

Sapphire Corundum Anomalies with Different Gold Anomalies, in Heavy Mineral Fractions of Stream Sediments on Epithermal-like CLY Gold + Bismuth Telluride Prospect, in south British Columbia, Canada

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Abstract. Very high counts of locally-sourced corundum grains occur in Heavy Mineral [HM] concentrates prepared from bulk stream sediments on CLY prospect gold quartz vein systems and skarn, south of Nelson in B.C. Most corundum grains [gns] are well-included and 'gritty'; a few are transparent varicolored blue, pink-grey and water-clear sapphire chips from larger gns, Figure 1. HM fractions anomalous in corundum gn counts differ in their gold anomalies. Only LW Ridge stream network has both anomalous recovered Visible Gold [VG] gn counts, Figure 4, and anomalous ppb Au by INAA in the non-magnetic <0.25 mm fine fractions, Figure 5. Other stream networks have only anomalous recovered VG gn counts. N-trending LW Ridge with its steep slopes follows an intrusive contact (map, Figure 3). Evidently glacially pulverized sulphidic skarn contributes fine gold to its W-flowing tributaries. On CLY Prospect corundum outlines a 2.7 km trend of gold-associated aluminous alteration, with garnets and Hercynite. Abundant corundum in HM concentrates can be used as an Indicator Mineral in other covered regions to signal potential for gold deposits with aluminous alteration, including epithermal-style bismuth-telluride enriched vein systems or scheelite (tungsten) + gold skarns. Corundum is not just solely developed by contact metamorphism.

1 Corundum types include sapphire on CLY gold prospect

Abundant grey, well-included 'gritty' corundum grains [gns] and a few clear, varicoloured sapphire chips, Figure 1, occur in several HM concentrates on CLY gold prospect, in southernmost British Columbia Canada, south of Nelson city, Figure 2.

Corundum is aluminum oxide Al_2O_3 , the end-member mineral of aluminous hydrothermal alteration in some epithermal gold systems and Cu-Au-Mo-(W) porphyry deposits. CLY showings have sulphides, native gold (or electrum) gns with native bismuth, bismuthinite, joséite-A, joséite-B, hedleyite and various rare bismuth tellurides.

1.1 Unusual abundance of corundum in one sample

Regarding an LW ridge sample, R. Huneault, Overburden Drilling Management Ltd. [ODM] President, commented Jan. 2015: "We do not have a reference where abundant sapphire corundum grains as found in CLY sample HM-18 are present ... the 8,000 grains is the highest concentration

... ODM has ever encountered. It is common to find low numbers ... occasionally up to 200 grains but not 8,000 grains". Two duplicate sample pairs have more than 1,700 gns - Figures 4 & 5. Since inception ODM has processed about 25,000 samples for HMs (R. Huneault, p.c.).

As they are often blue-grey ODM names all the corundum gns 'blue sapphire' corundum.

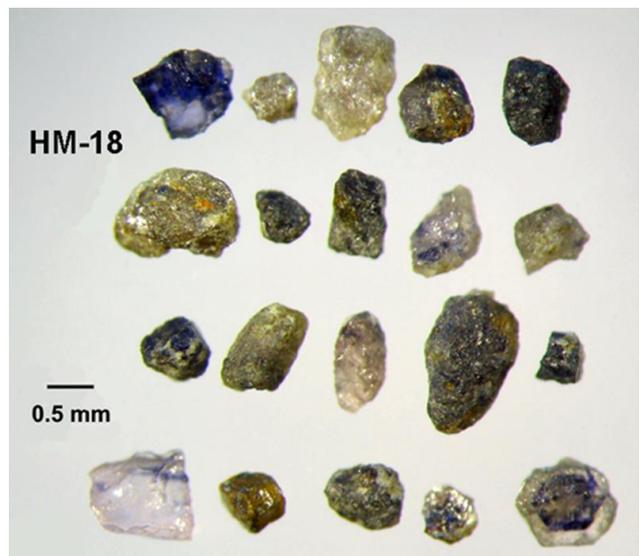


Figure 1. First 20 of 50 representative coarse corundum gns picked from HM-18, LW Ridge. Corundum is 12% of the coarse nonmagnetic fraction or 2,000 gns. Clear corundum overgrows dark blue in the chip at top left. Chip at bottom left has a dark blue fringe. Pink-grey grain at bottom centre may also be a broken chip. Photo by M. Michaud of ODM.

