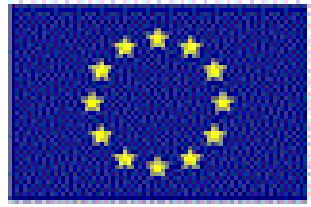


CO_2 Next Generation Capture And Storage

Project Summary Q3 2003 – Mike Saunders (BP)

Participants + Deliverables

BP: Coordination, financial, reporting, & technical oversight /participation

*ongoing; successful EU Technical Audit 2003.

STATOIL: Self-funded participant.

ECLT (AEAT): CO_2 storage in Forties reservoir & Risk Assessment (RA) study. *reservoir simulation study completed, RA study in progress.

IFP + GEUS: Basin Modelling to determine long term changes, if any, to safe storage of CO_2 in the reservoir, due to reservoir & basin changes/deformations.

*extensive geologic & seismic data collected & interpreted. Basin modelling underway.

BGS: Study of CO_2 storage potential of the Midland Valley (Scotland) & offshore in the Forth Approaches. Two interpreted regional seismic lines from the Forties area to the Scottish coast.

*studies completed, report in draft

IEA-GHG + CIEMAT + FZJ: Workshops for project technology transfer & publication of the EU-funded Clean Coal Technology Newsletter (CCTN).

- Newsletter #16 published, Two public workshops being organized for 2004.

Project Coordination - BP

- **Project Coordinator**

June 2003 – Present: **Mike Saunders**, EPT – DP/NW Sunbury
*March 2002-May 2003: **Demetrios V. Yannimaras**, UTG-RE-Sunbury CP,*
*October 2001-March 2003**: Tony Espie**, EPT-Sunbury*

- **Contracts & Legal**

June 2003 – Present: **Sheetal Handa**, Patents & Agreements, Sunbury
*2001-June 2003: **John Hargrove**, Patents & Agreements, Sunbury*

- **Finance**

June 2003 – Present: **Yehan Jayasena**, Business Analyst, EPT-Sunbury
*2001-June 2003: **Graham C. Perry**, Business Analyst, UTG-Sunbury*

- **Advisory**

Stephen J. Cawley, Petroleum Systems, Aberdeen, Basin Modelling
Steve M. Hall, HSE-Sunbury

Timeline: EU + CCP

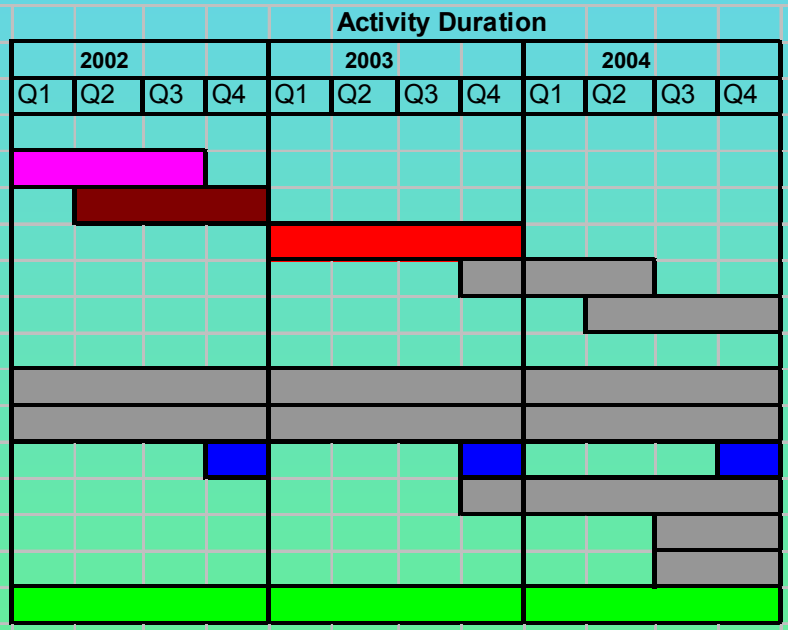
- **NGCAS-EU** is a **3 yr**. project ending in **Oct. 2004**

- **CCP** funding ends 12/2003, thus some NGCAS deliverables need to accomodate that deadline.

  - For CCP purposes, TPs need to compress program to 2-yrs, upping work and funds uptake.

  - Participants indicated that they can accommodate accelerated schedule, but some reporting and technology transfer will unavoidably be left for early 2004 (EU Funded).

