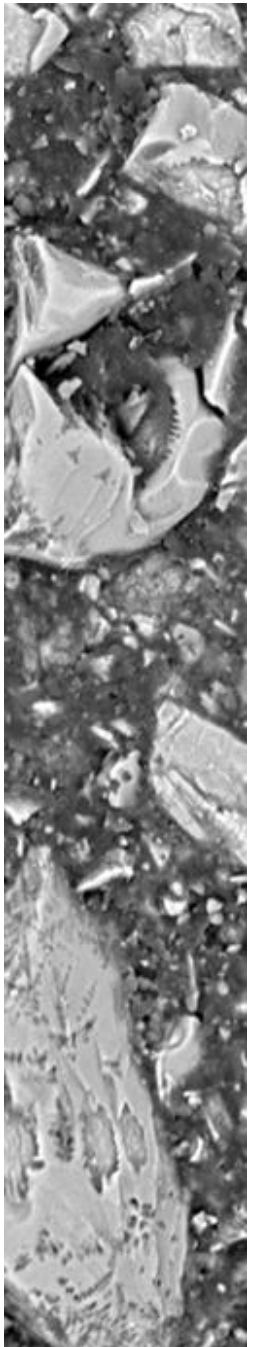


Low calcium high performance cements

2018 NanoMatLab/Biomat Meeting

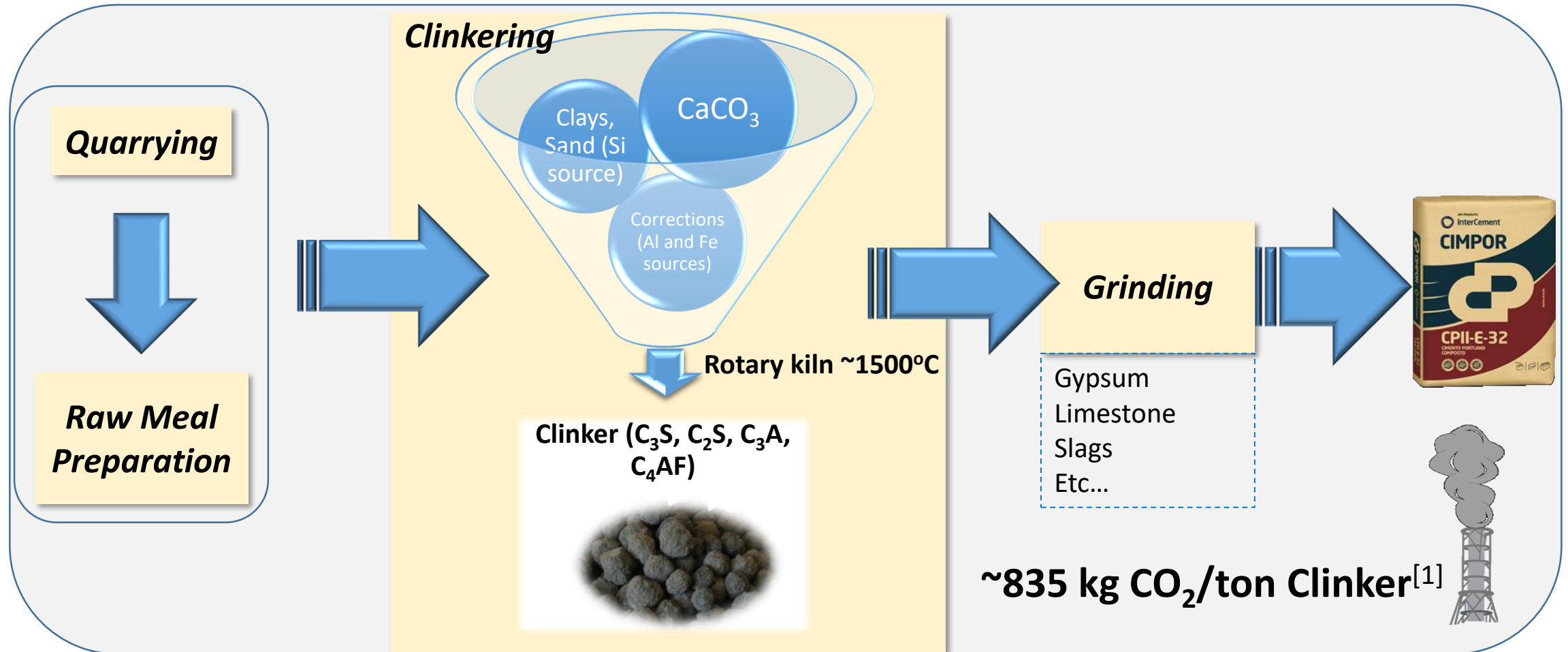
Lisbon, 16 December 2018



Cement Production

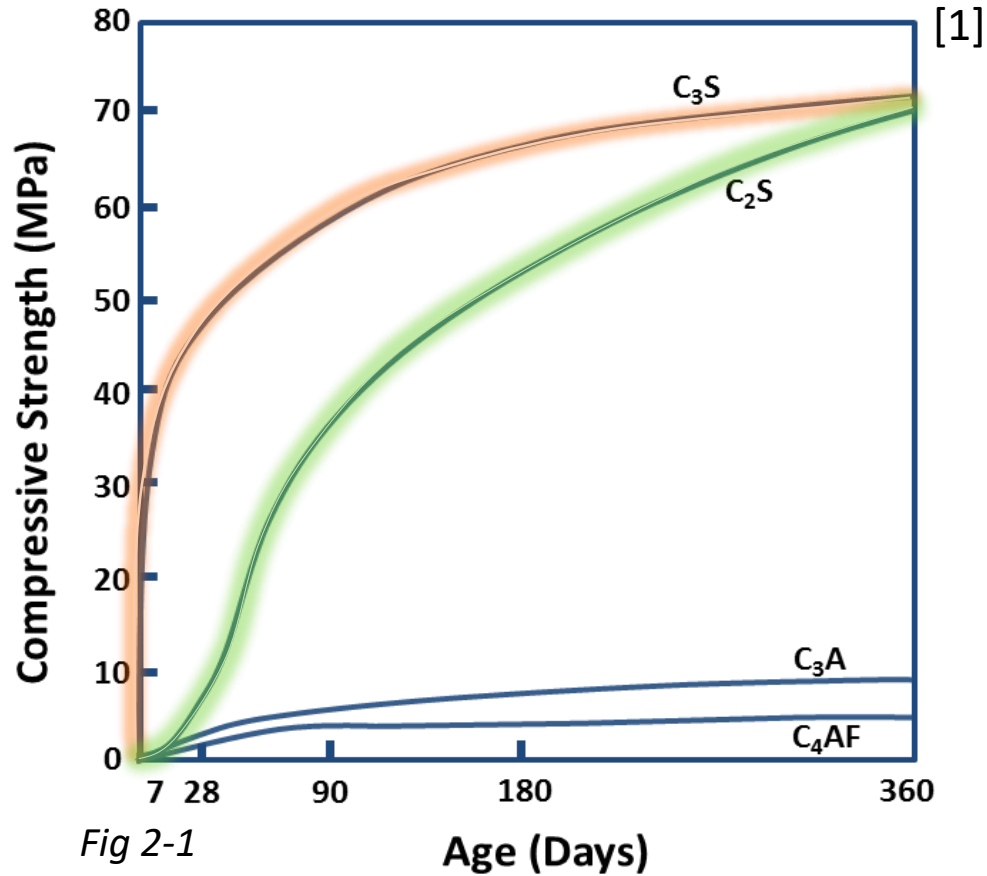
