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Application of U-Pb Detrital Zircon Geochronology to Delineate Regional Unconformities; Implications for Gold Mineralization in the Red Lake Mining Camp, Ontario, Canada

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The Archean Red Lake greenstone belt is host to several gold deposits including the world-class Campbell-Red Lake mine hosted in the Mesoarchean mafic-ultramafic volcanic rocks of the Balmer assemblage (2.99–2.96 Ga), which lies proximal to a folded regional angular unconformity, and the Madsen mine, which lies proximal to another regional unconformity. This spatial relationship between gold deposits and regional unconformities is characteristic of Archean greenstone gold mineralization and is recognized in the Red Lake mining camp for other gold deposits. Therefore, identifying their spatial distribution is a key exploration target. Several of these unconformities are delineated by sedimentary rock packages, and U-Pb detrital zircon geochronology is one of the main tools to unravel the stratigraphic position of these rocks and establish a structural and stratigraphic framework of the mineralization. In the Red Lake camp, two main stages of mineralization have been previously identified. The main gold mineralization event formed before 2712 Ma at the Campbell-Red Lake mine and is coeval with the emplacement of a series of stocks, the main penetrative deformational event, and the deposition of a package of polymictic conglomerates. At the Madsen mine, the main mineralization event is at least 10 m.y. younger, interpreted to have formed between 2700 and 2698 Ma, and is itself associated with a younger plutonic event and a coeval package of conglomerates and finer clastic sediments. New U-Pb detrital zircon geochronology suggests that younger Madsen-aged conglomerates are present along a broader structural corridor and proximal to the Campbell-Red Lake mine, which has implications for connectivity of large-scale regional unconformities across the Red Lake camp from the Madsen mine to the Campbell-Red Lake mine.