In Salah Gas

Carbon Dioxide Storage Assurance Project:

Report on Year 1

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Agenda

- What/Where is In Salah Gas ?
- The CO_2 Geological Storage Project
- Gas Production and CO_2 Injection History
- Storage Assurance Project
- Funding
- Forward Plan

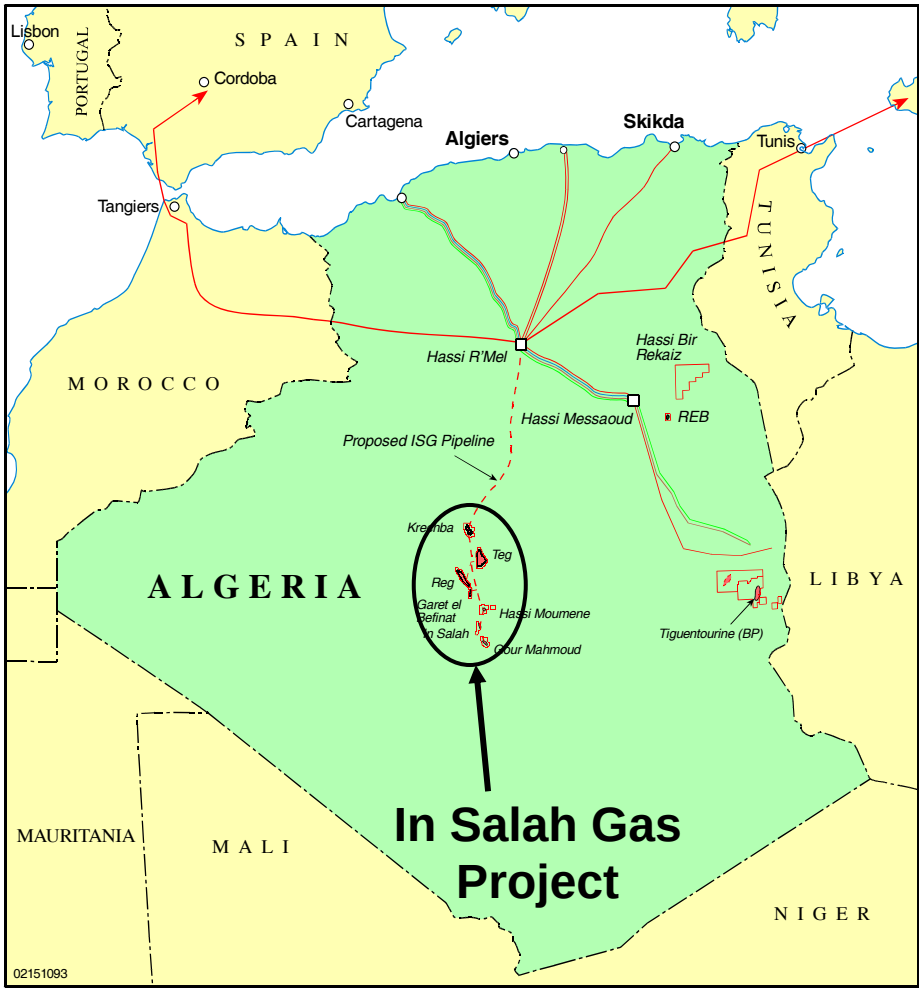
What is In Salah Gas ?

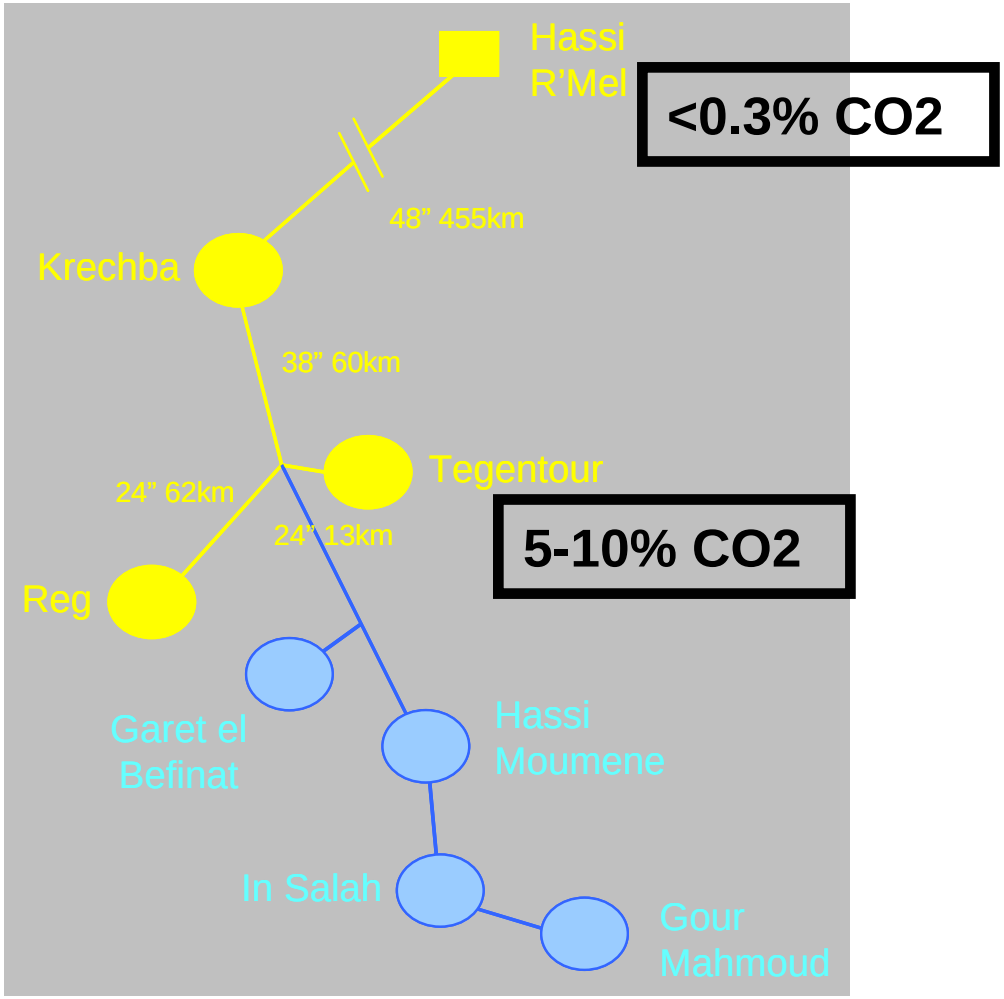
- **Industrial-Scale CO_2 Storage Project**
  - **1 million tonnes CO_2/year (separated from natural gas)**