Cement Notation

C – CaO, S – SiO₂, A – Al₂O₃, F – Fe₂O₃, H – H₂O



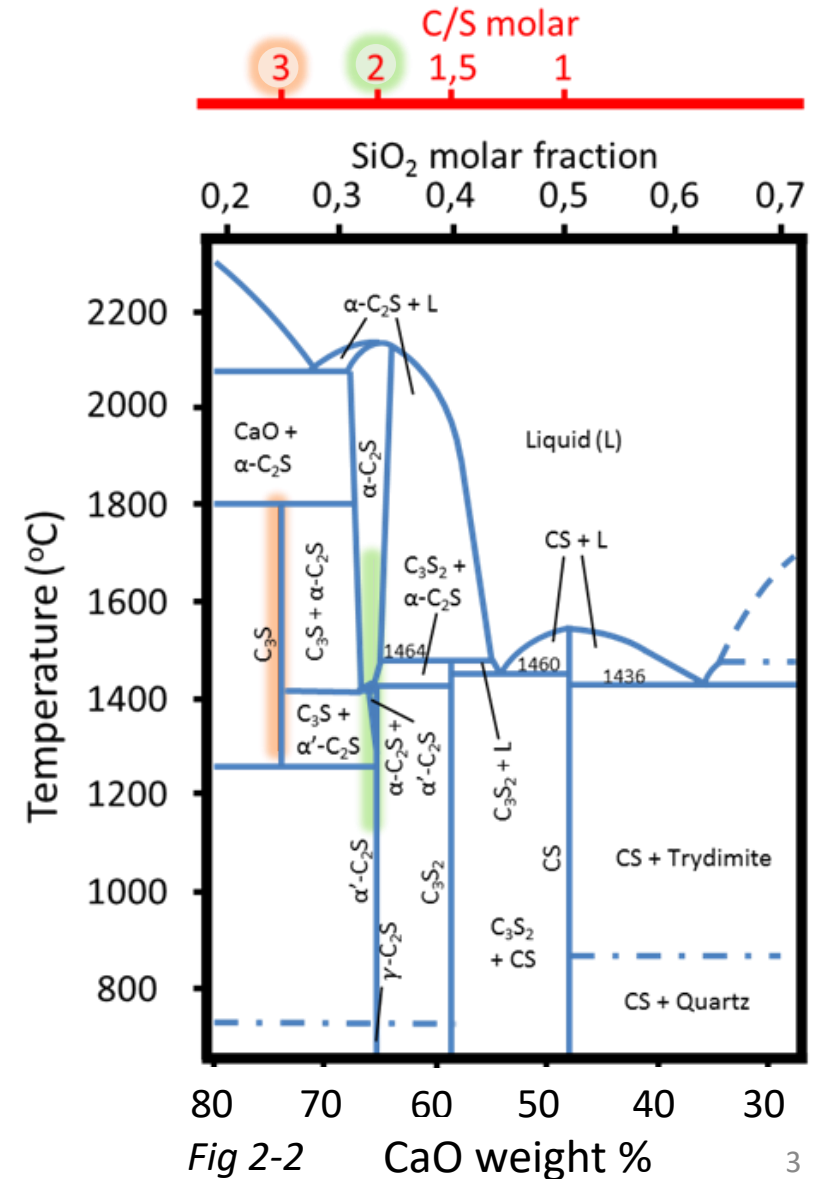
1.(WBCSD), C.S.I.C.o.t.W.B.C.f.S.D., CO₂ and Energy Accounting and Reporting Standard for the Cement Industry. 2011.

