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## Abstract

- Calcium leaching is a degradation process that removes calcium from hydrated Portland cement and hereby leads to an increase in porosity, decrease in pH, cracks formation and steel corrosion.
- In this study recalcification is explored as a method to repair degraded Portland cement microstructure.
- For the first time, formation of new Calcium-Silicate-Hydrate after recalcification is observed.
- Effects of calcium leaching and recalcification on Ca/Si ratio, porosity and pore size distribution are elucidated.

## Objectives

- Observe recalcification in calcium leached OPC.
- Investigate effects of leaching/recalcification on:
  - Microstructure.
  - Mineralogy.
  - Ca/Si ratio.
  - pH.


## Methodology

Calcium leached OPC

Ca(OH)<sub>2</sub>

Characterization

Recalcification

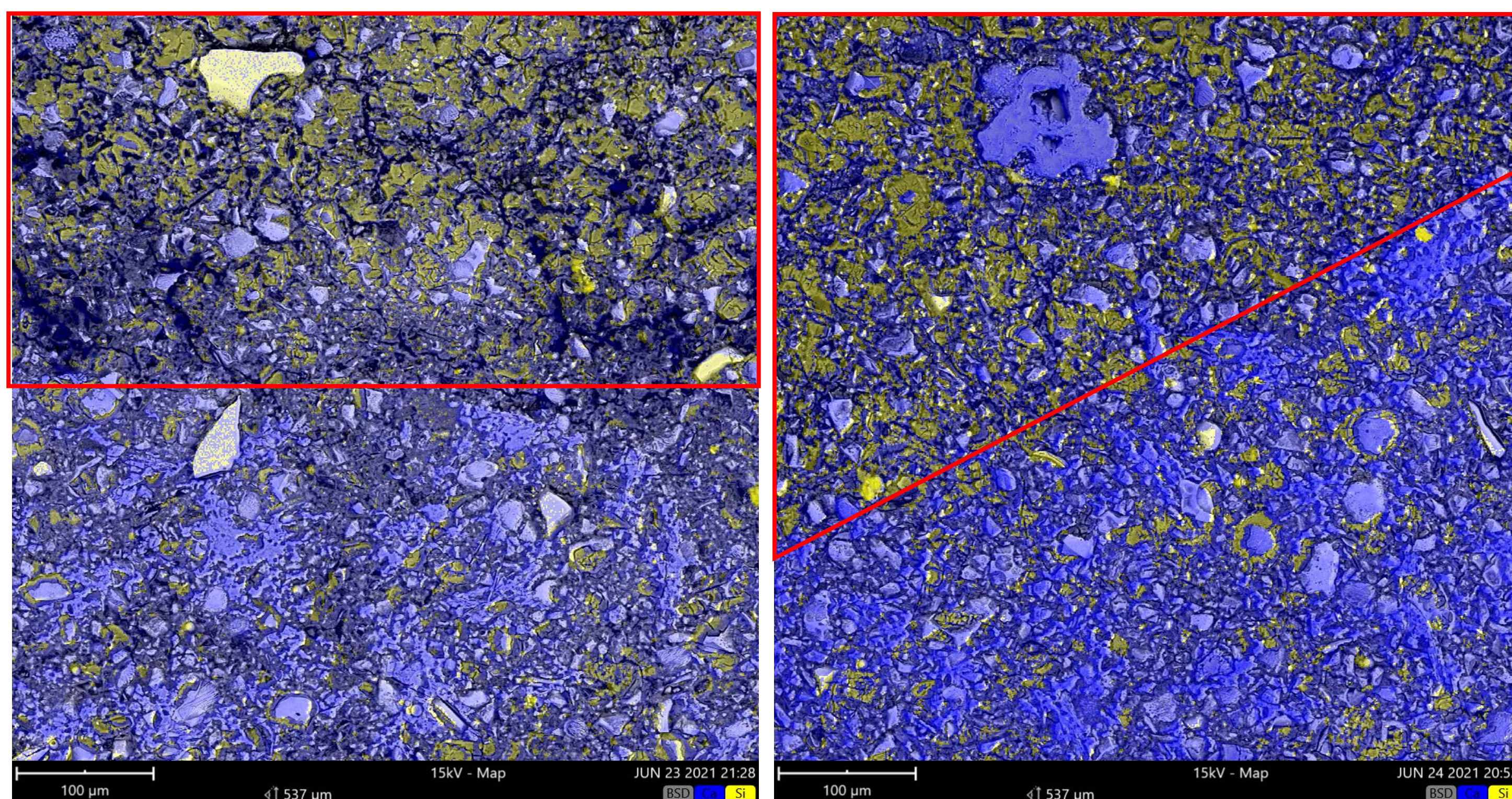


Leached

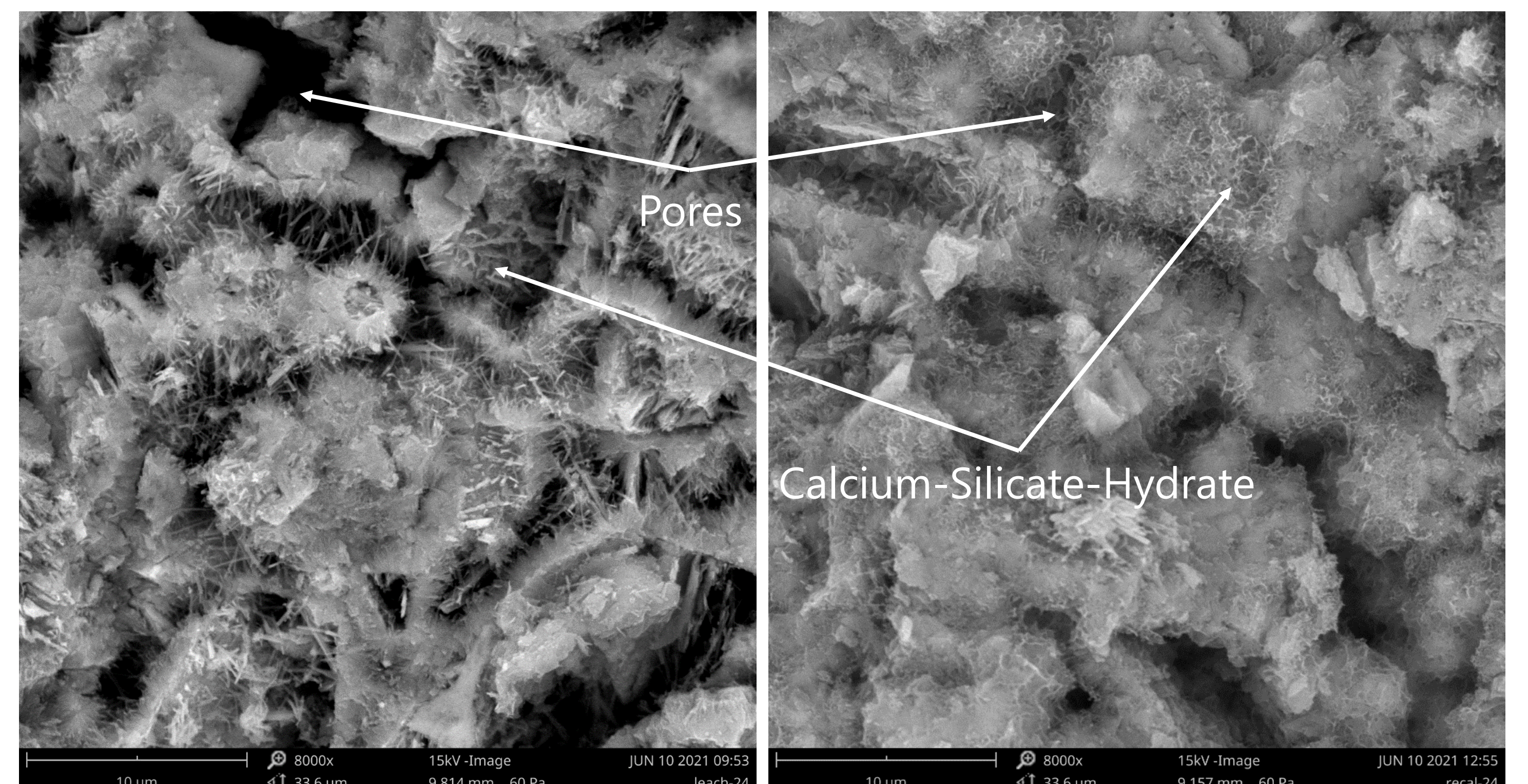
Recalcified

Properties		Value
Sample	Cement type	CEM I 52.5 N
	Water/cement ratio	0.5
	Curing	Sealed, 28 days
Leaching	Chemical	NH <sub>4</sub> NO <sub>3</sub>
	Concentration	6M
	Duration	4 – 6 – 8 – 10 – 24 hours
Recalcification	Chemical	Ca(OH) <sub>2</sub>
	Concentration	Saturated (~0.03M)
	Duration	6 days

