

## The Origin of Chlorite-Tremolite-Carbonate Rocks Associated with the Thalanga Volcanic-Hosted Massive Sulfide Deposit, North Queensland, Australia

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### Abstract

The Thalanga polymetallic massive sulfide deposit is hosted by felsic volcanics of the Cambro-Ordovician Mount Windsor subprovince in North Queensland. The sheetlike sulfide deposit consists of several semiconnected lenses, totaling 6.6 million metric tons (Mt), which lie at a single stratigraphic level between underlying subaqueously emplaced rhyolite and overlying dacitic to andesitic lavas, sills, and volcanoclastic rocks. The ores and host rocks have been deformed and metamorphosed to upper greenschist facies. Associated with the West Thalanga orebody are strata-bound lenses composed of chlorite, tremolite, dolomite, and calcite that previously have been interpreted as exhalites. They extend up to a few hundred meters along the mineralized horizon and locally also exist in the stratigraphic footwall around the fringes of the deposit.

Rhyolitic volcanics beneath the deposit are extensively altered. A pervasive sericite ± chlorite ± pyrite zone that extends greater than 200 m into the footwall envelops semistratiform proximal quartz + pyrite ± chlorite stringer zones. Major and trace element geochemical data indicate that Zr, Ti, and Al remained essentially immobile in the footwall rocks despite intense hydrothermal alteration involving significant mass transfers of mobile elements.

The chlorite + tremolite + carbonate assemblages associated with ore lenses have immobile element ratios identical to those of the altered rhyolites. Carbonate-rich assemblages retain some relict spheroidal and rhombic textures in dolomite, which suggest formation at an early hydrothermal stage in a matrix of chlorite or in open spaces.

The chlorite + tremolite + carbonate rocks probably represent metamorphic equivalents of hydrothermal chlorite + quartz + dolomite + calcite (or Mg smectite + quartz + dolomite + calcite) assemblages. The formation of tremolite by metamorphic reaction of quartz and dolomite is consistent with regional metamorphic conditions. With allowance for metamorphic decarbonation, carbon and oxygen isotope data from dolomite and calcite are consistent with precipitation of primary dolomite at 170° to 250°C from seawater-dominated fluid.

The chlorite + tremolite + carbonate rocks at Thalanga are consequently reinterpreted as altered rhyolitic volcanoclastics, containing variable proportions of hydrothermal carbonate. They probably formed in a zone of mixing of hydrothermal fluid and seawater, in a permeable substrate close to the paleosea floor. Siliceous ironstones that are present in distal parts of some Thalanga ore lenses have very low immobile element contents and are probably true exhalites.