Structural Controls on Gold Mineralization in the Walsh Formation of the Yellowknife Greenstone Belt

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The Yellowknife greenstone belt (YGB) is one of several greenstone belts located within the Archean Slave Province. It hosts several gold deposits including the past-producer Giant (8.1 Moz @ 16.10 g/t) and Con (6.1 Moz @ 16.0 g/t) deposits. These deposits are associated with a major fault zone called the Yellowknife River Fault Zone (YRFZ) cutting through a sequence of mafic metavolcanic rocks overlain by felsic metavolcanic rocks, turbiditic sandstone and capped by a Timiskaming-type conglomerate named the Jackson Lake Formation. Previous research has focused on mapping the kinematics of the Yellowknife River fault zone and related structural features within the Jackson Lake Formation as well as the structural controls on gold mineralization at the Giant and Con mines. This study focuses on the structural controls on gold mineralization at the Mispickel zone which is hosted within a sequence of thinly bedded graphitic and sulphidic argillite, siltstone, and turbiditic sandstone of the Walsh formation. The Walsh formation has been subjected to four deformation events (D_1 to D_4). D_1 structures are expressed at the Giant mine as a chlorite, sericite and arsenopyrite foliation and in the Walsh formation as rare, isoclinal, north-south trending, F_1 folds. These structures are overprinted by D_2 folds and cleavage which are the most prominent regional structures in the belt. Regional F_2 folds are north-south trending isoclinal folds with a pervasive axial planar S_2 cleavage. D_3 resulted in local, open Z-shaped folding of bedding and S_2 and they have an axial planar cleavage consistently counter-clockwise to S_2 cleavage. D_4 resulted in late kinking and brittle faulting. Mineralization is associated with fine-grained arsenopyrite and pyrite in quartz veins, their chloritized and silicified alteration halos, and in narrow stringer quartz veins. The veins are boudinaged and tightly folded within the hinge zones of the regional F_2 folds and therefore predate the formation of these folds. This timing of mineralization is consistent with mineralization present in the past producing major gold camps surrounding Yellowknife.