The Bisha volcanic-hosted massive sulphide (VHMS) deposit occurs within the Neoproterozoic Western Nafka terrane of the Arabian-Nubian Shield in Western Eritrea. The deposit totals 28.3 M tonnes in three zones: an oxide zone of 4.7 M tonnes containing 7.0 g/t Au, a supergene zone of 7.4 M tonnes containing 6.4% Cu, and a hypogene zone of 16.3 M tonnes containing 5.4% Zn and 1.0% Cu.

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Lithogeochemistry of host rocks to the Bisha Cu-Zn-Au volcanic-hosted massive sulphide deposit, Eritrea

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Unfortunately, hydrothermal alteration, metamorphic recrystallization, and deformation have made it difficult to identify the primary volcanic compositions and textures of the host rocks. Furthermore, to date, only chloritic alteration has been recognized, so the deposit does not conform to accepted models for VHMS mineralization. As a result, detailed volcanic stratigraphy and hydrothermal zoning models have yet to be developed for the deposit. Drill core logging and a lithogeochemical study of the host rocks to the Bisha and nearby Harena VHMS deposits were undertaken to develop such models. Seven drill cores spanning the largest stratigraphic sequence possible were examined, and 282 samples were collected and analyzed for major and trace elements.

Lithogeochemical results indicate that felsic volcanic rocks constitute the immediate footwall and hanging wall of both deposits. Intermediate volcanic rocks occur deep within the Bisha footwall, and mafic volcanic rocks occur in the Bisha deposit footwall and the Harena deposit hanging wall. The data show that a complicated volcanic stratigraphy exists in the Bisha Mining Camp, and that the two deposits are not located at the same stratigraphic level.

A weak muscovite alteration affects hanging wall felsic and mafic rocks, and is the most widespread alteration style observed within the camp. In felsic rocks, it comprises a quartz + muscovite assemblage, but in mafic rocks it consists of a quartz + muscovite + chlorite ± calcite assemblage. At Harena, metamorphism has resulted in the formation of biotite, epidote, and hornblende as successor minerals. Chlorite alteration is strong to intense, and occurs only in the footwall of each deposit. Two styles of chlorite alteration are recognized: quartz-chlorite alteration is accompanied by pyrite and chalcopyrite, and occurs deep within the Harena footwall and throughout the footwall of the Bisha deposit in both felsic and mafic rocks; chloritite alteration affects felsic and mafic rocks, and consists almost exclusively of chlorite having silica concentrations averaging 32%. This alteration style is restricted to the immediate Harena footwall. In these alteration zones, muscovite is phengitic, with an approximate composition of $[\text{K}_{1.40}\text{Na}_{0.15}\text{Ba}_{0.35}\text{Mg}_{0.25}\text{Fe}_{0.45}\text{Al}_{5.45}\text{Ti}_{0.05}\text{Si}_{6}\text{O}_{20}(\text{OH})_{4}]$, whereas chlorite is daphnitic $[\text{Mg}_{24/3}\text{Fe}_{4/3}\text{Al}_{16/3}\text{Si}_{16/3}\text{O}_{20}(\text{OH})_{16}]$. Both of these alteration mineral compositions are similar to those in Bathurst Camp VHMS deposits.

A log($\alpha_{K}/\alpha_{Na}$) versus log($\alpha_{Na}/\alpha_{H}$) mineral stability diagram has been used to understand the relationships between the three alteration styles. This thermodynamic model illustrates that the scarcity of muscovite alteration at Bisha is the result of a more sodic volcanic protolith than that observed in other VHMS camps.