Geophysical Research Abstracts,
Vol. 11, EGU2009-13747, 2009
EGU General Assembly 2009

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 consists of a system of hydrothermal Ni ore bodies. They are 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 mafic/ultramafic rocks in the area, and subsequent re-deposition in favourable structural traps. This is based on the low sulphur, low Cu and Platinum element content of the mineralization. The mineralization is spatially (at the edge) 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 constrains a number of early Cambrian ultramafic-mafic complexes in the West. The Ferrar large igneous province (LIP) extends over to Antarctica and is temporally and genetically related to the Karoo igneous province in southern Africa that comprises tholeiitic lava flows, sills, and dyke swarms. The Ferrar and Karoo igneous provinces were associated with the same thermal anomaly that was responsible for the break up of eastern Gondwana at ca 180 Ma. Despite of timeframe differences between the Avebury Ni deposits and the Ferrar LIP emplacement, similar geological settings to the Avebury could be duplicated along the Ferrar LIP. The presence of mafic/ultramafic rocks in favourable lithological packages and/or structural traps along the margins of the province indicate that this LIP could represent a possible exploration target for Ni hydrothermal deposits.

Based on this background, a prospectivity analysis for hydrothermal Ni deposits was carried out on a regional scale for the entire state of Tasmania to explore the prospectivity of for hydrothermal Ni deposits of this part of the Ferrar LIP for. A conceptual model of hydrothermal nickel mineral systems was used to identify the following as the most important exploration criteria for hydrothermal nickel deposits: (i) presence of 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 mafic-ultramafic rocks formed from magma with >7% MgO, large igneous province; major faults, and mineral alteration assemblages that could indicate 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.