Original NGCAS TimeLine



Deliverable from activity

GEOLOGICAL STORAGE TECHNOLOGY

1.1 Methodology for Optimizing storage Volume

1.2 Comparison of storage options

1.3 Risk assessment for long term geological storage

1.4 Options for mitigation of Carbon dioxide leakage

1.5 Report on Costs and Issues

TECHNOLOGY TRANSFER AND PROJECT MANAGEMENT

2.1 Quarterly and Annual Progress Reports

2.2 Technical Progress reports

2.3 Technology Transfer Workshops

2.4 Final Technical Reports and Monographs

2.5 Commercialization Strategy

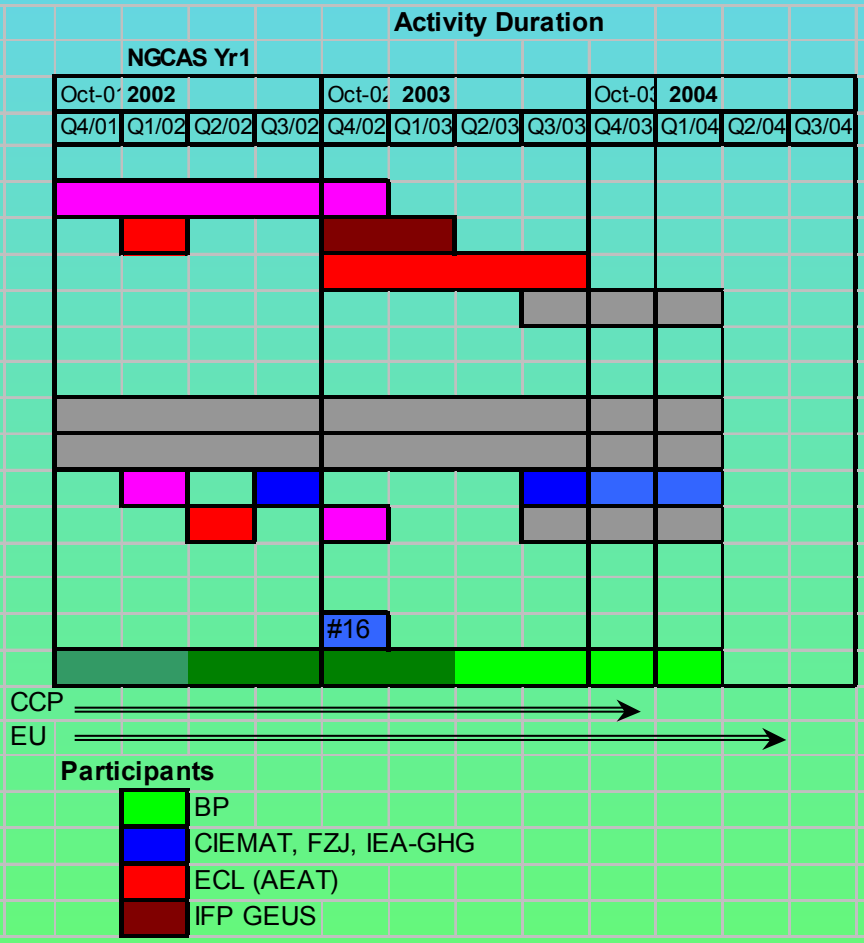
2.6 Socio-economic benefits statement

Project Coordination

Participants

- BP
- CIEMAT, FZJ, IEA-GHG
- ECL (AEAT)
- IFP GEUS
- ALL

Revised NGCAS TimeLine



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TECHNOLOGY TRANSFER AND PROJECT MANAGEMENT

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CCP Newsletters

Project Coordination

NGCAS Progress

2003

10/03 – Technical Assurance Process **meeting** (Paris)
09/03 – BGS Report published to participants
09/03 – IFP abstract submitted for presentation to ACS (American Chemical Society) in September
07/03 - Semi-Annual **meeting**(Paris)
06/03 – Technical Assurance Process **meeting** (Paris)
01/03 – **Financial submission** to EU for 2001-2002

2002

12/02 – development of BP document **website**
11/02 **-** Submitted first 6-mo. report to EU, distributed first EU payment.
09/02 - **Report**: ECL Reservoir Simulation Modelling of CO2 WAG injection.
09/02 – semi-annual **meeting**
06/02 – Basin Modelling **meeting** Aberdeen U.K.
05/02 - Risk Assessment **Workshop** at BGS Keyworth U.K.
05/02 – Establishment of "Quickplace" internet document **website**
02/02 - Technical **Meeting** Feb. 2002 in Sunbury, UK

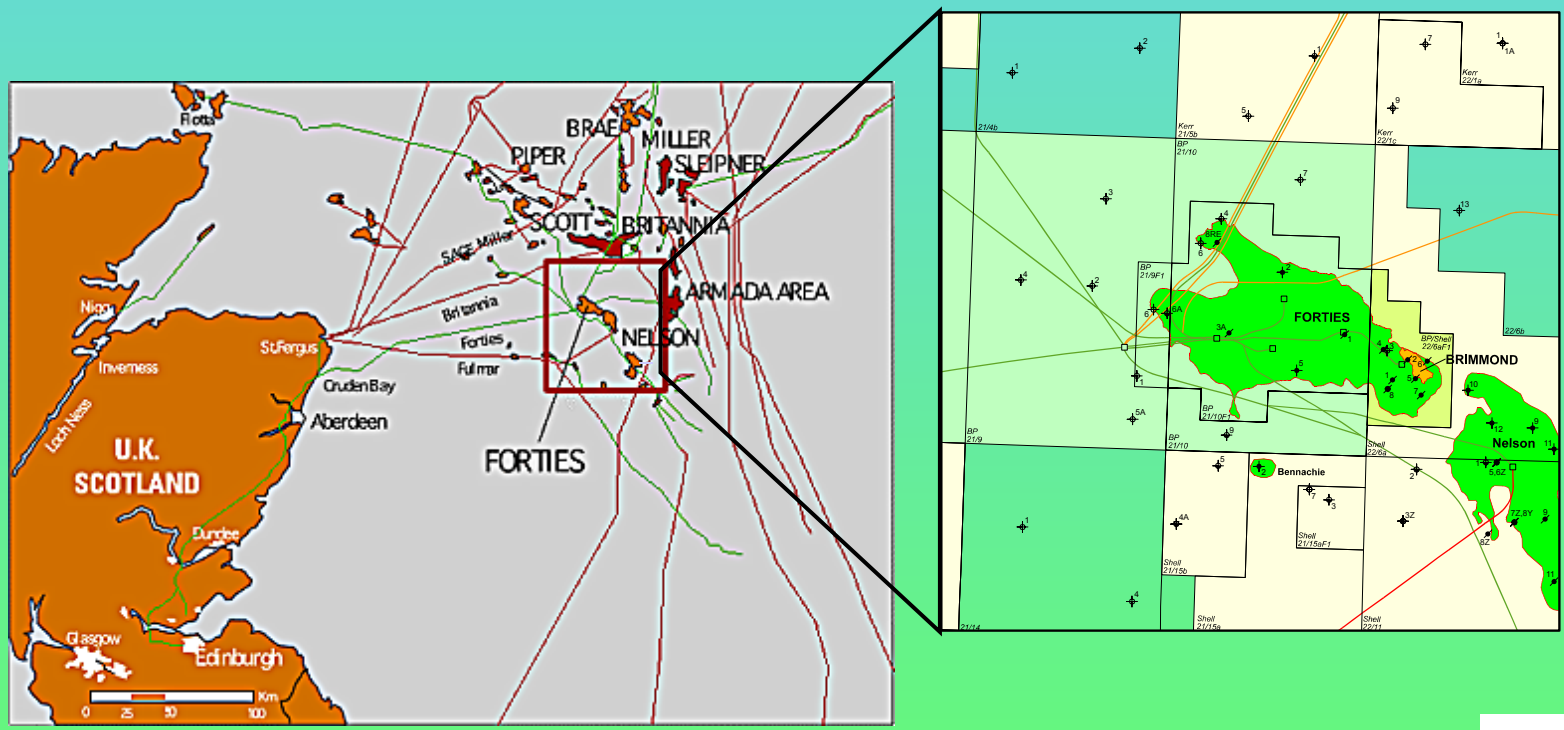
2001

10/01 - Initial **Meeting** in Oct. 2001

IFP+BGS+GEUS - Introduction

Role of IFP (institute Francais du Petrole) **BGS** (British Geological Survey) and **GEUS** (Geological Survey of Denmark and Greenland):

To create a numerical model able to simulate the long term **(1000 years)** environmental impact of stored CO_2 at basin and reservoir scales and test leakage scenarios.



