

September 2023 Interim Reporting Alaskan Placer Tailings – a search for critical materials

Research Assistant Isabelle Harris & Research Professor D.
Erik Spiller - Colorado School of Mines
and
Susan Karl
USGS



Kougarok River on the Seward Peninsula – a 2023 sample site



Project Goals

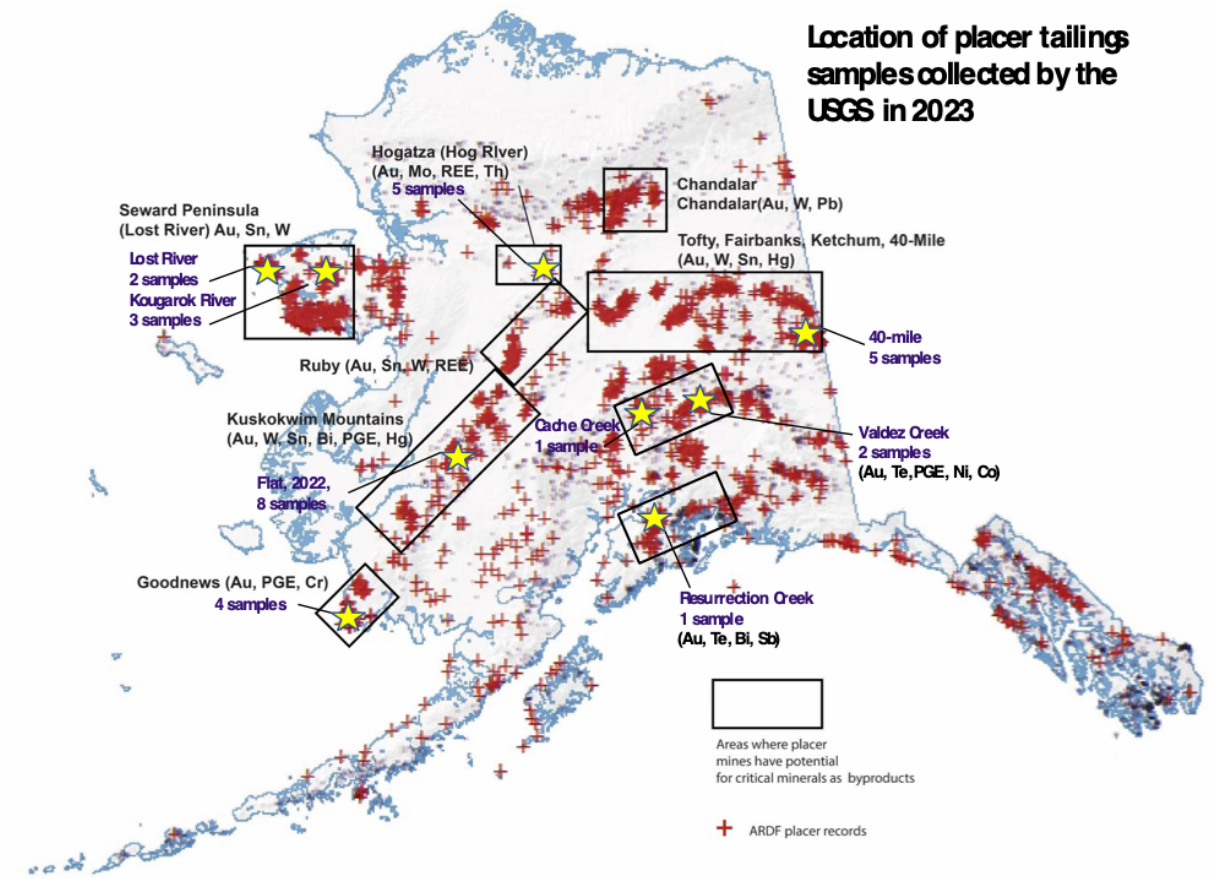
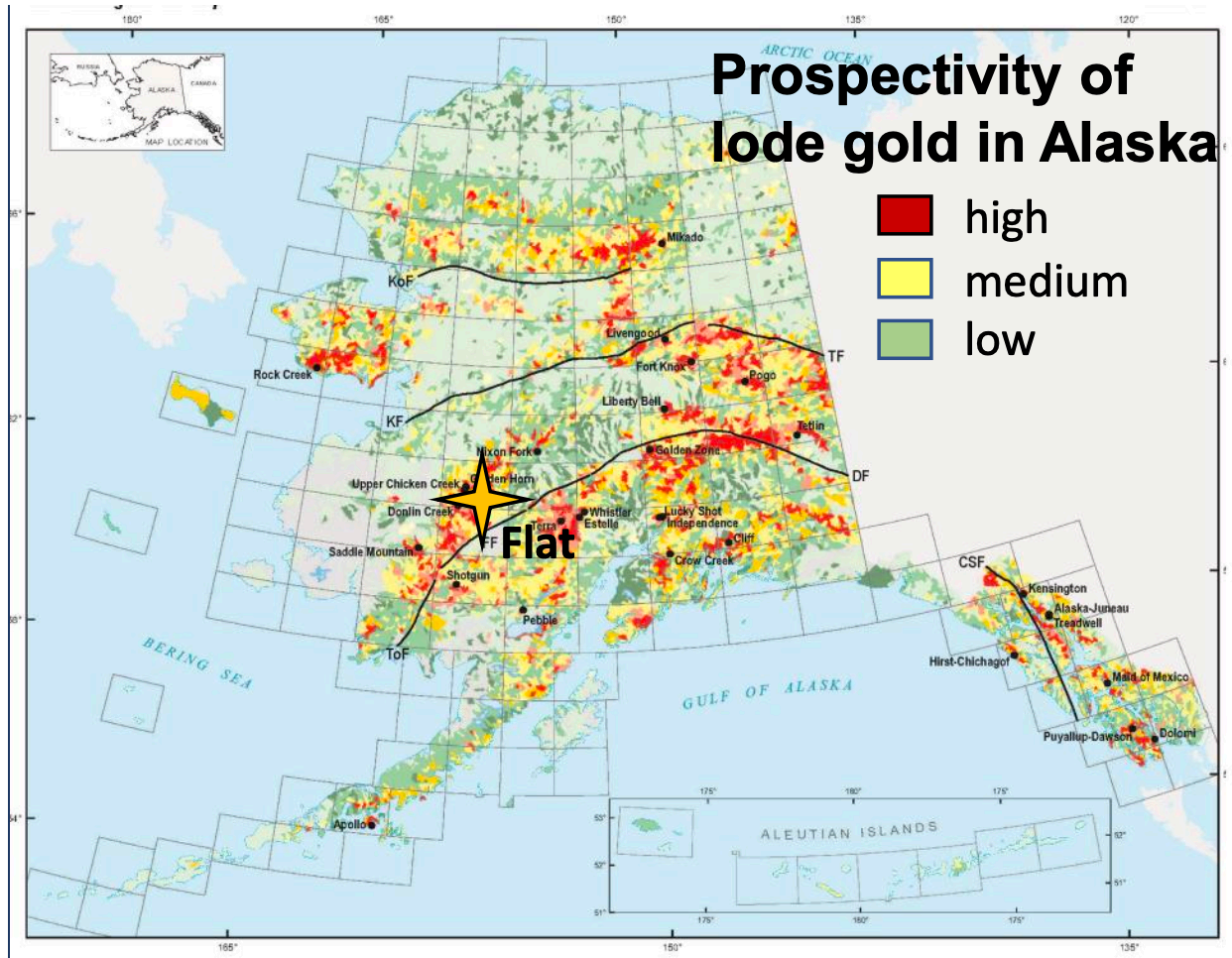
- ❖ Determine critical mineral content of placer deposits in different mineral sources.
- ❖ Measure volume and weight percent of critical minerals in different placer deposit types.
- ❖ Research engineering technologies for efficient and environmentally sensitive critical mineral separation.
- ❖ Research metallurgical technologies for efficient and environmentally sensitive critical element extraction from critical minerals.
- ❖ Delineate environmental benefit and risk factors of critical mineral extraction.
- ❖ Evaluate practical and economic feasibility of extracting critical element byproducts and coproducts from legacy and active placer operations.



