The Early Devonian, Evandale Porphyry Cu-Mo-(Au) deposit, southern New Brunswick: petrologic, geochemical, geothermobarometric, and geochronologic characterization of the host rocks and its origin*

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Relatively little research has been dedicated to porphyry Cu-Mo-(Au) systems associated with the granitoid rocks in Eastern North American orogenic belts. The circular Middle Devonian, hornblende-biotite Evandale Granodiorite (U-Pb zircon, 391.2 ± 3.2 Ma for the granite, and 390.2 ± 1.6 Ma for the aplite) intrusion is a locally Cu-Mo-Au mineralized polyphase pluton intruding through deformed Silurian sedimentary and mafic volcanic rocks of the Mascarene Basin in southern New Brunswick. The two intrusive phases have been identified as magnesian, calc-alkalic to alkali-calcic, peraluminous I-type granite generated by decompressional melting of the lower crust caused by post-collisional uplift. The Evandale Granodiorite consists of two textural, petrochemically related but distinct phases ranging from medium-to coarse-grained seriate to porphyritic and aplitic texture. INAA analyses of the aplitic and coarser granite phases found the highest concentration of Cu and Au (108 ppm Cu, and 33 ppb Au) and associated with pyrite, chalcopyrite, and arsenopyrite in the sampled aplitic dykes. Concentrations of up to 6 ppm Mo were detected in the coarse-grained granite, whereas only trace amounts of Mo were recognized in the aplite. Current models suggest that the transport of metals (particularly Cu and Au) are sourced from secondary two-phase fluids at shallow depths (approximately 1–2 kb), and is greatly affected by Cl fugacity of the magma. Analyses of biotite phenocrysts from both the aplite and granite contain an average of 0.21 wt% Cl, which is similar to other high grade Cu-Mo-(Au) porphyry deposits. The hornblende-plagioclase thermometry revealed the crystallization temperature of the granite to be 642°C and 600°C for the aplite (cooler than most deposits of the same type). Al-in-hornblende geobarometery indicates crystallization depths of approximately 2.1 kb for hornblende in the aplite and ~0.7 kb for the coarse-grained granite. The higher crystallization pressure of hornblende in the aplite phase indicates that it intruded to higher levels rapidly and pressure quenched (aplite to porphyritic texture) within the host granodiorite, which is consistent with volatile exsolution controlling emplacement and formation of porphyry Cu-Mo-(Au) mineralization at a shallower depth.

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