Structural Controls on Gold-bearing Veins of the Cariboo, Cassiar, and Sheep Creek Mining Districts, BC

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MDRU BC Orogenic Gold

Summary

Orogenic gold deposits remain an attractive global exploration target due to their typically high grades. In general, Phanerozoic belts have received much less exploration interest for orogenic gold relative to Archean orogenic gold districts such as Western Australia, West Africa, Ontario, and Quebec. However, recent exploration interest in the Cariboo district of BC, which historically produced 3.2 Moz from placer creeks and 1.3 Moz from lode souces, highlights the potential for similar systems in BC and elsewhere in the Cordillera. This study examines structural controls on orogenic gold in the Cariboo and similar settings in the Cassiar and Sheep Creek districts, in order to assess the timing and kinematic controls on mineralization as a function of tectonic processes.

Late Jurassic to Early Cretaceous gold-bearing quartz veins of the Cariboo and Sheep Creek mining districts of BC formed inboard (east) of the suture between the Quesnellia arc terrane and North American passive margin sediments of Upper Proterozoic to Lower Paleozoic age. Vein-hosted gold mineralization in the Cassiar district is similarly situated east of the Quesnellia margin, but is hosted mainly in metabasaltic rocks of the Slide Mountain terrane (Sylvester allochthon), which structurally overlies platformal North American strata. In all three localities, penetrative strain fabrics of the host rock sequence imply orogen-normal shortening and simultaneous orogen-parallel, longitudinal extension. This lateral escape tectonic style appears to have been accompanied by N-directed transport of the Slide Mountain terrane, as demonstrated by mylonitic shear fabrics along the Pundata thrust in the Cariboo, and vein geometries in the Table Mountain area of the Cassiar district.

Quartz vein geometries and shear sense indicators are kinematically compatible with coaxial progressive shortening under the same general stress regime responsible for early, thin-skinned fold-and-thrust style deformation. Gold mineralization associated with the late, low-strain stage of this deformation thus signals the transition from penetrative thick-skinned deformation in the Jurassic, to the partitioning of strain into Cretaceous strike-slip fault systems.

