CO2 Geological Storage: Two Years of Operation at In Salah

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Agenda

- **Three Projects at In Salah (Algeria)**
  - In Salah Gas Development (1bcf/d $2,000 million)
  - In Salah CO_2 Storage (1mmtpa $ 100 million)
    - Monitoring for resource extraction
  - In Salah CO_2 Assurance R&D (CSLF & EU $ 30 million)
    - Monitoring for Assurance
    - Monitoring for Research (tool development etc)
- **Summary**

BP's Technology Program

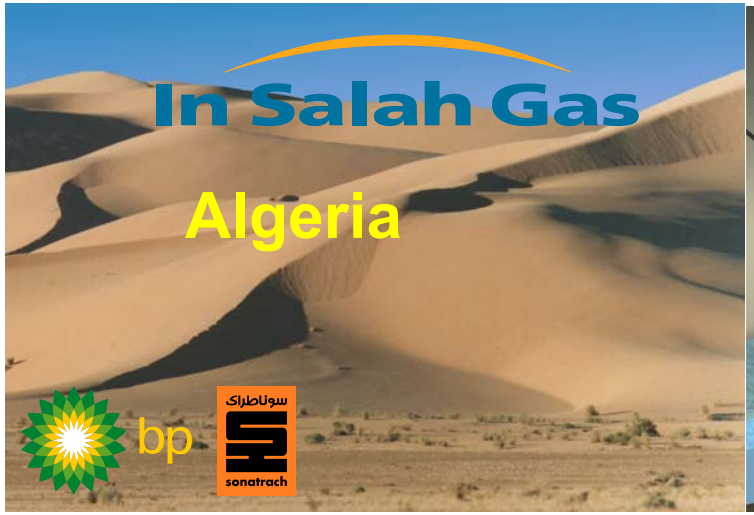
Science

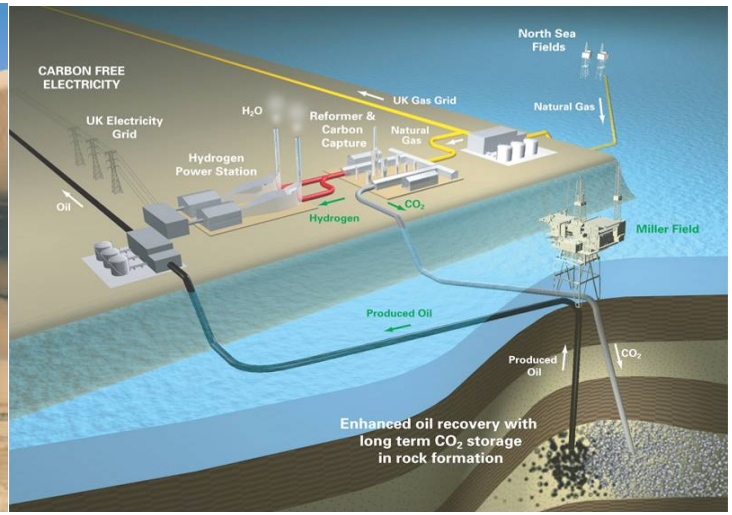
R&D

Demo

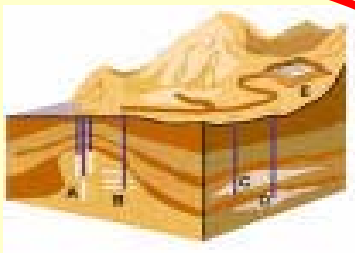
Business Application

Working with Government
Sleipner CO_2 Store
Weyburn EOR Demo
EU FP-6
US DoE, Norwegian RC





