The ~6 Moz Au Archean Rainy River Deposit, Superior Province, Canada: Sub-Seafloor Synvolcanic Au Mineralization

Mireille Pelletier,[1*] Patrick Mercier-Langevin,[2] Vicki McNicoll,[4] Justin Tolman,[3] Dean Crick,[3] Marc Richer-Laflèche,[1] Simon Jackson,[4] and Benoît Dubé[2]

[1]Institut National de la Recherche Scientifique, Centre Eau Terre Environnement, Quebec City, Quebec
[2]Geological Survey of Canada, Quebec City, Quebec, Canada
[3]New Gold Inc., Barwick, Ontario, Canada
[4]Geological Survey of Canada, Ottawa, Ontario, Canada
[5]Ontario Geological Survey, Kenora, Ontario, Canada

*E-mail, mireille.pelletier@ete.inrs.ca

This study focuses on the characterization of primary and secondary geological controls on mineralization grade and distribution for the Rainy River advanced exploration project, Canada. Rainy River is located in the western Wabigoon Subprovince of the Canadian Shield, contains estimated resources of 176 Mt at 1.14 g/t Au, 6.44 Moz Au (New Gold Inc.). The bulk of the Au mineralization is associated with pyrite, chalcopyrite, and sphalerite disseminations, and stockworks. Despite high Au to base metal ratios, there is a good correlation between Au and base metals (Zn and Cu) at the deposit scale. Mineralization is distributed in a series of stacked mineralized zones, with their current geometry now parallel to the main foliation (S_2: 102°/61°SE). An associated stretching lineation (L_2: 225°/51°SW) controlled the distribution of higher grade mineralized zones containing S_2-folded and transposed quartz-sulfide-tourmaline-carbonate veinlets.

The mineralized zones are entirely hosted in a calc-alkaline dacitic to rhyodacitic complex bounded by tholeiitic basalts. The host complex consists of domes, flows, lobes and associated flow- to talus-breccia deposits emplaced in a seafloor to sub-seafloor setting. The rocks were metamorphosed to regional greenschist facies during D_2. Proximal to immediate alteration in the deposit is characterized by abundant and pervasive sericite, chlorite, and Fe-Mg carbonates. Manganiferous garnets are also locally developed. Metamorphosed advanced argillic-style quartz-kyanite-chloritoid alteration is locally associated with mineralization. Rutile-rich assemblages are present in the mafic rocks close to ore zones.

Detailed mapping of volcanic facies, alteration assemblages distribution, sulfide zones, and high-grade Au zones indicates a direct correlation between primary porosity of the host rock (i.e., fragmental units), alteration intensity, and mineralization, pointing towards an early precious metal-rich mineralizing event largely influenced by the initial permeability of the host dacitic to rhyodacitic complex. Additionally, preliminary laser-ablation inductively coupled plasma mass spectrometry analyses (LA-ICP-MS) on pyrite grains show precious metal distributions restricted to the core of the grains, suggesting early Au-Ag enrichment in the crystallization history. The geochemical and volcanological features are consistent with an early, synvolcanic hydrothermal Au mineralizing event, onto which deformation and metamorphism were superimposed, modifying the geometry of the mineralized zones and high grade ore shoots.

Overall, the Rainy River shares analogies with other major Archean synvolcanic Au deposits, such as the Au-rich volcanogenic massive sulfide deposits of the Bousquet district. On the other hand, there are no massive sulfides at Rainy River, and its mineralization is interpreted to have formed in the sub-seafloor environment. Moreover, the bulk-tonnage nature of the Au mineralization and the high Au-to-base metal ratio of this deposit underlines differences in the immediate geological setting and potentially in metal precipitation processes. Such a large synvolcanic gold deposit is distinct from

“typical” greenstone-hosted Au deposits and its characteristics need to be included in exploration models in Precambrian terranes.