Syn-volcanic replacement and post-depositional deformations of the Archean Perseverance VMS deposit, Matagami mining district, Quebec, Canada*

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Perseverance is a medium size (5.2 million metric tons), high-grade (15.8% Zn, 1.24% Cu, 29.4 g/t Ag, and 0.4 g/t Au) polymetallic volcanic-hosted massive sulfide deposit located in the Matagami zinc district of the northern Abitibi greenstone belt. The deposit comprises four massive sulfide lenses within the upper part of the Watson rhyolite (~2726 Ma). Ore envelopes are characterized by vertical shapes discordant to the low dipping volcanic sequence and are surrounded by intense proximal alteration in chlorite. A marker tuffaceous unit called "Key Tuffite" and the Dumagami rhyodacite (~2725 Ma) constitute the hanging wall of the lenses. Geochemistry of host-rock alterations and detailed structural descriptions allowed to characterize the major processes recorded in Perseverance.

Mapping of mass balance calculations highlights significant variations in major element compositions into the whole sequence. Strong enrichments in MgO (exceeding 10 wt%) and significant depletions in K2O and Na2O (down to 0.3 wt%) affect both the footwall and hanging wall rocks. Mass changes represent an hydrothermal alteration in magnesian chlorite coeval with a breakdown of feldspars. Regional metamorphism to greenschist facies did not affect significantly this original distribution. The pattern of alterations continues for up to 70 m above mineralization with no break of intensity. Strong hydrothermal alterations in the hanging wall rocks suggest a model of dominant subsea-floor replacement for the mineralization in Perseverance. This model is supported by the very short time gap between the volcanic units and an absence of exhalative components in the Key Tuffite.

The Perseverance orebodies and surrounding host rocks have recorded strong post-depositional deformations. Felsic volcanic rocks enclosing mineralization are affected by a penetrative schistosity along which the four flattened orebodies are globally co-planar. Tights folds in the Key Tuffite unit show that the volcanic sequence is deformed in proximity to the orebodies, where hydrothermal alteration is also abundant. Most of the present fabrics and textures in the orebodies are the result of combined deformation and recrystallization. Massive ores show a highly-developed vertical layering in the pyrite-sphalerite assemblage that is combined with brittle and ductile deformation textures, durchbewegung textures, and replacement textures. Boudinage affects late intrusive dykes within the ore and reflects a cinematic in accordance with the schistosity. These structural elements characterize a post-volcanic deformation overprint where rheology of the materials played a significant role for the resulting deposit geometry. Mechanical remobilization affected ductile minerals such chalcopyrite and possibly explains the final Cu distribution.
Perseverance illustrates that syn-volcanic replacement processes can be at the origin of mineralization in the Matagami district. Subsequent deformation and accompanying remobilization have resulted in changes to the gross structure, orientation of ore orebodies, and distribution of Cu grades. The alteration zones have accommodated most of the post-ore strain due to their rheology. Hydrothermal alterations coincide spatially with the deformation zones and may therefore represent an useful footprint for exploration.