Sustainable mine waste management: a closer look at dry stacking

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The need for decarbonisation cannot be decoupled from an increase in demand for critical metals and minerals required for renewable energy technologies. These metals and minerals need to be extracted from ever lower grade deposits, resulting in more material being mined and processed and thus more associated waste, or mine tailings, being generated. The storage of those tailings using conventional strategies (i.e. wet tailing dams) not only represents the largest water sink in most mines but poses substantial social, environmental and safety challenges, as evidenced by recent disasters caused by the collapse of tailing dams.

Dry stacking is a more sustainable tailings management strategy that can be used to store filtered tailings. It involves the progressive deposition of layers of de-watered tailings onto sloped drying beds. In addition to avoiding the stability risks associated to wet tailings, dry stacking helps closing water loops in the processing plant and has the advantage of decreasing the volume and footprint of tailings. While being a well established technique in a number of sites, a paradigm shift is still required for a widespread adoption of dry stacking. This comes with the requirement to better understand how mineral properties, operating parameters, and environmental factors affect the process.

This project will develop a fundamental understanding of the deposition of de-watered particulate systems. By having a closer look at the phenomena taking place during the spreading and drying of deposited material, the student will be able to devise novel strategies to optimise the process and make it more environmentally friendly. The ultimate goal is to generate knowledge that can be used to control waste specifications, so that the material properties can be tailored to achieve optimal tailings deposition. This will in turn contribute to safer tailings management strategies that reduce environmental impacts.

As part of the project, a range of techniques that have been successfully exploited in advanced manufacturing processes will be used to allow a full characterisation of the dry tailings. In particular, the size, shape, roughness and surface chemistry of the particles will be determined and linked to the behaviour of the dry stack. Further, analyses of the effect of ore variability and changes in the level of moisture will be used to inform filtration requirements and deposition strategies for optimum spreading, capillary drying and compacting.

The PhD student will develop expertise in advanced analytical techniques that can be applied in a variety of fields. Opportunities to visit mine sites and research collaborators will expose the student to the various stakeholders. Overall, this will equip the student with the skills to develop innovative solutions and contribute to inform best practice in the field of sustainable raw materials, helping mitigate environmental impacts through robust scientific knowledge.

This project is available to students who apply for Imperial College scholarships or other international scholarship schemes.

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