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LA-ICP-MS as a Method to Study the Interfacial Transition Zone in a Concrete Model System

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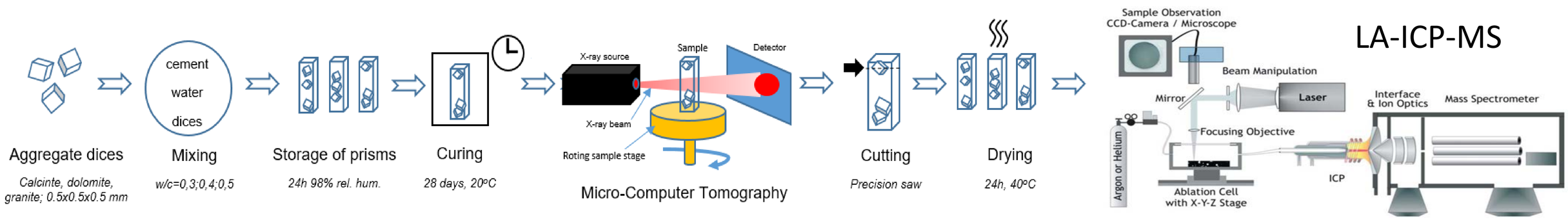
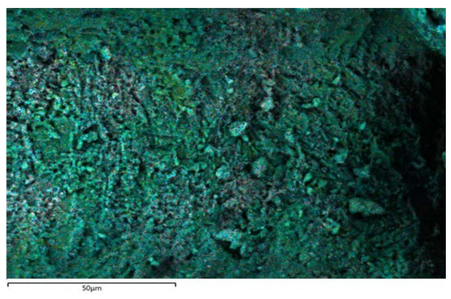
Motivation

We applied Laser Ablation - Inductively Coupled Plasma - Mass Spectrometry (LA-ICP-MS) as a method to examine the composition of the Interfacial Transit Zone (ITZ) in concrete. The ITZ describes the contact zone between aggregate and Hardened Cement Paste (HCP). This zone typically shows significantly higher porosity and is enriched in calcium compared to HCP. In consequence, the ITZ affects the mechanical properties and the durability of concrete considerably [1]. The aim of this study is to get a better understanding of the ITZ composition in concrete structures. The first step is to develop an optimal calibration strategy of the LA-ICP-MS results for a heterogeneous material like concrete to enable reliable quantitative interpretation.