Calcium Silicate Phases

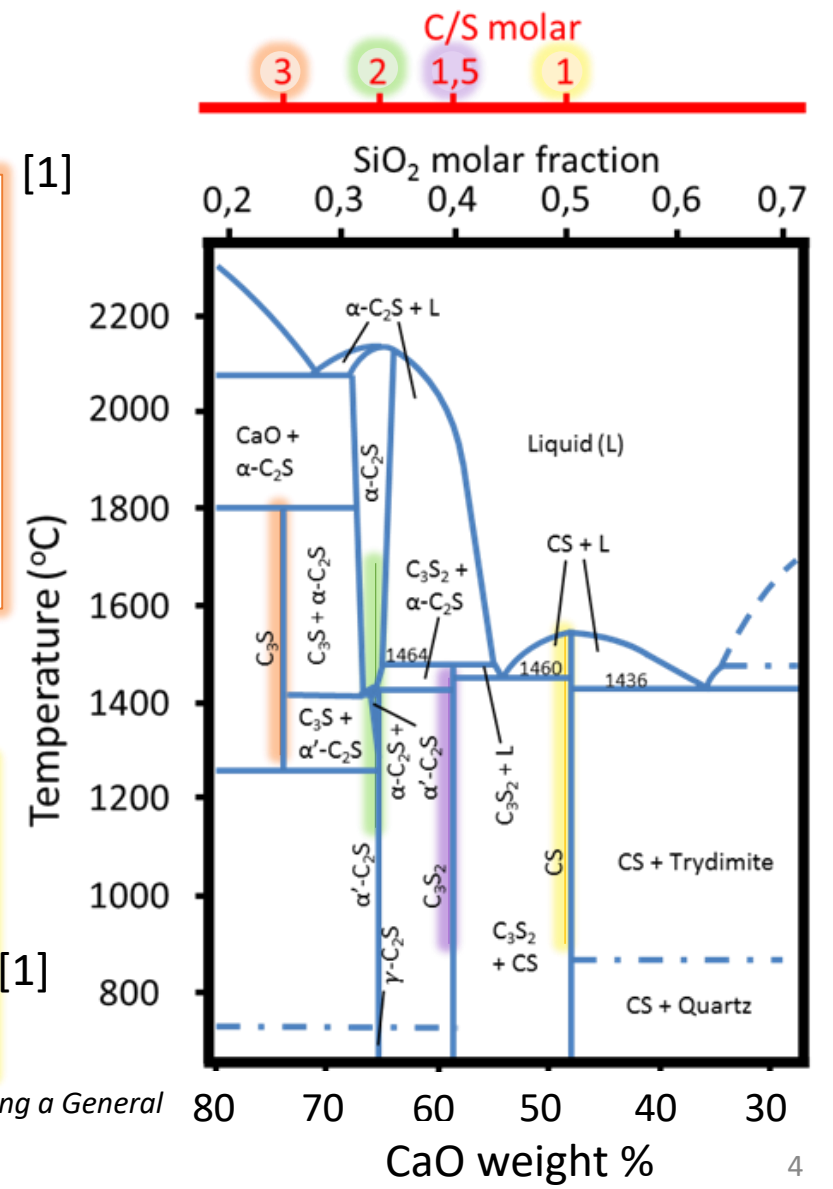
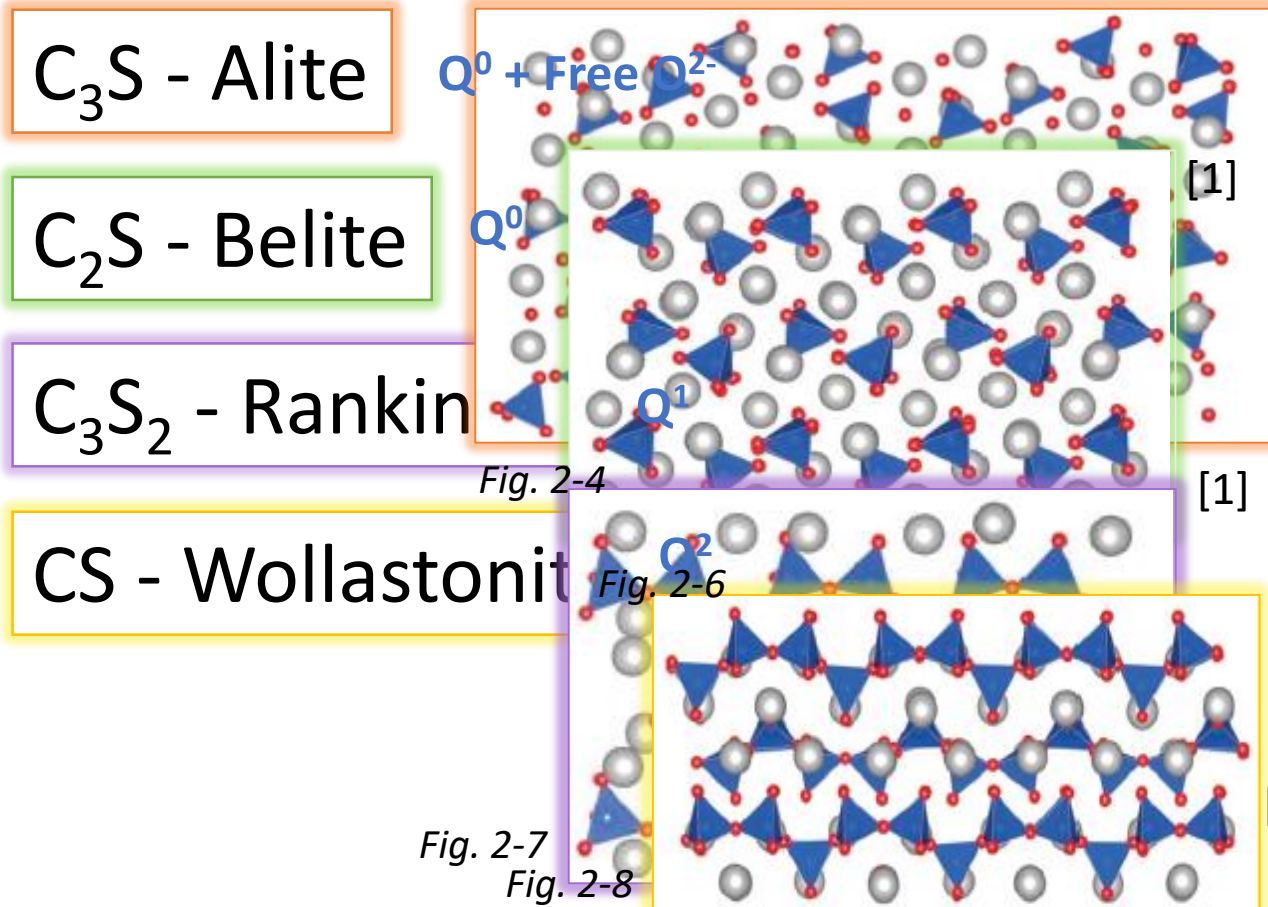


1.Zhang, Y.M. and T.J. Napier-Munn, *Effects of particle size distribution, surface area and chemical composition on Portland cement strength*. Powder Technology, 1995. **83**(3): p. 245-252.