How to Start the Hydrogen Economy



CO_2 Storage

In Salah

Hydro-Carbon

syngas manufacture

H_2

Combined Cycle Power Generation

e^-

'Carbon Free' Electricity

Provides optionality for future to supply H_2 into other sectors

H_2

Transportation

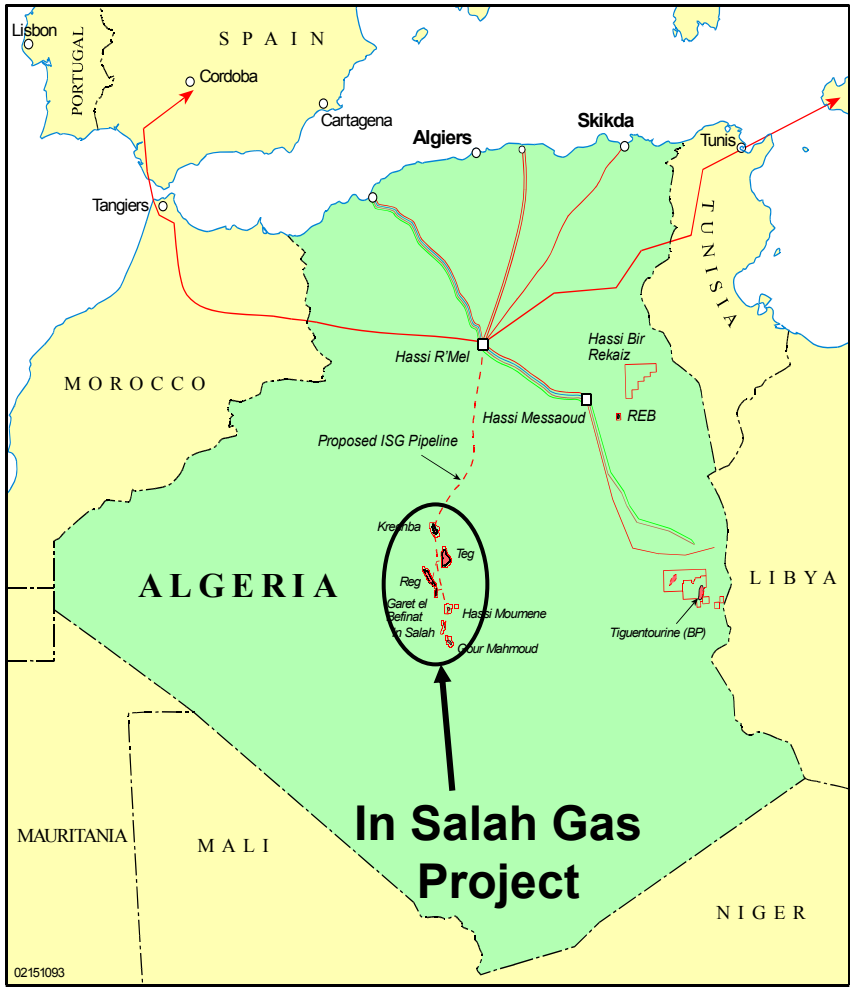
Three Projects at In Salah

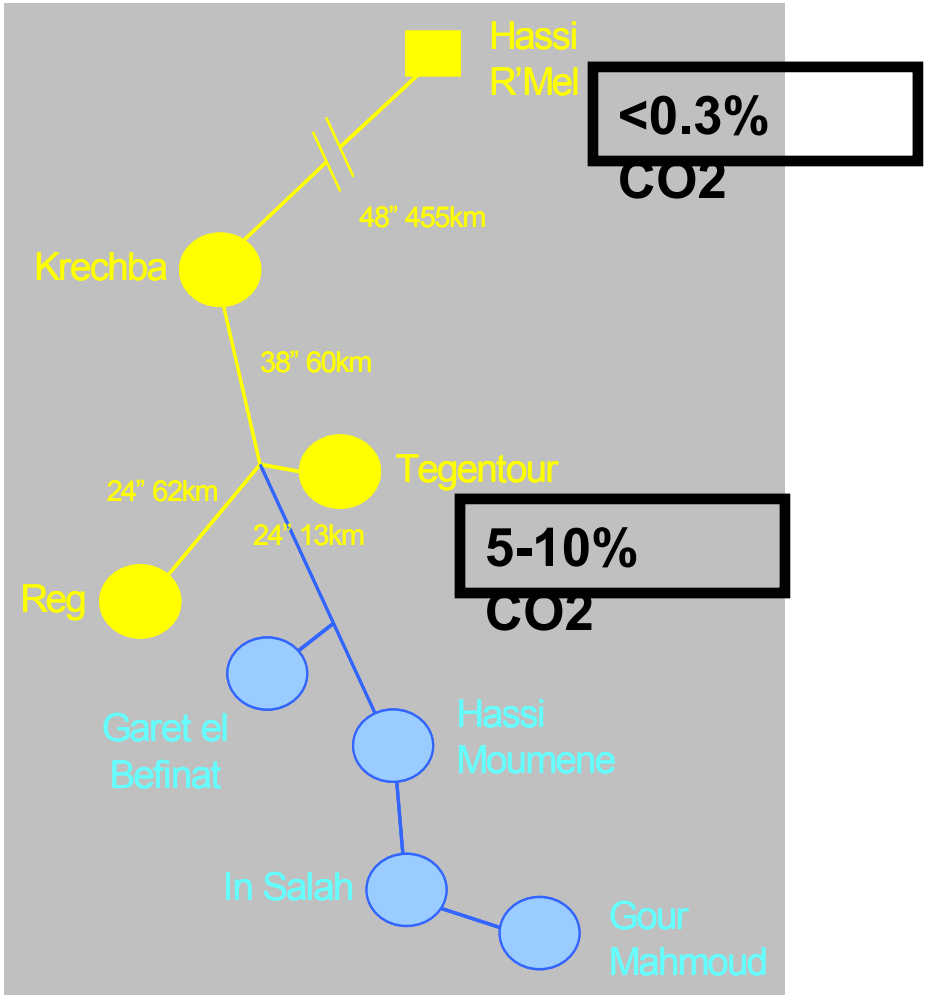
- **In Salah Project(s) Overview**
  - **In Salah Gas Development (1bcf/d $2,000 million)**
  - **In Salah CO_2 Storage (1mmtpa $ 100 million)**
  - **In Salah CO_2 Assurance R&D (CSLF $ 30 million)**

