Influence of calcination temperature in the pozzolanic reactivity of a low grade kaolinitic clay

Adrian Alujas

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CIDem
centro de investigación y desarrollo de estructuras y materiales

Proven pozzolanic properties when calcined under specific conditions (1:1 > 2:1)

Widely available all over the world

High grade clay deposits	Multicomponent clay deposits (common clays)

High grade kaolinitic clays → MK

Cement industry + (Paper industry, ceramics…)

Poor availability for raw materials and high demand from other industries limit its massive use as SCMs

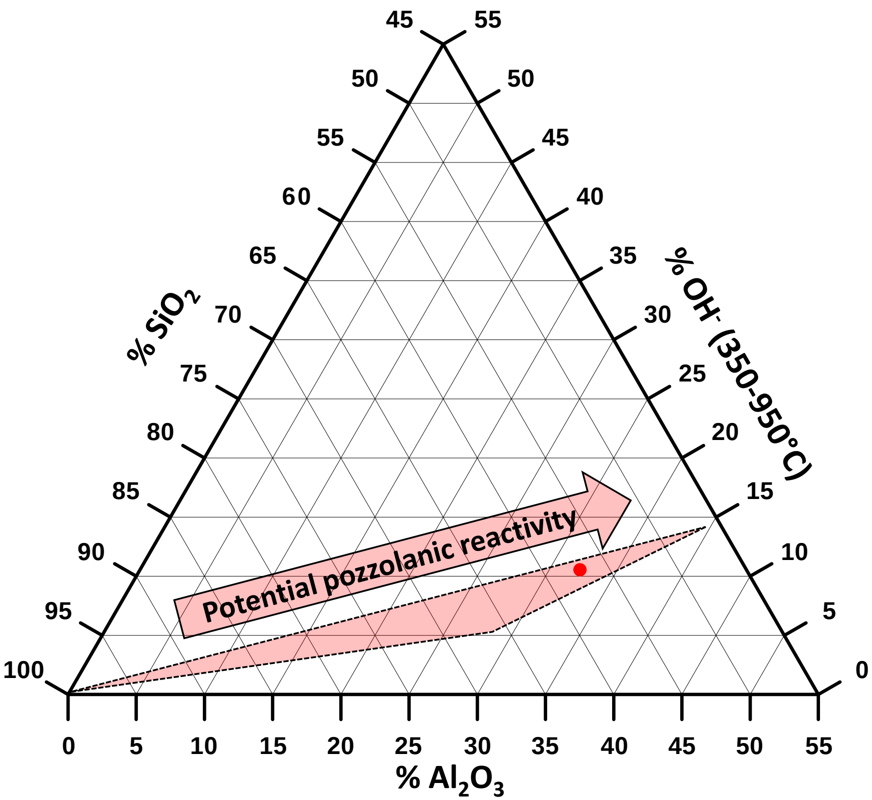
Low grade kaolinitic clays → ?

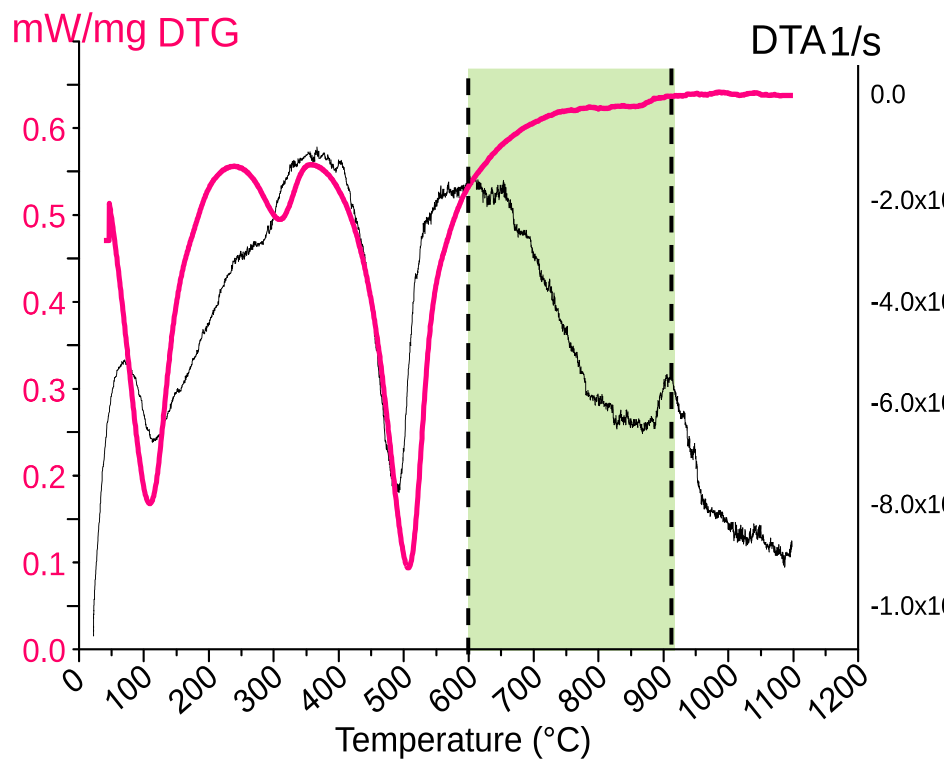
Widely available, specially in tropical and subtropical regions (developing countries)