Target area: Forties Field, North Sea

(note that Forties is now the property of Apache Corp)

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

GEUS

ECL (formerly AEAT)
WAG Study

Scope:

1 - numerical simulation of represent a sector of the Forties Charlie sand. Initially waterflooded and then subjected to WAG (Water Alternating CO_2 Gas). Simulated various effects including different WAG strategies, timing of initiation of postflush gas injection, well placement and well completions. The initial model contained approximately 21 MMrB of single-phase reservoir fluid oil and 5 MMrb of water.

Objective:

To investigate the optimisation of incremental oil recovery and the sequestration of CO_2.

Status:

ECL Technology has completed the modelling of CO_2 storage in the N. Sea Forties oil reservoir and the full report is available.

Conclusions : (a) increased oil recovery of 8-10% over the base waterflood case were obtained, (b) CO_2 sequestration of approx. 50 % HCPV (Hydrocarbon Pore Volume) can be achieved, (c) techniques to optimise the CO2 storage also aided oil recovery, (d) the use of WAG accelerated oil production and (e) significant fluid redistribution occurred after the reservoir was shut-in, with gas migration to the top of the reservoir and under shales.

ECL TECHNOLOGY
OIL & GAS
Formerly the Subsurface Engineering Business Unit of AEA Technology plc

CEIMAT and FZJ

The Clean Coal Technology Newsletter*

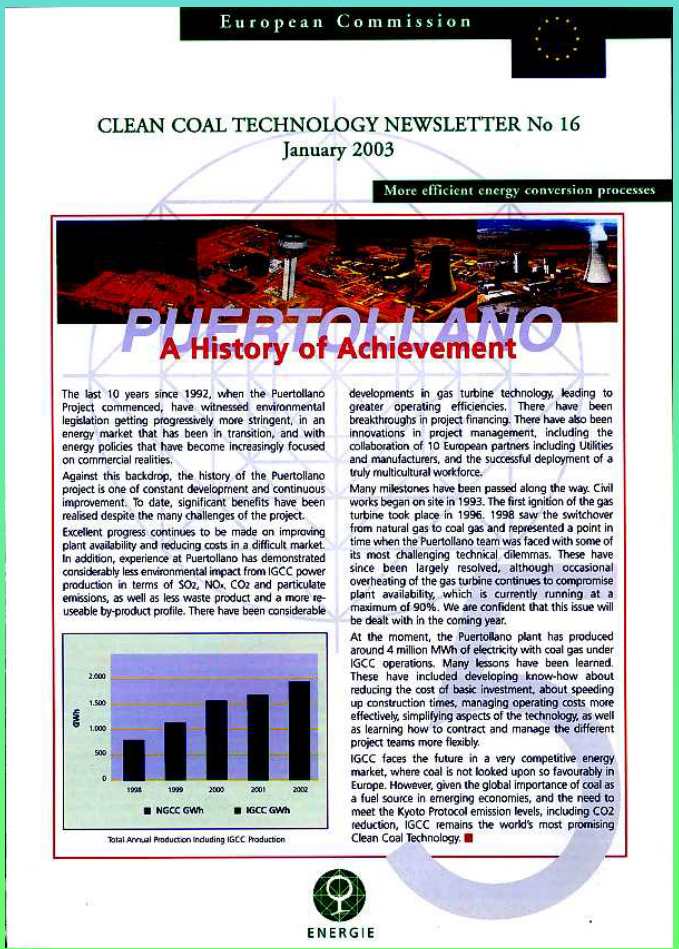
Objective:

The promotion of Clean Coal Technologies for large-scale power generation and projects results to inform to all the target audience about the state of the art of such topics. The aim of this action is also to continue with the series publication of CCT NEWSLETTER, which has been published since 1992

Status:

CCTN 16 published by CEIMAT January 2003.

CCTN 17 Work in progress at FZJ - could incorporate in more extended space the situation of NGCAS project


European Commission

CLEAN COAL TECHNOLOGY NEWSLETTER No 16
January 2003

More efficient energy conversion processes

PUERTOLLANO
A History of Achievement

The last 10 years since 1992, when the Puertollano Project commenced, have witnessed environmental legislation getting progressively more stringent, in an energy market that has been in transition, and with energy policies that have become increasingly focused on commercial realities.

Against this backdrop, the history of the Puertollano project is one of constant development and continuous improvement. To date, significant benefits have been realised despite the many challenges of the project.

Excellent progress continues to be made on improving plant availability and reducing costs in a difficult market. In addition, experience at Puertollano has demonstrated considerably less environmental impact from IGCC power production in terms of SO_2, NO_x, CO_2 and particulate emissions, as well as less waste product and a more re-useable by-product profile. There have been considerable developments in gas turbine technology, leading to greater operating efficiencies. There have been breakthroughs in project financing. There have also been innovations in project management, including the collaboration of 10 European partners including Utilities and manufacturers, and the successful deployment of a truly multicultural workforce.

Many milestones have been passed along the way. Civil works began on site in 1993. The first ignition of the gas turbine took place in 1996. 1998 saw the switchover from natural gas to coal gas and represented a point in time when the Puertollano team was faced with some of its most challenging technical dilemmas. These have since been largely resolved, although occasional overheating of the gas turbine continues to compromise plant availability, which is currently running at a maximum of 90%. We are confident that this issue will be dealt with in the coming year.

At the moment, the Puertollano plant has produced around 4 million MWh of electricity with coal gas under IGCC operations. Many lessons have been learned. These have included developing know-how about reducing the cost of basic investment, about speeding up construction times, managing operating costs more effectively, simplifying aspects of the technology, as well as learning how to contract and manage the different project teams more flexibly.