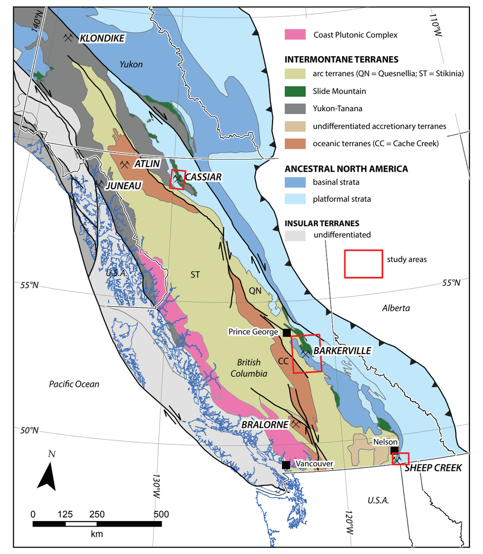

Figure 1. *Terrane map of BC, showing study areas*

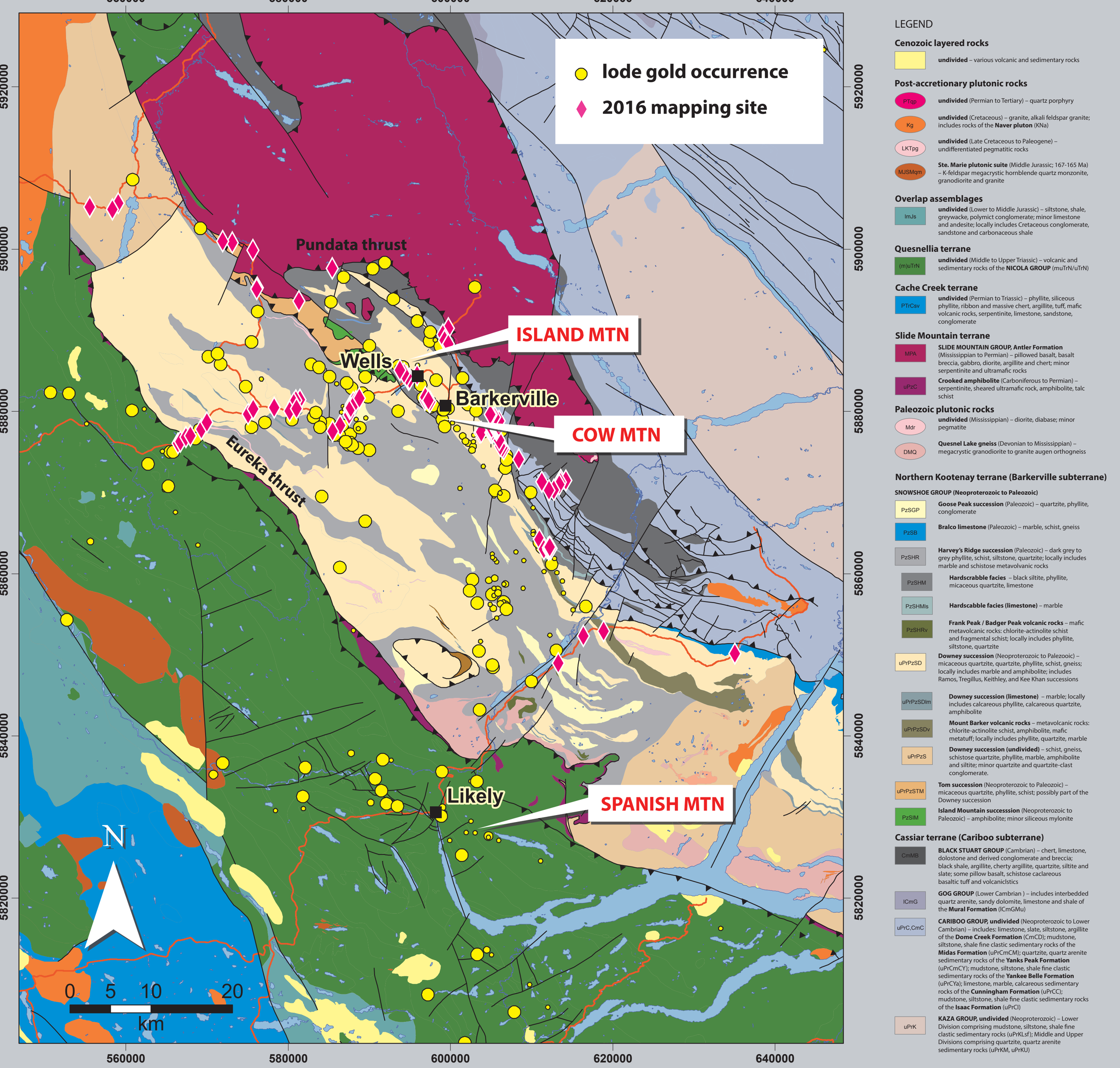

Figure 2. *Geologic map of the Cariboo gold district, showing location of structural measurements*

Cariboo

Gold mineralization in the Wells-Barkerville camp is hosted in variably carbonaceous and calcareous metasediments of the Neoproterozoic to Paleozoic Snowshoe Group, Barkerville subterrane (Fig. 2). These rocks are overridden along the Pundata thrust by oceanic rocks of the Slide Mountain terrane (Fig. 2). The regional stratigraphy and structural architecture of region remains problematic, but field observations made during this study support the interpretation that Snowshoe Gp. rocks are folded in a SW-vergent nappe structure, as originally proposed by Ferri and Schiarizza (2006).

Bedding (S0) in Snowshoe Gp. sediments is locally well-preserved, with excellent examples of graded bedding (Fig. 4). Bedding is typically strongly transposed by an early deformation event (D1) and subsequently folded into NW-trending folds (F2) with steeply NE-dipping axial planar fabrics (S2). A penetrative intersection and stretching lineation (L2) is developed regionally, which plunges shallowly to the NW at the Island Mountain and Cow Mountain deposits, but shows significant variations in plunge regionally and locally (Fig. 6). A D3 deformation event associated with open, upright folds of S1 and S2 is recognized locally, and is defined by a steeply dipping, NW-trending crenulation cleavage, and with a WNW-plunging crenulation lineation (L3) (Rhys and Ross, 2001).

