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Unraveling the Geological History of the Fenelon Gold Deposit, Québec

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The Abitibi Greenstone Belt is the most important gold-producing area in Canada and one of the most important globally. Presently, most of the known deposits occur in the southern Abitibi which has been the primary focus of exploration endeavors due to the abundant rock exposure at surface. However, increasingly more effort is being expended exploring the northern Abitibi, which has a high probability to contain undiscovered mineral resources. The Fenelon Gold deposit, situated along the Sunday Lake Deformation Zone in the northern Abitibi, is the focus of this research project. Through this Master's thesis, I aim to improve the understanding of the intrusive rocks which host gold at the Fenelon Property and constrain the timing of gold mineralization. Using a combination of geochronology, geochemistry, and drill core observations, I establish the local geology in order to place Fenelon within the wider geological context of the northern Abitibi.

The Jeremie Diorite is the largest intrusive body within the Fenelon Property, and it hosts gold mineralization that was discovered by the Wallbridge Mining Company Ltd. in early 2019. Current drilling suggests that there is a spatially distinct mafic phase of the Jeremie Diorite. Delineating the mafic phase is important for improving the geological model and determining whether it has any controls on mineralization. During my undergraduate thesis, I determined the age of the Jeremie Diorite to be 2697 Ma using Thermal Ionization Mass Spectrometry (TIMS). Diamond drill core suggests that the Jeremie Diorite was emplaced into a sedimentary basin composed of greywacke and argillite. A large gabbro sill and related dyke swarm crosscut both lithologies. Age dating of zircons by Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) confirmed the paragenetic relationship between the Jeremie Diorite and the sediments, and the age of the gabbro was determined using TIMS. Detrital zircons extracted during dating reveal the provenance of the sediments and help reconstruct the geological history and crustal evolution of the region. Gold mineralization post-dates the emplacement of the Jeremie Diorite as the gold is hosted in crosscutting smoky quartz veins. Molybdenite found within a gold-bearing vein was analyzed using Re-Os dating techniques to determine the absolute age of the gold mineralization at the Fenelon deposit.

The results of this thesis will significantly improve the geological understanding of the Fenelon deposit, and allow for comparison with established deposits including the neighbouring Detour Lake Gold Mine. There has been very limited research conducted along the Sunday Lake Deformation Zone outside of Detour Lake, and this study contains the first age dates of the rocks and mineralization at the Fenelon Property, setting the geological framework for all future research. Its success will create a strong precedent that will encourage future exploration in the northern Abitibi, generating continued growth for the Canadian mineral resource sector.