More research and funding needed for mineral processing

Mining is essential to our life on Earth, but our mineral resources are not renewable and are being depleted rapidly. We will need to recycle more and more minerals and move towards a circular mining economy, in order to meet future demand. This is easy to state but very difficult to achieve in practice, and will need global coordination in a world where we are sadly becoming more polarized and radical.

It is well known that mineable mineral deposits are becoming deeper, more remote, and with lower grades. On the positive side the 4th and 5th Industrial Revolutions will benefit the mining industry the most as we design, build, and operate in 'naturally variable and failed' material (rock). Real-time monitoring, automation, artificial intelligence, and robotics will help make mines much safer as people will be removed from the advanced faces, and much more productive. The skills levels required will also increase dramatically as the mining industry will need computer scientists, mechatronic engineers, instrumentation designers, and technicians to name just a few. Cyber-security will become absolutely essential due to the potential dangers of robotic equipment being hacked.

The resolutions and emission goals for 2030 and 2050 proposed at the recent Conference of the Parties (COP 26) in Glasgow, Scotland, while essential for the global environment, will enormously increase the demand for mainly battery minerals such as copper, nickel, lithium, and graphite. No consideration has been given to how these demands will be met, and the lead time for new mines is 5 to 10 years at least.

Considerable research is being undertaken in the fields of 'green' and 'smart' mining, but I believe that not enough is being done in the field of mineral processing. Specialized metallurgical engineering programmes are being closed globally and absorbed into mainly chemical engineering programmes. This makes financial sense due to low enrolments in metallurgy programmes, but specific and focused courses are essential for at least postgraduate studies and upskilling.

Research areas that I think need more research and implementation include:

- *Grade control* (geometallurgy) – the benefits can be achieved in the short term and can have an immediate effect on most metal mines. It is strange that few mines have investigated the potential real benefits of this.
- *Urban mining* – specifically of electronic devices, in which the gold and rare earth grades are higher than most orebodies. This also carries significant environmental benefits.
- *Water conservation and protection* – reducing fresh water use is essential and can be achieved by more recycling, lower tonnages processed, and the development of less water-intensive processes.
- *Dry processing* – water is a scarce resource and mining competes with other industries, agriculture, and domestic use. Is an important research field that is not a simple task, but should be an area of research focus due to the massive benefits.
- *Energy conservation* – mines are traditionally energy-intensive, especially for ore comminution. Efforts must be made to reduce total energy consumption and use more green energy.
- *Waste reduction and repurposing on surface* – mining produces the largest amount of waste of any industry, and this must be significantly reduced. This can be achieved by maximizing backfilling underground and trying to repurpose the remainder of the waste.

Most of the above are obviously interrelated.

For the mining industry to succeed and help meet the demands of society, more investment into processing is required. International research cooperation is also vital as it tends to generate solutions faster, more efficiently, and at a lower cost.

Prof A.J.S. (Sam) Spearing
School of Mines China University of Mining & Technology