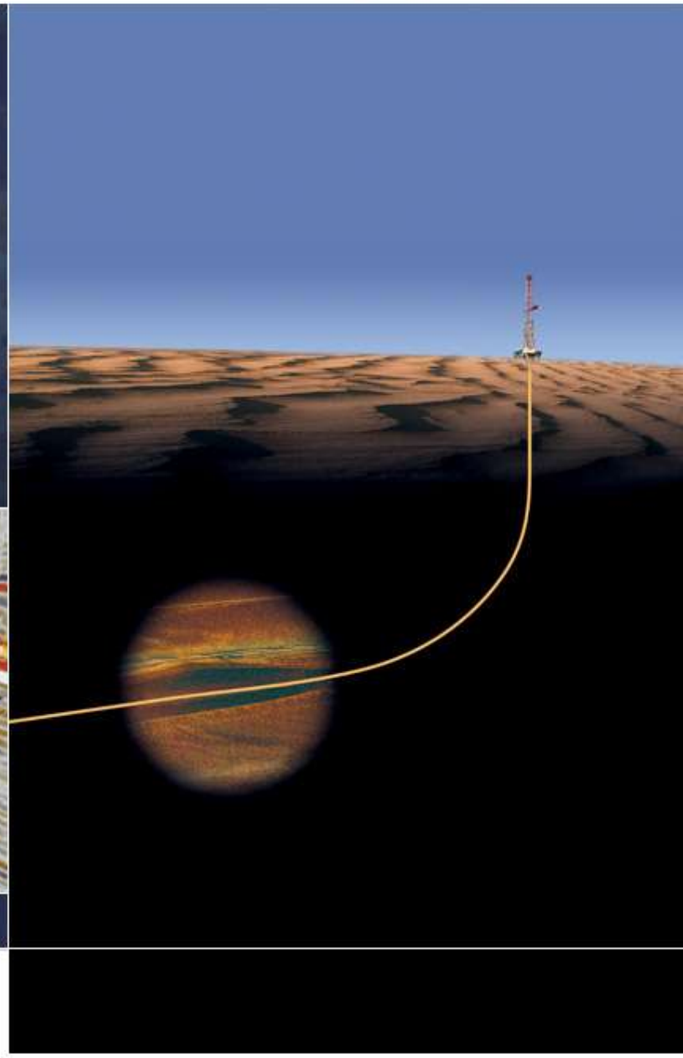
CCS in the Middle East

- The region has huge storage capacity.
- CO_2 EOR can make sequestration economically attractive in the short term.
- Storing CO_2 in carbonate reservoirs has not been done elsewhere, and offer unique opportunities.
- High volume demonstration projects needed
- E&P industry could be a part of “Solution to Climate Change” issue

Enhancing Global Energy Security, Role of Technology in the Petroleum Sector

Thank you



Schlumberger Carbon Services Middle East and Asia

Schlumberger