Rodrigo Santos



Structure and Reactivity



1. Freitas, A.A., et al., *From Lime to Silica and Alumina: Systematic Modeling of Cement Clinkers using a General Force-Field*. Physical Chemistry Chemical Physics, 2015. **17**(28): p. 18477-18494.
Rodrigo Santos

Production Concept

Development of amorphous hydraulic binders

Development of amorphous hydraulic binders

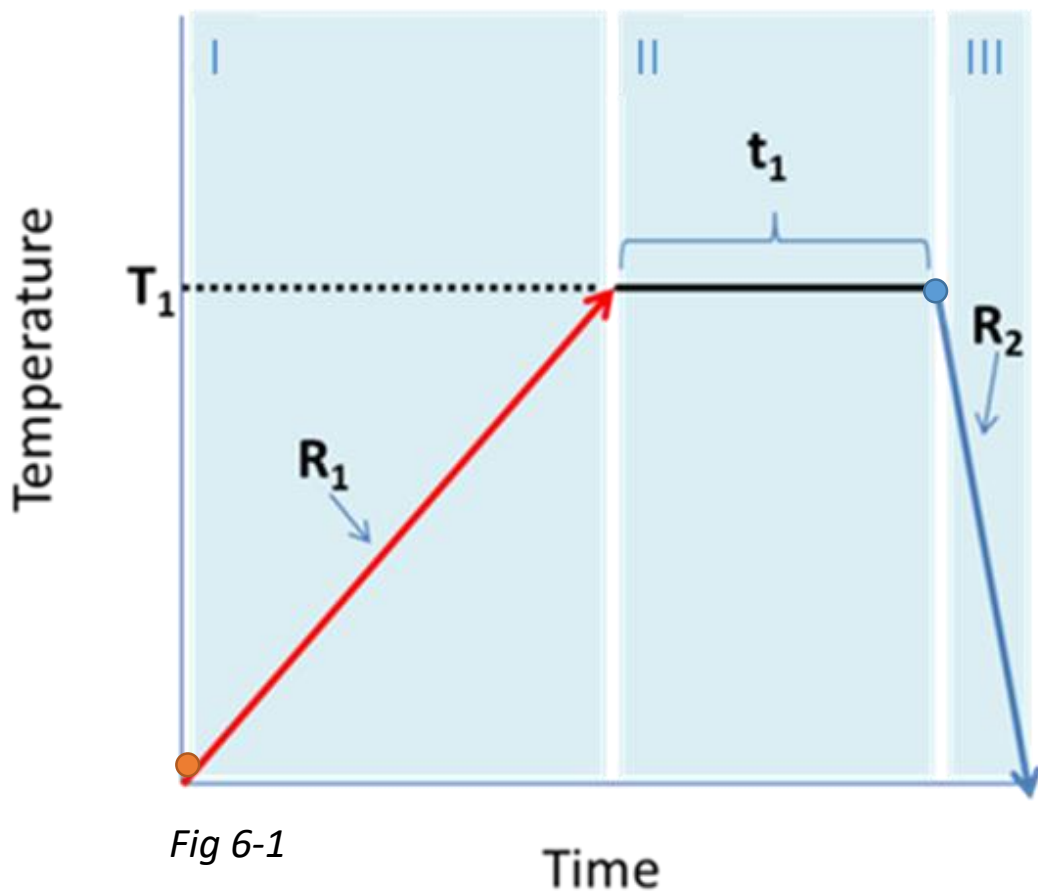


Fig 6-1

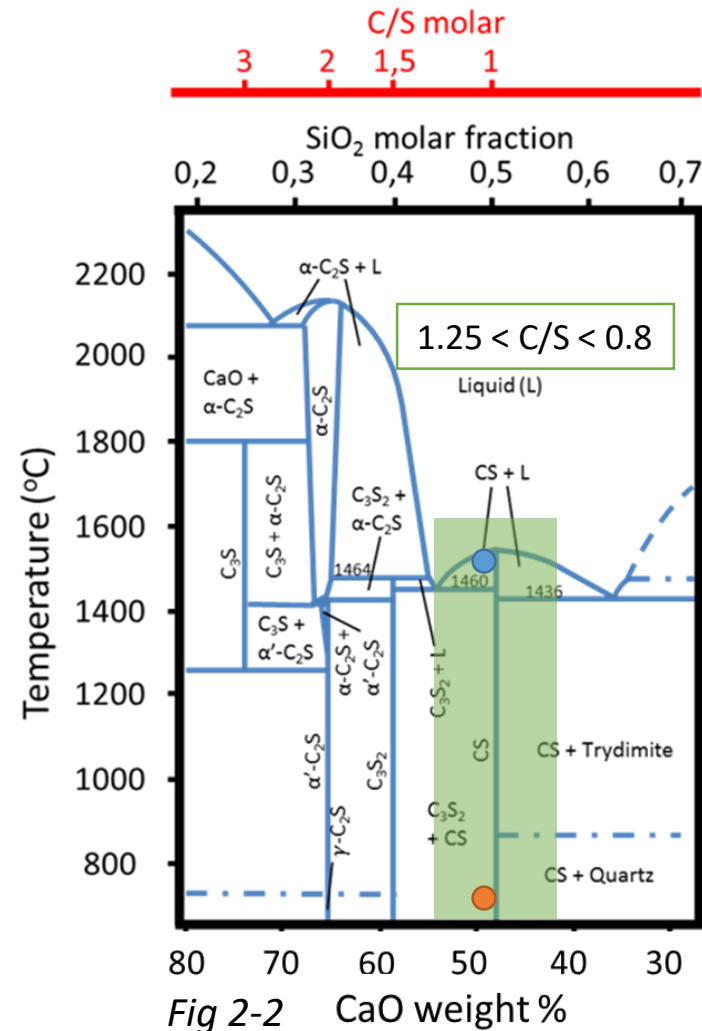
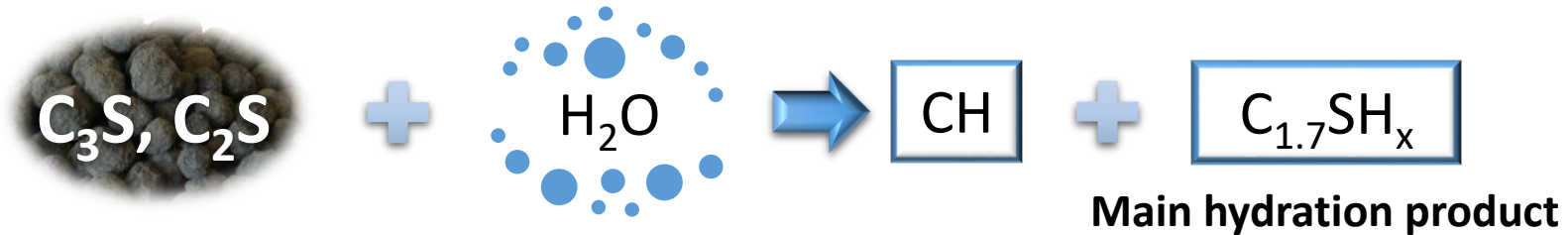