–In Salah Gas Development

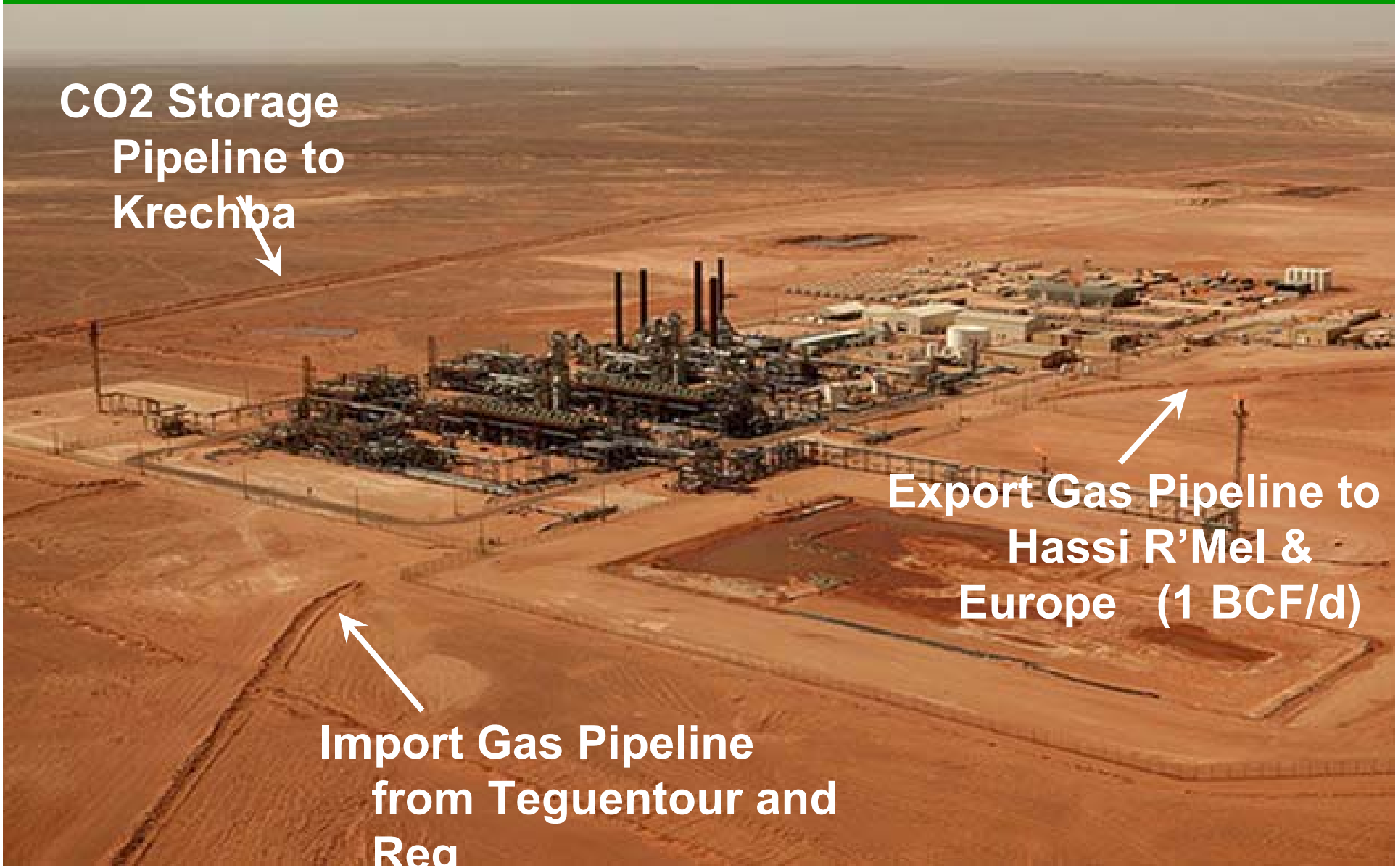
- (1bcf/d $2,000 million)

In Salah Gas Project

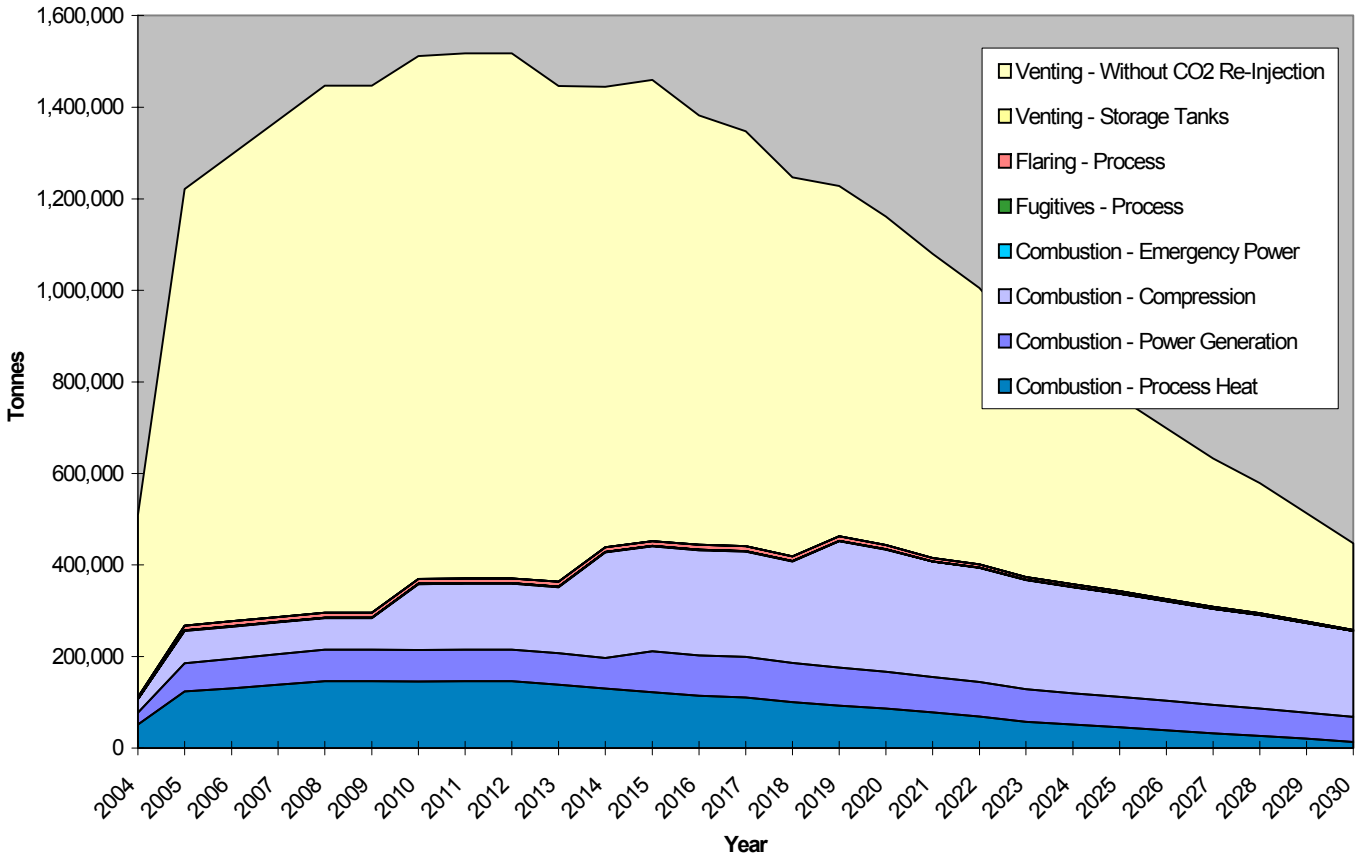




In Salah Gas Processing Plant



In Salah: 25-Year CO_2 Profile



- **Only the separated (yellow) CO2 will be stored – the combustion CO_2 (blue) will be vented**