The quality of some clear, blue & pink-grey sapphire chips as precious gems has not been investigated. The source of the exceptionally anomalous corundum in HM-18 Bmin trib watershed (map, Figure 3) is likely banded calc-silicate bedrock exposed in the creek bed.

2 Regional to district scale structural – geologic setting

CLY prospect is located over the continental accretionary suture zone at the Quesnellia - Slide Mountain - Kootenay Terrane boundary, Figure 2.

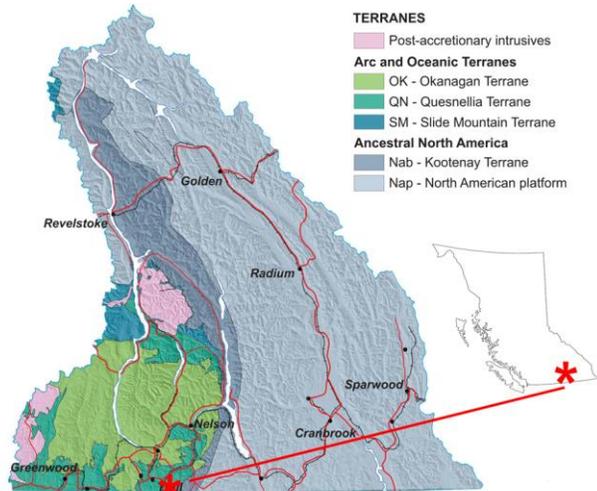


Figure 2. Location of CLY Prospect in south British Columbia over the terrane accretionary boundary, with highways. From Nelson Colpron and Earle (2013).

The layered rock units are metasediments, metavolcanics and ultramafics of the Slide Mountain Terrane Harcourt Ck Assemblage (Tapsoba Part III in Howard Ajibode Tapsoba 2016) and varied carbonaceous, argillaceous limestone and marl beds of the Kootenay Terrane Index Formation. The geologic setting in a fold and thrust belt is complex, with oft-reactivated thrust faults and shear zones (Tapsoba and Howard 2017).

Contact metamorphism by Cretaceous ‘S-type’ granitoid bodies, including the Wallack Ck stock and the Bunker Hill sill, formed the abundant ‘gritty’ corundum gns. Siliceous epithermal gold mineralization is associated with Tertiary Eocene age alkalic Coryell suite mafic syenites & lamprophyres. Varicoloured clear sapphire may be neo-formed from ‘gritty’ opaque corundum. Shallow glacial drift is extensive.

3 Mineralization in the Rossland-Trail-Salmo-Nelson region

The region about CLY prospect is highly mineralized with significant production & reserves in several gold camps, Million oz: Rossland 25 km W, 2.94; Sheep Ck 20 km NE, 0.91; Ymir ~30 km NNE, 0.56; and the Kena KGM zones near Nelson city, 1.89 M. oz NI total reserves. All except the Sheep Ck vein field are along the accretionary boundary, the Waneta – Tillicum Fault system.

3.1 Historic Bunker Hill mine on central CLY

Total recorded production of the Bunker Hill mine 1933 – 1942 from 4 adits and surface trenches totals 375 tons, at average grade 0.30 oz/ton gold and 0.87 oz/ton silver (10.3 g/t Au & 29.8 g/t Ag).

The Bi–Te–S mineralogy, mineral stages, structural setting and age of the associated intrusion is similar to the

Liese zone Pogo deposit, AK with 6.5 M. oz *plus*. Mineralization is bismuth and tellurium enriched with several very rare bismuth (sulpho)tellurides, e.g. first occurrences of ikonolite Bi_4S_3 and ingodite $\text{Bi}(\text{Te},\text{S})$ in Canada (Cook, Part II in Howard Cook and Ciobanu 2009). At the Bunker Hill mine crossing veins form ore shoots, a Tension Vein Array (Tapsoba and Howard 2017).