    = Small power plant

    = 200,000 cars off the road
- **Started up August 2004 (problem with one compressor)**
- **Injection into the water leg of a producing gas reservoir**
- **60ft thick, 20mD permeability, Carboniferous Sandstone**
- **Looks like formations found in the Illinois basin**
- **Significant new storage assurance dataset**
- **Opportunity to demonstrate new technology**

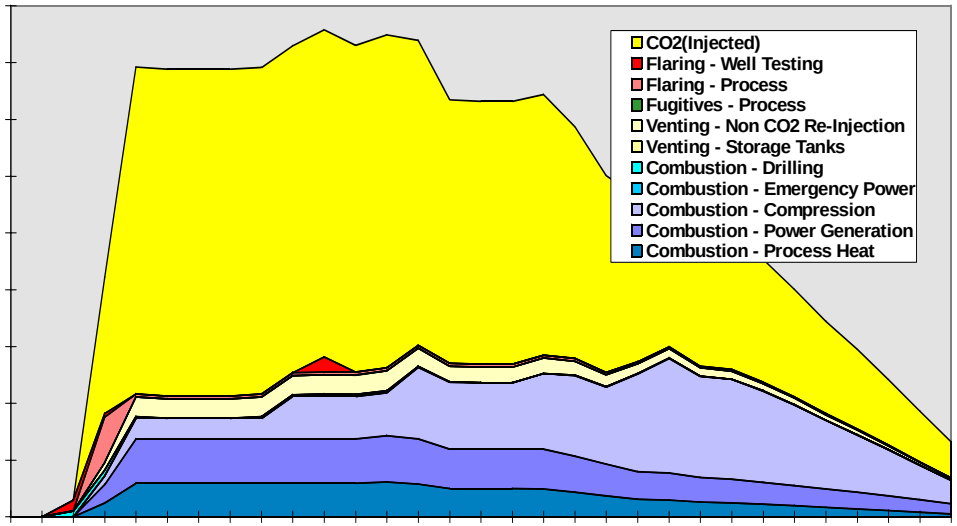
Project Location





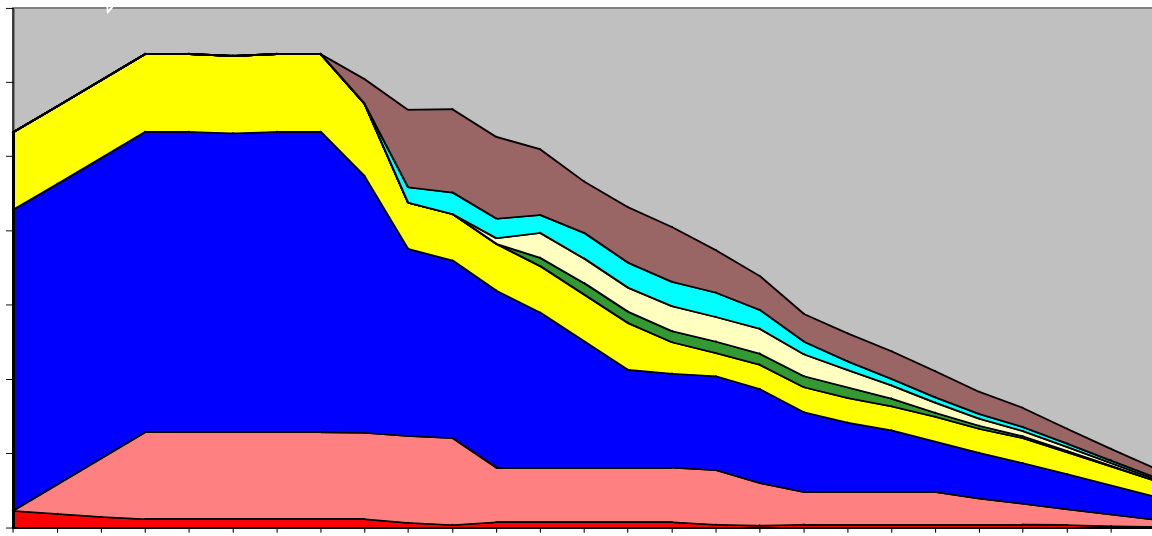
Carbon Dioxide Profiles

CO2 Emissions by Source

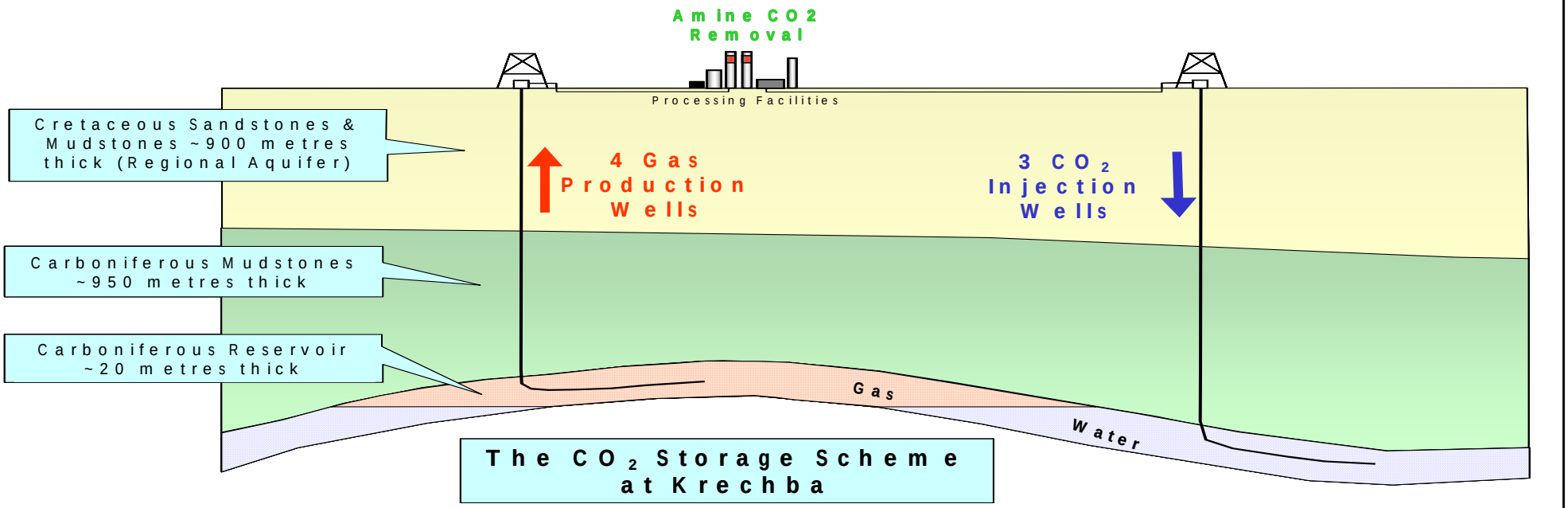


- **Only the separated (yellow) CO2 will be re-injected ~50 mmscf/d (1mmtpa)**
- **CO2 from combustion sources will be vented**