–In Salah CO_2 Storage

- 1mmtpa $100 million

CO2 Storage Infrastructure

50mmscf/d CO2

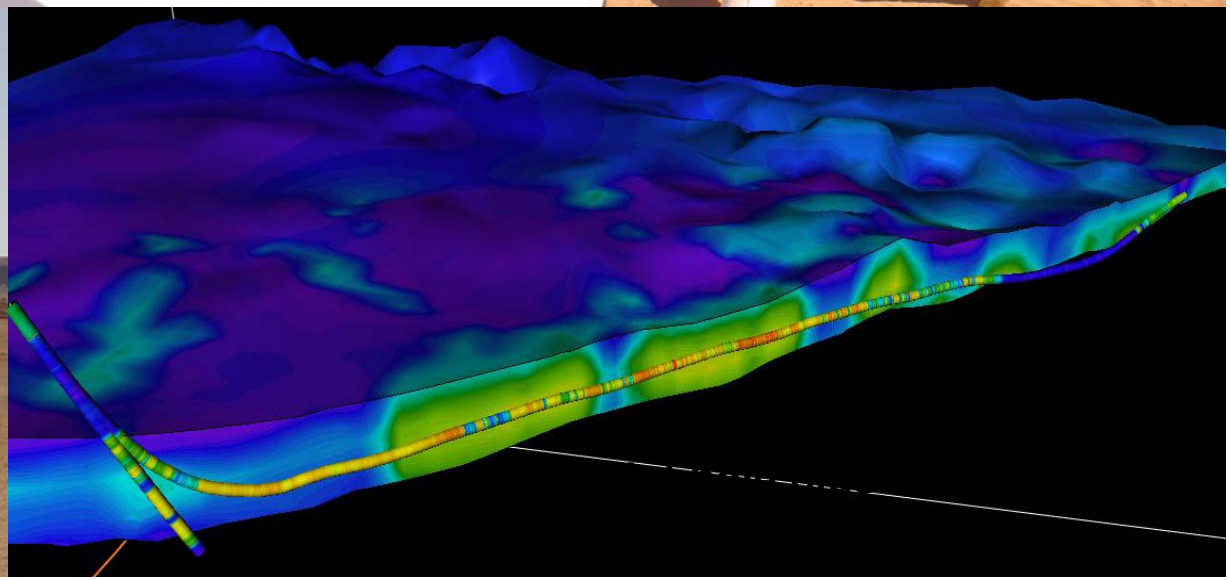
(1mmtpa)

Compression

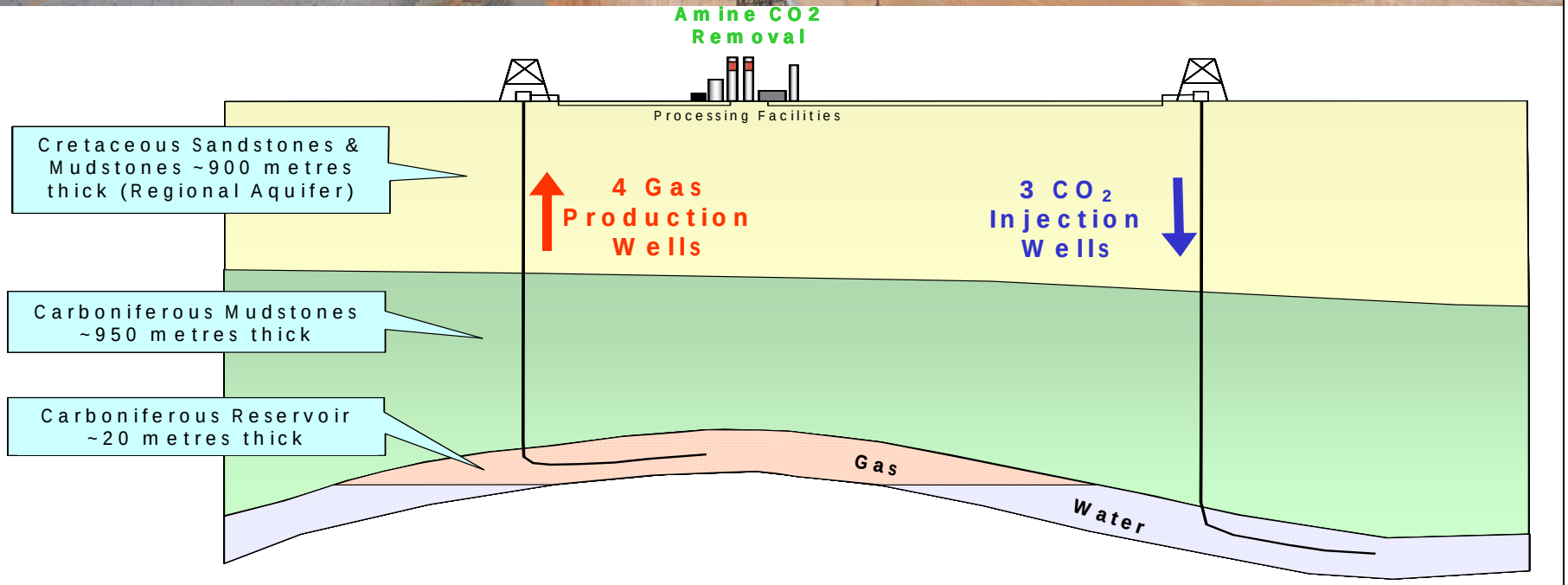
Transportation

Injection

Storage



In Salah CO_2 Storage Operation



–In Salah CO_2 Assurance

- R&D (CSLF $30 million)

