MINFLOT

Improving MINeral recovery efficiency of FLOTation using reactive transport modeling from atomic to reactor scale

FRANCE 2030 — PROGRAMME DE RECHERCHE — SOUS-SOL

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In France, the energy transition induces a growing need for critical metals, including Li, W, Co, or Ni, mostly extracted from ores and mining residues.

Problematic: ***The processes commonly used to beneficiate ores are not efficient enough to recover with satisfactory performances critical metals from the subsoil in an environmentally-friendly way.***

Objective: ***To improve the efficiency of these techniques to extract sustainably critical metals.***

FLOTATION TO RECOVER CRITICAL METALS

- ✓ Highly efficient mineral processing technique to separate minerals of interest from their gangue.
- ✓ Based on the use of reagents to modify the surface tension of mineral surfaces, followed by the injection of air bubbles to recover the hydrophobicized particles (Fig. 1).
- ⚠ Heterogeneous materials, complex water chemistry, interacting particles, bubbles and reactants in complex flows.
- ⇨ Difficulty of understanding and simulating adsorption phenomena at interfaces, and their link with particle transport and recovery of critical metals in turbulent flows, particularly for fine materials of growing interest.
- ⇨ Flotation: time-consuming and costly process, i.e. still not optimal.
- ⚠ At present, only atomic simulations and phenomenological/empirical fluid dynamics simulations on the considerably larger reactor scale. Missing intermediate scale description that would consider mechanistic understanding of the phenomena involved.
- ⇨ Considering multi-physical and multi-scale phenomena, from the atomic scale to the reactor scale, by understanding and mechanistically simulating the interaction forces between particles and their environment during transport.
- ⇨ Improvement of the flotation efficiency by enhancing its simulation, and then the recovery of critical metals.

GOALS OF THE MINFLOT PROJECT

- ✓ New and innovative multi-disciplinary and multi-scale approach.
- ⇨ Combining closely cutting-edge experiments and numerical modeling from the atomic scale, where key physicochemical phenomena at interfaces occur, to the reactor scale, via the particle and microreactor scales.
- ✓ Inputs: molecular dynamics simulations constrained by spectroscopic measurements coupled with artificial intelligence.
- ⇨ Colloidal interaction forces simulated at interfaces intervening in computational fluid dynamics-discrete element method (CFD-DEM) to simulate particle reactivity and flow in microreactors (Fig. 2).
- ✓ Simulations validated using microfluidics and microreactor experiments.
- ✓ Electrokinetic, wettability and geochemical measurements and models making the link between atomic and hydrodynamic simulations.
- ✓ Flow and reactive transport modeling at the larger reactor scale considering the results of smaller-scale simulations and mineral/metal recovery measurements.
- ⇨ Improvement of the reliability of froth flotation simulations and the efficiency and cost of the process by the expected breakthroughs.
- ⇨ Larger amounts of ore and mining waste to be treated to recover from them critical metals like tungsten and lithium.

