Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.17727

Mining of nickel laterites – towards more environmentally responsible operations

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Primary mining of technology metal ores is needed to enable effective decarbonisation. The use of nickel in rechargeable batteries is expected to increase global demand for nickel rapidly over the coming years. Over 60% of annual global nickel production originates from nickel laterites, with Indonesia and the Philippines leading the market. Mining of nickel laterite ore can adversely affect the environment through the release of CO_2 and potentially hazardous elements (PHE), such as hexavalent chromium, or asbestiform minerals. Through our better understanding of the social and environmental impacts of mining operations and the availability of technologies that can potentially mitigate adverse impact, it is paramount to aim for more responsible mining and metal recovery operations.

This study focuses on the Sta Cruz nickel laterite deposit in the Philippines. Through a multi-scale and multi-technique analytical programme and drawing on existing knowledge[1,2], we appraise the deposit holistically, focusing on (i) the geochemistry and mineralogy of major commodities and trace metals, such as the platinum group elements; (ii) carbonate forming metals, *e.g.* magnesium and (iii) the presence and ecotoxicity of PHE and minerals. We use this understanding to assess the potential for a circular economy in mining, *via* complete utilisation of the ore to maximise the metal output and minimise the waste produced. This includes the removal of CO_2 through the formation of carbonate minerals (mineral carbonation). We also investigate the potential of carbonates to immobilise chromium crystallographically alongside the CO_2. This aspect of mineral carbonation is currently poorly understood. We have carried out laboratory synthesis of chromium-doped carbonates at ambient P-T conditions, which indicates that the most common magnesium carbonates do not readily accommodate chromium. However, other carbonate-bearing minerals, including those belonging to layered double hydroxides, present a viable alternative. The combined PHE-CO_2 mineral carbonation, when implemented at different stages of metal recovery, from ore extraction to processing, could lead to a reduction of the volume and toxicity of waste, collectively contributing to the mitigation of the adverse environmental impact of nickel laterite mining.

[1] Acquino et al (2022) *Minerals*, *12*(3)
[2] Bacuta et al (1990) Journal of Geochem.Exploration, 37