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Gold Deposits of the Archean Abitibi Greenstone Belt, Canada

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The Neoarchean Abitibi greenstone belt in the southern Superior province has been one of the world's major gold-producing regions for almost a century with >6,100 tonnes (t) Au produced and a total endowment, including production, reserves, and resources (measured and indicated), of >9,400 t Au. A significant part of that gold is synvolcanic and/or synmagmatic and was formed during the volcanic construction of the belt between ca. 2750 and 2695 Ma. However, >60% of the gold is hosted in late, orogenic quartz-carbonate vein-style deposits that formed between ca. 2660 and 2640 ± 10 Ma, predominantly along the Larder Lake-Cadillac (LLCF) and Destor-Porcupine (DPF) fault zones. This ore-forming period coincides with the D_3 deformation, a broad north-south main phase of regional shortening that followed a period of extension and associated crustal thinning, alkaline to sub-alkaline magmatism, and development of fluvial-alluvial sedimentary basins (ca. 2680–2670 Ma). These sedimentary rocks are referred to, in the southern Abitibi, as Timiskaming-type. The tectonic inversion from extension to compression is <2669 Ma, the maximum age of the D_3-deformed, youngest Timiskaming rocks. In addition to the quartz-carbonate, vein-style, stockwork-disseminated, veinlet, and replacement-style mineralization is hosted in and/or associated with ca. 2683-2670 Ma, early- to syn-Timiskaming alkaline to sub-alkaline intrusions along major deformation corridors, especially in southern Abitibi. The bulk of such deposits formed late- to post-alkaline to sub-alkaline magmatism and the largest deposits are early- to syn-D_3 (ca. 2670–2660 Ma), whereas the bulk of the quartz-carbonate vein systems formed syn- to late-D_3. At belt scale, these illustrate a gradual transition in ore styles in orogenic deposits throughout the duration of the D_3 deformation event along the length of the LLCF and DPF. The sequence of events, although similar in all camps, was probably not perfectly synchronous at belt scale, but varied/migrated with time and crustal levels both along the main deformation corridors and from north to south.

The presence of high-level alkaline intrusions, which are spatially associated with Timiskaming-type conglomerate and sandstone, large-scale iron-carbonate hydrothermal alteration, and numerous gold deposits and prospects along the LLCF and DPF, indicates that these structures were deeply rooted and tapped auriferous metamorphic-hydrothermal fluids and melts from the upper mantle and/or lower crust, late in the tectonic evolution of the belt. The metamorphic-hydrothermal fluids, rich in H_2O, CO_2, and H_2S, were capable of leaching and transporting gold to the upper crust along the major faults and their splays. Although most magmatic activity along the faults predates the bulk of the gold, magmas have, in some cases, contributed fluids and/or metals to the hydrothermal systems. The exceptional gold endowment along the structural corridor defined by the LLCF and DPF may also suggest that these faults have tapped particularly fertile upper mantle-lower crust gold reservoirs. The concentration of large synvolcanic and synmagmatic gold deposits along the LLCF corridor supports the idea of a broad, gold-rich source(s) that may have contributed gold to the ore-forming systems at different times during the evolution of the belt.