Metal behaviour during magmatic-hydrothermal processes in intrusion-related gold systems, southwestern New Brunswick, Canada

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Several gold deposits and occurrences associated with granitoid intrusions in New Brunswick share some similarities with newly recognized types of intrusion-related gold systems; they differ from porphyry copper-gold systems in several aspects such as fluid compositions, mineralization style, alteration, element, and mineral assemblages. In southwestern New Brunswick, two main groups of granitoid intrusions associated with gold are recognized. These are 1) a late Devonian granitic series (GS) including the Mount Pleasant, True Hill, Beech Hill, Pleasant Ridge, Kedron, and Sorrel Ridge granites, and 2) a late Silurian to early Devonian granodioritic to monzogranitic series (GMS) granitoids including the Magaguadavic, Bocabec, Utopia, Tower Hill, Evandale, Poplar Mountain, and Lake George intrusions. The former occur along the northwestern flank of the Saint George Batholith as satellite plutons, and the latter form parts of this batholith and the Pokiok Batholith to the north.

Gold abundances in these two series are fairly low compared to continental crust, although the GMS rocks appear to contain higher gold (up to 77 ppb), suggesting that the geochemical behaviour of gold during magmatic-hydrothermal evolution is a key factor controlling gold mineralization in the region. In the differentiation sequence of a granitoid complex, gold usually behaves as a compatible metal, implying that gold partitions in favour of the early phase granitoid, and therefore, late stage highly evolved granites may have a relatively low potential to generate gold deposits. In contrast, tin and tungsten behave as highly incompatible elements, and their mineralization is closely associated with highly evolved GS rocks. However, some greisenized granites contain significantly high gold (e.g., 1 g/t at Kedron, 0.1 g/t at True Hill), which indicates that the GS series could be prospective for deposits in this area.

In granitic magma systems, several other factors are important for producing intrusion-related deposits. Gold strongly enters sulphides, which constitute a large portion of gold in the granitoids based on previous experimental studies, and any sulphide formation must significantly deplete gold from residual silicate melts. Sulphide liquid saturation is a function of redox, which is controlled by the magma intensive $f(O_2)$, coupled with degree of hybridization during ascent and emplacement at this level of the crust. Further, local geological setting and intrusion-driven hydrothermal fluid systems are important. Late stage hydrothermal fluids with low pH and relatively high oxidation may scavenge Au that is incorporated into sulphides in early immiscible sulphides within granitoids. If a significant amount of Au produced in this manner is concentrated in a suitable geological environment, such as fault zones and/or hydrofracture systems, it is possible to form intrusion-related gold deposits.