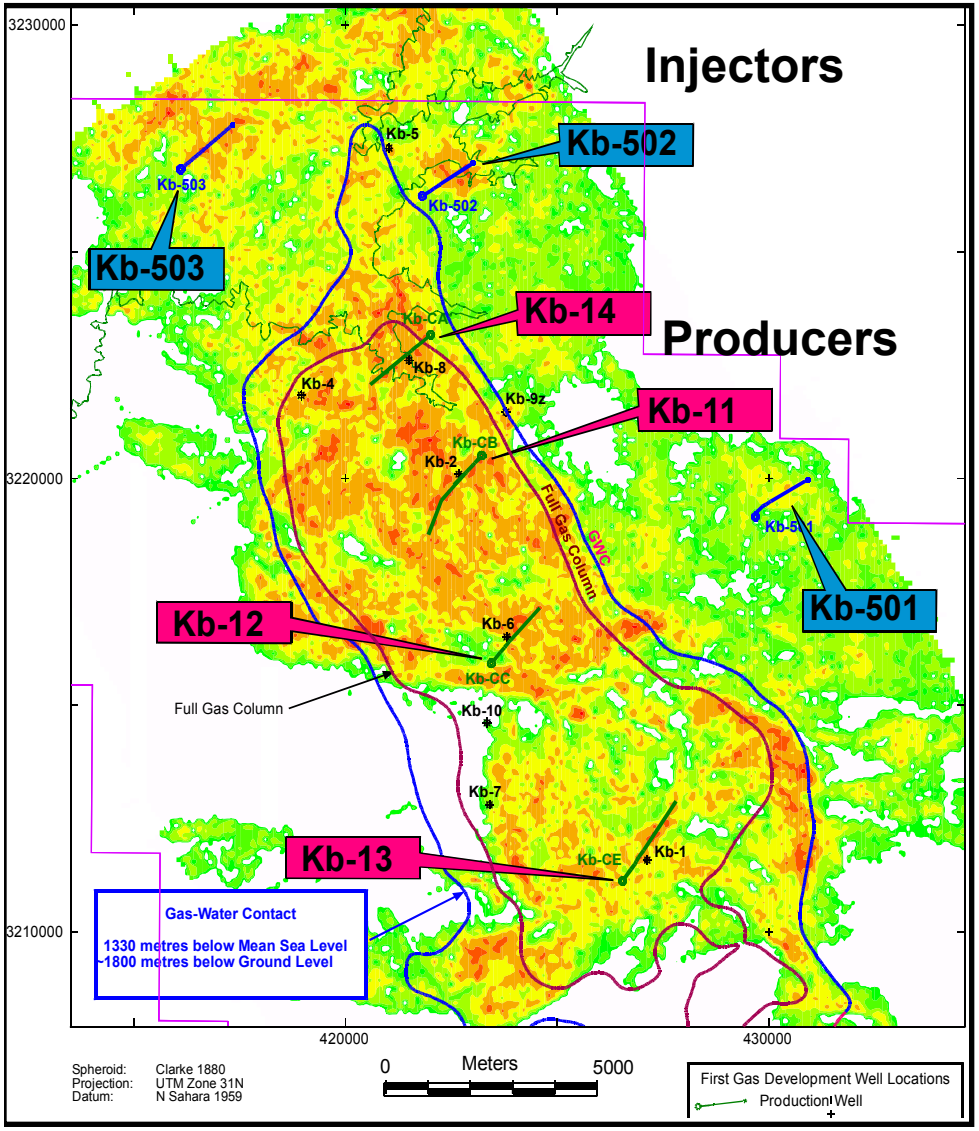
Joint Industry R&D Project

Objectives (2004-09)

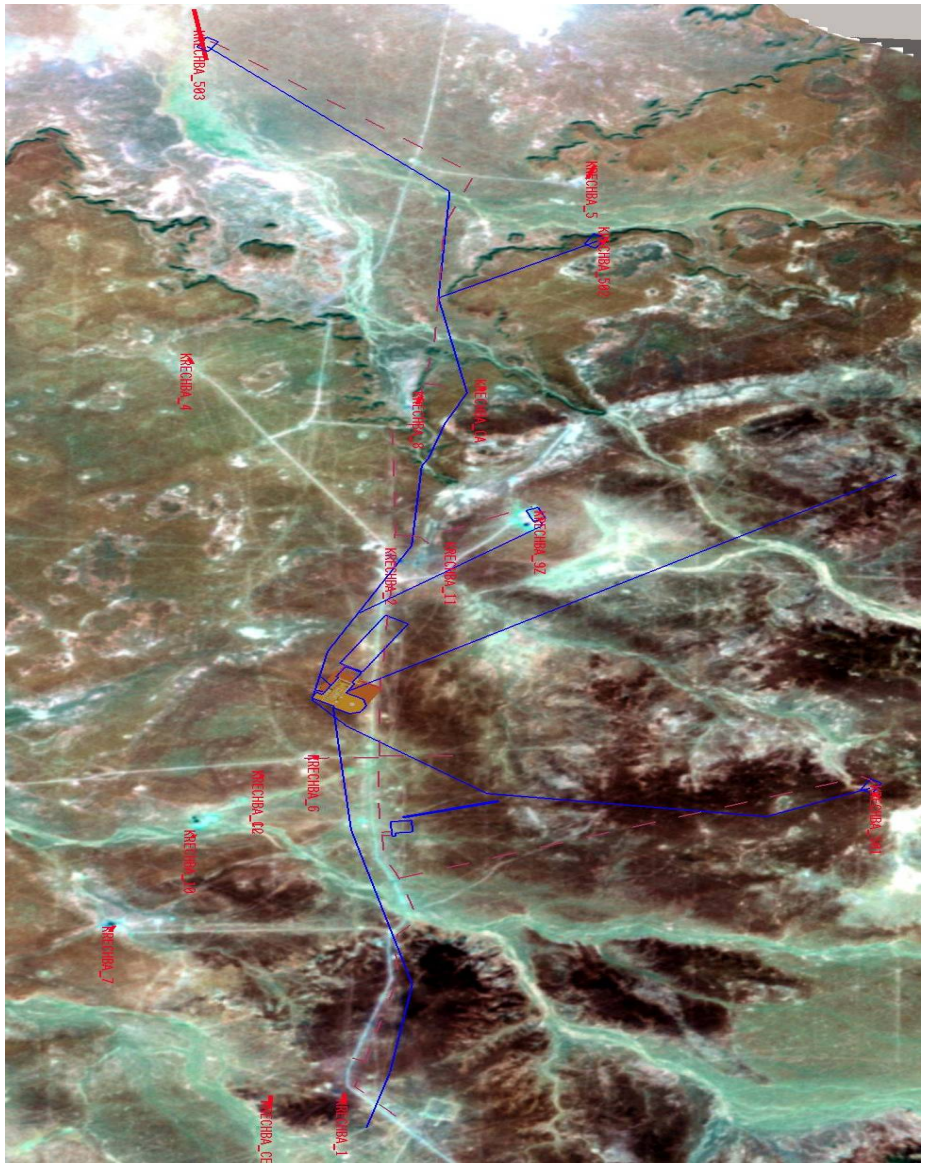
1. Provide assurance that secure geological storage of CO_2 can be cost-effectively verified and that long-term assurance can be provided by short-term monitoring.
2. Demonstrate to stakeholders that industrial-scale geological storage of CO_2 is a viable GHG mitigation option.
3. Set precedents for the regulation and verification of the geological storage of CO_2, allowing eligibility for GHG credits