Geologically stored CO2 comes from several sources



CO_2 Storage at Krechba



Science Advisory Board

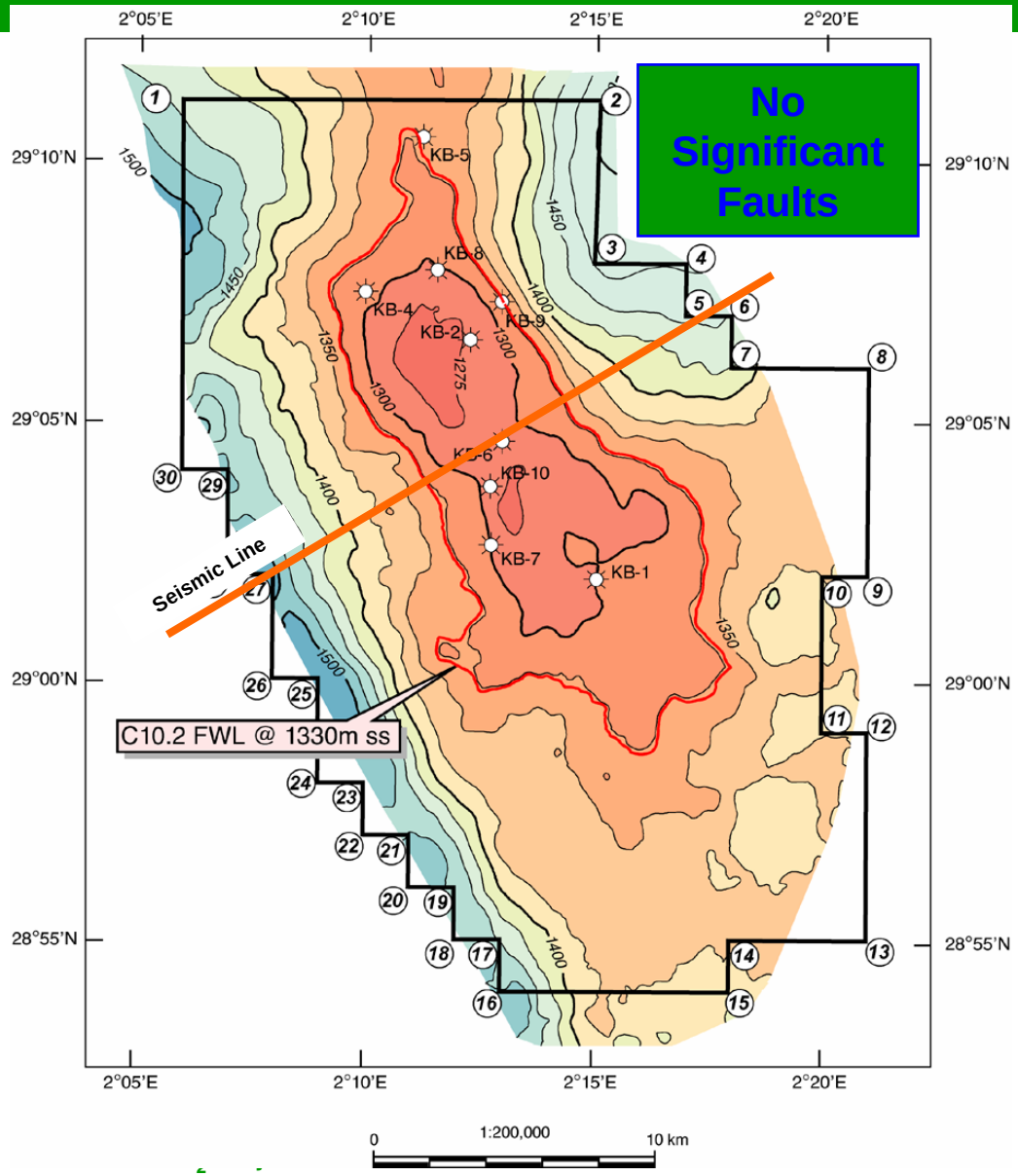
April 21st 2005

