Engineering Design, Construction, Commissioning and Start of Operation of the Hontomin Pilot

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The origin. Main goals

European Energy Programme for Recovery

Objectives Phase I

Technology development for CO_2 oxy capture, inland transport and storage in saline aquifers supporting a future demo 300 MW CCS oxyCFB Power Station

- CIUDEN´s Tasks:
  - Capture at 1:30 scale - Oxycombustion
  - Transport - Closed-loop test rig 3 km long
  - Storage - Saline aquifer for advanced injection & monitoring

3 TDP for:

Storage main goals

- Refine CO2 storage technologies in "on-shore" deep saline aquifer conditions (fractured carbonates).
- Identification of cost reduction action for the whole of the process.
- Potential risk assesment and corrective measures proposal.
- Support for developing alternative geophysical technologies to characterize the seal-reservoir complex
- Tools development for dynamic modelling (hydraulic, hydrodinamic and chemical scope)

Technology upscaling development from pilot to industrial size in **"Real Life Conditions"**

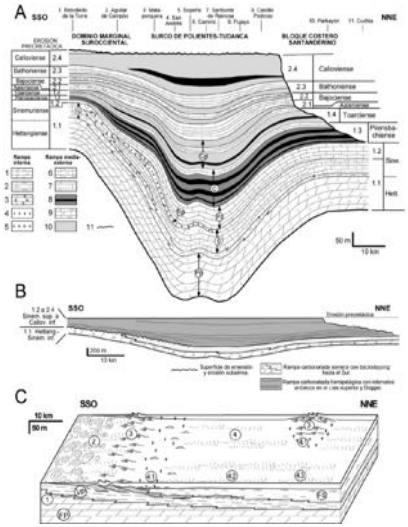
Decision making. Site location

Why Hontomín?

1.-Regarding the project goals:

- Deep saline aquifer
- Fractured carbonates
- Enough capacity for upscaling (2-4 Mt)

2.-High knowledge level on the geological formations and especially related with the seal and reservoir complex. The exploration permit “Ciuden I” for carbon dioxide storage, is part of the hydrocarbon license “Huermeces”



3.- The populations are located in small villages around the site, with implantation of traditional oil sector activities in the area. Actually with a great opposition with the fracking projects located at the neighboring exploration licences.

Decision making. Geological Characterization

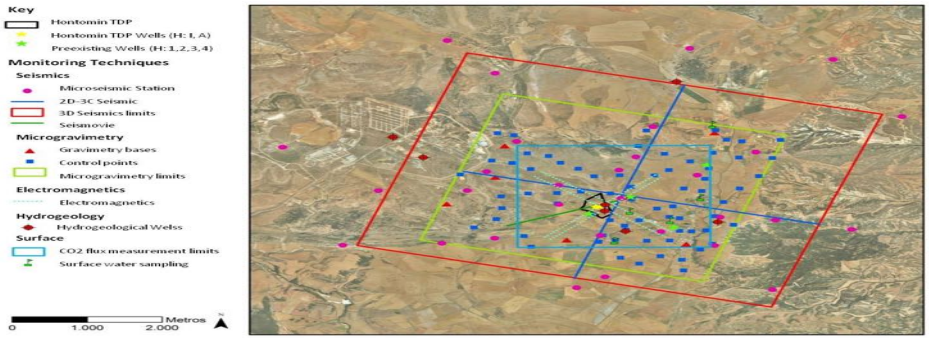
Geophysical Campaigns

❖ Induced seismicity 2D-3D. Target: For determining the geometry, tectonic structure, top allocation, formation thickness, petrophysical properties and the rest of the data needed to develop the geological static model (Project OXYCFB300)

❖Electromagnetichal Techniques CSEM, Magnetotelluric . Target: To define the base lines needed to track the CO_2 plume evolution for developing of future works to control de injection evolution. Different techniques have been deployed for this goal (LEMAM, ERT, Magnetotelluric, etc) in the projects OXYCFB300 and EM Hontomín.

❖Microgravimetry. The target is to determine the base line and the alternative technique for the CO_2 plume tracking. (Project OXYCFB300)

❖DIN SAR and GB SAR. The use of satelital images and ground radar technique to analyze the surface subsidences produced by the injection. (Project OXYCFB300)



Features of the Seal and Reservoir Complex

1.- Site: on-shore deep saline aquifer storage (1.600 m depth).

2.-Location: Hontomín (Burgos), Castilla y León Region, Spain.

3.- Nature of the cap rock: carbonates (Marly Lias 150 m width).

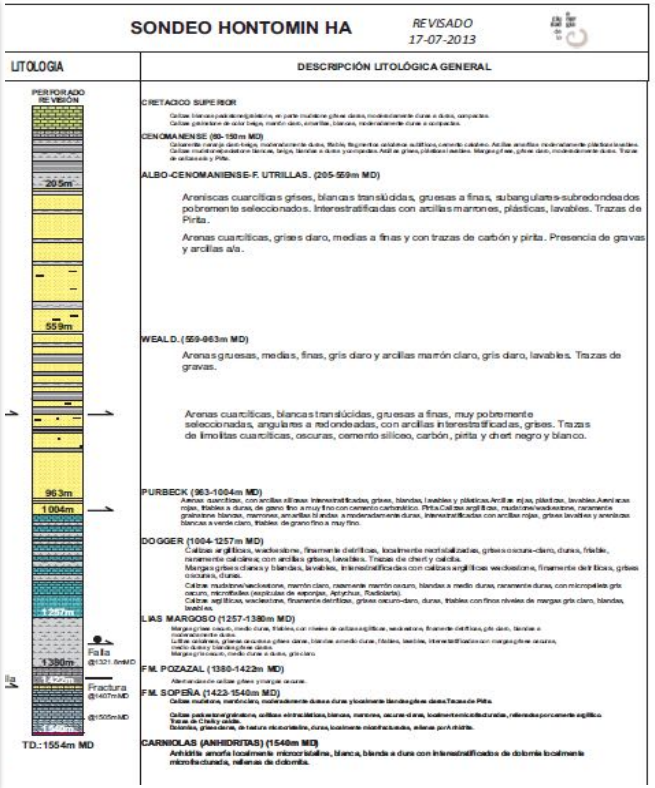
4.-Nature of the store rock: carbonates (limestones and dolomites).

