

Description of the infrastructure	
<b>Name(s) of the infrastructure(s)*:</b>	TA14.1 BRGM BIOREP
<b>Location (town, country):</b>	France
<b>Website:</b>	<a href="http://www.brgm.fr">www.brgm.fr</a>
<b>Legal name of organisation operating the infrastructure:</b>	BRGM
<b>Location of organisation (town, country):</b>	Orléans, France
<b>Infrastructure Contact</b> <i>(i.e. name, email of primary contact)</i>	Sébastien Dupraz s.dupraz@brgm.fr
<b>RICC Contact</b> <i>(i.e. name, email of secondary contact)</i>	Sébastien Dupraz s.dupraz@brgm.fr
*Infrastructure (s): means a facility, a resource (or a coherent set of them) together with the related services that are used by the scientific community to conduct research. **Installation: means a part of an infrastructure that could be used independently from the rest.	

**Description of the facilities**

Brief general description of the infrastructure to which access is offered highlighting its state-of-the-art equipment and services offered to users that make it rare or unique in Europe. Outline the areas of research normally supported by the infrastructure, as well as any possible new areas opening to users. If the infrastructure is composed of several installations\*\*, are these described here including their specific features. If parts of the infrastructure are still under construction, the description includes the starting date of construction and indicative date when access can realistically be made available.

## TA14.1 BRGM BIOREP

### Purpose and brief technical description, including figures as appropriate

#### Description of the facilities

The BIOREP facility is a high pressure set up to perform percolation and transfer experiments on fluid-rock interactions under a large range of pressure and temperature conditions, while continuously monitoring geochemical and bio-geochemical evolution. The facility is particularly adapted to monitor biological system evolution during the experiment.

The range of pressure and temperature of BIOREP allows for simulating conditions that are typical for CO<sub>2</sub> storage or for CO<sub>2</sub> leakage along a deep well or in the overburden. It could be also employed to simulate other subsurface storage conditions (e.g. other gas, water, oils) and systems of exploitation (e.g. geothermal, in-situ biolixiviation).

The facility could be used to conduct classical batch experiments, equilibration or transfer experiment between compartments through columns and also microfluidic percolations in highly pressurized micro-chips.

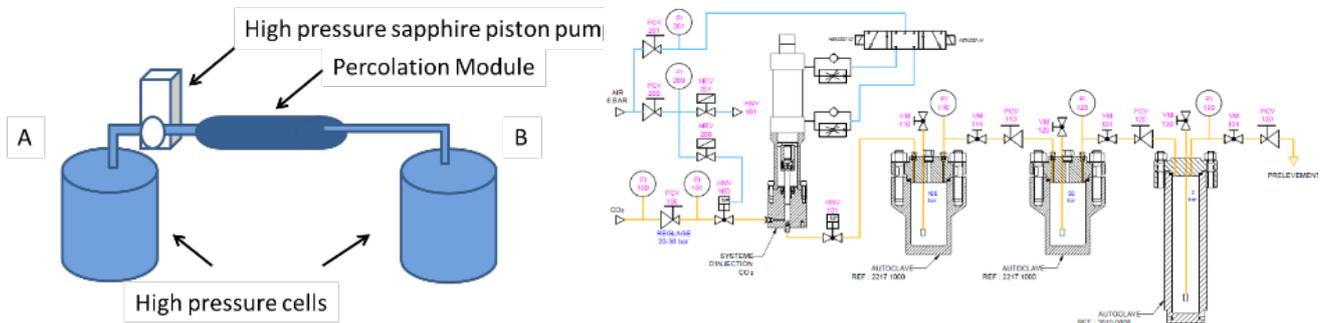


Figure 1: examples of possible set up in biorep

The percolation is performed between two or three high pressurized batch cells, with a high pressure syringes or a pump and can be applied to fluids (gas or liquids, supercritical fluids). Different setups can be realized to answer specific questions (i.e. with different types of regulating modules between these cells). For instance: Batch A can be set up with a predefined geochemical equilibrium and a gas phase can be introduced. A chosen reaction matrix (being crushed rock, sediments, pellets or synthetic material) inoculated with microorganisms can be tested in different percolation systems (column, Hassler cell or microcells). The B batch allows collecting fluids after percolation for sampling purpose. At the end of experiment, the column can be analysed.

