

# Investigation of the Interfacial Transition Zone of Concrete in a Model System by LA-ICP-MS

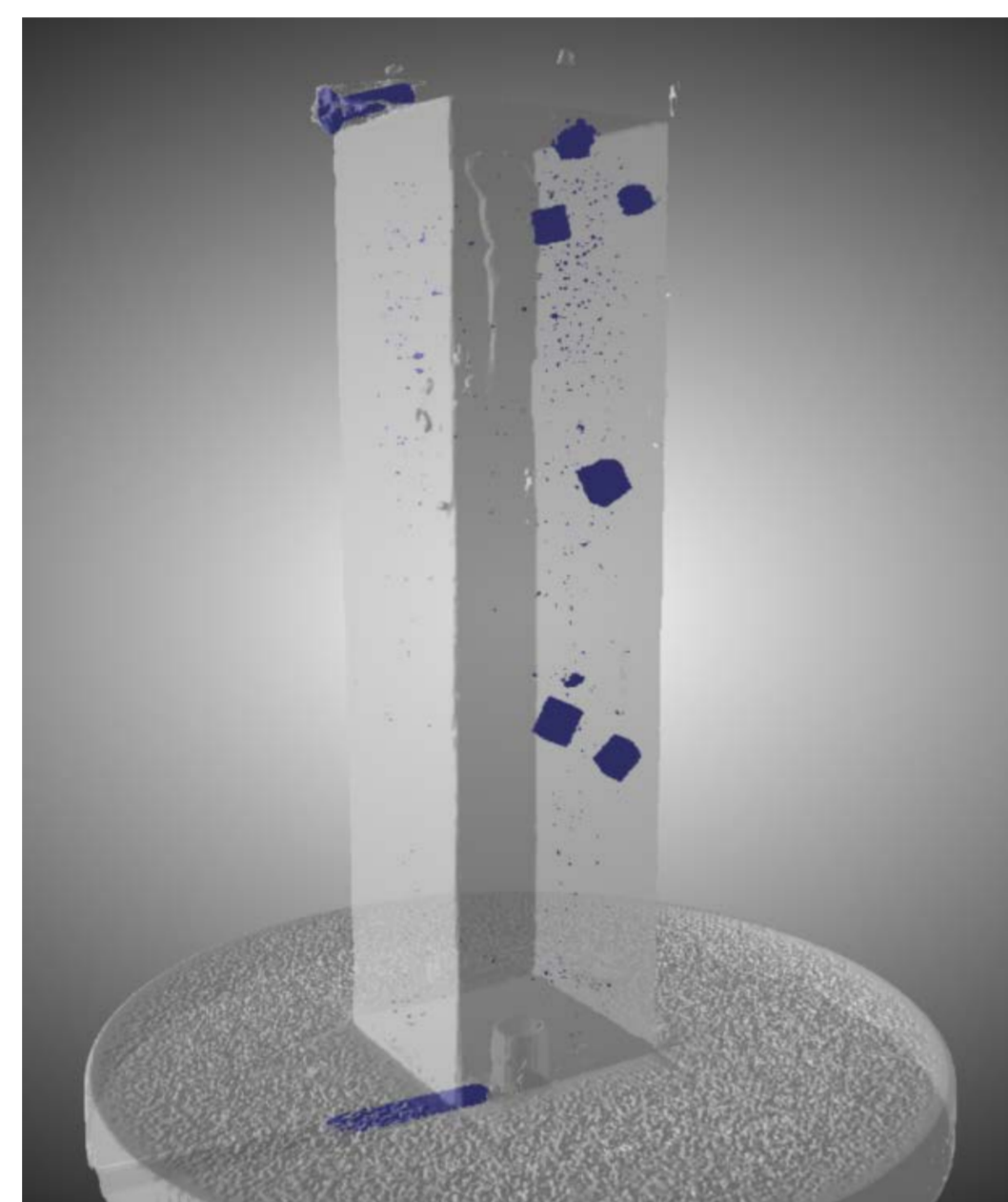
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## Motivation

We applied LA-ICP-MS as a method for examining the composition of the Interfacial Transit Zone (ITZ) in concrete. The ITZ describes the contact zone between aggregate and hardened cement paste. This zone typically shows significantly higher porosity and contains more calcium than bulk hardened cement paste. In consequence, the ITZ affects the mechanical properties and the durability of concrete considerably [1]. The aim of the study is to develop an optimal strategy to evaluate the LA-ICP-MS results of a heterogeneous material like concrete for quantitative interpretation, in an attempt to have a deeper look at the ITZ composition in concrete structures.

## Experimental

For our research, we prepared special prisms (4x4x16cm) consisting of cement paste and randomly distributed cubic aggregates (0.5x0.5x0.5cm). To determine the position of every dice, we conducted CT measurements.