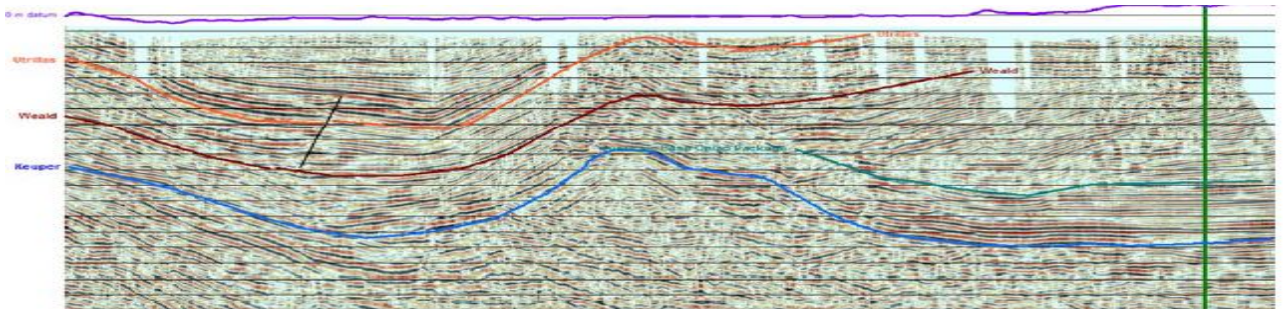
5.-Capacity of the site: 100.000 T CO_2 (administrative requirement, Spanish Law 40/2010 CO2 Geological Storage).

6.-CO_2 injection strategies: liquid, supercritical and alternative.

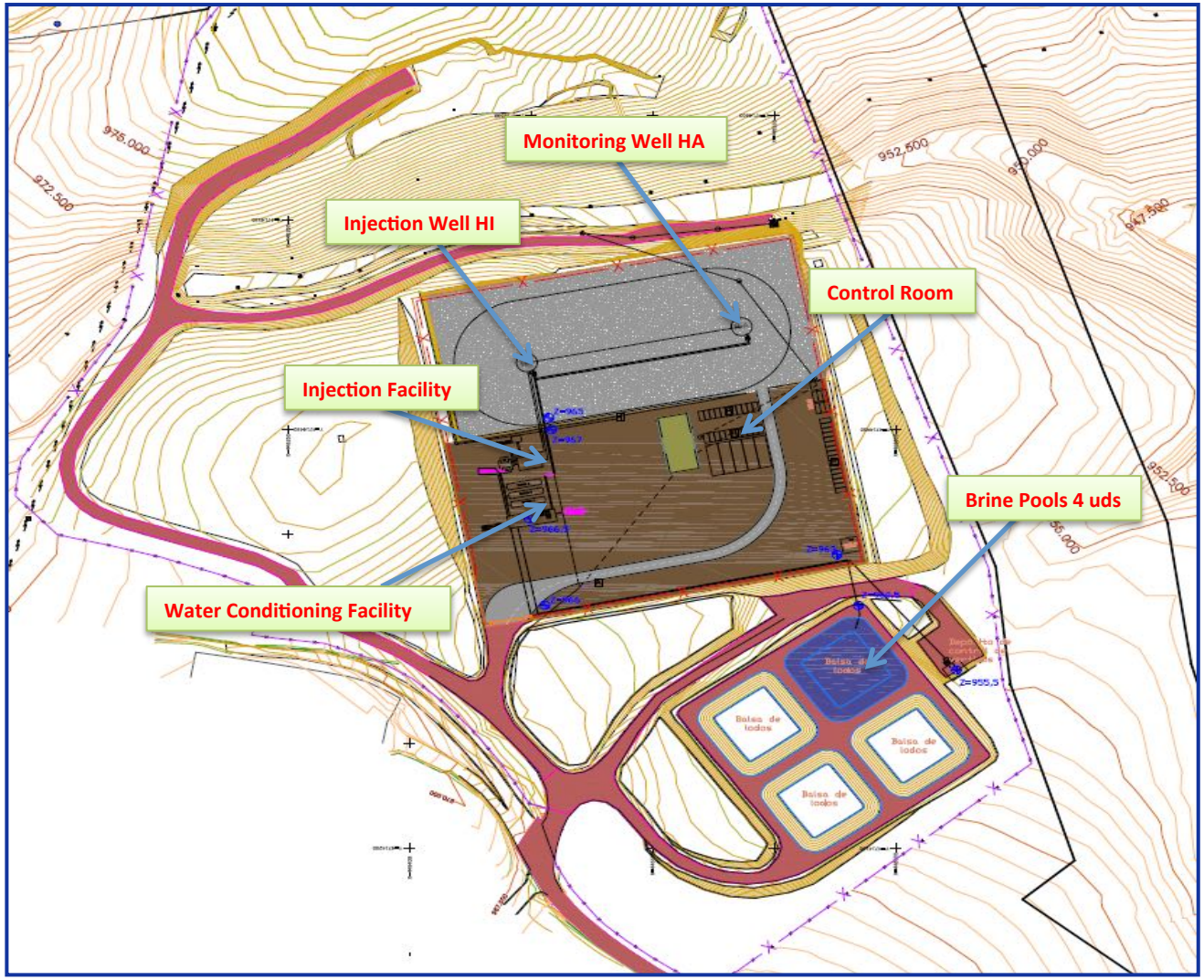
7.-Safe storage operation: irregularities and leakage control.

