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Geological and Structural Characterization of the Odyssey Project, Malartic Mining Camp, Abitibi, QC: Age and Structural Controls on Gold Emplacement

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Felsic-intermediate intrusive rocks are present in most orogenic and intrusion-related gold systems, and commonly act as local structural or/and chemical traps for mineralizing fluids. This study aims at characterizing the gold-mineralized fracture network of a complex ore system and its host intrusive rocks in order to determine the nature of the main controls on mineralization.

Discovered in 2014, auriferous zones of the Odyssey project are located 2 km east of the Canadian Malartic open pit gold mine and could represent a significant underground extension of this world-class deposit (~16 Moz Au; reserves and past-production). Mineralized zones are developed within the Larder Lake-Cadillac fault zone, a major crustal break that marks the contact between the Abitibi and Pontiac subprovinces (Fig. 1A). Twenty oriented drill cores from the North, South, and Internal zones of the Odyssey project have been logged and sampled for mineralogy, lithogeochemistry, and U-Pb geochronology.

The North and South zones (1.56 Moz indicated and inferred gold resources) are developed along the faulted contacts of a sub-alkaline to alkaline porphyritic quartz monzodiorite intrusion that was emplaced between the metamorphosed ultramafic rocks of the Piché Group and sedimentary rocks of the Pontiac Group. These zones are ~10 m thick, dip >60° toward the south, and are composed of discontinuous quartz ± calcite ± pyrite ± gold veins and disseminated pyrite ± gold in the host intrusion. Westward, the North zone can be mapped almost continuously into the Sladen fault, one of the main metallotects of the Canadian Malartic system.

The Internal zones are more complex and appear to be spatially-associated with dikes crosscutting the main intrusion, regardless of their composition. The dikes are sub-alkaline and range from mafic to felsic, with equigranular, porphyritic, and aplitic textures. The Internal zones consist of a complex assemblage of sericite-quartz-pyrite-gold shear zones and various types of veins, the most common ones being quartz ± calcite ± pyrite ± gold veins and silica flooding zones, which are associated with carbonate ± pyrite ± chlorite ± hematite alteration and a locally developed N-S- to NNW-SSE-trending mineralized fracture cleavage. Ore shoots are steeply plunging and appear to be developed in the vicinity of the dikes. The auriferous veins locally contain hydrothermal titanite, paragenetically associated with gold and yielding a U-Pb age of ~2661 Ma (ID-TIMS), almost identical to the 2664 Ma Re-Os molybdenite age for mineralization, determined in previous studies at the Canadian Malartic deposit.

This study suggests that, independently of genetic considerations, the Internal zones are spatially associated with dikes that played a key role in the emplacement of mineralization. The North zone of the Odyssey project and those of the Canadian Malartic deposit are in structural continuity, and dating of hydrothermal titanite suggests that mineralization was contemporaneous, increasing the overall extent of the Canadian Malartic ore system to more than 5 km along-strike.

Figure 1: A) Simplified geological map of the Canadian Malartic mine area and location of the Odyssey project. LLCfz: Larder Lake – Cadillac fault zone. B) Section across the Odyssey project.