Quartz veins in the region form diachronously during progressive D2 deformation. Early, barren quartz veins are variably folded and boudinaged in response to NE-SW shortening. Carbonate-pyrite alteration associated with early hydrothermal alteration is recognized by porphyroblasts with strain shadows. Mineralized veins are generally late-D2, and have four main structural associations:

(1) Extensional quartz-carbonate +/- sulphide veins are subvertical, NE-striking, with fibrous to columnar margins, and with massive to vuggy interiors; (2) N-trending en echelon vein arrays and shear veins with dextral-oblique normal shear sense occur in the Wells-Barkerville camp and regionally. Conjugate sinistral features have an ENE trend; (3) Fault-filling veins such as the BC vein (Fig. 9) originate early in the deformation history due to ductile overprints, and were mineralized at a later, brittle stage of deformation; (4) NW-plunging pyrite replacement bodies are typical of the Island Mountain area, and formed by replacement of calcareous units along F2 fold necks (Fig. 13). Vein mineralization is best developed in more competent psammite, whereas phyllitic units are dominated by lower vein density and ductile deformation features.

Syn- to post-mineral F4 chevron folds with NE-trending axial planes and steeply plunging fold axes are locally developed in phyllitic units (Fig. 10). These are best explained by differential NE-SW shortening along strike, such that lateral extrusion of ductile material from a zone of active shortening leads to a local zone of orogen-parallel (NW-SE) shortening in the presence of a backstop such as a fault (Fig. 14).