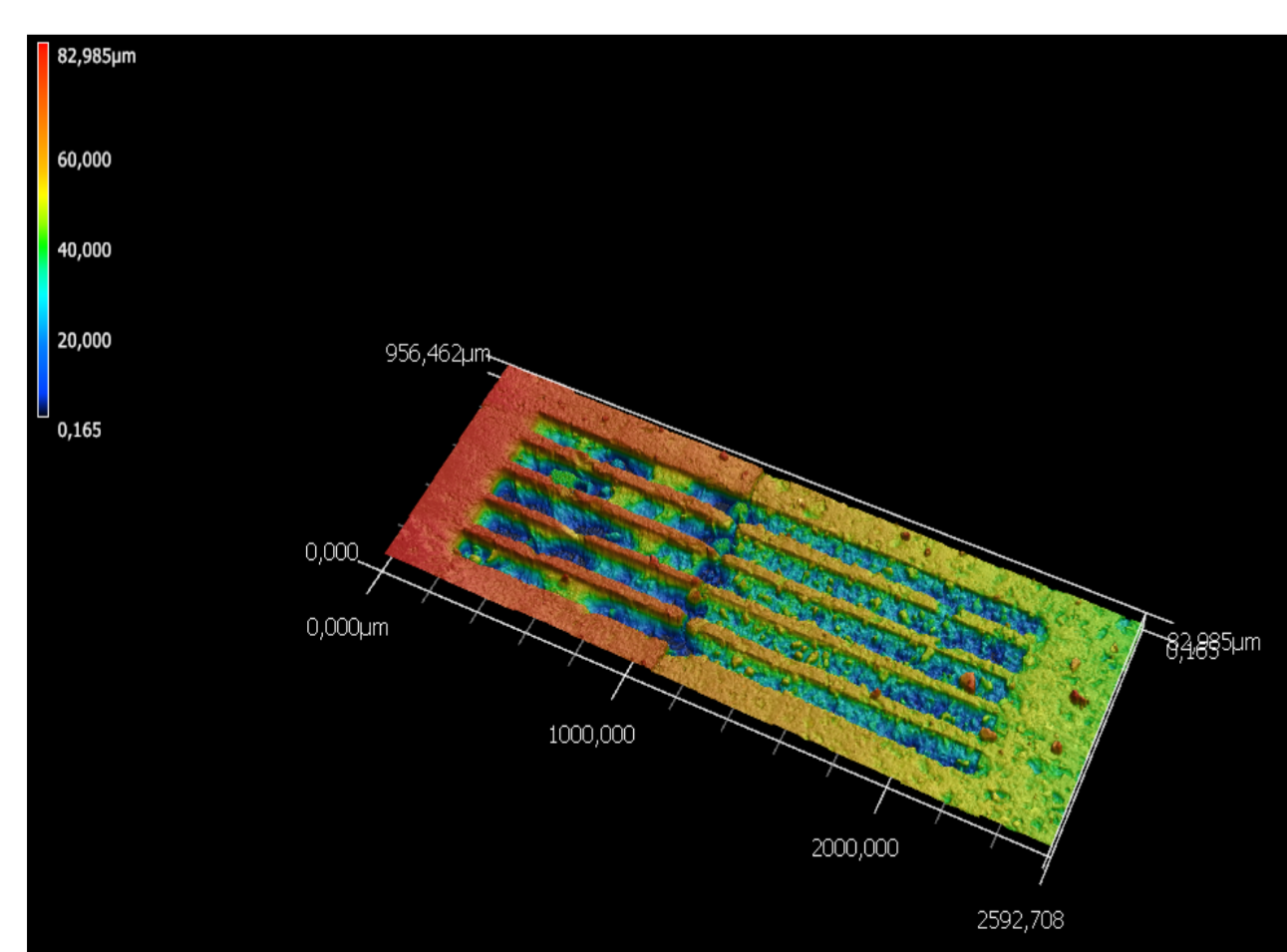
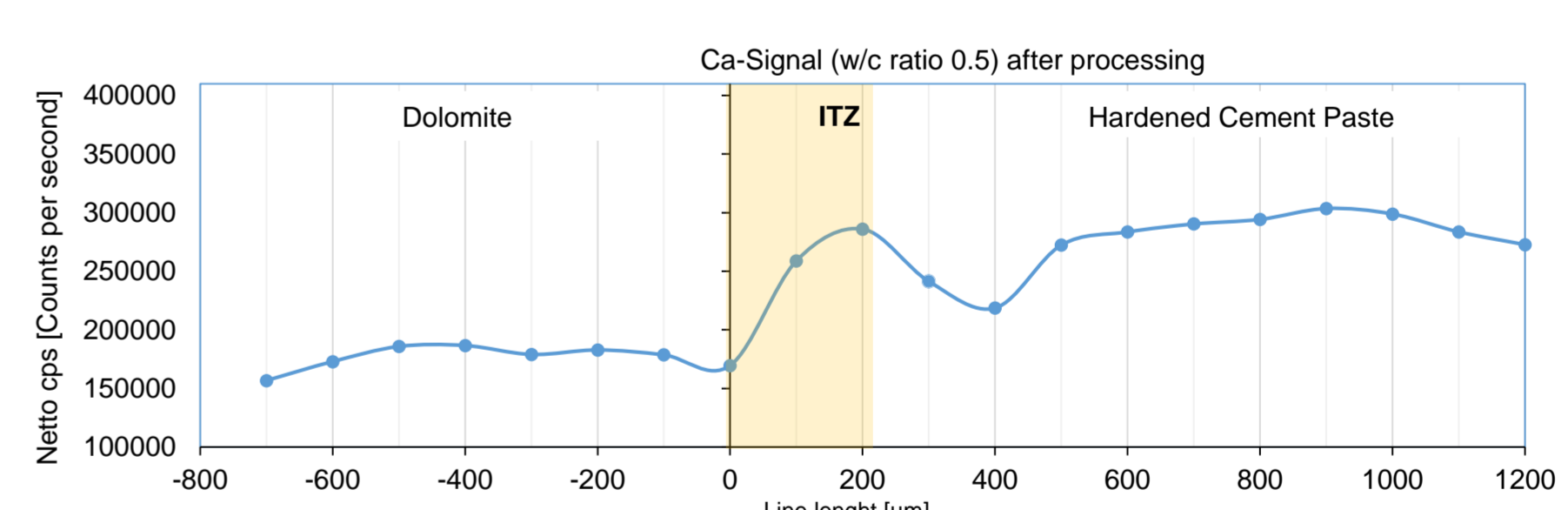
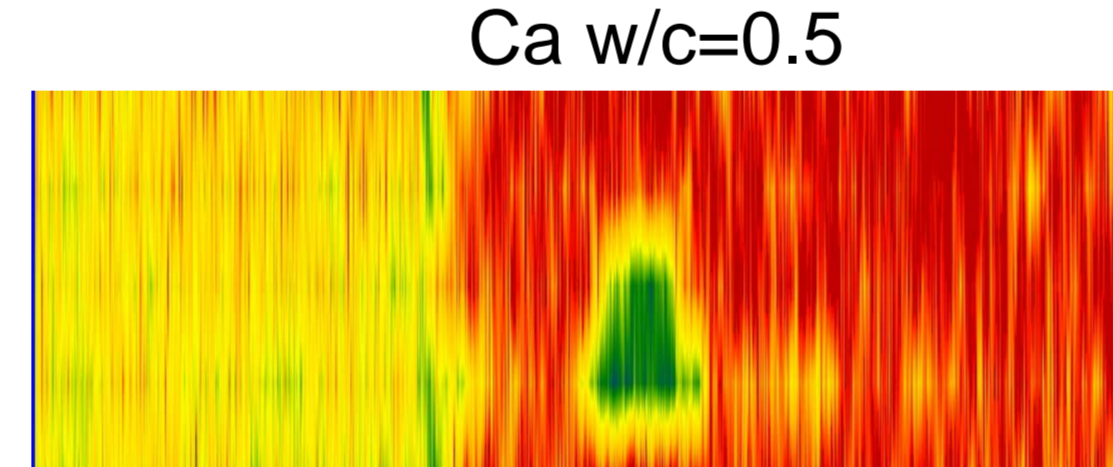
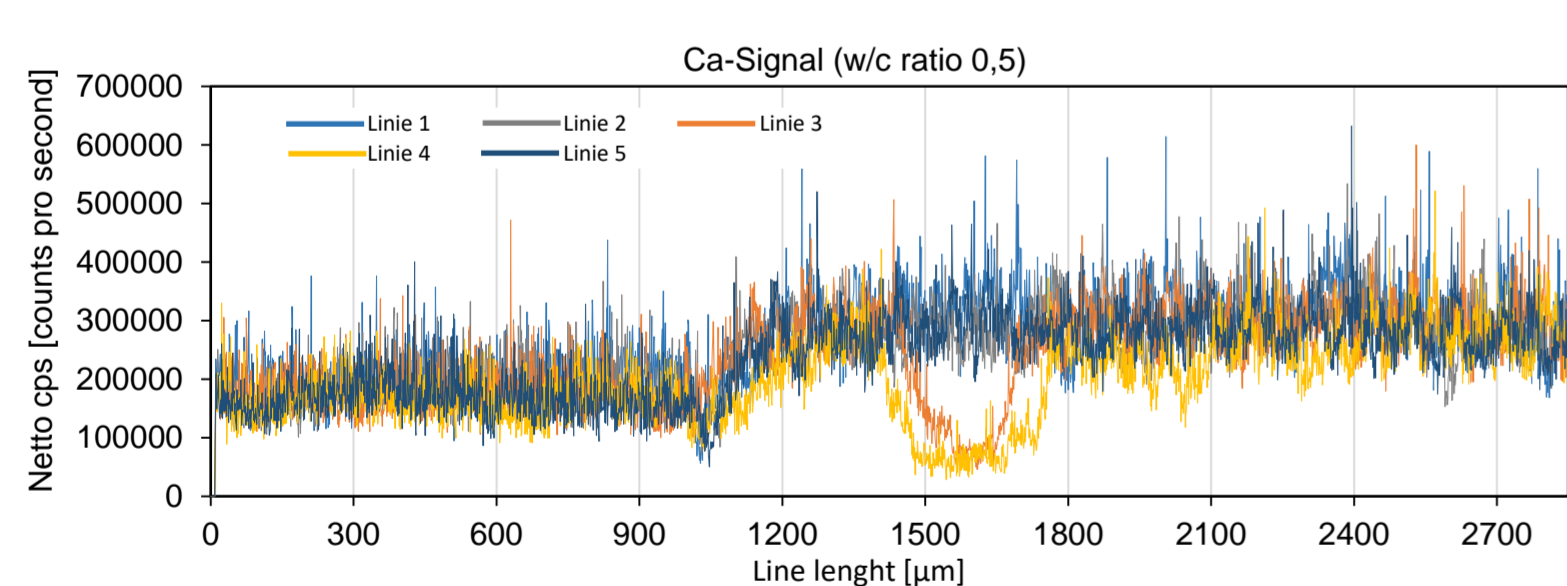
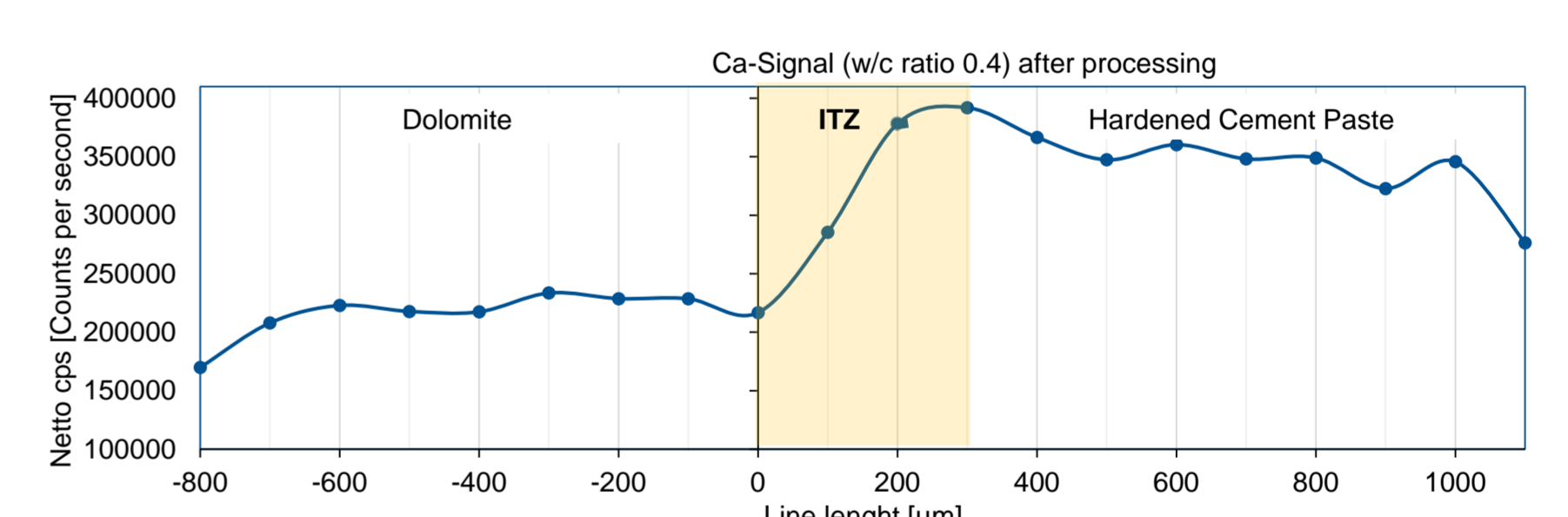
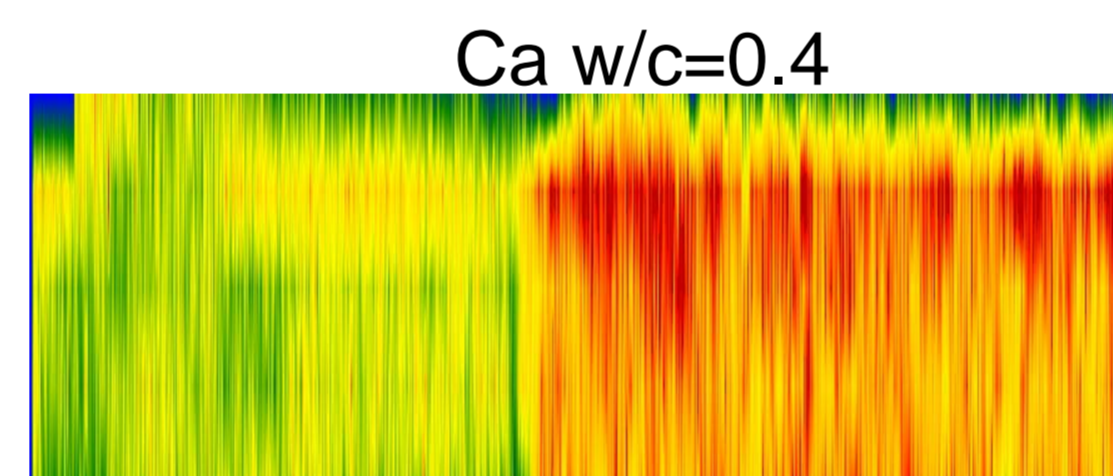
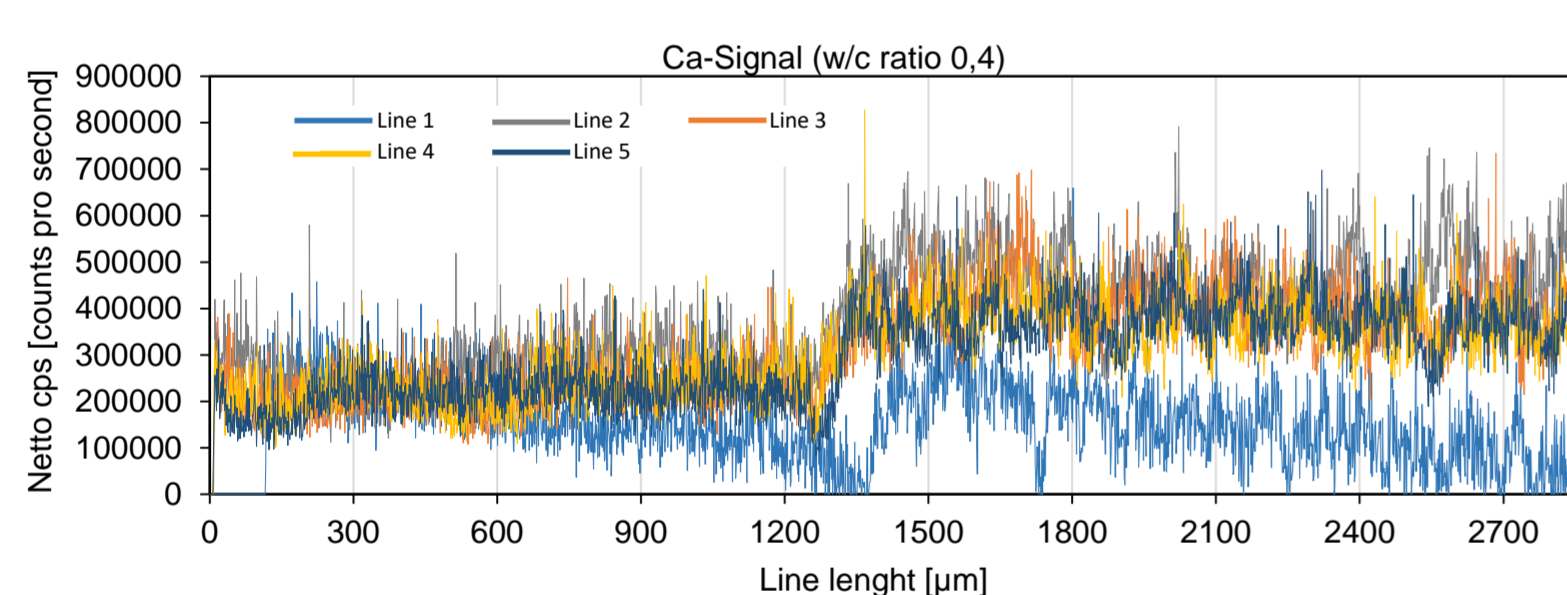