Information Desired as Direct Outcome of Testing Program

- ❖ Mineral Separation
- ❖ Mineral Identification
- ❖ Metallurgical Extraction from Value Minerals

Placer Deposits in Alaska and Planned Study Areas - 2023



Year 2023

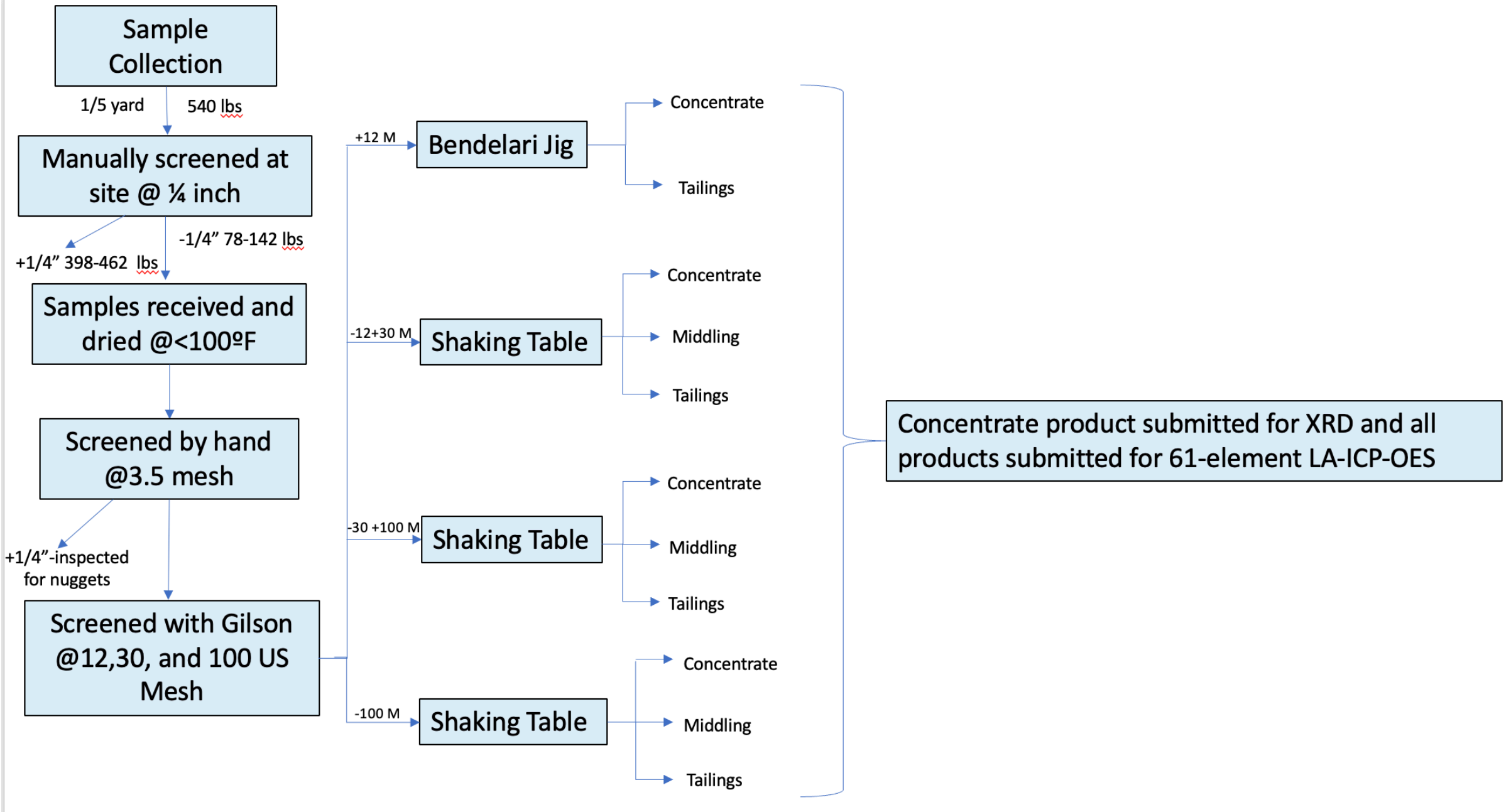
Location	Number of Samples	Target Elements
Hog River	5	Au, Mo, REE, Th
Goodnews Bay	4	Au, PGE, Cr
Western Seward Peninsula	5	Au, Sn, W
Valdez Creek	2	Au, Te, PGE, Ni, Co
40-Mile District	5	Au, W, Sn, Hg
Cache Creek, Talkeetna Mountains	1	Au, Te, Bi, Sb, PGE
Resurrection Creek, Hope District	1	Au



