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Multidisciplinary characterisation of groundwater flow and contaminant transport in legacy mine wastes, Endurance Mine, northeast Tasmania

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The Endurance mine site is a legacy alluvial cassiterite and kaolinite mine located in northeast Tasmania, Australia. Mining occurred between 1874 and 1982, leaving a series of pit lakes and over 70 ha of coarse-grained mine waste at surface. These mine wastes continue to generate acid and metalliferous drainage (AMD), despite low observed pyrite content. Endurance is a remediation site of priority for Mineral Resources Tasmania, driven largely by public use of the site for recreation. By combining geochemical, mineralogical, hydrogeological, and geophysical techniques, this study aims to characterize the internal structure of the heterogeneous mine wastes and determine the preferential pathways of AMD transport in groundwater.

Three primary hydrogeological units within the mine wastes were identified and characterised by integrating inverted direct current resistivity and seismic refraction models with ground penetrating radar data and confirmed through drilling, hydrogeological testing, and geochemical analysis. The mine wastes (~4 Mt), composed of poorly sorted, quartz-rich (94% SiO_2, < 2% sulfides) gravelly sand, range in thickness from 1.2–17.7 m and provide the main conduit for groundwater flow. Integrated 3D geophysical and steady-state numerical hydrogeological models indicate southward groundwater flow through the mine wastes from Blue Lake (main pit lake) towards Ruby Lagoon (AMD collection pond), predominantly controlled by subsurface paleochannels in the granitic basement. Dissolved Fe, Al, and SO_4 and trace metal loadings in groundwater and Ruby Lagoon suggest that the oxidation and/or dissolution of mineral phases (trace sulfides, authigenic Fe-bearing oxides, and aluminosilicates) generate AMD as water flows southwards.

This broad-scale, multidisciplinary characterisation of mine wastes will inform the long-term remediation of the Endurance mine site. It is hoped that this approach, when applied to other impacted mine sites, will provide new insight into the origins and transport of contaminants through mine wastes.