2nd International Forum on Recent Developments of CCS implementation

Fundación Ciudad de la Energía

Analysing the effect of impurities in the CO_2 stream injected on fractured carbonates

M.A. Delgado*, J.C. de Dios, C. Martinez, A. Ramos, J.A. Marín, N. Salvador, L. Valle

Athens, 16-17 December 2015

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The impact of the quality of CO_2 on transport and storage behaviour

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CIUDEN TDP´s

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Who is CIUDEN?

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CIUDEN was created by the Spanish Government in 2006 as a non-profit R&D institution fully conceived for **collaborative research in CCS**.

Clean Combustion Technologies Centre

Location: Cubillos del Sil (León)

CO_2 geological storage Centre

Location: Hontomín (Burgos)

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Storage TDP lay out

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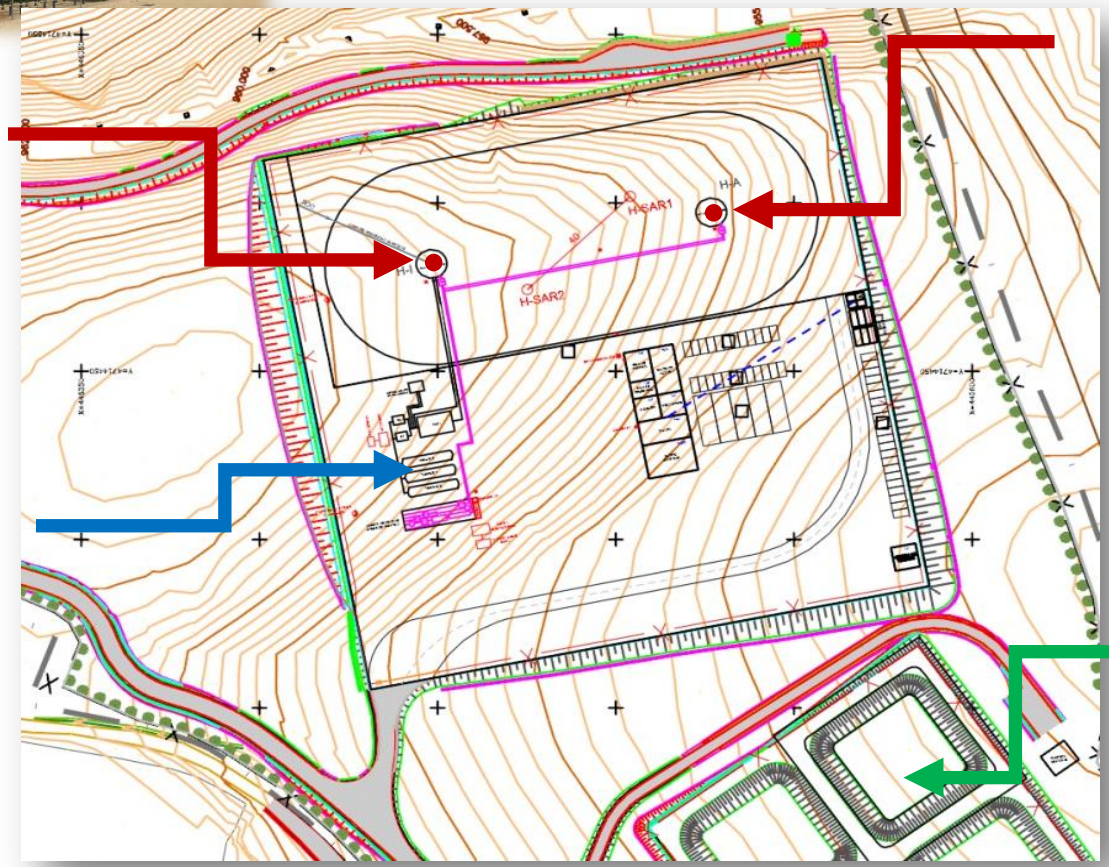
Injection Well (HI)



Observation Well (HA)

CO2 Injection and Brine conditioning facilities

Brine Pools

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Observation well (HA)

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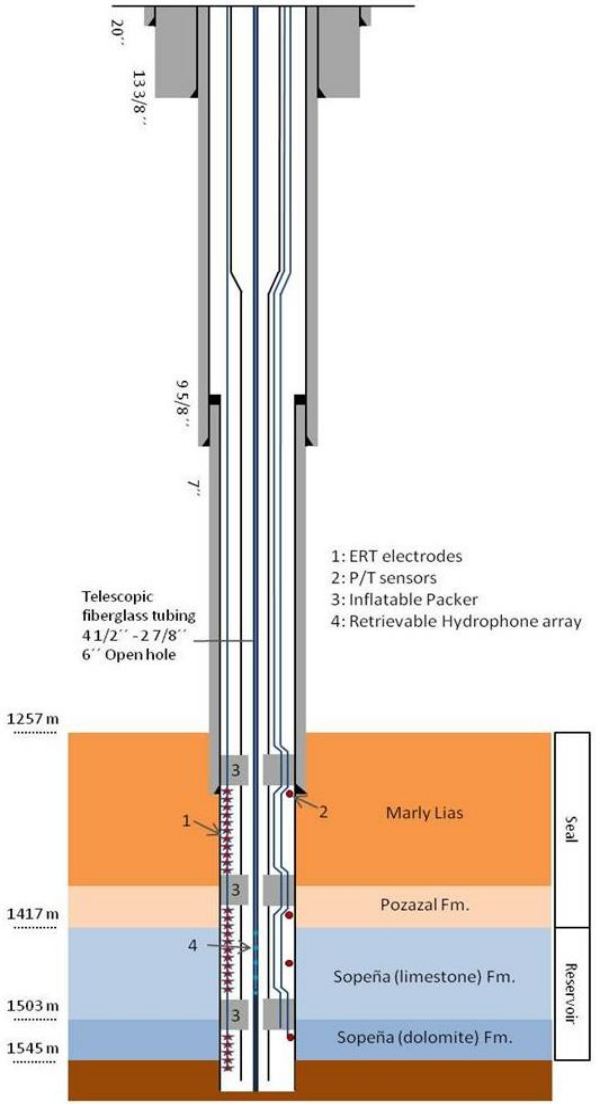

