IRSN
INSTITUT
DE RADIOPROTECTION
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SEALEX In-Situ Experiments- Performance Tests Of Repository Seals: Experimental observations and modelling

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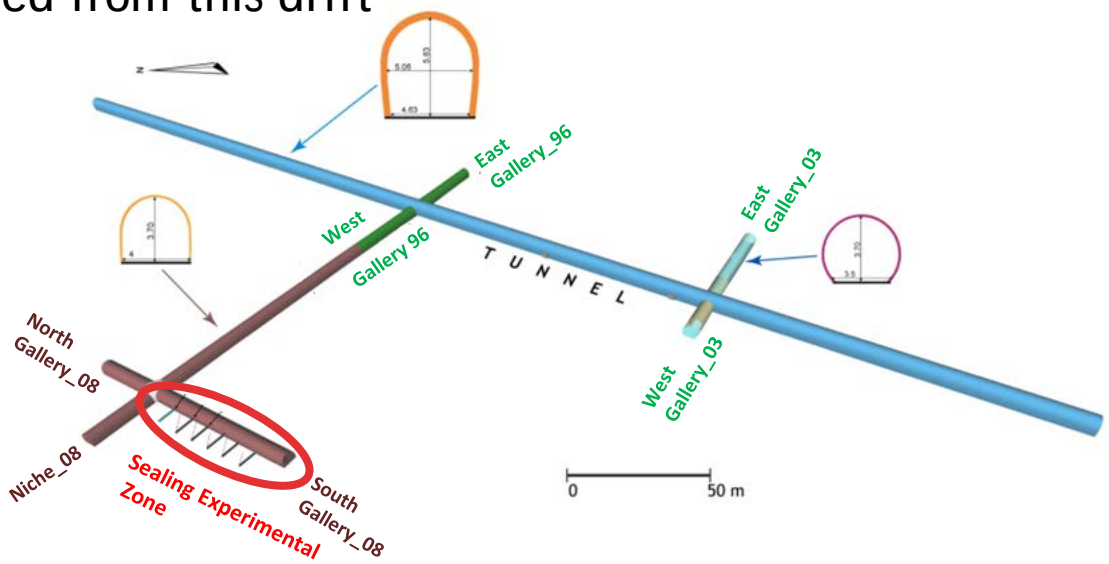
1-SEALEX experimental program

- New drift excavated in 2008 in Tournemire URL
- **6** SEALEX in-situ tests are installed from this drift

- Test the long-term hydraulic performance of sealing systems (in normal conditions), for different core compositions (pure bentonite, sand/bentonite mixtures) and conditionings (pre-compacted blocks or in situ compacted powder)
- Quantify the impact of intra core geometry —construction joints in the case of pre-compacted blocks— on the hydraulic properties of sealing systems
- Quantify the effect of altered conditions (loss of mechanical confinement)

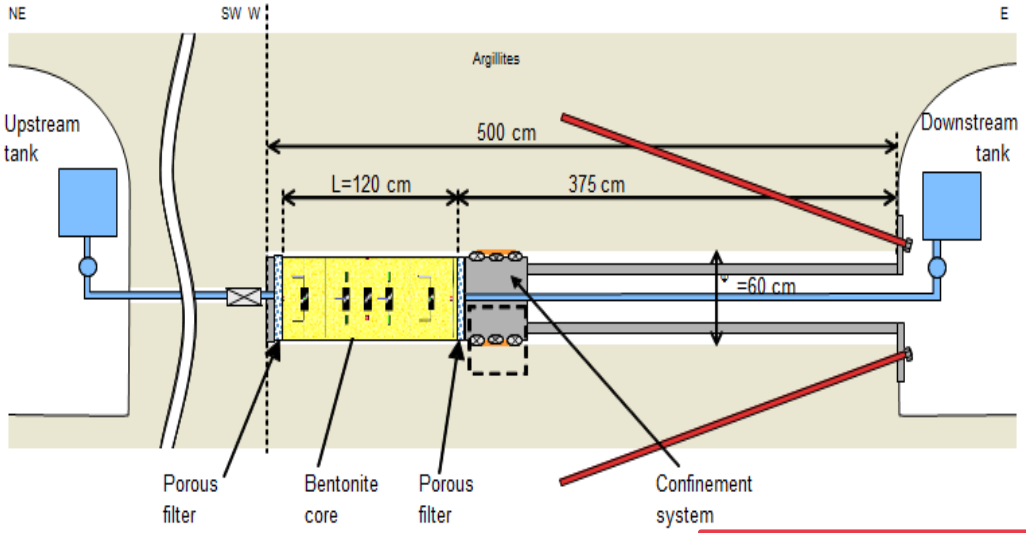


SEALEX program: Parametric approach

	Reference Tests	Performance Tests	Intra-core geometry Core conditioning Composition (Bentonite/sand)	Core view	Altered conditions	Emplacement date
Base case	RT-1	PT-N1	Monolithic disks Precompacted (70/30)		No	12/2010 06/2011
Variations / Base case	-	PT N2	Disks + internal joints (4/4) Precompacted (70/30)		No	12/2011
	-	PT A1	Monolithic disks Precompacted (70/30)		Confinement loss	06/2012
	-	PT-N3	Pellets/powder In situ compacted (100/0)		No	01/2013
	-	PT-N4	Pellets/powder In situ compacted (100/0)		Confinement loss	09/2013