8.-Public Acceptance: positive

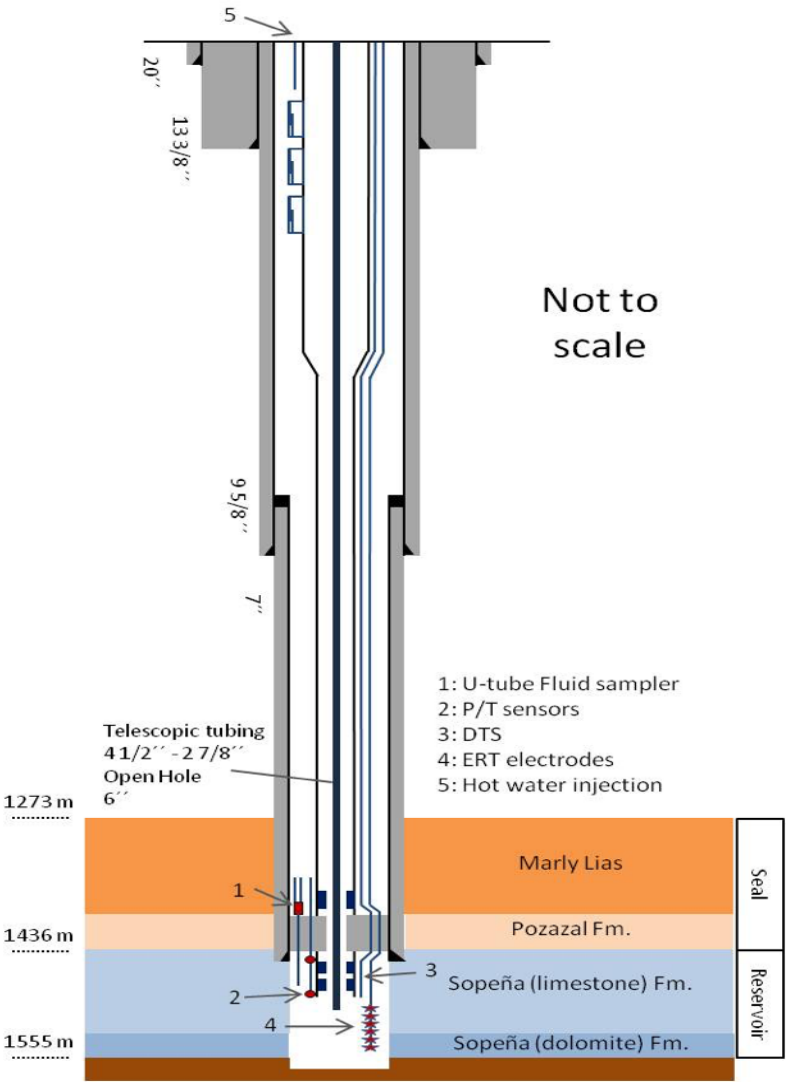


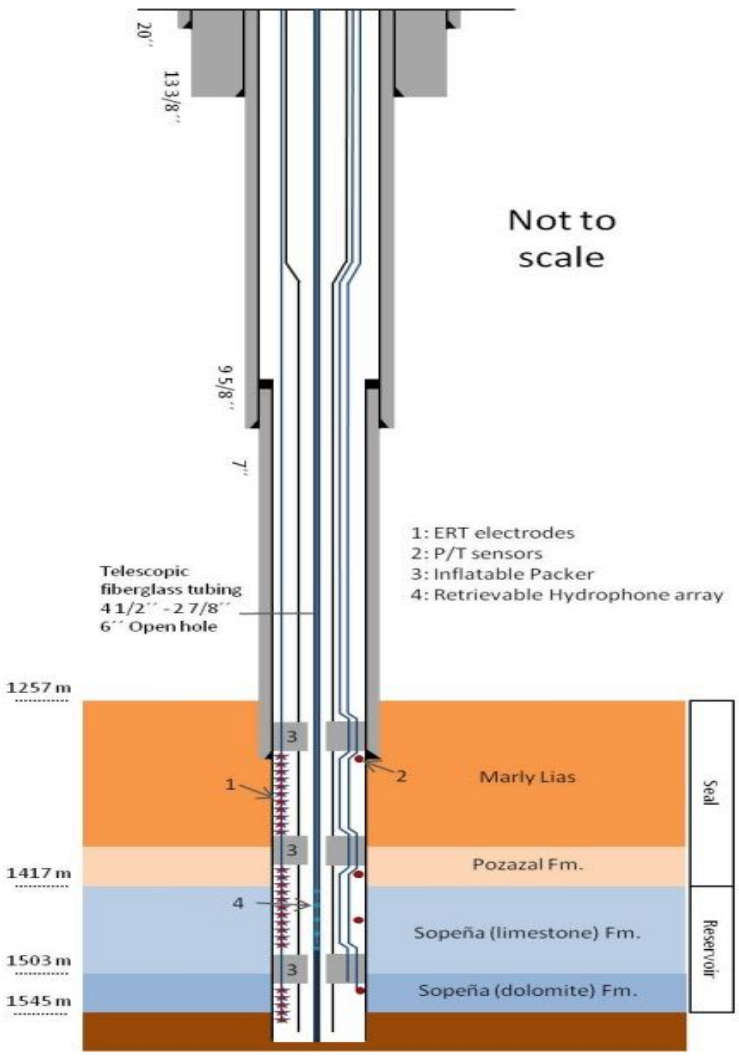


Engineering Design. Pilot Plant Layout

