Looking backward to look forward – Palaeoclimate recreations and potential applications for mine closure

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# ABSTRACT

Effective life of mine planning is increasingly facing the challenge of designing for perpetuity. To allow effective mine closure, landforms must accommodate a closure state that is safe, stable, non-polluting, self-sustaining and supports a post mining land use. This challenge is magnified by the requirement to consider various future conditions, such as uncertain climates in the medium term, and the possibility of substantially modified regional climatic conditions, should key climatic drivers / regulators, such as the Atlantic Meridian Overturning Circuit (AMOC), collapse or substantially change.

For hydrologic and hydraulic landform design in the medium term to perpetuity, the challenge has resulted in substantial challenges in establishing the design climatic conditions that should be considered across a mine’s life-cycle, such as the Probable Maximum Precipitation and Flood (PMP and PMF) or continuous climatic conditions. These assumptions are key in establishing hydrologic, hydraulic, landform evolution, cap and surface design aspects.

In Australia, recent national guidance (Australian Rainfall & Runoff (AR&R)) has stressed the need to consider adaptive management in landform design and management. However, methods to estimate potential future conditions primarily involve the introduction of additional uncertainty within estimates with ensuing outcomes difficult to communicate to key stakeholders.

Paleoclimates, are geologically studied conditions, which represent a potential alternative approach for design in perpetuity by considering the potential envelope of conditions that could be experienced in post-closure, in addition to traditional approaches.

Palaeoclimates are developed from proxies, such as tree growth rings, corals, to Antarctic ice cores, and can allow us to reconstruct historical climate conditions. This paper leverages the Queensland Government and Seqwater’s Drought and Climate Adaptation Program: “Palaeoclimate for Water Security,” which provides a database of palaeoclimate studies relevant to hydroclimate in Australia, and a tool which recommends the most suitable palaeoclimate proxies based on location.

This paper applies these tools to develop insights into past climate, which is then used as indicators of potential future climate relevant to mine closure designs in Queensland. We discuss the financial, physical, societal, and environmental implications of incorporating palaeoclimate considerations into final landform and hydraulic structure closure designs. We provide a suggested framework for considering adaptive management for post-closure design, and communication of potential conditions to stakeholders. The paleoclimates and developed methodologies will be compared to traditional rainfall scaling methods available in Australian guidance.

Palaeoclimate recreations will provide mine owners and designers with an appreciation for natural climate variability – if it has happened before, can it can happen again? This provides an opportunity for palaeoclimate recreations to provide confidence in closure designs, as palaeoclimate recreations can establish a more robust benchmark for natural climate variability, and envelope the quagmire of uncertainty in future climate condition estimates.