Temporal and Genetic Relationships Between Gold Mineralization, Magmatism, and Deformation: The Neoarchean Windfall Gold Deposit, Northern Abitibi, Canada

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The Archean Abitibi greenstone belt (Superior Province) is well known for its gold endowment (>300 Moz Au), exemplified by a variety of well-documented styles of mineralization such as gold-rich volcanogenic sulfide lenses, intrusion-associated dissemination/veins, and quartz-carbonate orogenic veins. These styles are related to specific time intervals in the tectonic evolution of the belt and display distinct alteration footprints. For instance, the main shortening phase associated with thick-skinned deformation (2670-2640 Ma) has produced most of the structurally controlled quartz-carbonate orogenic veins. Whereas the southern Abitibi hosts >85% of the production, reserves, and resources, its less-studied, -exposed, and -explored northern counterpart has recently witnessed growing interest with the discovery of multiple >1-Moz Au deposits. Much like the southern Abitibi, mineralization is commonly peripheral to major E-W–oriented high-strain zones and/or along second-order structures. Mineralization that post-dates the bulk of volcanic cycles (<2700 Ma) and pre-dates the main shortening phase (>2670 Ma) possesses timing or genetic characteristics and complex relationships with structural events that require more detailed study. Here, we focus on the 7.4-Moz Windfall gold deposit in northeastern Abitibi, which is hosted in folded 2715 Ma tholeiitic bimodal volcanic sequences and gabbroic dikes along the structural footwall of a regional SE-dipping deformation zone. Units define a NE-plunging synform and are cut by ~2698 Ma axial-planar, calc-alkalic intermediate-felsic dikes. Two penetrative fabrics are documented: a NE-dipping foliation (S_n) crenulated and folded by a steeply dipping, NE-trending S_{n+1}. Gold is associated with pyrite-quartz-sericite stockworks and quartz-pyrite±carbonate veins that are oriented (sub-)parallel to S_{n+1}. Petrochronological and Re-Os sulfide dating suggest gold introduction penecontemporaneous to the emplacement of ~2698 Ma felsic dikes, whereas relative timing of deformation in relation to the gold-bearing veins suggests a possibly younger event. Resolving this apparent dichotomy is critical for developing robust metallogenic and exploration models for gold systems.