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THE GEOLOGY AND GENESIS OF THE CHLORITE-CARBONATE ALTERATION IN THE FOOTWALL OF THE HELLYER VOLCANIC- HOSTED MASSIVE SULPHIDE (VHMS) DEPOSIT

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*A research thesis submitted in partial fulfilment of the requirements of the
degree of Bachelor of Science with Honours*



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ABSTRACT

The chlorite-carbonate alteration assemblage is an unusual feature in the footwall of the Hellyer volcanic-hosted massive sulphide deposit, Tasmania. Carbonate alteration is common to many VHMS deposits however its origin and characteristics has been rarely studied in detail.

Chlorite-carbonate alteration is defined as texturally diverse dolomite in a matrix of fine-grained chlorite. This distinctive alteration is found at the top of the chlorite-alteration zone around the central and northern hydrothermal discharge sites beneath the deposit. On the ore contact ('contact zone'), the chlorite-carbonate assemblage occurs as thin discontinuous lenses. A lower stratiform chlorite-carbonate alteration zone ('lower zone') occurs approximately 40 metres below the contact zone, is more laterally continuous and only occurs on the west side of the east flank of the ore deposit. Carbonate alteration is associated with sericite, chlorite and quartz in the contact zone but is primarily associated with chlorite in the lower zone. Carbonate-chlorite assemblages have not been observed at greater depths in the footwall alteration pipe, or distal to the deposit.

The carbonate mineralogy is Fe-dolomite or dolomite. Carbonate textures consist of large and small spheroids, rhombs, massive carbonate and veinlets. These textures appear to be associated with the initial porosity and permeability of the host rock. The various carbonate textures formed synchronously and have no textural zonation within the contact and lower alteration zones.

Whole-rock geochemical studies indicate major gains in Ca, Mg, and Fe and losses in Si and Na in the chlorite-carbonate alteration compared to the unaltered footwall andesite. An absolute mass-gain of 18g/100g is achieved when converting an andesite to a chlorite-carbonate altered rock.

Carbon isotopes ($\delta^{13}\text{C}$) range between +0.31 and +2.8‰ and oxygen isotopes ($\delta^{18}\text{O}$) range from +10.29 to +18.29‰. Isotope studies indicate that the dolomites formed from upwelling hydrothermal fluid (modified seawater with a minor magmatic input) in the lower zone or from the mixing of the hydrothermal fluid with infiltrating seawater in the contact zone. Carbon isotopic values are uncharacteristically high at Hellyer compared with other VHMS deposits and could indicate deep-seated contributions of $\delta^{13}\text{C}$.

From distribution and textural evidence, it is proposed that the dolomite alteration formed by direct precipitation within chloritised volcanoclastic units near the seafloor or in shallow sub-seafloor units in the mixing zone between upwelling hydrothermal fluids and infiltrating seawater. As the hydrothermal fluid mixed with infiltrating seawater a pH increase counteracted the effects of cooling and caused dolomite to precipitate.

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