But – lets go back to 2022, Year 1 sampling events & accomplishments

- ❖ **2022 Study Team**, Isabelle Harris, PhD candidate and advisors Elizabeth Holley, Econ. Geol. Prof, Erik Spiller, Research Prof Kroll Institute at Mines, and Sue Karl USGS-Alaska. Note, no literature exists defining protocols for separating CM from placer tailings.
- ❖ **Accomplishments on 2022 samples:**
 - 8 samples of placer tailings (1/5 Yd³ each) field collected from Flat, Alaska in 2022:
 - » Each sample (8) screened in field at ¼-inch and the minus size material shipped to Mines particulate separation laboratories
 - » As-received <1/4-inch samples further screened into four size fractions: -1/4"+12M, -12+30M, -30+100M & -100M (US Mesh)
 - » The four size fractions from each sample were concentrated by gravity separation to produce heavy, middling, and light specific gravity products
 - » In-progress, gravity separation products were and are being submitted for chemistry at USGS contract labs for each of the 8 samples. Each sample is getting the full MRI analytical package including WDXRF, MS-ICP-61 element Na-fusion, Au-PGE fire assay + ICP, Hg, F, S, C, etc.
 - » Selected samples submitted for XRD and MS-ICP at Hazen Research
 - Tescan automated mineralogical-liberation analysis and mineral identification will be performed on each sample. The purpose is for chemistry and mineralogy to determine in which size fraction the critical minerals exist. Isabelle will be working with Erin Marsh to compare impurities in gold in samples to gold in samples retrieved from GMC warehouse from local Golden Horn mine (1 km upstream from samples 7 and 8.) The goal is to understand the source mineral systems that yielded the suite of critical minerals found.
 - Fan Yang is a Spiller postdoc in chemical metallurgy investigating environmentally sensitive extraction protocols for beneficiation of critical elements from critical minerals, and applied to this project
 - Owing to a personal conflict for my son's wedding, Erik Spiller will be presenting project status for me at the Alaska Minerals Stakeholders workshop September 12-14 in Fairbanks. I have provided PowerPoint slides and photos for Isabelle and Erik to complement with Isabelle's lab flowsheet protocol development for Erik's presentation.





Year 2022: Flat, Alaska -

Sample		As-Received	<1/4-inch fraction
ID	Location	Dry Weight (lbs)	wt. % of tailings - yd ³ (1,2)
22SK001	Prince Creek	130.3	36.2
22SK002	Happy Creek	134.36	37.3
22SK003	Upper Chicken East	127.65	35.5
22SK004	Lower Chicken Creek	97.14	27.0
22SK005	Upper Flat Creek	118.04	32.8
22SK006	Lower Flat Creek	78.56	21.8
22SK007	Otter Creek	135.12	37.5
22SK008	School House	142.32	39.5

❖ Target critical & value elements:

- Gold
- Tungsten
- Boron
- Bismuth
- Lead

❖ Will be a function of recovery and market value of metal

(1): Weight percentage of <1/4 inch gravel in a cubic yard
 (2): Estimate of 100 lb of gravel per cubic ft, from Taggart, A.F., 1945, Handbook of Mineral Dressing: Ores and Industrial Minerals, John Wiley and Sons, 3-92 p.