IGCC faces the future in a very competitive energy market, where coal is not looked upon so favourably in Europe. However, given the global importance of coal as a fuel source in emerging economies, and the need to meet the Kyoto Protocol emission levels, including CO_2 reduction, IGCC remains the world's most promising Clean Coal Technology. ■

Total Annual Production including IGCC Production

ENERGIE

Ciemat

Forschungszentrum Jülich
in der Helmholtz-Gemeinschaft

*the original source of EU funding for NGCAS

British Geological Survey (BGS)

Investigating Non-Forties Storage Options (1)

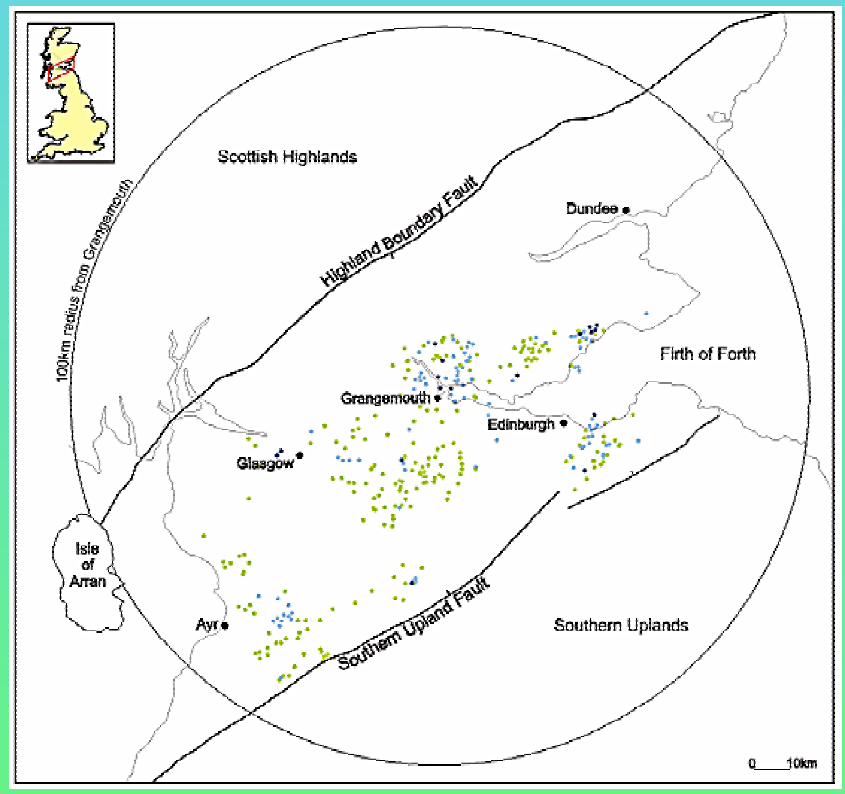
Objective:

BGS's main objectives will be complete with delivery of the final report on the potential to sequester CO_2 in the Midland Valley of Scotland.
The report looks at storage in aquifers, reservoirs and coal seams.

Scope:

1- examine geological storage alternatives to sequestering CO_2 from Grangemouth into the Forties field.

2 - Examine CO_2 geo-storage potential in the Midland Valley of Scotland and an in offshore east coast of Scotland between 55° 50' N, 57° 20' N, Zechstein limit at approximately 2° 24 W and 0° 00'.



3 - interpret regional seismic line as basis of a 2D model of natural fluid flow in Tertiary strata between Forties field and Scottish coast.

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

BGS

Investigating Non-Forties Storage Options (2)

Status:

The draft report on the potential to sequester CO_2 in the Midland Valley of Scotland is complete after internal review within BGS. Draft presented September '03.

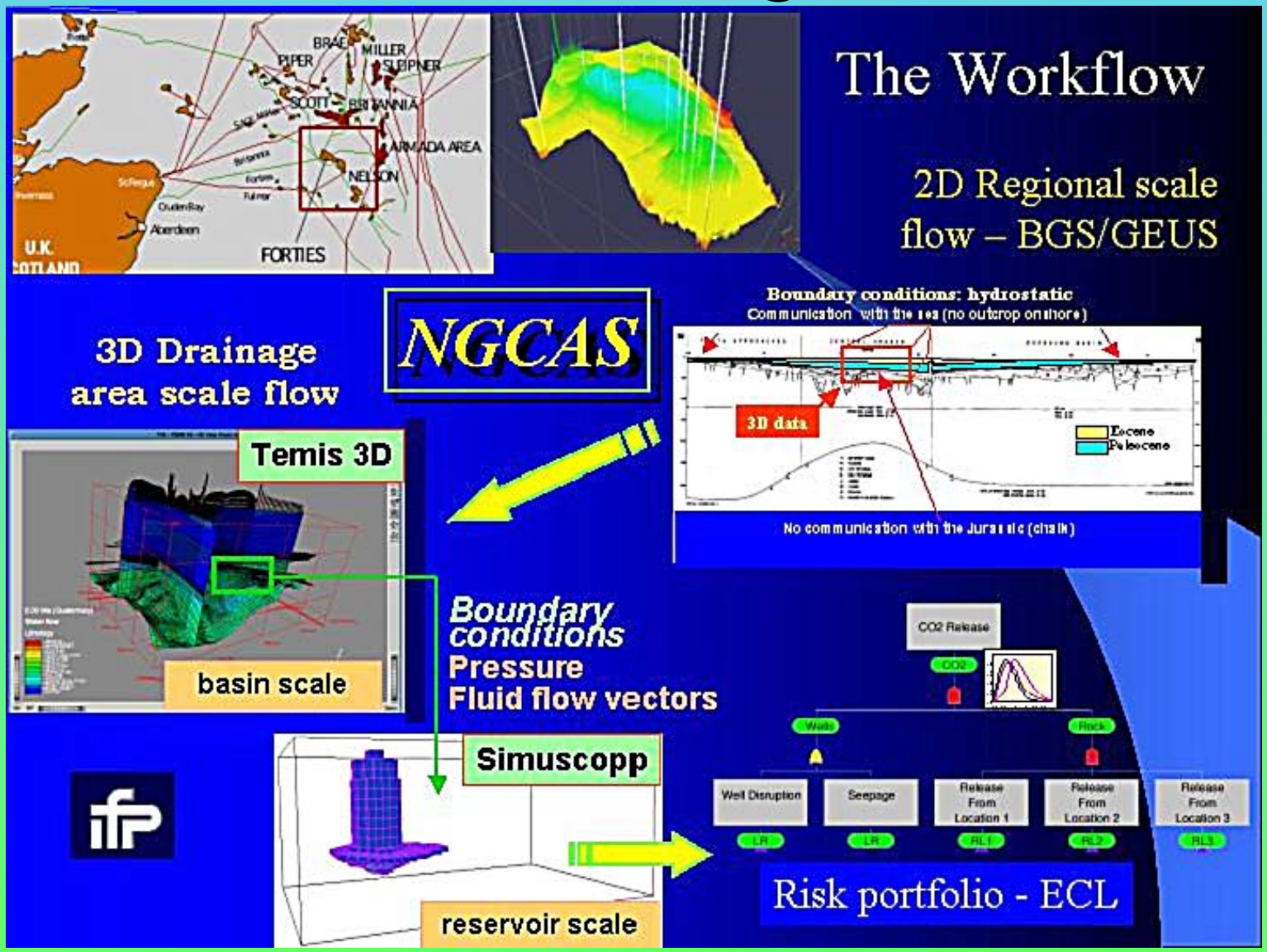
Action on BGS to deliver to GEUS further interpretation of a regional E-W seismic line has been discharged.

