Aiming at characterizing and evaluating the potential storage complex and surrounding areas referred to in Article 4(3) of the European Directive 2009/31/EC (CCS Directive) it is stated that data collection shall provide sufficient information to construct a 3D model for the storage site and the storage complex. The intrinsic characteristics stated on this Directive, which shall be studied to the well understanding of the storage complex. This includes volumetric calculation of pore volume for CO₂, fluid flow behavior, related aspects (as dissolution/mineralisation rates), geomechanics concerning the seal and reservoir conditions, etc. However, it is worth noting that the data are given to fulfill these necessities. This contribution of the LaMeRoc presents a first attempt to summarize some key information with the objective of identifying laboratory procedures for rock characterization in CCS projects.

Several plugs were extracted following three orthogonal directions in order to assess anisotropic phenomena in the rock. Different properties, including the porosity distribution, have been also characterized via X-Ray microtomography. Worth mentioning is the development of pressure-dependent hysteretic phenomena affecting permeability.

A preliminary assessment, transport processes were studied in three orthogonal sections of the rock using electrical conductivity as a conservative tracer. Steady flow conditions were set in the experiments. An initial constant DIW flow was followed by the injection of a monovalent (NaCl) saline solution (1000 ppm) over a length of equivalent volume of one half of the pore volume of the plug. Temperature-corrected EC data was gathered downstream with a flow-through microelectrode. Results are being modeled.

When studying the properties of rocks (whether chemical, mineralogical or mechanical) it is important to have at hand reference materials, perform intercomparison (benchmark or ring) tests of specific experimental procedures, etc. Literature refers to a number of well-known sandstone reference materials (Berea and Fontainebleau sandstones, for instance). In general, any rock type could be used as reference material provided that a number of criteria (homogeneity, availability, accessibility, etc.) are met. In our case, we are considering a silicic continental tertiary sandstone (Anserica de Corridi) as a potential reference material. Here we present a summary of the characterization results obtained so far.

The MTS rig was also used to perform Brazilian (i.e. indirect tension) tests on 10 randomly oriented samples. The low tensile strength of the sample and the presence of anisotropy planes (bedding) resulted in a high number of failed experiments when tested under direct tension mode. However, when testing in an indirect tension mode (or attempting to do so), the samples responded to load. Again, after a certain time ($t$), the gas flows through the sample and the breakthrough pressure is determined. The effective permeability of the gas changes and tends to approach $P_c$ (The residual pressure difference is the breakthrough pressure).

The applied methodology allows for the sequential determination of both permeability ($k$) and breakthrough pressures ($P_c$). First, samples are saturated, based on a criterion of linear kinetics and stable conditions, when water flow becomes constant. It can be assumed that effective pore space ($S_e$) is full of water ($\text{H}_2\text{O}$) in equilibrium with injection pressure ($P_i$). After saturation, the sample is injected with gas (in this example, a mixture of $\text{CO}_2/\text{He}$, depending on the experimental rig). Once the injection pressure ($P_i$) is reached, the gas flows through the sample and the recorded downstream pressure ($P_d$) changes and tends to approach $P_c$. The residual pressure difference is the breakthrough pressure.

The reservoir capacity is being tested in terms of permeability and gas migration potential. Permeability and breakthrough pressure measurements tests are being performed using an experimental rig composed by a thermally-isolated high pressure core holder (massive-type) and pumps. The hydraulic system is compartmented in order to get good control of the volumetric properties and pressure.

Transport Properties: Permeability & Pore Distribution

The anisotropic behavior of the rock was also tested from the point of view of its direction-dependent acoustic velocities. The arrival time of $P_i$, $S$, and $V_p$ waves was picked onverting X-Y-Z samples in different directions (20 steps). The results illustrate that significantly lower velocities are obtained in the X direction. This is consistent with what is observed with permeability. The highest value is observed also in this direction.