Two Selected 2022 Samples, Descriptive Weight Distributions

Sample 1, Prince Creek

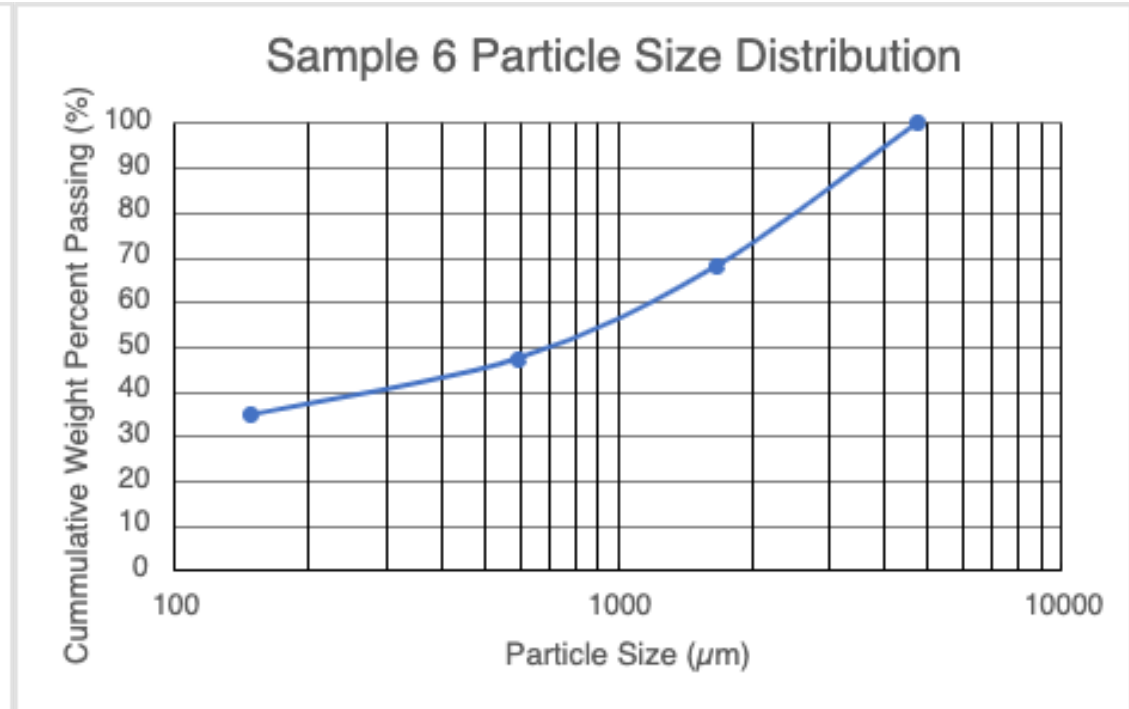
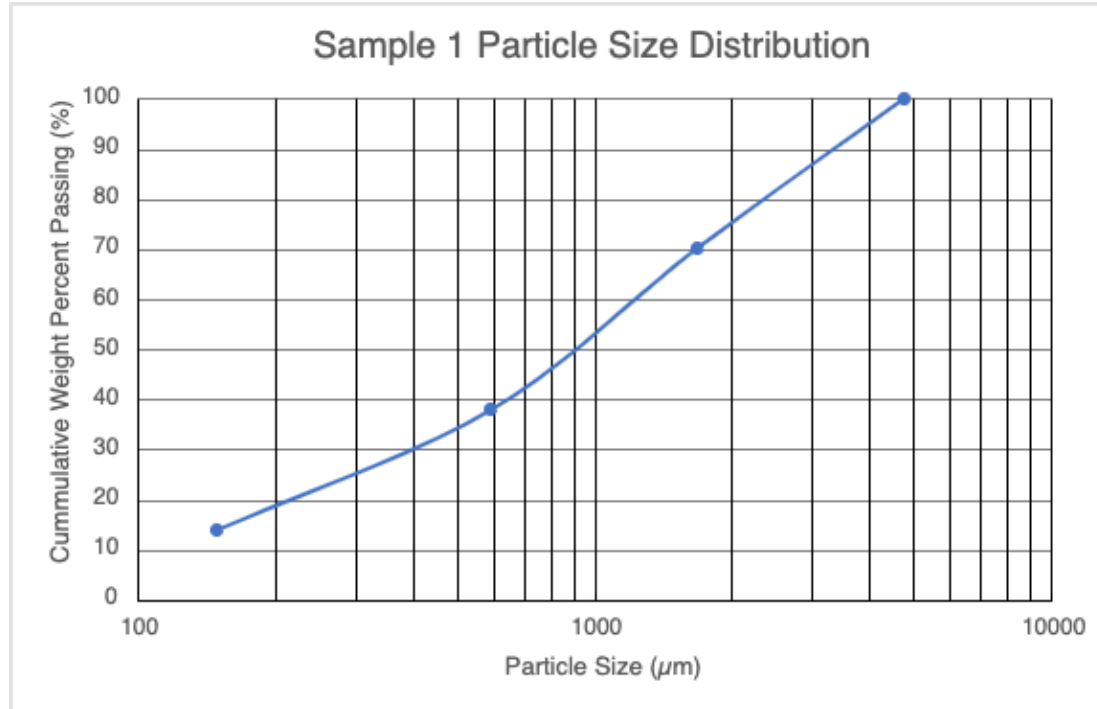
Sample 6, Lower Flat

Sample ID	Product	Weight (lb)	wt% of 1 yd ³
1	-100 mesh (US) Gravity Tailings	13.46	2.49%
1	-100 Gravity Middling	NA	NA
1	-100 Gravity Concentrate	2.64	0.49%
1	-30+100 Gravity Tailings	5.86	1.09%
1	-30+100 Gravity Middling	17.76	3.29%
1	-30+100 Gravity Concentrate	1.57	0.29%
1	-12+30 Gravity Tailings	29.57	5.48%
1	-12+30 Gravity Middling	4.92	0.91%
1	-12+30 Gravity Concentrate	15.58	2.89%
1	+12 Gravity Tailings	26.15	4.84%
1	+12 Gravity Concentrate	11.53	2.14%

Sample ID	Product	Weight (lb)	wt% of 1 yd ³
6	-100 Gravity Tailings	3.3	0.61%
6	-100 Gravity Middling	15.74	2.91%
6	-100 Gravity Concentrate	0.16	0.03%
6	-30+100 Gravity Tailings	0.08	0.01%
6	-30+100 Gravity Middling	8.64	1.60%
6	-30+100 Gravity Concentrate	0.37	0.07%
6	-12+30 Gravity Tailings	1.82	0.34%
6	-12+30 Gravity Middling	8.92	1.65%
6	-12+30 Gravity Concentrate	6.13	1.14%
6	+12 Gravity Tailings	14.84	2.75%
6	+12 Gravity Concentrate	9.51	1.76%