Conclusion (extract)

"... it appears that the coal resources in the Limestone Coal Formation in the Clackmannan Syncline (in the immediate area of the Grangemouth plant) could be exploited for ECBM.
"However, there is very little practical experience of injecting CO_2 into coal seams and very little realistic knowledge of the practical safety and security of storage issues.
"...This requires that both the methane and CO_2 budgets to be fully accounted for in a real project. Furthermore the major conflict of interest with the potential future use of coal as an energy source has to be resolved. This cannot realistically happen until more pilot projects have been established. "

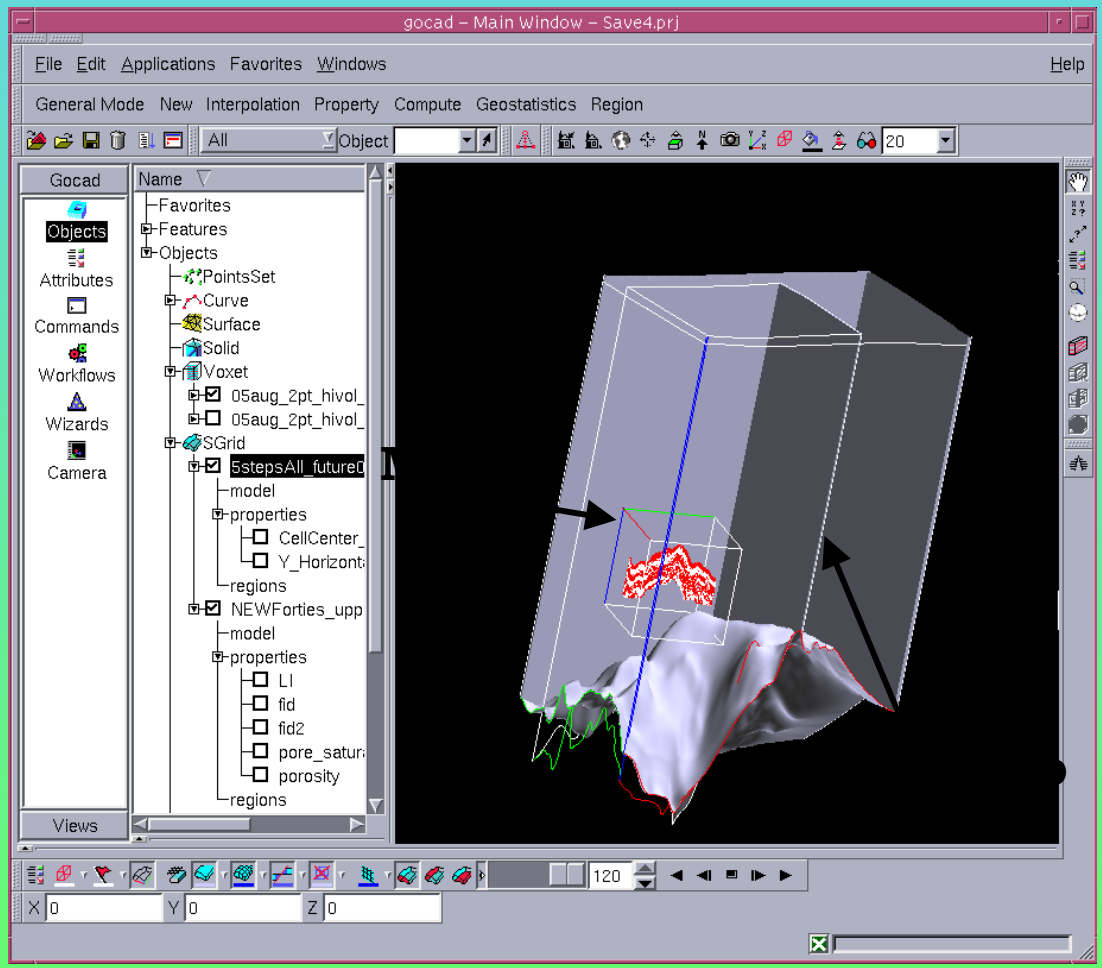
British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

IFP+GEUS
Field/Basin Modelling Workflow



IFP + GEUS

Temis3D gridding the « Russian Doll »