- **P & T sensors** to measure at 4 different levels
- 28 **electrodes** for electrical resistivity tomography
- Removable **hydrophones**

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Injection well (HI)

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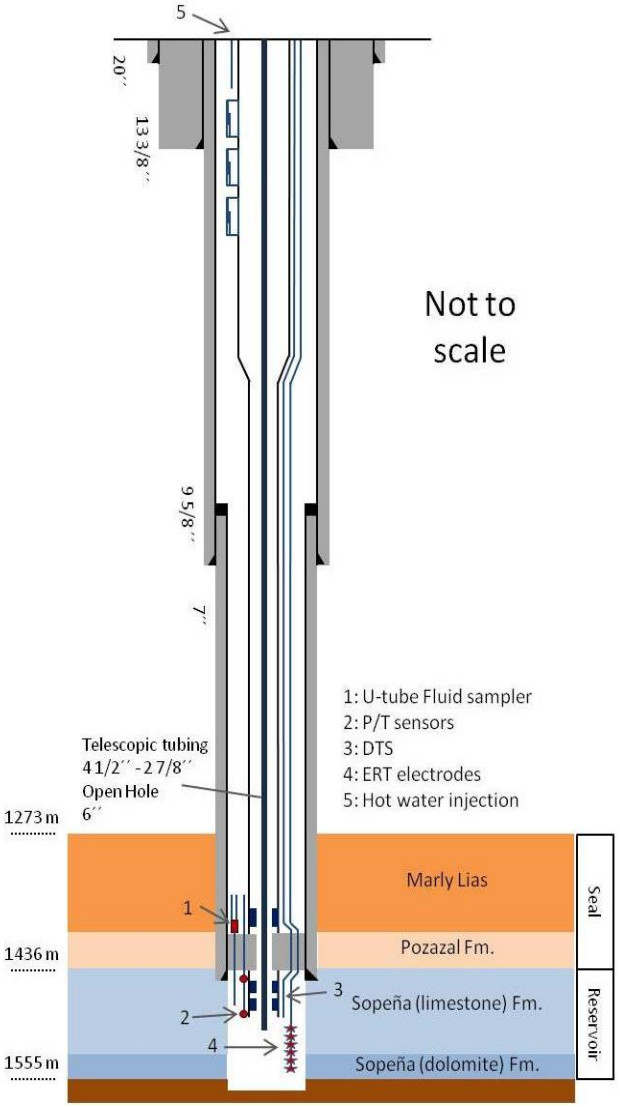

- Distributed temperature sensing system, **DTS**
- Line with 2 dual **P/T sensors**
- Sampling fluid system from the reservoir where CO_2 is injected (**U-Tube system**).
- 6 electrodes set for electrical tomography system (**ERT**)

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Schematic PFD

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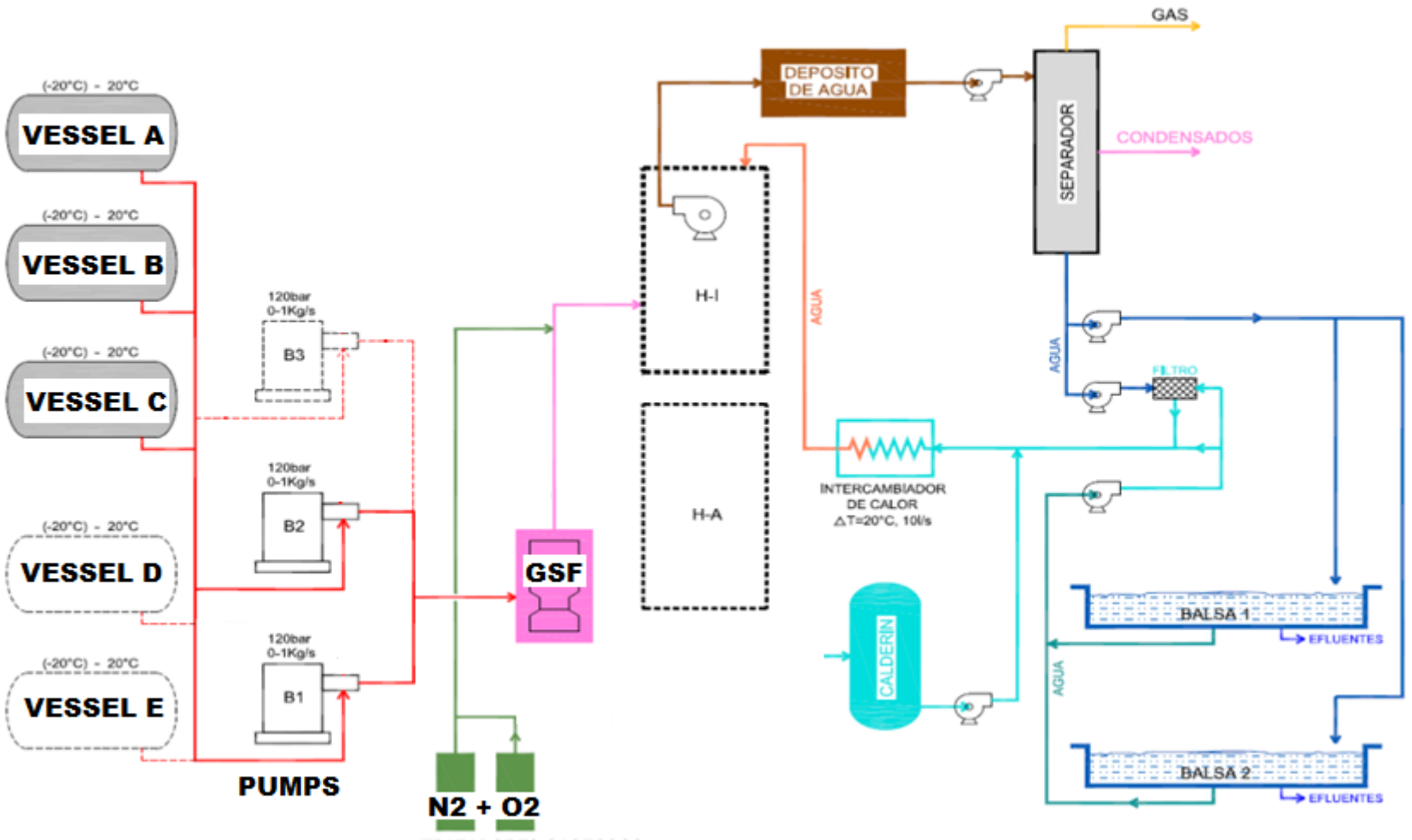