Krechba Field

Reservoir



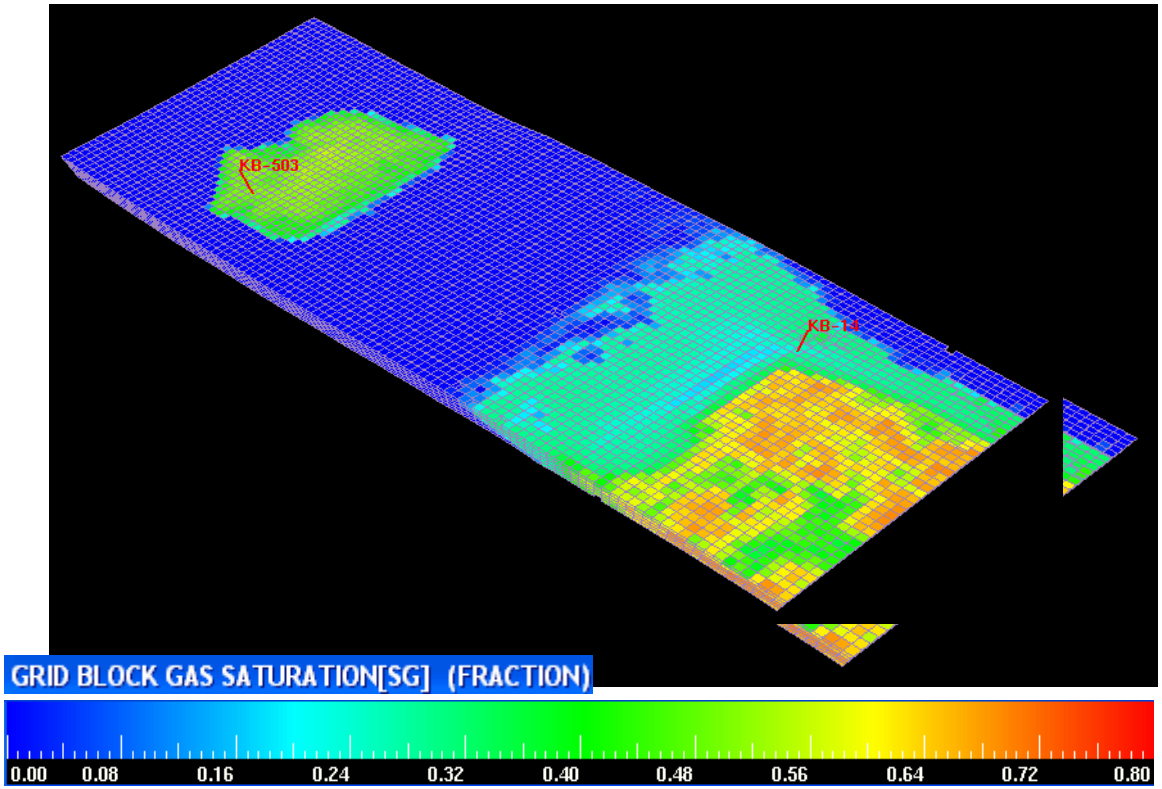
Surface



SMV Program: Status

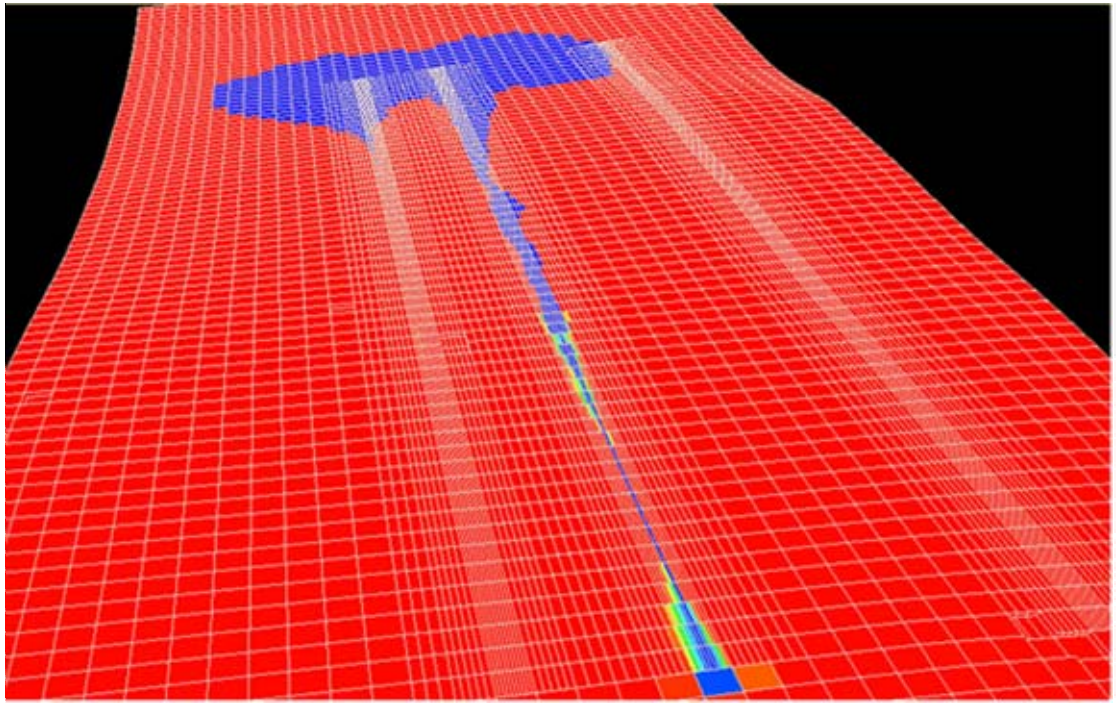
Technology		Status
4D Seismic/VSP		Programme recommended – KEY TECHNOLOGY
4D Gravity		Modelling completed – marginal response
Tracers		Due to commence 1Q2006
4D Electrical/EM		Initial modelling suggests no response
Dynamic modelling		Building new model in Eclipse
Flow meter surveys		Reviewed and Not Recommended
Wellhead CO_2 Monitoring		Sampling programme ongoing
Formation water chem.		Analyses incorporated in Shared Earth Model
Injection monitoring		Ongoing by JV
Rock-fluid/Pressure Interactions		Studies ongoing in Norway