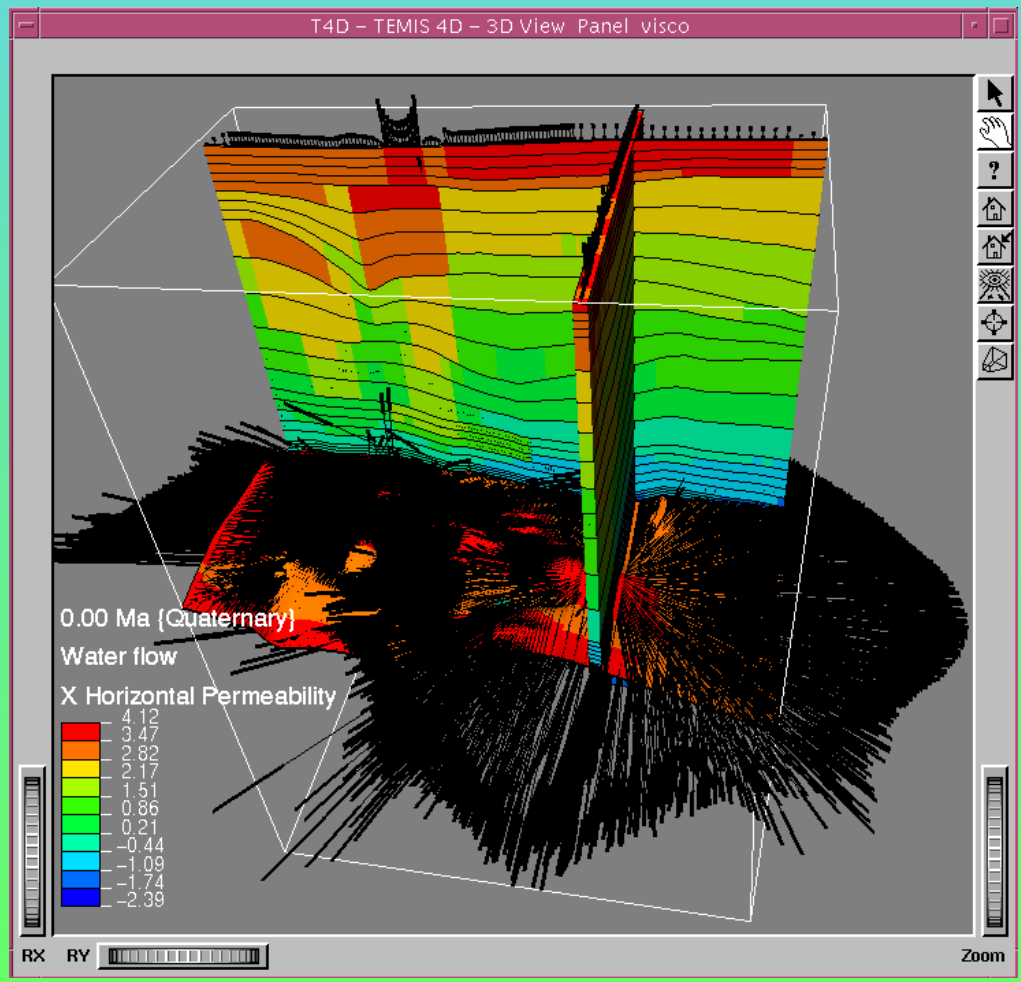
IFP+ GEUS

Temis 3D

Results: Present-day water flow

- water flow in the reservoir is very slow (max. 6000 m/Ma)

- flow vectors have a much higher horizontal component

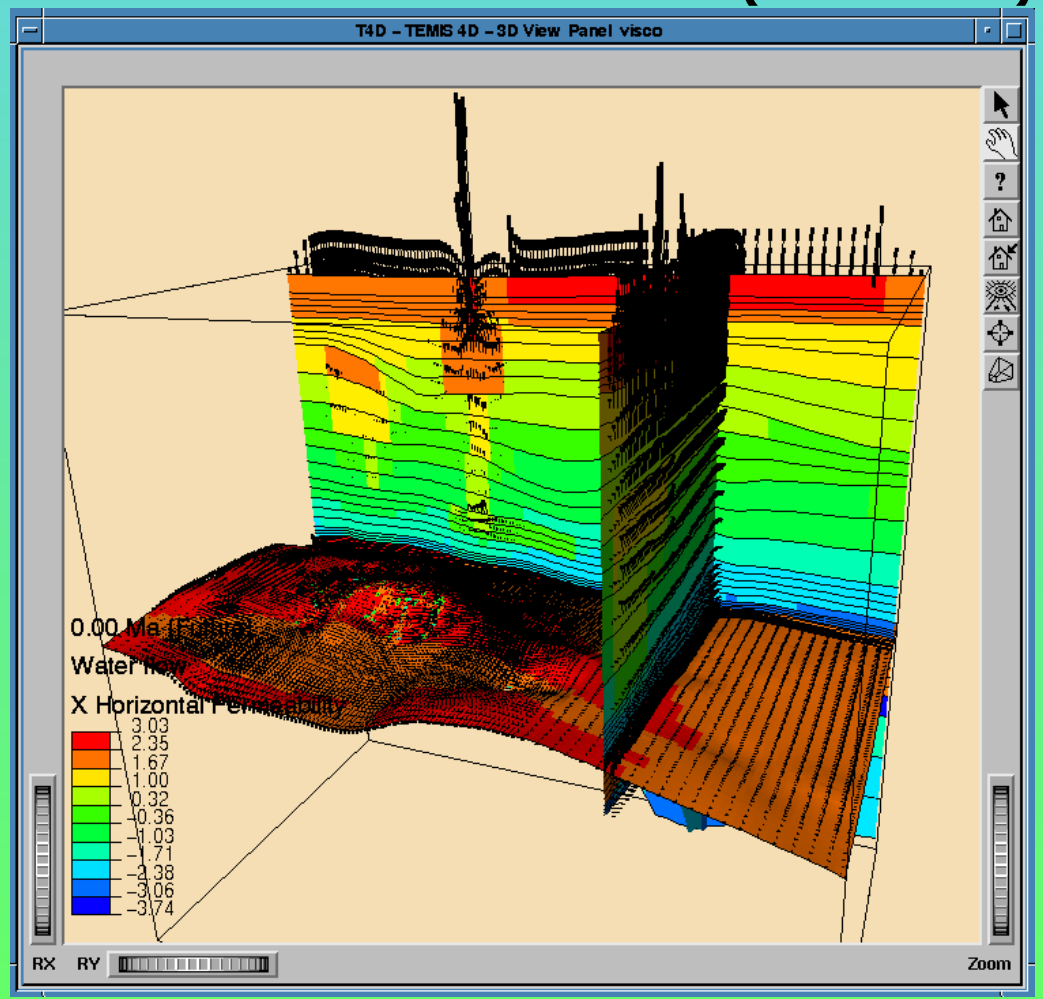


IFP + GEUS

Temis 3D

Results: Future "Forties" conditions (next 1 Ma)