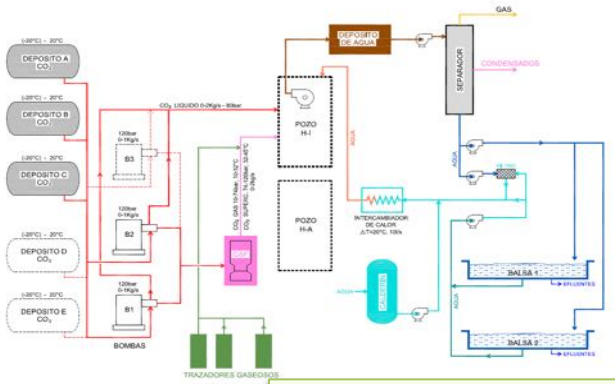


Engineering Design. Wells

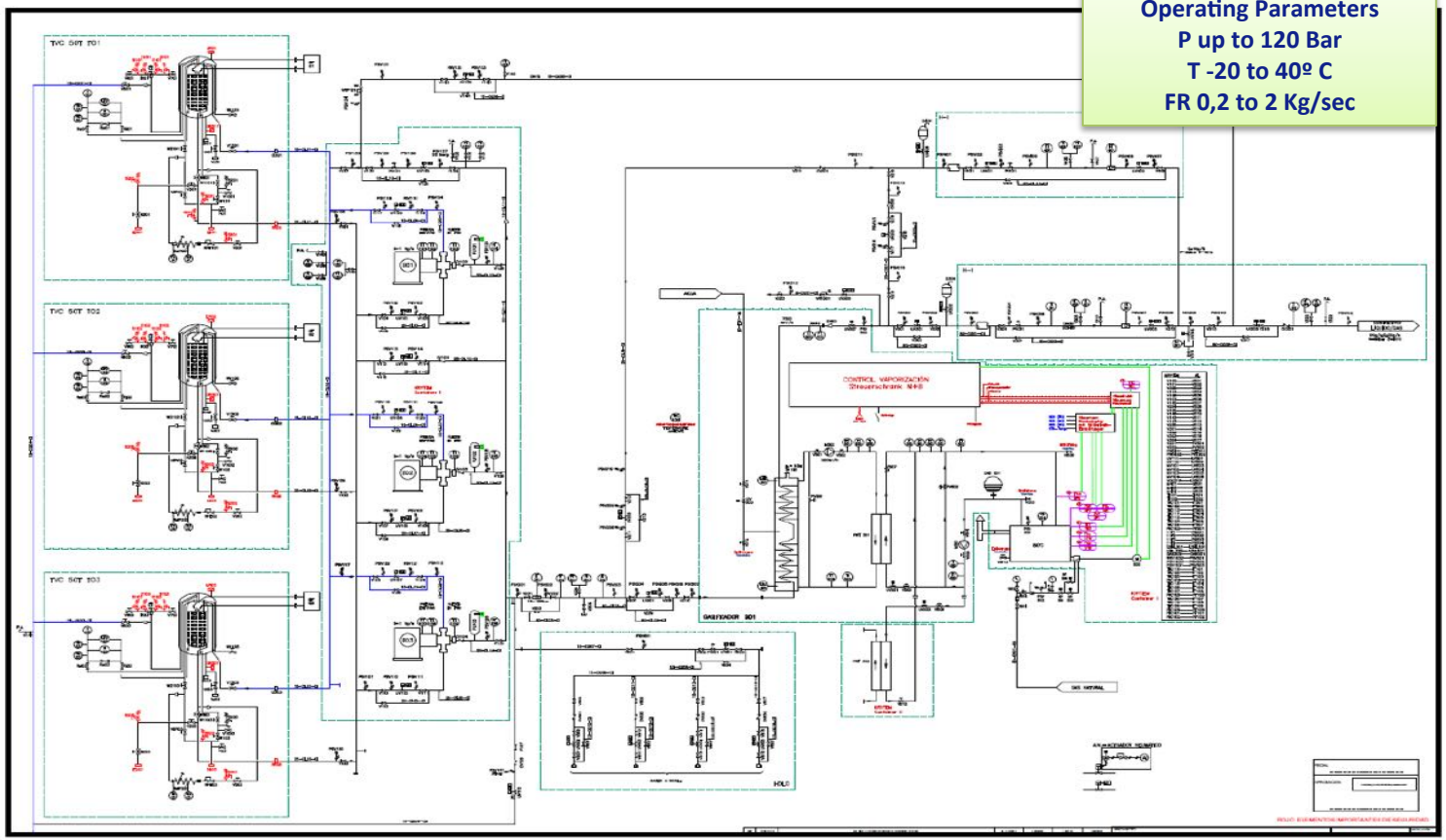




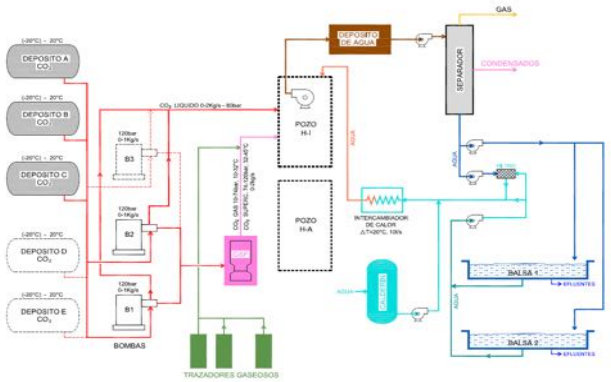
Engineering Design. CO_2 Injection Facility

