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# Monitoring CO<sub>2</sub> injection at K12-B Current Status

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**Outline** 

Tuesday May 10th 2011 - Venice Vincent Vandeweijer - Monitoring K12-B





Location Layout Geological setting Gas production CO<sub>2</sub> injection

#### **Monitoring Techniques and Results**

Well integrity:

Multi-finger imaging tools CBL and Down-hole video log Electromagnetic imaging tool and Scale  $CO_2$  Migration: Chemical Tracers and Gas analysis Down hole water sample  $CO_2$  injection well Dynamic flow modeling

**Conclusions & Future plans** 

#### Intro





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# Location

Gas field in the Dutch sector of the North Sea

#### 150 km NW of Amsterdam





1:40000

TO DE









#### **Gas Production**









# CO<sub>2</sub> Injection



Projects at K12-B: ORC, MONK, CO<sub>2</sub>ReMoVe, CATO2, CO<sub>2</sub>Care

- CO<sub>2</sub> injection started 2004 in K12-B8
- >10 kTon injected in compartment 4
- CO<sub>2</sub> injection since 2005 in K12-B6
  - Producers K12-B1 and K12-B5

#### Approx. 70 kTon injected in compartment 3







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#### **Monitoring Techniques and Results**



#### Well integrity

Multi-finger imaging tools CBL and down-hole video log Electromagnetic imaging tool and scale

**CO<sub>2</sub> Migration** 

Chemical tracers and gas analyses Down hole water sample CO<sub>2</sub> injection well Dynamic flow modeling





### **Multi-finger Imaging Tools**

First multi-finger caliper in 2005, 3 time-lapse runs completed







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### **CBL and Down-hole Video Log**





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## **ElectroMagnetic Imaging Tool and Scale**





# Chemical Tracers and Gas Analyses

Injection of two types of tracers took place March 2005

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Tracer data from wells K12-B1 & K12-B5 was used to determine breakthrough

In combination with gas analyses used to investigate the migration of  $CO_2$ 

Provide information to evaluate the effects of certain mechanisms on EGR











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### Down hole water sample CO<sub>2</sub> injection well



First measurements of down-hole water conditions in a CO<sub>2</sub> injection well

Data can be used in chemical and dynamic flow modelling and well integrity studies

Measurements were an alternative for the down hole pH measurements

| CATIONS      |      | mq/l        | meg/l | PROPERTIES                 |              |
|--------------|------|-------------|-------|----------------------------|--------------|
| Sodium       | Na   | 93150       | 4052  | pH @ 20°C                  | 6.10         |
| Potassium    | К    | 918         | 23    | Specific Gravity @ 15.6°C  | 1.186        |
| Calcium      | Ca   | 13300       | 664   | Resistivity@15.6°C (Ohm.m) | 0.044        |
| Magnesium    | Mg   | 2156        | 177   | Dissolved solids (g/l)     | 281.4        |
| Barium       | Ba   | 6.1         | 0.09  | H <sub>2</sub> S Content   | not detected |
| Strontium    | Sr   | 184         | 4.2   |                            |              |
| Iron (tot.)  | Fe   | 274         | 9.8   | ADDITIONAL ELEMENTS        | mg/l         |
| Iron (diss.) | Fe   | 245         | 8.8   | Lithium Li                 | 40           |
|              |      |             |       | Silicon Si                 | 20           |
| ANIONS       |      | <u>mg/l</u> | meg/l | Phosphorus P               | < 7          |
| Chloride     | a    | 172884      | 4876  | Boron B                    | 76           |
| Sulphate     | SO4  | 358         | 7.5   | Aluminium Al               | < 6          |
| Bicarbonate  | HCO3 | 233         | 3.8   |                            |              |
| Carbonate    | CO3  | nil         | nil   |                            |              |
| Hydroxide    | ОН   | nil         | nil   |                            |              |





### **Dynamic Flow Modeling**

History matched reservoir models of various compartments and combinations

Complemented with down-hole pressure and temperature data







### **Dynamic Flow Modeling - Eclipse 300**

History matched for pressure, flow and CO<sub>2</sub> concentration in wells K12-B1, B3, B5 and B6

Near well grid refinement

Decreased kh in well K12-B6 (possibly caused by intruding water)









#### Conclusions

CO<sub>2</sub> injection at K12-B has not brought any unforeseeable problems

State of the well and tubing are OK

Chemical tracers supplied valuable data

EGR through pressure support

EGR through the partitioning behavior of the CO<sub>2</sub>, too little data









#### Future work / plans









### Questions....