Poorly studied as a source of SCMs!!!

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	K_2O	MnO	Na_2O	Others	LOI
43.89	24.73	11.13	1.38	2.63	0.08	1.10	0.14	1.99	3.11	9.81

1:1 Clay minerals (~ 40%)	2:1 Clay minerals (~ 40%)	Others
Kaolinite	Montmorillonite, Illite	Quartz, Albite, Gohetite

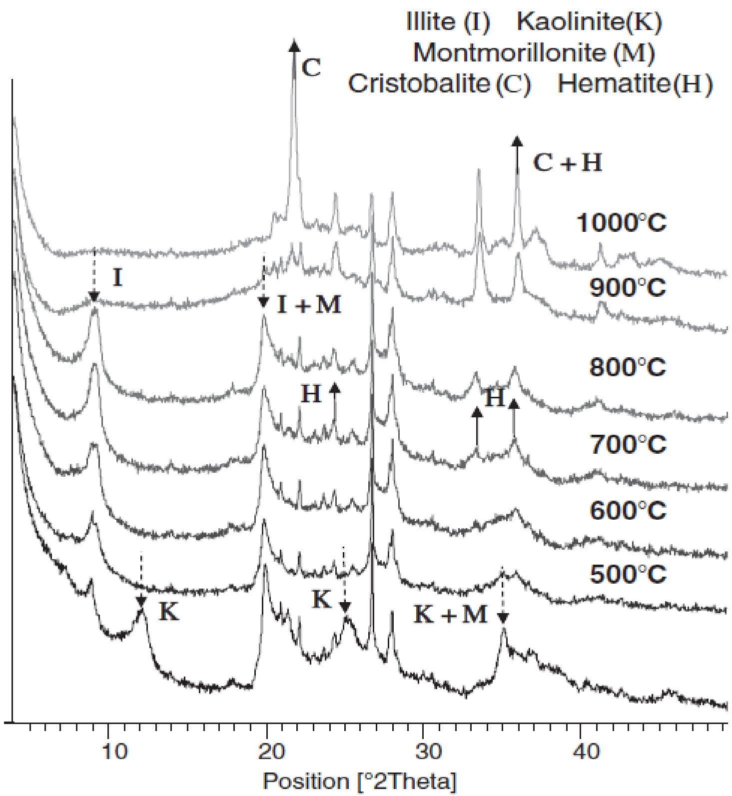




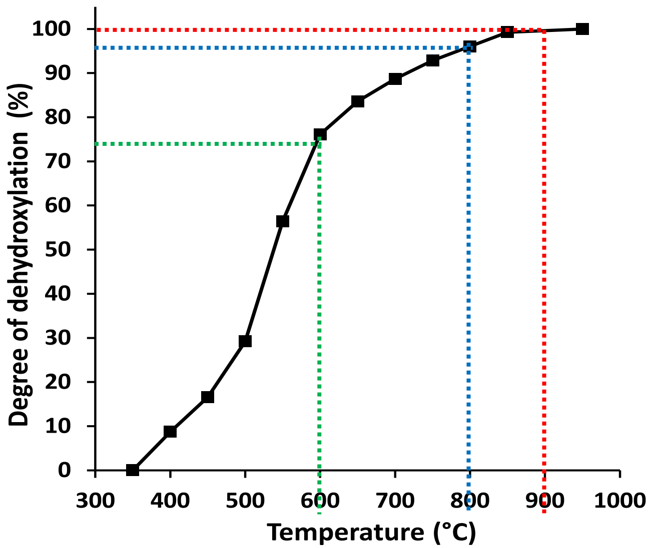
Raw clay (powder)