Experimental conditions: Temperature from -10 to 120°C. Pressure up to 200 bar. Materials in contact with fluids: PTFE, PEEK, C276 (Hastelloy) and silica and borosilicate for the microfluidic cells. All the gases and liquids can be collected under pressure or progressively degassed to avoid risk and biases linked to decompression. The microfluidic line is being tested and should be ready to use in 2016. This line will allow online pH and redox measurements as well as direct microscopic/Raman observations. Moreover, a Hassler cell will be added to this platform during 2016 and will be also available after.

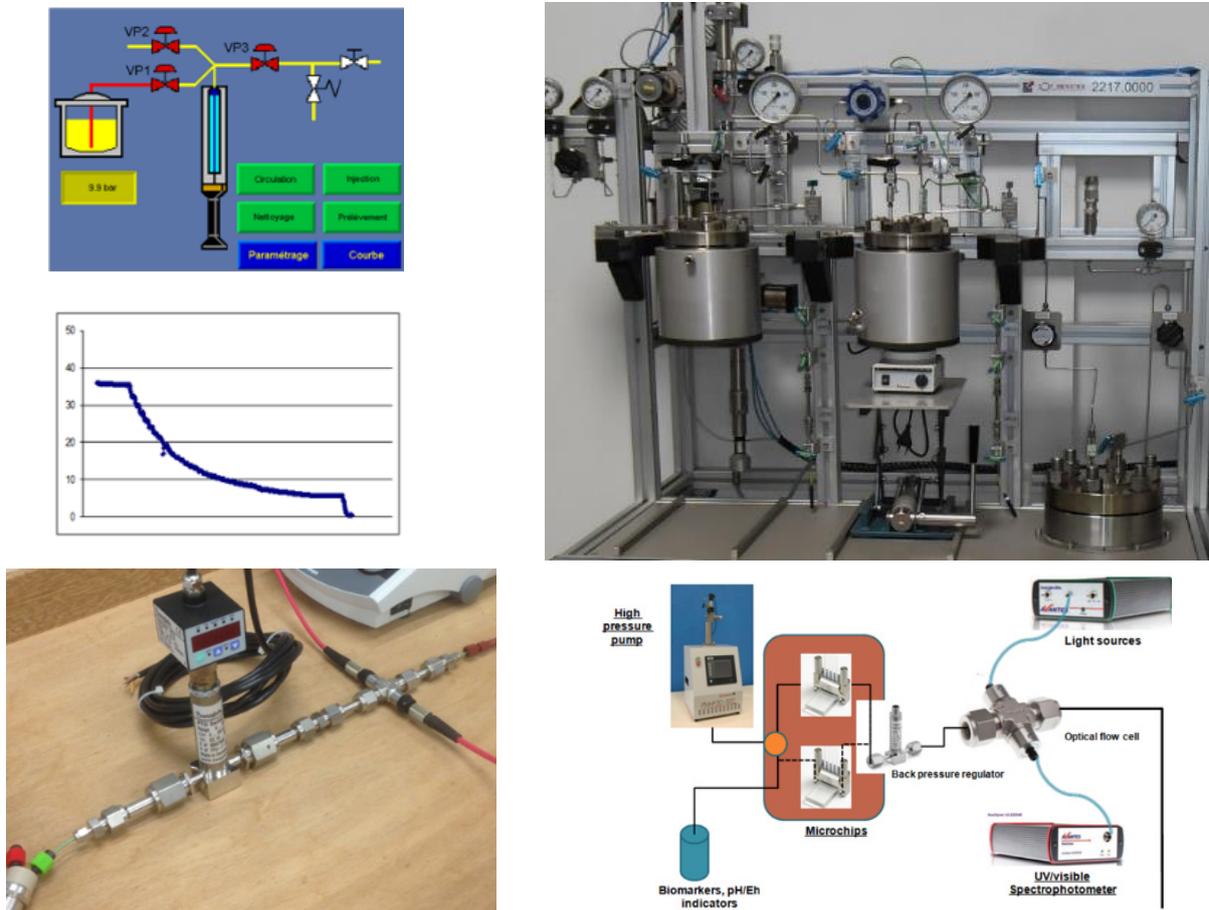


Figure 2: Example of set up with 3 batch cells and measurements systems on the microfluidic line.