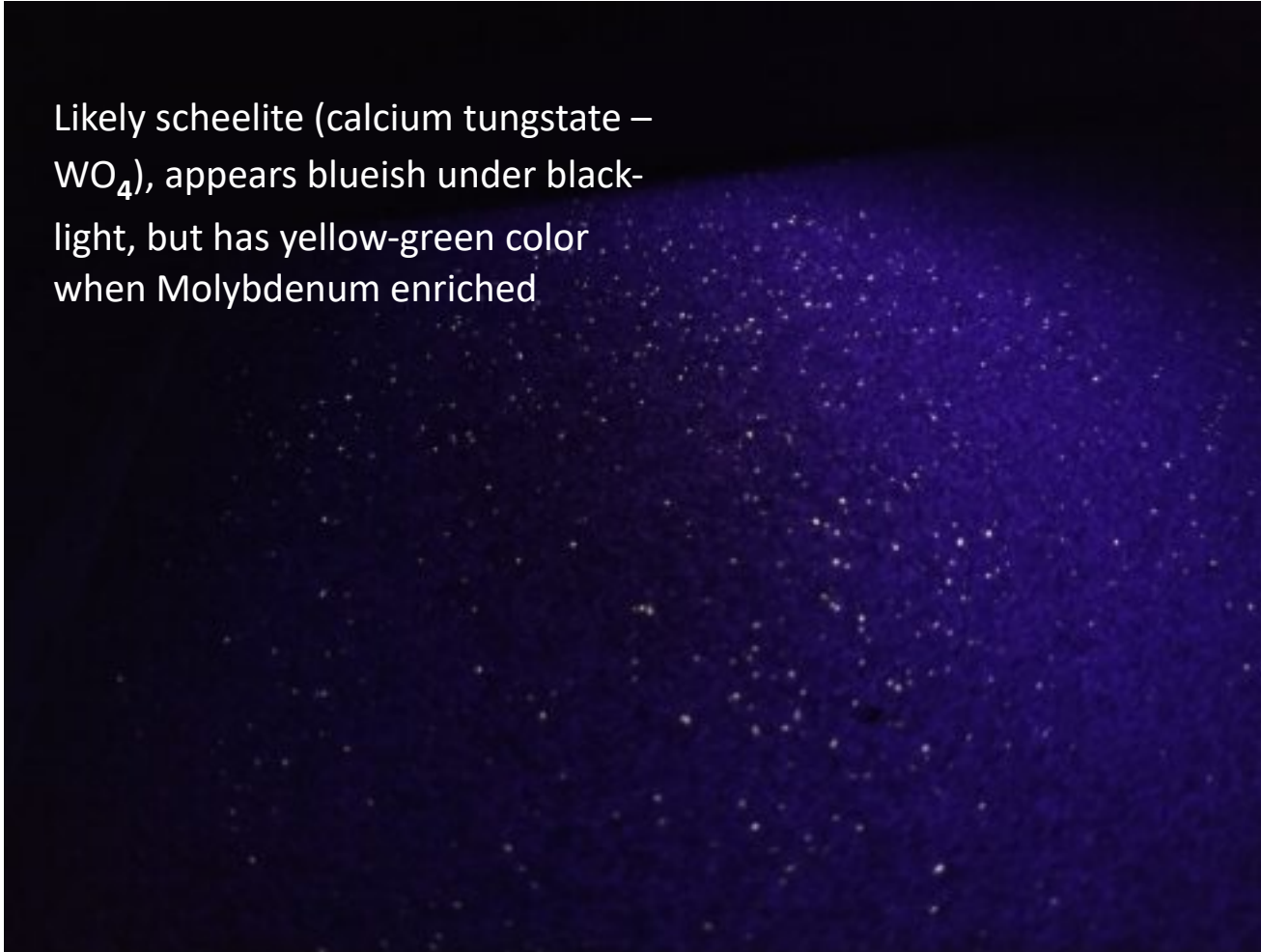
Particle Size Distribution of Prince Creek and Lower Flat Creek Samples

The particle size distribution of two selected 2022 Tailings samples were similar showing P_{80} values of near 1150 microns (nominally 14 US Mesh)