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IMPACTS project

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Introduction

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PROJECT

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PILOT PLANT

CO_2 transport
Cubillos del Sil (Spain)

CO_2 storage
Hontomin (Spain)

MAIN GOAL

- Effects of impurities
- Depressurization
- Modelling
- Lab tests
- Field scale tests

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Test matrix. CO_2 storage Hontomin TDP

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Fluid	Controlled variable	WHP (barg)	Volume flow rate (T/h)	Description and target
BRINE	Well pressure	80		Brine injection (start up routines)
Pure CO2	Flow		7,2	Pure CO2 injection
Impure CO2	Flow		7,2	CO2 injection with N2/O2 (around 1 % v)
Impure CO2	Flow		7,2	CO2 injection with N2/O2 (around 3 % v)
Impure CO2	Flow / Well pressure		7,2	CO2 injection with N2/O2 (around 5 % v)
BRINE	Well pressure	80	7,2	Brine injection (shutdown routines)

** Synthetic Air composition: N_2 79% O_2 21% (5% Flue Gas Stream in Oxyfuel Process)

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Case study. CO_2 storage Hontomin TDP

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Fluid	Controlled variable	WHP (barg)	Volume flow rate (T/h)	Description and target
BRINE	Well pressure	80		Brine injection (start up routines)
Impure CO2	Well pressure	80	7,2	CO2 injection with N2/O2 (around 5 % v)
BRINE	Well pressure	80	7,2	Brine injection (shutdown routines)

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Results

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Composition of the injected stream

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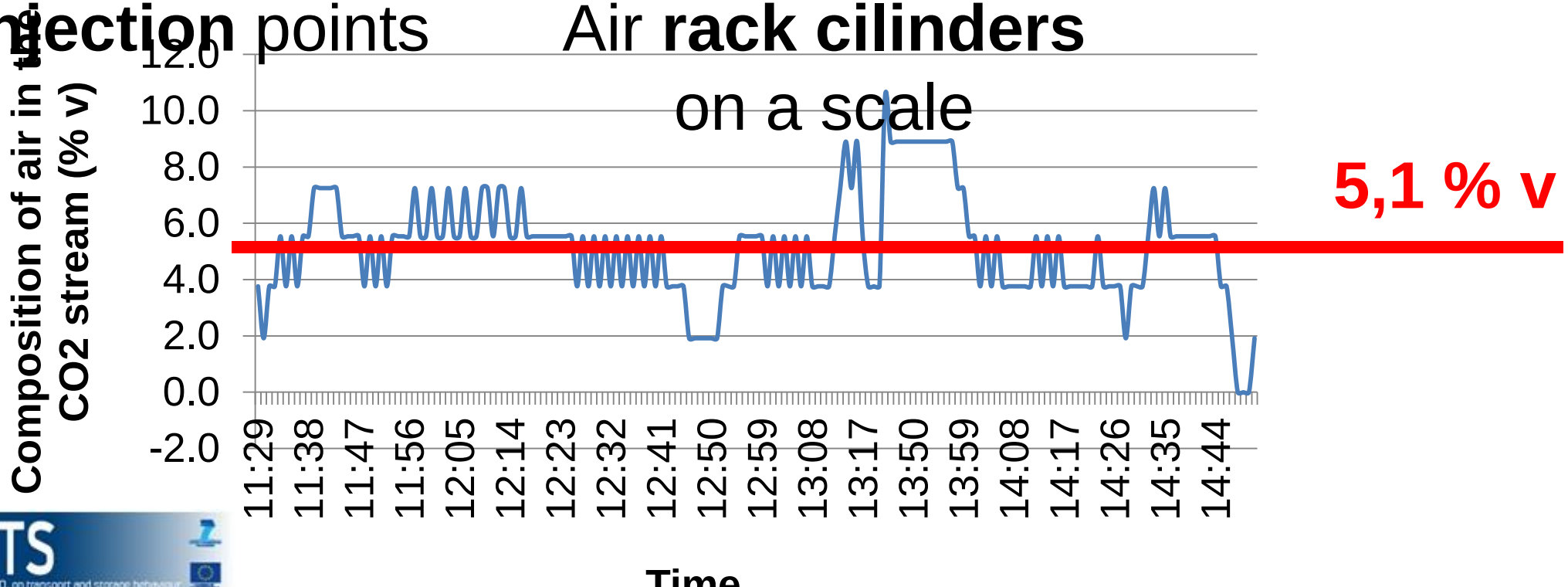
Injection points Air **rack cilinders** on a scale



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Injection regime; WHP and BHP