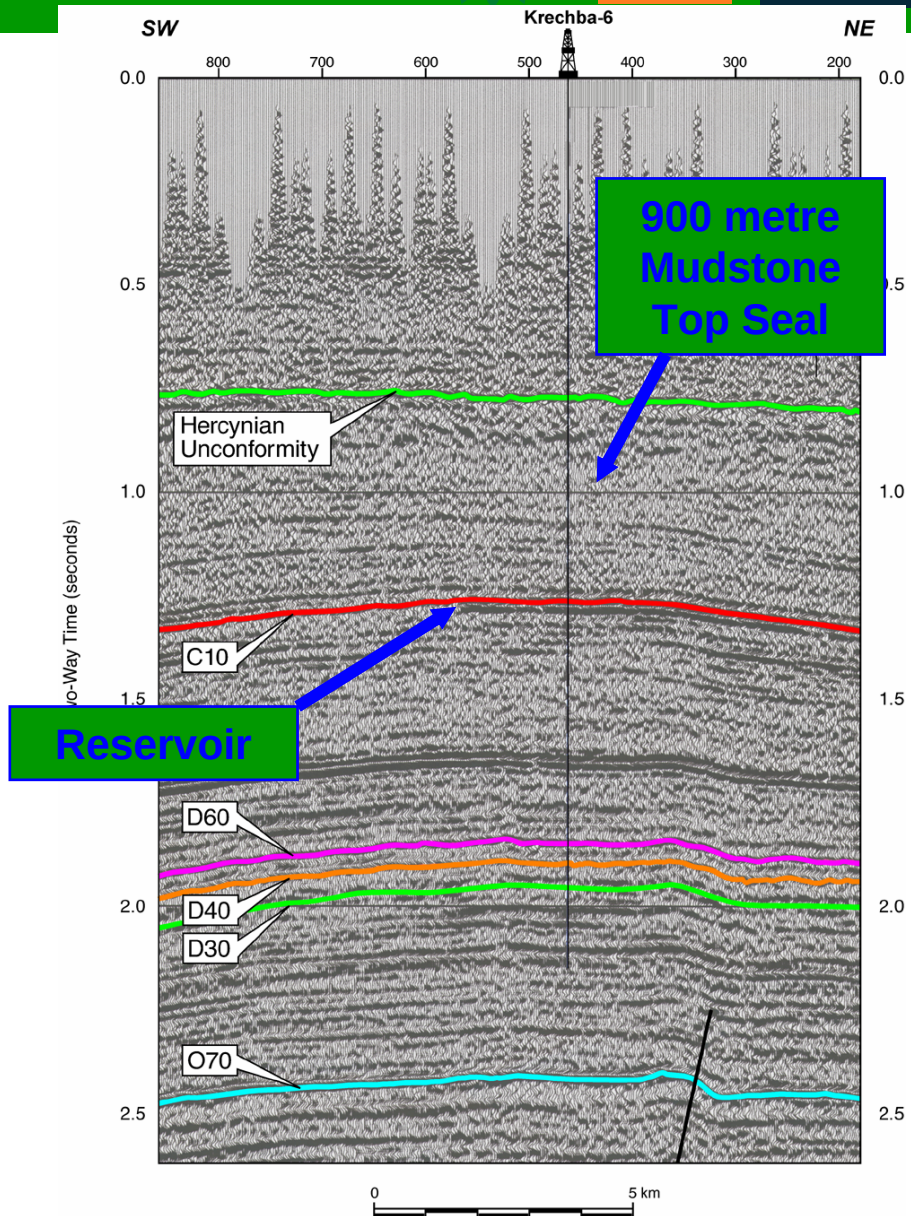
CO_2 Compressor

KB502 Injection Well

Topography Around Injectors

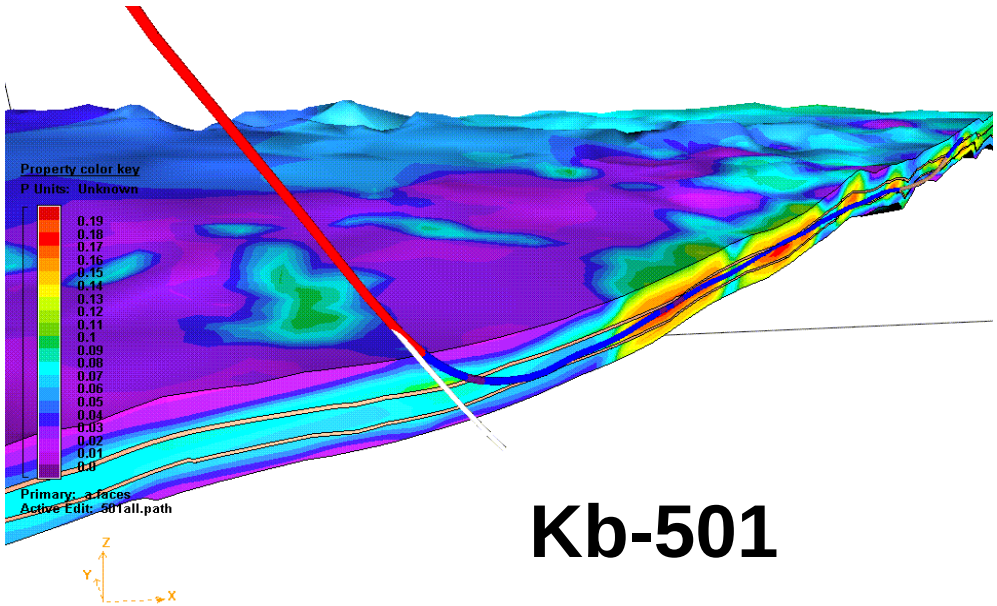
Carboniferous Reservoir

