P12: Transport and water dynamics in the nanopores of C-S-H

Vadim Yermakov[1,2] , Jeff Chen[1] , Peter McDonald[2]
[1] Lafarge Research Centre, [2] University of Surrey

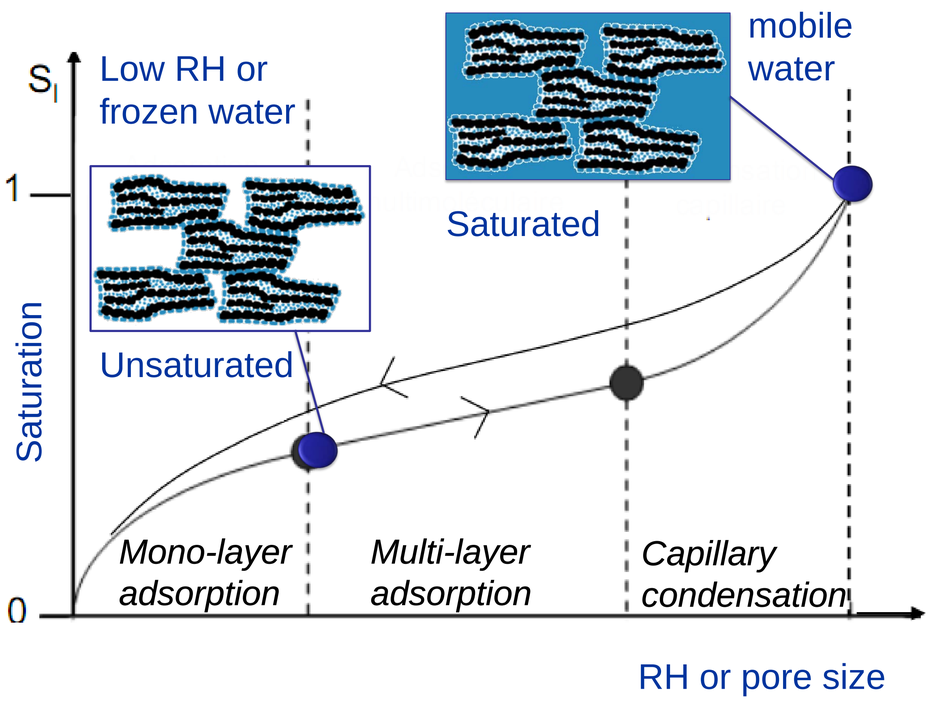
A native of Belarus, Vadim Yermakov got his Diploma in Physics at the F. Skaryna Gomel state University in Belarus in 2007. He started to work at Lafarge Centre of Research Oct 1st, 2011.

The main goal is to investigate water transport and cement morphology at the nano and especially meso scale. At the moment there is a lack of information about what type of pores form a connected network. Another question to be answered is how does water move at the nanoscale?

In order to investigate pore connectivity in cement we propose to combine NMR 2D relaxation exchange analysis and NMR cryoporometry. Demonstrate of such as experiment - which is novel - shall be highly applicable to transport studies in cement and it will give new experimental data on pore connectivity and diffusivity in C-S-H pores. Coupling of relaxometry and cryoporometry requires getting both methods working routinely at Lafarge.

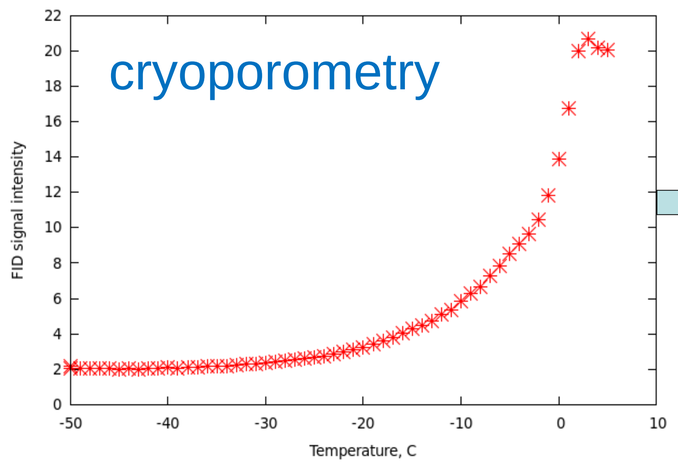
Method

Measure diffusivity on paste/compacts at different water contents by varying RH or ice content.



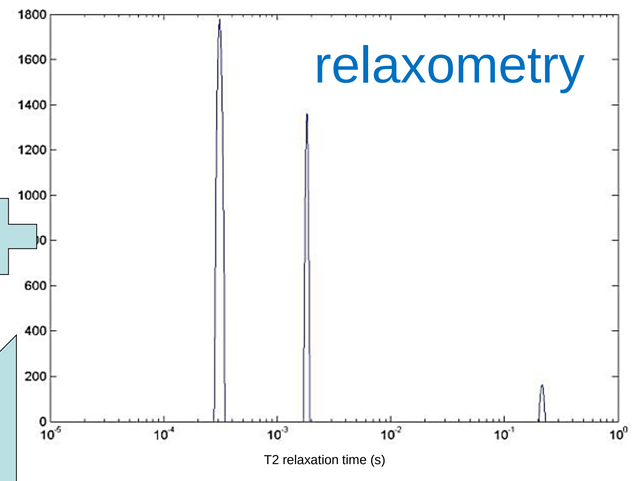
Approach

Using cryoporometry as proposed by Strange (1993) measuring total NMR signal during melting one can map it to pore size distribution via Gibbs-Thomson equation.