Specialist CO_2 modelling		Part of geochemistry studies ongoing in Norway
Microseismic		Programme recommended- awaiting info on access to suspended wells

CO2 Movement Simulation (No Fractures)



2027

CO_2 Movement Simulation (Two Fractures)



2027

Kf = 20x Kf = 100x

Focus on Two Monitoring Techniques

1. Seismic
2. Soil-Gas sampling

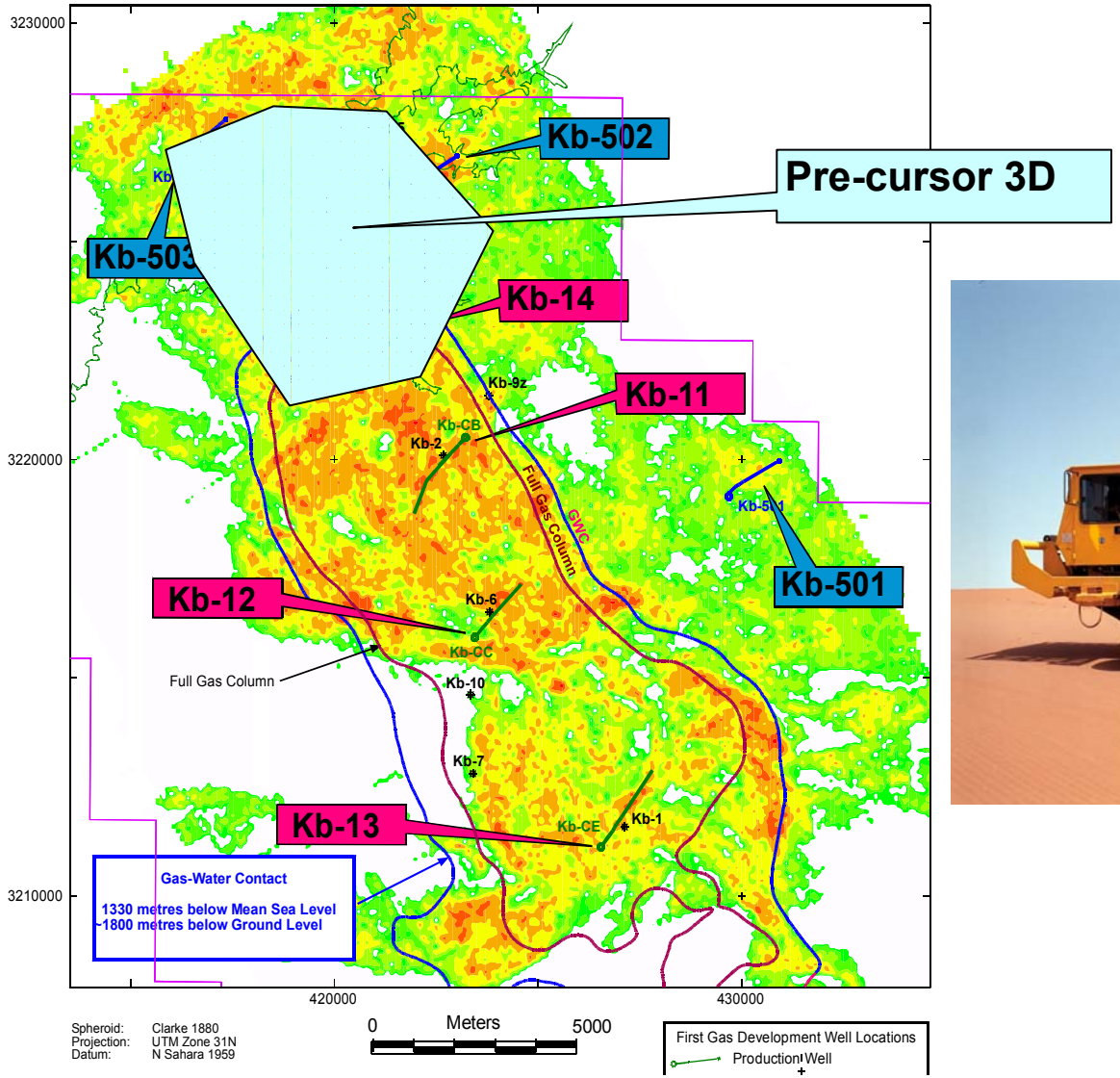
Objectives of Seismic Program

- Repeatable, high quality time lapse data
- Seismic on demand
- Framework for overall programme integration
- Overburden imaging
- Early overburden leak detection
- Equipment reliability/availability
- HSE (due to minimal mob/demob etc.)