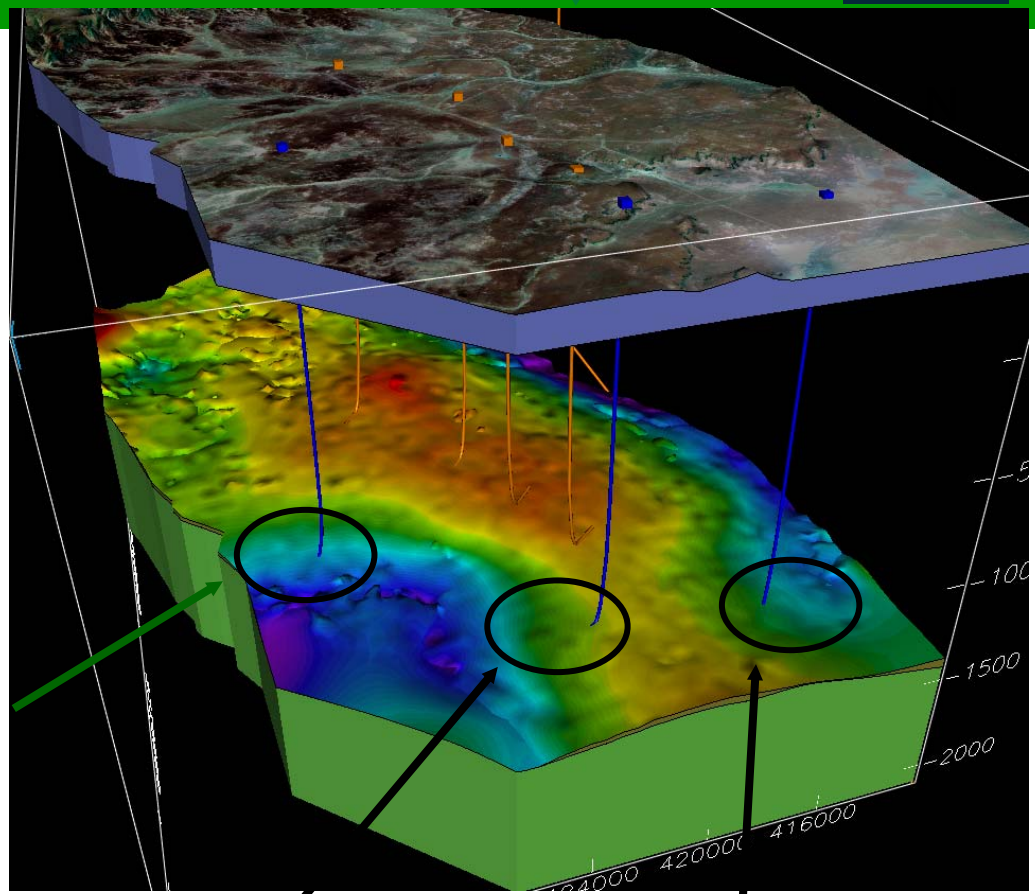




Drilling CO_2 Injection Wells

- Geosteering of wells to target high porosity / permeability intervals
- Well tests to assess injectivity