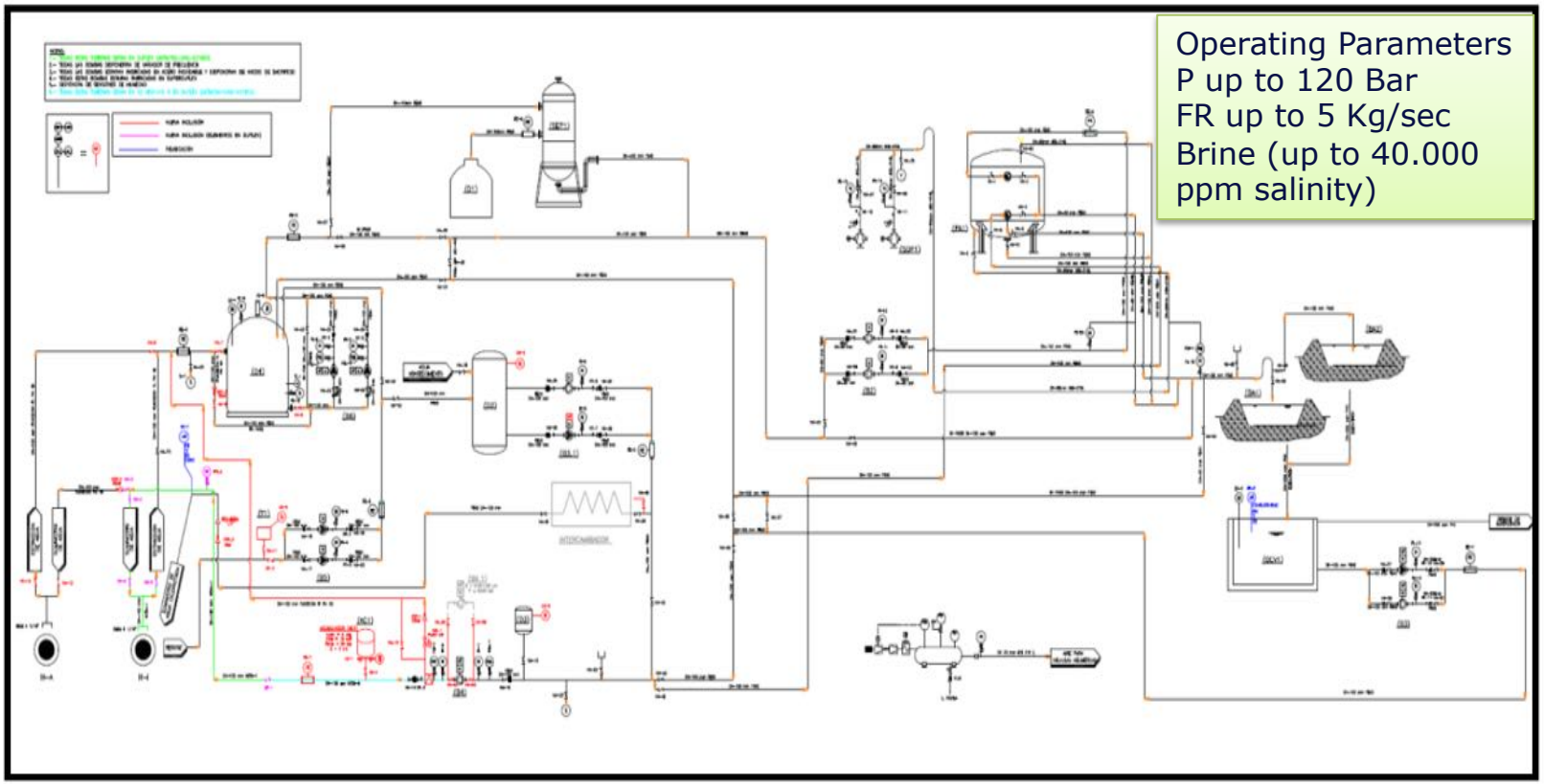


Operating Parameters
P up to 120 Bar
T -20 to 40º C
FR 0,2 to 2 Kg/sec



Engineering Design. Water conditioning facility

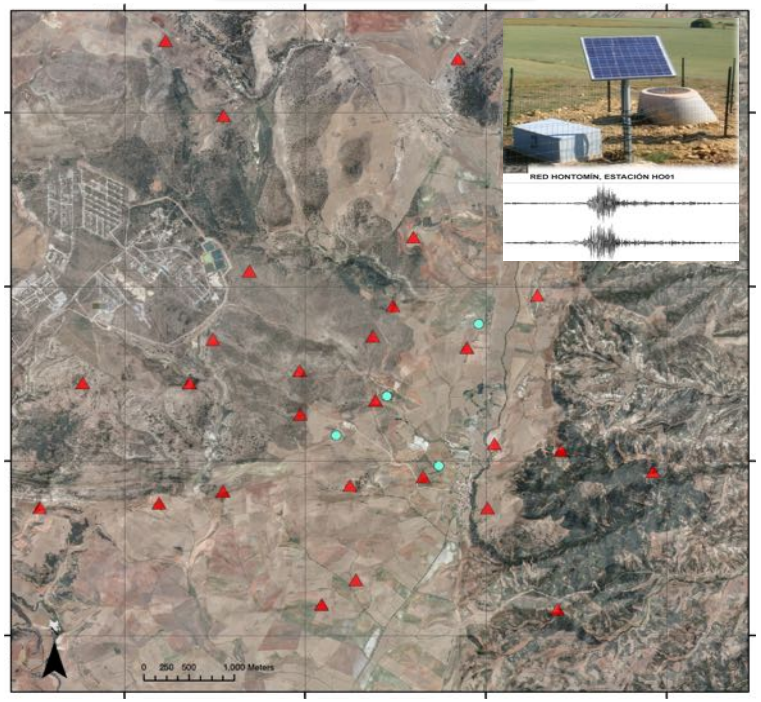




Operating Parameters
P up to 120 Bar
FR up to 5 Kg/sec
Brine (up to 40.000 ppm salinity)

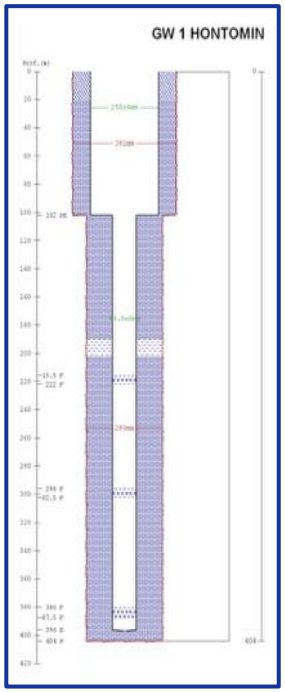
Engineering Design. Seismic and Hydrogeological Control Networks

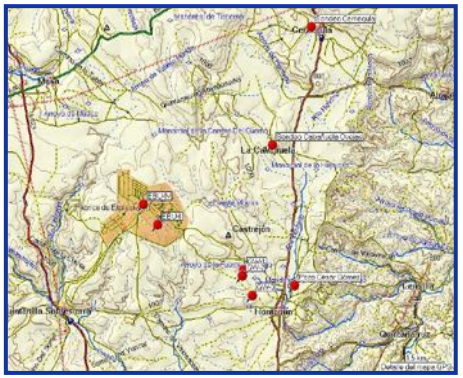
Seismic Network

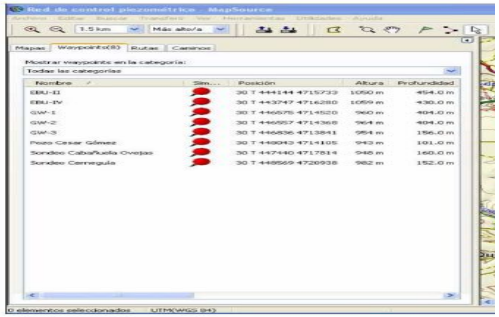


30 passive seismic stations
20 sensors SARA SS 45 (4,5 Hz)
10 sensors Lennarzt LE 3D (20 seconds period)
1 accelerometer
Specific software (Control Room)

