

## **Mineral Exploration in Areas Covered by Glacial Diamictites Using Indicator Heavy Minerals, Yilgarn Craton, Western Australia**

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Glacial sediments have been thoroughly integrated into mineral exploration protocols in the Northern Hemisphere (e.g., Canada and Fennoscandia), but have received less attention in Australia. In the northeast of the Yilgarn Craton, Western Australia, Permo-Carboniferous diamictites, buried by younger Cenozoic sediments, cover scattered areas that have potential to host gold and nickel mineralization. A systematic stratigraphic, mineralogical, and geochemical study was undertaken to determine whether Permo-Carboniferous diamictites in the Agnew-Lawlers gold province have properties that may help target concealed mineralization.

Glacial sediments intersected in 31 drill holes NE of the Waroonga gold mine were interpreted in terms of lithological, textural and palaeotopographic, mineralogical, and geochemical variations to select the best sampling media for mineral exploration and provenance assessment. The restricted spatial extent, matrix-supported fabric, angular clasts, and poorly sorted texture of diamictites covering greenstone belts indicate mechanical dispersion from proximal mafic and ultramafic source rocks. The clasts and matrix of these diamictites are rich in ferromagnesian minerals, chromite, Cr-magnetite, magnetite, Mn-poor ilmenite and Ni-Cu-Fe sulfides. Monazite, apatite, zircon, Mn-rich ilmenite, and pyrite-bearing quartzite clasts increase in abundance in diamictites covering granitoid/gneiss terrain and the mafic-dominated metasediments of the Scotty Creek Formation. Felsic diamictite clasts are rounded, with striated surfaces, which indicates mechanical dispersion from distal granitoid/gneiss terrains. Alteration of ilmenite to titanite, monazite to apatite and thorite, and pentlandite replacing and cutting across monazite suggest felsic, intrusive-related hydrothermal alteration of the mafic and ultramafic source rocks prior to glacial weathering and erosion.

Post-Permian chemical weathering of glacial diamictites associated with oscillation of the water table have created oxidation and reducing zones within the Permian sequence. In the reducing zone below the water table, diamictites are unweathered, rich in detrital sulfide and opaque oxide minerals and can be used in provenance studies. The unweathered diamictite is the optimal sampling medium target for provenance studies and mineral exploration. In the oxidation zone above the water table, diamictites are variably weathered to ferruginous and bleached kaolinitic saprolites which are stable under oxidizing, circum-neutral conditions. Weathering of near-surface diamictites restricts the application of heavy minerals in prospecting for economic minerals, with the exception of resistate ore minerals or their indicators (e.g., chromite). However, weathered diamictites are rich in recycled redox-sensitive elements derived from oxidation of ferromagnesian and opaque heavy minerals. These weathering features can be used to identify metal haloes formed by hydromorphic dispersion.

Application of diamictites in other parts of Australia can be powerful for mineral exploration in areas covered by deep transported cover.