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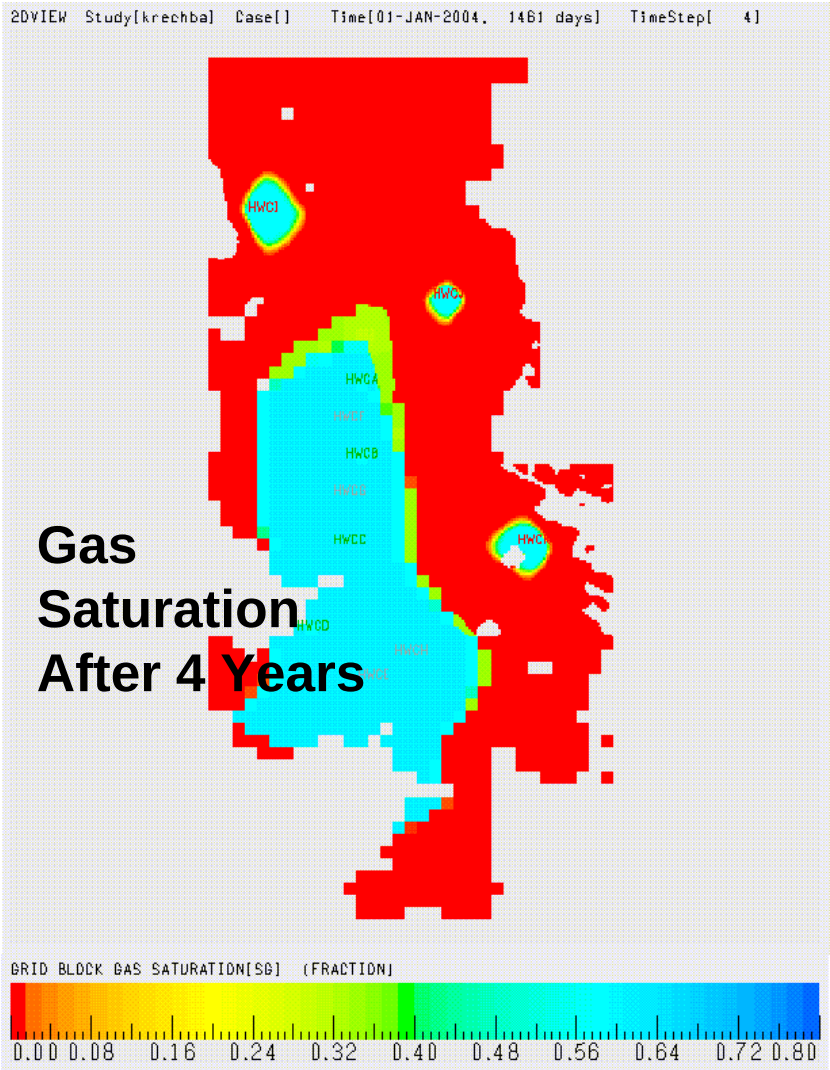
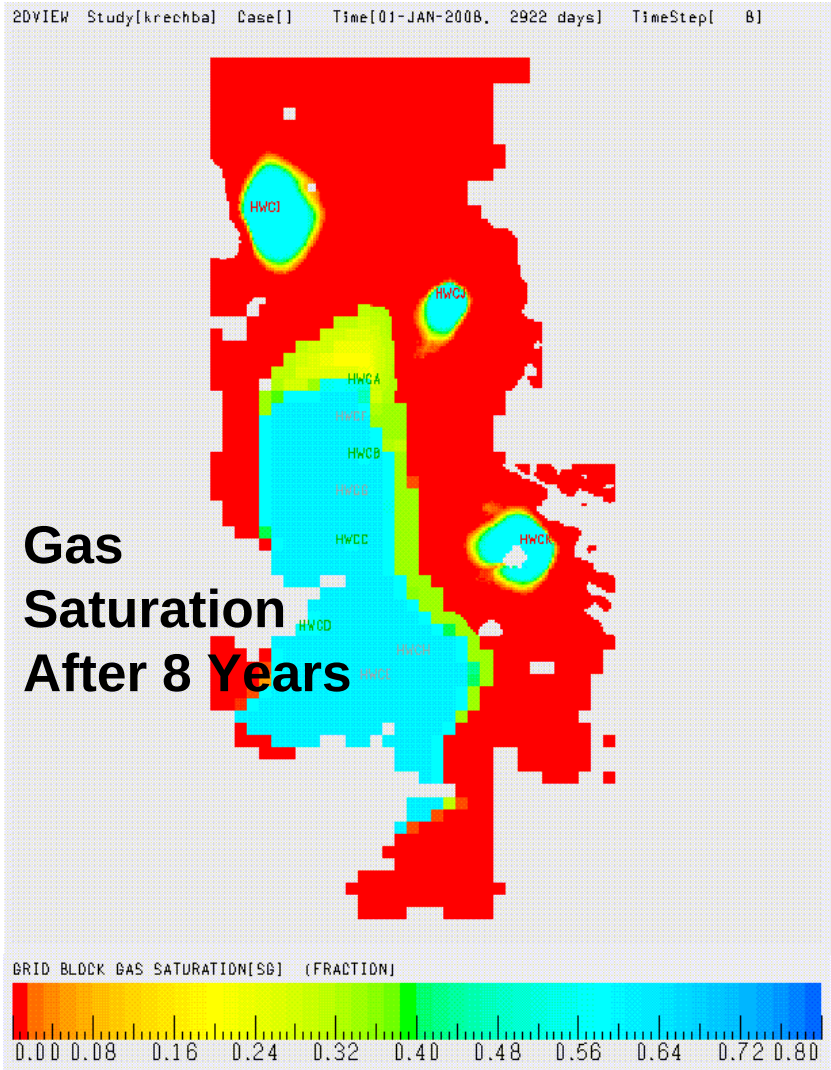
Simulated CO_2 Injection