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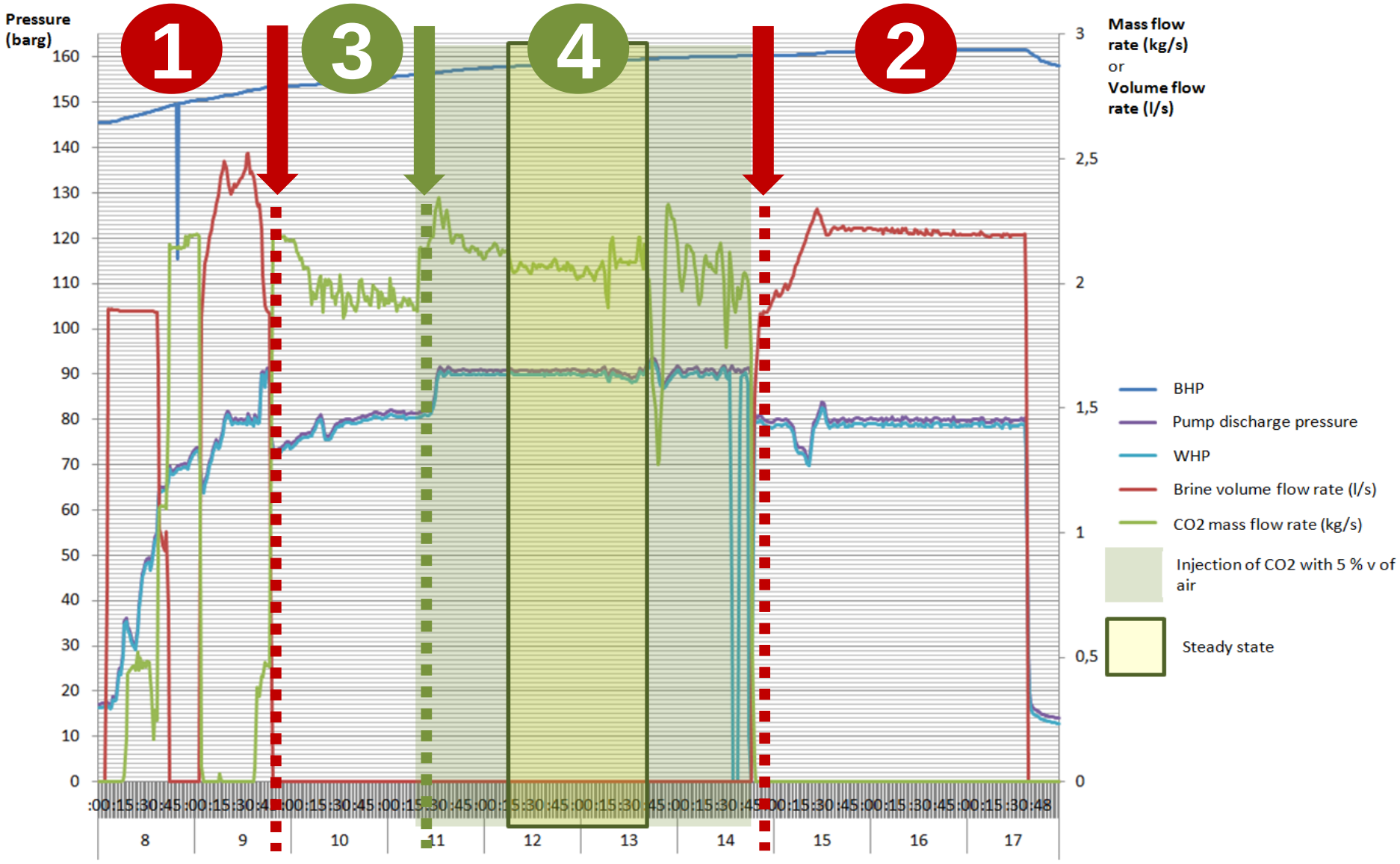

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Bottom hole conditions

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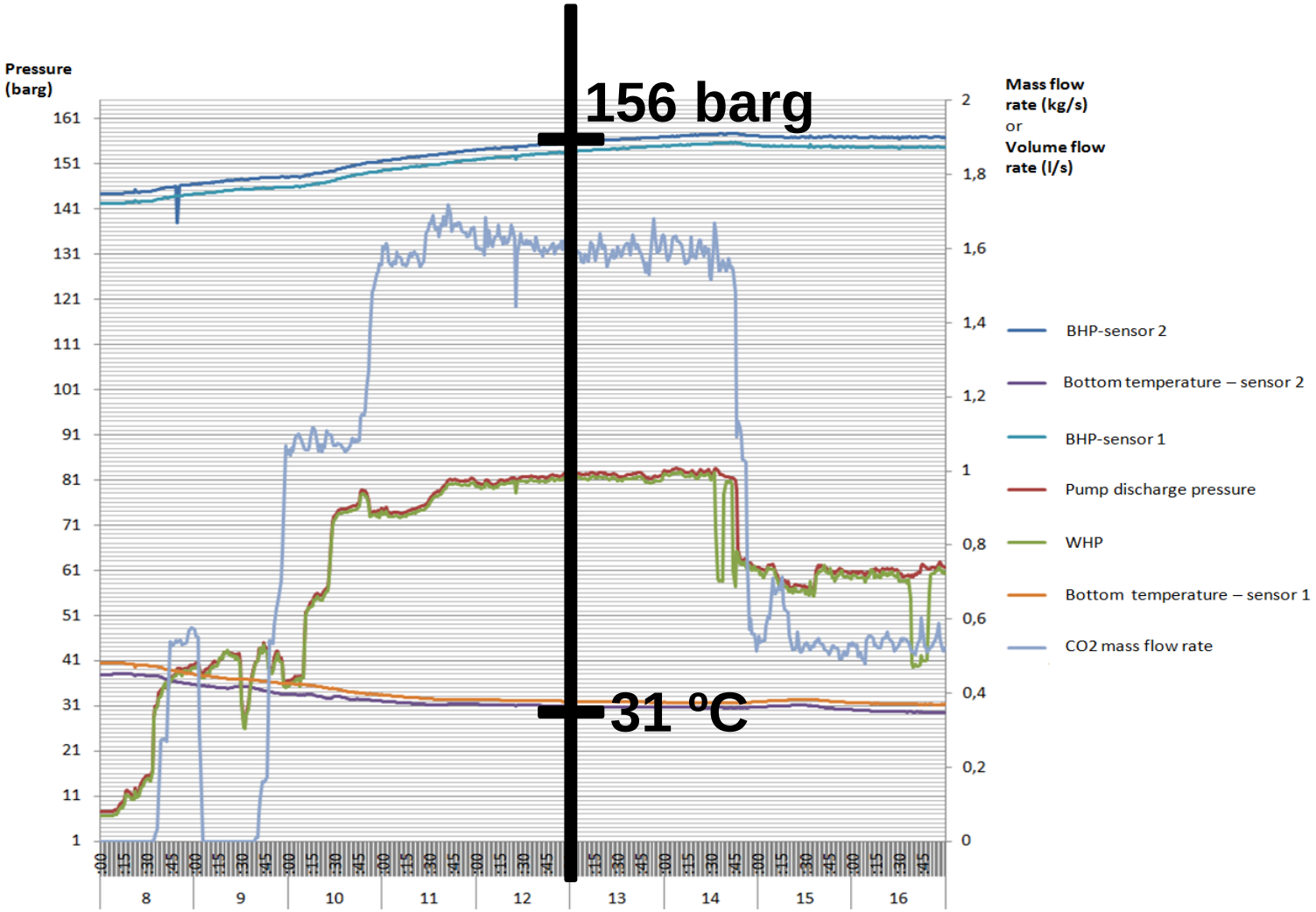