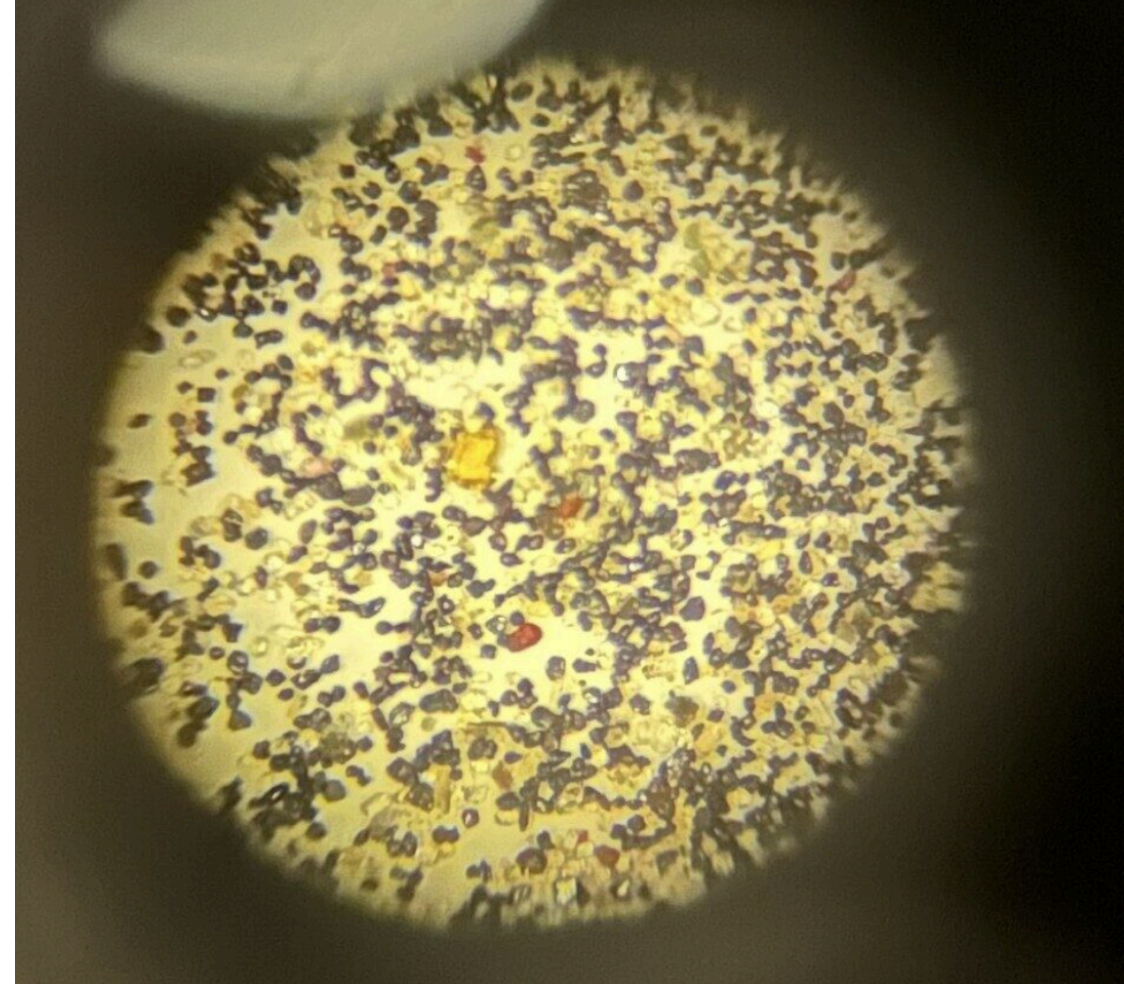


Fluorescent Minerals and Gold – Exciting Observations 2022

Likely scheelite (calcium tungstate – WO_4), appears blueish under black-light, but has yellow-green color when Molybdenum enriched



-100 mesh, Gravity Concentrate under black-light



-100 mesh, Visible Free Gold in Gravity Concentrate

LA-ICP-MS Results, Selected Products - 2022

Gravity Concentrate produced on -100M feed	Sn (Tin) , Oz/Ton	W (Tungsten) Oz/Ton
1-Prince Creek	< 0.02	1.13
2- Lower Flat Creek	0.03	11.1 (312 g/ton)

Note: XRD detection Limit is 2-5%



XRD Results, Selected Products - 2022

The -100M fraction of each as-received 2022 sample was gravity concentrated and the concentrate analyzed for major mineral presence with a detection limit near 2.5 wt.%. No value minerals were identified.

