CEMTEX Project: Physico-chemical evolution of concrete at high temperature in a radioactive waste repository in clay formation

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Context and objectives

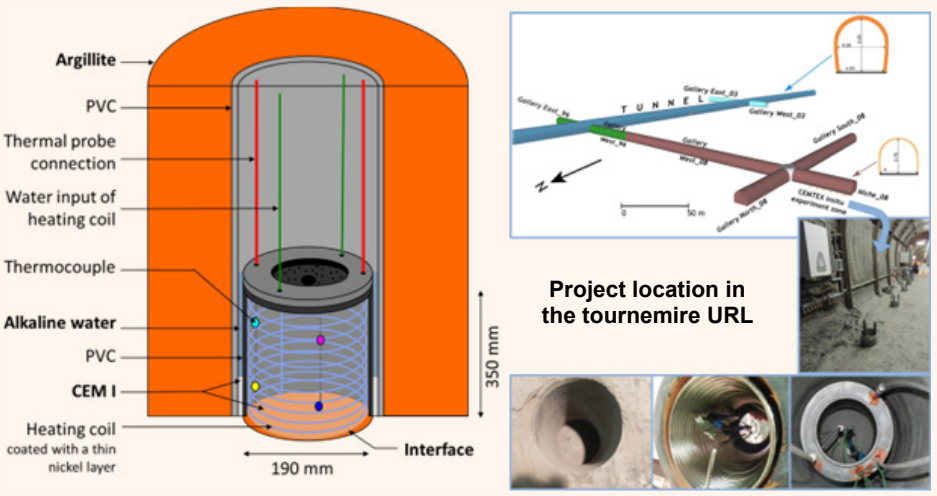
French radioactive waste disposal concept involves cementitious material in a clayey host-rock. Two types of cement are considered: CEM I and low-pH binders. The CEMTEX project focuses on studying the evolution of chemistry, porosity and diffusion properties around argillite/cement paste interfaces at 70°C (temperature that may be reached in the IL-LW and HLW cells).

What are the impacts of clayey environment on the cementitious materials at 70°C?
Does the temperature significantly affect the containment and swelling properties of argillite?

CEMTEX In situ

Protocol

6 experiments under saturated conditions:
3 CEM I and 3 low-pH cement pastes.
Duration: 1, 2 and 5 years at 70°C.