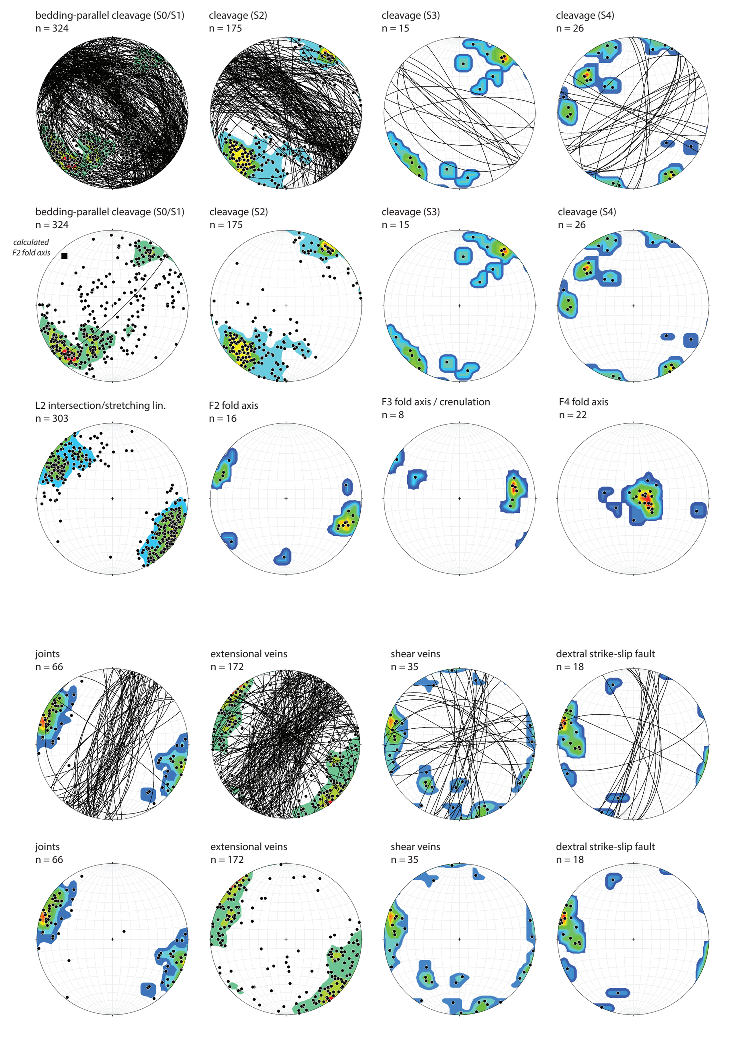

Figure 3. *Equal-area projections of Cariboo structural data*

Figure 4. *Graded bedding in weakly calcareous turbidite sequence*

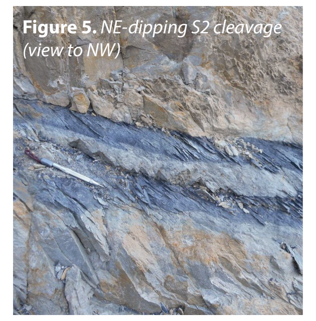

Figure 5. *NE-dipping S2 cleavage (view to NW)*

Figure 6. *Prominent NW-plunging L2 lineation*

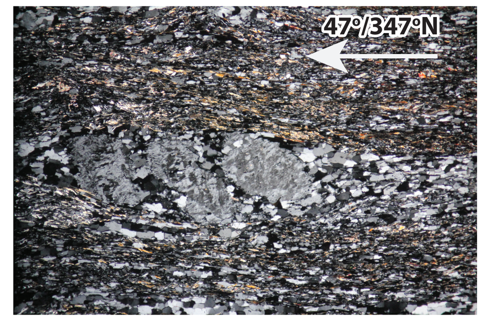

Figure 7. *Mylonite at base of Pundata thrust. Top-to-N shear sense given by domino-blocked K-feldspar porphyroclast*