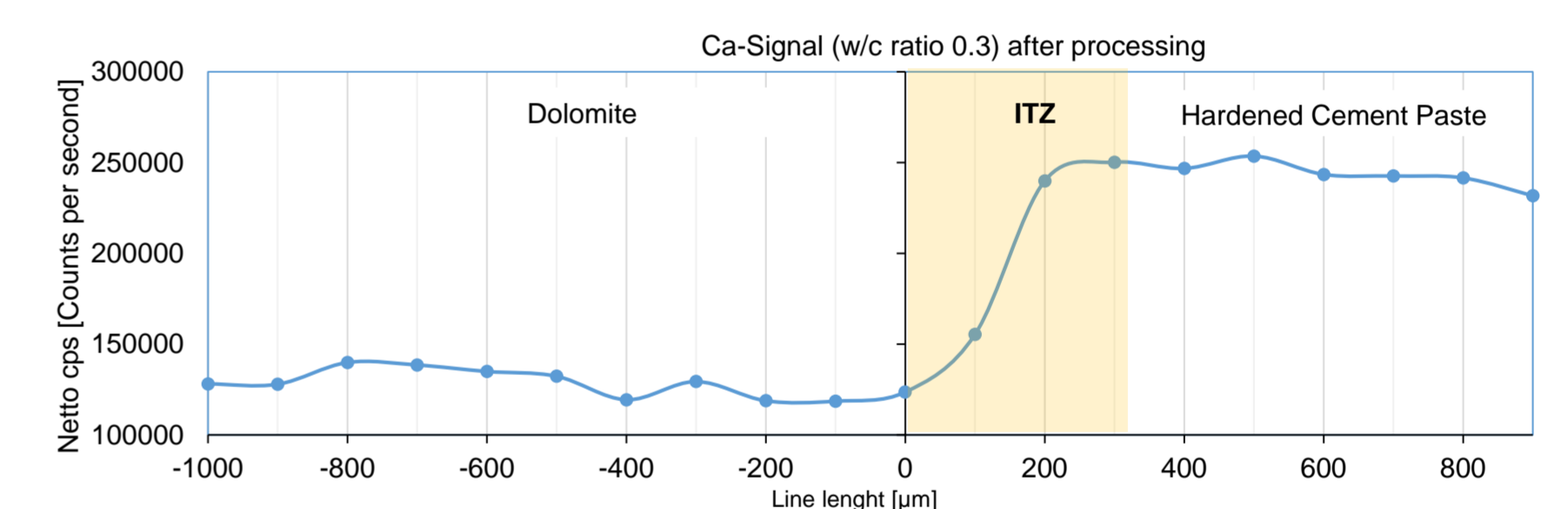
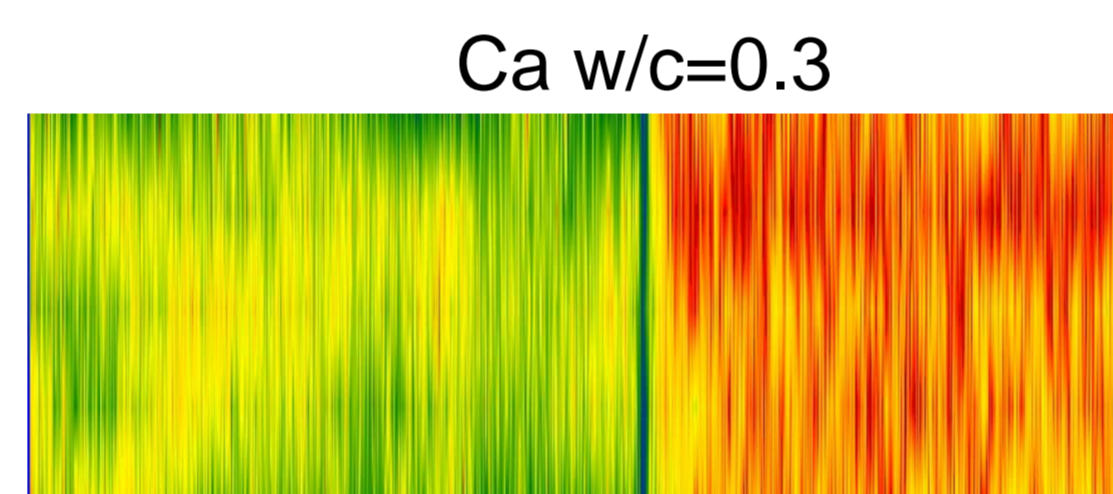
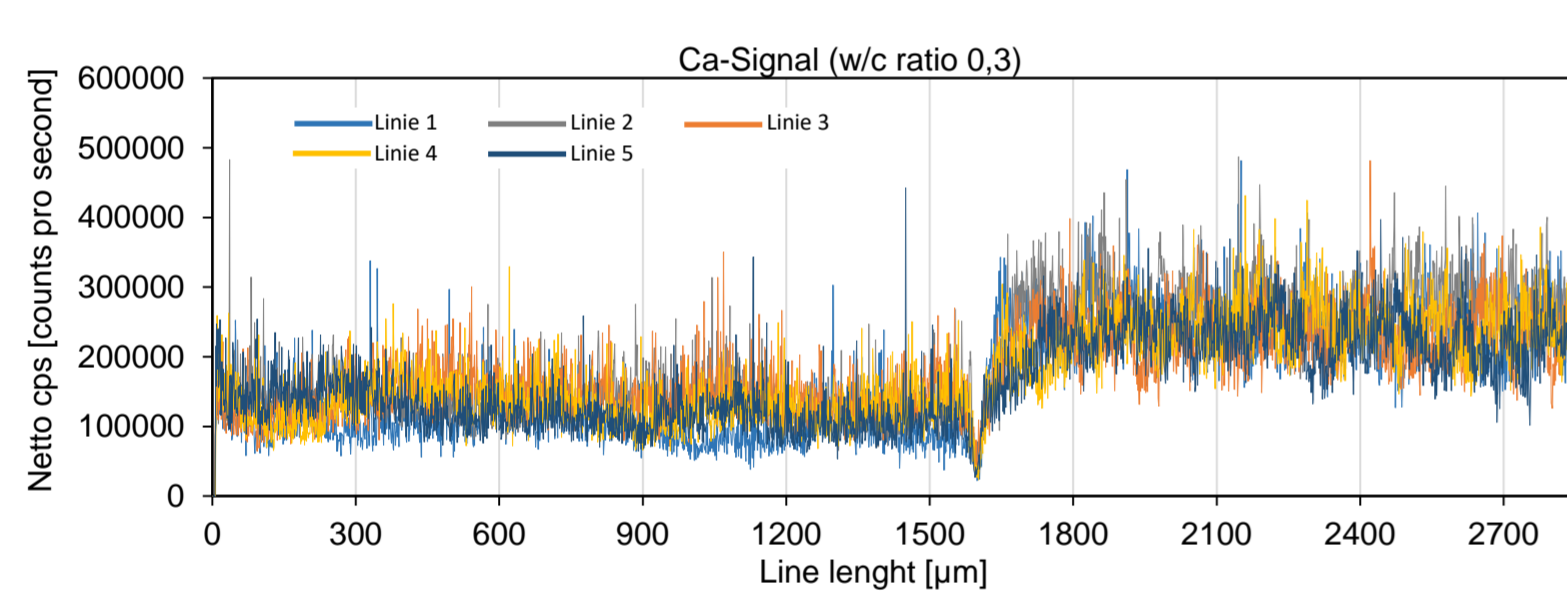
The prisms were cut in the middle of every dice with a precision saw. It is possible to achieve adequate surface quality to carry out Laser Ablation line scans from aggregate through the ITZ into the bulk cement paste.