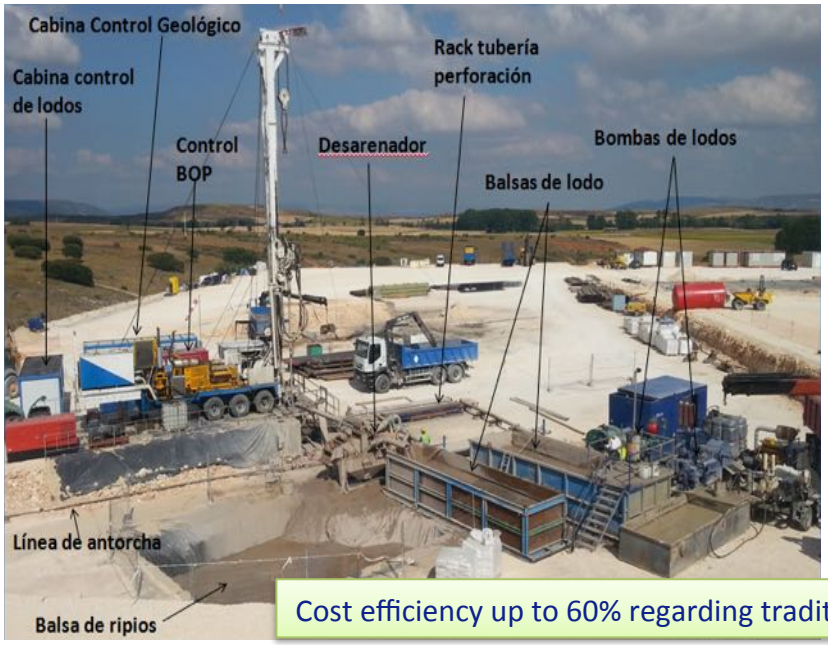
Hydrogeological Network

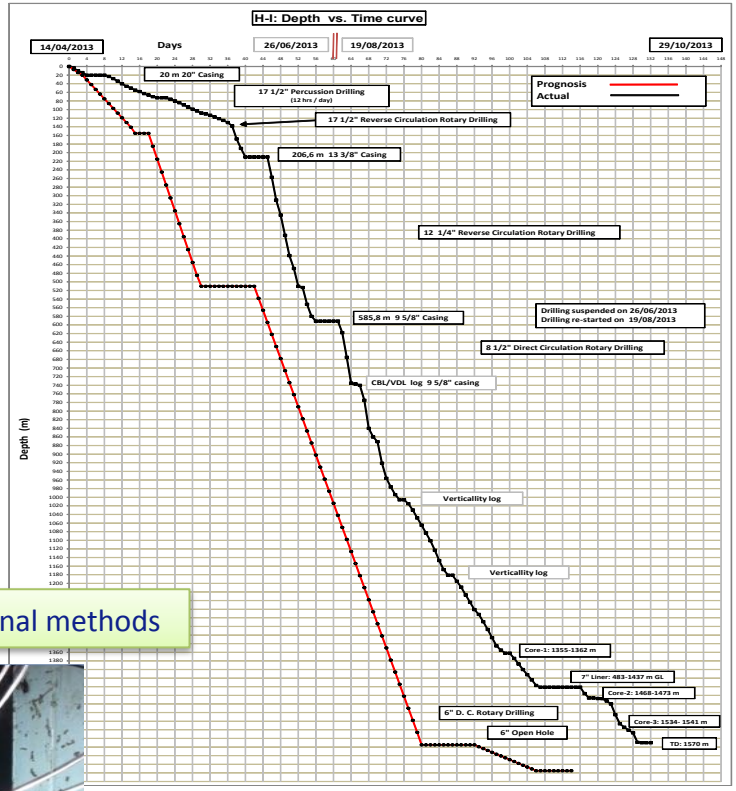




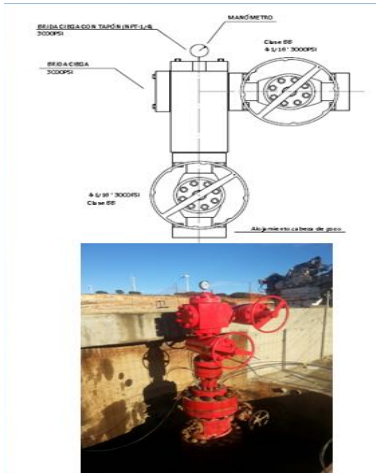


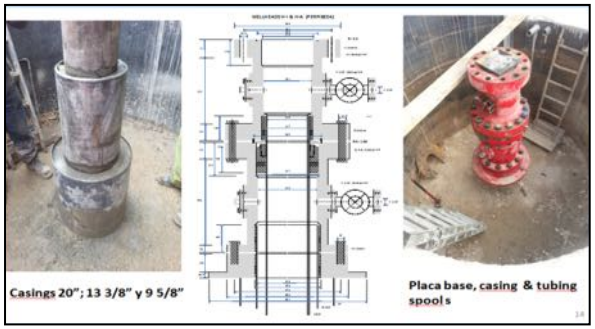
Construction. Wells-Light Drilling Technique





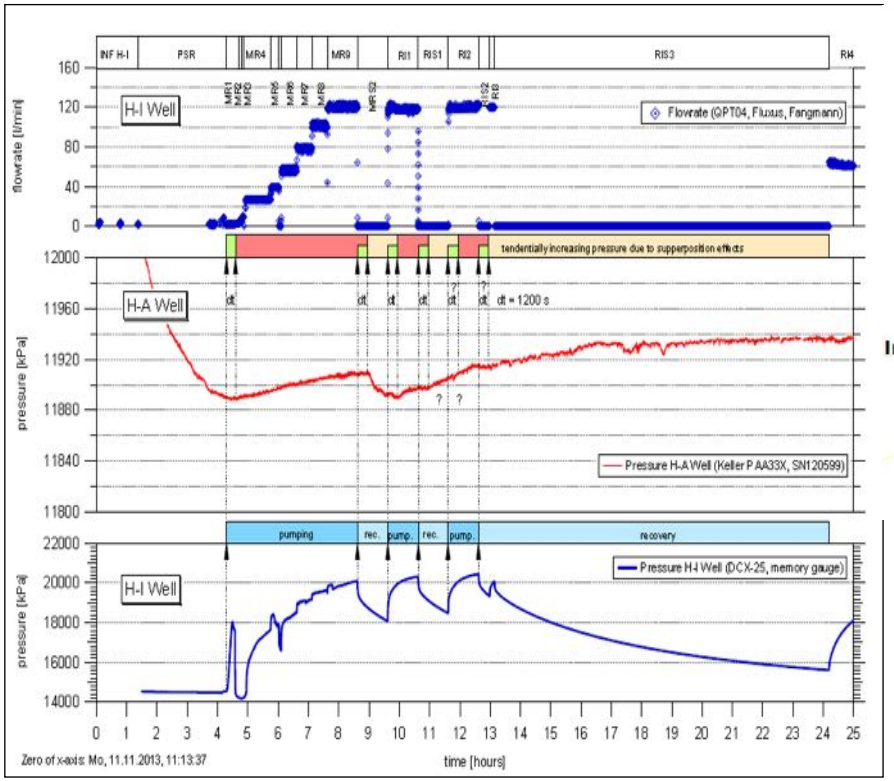
Cost efficiency up to 60% regarding traditional methods