Figure 8. *N-trending dextral shear vein (Cariboo Thompson area)*

Figure 9. *NW-striking fault-fill vein (BC vein)*

Figure 10. *F4 cross-folds in a zone of mineralization, Bonanza Ledge*

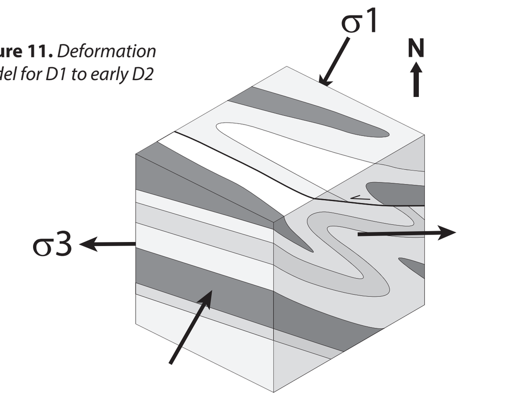

Figure 11. *Deformation model for D1 to early D2*

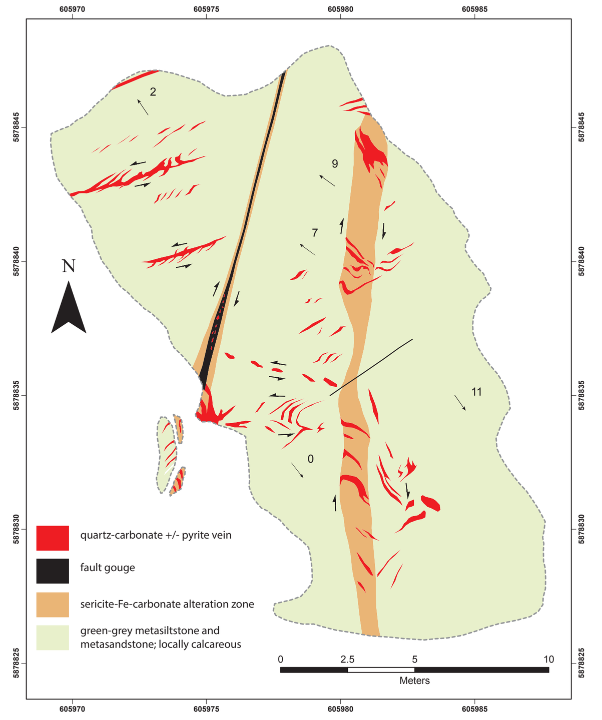

Figure 12. *Outcrop map showing vein and fault relationships*

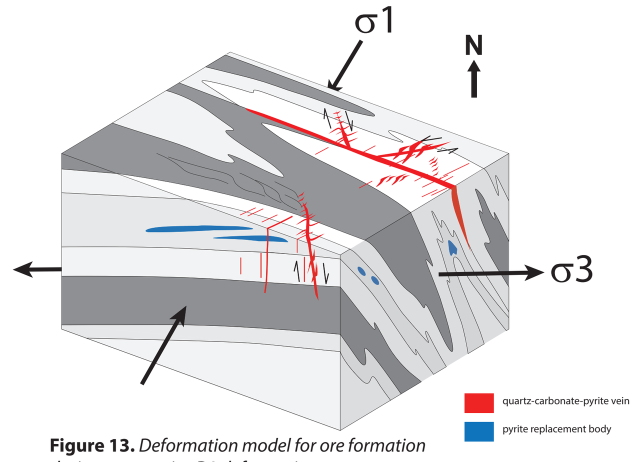

Figure 13. *Deformation model for ore formation during progressive D2 deformation*

