Demystifying the Heterogeneity of Coal Fly Ash through Washing Cycles

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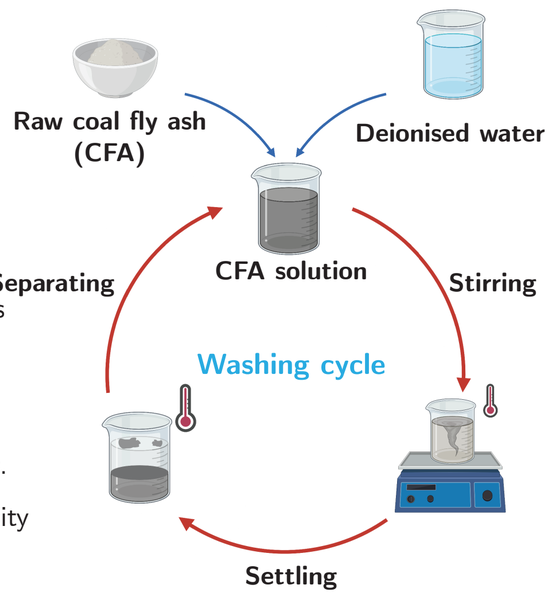
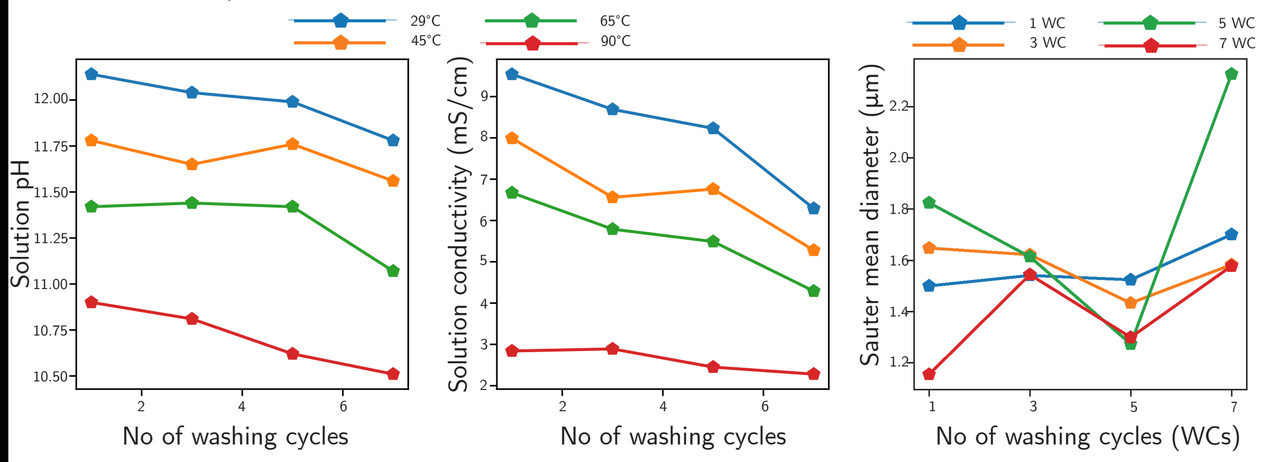
Washing cycles

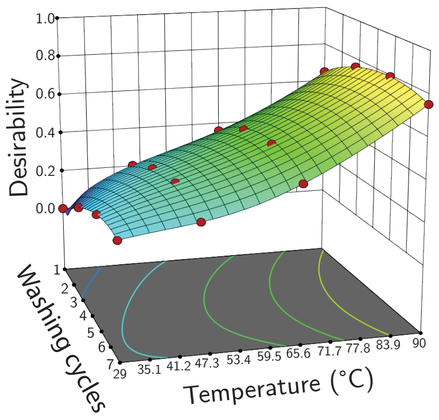
- Preprocessing CFA is crucial for the following reasons:

1. To reduce the easily soluble ions
2. To decrease the basicity of CFA particles
3. Creating new avenues for utilisation through multi-component separation

- We employed a simple scientific approach of water leaching for CFA pre-processing and discovered various opportunities of utilising CFA.
- These include cenospheres, substrate for zeolites, sources for critical elements, and fertiliser components.
- In addition, the washing cycles enhance the homogeneity of each components, leading to improved purity of value added products.