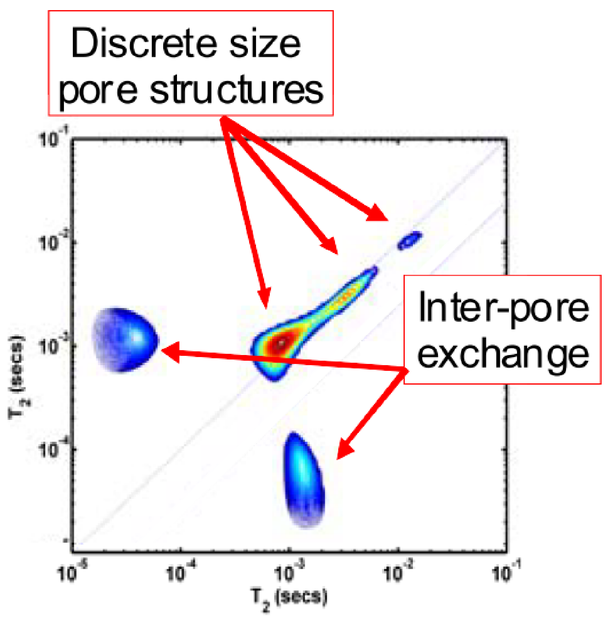
Cryoporometry performed on a 3 days old cement paste w/c = 0.4.
Liquid water signal increase with the temperature as water melts.

Difference between water trapped in the porous system to the bulk water measured by relaxometry is used to access pore size distribution.



Relaxometry performed on a 3 days old cement paste w/c = 0.4 at +25 C
Shorter relaxation times (T2) match smaller pores.

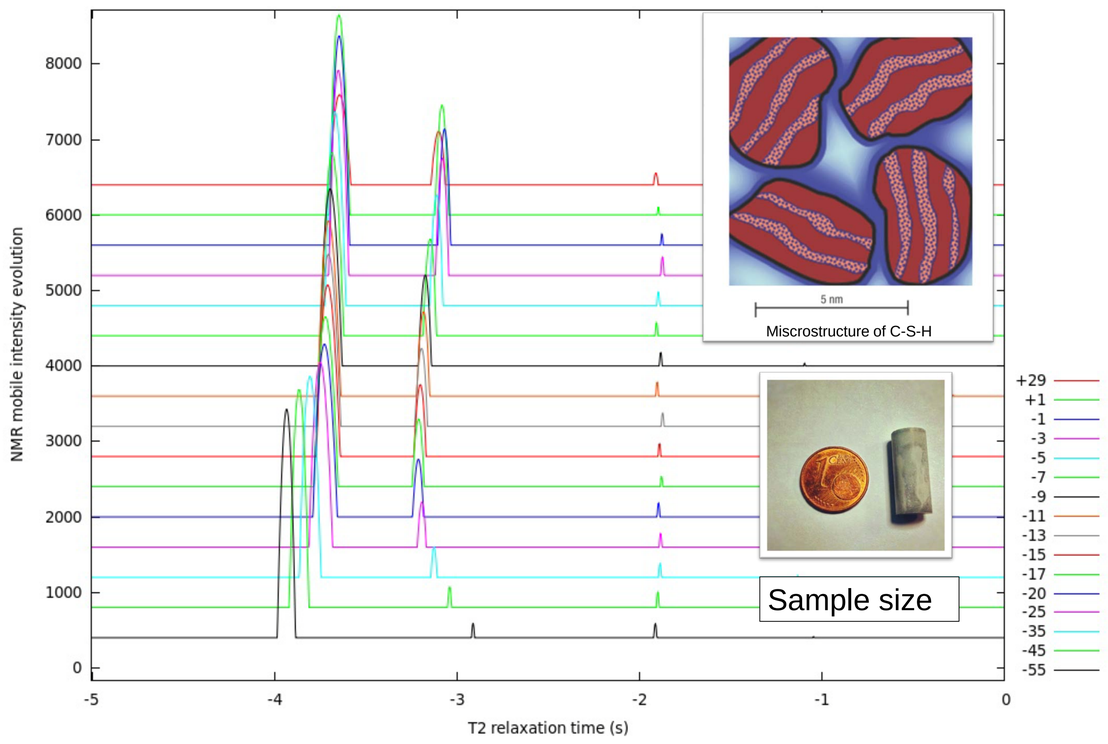
Future work



2D T2 -T2 NMR exchange spectrum of cement

By combining both methods, you can selectively investigate different parts of the pore system. For example, by progressively freezing a saturated sample, you can effectively 'freeze out' the larger capillary pores, while leaving water in the smaller gel and interlayer pores of C-S-H. From a 'T2-T2' test you can then find out how water is transporting uniquely in C-S-H.

Results



Combined cryoporometry-relaxometry experiment performed on the 3 days old cement w/c=0.4

Reference: J.H. Strange, M. Rahman, E.G. Smith ,Characterization of porous media by NMR (1993*) Physical Review Letters*
R M E Valckenborg, L Pel and K Kopinga , Combined NMR cryoporometry and relaxometry (2002) *Journal of Physics D*

ACKNOWLEDGMENTS: The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7 / 2007-2013) under *grant agreement* 264448.