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Drop pressure valve (choke) installed at 1000 m depth in the injection tubing to avoid overpressure on the reservoir and prevent leakages and seismic response

Density in the bottom well

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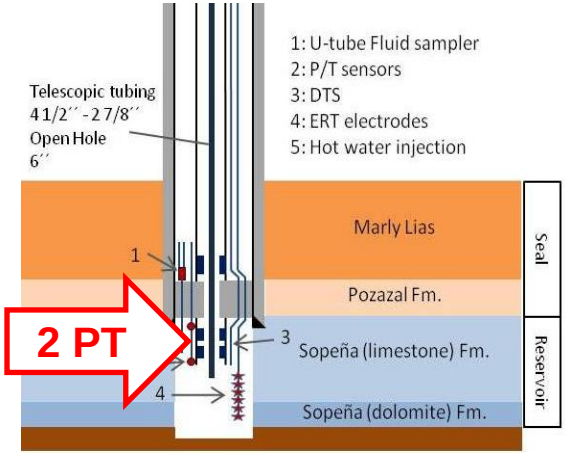
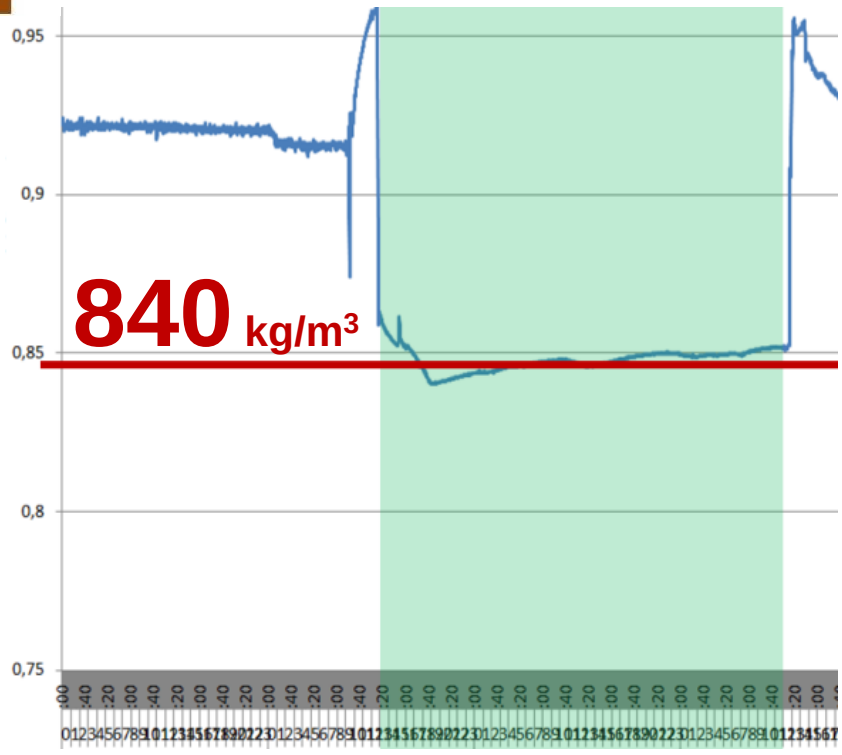
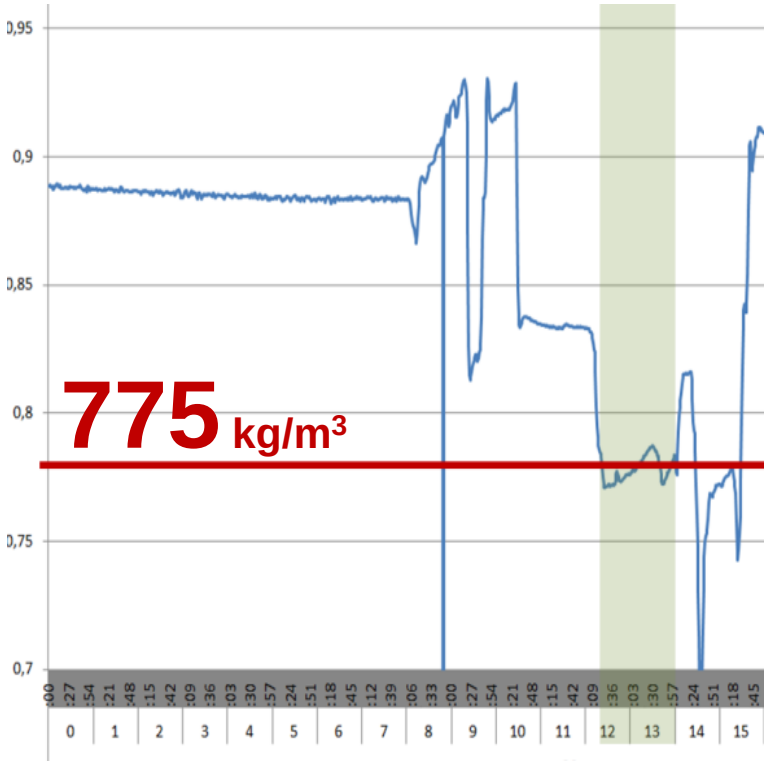