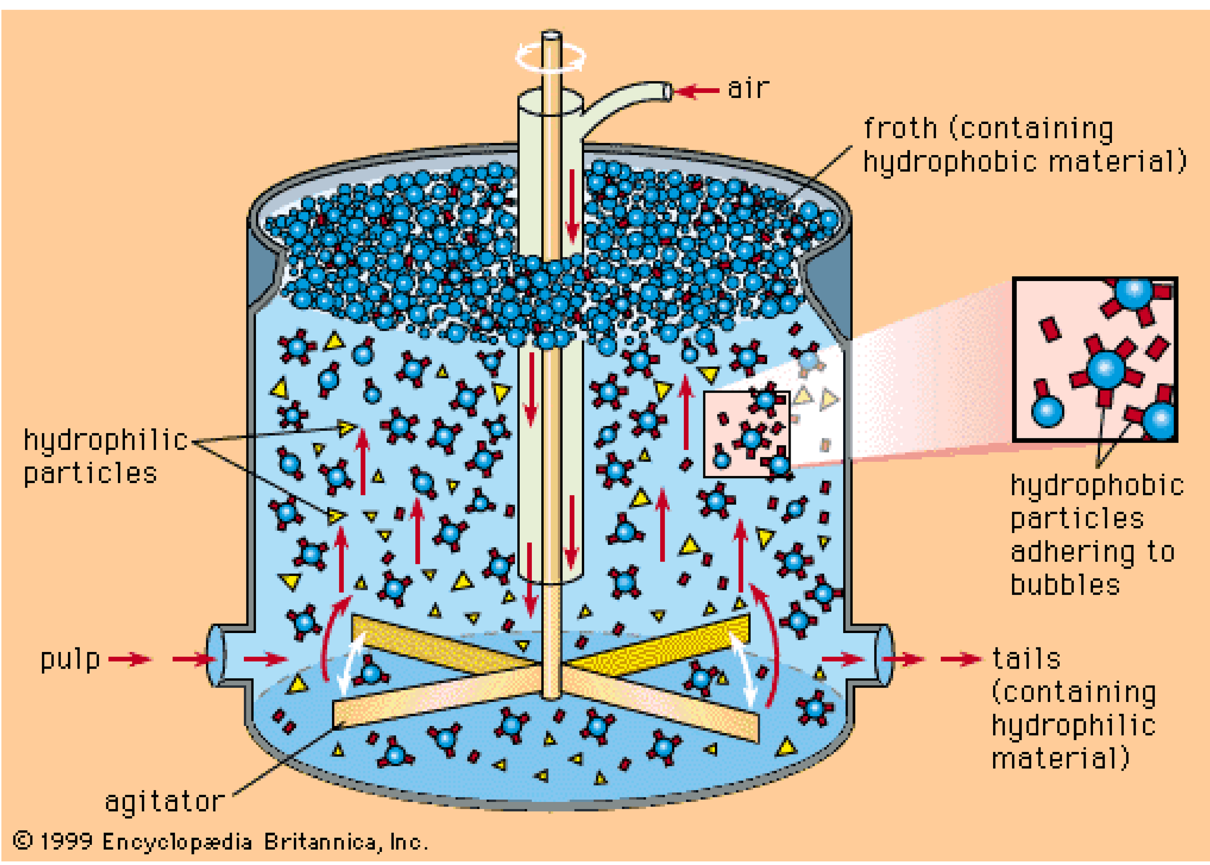

Figure 1. Sketch of the froth flotation method to recover hydrophobic valuable particles (from Encyclopedia Britannica).

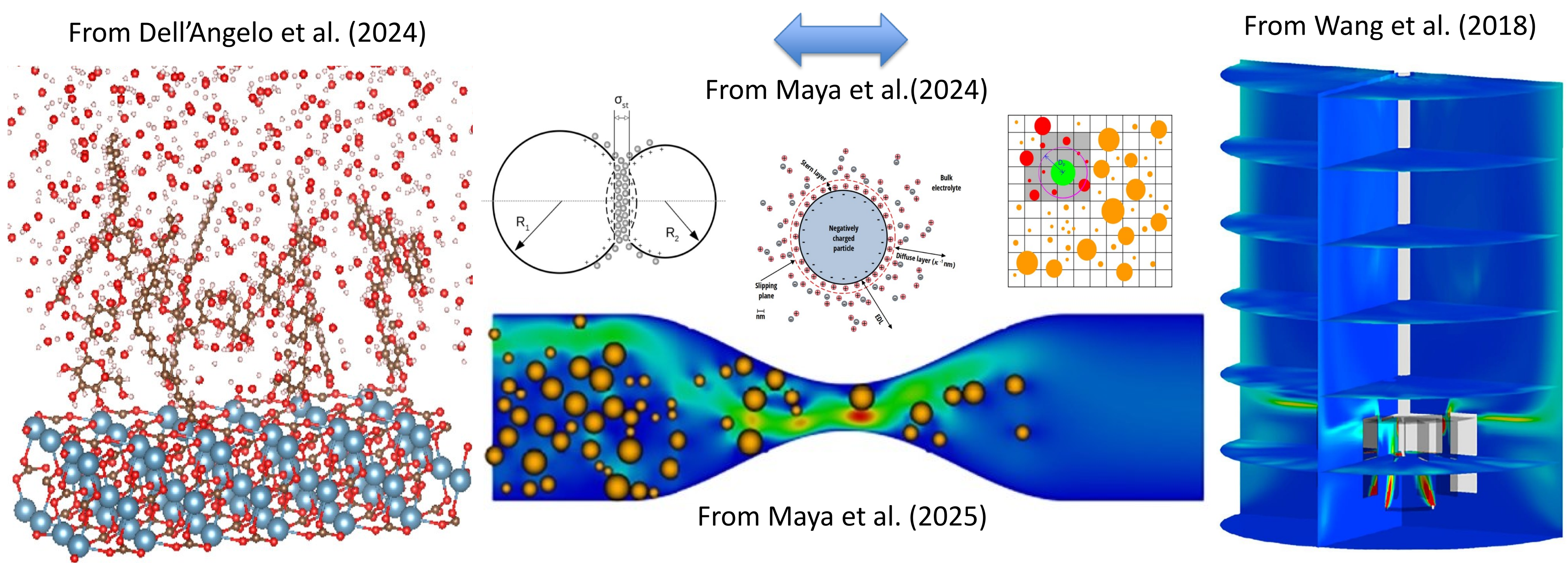

Figure 2. MINFLOT methodology. Bridge of the CFD-DEM simulations between the molecular simulations and the phenomenological/empirical reactor scale flotation simulations.

References

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