500°C 60 min 1000°C

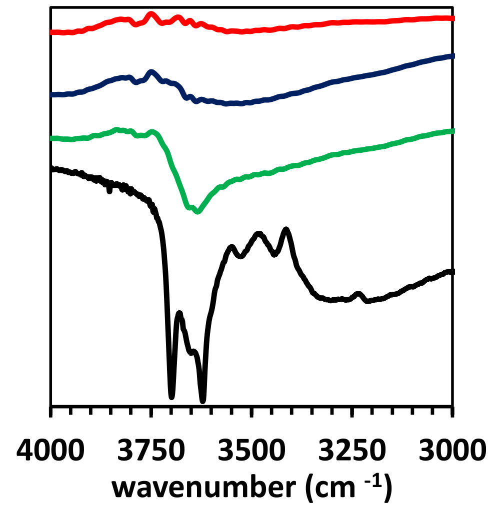
XRD Calcined clays



Degree of dehydroxylation



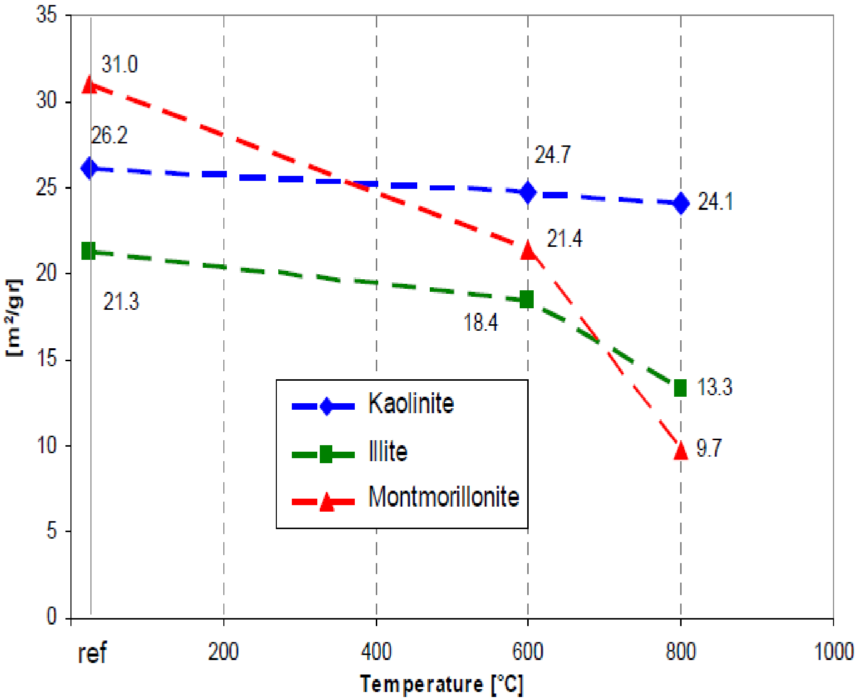
FTIR



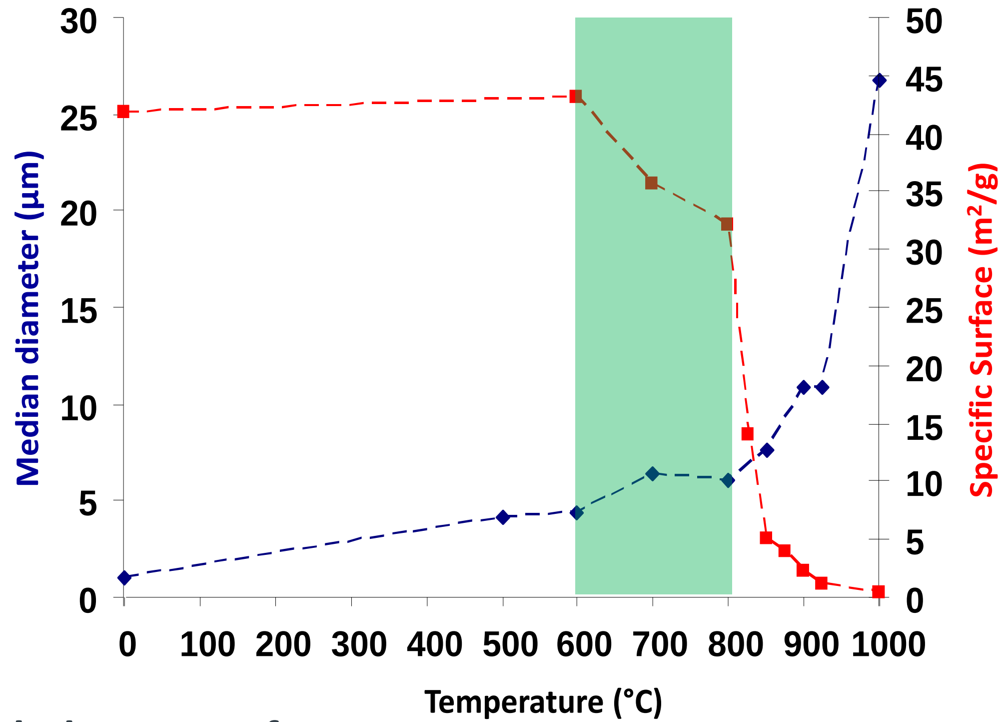
925°C Complete thermal activation of clay fraction, onset for the recrystallization of new phases

800°C Almost complete dehydroxylation of 2:1 clays, Illite detected by XRD

