Distribution, characteristics, and relationship between brittle and ductile dextral transpressive structures along the Larder Lake-Cadillac deformation zone in the Kirkland Lake area of the Abitibi subprovince, Canada

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The regional-scale Larder Lake-Cadillac deformation zone (LLCDZ) and its immediate splays are spatially associated with several world-renowned orogenic gold deposits, therefore, its tectonic evolution is well-constrained. However, structure distal to the LLCDZ is poorly-understood due to a lack of detailed mapping and discovered orogenic gold deposits. We investigated the structural characteristics and distribution of strain from a broad, ~70 km^2 area surrounding the LLCDZ in Kirkland Lake. New structural data is used here to investigate structural controls on orogenic gold mineralization and to better understand the role of strain localization mechanisms in the development of major regional deformation zones in Archean greenstone belts. The dominant structural fabric is a steeply NNW- or SSE-dipping penetrative foliation (S_D) and an associated moderately to steeply NE-plunging mineral/elongation lineation (L_D). S_D/L_D is best developed in ENE-trending high-strain zones (HSZs) that are <1m to >100m in width, spaced at ~500 m, and occur at least 10 km afar from the LLCDZ. Within the HSZs, S_D is associated with dextral shear sense indicators such as Z-folds and sigma clasts and is commonly defined by sericite- and/or iron-carbonate mineral-rich folia. We suggest that L_D developed during dextral shear and is indicative of a subvertical extension component. This is consistent with previous interpretations of dextral transpression along the LLCDZ. Brittle deformation features within the HSZs include discrete fault planes with reverse shear sense indicators, fault gouge, and cataclasite. Furthermore, the HSZs commonly contain shallowly dipping vein sets, pervasive Fe-carbonate metasomatism, and sulfide mineralization. Kinematic analysis of the fault and slickenline data indicates that they developed during NNW-SSE shortening. The brittle and ductile structures in the HSZs display complex, mutually cross-cutting relationships, which indicate that they are broadly coeval. The major ductile HSZs in the study area are spatially coincident with structures interpreted to have originated as brittle fault zones. Thus, brittle damage zones, including cataclasites, may have resulted in ductile shear localization, likely due to grain size reduction. The association between alteration and deformation in the transpressional HSZs up to 10 km away from the LLCDZ suggests that relatively distal HSZs may be prospective for orogenic gold in the Kirkland Lake area.