4 Bulk stream sediment survey, with two pairs of duplicate samples

For field sampling the standard GSC procedure was used (B. McClenaghan p.c., 2014). In flowing creeks, or nearly dry gullies, use of 4 and 12 mesh screens removed oversize clasts. An average ~8.4 kg of stream sediment (silt) was collected in new 5.7 litre plastic boxes. All equipment was thoroughly washed between samples.

Two pairs of duplicate silts were collected, using the same sampling protocol, close to the anomalous HM-18 site, from Bmin trib below LW Ridge.

5 ODM lab methods

Overburden Drilling Management Ltd. of Ottawa is a leading laboratory in gold grain and Heavy Mineral recovery. They followed typical lab procedures, detail is at <http://www.odm.ca/>. From CLY prospect ODM tabled 54 bulk stream silts, recovering Visible Gold [VG], scheelite and metallic mineral gns, and prepared 34 Heavy Mineral [HM] fractions, Figures 3 to 5. Over the three year survey D. Holmes did all microscopic identification, counting and picking of the VG and HM gns.

ODM prepared 47 nonmagnetic <0.25 mm fractions sent to Activation Labs Ltd., Ancaster ON, for INAA.

5.1 Re-counts of some suspect counts

The advantage of sampling streams over tills is that fluvial dispersion can be used to check count estimates in silts from the same creek or stream network. Generally upstream concentrations must decrease downstream.

11 of 34 HM samples were re-counted for corundum. Each has 3 gn sizes, thus 33 re-counts. For 12 the counts increased, for 6 they decreased. Often mica coats corundum (and grossular garnet) gns confounding the count estimates. The counts are semi-quantitative data fully sufficient for the survey goal, exploration targeting.

6 Results: recovered visible gold grain counts

ODM recovers a known proportion of the VG gns depending on their size. Anomalous thresholds of gn counts are set at gaps on log normal probability plots. The limits have varied little in 3 survey years (Howard Ajibode and Tapsoba 2016). Anomalies are designated **Class I, II** or **III** in order of decreasing decimal gn counts. As a check, counts of duplicate HMs are often the same anomaly class.