600°C Dehydroxylation of kaolinite, 2:1 clays detected by XRD and FTIR



(Fernández López, Martirena Fernández et al. 2011)



High decrease of Specific Surface

600°C **800°C** **900°C** **1000°C**

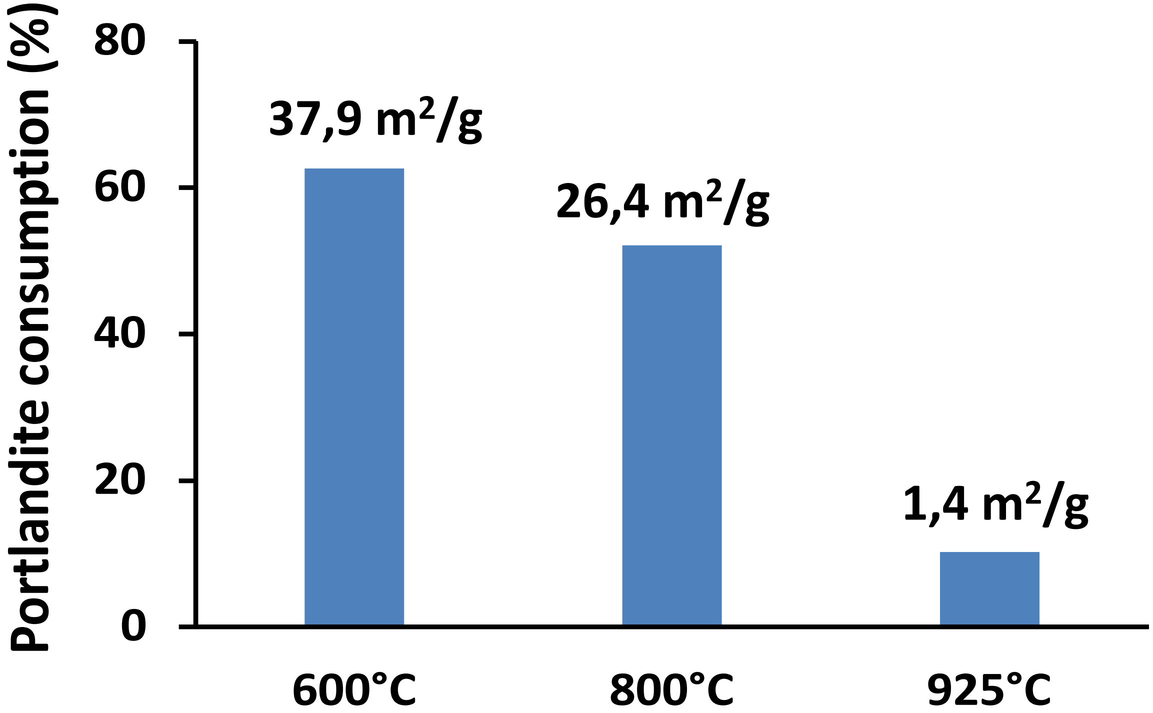
Correlated decrease of Sp. Surface and increase of particle size