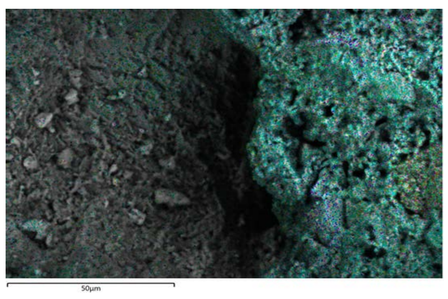
Experimental approach



Results and Discussion

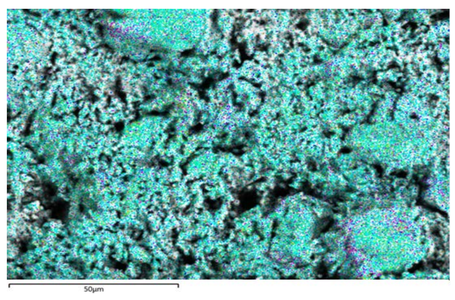


SEM/EDS image of aggregate

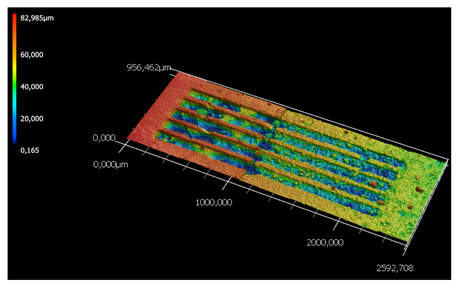


SEM/EDS image of ITZ

K S B Fe Si Mg Ca Na P Al



SEM/EDS image of HCP

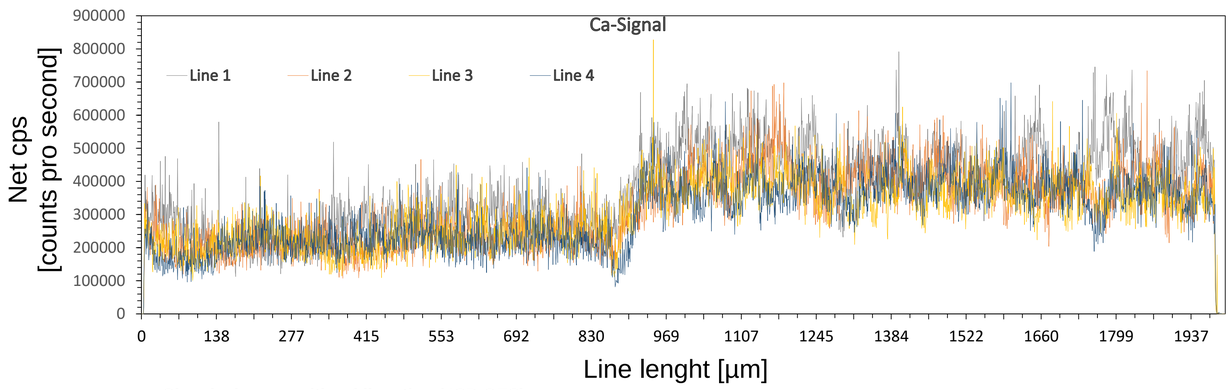


Confocal microscopy image of topography of the sample after laser ablation

Different ablation behavior of aggregate and HCP

LA-ICP-MS measurement of the sample with dolomite and w/c ratio 0.4

- To reduce the amount of the net signal data obtained, we averaged the data from four lines in 10 µm intervals.
- '0' on the coordinate system indicates the threshold of the ITZ.



Raw data

Simple Calibration

Raw data

Multi-RM Calibration

Chemical composition (digestion / ICP-OES)

Parameter	*Aggregate*	*HCP*
CaO	30,42	44.57

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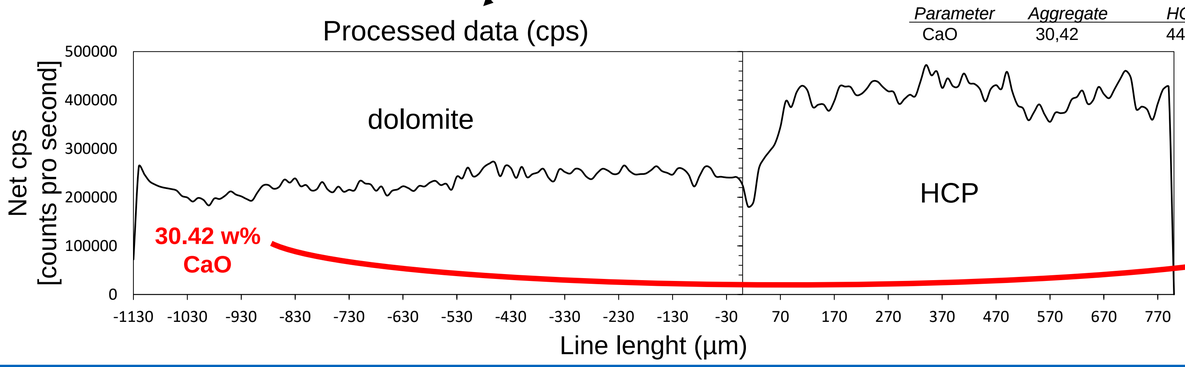
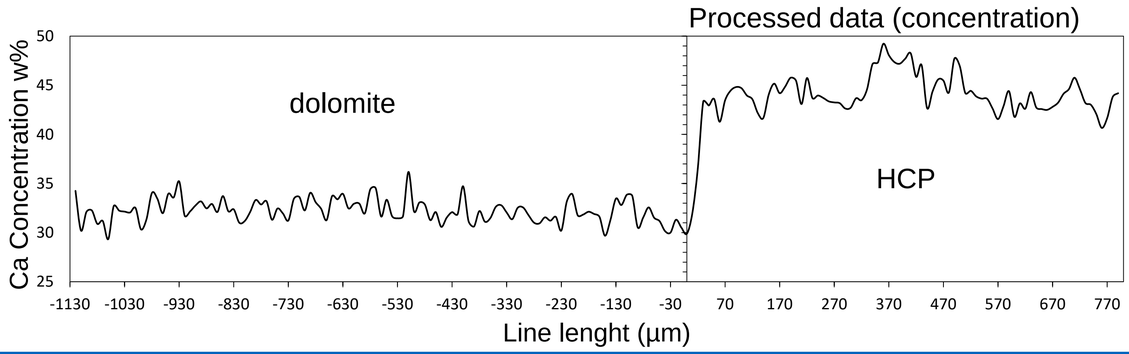
61.0 w% CaO

Processed data (cps)



Processed data (concentration)



Conclusion and Further Steps

- With the obtained results, we could show the variation in composition between aggregate, ITZ, and hardened cement paste
- Simple Calibration Strategy with One Reference Material delivers too high Ca contents for the HCP compared to chemical analysis (ICP-OES)
- Multi-Reference Materials Calibration Strategy was developed with two reference materials and displays accurate Ca concentration for aggregate and HCP

Acknowledgements

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References

[1] The Interfacial Transit Zone (ITZ) between Cement Paste and Aggregate in Concrete, K.L. Scriviner, A.K. Crumbie P. Laugesen, Interface Science 12 (2004), 411-421

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