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

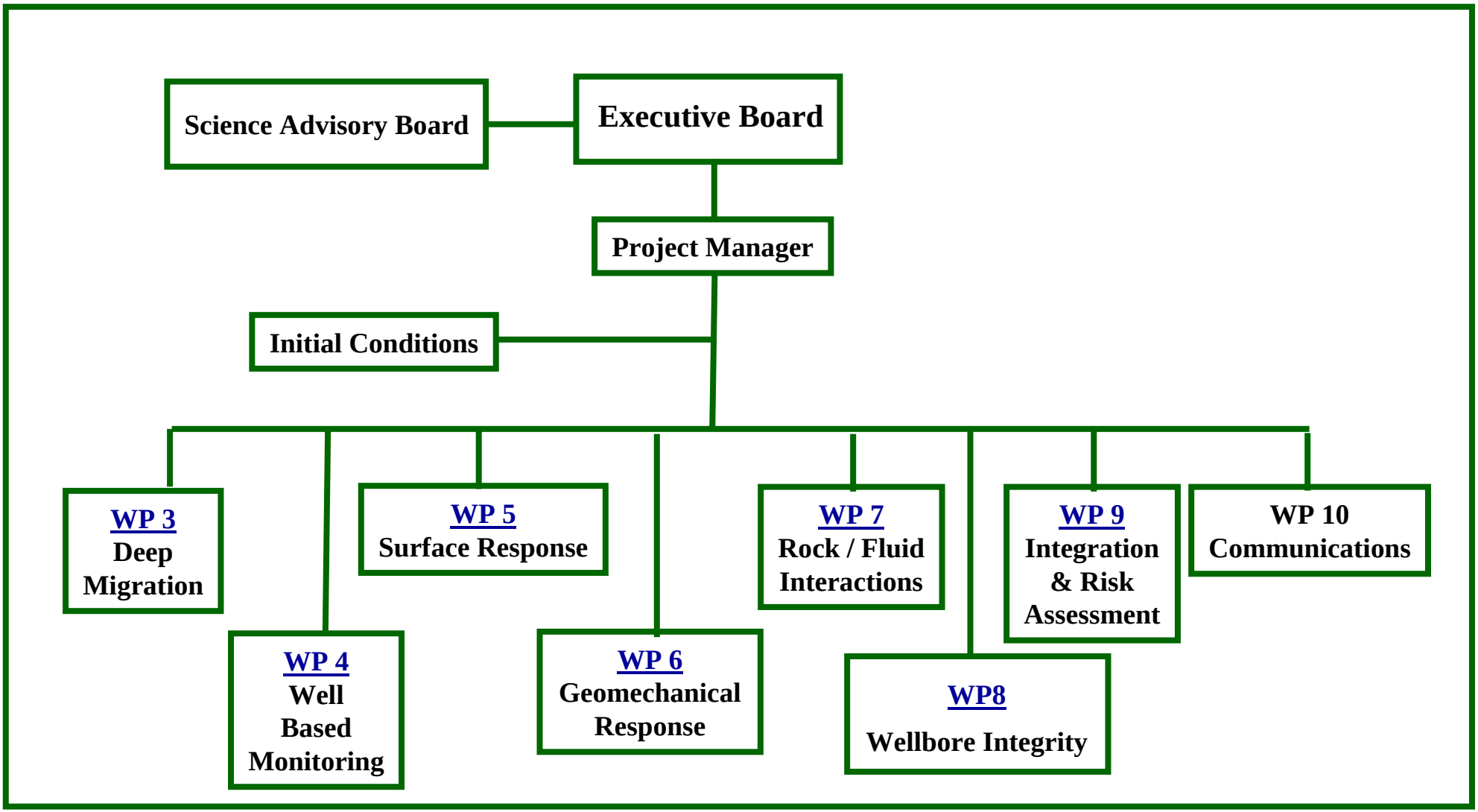
Technical Challenges

- **Storage duration**
- **Processes**
  - **Migration**
  - **Geochemical**
  - **Geo-mechanical**
  - **Well-bore**
- **Impacts and effects of leakage**
  - **Where, how much, flux ?**
- **Monitoring and mitigation**

Monitoring Objectives

- **Optimisation of hydrocarbon production**
- **Understanding CO_2 storage performance**
  - **Integrated system efficiency**
  - **Dataset for validation of long-term storage performance prediction methods**
- **Identify appropriate options for long term monitoring**
- **Demonstrate ability to identify unexpected behaviour**

Project Organization



Initial JIP Technical Program

- Sample analysis of water, gas and solids.
- Noble gas tracers will be injected with the CO_2
- Pressure surveys, surface and down-hole (static and interference)
- Electric logs (production, SP and tomography)
- Gravity baseline, soil-gas survey, micro-seismic and tilt-meters
- Meteorology and microbiology
- 4D Seismic
- Aquifer monitoring well with oriented cap-rock core and cuttings analysis
- Down-hole gravity and geo-mechanical monitoring
- Surface eddy flux co-variance data

Funding: Performance Prediction

Requirement : Performance Prediction	Cost $000	Existing	JIP Partners	EU	Yet To Be Funded	Summary
System Characterisation						
3D Seismic	5000	5000				**11,050**
Well logs	5000	5000				
Core - reservoir	500	500				
Core - caprock	250	250				
Fluids analysis	300	300				
Performance Prediction & Risk Analysis	5000		4000	1000		**5,000**
Model building - semi regional						
Model building - system volume						
Storage performance prediction						
Risk analysis						

Key

- Field Operations Practices
- CO2ReMoVe Project
- Existing data

Funding: Migration of CO_2

Risk : Migration of CO_2 Out of Injection Interval	Cost $000	Existing	JIP Partners	EU	Yet To Be Funded	Summary
Fluid Migration : subsurface						17,750
4D seismic	10,000		5000	2500	2500	
4D Gravity	1000		500	120	380	
4D Electrical/other	500		250	120	130	
Tracers	250		125	110	15	
Observation well(s) - deep	5000		2500		2500	
Observation well(s) - shallow	1000		500		500	