Coarsening, little impact on Sp. Surface

70% OPC (42.5 Mpa) | 30% Calcined clay

Pastes

Consumption of Portlandite in blended pastes at 90d normalized by Porlandite in OPC

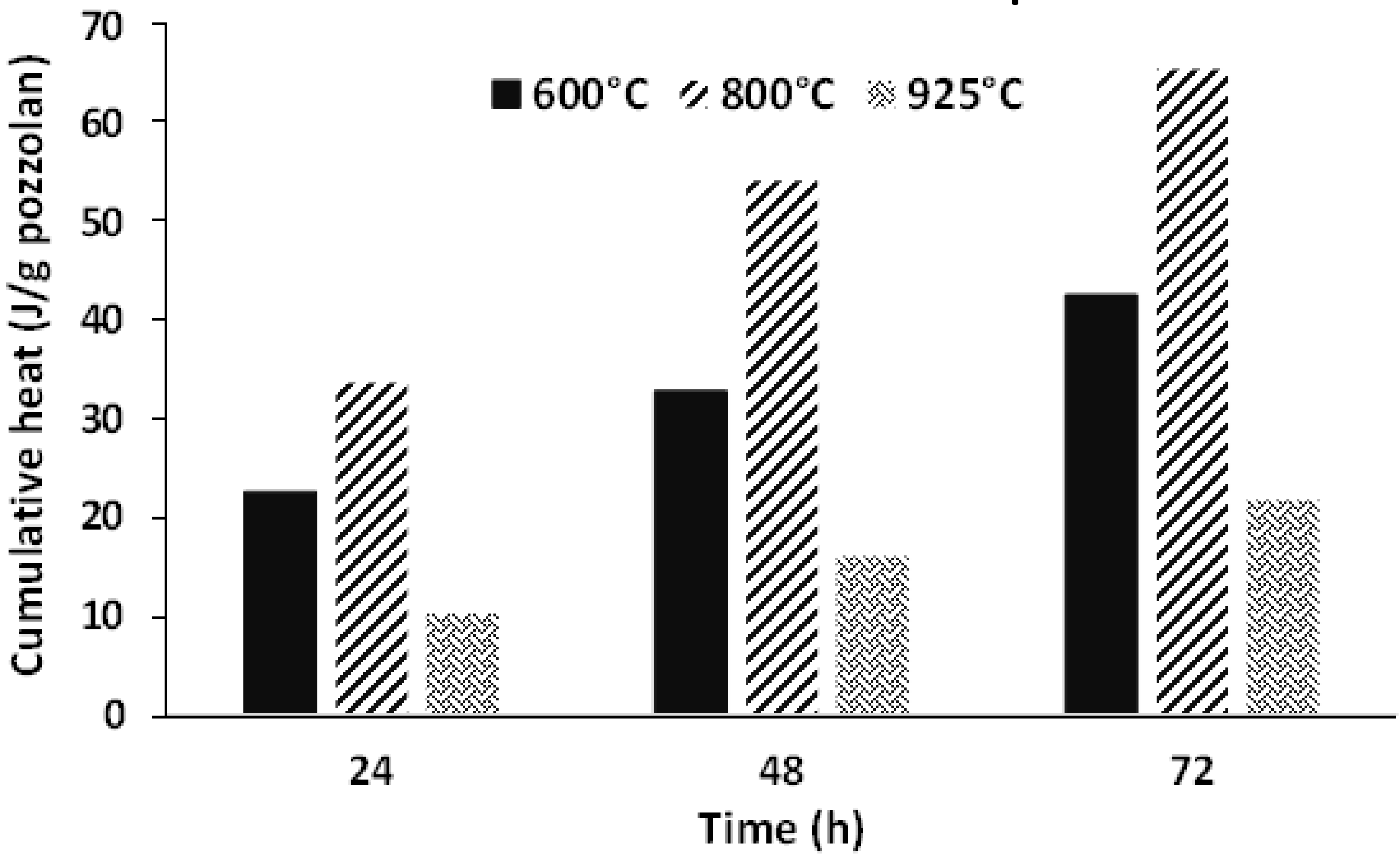


40% $Ca(OH)_2$ | 60% Calcined clay

Pastes

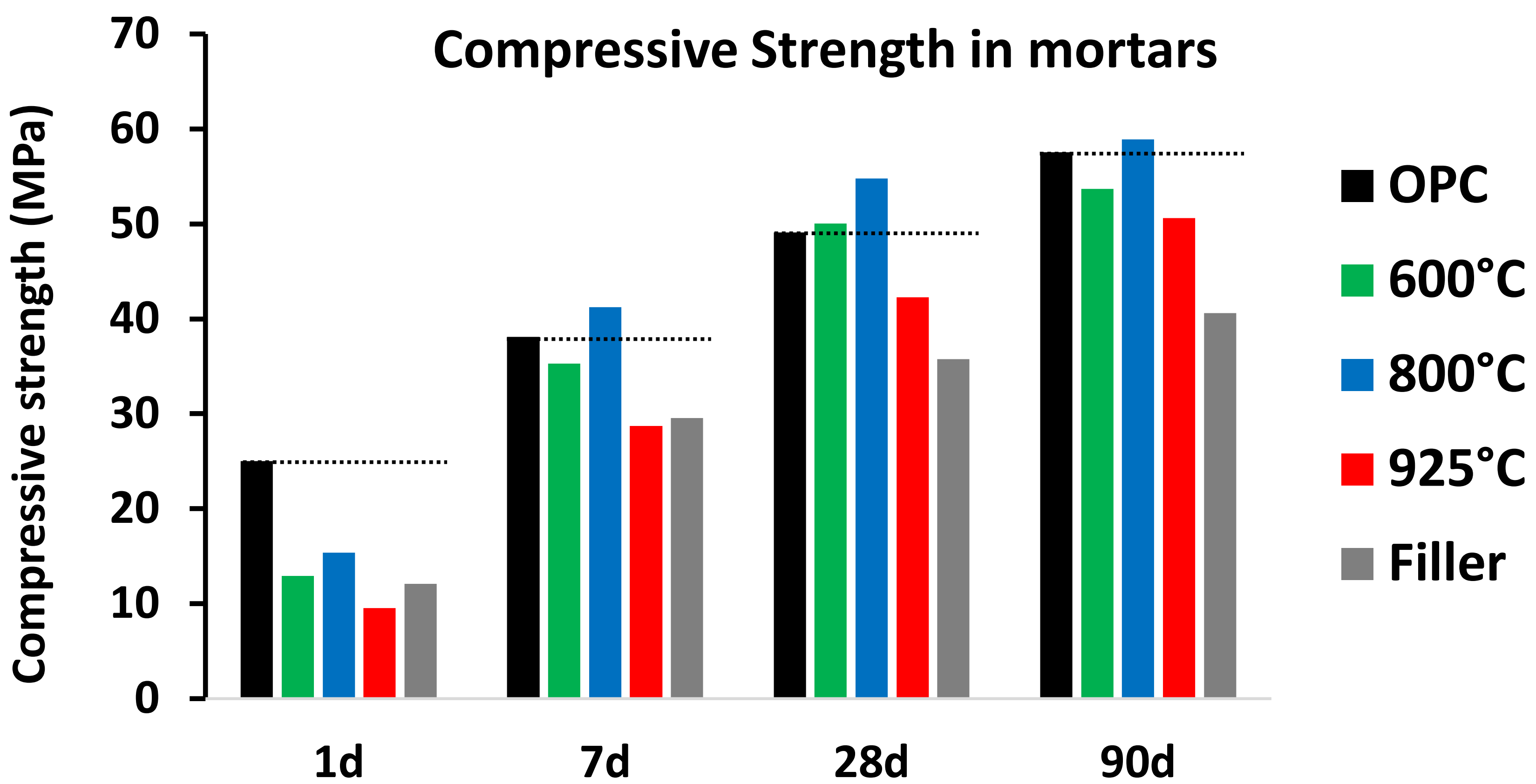
+ 0.5 NaOH

Cumulative heat in Lime-Pozzolan pastes



70% OPC (42.5 Mpa) | 30% Calcined clay

Mortars



CONCLUSIONS

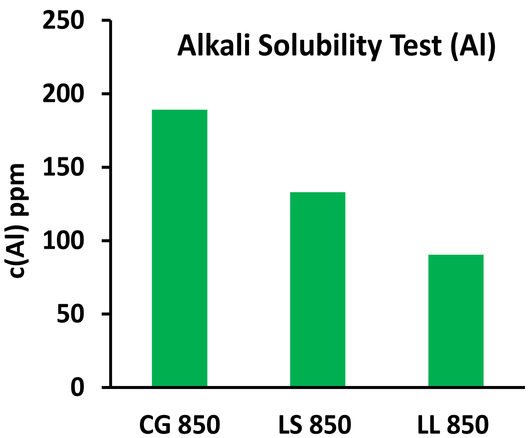