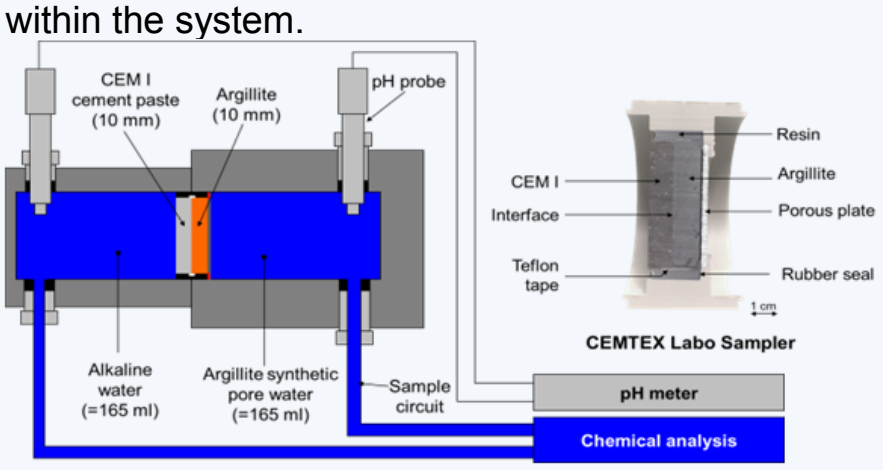


CEMTEX in situ borehole device

CEMTEX Labo

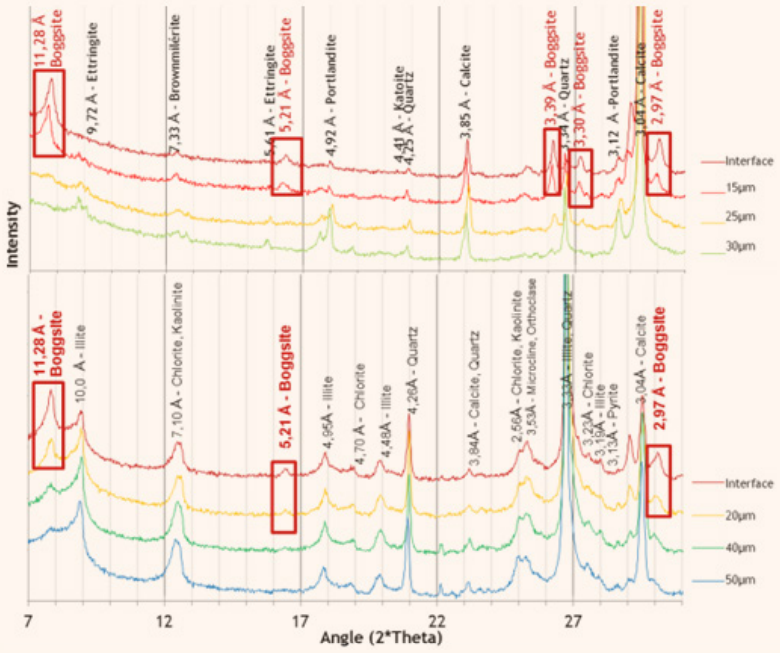
Dedicated diffusion cells are designed to reproduce cement paste / argillite interfaces in saturated conditions. The cells are placed into a thermal chamber in order to maintain 70°C.

A two part experiment:
- The reservoir contents are analysed periodically (anions, cations, C-content).
- After 2, 6 or 12 months, cells are dismantled and in others cells, tracers are injected and followed within the system.



Diffusion cell

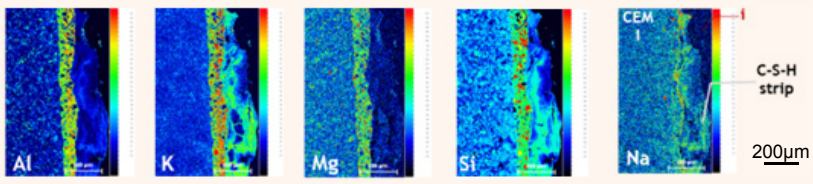
Results



CEM I (up) and argillite (down) XRD patterns (Cu-Ka) of the argillite/cement paste interface after 1 year contact at 70°C

Zeolite (analcime-type) formation is observed around the interface.

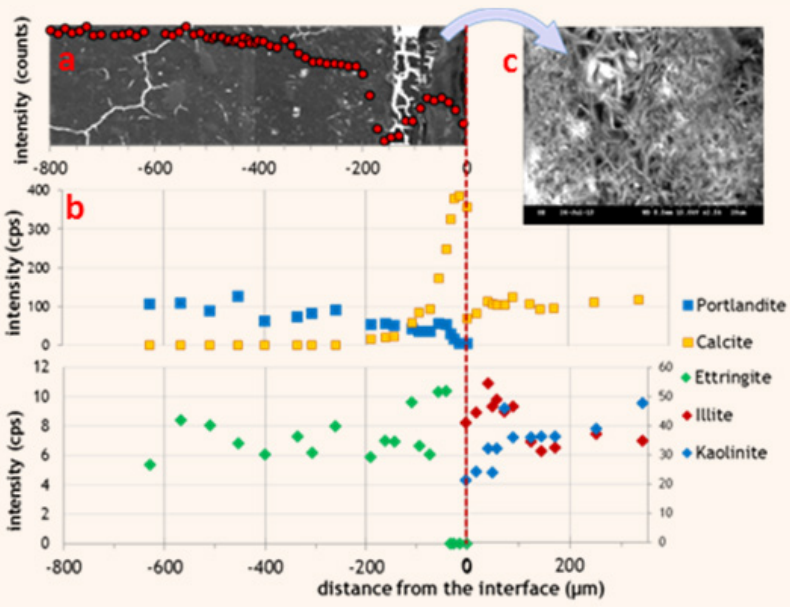
Retention capacity increase?



SEM-EDS elementary mappings of the argillite/cement paste interface after 1 year contact at 70°C

Cation enrichment zone is observed in the interface area.

Formation of a barrier to diffusion?



a) SEM picture of the interface with the Ca profile (EDS) ; b) XRD minerals profiles; c) C-S-H layer formation (SEM)

Carbonation, decalcification, leaching and illitisation are the main processes highlighted.

Porosity and cationic exchange evolutions?

Conclusion

According to these first results, the temperature increase has a positive impact on the cementitious material durability: carbonation, zeolite formation and low decalcification.
Nevertheless, the argillite is losing part of its containment and swelling properties, potentially due to an illitisation process.

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