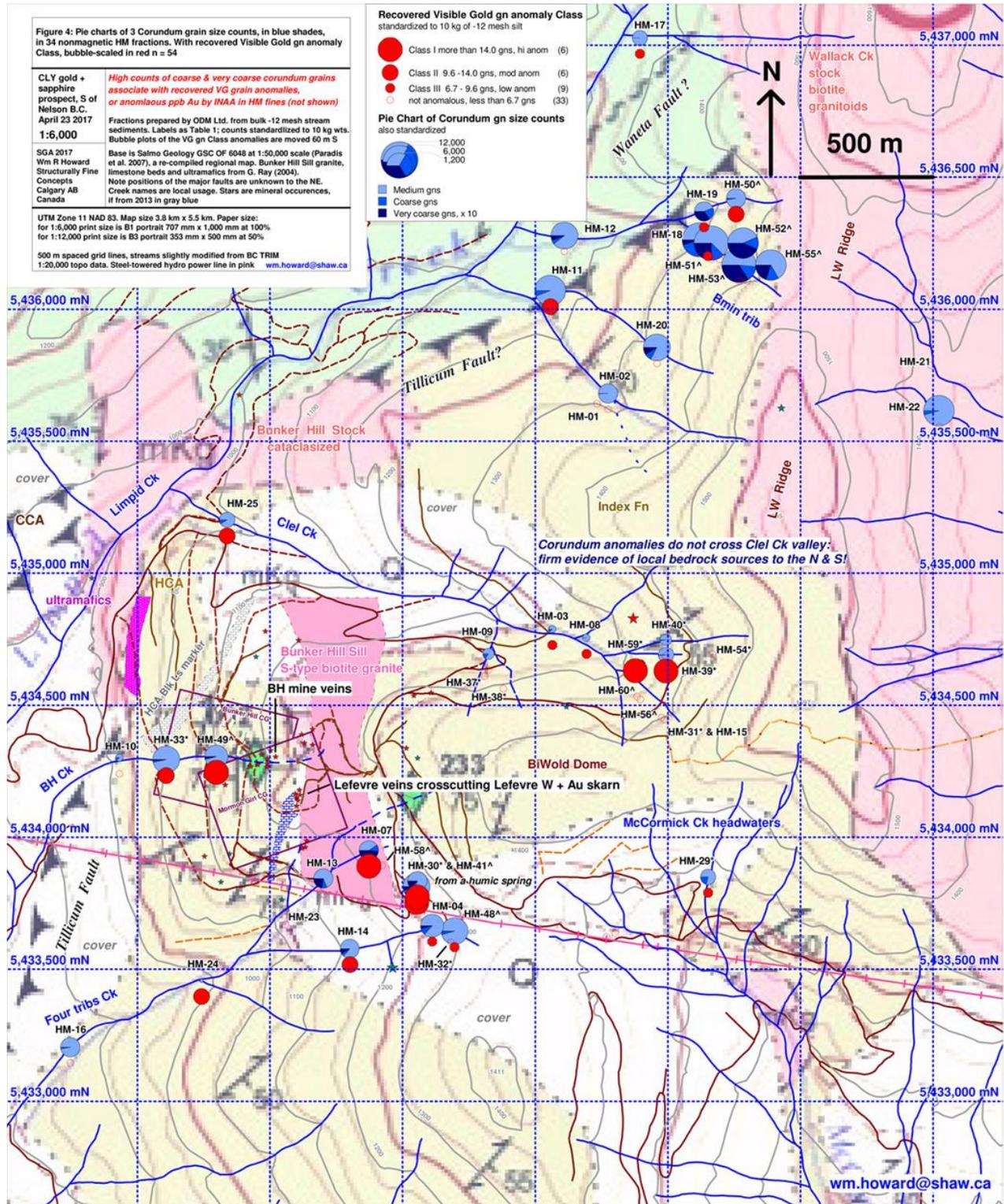


Figure 3: Pie charts of three corundum gn sizes in 34 nonmagnetic HM fractions. Pie sectors in dark & very dark blue represent numbers of coarse and very coarse corundum gns. Recovered Visible Gold gn anomaly classes are bubble-scaled in red, offset to the south for legibility. Fractions with high counts of coarse and very coarse corundum gns always have VG gn anomalies. The reverse co-association is not necessarily true: two **Class I** VG anomalies in upper Clel Ck have very few glacially-dispersed corundum gns. Revealingly, the high corundum counts do not cross Clel Ck. This is firm evidence the corundum is locally sourced: if coarser-sized gns have high counts the corundum sources are restricted to the sampled watershed. Bowl-like stream headwaters are weathered alpine cirques; W-E trending BiWold Dome is a roche moutonnée (sheep back). Not shown are Au by INAA anomalies in 47 nonmagnetic HM fine fractions.

7 Results: corundum grain counts

For medium size corundum the anomalous thresholds are set at: potentially anomalous 1,100 gns (rather high) and distinctly anomalous 2,200 gns, lines on Figures 4 & 5.