Seismic modelling at Kb-2

- Modelling suggests low seismic response at reservoir
- Time lapse monitoring may record CO_2 movement
- Need high repeatability and accuracy of repeat measurement

Pre-Cursor Seismic Location

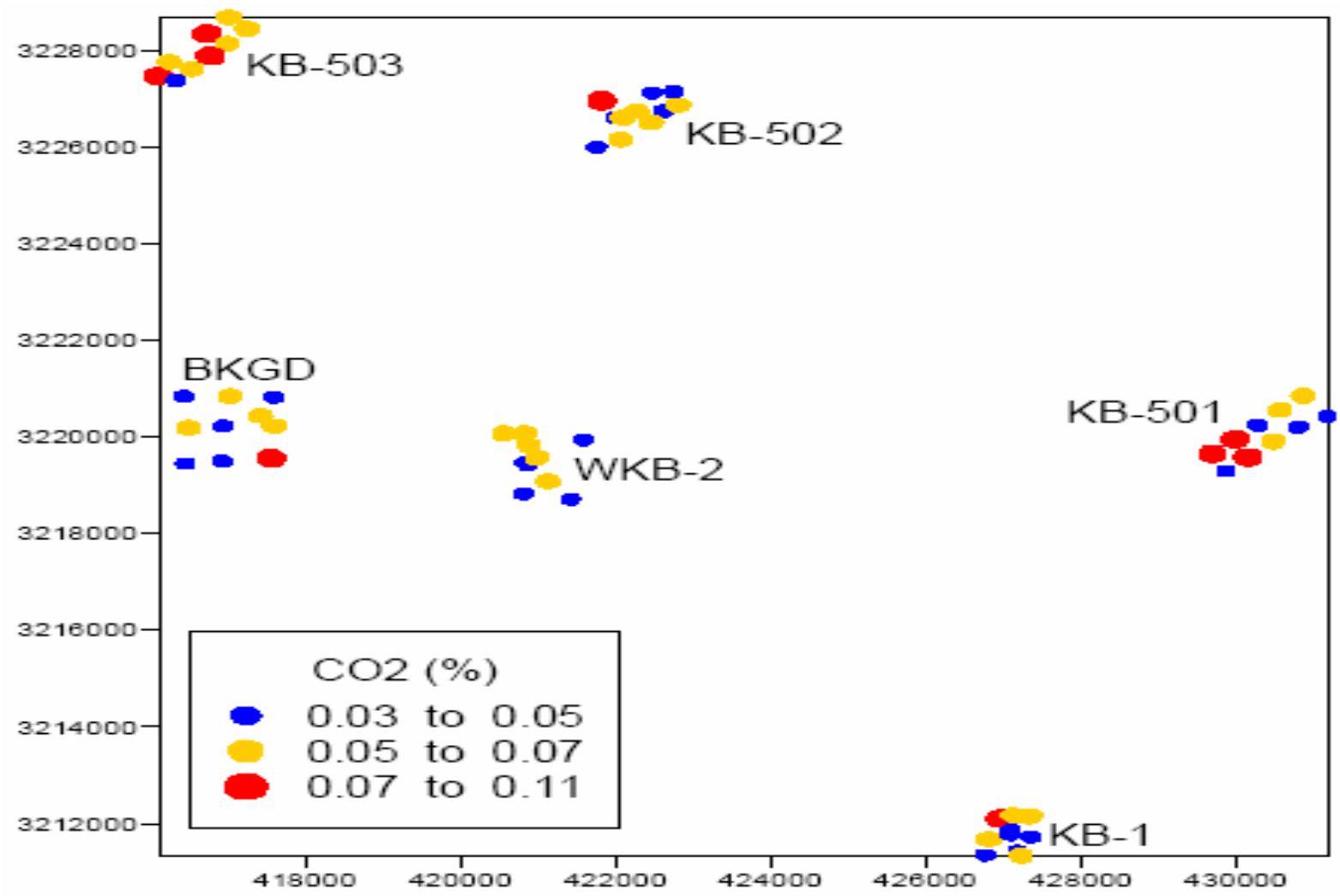


Soil Gas Sampling

2004 Baseline Survey

- Survey difficult due to hard surface conditions
- Measured concentrations of all gases very low
- CO_2 concentrations very low background
  - possibility of detecting CO_2 seepages greater
- Methane and Helium concentrations higher than anticipated
  - Migration from depth
- Gamma spectrometer traverses of field may be useful adjunct
- Surface lineaments should be identified to locate monitoring sites
- Consider continuous monitoring of gases at selected sites, including buried probes, and automatic surface monitoring stations
- Consider long path infra-red laser systems for wide area surveillance

Mapped CO_2 Concentrations: Before Injection



Forward Program: Soil-Gas Sampling

Phase 1 : Appraisal and Sampling Array Design

- Lineament Analysis
- Gamma Spectrometer Survey
- Surface Geological Appraisal
- Surface Flux Measurements
- Assessment of sampling depths

Phase 2 : Installation of Sampling Array/ Initial Sampling

- Shallow Boreholes
- Gas Flux Measurements

Phase 3: Repeat/Continuous Monitoring

Phase 4?: Optional monitoring

- Different gases
- Buried probes measuring radon
- Infra-red lasers

In Salah CO_2 Summary

- Industrial Scale Demonstration of CO_2 Geological Storage (Conventional Capture)
- Excellent Analog for US Mid-West
- Started Storage in August 2004
- 1mmtpa CO_2 Stored (17mm tonnes total)
- $100mm Incremental Cost for Storage
  - No commercial benefit
- Test-bed for CO_2 Monitoring Technologies
  - $30mm Research Project