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Structural and alteration controls on gold mineralization the of the amphibolite facies Detour Lake Deposit, Canada

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The 15M oz Detour Lake deposit is a Neoarchean orogenic gold ore body located in the northern most region of the Abitibi district within the Superior Province. The mine is an open pit design in the high strain zone of the Sunday Lake Deformation Zone (SLDZ). The ductile-brittle SLDZ parallels the broadly E-W Abitibi greenstone belt and the deposit is situated in a dilation zone between volcanoclastic rocks of the Caopatina Assemblage and Lower Detour Lake Formation, consisting of ultramafic talc-chlorite-sericite schist. The Upper Detour Lake Formation consists of pillowed and massive flows and hyloclastic units crosscut by minor felsic to intermediate dykes. All of the formations are sub-vertical, north-dipping units with stretching lineations indicating dip-slip motion. The Detour deposit differs from other classic ore deposits in the dominantly greenschist facies Abitibi Subprovince by possessing an amphibolite facies metamorphic assemblage of actinolite-biotite-plagioclase-almandine. Consequently, the typical indicator minerals used to identify alteration and mineralization, such as secondary biotite, may not be useful. Petrological and geochemical analyses have revealed at least four populations of biotite: 1) large euhedral crystals located within quartz-carbonate veins, 2) small, euhedral zoned crystals present as alteration haloes, 3) very small, anhedral to subhedral indistinct crystal present in mafic volcanic host rock, and 4) large euhedral crystals defining the main metamorphic foliation in the metasediments. Extensive examination of mineral assemblages, alteration products, and vein structure in rock core across barren and mineralized zones has documented over a dozen vein types which can be grouped into two main categories: 1) sulfidized quartz-carbonate veins associated with biotite alteration and 2) late carbonate veins. Gold grades do not prove to be dependent on vein type but rather on the host rock composition: the highest ore grades are present in the massive mafic volcanic units exhibiting alternating bands of biotite and chlorite alteration. Scanning electron microscopy imaging reveals that some of the gold present is found in Au-Bi-Te clusters indicative of late remobilization of the gold in the history of these rocks. Detailed mineral chemistry and chemical mapping of the micas will help determine if gold precipitation is a result of biotite breakdown during metamorphism or possibly from a metasomatic biotite-calcite reaction. Investigating higher metamorphic grade deposits will help us better understand ore deposit which form deeper in the crust.