Fig 2-2

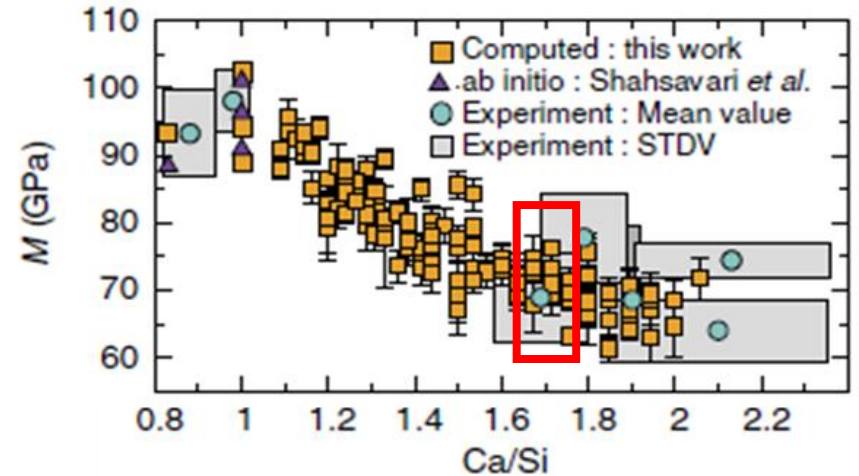
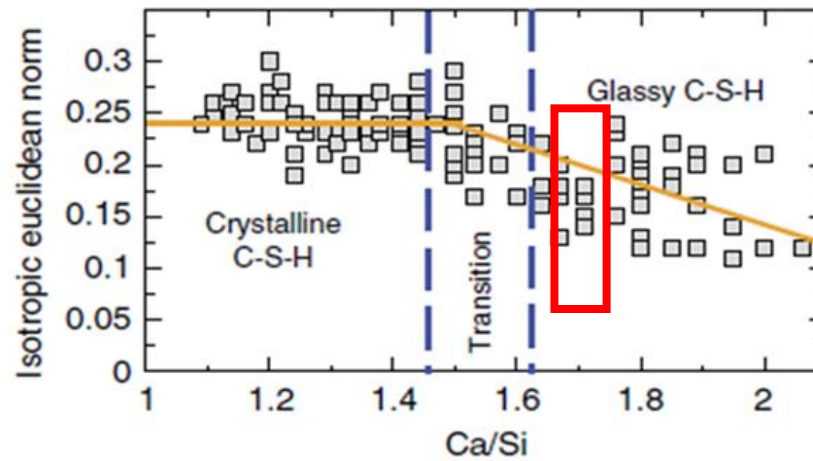
Hydration of Calcium Silicate Phases



Waste of Ca

Unnecessary CO₂ emissions

Non-optimized C-S-H



Hydration of Amorphous Hydraulic Binders

²⁹Si MAS NMR

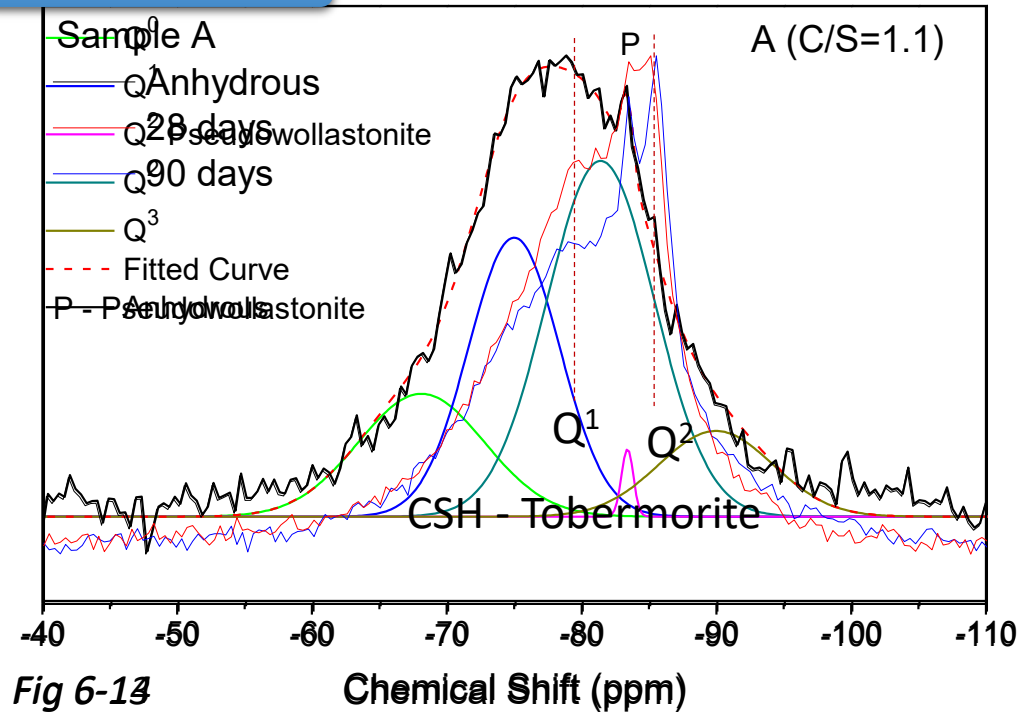


Fig 6-13

Development of semi-crystalline structures with peaks attributed to Tobermorite (Q¹ and Q²)

