# Investigations into the Lucky Shot Mine, an 'orogenic' Willow Creek gold vein.

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The Willow Creek Mining District is historically the third largest producer of lode gold in the state of Alaska. Post-mineralization faults pervasively cut and offset the veins, hence the search for additional veins requires understanding and recognizing the distal alteration/elemental signatures of the veins and their changes with proximity to ore. The situation is aided by presence of a single host rock, the Willow Creek (Tkt) Pluton.

Visible alteration is broken out qualitatively by degree of mafic mineral change seen in mineral colors: dark green is mostly chlorite; apple green is sericite, tan is rutile-rich. Parallel changes in magnetic susceptibility (MS) records magnetite destruction.

| Intensity | hornblende | biotite | sphene | MS (SI) | width (cm) |
|---|---|---|---|---|---|
| 'fresh' | black | black | dark brown | 6-9 x $10^{-3}$ | |
| very weak | dark green | black | dark brown | 4-6 x $10^{-3}$ | < 20 m |
| weak | dark green | dark green | tan | 2-4 x $10^{-3}$ | < 10 m |
| moderate | apple green | dark green | tan | 1-2 x $10^{-3}$ | < 1 m |
| strong | massive sericite + carbonate + quartz | | | 0-1 x $10^{-3}$ | < 2.5 m |

Fresh hornblende and biotite have nearly identical Mg#s (100*at Mg/Mg+Fe) of 0.57 and 0.55; chlorite replacing hornblende is more Mg-rich than chlorite replacing biotite. White micas also contain significant Mg and Fe ('celadonite'). Petrographic, electron microprobe, and XRD studies indicate that silicate alteration is accompanied by variable amounts and types of carbonates: calcite is pervasive, ankerite (Mg#45-70) first appears with very weak and Mg-siderite (Mg# 25-40) with weak alteration. Carbonate preferentially replaces sphene > hornblende > biotite. Carbonate compositions indicate temperatures of ~ 300-350C with no significant cooling gradient away from veins.

Aqua Regia digest (ARD) ICP AES analyses yields good recovery for elements present as sulfides, oxides, and (or) carbonates, but poor recovery for elements present in silicates. Consequently, ARD Mg and Ca reflect carbonates. High ARD Mg- and Ca- in drill core confirms petrographic observations that alteration is pervasive, even in 'fresh' rocks. Further, very high ARD Ca/Mg characterizes ore zones, indicating that quartz + calcite dominates veins although siderite and ankerite dominate adjacent altered rocks.

XRF major and minor element compositions of representative samples from the various alteration types show that many elements are conserved or remobilized by alteration. TiO2-normalized data shows most major and minor elements (Mg, Ca, Fe, P, Co, Ni, Zn,Sr, Ba…) are modestly leached; in contrast, K, Rb, V are depleted in distal alteration but enriched in strongly altered rocks—indicating remobilization, not overall addition or depletion. The very low normalized SiO2 of strong alteration apparently caused deposition of vein quartz. Other elements apparently re-concentrated include Cr, Cu, Zn, and Pb. The only truly 'exotic' component are As, S, Au, and $CO_2$.

Plotting of >500 assays from historic underground assay maps shows no relation between gold grade and quartz vein thickness ($R^2$ ~0). We suggest this is due to gold deposition from fluid changes (probably boiling), while quartz deposition (hence, vein thickness) is due to SiO2 released from surrounding alteration. Post-ore tilting suggested by tilted foliation and bedding in surrounding rocks further complicates matters.