Economic Geology
Vol. 96, 2001, pp. 1175-1200

Alteration of Felsic Volcanics Hosting the Thalanga Massive Sulfide Deposit (Northern Queensland, Australia) and Geochemical Proximity Indicators to Ore

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Abstract

Thalanga is an Early Ordovician, stratiform Zn-Pb-Cu-Ag-rich massive sulfide deposit in northern Queensland (Australia) with a total resource of 6.6 Mt of ore. The host-rock succession consists of variably altered rhyolite in the footwall and a dacite-dominated volcano-sedimentary sequence in the hanging wall. The sulfide deposit and the enclosing volcanic sequence were metamorphosed under upper greenschist conditions.

A laterally continuous footwall alteration zone extends beneath the entire deposit (~3,000 m) and to a stratigraphic depth of at least 300 m below the ore lenses. The bulk of this zone is occupied by feldspar-destructive, muscovite-biotite-chlorite-rich, mottled alteration facies with disseminated pyrite, representing the metamorphic equivalent of phyllosilicate-dominated hydrothermal alteration. Discordant zones of intense quartz-pyrite alteration represent the principal fluid pathways during mineralizing hydrothermal activity. Locally, quartz-K feldspar alteration facies exist on the fringes of the system, and calcareous alteration and chlorite-pyrite alteration facies exist in the upper part of footwall rhyolite, proximal to sulfide lenses. Quartz-feldspar-porphyritic rhyolite laterally surrounding the footwall alteration zone and feldspar-porphyritic dacite in the hanging wall are unaltered or weakly altered.

The compositional diversity of altered footwall rhyolite implies that hydrothermal alteration at Thalanga was a complex processes. This paper presents a model for the evolution of the footwall alteration zone. Calcareous alteration probably represents the initial phase of hydrothermal activity. This was followed by diffuse upwelling of acidic, seawater-dominated fluids causing destruction of primary feldspar, precipitation of pyrite, and formation of hydrothermal sericite, chlorite, and clay minerals. Subsequent, intense quartz-pyrite alteration was directly associated with mineralization.

The Thalanga footwall alteration zone has several geochemical characteristics that show systematic changes with increasing proximity to ore. These include Na depletion and elevated Mg, S, alteration index (AI), chlorite-carbonate-pyrite index (CCPI), Mo, Bi, and As. Furthermore, the X_{Mg} of chlorite and biotite increases systematically from values of 0.45 to 0.5 in least altered rhyolite to values >0.9 immediately below ore. These geochemical features can be used in exploration for massive sulfide deposits as vectors to ore, at the prospect scale, and in discrimination of prospective hydrothermal from unprospective diagenetic alteration systems, at the regional scale.