Consumption of less coordinated structures (Q⁰ and Q¹)

“C-S-H Quality”

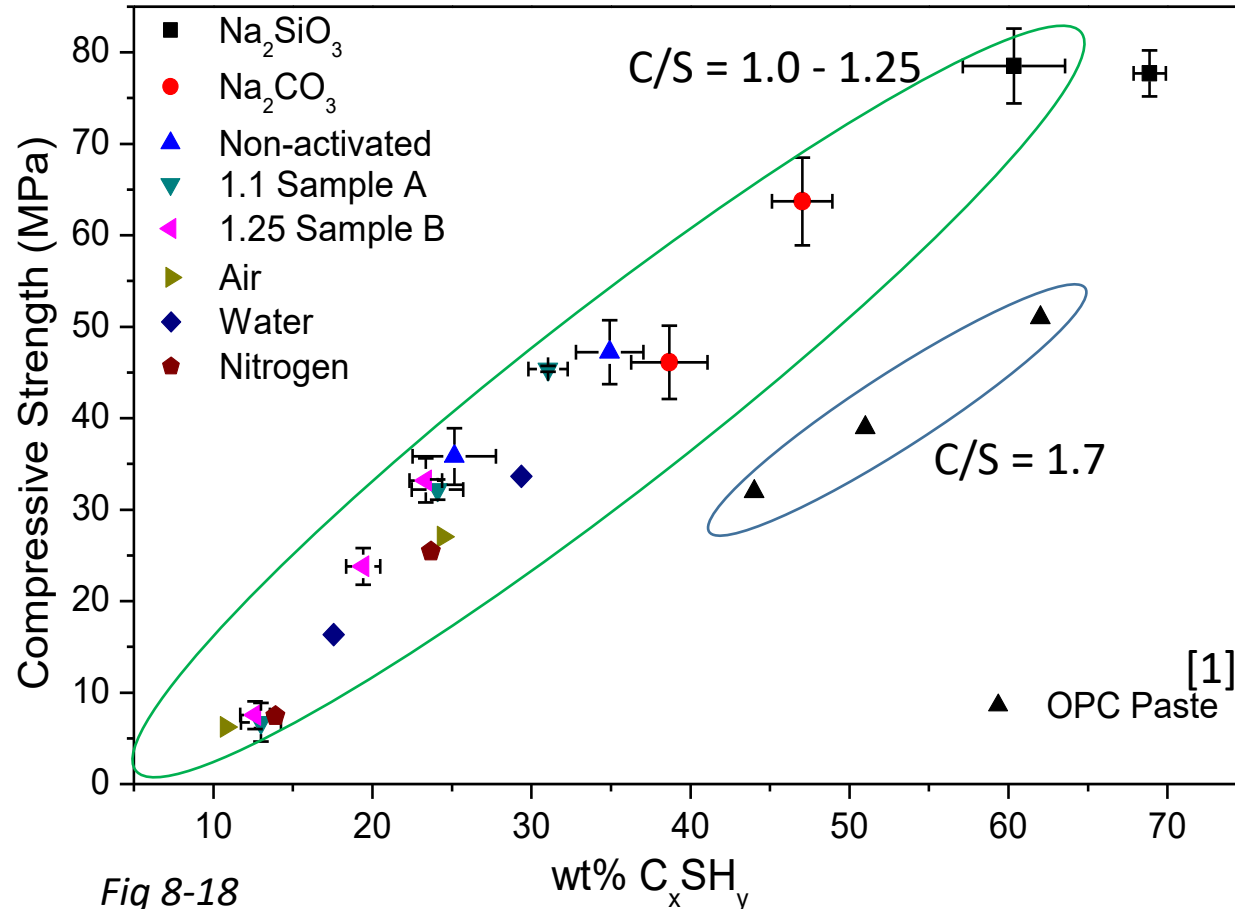
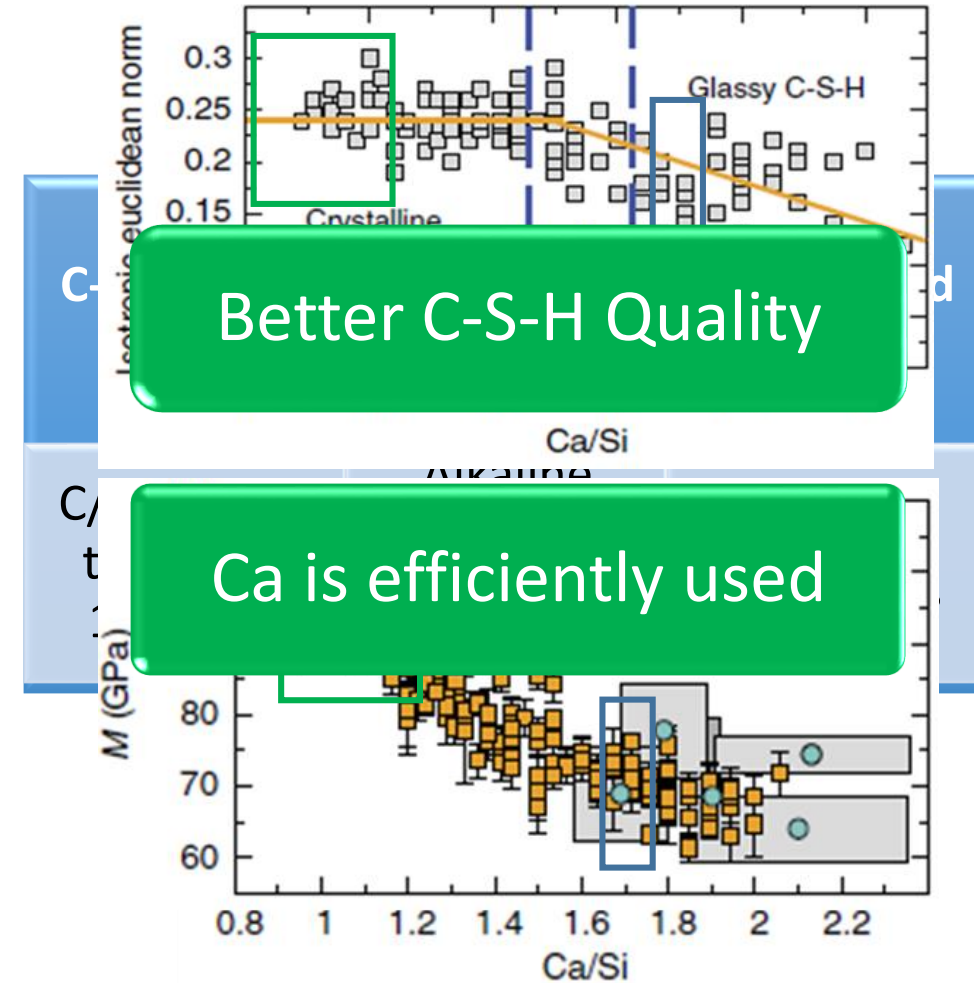