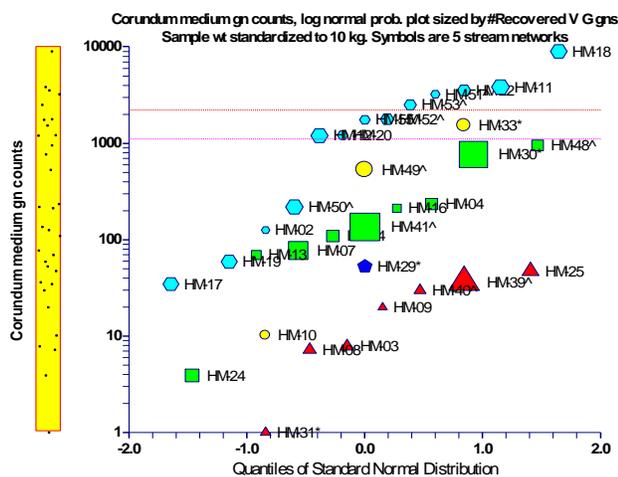


Figure 4: Log normal probability plot of medium corundum gn counts in 34 nonmagnetic fractions, sized by recovered VG gns counts. Purple line is provisionally anomalous threshold, set rather high at 1,100 gns; red line is distinctly anomalous, 2,200 gns. Symbols represent the stream networks: light blue hexagons LW ridge; yellow dots BH Ck; green squares Four tribis Ck; single dark blue pentagon is McCormick Ck; red triangles Clel Ck. Counts standardized to 10 kg of -12 mesh stream sediment.

A duplicate pair of humic spring samples from Four tribis Ck network (green) have the highest recovered VG gns counts, standardized 36.0 and 33.7 gns, both **Class I**.

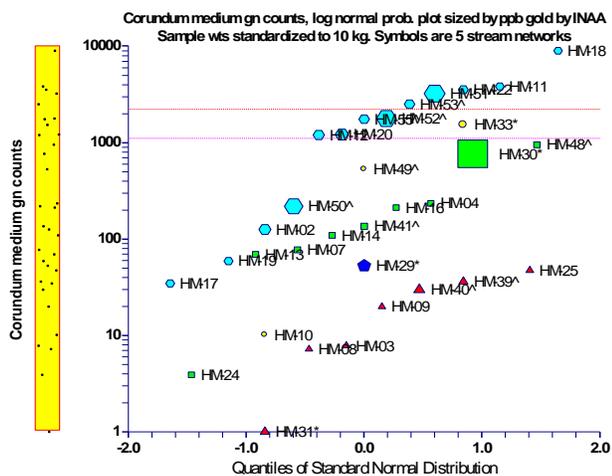


Figure 5: As Figure 4 but sized by ppb Au by INAA in the <0.25 mm fractions. Symbols represent different stream networks like Figure 4. The outlier in green is one analyses of a duplicate from the humic spring in Four tribis Ck network; its other analysis is background. Counts standardized to 10 kg.

Consistently LW ridge HM fines (light blue) have the highest ppb Au by INAA values. **Two BH Ck silts HM-49[^] & -33* (yellow) have little ppb Au by INAA.**

8 Conclusion - corundum anomalies have different gold anomalies

Stream networks anomalous in medium corundum gns in HM fractions also have anomalous gold, as recovered Visible Gold (electrum) ‘VG’ gns, *or* ppb Au by INAA in nonmagnetic <0.25 mm HM fine fractions, *or both*. **Only LW Ridge stream sediments (light blue hexagons) have both.** Bunker Hill [BH] Ck, Four tribis Ck, and Clel Ck networks only have anomalous VG gns counts.

This difference is plausibly due to **more fine particulate gold in sediments from LW Ridge**, from pieces of glacially pulverized sulphidic skarn. LW Ridge has steep W or E facing slopes that follow the intrusive contact of the granitic Wallack Ck stock (map, Figure 3). Figure 4 shows the gold content in the other stream networks is most all as native VG (electrum) gns. Sources in their watersheds are about 500 m or more from intrusive contacts, on moderately sloping land. Examples are the BH mine and Lefevre Au(Ag)-Bi-Te-As-Sb-Pb-W-Fe veins in Four tribis Ck watershed. Long-term weathering in the Tertiary modified most gold grain shapes, enlarging some.

High corundum counts *do not cross Clel Ck* (map, Figure 3). This conclusively shows its sources are local, in the sampled watersheds. Abundant corundum in HM concentrates is one indication of a 2.7 km trend of gold-associated aluminous alteration on CLY prospect. Corundum can be used as an Indicator Mineral in other covered regions to target gold deposits with associated aluminous alteration, possibly with garnet and hercynite. Eocene Coryell mafic alkalic rocks may form gem-quality sapphire from ‘gritty’, well-included, opaque corundum and epithermal bismuth telluride-associated gold deposits.

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