The investigated low grade kaolinitic clay, containing both kaolinite and 2:1 clay minerals, shows the highest pozzolanic reactivity when calcined at 800°C, a calcination temperature which represents the best compromise between a high degree of thermal activation of the clay fraction and a high specific surface.

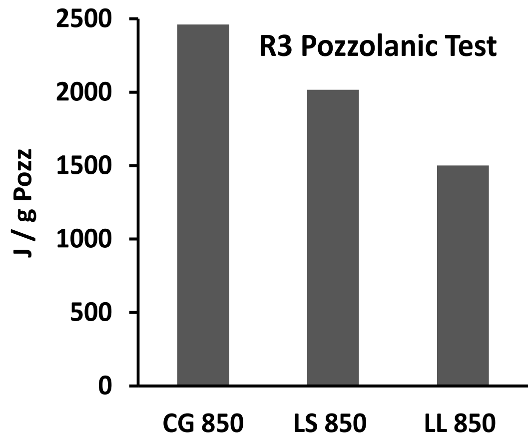
The pozzolanic reactivity appears to be primarily driven by thermal activation of kaolinite at temperatures around 600°C. At higher temperatures the contribution from thermally activated 2:1 clays should not been ruled out. The increase in pozzolanic reactivity with calcination temperature up to 800°C could be associated to a more complete thermal activation of the clay fraction.

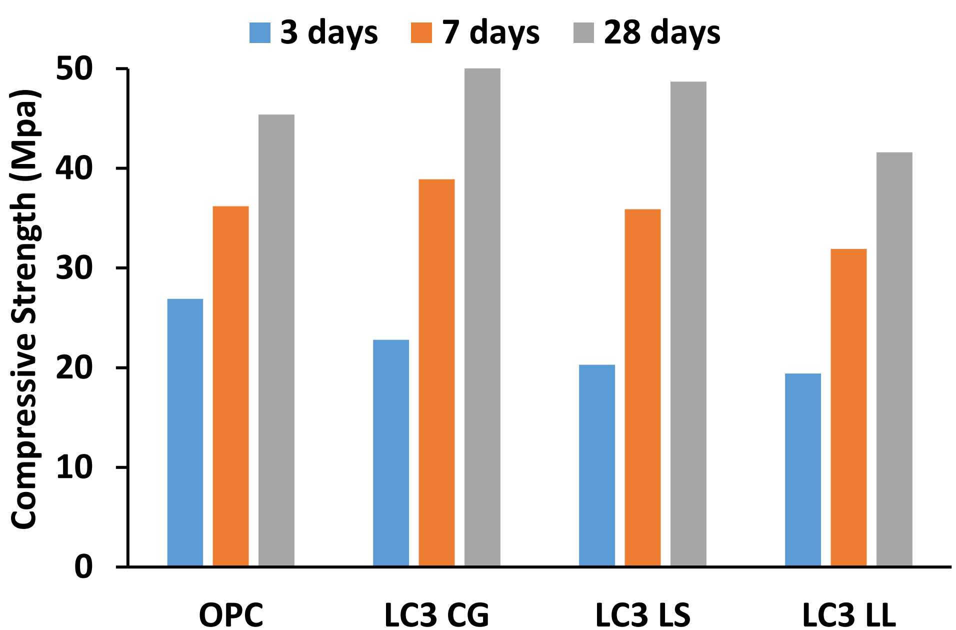
The increase of pozzolanic reactivity with calcination temperature is limited not only by structural reorganization phenomena that take place above 900°C, but also by the sudden decrease of the specific surface that occurs above 800°C.