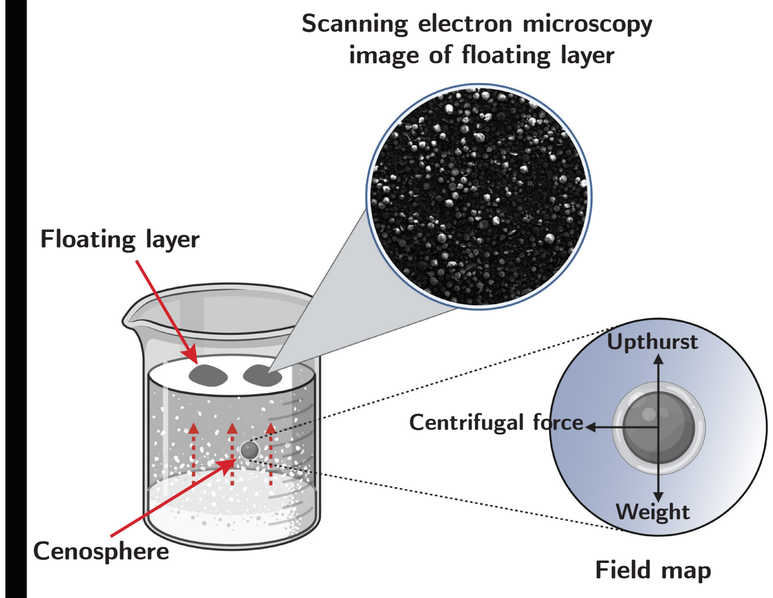




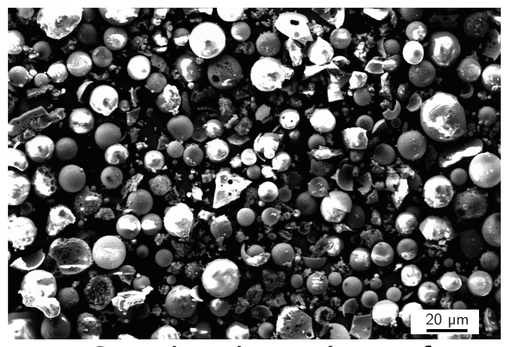


Washing the CFA five times (i.e., 15 minutes stirring and 15 minutes settling for five times) at 70°C affirmed to be effective through response surface methodology.

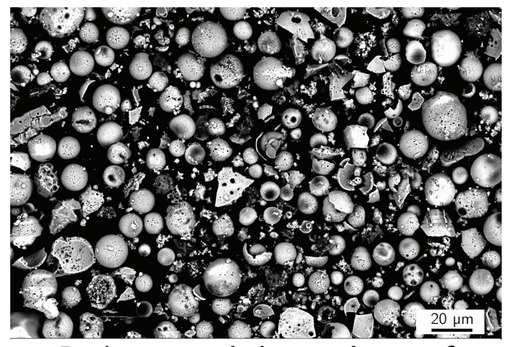
Cenospheres



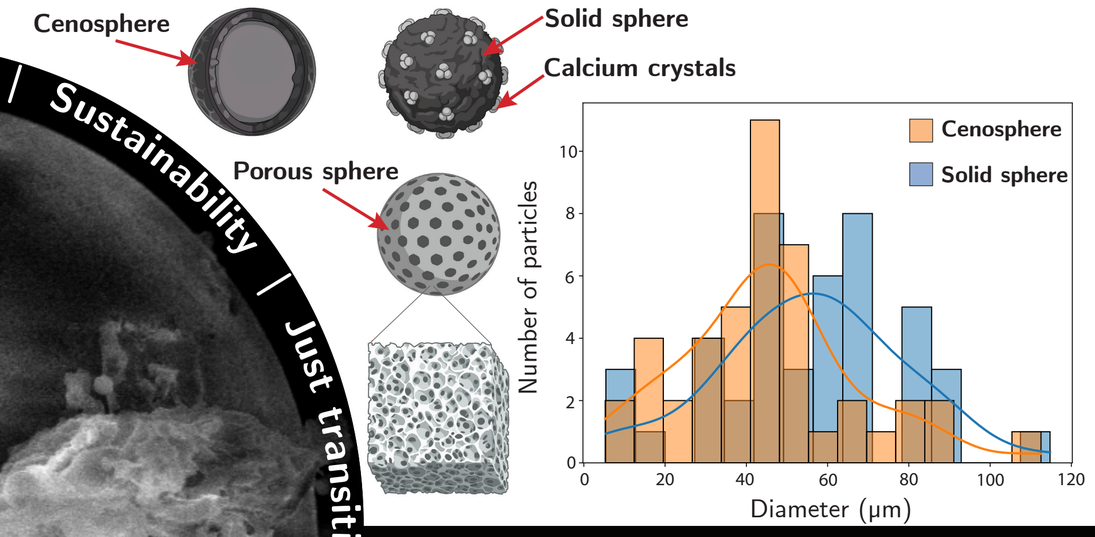
- Most valuable product from CFA
- Spherical-shaped hollow particles with cell walls primarily composed of Silicon and Aluminium
- Particle size varies from nanometres to hundreds micrometers.
- 0.01 to 4.80 wt% of CFA
- Density: 0.2 to 2.6 g/cc