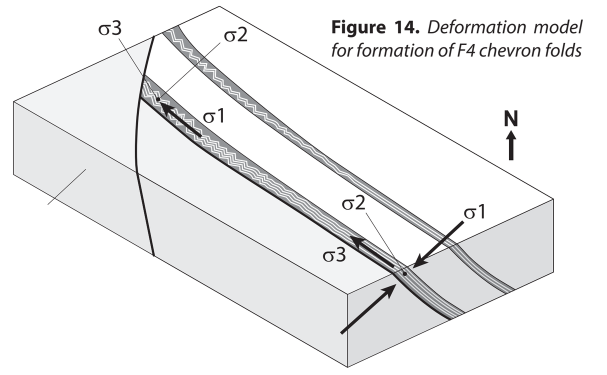

Figure 14. *Deformation model for formation of F4 chevron folds*

Cassiar

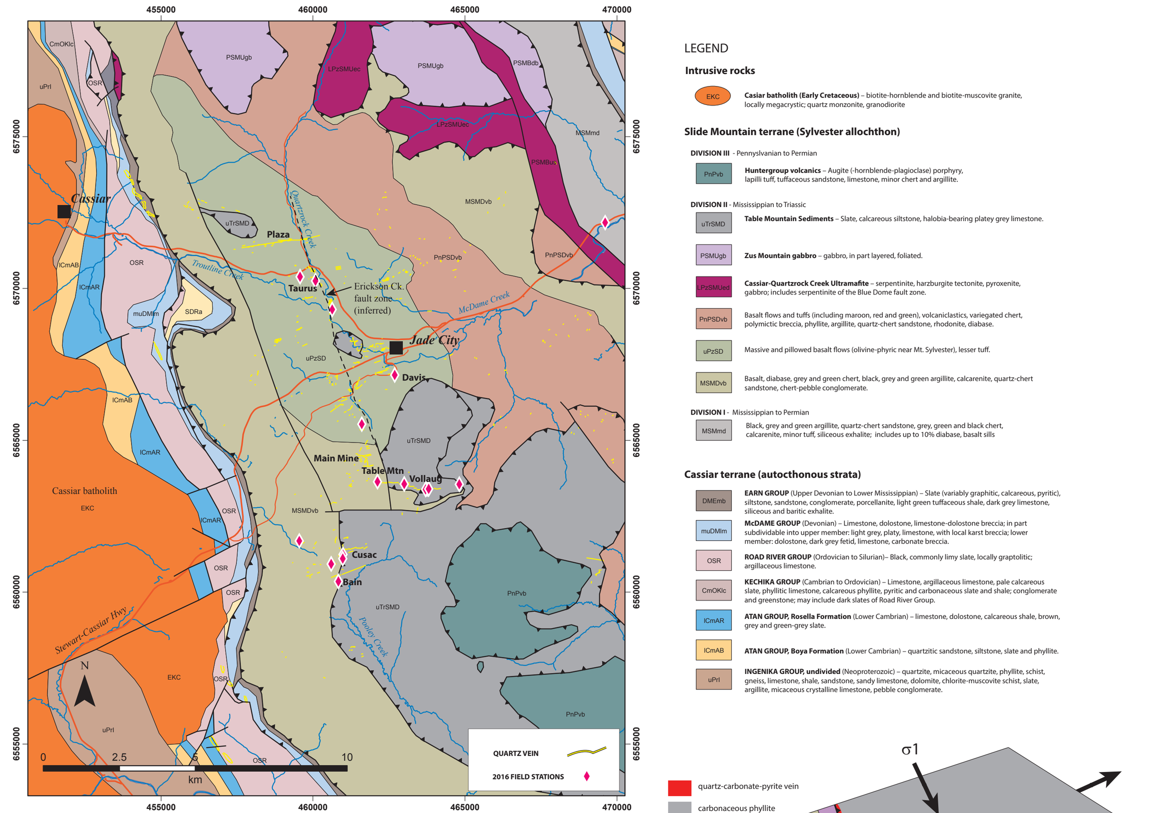

Figure 15. *Geologic map of the Cassiar gold district*

The Cassiar gold district is located in Slide Mountain terrane oceanic rocks (Sylvester Allochthon) (Fig. 15). Mineralized veins of the Table Mountain area are preferentially formed in the footwall of a major regional thrust surface that juxtaposes carbonaceous phyllites over mafic and ultramafic metaigneous rocks, with listwanite (quartz-carbonate-fuchsite) altered ultramafites in the immediate footwall (fFig. 16). The footwall sequence is dissected by additional thrust faults exposed in underground workings. Two main vein styles are recognized: (1) Thrust fault-filling veins such as the Vollaug (Fig. 17); (2) shear veins that preferentially form in metabasaltic rocks in the immediate footwall below thrust faults (Fig. 18). The latter type are typically E-W trending, N-dipping and have oblique sinistral-normal shear sense as indicated by NE-trending sets of extensional veins (Rhys, 2009).

Mineralization in the Taurus deposit area is dominated by subvertical, ENE-striking extension veins and W- to WNW-striking sinistral-normal shear veins and en echlon vein arrays (Figs. 19-20). Pillow basalt host rocks show a consistent shallow SSE plunge, i.e., nearly perpendicular to auriferous extensional vein arrays.

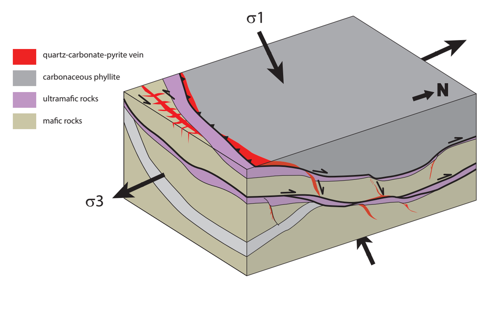

Figure 16. *Deformation model for vein types in the Cassiar district*

Figure 17. *Highly sheared thrust-filling Vollaug vein*

Figure 18. *Shear-extension vein relationships, Bain decline (view up at back, so shear sense is sinistral in plan view); from Rhys, 2009*

Figure 19. *ENE-trending swarm of extension veins in deformed pillow basalt host rocks, Taurus. Note halo of ankeritic alteration.*

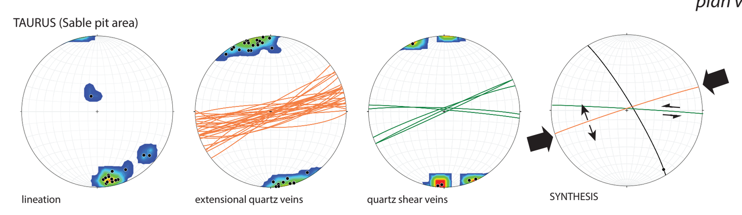

Figure 20. *Structural measurements and kinematic interpretation at the Taurus deposit*