Fig 8-18

1. Hoshino, S., K. Yamada, and H. Hirao, *XRD/Rietveld Analysis of the Hydration and Strength Development of Slag and Limestone Blended Cement*. Journal of Advanced Concrete Technology, 2006. 4(3): p. 357-367.

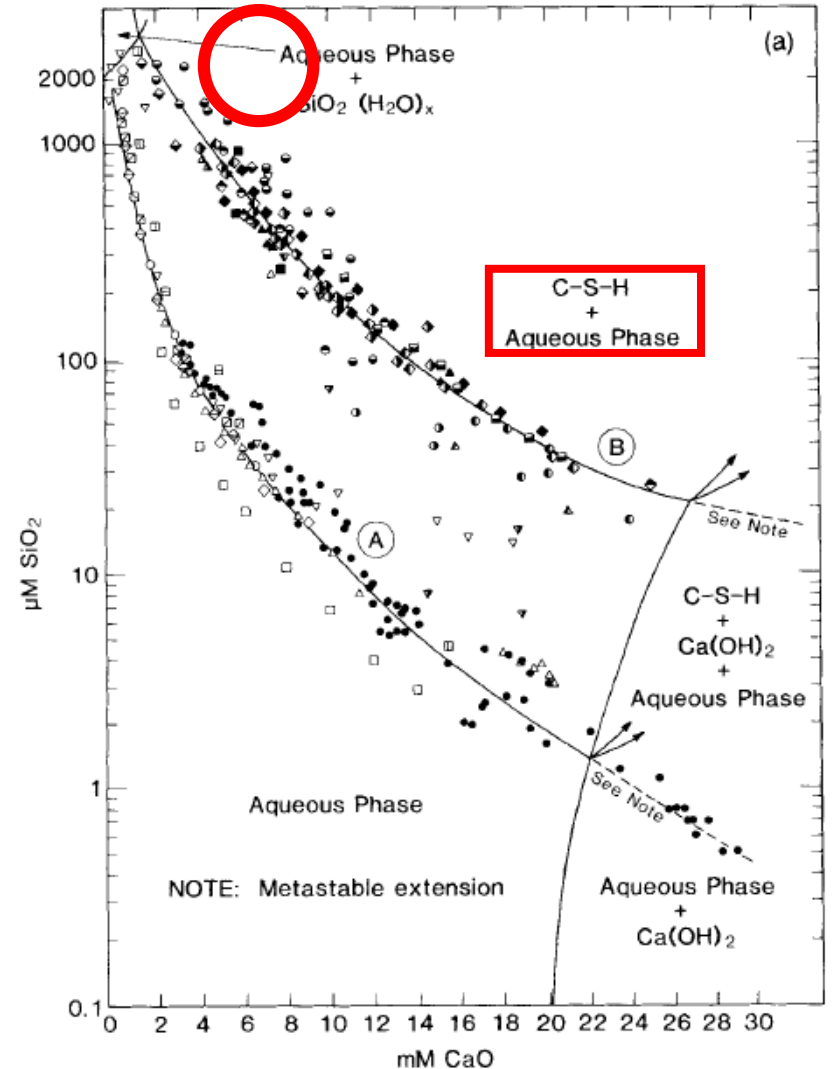
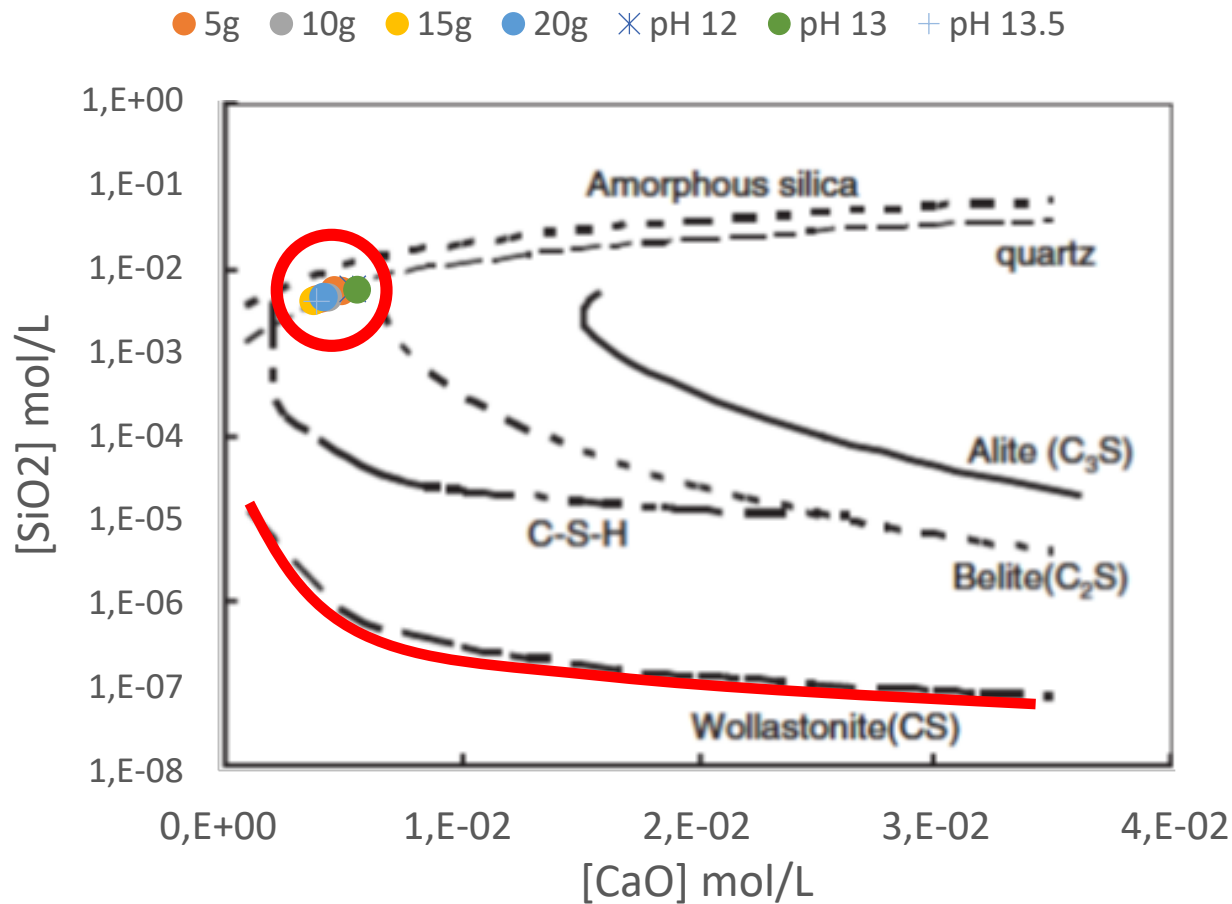
2. Abdolhosseini Qomi, M.J., et al., *Combinatorial molecular optimization of cement hydrates*. Nat Commun, 2014. 5.