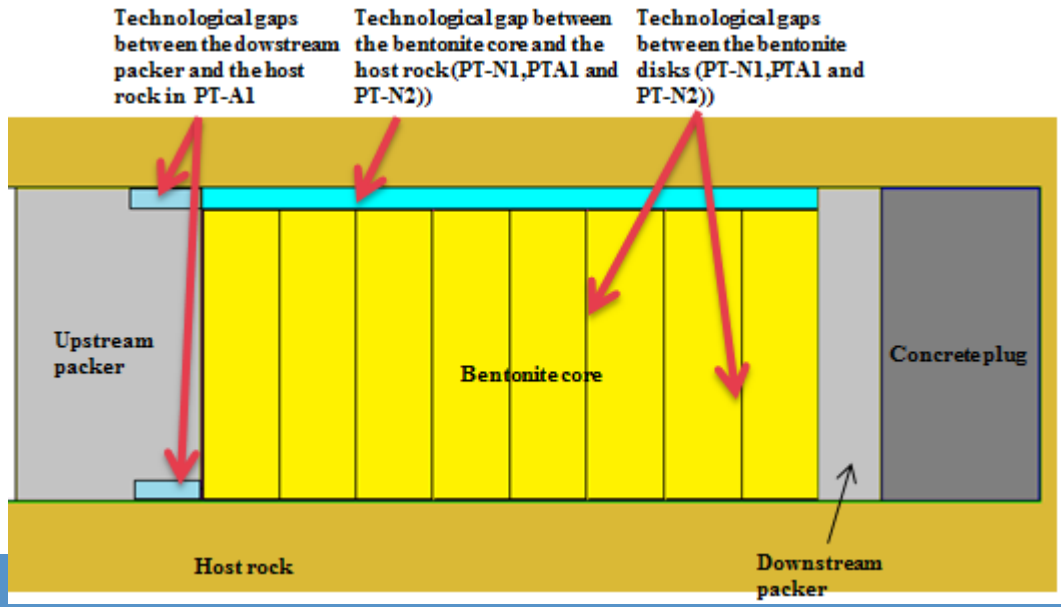
2. Description of SEALEX in-situ tests

Bentonite-based core **fully instrumented with 21 wireless sensors**: 5 σ, 8 P_p, 8 RH

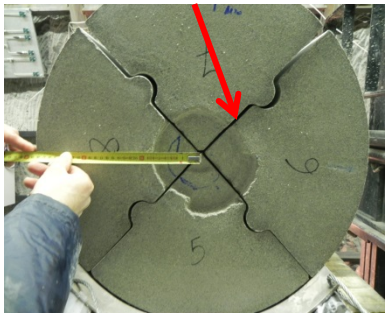


Flooding phase: fill as much and as possible with water all the technological voids 1 hour
The saturation phase: fully saturate the bentonite-based core from the water pressure condition imposed at both ends of the core.
The performance tests phase: hydraulic tests (pulse, injection…)
Confinement loss phase: removal of the axial confining pressure

Various Technological Gaps



Gaps within the bentonite based disks (PT-N2)

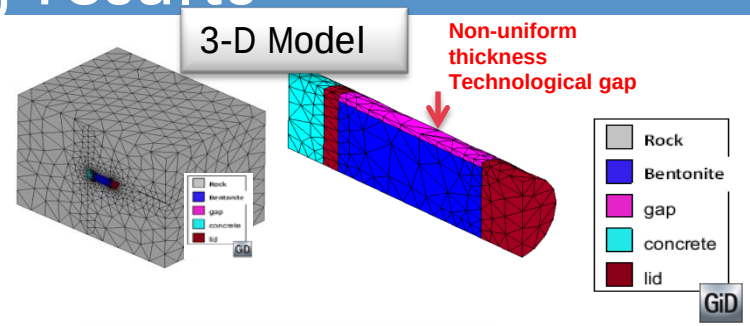


3. Experimental and modelling results

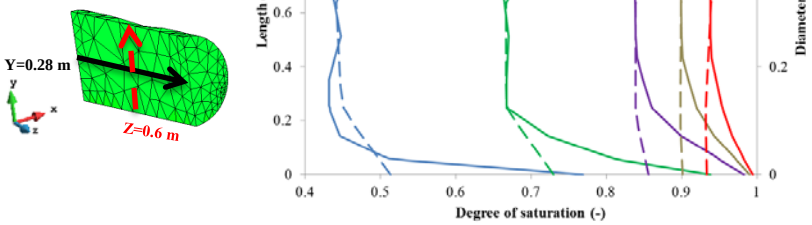
Base case: performance test, PT-N1

- Bentonite/sand mixture (70/30 dry mass)
- 8 monolithic pre-compacted discs
- Initial water content ~11%
- Initial dry density of 1.97 Mg/m3
- Non uniform technological void

