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Structural Modification of VMS Deposits

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Ancient VMS deposits formed in extensional geodynamic environments and were deformed during later convergent accretionary events. How tectonic structures form in VMS deposits is influenced by primary features. During deformation, strain is typically taken by the sulfide bodies because common sulfides in VMS deposits are weaker than volcanic host rocks. The deposits act as shear zones, undergo hinge thickening and limb attenuation during folding, and are deformed into elongate bodies parallel to regional fold hinges and stretching lineations. A tectonic foliation may form as a sulfide banding in the interior of VMS lenses due to the shearing and flattening of primary textural and compositional heterogeneities, and as a banded silicate-sulfide tectonic foliation along the margins of the VMS lenses due to transposition and shearing of primary silicate (exhalites)-sulfide layers (Fig.1). Cusps, piercement cusps and veins, and durchbewegung structures are other structures that form as a result of the strong competency contrast between the massive sulfide deposits and host volcanic rocks.

Some features in VMS deposits may have both primary and tectonic components. One example is the vertical stacking of VMS lenses, which may be primary and due to rapid burial of lenses by volcanic and sedimentary deposits during long-lived upflow of hydrothermal fluids or tectonic and due to thrusting and isoclinal folding of VMS lenses. A second example is the elongation of VMS lenses that may have a primary component due to the deposition and coalescence of sulfide lenses along linear synvolcanic faults or a tectonic component due to remobilization of sulfides parallel to linear structural features in the host volcanic rocks. Careful mapping of volcanic lithofacies and primary and tectonic structures is needed to assess the nature of structures in VMS deposits. This is hindered by the low temperatures of recrystallization of sulfide minerals, as recrystallization may conceal or destroy deformation fabrics and structures in VMS lenses. Discontinuous and abrupt lithofacies changes in the host volcanic rocks may hamper mapping and the definition of large-scale structures because of the added complexities in correlating rock units. The weak development of tectonic fabrics, which are commonly used as structural datum for correlating generations of structures, and the strong strain partitioning in weaker fault zones, which may undergo multiple reactivation events, also complicate the structural analysis of volcanic terranes. To mitigate these issues, mapping of volcanic rock should be done with structural mapping to delineate repeated stratigraphic panels across early thrust faults and reactivated later faults and to identify regional folds characterized by abrupt changes in strata orientation from limbs to hinge. If well-layered sedimentary rocks are present, the sequence of deformation events that affected the volcanic rocks and their VMS deposits can be determined by first mapping structures in the sedimentary rocks, then correlating these structures with those in volcanic rocks.

Fig. 1. Tectonic foliations in deformed VMS lenses: (a) Ribbon ore with layers of chalcopyrite from the Devonian, Neves Corvo deposit, Portugal. (b) Tectonic foliation defined by deformed and transposed pyritic stringer zone from the Mobrun deposit, Noranda camp, Quebec.