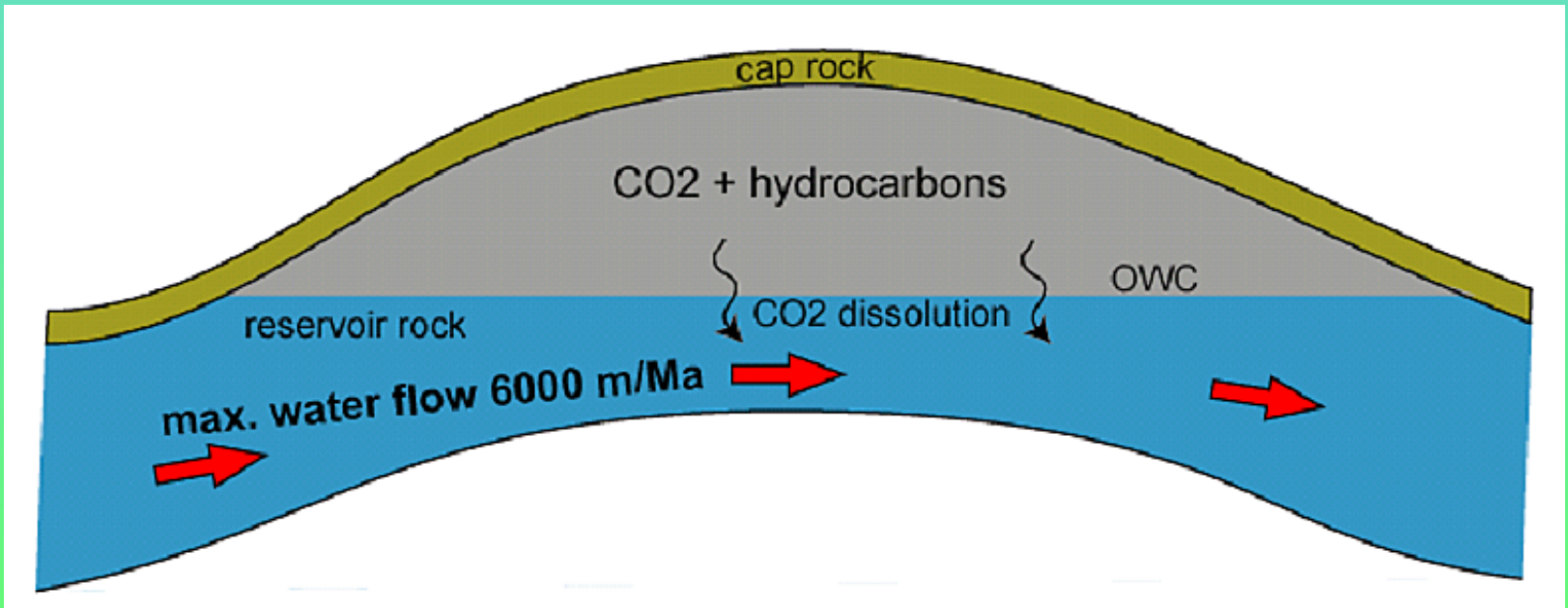
- Assuming rates of deposition as in the Quaternary the water flow in the reservoir is considerably slower than at present at a max. of 350 m/Ma



IFP + GEUS
Temis 3D: conclusions

- Water flow velocities in Forties are fairly slow (max. 6000 m/Ma).

==> CO_2 removal by water circulation represents no environmental hazard at 1000 yr time scale



IFP + GEUS

Temis2D – escape models

(e.g.,Wellbore Leakage)

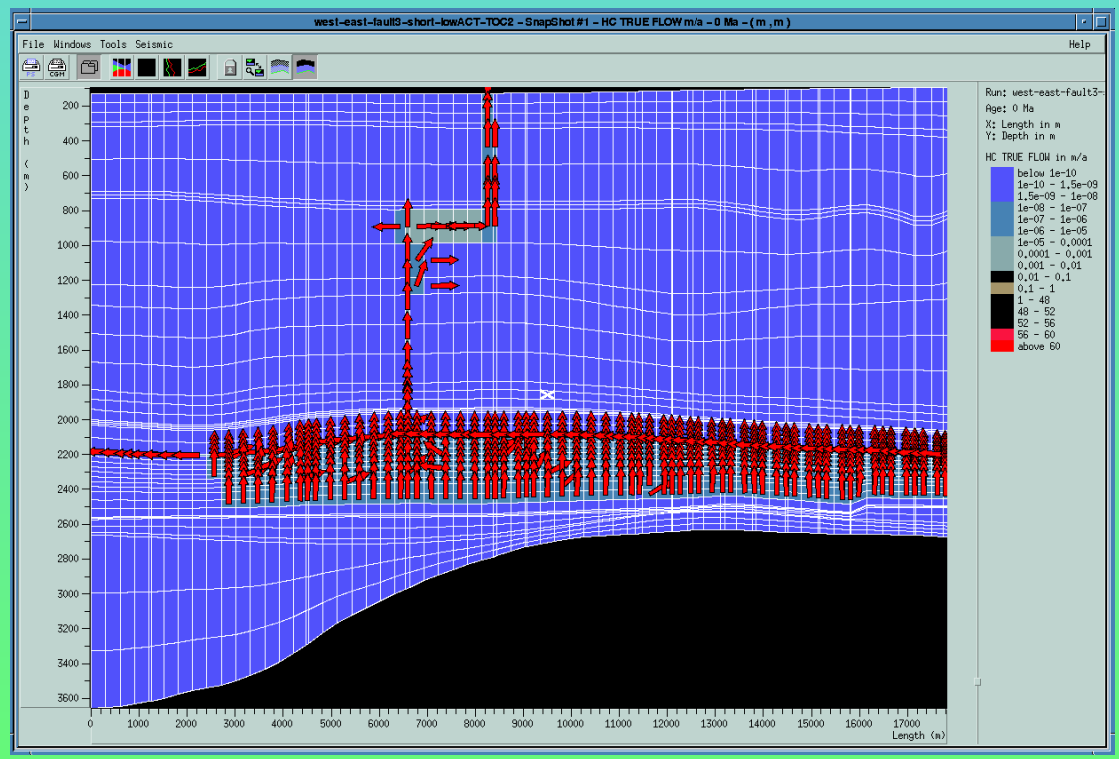
Objective:

to simulate the pathways followed by CO_2 in an eventual escape from the trap to the overburden units.