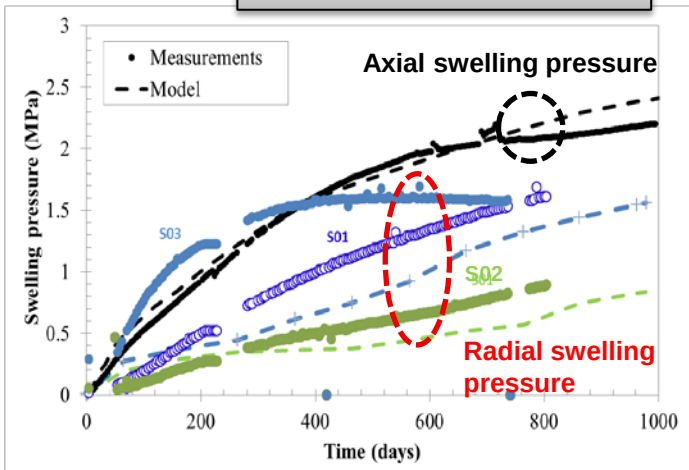
3-D Model

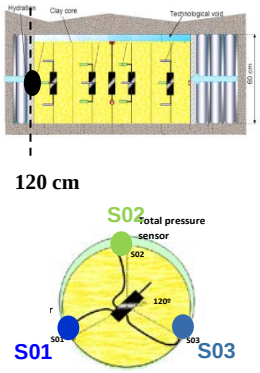


Saturation profiles

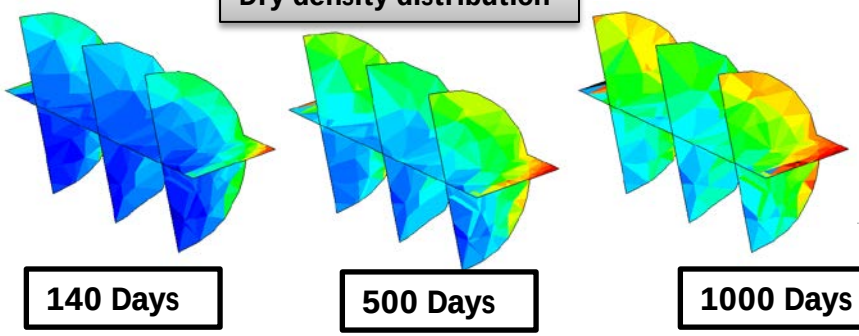


Swelling pressures evolution

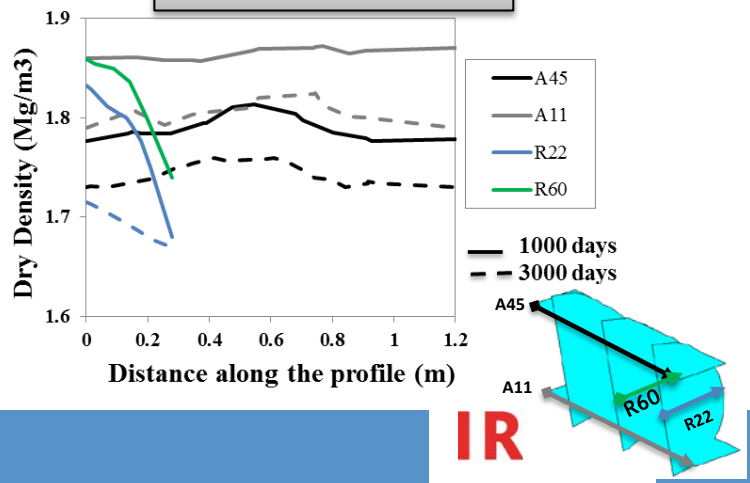




Dry density distribution



Profiles of Dry density



3. Outcomes

- Important role of the technological gap, on the saturation and swelling pressure kinetics.
- Different evolutions of radial swelling pressures suggests a heterogeneous structural distribution of bentonite/sand mixture within the blocks (confirmed by μ-CT observations).
- Heterogeneous distribution of dry density is observed.
- The non uniform thickness technological gaps increases this heterogeneous distribution of dry density.
- Remaining dry density gradient after ~10 years of hydration.
- The effect of this dry density gradient should be considered in the evaluation of long term performance of engineered barriers, which focus essentially on the required average dry density.

Thanks for your attention