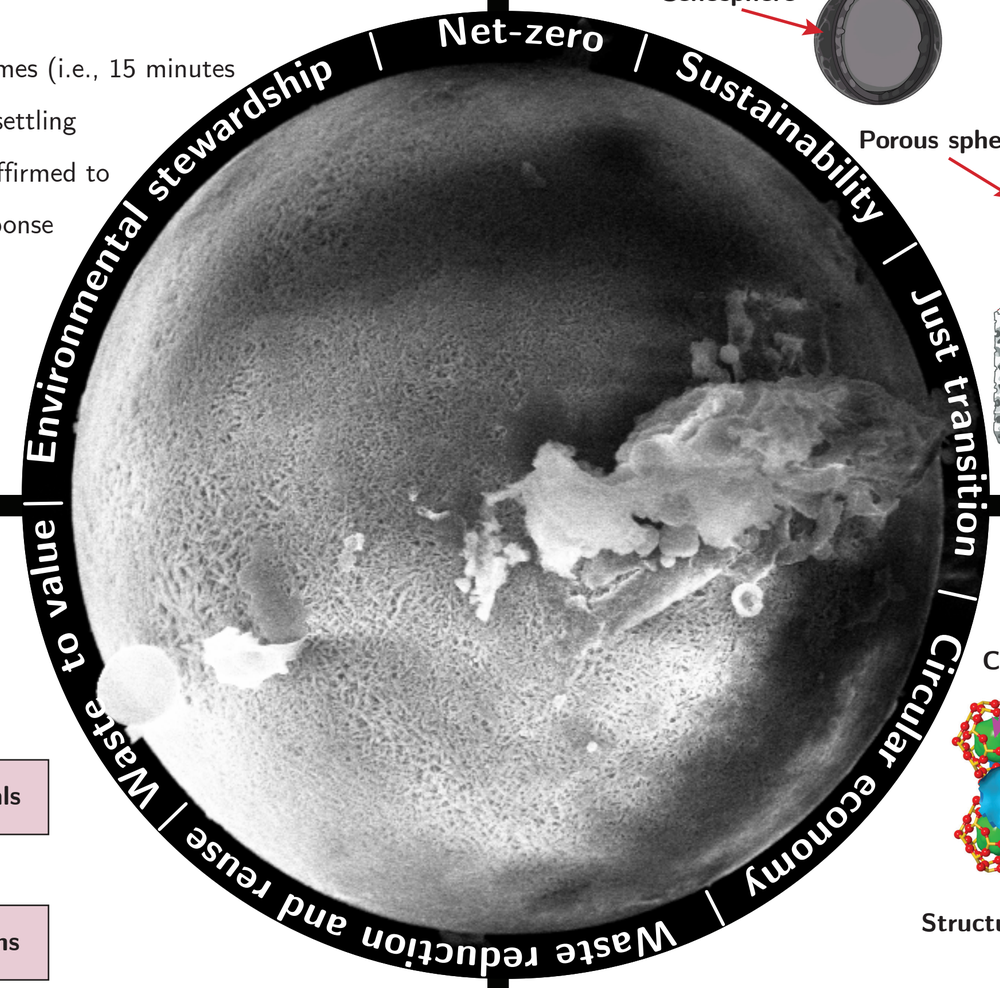


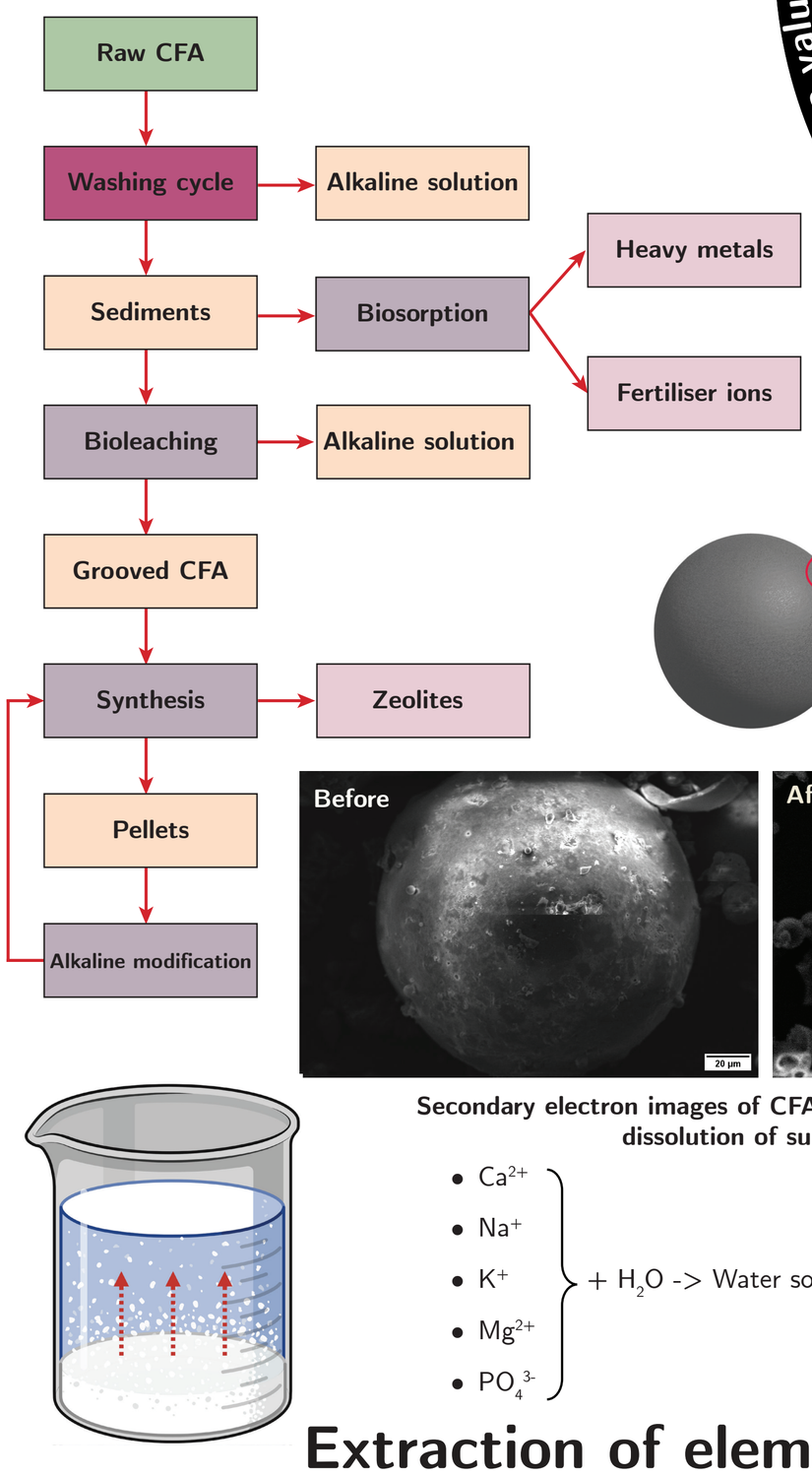
Secondary electron image of floating layer

