Goldschmidt 2024 Abstract
https://doi.org/10.46427/gold2024.24687

Unveiling Metal-Rich Ore Deposits: A Multi-Faceted Approach Integrating Metagenomics, Geospatial Analysis, and Biomolecular Techniques

BIANCA RENEE PALOMBI, JAVED FOYSAL AND BRETT NEILAN

University of Newcastle

Presenting Author: BiancaRenee.Palombi@uon.edu.au

Mineral exploration faces challenges like extensive post-mineralisation cover and diminishing effectiveness of traditional methods, leading to the adoption of innovative geomicrobial approaches for continued exploration success. This study integrates metagenomics, advanced biomolecular techniques, and geospatial modelling using machine learning (ML) to exploit associations between metal-rich deposits and the occurrence of heavy metal resistance genes in groundwater microbial communities. The primary objective is to develop a spatial abundance model based on distinct genomic markers, constraining regions of gold mineralisation potential while enhancing understanding of factors regulating metal resistance in microbial communities.

Research to date has applied amplicon sequencing to identify a core microbiome of metal-resistant specialists, revealing differences in microbial diversity and community structure between metal-rich and background environments. Further research will explore samples by shotgun sequencing to elucidate functional profiles of metal-resistant genes, informing adaptive strategies under metal-rich conditions. These findings will contribute to development of a genomic database comprising target metal-resistance genes, facilitating high-throughput screening with primers pinpointing the presence of specific gene clusters like our demonstrated approach with the golTSB regulon. Additional techniques, including cloning of target genes informed by the database, will demonstrate development of whole-cell biosensors for monitoring on-site metal concentrations in samples.

Finally, by leveraging high-performance computing and supervised ML algorithms like Random Forest, this study will integrate geospatial and genomic data to uncover hidden spatial patterns within microbial communities, expanding exploration tools to include predictive microbiome provenance as a novel way of identifying the precise geolocation of metal-rich mineralisation. This interdisciplinary research showcases cutting-edge methodology, positioning ML, biotechnology, and genomics at the forefront of genome-informed mineral prospecting. Findings extend beyond mitigating environmental impacts often linked with conventional exploration techniques, offering a replicable framework for exploiting other geomicrobial relationships. Emergent opportunities include biogeochemical relationships seen in resources such as tellurium, platinum, and lanthanides, suggesting promising avenues beyond gold.