The upper Hazelton Group in northwest British Columbia: an example of an ore-forming arc to rift transition

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In island arcs, the latest stage of subduction-related processes is commonly followed by an extensional tectonic regime. The Stikine terrane of the Canadian Cordillera records one such transition in the rocks of the Early to Middle Jurassic upper Hazelton Group, in northwestern British Columbia. These rocks are host to the world-class Eskay Creek volcanogenic massive sulphide (VMS) deposit. Recent targeted studies of the upper Hazelton Group have documented a number of characteristics which confirm that the upper Hazelton Group represents a shift from arc building during the Early Jurassic to an extensional environment during the late Early to Middle Jurassic. These characteristics include 1) the presence of original rift bounding faults; 2) unconformities that are associated with rift filling conglomerates, including one that grades into more distal facies argillite; 3) a shift in the geochemical signature of mainly intermediate Early Jurassic calc-alkaline volcanic rocks to Middle Jurassic bimodal rhyolites and tholeiitic basalts; and 4) evidence for a major transcurrent tectonic regime, which opened distinct rift segments that were separated by horsts of older Stikinian units. Although the upper Hazelton Group is composed of separate sub-basins, the lithologies, geochemistry and morphologies of far-separated segments correspond closely to one another. The Willow Ridge Complex (WRC), and the Pillow Basalt Ridge Complex (PBR), which are 100 km apart, each contain a succession of sedimentary and bimodal volcanic rocks between 1000 m thick sequences of mainly pillow basalt. These middle units, in both regions, are very similar to the strata that host the Eskay Creek deposit and may represent a repetition of the conditions that were favourable to mineralization at Eskay Creek.

New whole-rock major oxide and trace element geochemical analyses of 17 samples collected from the WRC agree with previous interpretations that they were deposited in a rift setting. The chemistry of these rocks is similar to those that host the Eskay Creek VMS deposit and other VMS-hosting volcanic rocks world-wide. The WRC is composed of a bimodal suite of mainly basalts and rhyolites. Basalts from the WRC are characterized by: a) a negative correlation of TiO_2 with Mg number in compositionally-similar, TiO_2-rich tholeiitic MORB; b) a slight enrichment in light REE ($La_n/Sm_n = 1.83$) and flat heavy REE ($Gd_n/Yb_n = 1.19$); c) slight enrichment of strongly incompatible elements and a small negative Nb anomaly in mantle-normalized incompatible-element diagrams. Rhyolites from the WRC have broadly similar characteristics to basalts ($La_n/Sm_n = 3.01$, and $Gd_n/Yb_n = 0.86$) but they have strong negative Ti and weak positive Zr anomalies. The similarity in trace element abundances between rhyolites and basalts rules out derivation of rhyolite from basalt via fractional crystallization. All but the most primitive basalts are interpreted to be derived from sub-lithospheric mantle, and rhyolites are interpreted to be derived from partial melting of crustal rocks.