Sheep Creek

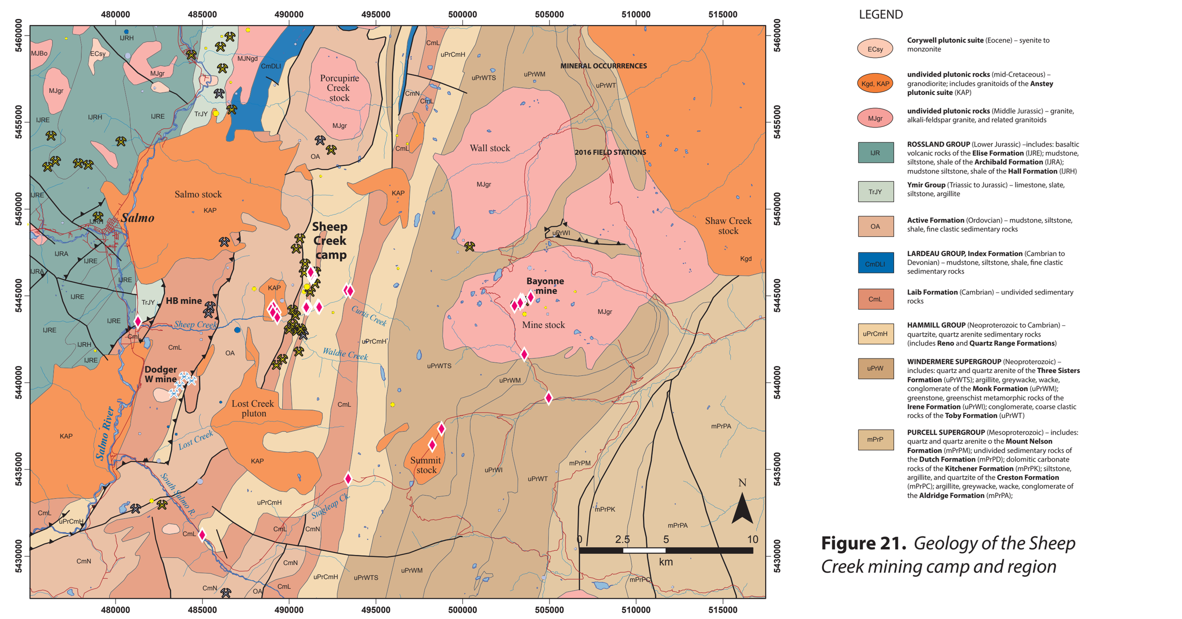

Figure 21. *Geology of the Sheep Creek mining camp and region*

Underground workings in the Sheep Creek mining camp produced a 736 koz of gold from 1899-1951 (Mathews, 1953). The geology of the camp is dominated by variably micaceous quartzites of the Neoproterozoic to Cambrian Hamill Group (Figs. 21-22). Historic mineralization was contained almost exclusively in the overturned western limb of the N-trending, E-dipping Sheep Creek anticline (F2). The age of mineralization is bracketed by pre- to syn-tectonic Middle Jurassic granitoids to the east (e.g., Mine stock), and post-mineral mid-Cretaceous granitoids to the west (e.g., Sheep Creek stock).

According to historic descriptions, mineralization is hosted almost exclusively by low-displacement, ENE-trending dextral shear veins. Measurements at surface exposures indicate a subhorizontal NNE-trending stretching lineation (L2) and sub-perpendicular set of ESE-trending steep joints and extensional veins. Overall, mineralization formed during progressive WNW-ESE directed shortening along this segment of the Kootenay arc.

Figure 22 *Lineated quartzite cut by barren extensional quartz veins*

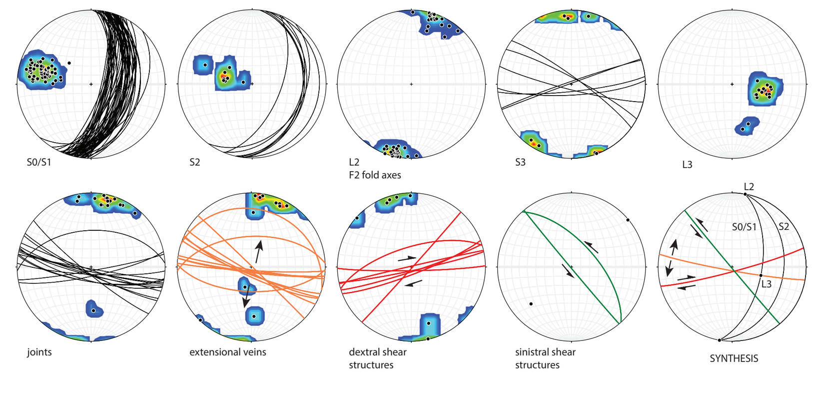

Figure 23. *Structural measurements and kinematic interpretation for the Sheep Creek camp and region*

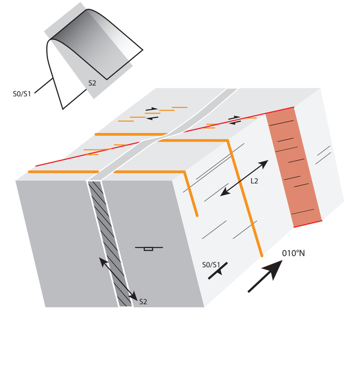

Figure 24. *Deformation model for the Sheep Creek camp*

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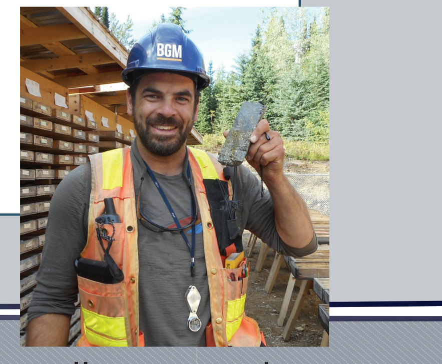

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