@ (156 barg, 31 ºC)

Pure CO_2



Impure CO_2 (5 % air)



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DTS

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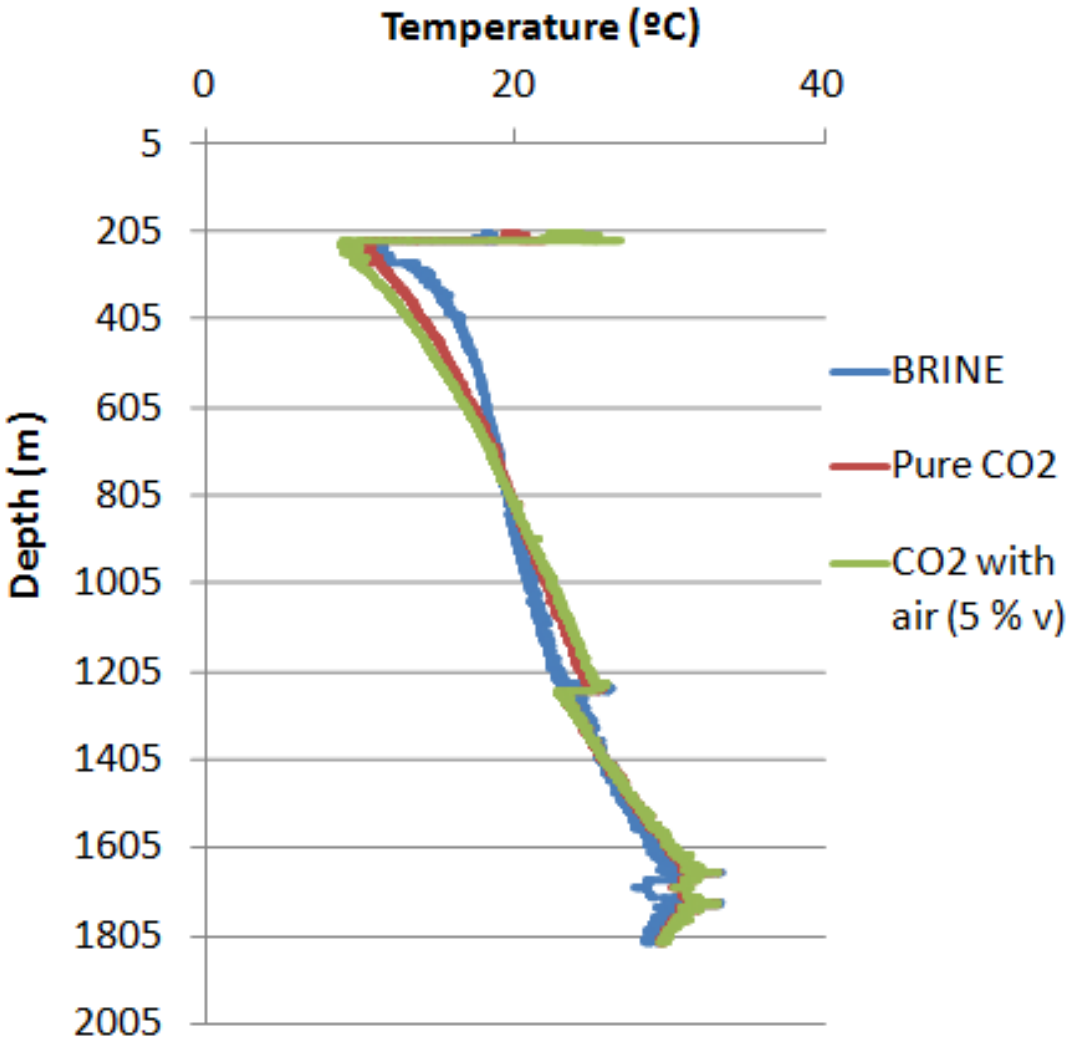

The **injection** is performed in **liquid-phase flow**

Perturbance due to **18 linear meters** of **chokes** installed

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Mono-phase flow during injection Liquid (WH) – Liquid (BH)