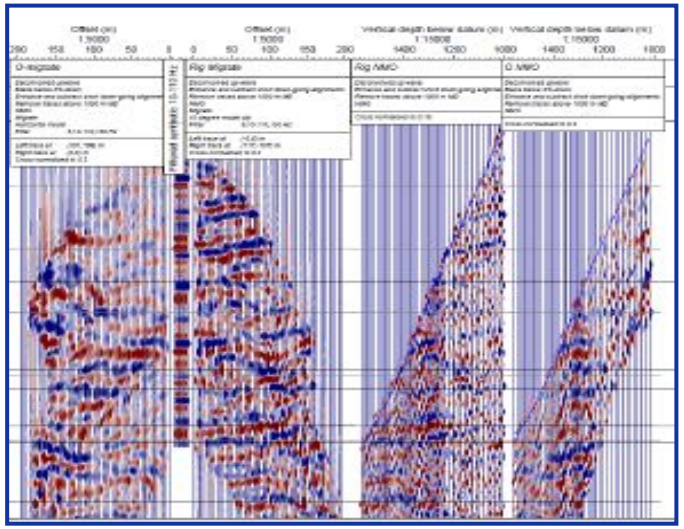


Construction. Wells-Connectivity tests and VSP campaign

Hydraulic Tests



VSP

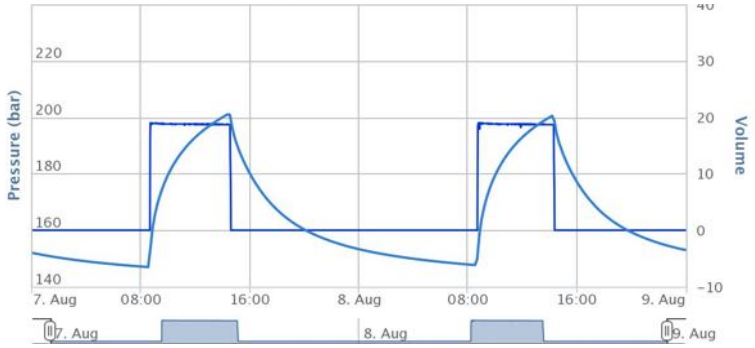


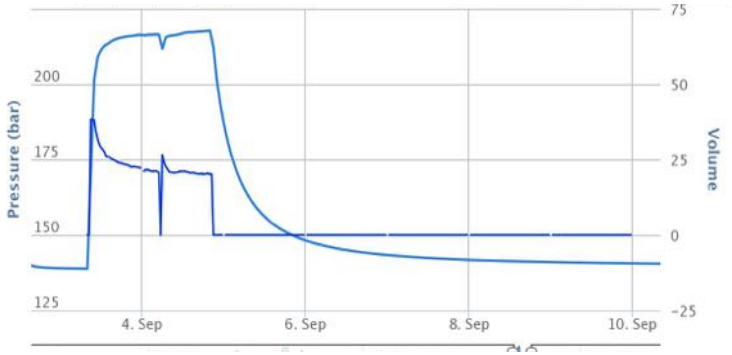
Both wells are in the same reservoir block

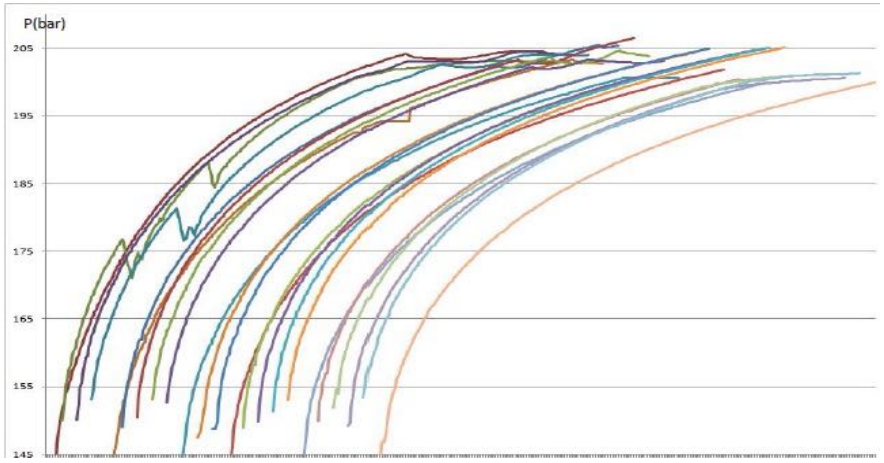
Commissioning

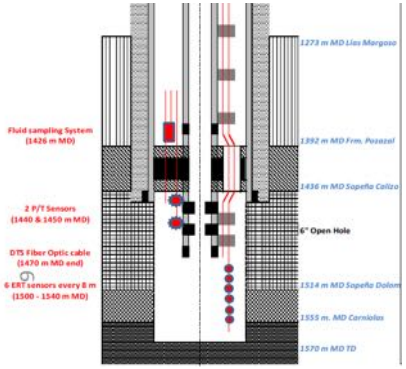
14.000 m^3 of brine and 1 t of CO_2 have been injected in the reservoir following the modes: “pressure control”, “flow control” and “injection-production” to determine the safe and efficient operation parameters (pressure, flow rate, temperature, etc)