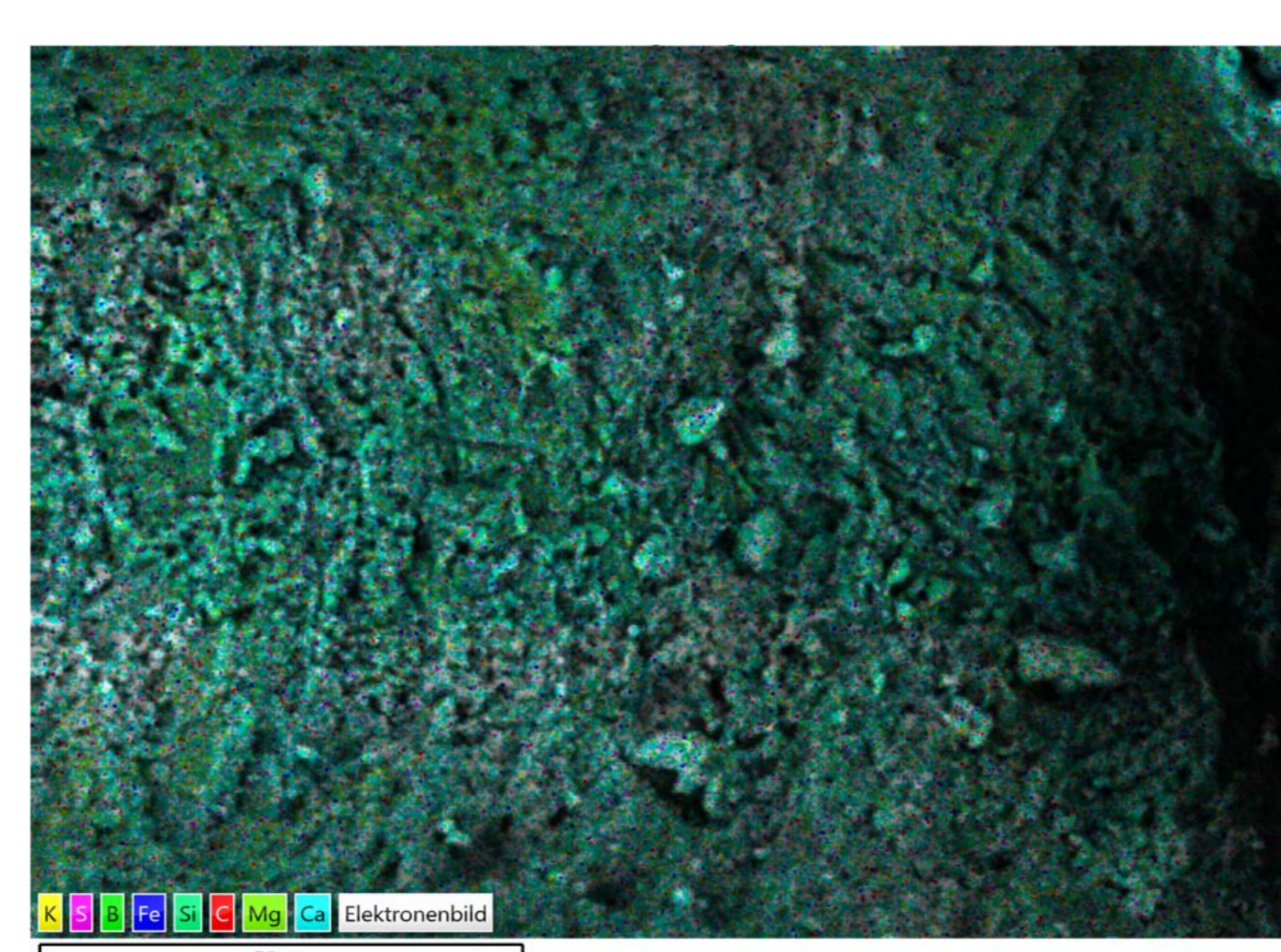
LA-ICP-MS Measurements Conditions	
Lasers	ESI NWR 213 (ESI New Wave Research, USA) Nd:YAG
Wavelength	213 nm
Frequency	20 Hz
Fluence	5.7 J/cm <sup>2</sup>
Diameter	100 µm
Scan Velocity	8 µm/s
Line length	2000 µm
