



# Geochemical Engineering

Earth Systems is a global pioneer and leader in geochemical engineering with over 20 years' experience in designing geochemically stable mineral waste storage facilities for the mining industry. Geochemical engineering is an assurance service that involves routine assessment and auditing of mine waste management procedures over the life of the mine to minimise the risk of environmental impacts and associated costs.

The generation of acid and metalliferous drainage/acid rock drainage (AMD/ARD) and neutral metalliferous drainage (NMD) is an issue that affects mining operations worldwide. The short- and long-term environmental and economic liabilities of contaminated mine drainage are estimated to cost the mining sector hundreds of millions of dollars annually.

Management and treatment of such impacted drainage can present major challenges for compliance and incur substantial costs not only over the life of the project but also over the long term, sometimes for hundreds of years after the site is decommissioned.

In the majority of cases, the generation of AMD and/or NMD at mine sites could be avoided or significantly mitigated by incorporating concepts of geochemical engineering into mine design and assuring the geochemical stability of mineral waste storage facilities over the life of the mine and beyond.

Geochemical stability is as important as geotechnical stability in ensuring the long-term structural competence of mine components and assuring against economic, social and environmental impacts during operations and post-closure. Regulators now expect leading geochemical engineering practices to be incorporated into mine design. Assuring geochemical stability can assist in avoiding many of the long-term legacy issues now faced by mine sites worldwide.

Earth Systems has a world-class team of experts in geochemistry and water chemistry that have been devising innovative, cost-effective and elegant geochemical engineering solutions for the mining industry in Australia and internationally for over 20 years.

## ADVANTAGES OF GEOCHEMICAL ENGINEERING

Geotechnical engineering is a routine part of mine design and development, but it only represents half the story. Geochemical engineering addresses many of the critical issues not captured by geotechnical engineering in mineral waste storage facility design—issues that can have major impacts on operations and result in costly long-term environmental and social liabilities. These issues include:

- Potential for AMD/NMD/salinity generation
- Subsidence of stored wastes due to significant mass loss over time associated with the dissolution of carbonates, reactive sulfides and sulfates, and other geochemically unstable minerals.
- Ion exchange of clays in geotechnical liners, clay cores and clay caps due to geochemical processes in waste storage facilities, which can result in degraded geotechnical stability.
- Potential for in situ management/treatment of contaminated seepage to prevent or mitigate AMD discharge.
- Long-term impacts of accumulation of acid-storing secondary minerals.
- Overall long-term geochemical and geotechnical stability of closure landform.

## GEOCHEMICAL ENGINEERING IN MINE DESIGN AND MANAGEMENT

Integrating geochemical engineering into mine design and management is straightforward and coordinates seamlessly with routine geotechnical engineering activities.

Assuring geochemical stability is a critical aspect of leading practice for the mining industry, and in the past has generally been implemented post-design on an ad hoc basis. Earth Systems offers a fixed price, staged framework for geochemical stability assurance that encompasses the entire mine lifecycle.

The key components of our industry-leading geochemical engineering program include:

- Geochemical Stability Scoping Study
- Geochemical Stability Risk Assessment or Audit
- Site Geochemical Stability Strategy (operations & closure)
- Detailed design (geochemical/geotechnical)
- Geochemical Stability Monitoring Plan
- Geochemical stability monitoring and assurance
- Annual geochemical stability reporting and audits
- Geochemical troubleshooting and remediation



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