Fluid Migration : shallow/ surface						
Soil gas monitoring	400		150	250		1,200
Surface monitoring - EFC, laser etc	500		250		250	
Meteorology	200		100		100	
Microbiology	100		25	75		

Key

- Field Operations Practices
- CO2ReMoVe Project
- Existing data

Funding: Seal & Wellbore

Risk : Breach of Seal	Cost $000	Existing	JIP Partners	EU	Yet To Be Funded	Summary
Geomechanical Monitoring						1,800
Microseismic	400		150	250		
InSAR	150		75	75		
Tilt	300		200	100		
Geochemistry						
Compositional profile of produced fluids	300		150	50	100	
Rock fluid interaction tests	300		150		150	
Cement-fluid interactions	300		150		150	
Modelling - UoL PhD student	50		25		25	
Risk : Wellbore Leakage						**1,500**
Integrity						
Operational Monitoring Protocols						
Logging						
Tool qualification & novel techniques	1500		500		1000	
Risk : Environmental						
Operational targets						
Operations optimisation protocol						
External perception and acceptance						
Monitoring programme						

Key

- Field Operations Practices
- CO2ReMoVe Project
- Existing data

Funding: Other & Total

	$000	Existing	JIP Partners	EU	Yet To Be Funded	Summary
Risk : Migration of CO_2 Out of Injection Interval						
Fluid Migration : subsurface						**11,500**
Tracers & Observation wells	250		125	110	15	**6,250**
Fluid Migration : shallow / surface						**1,200**
Risk : Breach of Seal						
Geomechanical Monitoring						**850**
Geochemistry						**950**
Risk : Wellbore Leakage						**1,500**
Logging						
Requirement : Performance Prediction						
Performance Prediction & Risk Analysis	5000		4000	1000		**5,000**
Sub-total - technical	27250		14800	4650	7800	**27,250**
Project management (10%)	2725		2725			**2,725**
Communications	500		500			**500**
Total	**30475**	**11050**	**18025**	**4650**	**7800**	**30,475**

Key

- CO2ReMoVe Project
- Existing data

Summary

- A major new Industrial Storage project is operating
- Opportunities to demonstrate new MMV technologies
  - $30mm program envisaged
  - 50% funding from Industrial Partners
- Great analog for US locations
- Integration with EU's CO_2 ReMoVe project
  - $4mm funding ?
- Proposed for CSLF approval
- Open to new ideas and technologies

Questions ?