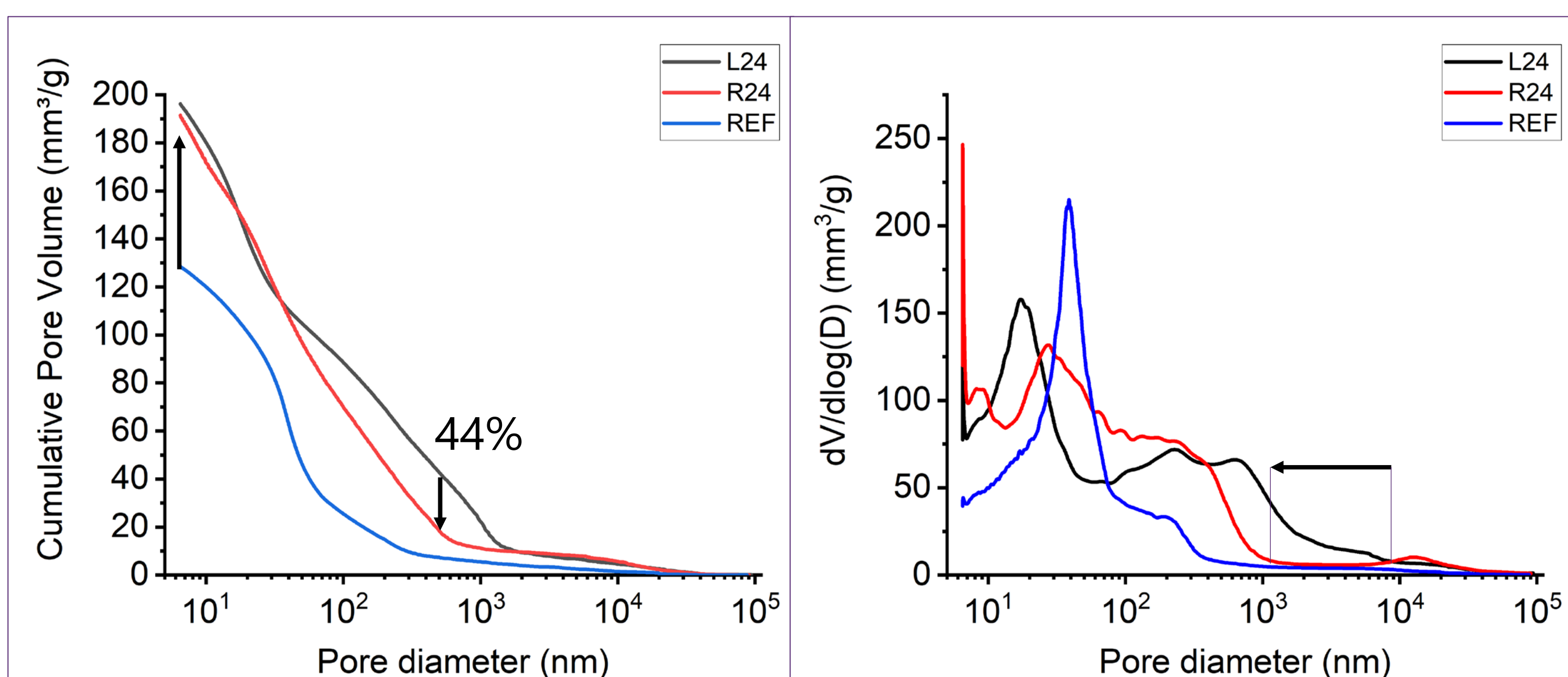
## Results



SEM-EDX capturing Ca/Si ratio of (left) leached and (right) recalcified sample. Leached zone is red circled, intact zone bottom half.



SEM-SE showing formation of Calcium-Silicate-Hydrate network filling leaching-derived pores. (Left) leached and (right) recalcified sample.



Mercury Intrusion Porosimetry (MIP) measurement on 24h-leached (L24), 6d-recalcified (R24) and reference (REF) sample.

- Porosity of leached zone drops from 31.9% to 25.4% after recalcification as estimated by SEM-BSE. SEM-calculated average porosity of reference is around 15%. Porosity reduction after recalcification is also observed by MIP.
- Average Ca/Si of leached sample (1.84) increases after recalcification (1.91).

Leaching duration (h)		0	4	6	8	10	24
Porosity by MIP (%)	Leached	21.8	25.9	26.7	25.6	25.3	30.0
	Recalcified	21.8	23.9	25.8	24.7	27.32	28.4

## Conclusion

- Evidence of new Calcium-Silicate-Hydrate formation to fill leaching-created pores is observed with SEM-SE.
- EDX mapping shows an increase in average Ca/Si ratio after recalcification.
- MIP-derived cumulative pore volume decreases after recalcification, together with shifting threshold pore diameter to smaller sizes.
- Pore volume from 50 – 1000 nm drops by 44% after recalcification.
- Pore size distribution becomes narrower after recalcification compared to leached MIP curve.