Table 2. XRD Results

Phase ID	Chemical Composition	Presence							
		23H02523 1	23H02523 2	23H02523 3	23H02523 4	23H02523 5	23H02523 6	23H02523 7	23H02523 8
Quartz	SiO ₂	Minor	Minor	Minor	Minor	Major	Major	Major	Major
Mica (Biotite/Muscovite)	K(Mg,Fe) ₃ [AlSi ₃ O ₁₀ (OH,F) ₂]	Trace	Trace	Trace	Minor	Minor	Minor	Minor	Minor
Talc	Mg ₃ Si ₄ O ₁₀ (OH) ₂	Trace	Minor	Minor	nd	Trace	Trace	Trace	nd
Amphibole (Actinolite)	Ca ₂ (Mg,Fe) ₅ Si ₈ O ₂₂ (OH) ₂	Major	Major	Major	Minor	Minor	Trace	Trace	Trace
Chlorite	(Mg,Fe) ₅ Al(Si ₃ Al)O ₁₀ (OH) ₈	Trace	Trace	Trace	Minor	Minor	Minor	Minor	Major
Orthoclase (Microcline)	KAlSi ₃ O ₈	Major	Minor	Major	Major	Minor	Minor	Minor	Major
Amphibole (Anthophyllite)	Mg ₇ Si ₈ O ₂₂ (OH) ₂	Minor	Minor	Minor	nd	nd	nd	nd	nd
Plagioclase	(Na,Ca)(Si,Al) ₄ O ₈	Major	Major	Dominant	Dominant	Major	Major	Major	Major
Dolomite	CaMg(CO ₃) ₂	Trace	Trace	Trace	nd	Trace	Trace	Trace	nd
Kaolinite	Al ₂ Si ₂ O ₅ (OH) ₄	nd	nd	nd	nd	nd	Minor	Minor	Minor
Augite	(Ca,Na)(Mg,Fe,Al,Ti)(Si,Al) ₂ O ₆	Minor	Minor	Minor	Trace	Minor	Trace	Trace	nd

Note: Dominant indicates >50 mass%, Major indicates >10 mass%, Minor indicates <10 mass%, trace indicates <3 mass%

nd=not-detected

Note: XRD detection Limit is 2-5%

Program Continues 2023

- ❖ **FY23 sampling progress:** collaboration with BLM and placer mine operators. TAAs are tracking with mine operators/claim owners. Best-producing placer deposits in different primary mineral districts in Alaska were selected for sampling. The premise is that only the gold was ever produced, and all the byproduct critical minerals should still be in the tailings. Checking back with Isabelle, Erik Spiller, and placer operators, the conclusion is to stick with a minimum sample size of 1/5 yard for obtaining a representative sample of the tailings. As with the Flat pilot study, cobbles of each rock type in the tailings were estimated for relative abundance and sampled for polished section and chemical analysis to identify sources of the critical minerals in the tailings.



Program Continues in 2023, Properties Sampled (page 1/2)

- ❖ Hog River: Kevin Greenfield and Jerry Birch owners, Taiga Mining. 5 samples were collected from 4 different streams in their claim block. On state, not federal claims.
- ❖ Goodnews Bay: Goodnews Bay Mining Company on Salmon River, federal claims. With BLM collected washplant tailings that have not yet been reprocessed (except for Squirrel Ck) after original mining before 1950's. Old wash plant tailings on the east bench are rich in Au and PGE's. The west bench is stacked dredge tailings with huge boulders, also rich but hard to sample by hand. We collected 4 samples:
- ❖ Western Seward Peninsula, in the tin-zinnwaldite granite district, 5 samples, with permission from claim owners and Bering Straits and Wales village native corporation subsurface landholders.



Program Continues in 2023, Properties Sampled (page 2/2)

- ❖ Valdez Creek. Sample partner was Dave Turner, chief geologist for Regeneration (Salmon Gold). Au, Cu, PGEs, nickel, cobalt, cinnabar. We spent a day with John Cioffoletti, property owner, who directed us to
- ❖ 40-Mile district, State and Federal Claims. 5 samples. Many overlapping mineral systems – Au, Te and pathfinders, Hg, PGEs, Ni, Cu, Zn, Pb. All landowners were present and took us to their best sites, just below excavators and wash plants actively working the streams. Our samples will directly indicate what minerals they will encounter this week and next season.
- ❖ Cache Creek, Talkeetna Mountains, sampled by David Turner, Au, PGEs
- ❖ Resurrection Creek, Hope District, sampled by David Turner, Au, Au-pathfinders
- ❖ Total 2023 samples for me to process and analyze chemistry and minerals: 21 placer tailings samples, plus 2 previously unprocessed gravel samples that are currently being mined.



End



Placer Tailings Sampling – Cassiterite Creek



Placer Tailings Sampling – Clear Creek



Placer Tailings Sampling – Clear Creek Unprocessed Gravel



Placer Tailings Sampling – Goodnews Salmon River