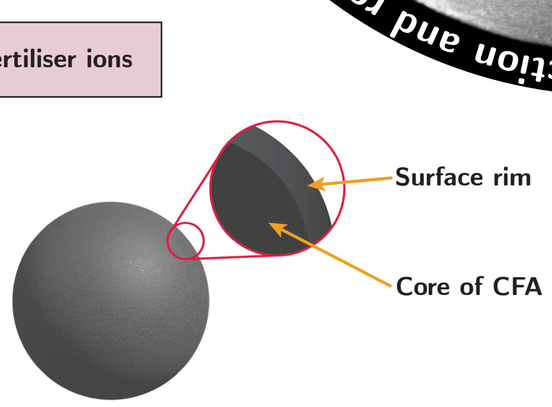


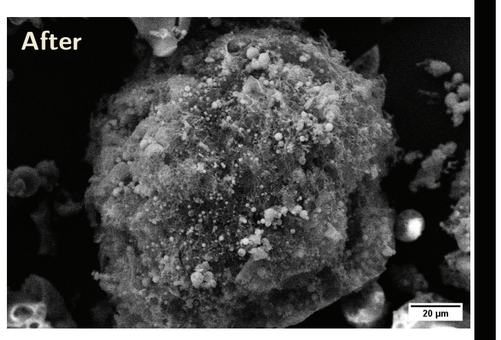
Back-scattered electron image of floating layer









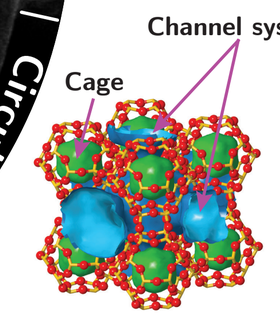


Secondary electron images of CFA particle before and after dissolution of surface rim

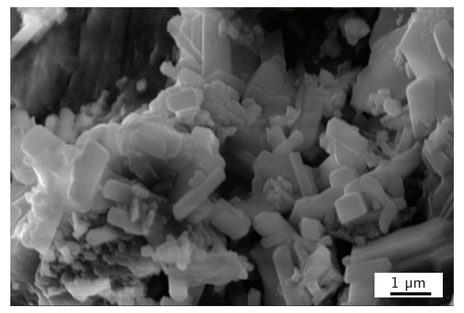
- Ca^{2+}
- Na^{+}
- K^{+}
- Mg^{2+}
- PO_4^{3-}

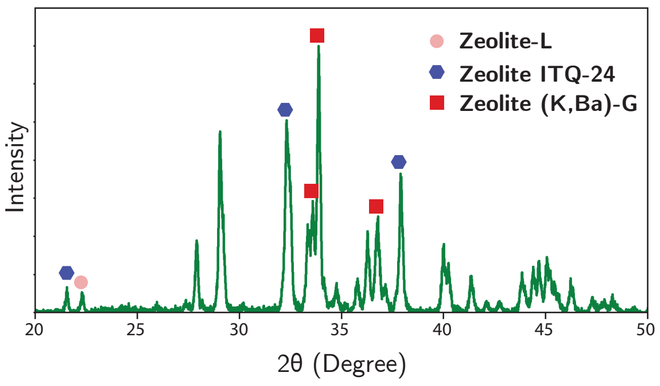
+ H_2O -> Water soluble alkaline hydroxides

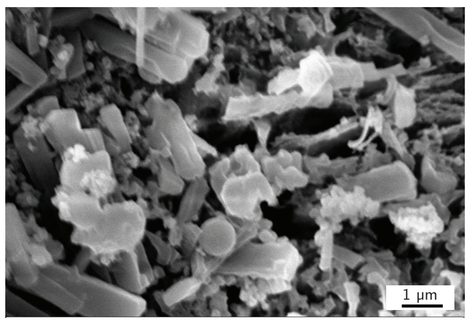
Extraction of elements



Structure of Zeolite-LTA







Secondary electron images of zeolite crystals

- Zeolites are a popular adsorbent in removing heavy metals, dyes, and anions in wastewater treatment because of their following properties:

1. well-defined molecular and porous structures
2. high thermal stability
3. ion selectivity
4. ion exchange capacity
5. surface area

- Synthesis zeolites have 6 to 7 times better absorption capacity than raw CFA and 3 to 5 times higher than natural zeolites.
- Synthesising zeolites is helpful in both minimising waste (i.e., CFA) and treating the waste (i.e., wastewater).

Zeolites