ICP-MS	NexION 300D Perkin Elmer, USA
Dwell Time	10 ms
Carrier Gas [l/min]	0.7 L min <sup>-1</sup> He 0.76 L min <sup>-1</sup> Ar
Torch RF power	1200 W
Measured Isotopes	<sup>7</sup> Li, <sup>13</sup> C, <sup>23</sup> Na, <sup>25</sup> Mg, <sup>27</sup> Al, <sup>28</sup> Si, <sup>32</sup> S, <sup>36</sup> Cl, <sup>39</sup> K, <sup>43</sup> Ca, <sup>51</sup> V, <sup>52</sup> Cr, <sup>54</sup> Fe, <sup>55</sup> Mn, <sup>65</sup> Zn, <sup>88</sup> Sr, <sup>137</sup> Ba, <sup>207</sup> Pb

## Results and Discussion:

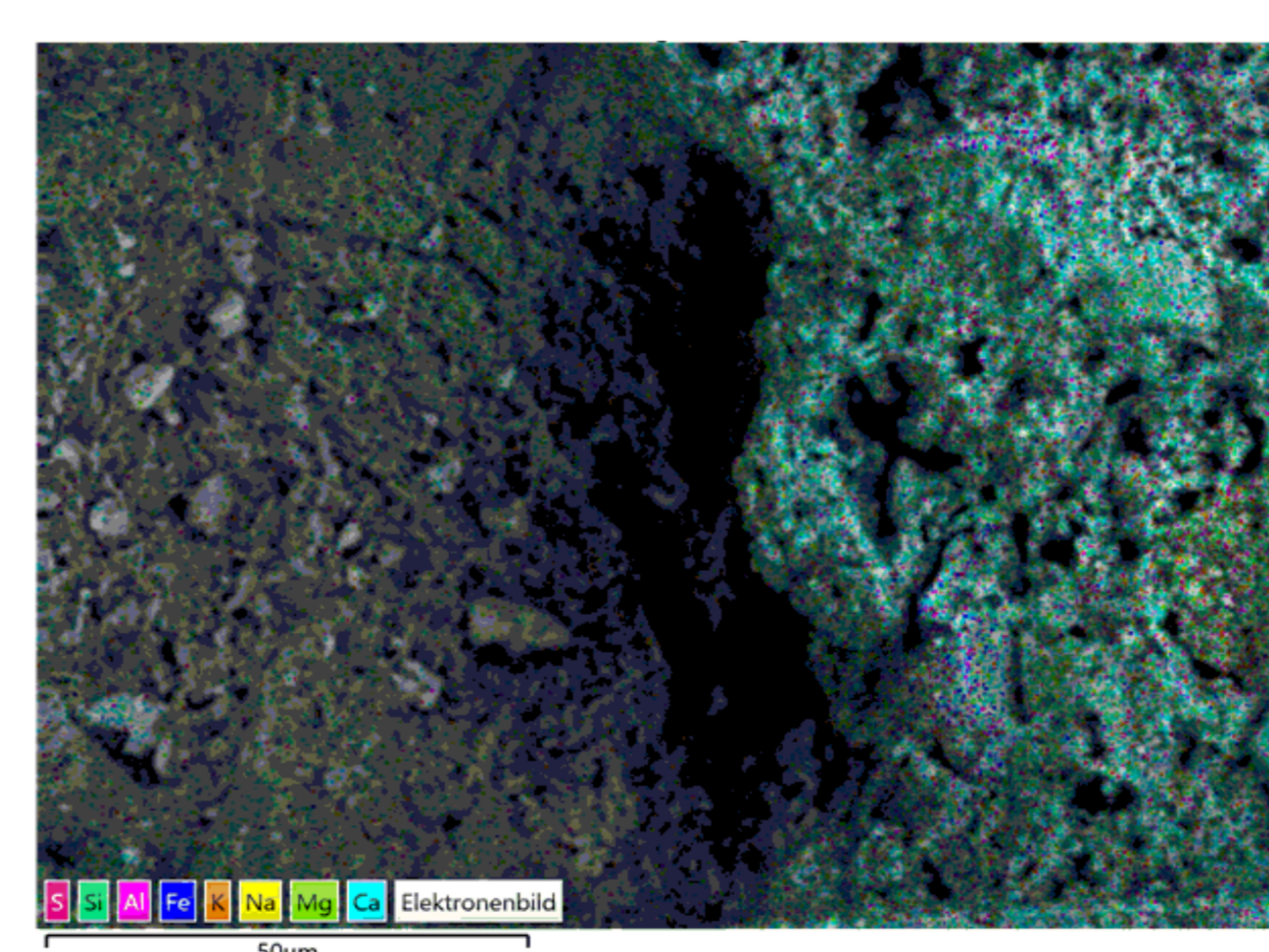
### 2D Mapping



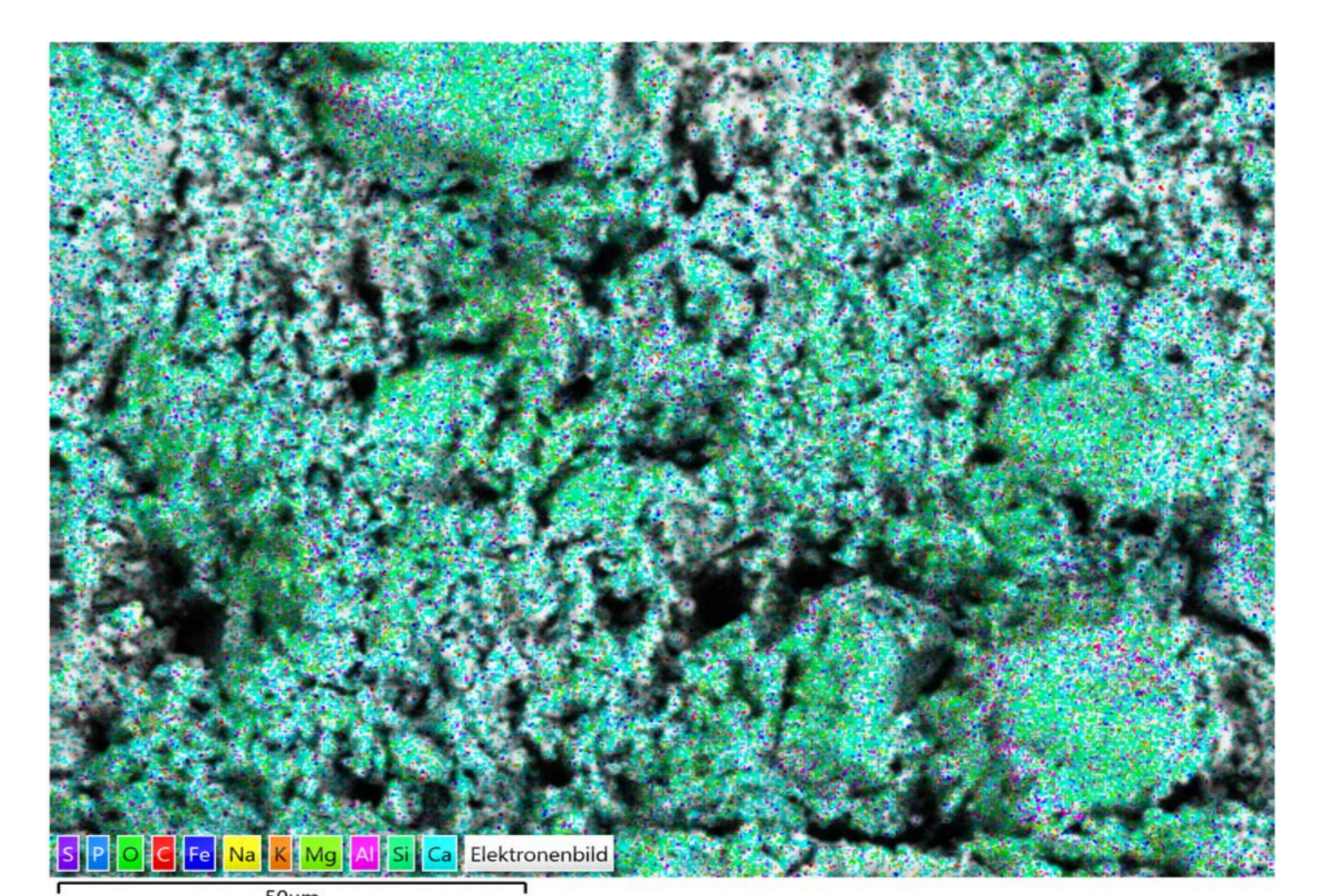
**Topography of measured sample**  
With confocal microscopy, we evaluate the ablation depth after Laser shooting



**SEM/EDS image of Aggregate**



**SEM/EDS image of ITZ**



**SEM/EDS image of Hardened Cement Paste**

- With the obtained results, we display the measured signal was more evenly for the hardened cement paste than for the aggregate
- The subjected phases indicate the variation by the amount of removed material. Thus, by the selection of the calibration method, we take into consideration different conversion ratios for individual phases.
- As a validation method, we used SEM/EDS