DTS

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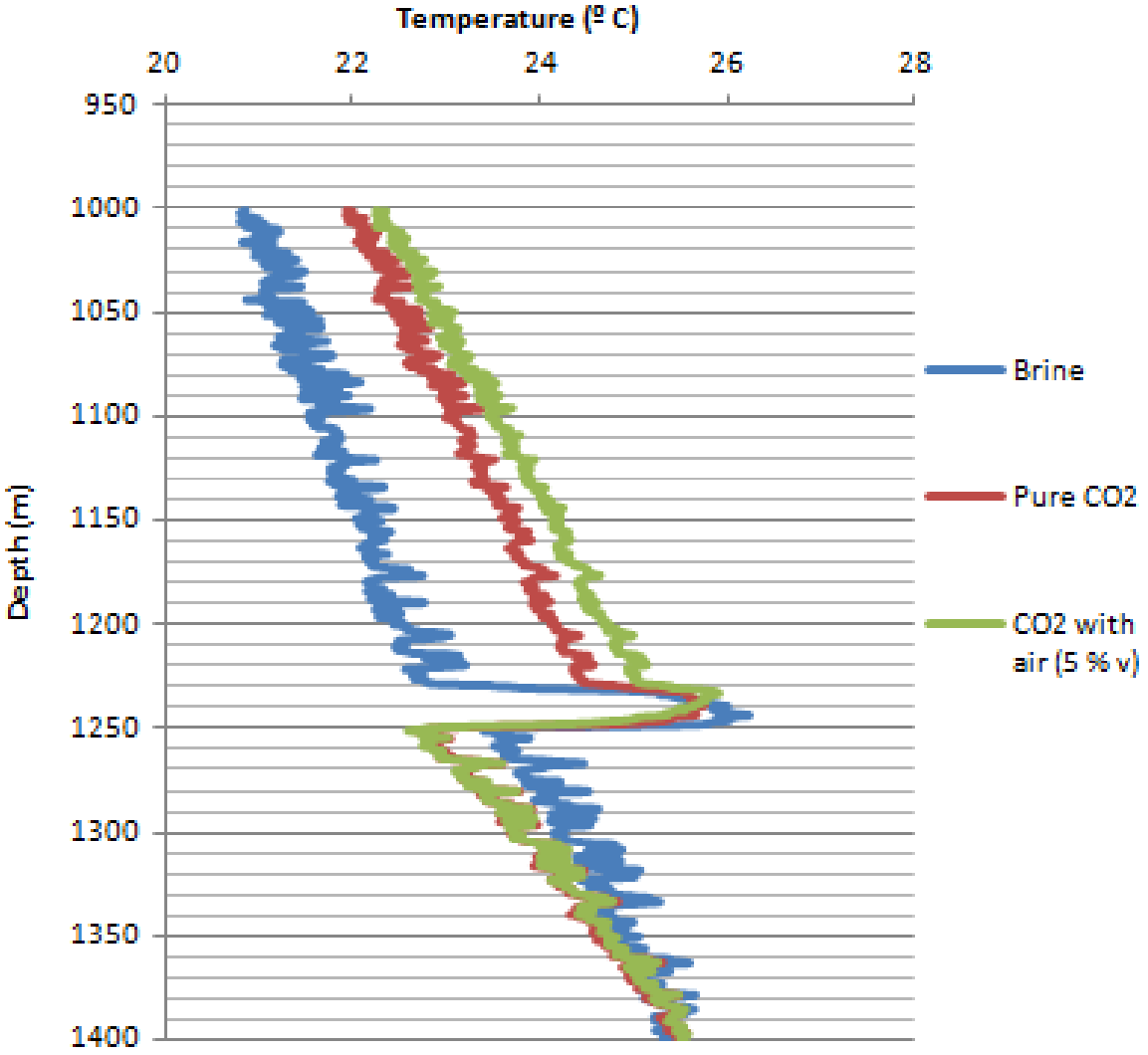

Joule-Thomson Effect

Sample analysis

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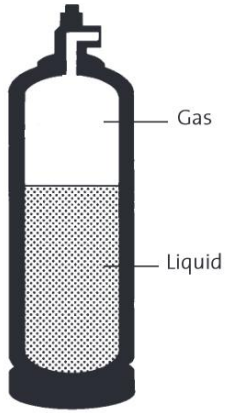

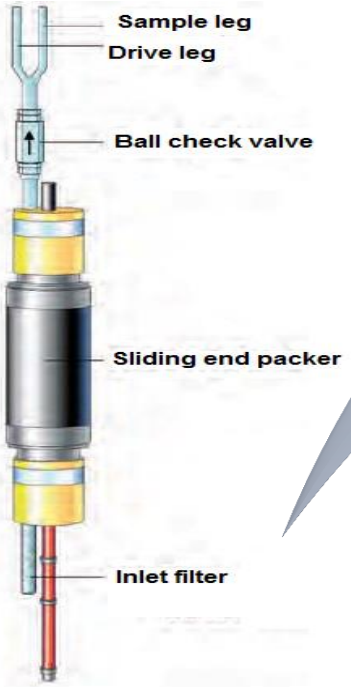

U-tube

DOT´s

L-G sample

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pH and CO2 dissolved

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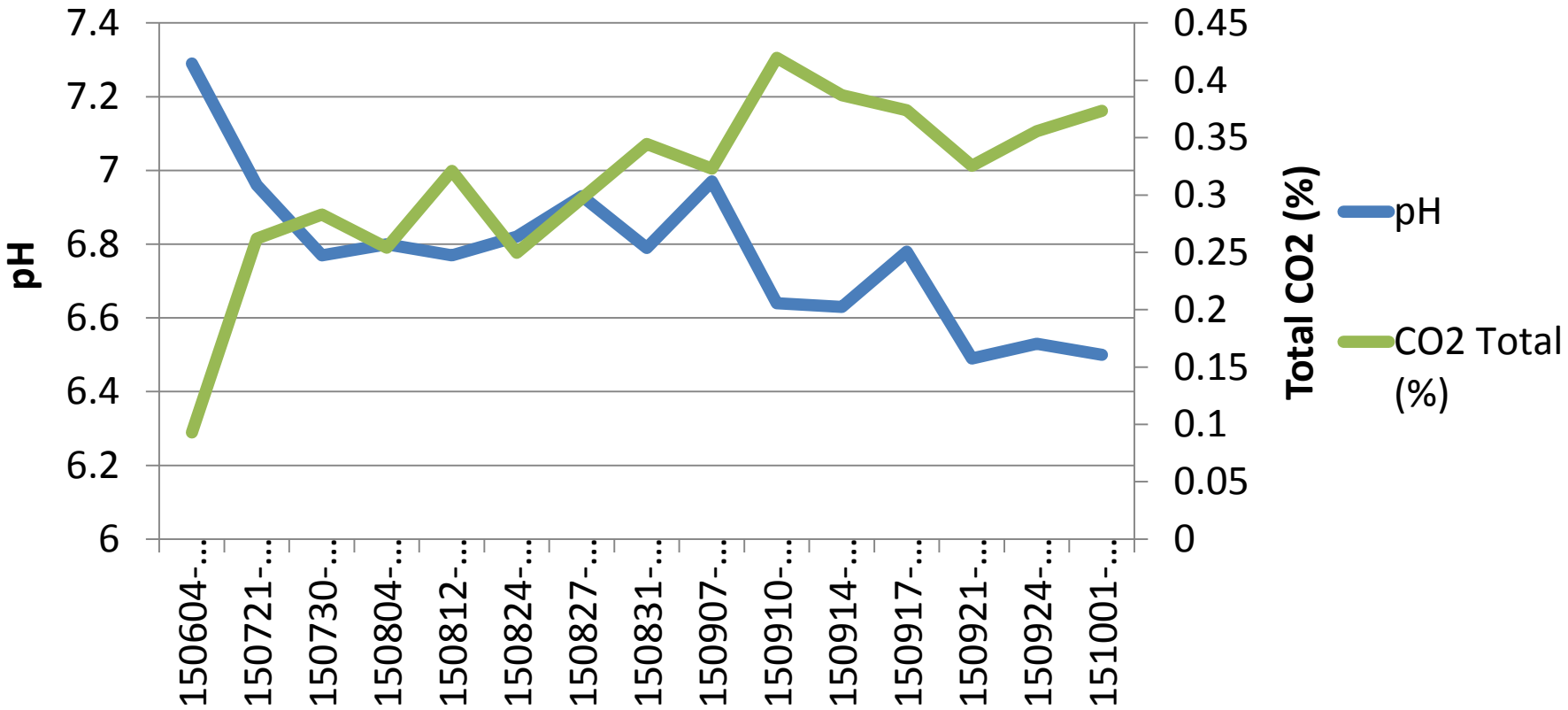