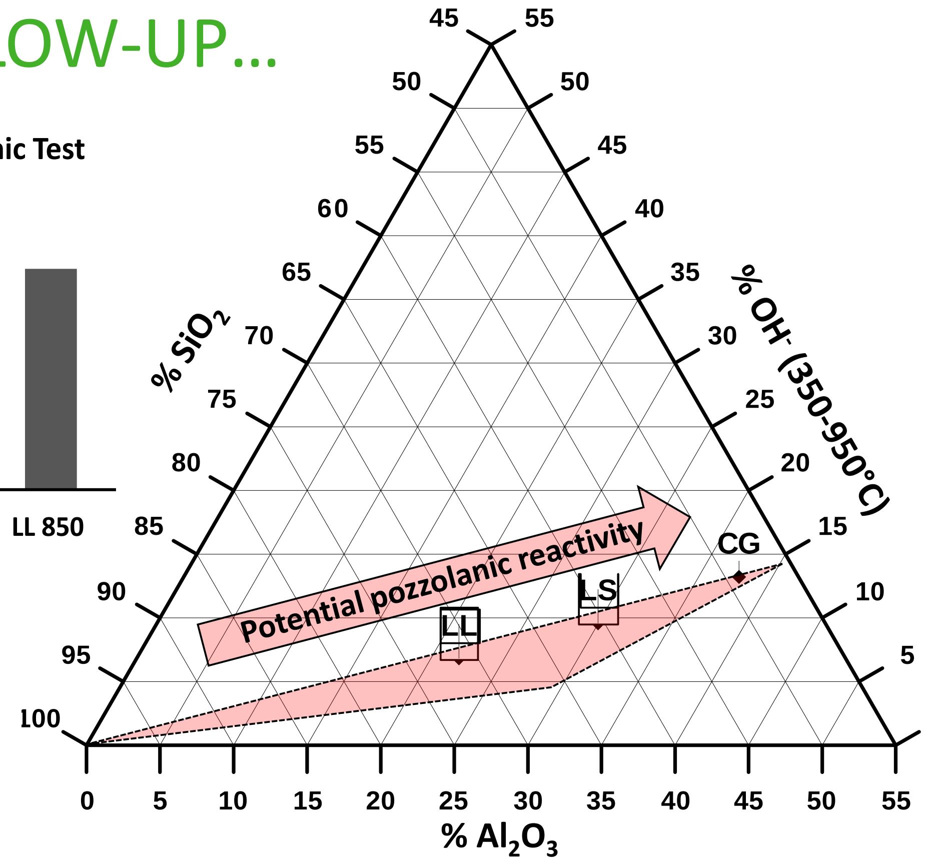
Experimental results indicate that low grade kaolinitic clay constitute a potential source of high reactivity pozzolanic materials, if properly activated.

FOLLOW-UP…









850°C **Grinding** → **90% passing 90 µm sieve**

MUCHAS GRACIAS!!!

UNIVERSIDAD CENTRAL "MARTA ABREU" DE LAS VILLAS
VERITATE SOLA NOBIS IMPONETUR VIRILIS TOGA
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SANTA CLARA

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Limestone Calcined Clay Cement