Tests in the mode “Pressure Control” (Well HI)







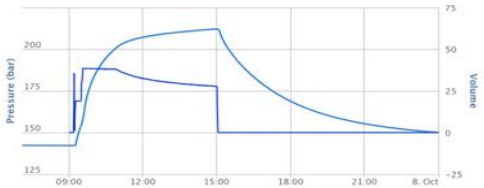


Further explanations at the lecture *“Injection strategies design and implementation in fractured carbonates”*

Starting the Operation. Supercritical Injection Strategy

1st Stage.-Injection well pressurization with brine

Formation water injection in the reservoir, tubing and head well up to 75 bar



2nd Stage.-CO_2 Conditioning to be injected

Pressure .-75 bar Temperature.-More than 10º C (to avoid hidrate formation)

3rd Stage.-CO_2 Injection

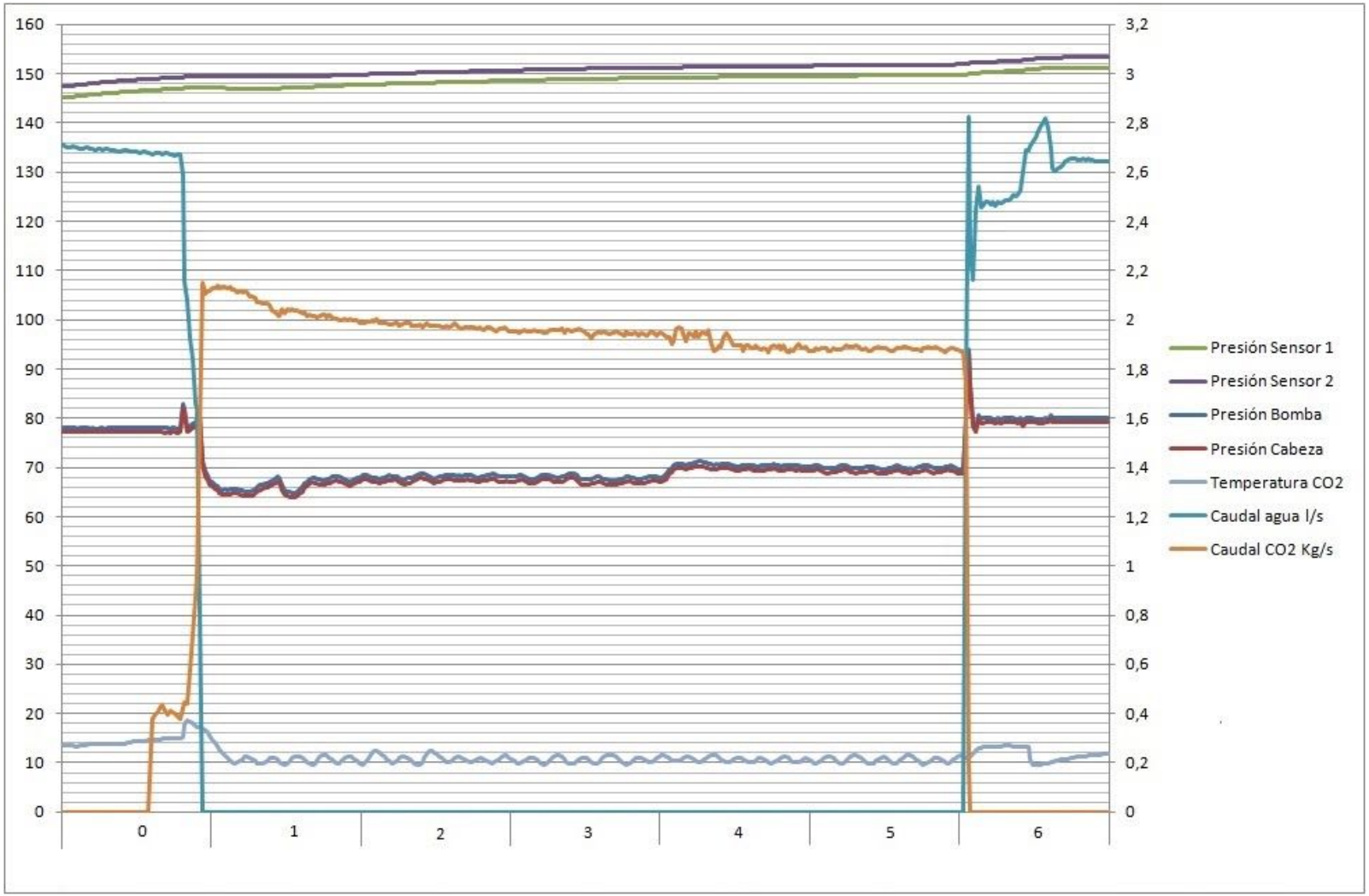
The carbon dioxide pushes the brine into the reservoir.

4th Stage.- Tubing cleaning

Brine injection in a volume double than the completion and well bottom volume value.

The operation parameters efficiency and the safe control method will be analyze at the lecture ***"Injection strategies design and implementation in fractured carbonates"***

Starting the Operation. CO_2 Supercritical Injection Strategy



Future Challenges

- Low cost drilling techniques (light equipment) as an efficient tool for exploration and construction activities. Except the EHR cases, CO_2 storage is an industrial process for waste treating in geologogical formations.

- Cost-effective injection strategies in fractured rock massifs with poor porosity and high anysotropy. Cold injection (avoiding the hidrates effects), solved with brine (regarding the mixture acidification), etc.

- Go further with the existing projects and studies to improve the alternative geophysical techniques (CSEM, Gravimetry, DIN SAR, GB SAR, etc)

- Deep monitoring tools to control the reservoir behaviour for the whole of the project life.

- Innovative dynamic modelling for a realistic capacity and plume evolution assessment.

- Advanced tools for the interpretation of the seismic response related with the injection operations.

- New abandonment well techniques

- Good practice guidelines reagarding the different project stages (exploration, construction-commissioning, operation, abandonment and the liability transfer) as the first step for developing an updated European Legal Framework for CGS.

Thank you for your attention

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