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Hydrothermal Ni Prospectivity Analysis of Tasmania, Australia

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Tasmania contains the largest hydrothermal Ni deposit in Australia: Avebury (118,000 Ni metal tonnes). This Devonian deposit was discovered in 1998 in the Dundas geological region, and represents an outstanding example of hydrothermal Nickel sulphide mineralization type. Avebury Ni deposit is a system of hydrothermal Ni ore bodies. It is hosted by an intensely altered and serpentinized Cambrian ultramafic suite in close proximity to major structural features. The mineralization is considered to be the result of hydrothermal scavenging and remobilization of the original nickel content of the mafic/ultramafic rocks in the area, and subsequent re-deposition in favourable structural traps. The mineralization is spatially and temporally related to a large granitic intrusion, the Heemskirk Granite, which is considered to be the source of the hydrothermal fluids as well as the necessary thermal gradients for the circulation of the fluids.

Tasmania is largely covered by the Jurassic Ferrar Continental Flood basalt Province in the East and presents early Cambrian ultramafic-mafic complexes in the West. The Ferrar large igneous province (LIP) extends over to Antarctica and is related to the Karoo Province in southern Africa that comprises tholeiitic lava flows, sills, and dyke swarms. The Ferrar and Karoo provinces were associated with the same thermal anomaly that was involved in the break up of Gondwana. The presence of mafic/ultramafic rocks in favourable lithological packages and/or structural traps along the margins of the province, as well as several prospective reduced or reactive sedimentary packages within and around the Ferrar indicate that this LIP could represent a novel promising ground for Ni hydrothermal exploration.

Based on this prospective geological background, a prospectivity analysis for hydrothermal Ni deposits was carried out on regional scale for the entire state of Tasmania. A conceptual model of hydrothermal nickel mineral system was used to identify the following as the most important exploration criteria for hydrothermal nickel deposits: (i) potential nickel sources, (ii) heat and fluid sources, (iii) permeable transportation channels for circulating hydrothermal fluids, and (iv) prospective lithological and structural traps conducive for sulphur saturation and deposition of nickel sulphides. Available public domain exploration datasets were processed using GIS functionalities to derive a series of derivative GIS layers that could be used as proxies for each of the above exploration criteria. These included komatiites/picrites/mafic-ultramafic rocks formed from magma with >7% MgO, large igneous province; major faults; crustal contamination, older sulphur bearing rock suites, redox gradients and/or reduced fluids highly concentrated in chloride etc..

A two-pronged approach involving GIS-assisted manual prospectivity analysis and GIS-based (automated) prospectivity analysis was used for identifying the most prospective ground for hydrothermal nickel deposits in Tasmania. The manual analysis involved a conceptual review of all geological regions of the state, while the GIS-based automated approach used a spatial fuzzy model. The results of the two analyses were subsequently integrated and, after a detailed geological follow-up study, were used to generate a hydrothermal nickel prospectivity map of the state.

The methodology developed in this study could be potentially applied to frontier exploration grounds with similar geological setting, such as Papua New Guinea.