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Ion migration

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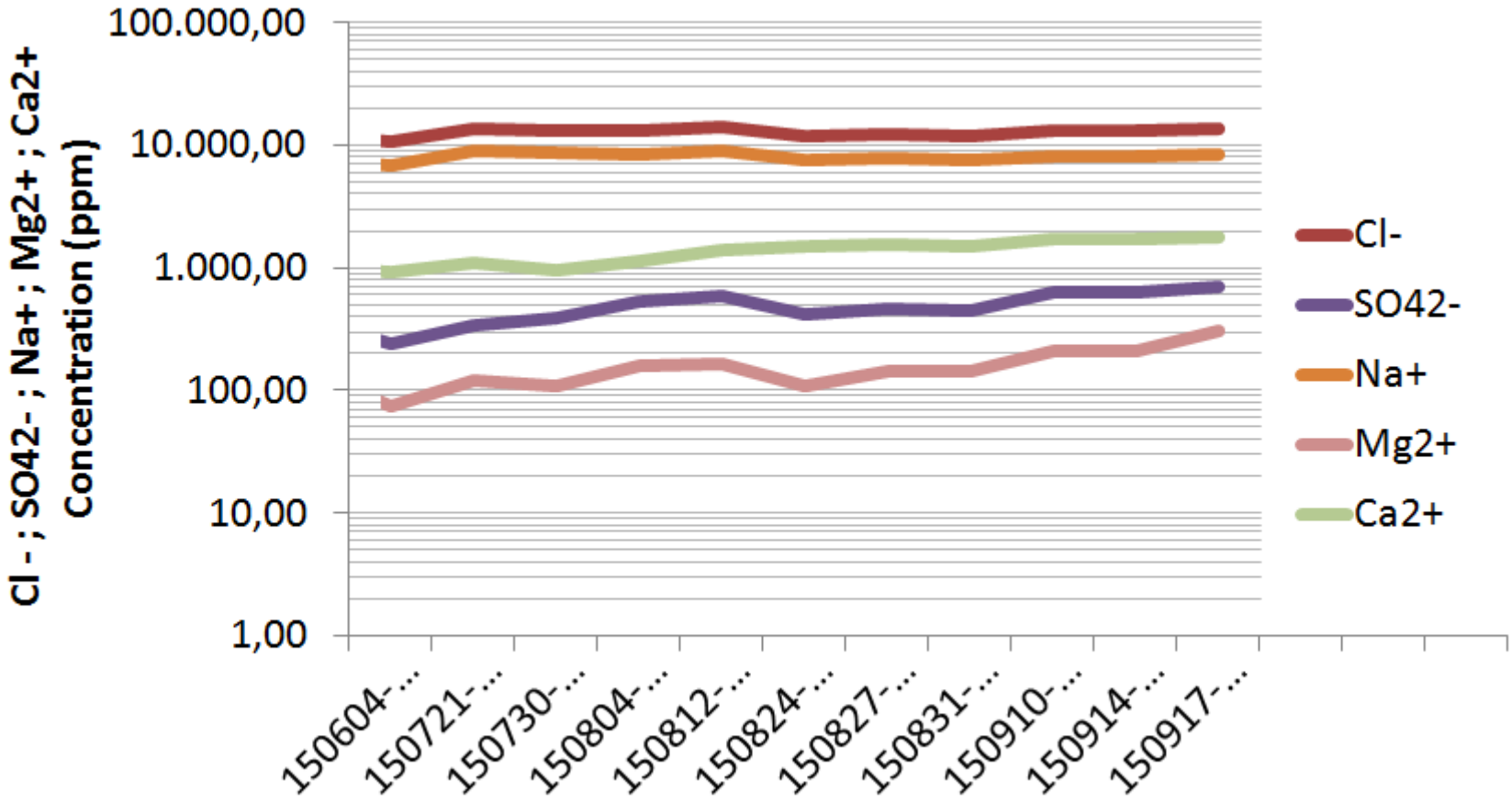

Conclusions

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Short-term **injection-extraction tests of CO_2 and synthetic air** (i.e. O_2 and N_2) were carried out. Concentration of impurities covering the range from 1,4 to 5,1 % v

The **injection** is performed in **liquid-phase flow**. Consequently, the coupling between WHP and BHP due to single phase fluid conditions during injection was also confirmed

Comparing the base case with the case of CO_2 containing 5,1 % v of air, the **density decreases from 840 kg/m^3 to 775 kg/m^3** at the storage conditions

The **higher** the concentration of **air** in CO_2 stream, the **higher the variation of temperature** (J-T effect)

Ca^{2+}, SO_4^{2-}, Mg^{2+} and K^+ have **migration effects** in the rock. The order of magnitude is ≈ 1 mmol/l in 10 years.

Thank you for your attention

Further information:

Miguel Ángel Delgado, ma.delgado@ciuden.es

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