Status: 1- Work with Temis2D

The work with Temis2D aimed to simulate the pathways followed by CO_2 in an eventual escape from the trap to the overburden units. We ran several tests and examples of output information are on the figure below (arrows indicate CO2 pathway in the overburden units). This technique should be applied to Temis3D as well. Results of this simulation will aid to define escape scenarios in the Simuscopp model.

Work is ongoing.



A CO_2 Escape Scenario in the IFP Temis2D model.

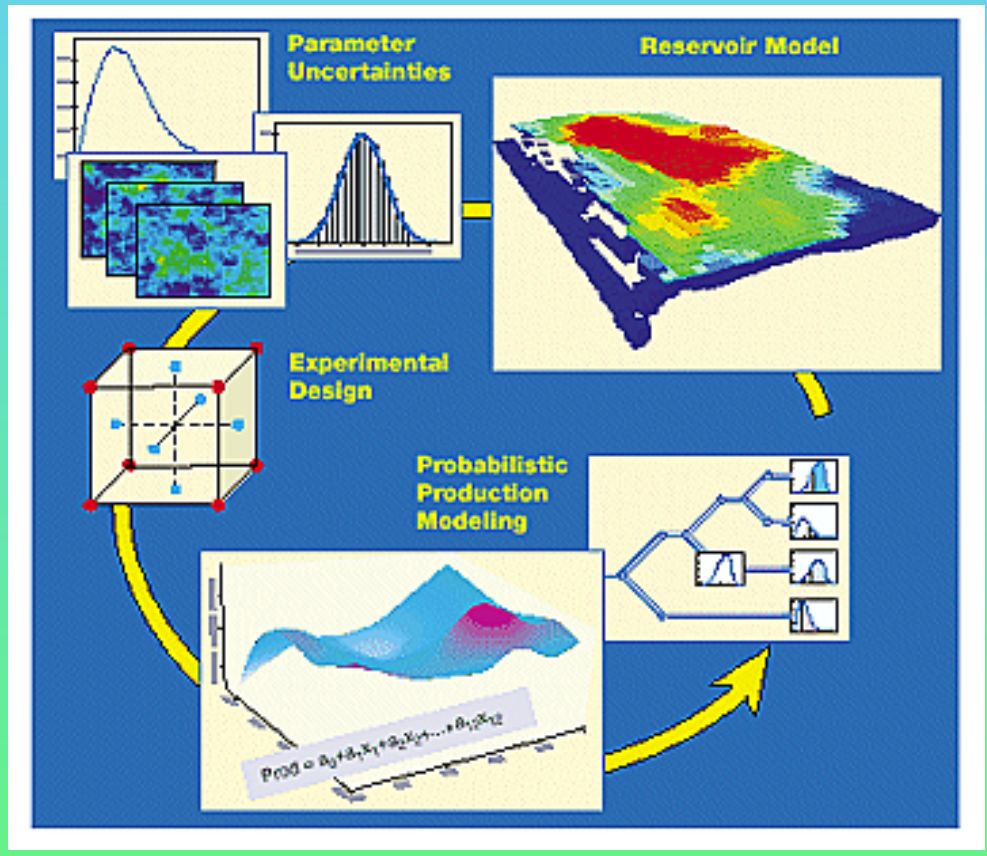
Next Steps : IFP +ECL

IFP: Work on Simuscopp:

- Additional data (relative K, capillary pressure)

- Run limited number of key leakage scenarios

- analytical representation of the model



Publication:

Writing of an abstract for the the 226th ACS National Meeting, New York, NY, September 7-11, 2003 in New York

The abstract has been accepted for oral presentation in the session of the Division of Geochemistry, entitled "CO2 sequestration: advanced technologies for predicting and monitoring isolation performance".

ECL: Risk Management Study (1)

Brief description of Risk Management Scenarios (RMS) to be run with data transfer from IFP/SIMUSCOPP to ECL:-

ROCK-RELATED ESCAPE: RMS Scenarios	**Product**
1 - Caprock and Overburden permeability increase (Kv and Kh x100) timescale? 100 year "vertical migration front	SIMUSCOPP - rate of CO2 flux/unit area Breakthrough to seabed in project

2 - a/a with extra Forties-type sand layer/s depth dependent on RMS #1 results
Extrapolate Rate of flux curve for lateral migration where vertical flux reaches depth z, out of the AOI.

a) sand at 100 year VMF above Forties
b) sand at 500 year VMF above
c) sand at 1000 year VMF above

Status:
Data formats agreed. Work to commence Q3 03.

ECL TECHNOLOGY
OIL & GAS
Formerly the Subsurface Engineering Business Unit of AEA Technology plc

ECL (formerly AEAT)

Risk Management Study (2)

WELL-RELATED ESCAPE

(SIMUSCOPP well = local grid refinement from Forties to Seabed, 0.5-1m scale cell size; "infinite" vertical permeability)

3 –

a) Wellhead cement plug e.g. 500m thick
b) Wellhead cement plug e.g. 1000m thick

For each of a) and b):-

i) Liner/casing etc fully intact
ii) Liner/casing fully eroded (ie open hole ii)
iii) Liner/casing eroded for 1 strat layer below base of wellhead cement plug

Status:

Data formats agreed. Work to commence Q3 03.

IEA-GHG

Scope:
Publication and dissemination of results to the wider community.
IEA GHG activities are principally involved with the organisation of the final workshop.

Objective:
One workshop/meeting for 50-70 people to be arranged for the last six months of the project to promote results of project. Project held in accord with EC, CCP, CO2NET and IEA GHG.

Status:
IEA-GHG attended meeting in Paris July 3rd. Met in August 2003 to plan Workshops and presentations to be held Q1 04.