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Timing of Gold Mineralization at Red Lake, Northwestern Ontario, Canada: New Constraints from U-Pb Geochronology at the Goldcorp High-Grade Zone, Red Lake Mine, and the Madsen Mine*

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Abstract

The Goldcorp High-Grade zone at the Red Lake mine has reserves (proven and probable) established at 1.775 million tons (Mt) at an average grade of 80.6 g/t Au. New U-Pb geochronologic data combined with detailed mapping and crosscutting relationships provide timing constraints and new insights into the formation of the exceptionally rich Goldcorp High-Grade zone. The results show that the main stage of the high-grade mineralization in the High-Grade zone formed before 2712 Ma and that a second stage of gold mineralization, much smaller in terms of total gold content but spectacular in terms of grade, formed after 2702 Ma. This second stage is attributed to gold remobilization caused by the enhanced thermal gradient and deformation associated with the emplacement of the Cat Island pluton (2699 Ma), approximately 7 km east of the deposit, or by the ca. 2.63 to 2.66 Ga postorogenic regional thermal event indicated by hornblende, muscovite, and biotite Ar-Ar cooling ages from the Uchi subprovince. It is proposed that the main stage of high-grade mineralization formed between ca. 2723 to 2712 Ma, possibly synchronous with emplacement of the Dome and McKenzie Island stocks, the Abino granodiorite, and Hammell Lake batholith, as well as with penetrative D₂ main-stage regional deformation.

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Lamprophyre dikes spatially associated with the deposit postdate main-stage mineralization by at least 10 m.y. A postore granodiorite dike from the Madsen mine, the second largest deposit in the district, was dated at 2698 ± 1 Ma. This age is similar to a postalteration and late-deformation diorite dike at the Creek zone showing near the former Starratt-Olsen mine, which was dated at 2696 ± 2 Ma. The crosscutting relationships confirm that the main stage of mineralization at the Madsen mine is pre-2698 Ma.

A folded and metamorphosed polymictic conglomerate located stratigraphically above the Campbell-Red Lake deposit, and deposited after ca. 2747 but before 2712 Ma, is correlated with the newly recognized Huston assemblage. Crosscutting and overprinting relationships between the conglomerate and the alteration indicate protracted multistage aluminous and iron-carbonate \pm quartz veining and/or alteration event(s) before and after deposition of the conglomerate. The age of the conglomerate confirms that the Campbell-Red Lake deposit is proximal to a folded regional unconformity, consistent with the empirical relationship between large gold deposits and unconformities elsewhere in Archean greenstone belts. This paleosurface represents a key first-order exploration target, and it is proposed that areas of high potential for gold exploration in Red Lake occur in the Balmer assemblage rocks within 500 m to 1 km of the unconformity.