[2]

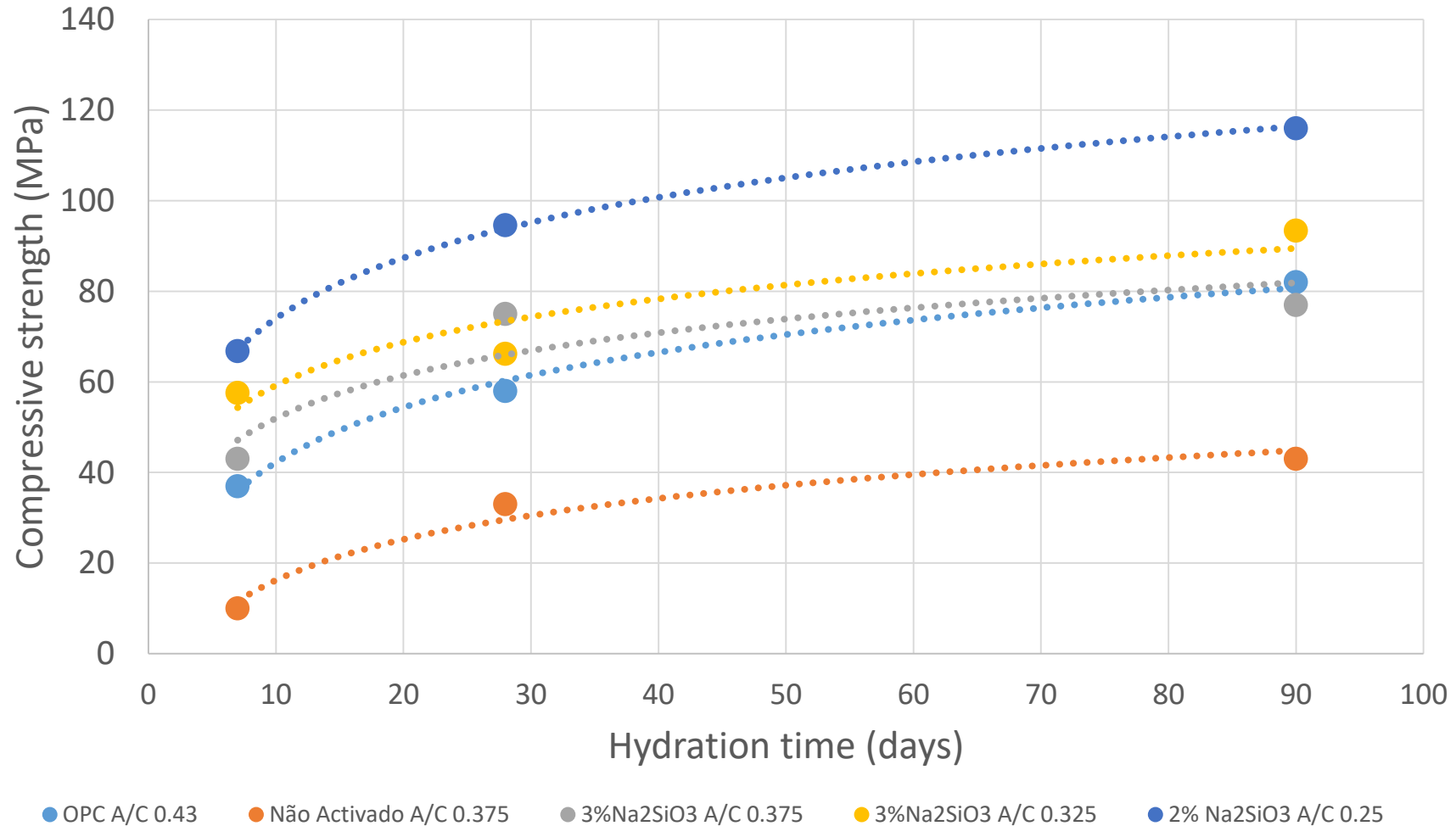




The origin of reactivity



Product optimization



THANK YOU 😊