**State of the Art, uniqueness (if applicable), and any specific advantages (e.g. technical, economic etc)**

BIOREP allows the monitoring of microbiological systems in high pressure and dynamic conditions, which is unique. In particular BIOREP differs from other facilities on the following properties:

- Respect of the biologic neutrality of the containment and limit the risk of bio-corrosion associated. Most material in contact with the studied medium and biological system is Téflon or Hastelloy.
- Sampling procedure and process adapted to micro biological material to ensure a slow decompression and avoid cell lethality related to decompression.
- Possibility of managing independently the batch's geochemistry and therefore to create gradients through the column between the two batches (for instance between oxic and anoxic areas).
- Possibility to use geological laboratories on chips as well as transfer cells (Hassler cell, columns).
- Pressure, temperature, gas consumption and regulation, flow rate, pH and redox can be monitored on line depending the designed setup.

**Scientific environment** (related and potentially available scientific and technical services at RI's location e.g. analysis, material preparation etc.)

Thanks to its modular and compartmentalized conception, BIOREP allows a wide range of experiments to study microbiological and geochemical processes with *in situ* conditions typical of, or related to (well, overburden condition), CO<sub>2</sub> storage.

## CCS PROJECTS:

### EU-funded CCS projects:

CPER Artenay (FEDER funding)

### Other CCS projects:

ANR CGS µlab, TGR-BF, CPER Artenay, STICCS and IMPER projects

### Main/major non-CCS projects:

### Patents:

“BIOREP” Patent Number: 1351753 (27/02/2013)

### Selected publications:

- Dupraz, S., Fabbri, A., Jouliau, C., Dictor, M.-C., Battaglia-Brunet, F., Ménez, B., Crouzet, C., Henry, B., Garrido, F., 2013. Impact of CO<sub>2</sub> concentration on autotrophic metabolisms and carbon fate in saline aquifers – A case study. *Geochimica et Cosmochimica Acta* 119, 61-76.
- Dupraz, S., Ménez, B., Gouze, P., Leprovost, R., Bénézech, P., Pokrovsky, O.S., Guyot, F., 2009a. Experimental approach of CO<sub>2</sub> biomineralization in deep saline aquifers. *Chemical Geology* 265, 54-62.
- Dupraz, S., Parmentier, M., Ménez, B., Guyot, F., 2009b. Experimental and numerical modeling of bacterially induced pH increase and calcite precipitation in saline aquifers. *Chemical Geology* 265, 44-53.
- Guyot, F., Daval, D., Dupraz, S., Martinez, I., Ménez, B., Sissmann, O., 2011. CO<sub>2</sub> geological storage: The environmental mineralogy perspective. *Comptes Rendus Geoscience* 343, 246-259.
- Ménez, B., Dupraz, S., Gérard, E., Guyot, F., Rommevaux-Jestin, C., Libert, M., Jullien, M., Michel, C., Delorme, F., Battaglia-Brunet, F., Ignatiadis, I., Garcia, B., Blanchet, D., Huc, A.Y., Haeseler, F., Oger, P., Dromart, G., Ollivier, B., Magot, M., 2007. Impact of the deep biosphere on CO<sub>2</sub> storage performance. *Geotechnological Science Report* 9, 150-163.

## FACILITY AVAILABILITY:

### Unit of access:

Week

### Availability per year:

Minimum 4 weeks

### Expected duration of single experiment:

4 weeks

## OPERATIONAL OR OTHER CONSTRAINTS:

### Specific risks:

Risk associated to high pressure vessels as well as to the use of pressurized gas.

### Legal issues:

