DGGS investigations of gold prospects in the Tok River area, eastern Alaska

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During 2015 and 2016, as part of the Tok River geologic mapping project, geologists with the Alaska Division of Geological & Geophysical Surveys investigated several gold-bearing prospects (fig. 1) with a range of styles, ages, and apparent genetic models. These include a ‘porphyry-type’ gold-copper-silver prospect clearly associated with a Late Cretaceous intrusive stock (Hona prospect); structurally controlled, gold-bearing quartz vein prospects ambiguously associated with dikes of early Tertiary(?) age (including the Low prospect); and gold-bearing quartz-sulfide vein prospects with no known associated intrusive rocks (including the Shalosky prospect).

The Hona prospect is associated with a multiphase hypabyssal intrusive stock (Sicard and others, 2017) emplaced in quartzite and siliceous schist. The stock consists of fine- to medium-grained phaneritic granodiorite intruded by aphanitic granodiorite porphyry, which also forms the matrix of locally developed magmatic breccias.

Mineralization appears to be preferentially hosted within the porphyry phase and adjacent country rocks rather than within the phaneritic granodiorite. It comprises both quartz-sulfide veinlets (sometimes vuggy) and disseminated sulfides; both styles of mineralization occur in the porphyritic intrusion and in the country rock. Total sulfide content ranges from trace to 5 percent. Within the porphyritic intrusion, sulfides include chalcopyrite, pyrrhotite, and local molybdenite. In the country rocks, veinlet and disseminated sulfides include pyrite, pyrrhotite, chalcopyrite, and local arsenopyrite.

Potassic alteration is locally developed near the northern contact of the Hona stock; this occurs as patchy to locally pervasive, very fine-grained secondary biotite in the magmatic breccia, and as local bands of K-feldspar replacement in schistose country rock. Sodic alteration also occurs locally as vein selvages and replacements of schist. Both alteration types are associated with chalcopyrite and gold. More spatially extensive (but poorly mineralized) alteration assemblages include silicification, sericitization, and replacement of mafic minerals by pyrrhotite.

The Hona stock (71-76 Ma; Benowitz and others, 2017) is similar in age to the intrusions (69 Ma), and skarn amphibole (69-72 Ma) at the Peak gold-copper-silver deposit on the Tetlin property, 16 miles to the east (Illig, 2015). Major- and trace-element compositions of the Hona stock and coeval intrusive rocks at Tetlin are closely similar. Other similarities between the Hona prospect and Peak deposit include their economically important elements and sulfide mineralogy. The most prominent difference is that Peak is a distal skarn (Illig, 2015), whereas Hona is hosted by intrusive rocks and adjacent non-calcareous schist.

The Low prospect (fig.1; Rhyolite Resources, 2015) consists of gold ± arsenopyrite mineralization associated with brecciated, veined, faulted, and altered metamorphic rocks proximal to a series of dikes that dip steeply to the west. At least two different types of dikes are present: biotite-bearing mafic dikes and quartz-feldspar porphyry dikes. Both may be either mineralized or barren, and we interpret them to be pre- to syn-mineralization in timing. Alteration at the prospect is dominated by ferroan dolomite and may also include sericite and clay minerals.

Biotite-bearing mafic dikes, such as those found at the Low prospect, are part of a series of mostly northeast-trending, steeply dipping dikes of similar composition mapped by DGGS in the Dry Tok Creek area (Sicard and others, 2017). One such dike yielded an $^{40}Ar/^{39}Ar$ biotite plateau age of 58.4 ± 0.2 Ma (Benowitz and others, 2017), thus we interpret gold mineralization at the Low prospect to be late Paleocene to Eocene in age.

The Shalosky prospect is a 5- to 35-meters-thick, shear-type quartz vein (Rhyolite Resources, 2015). Gold mineralization is accompanied by arsenopyrite, pyrite, and locally stibnite; alteration includes silicification, sericitization of metamorphic micas, and albitization. The dip of the vein is sub-vertical and the strike is east-northeast, parallel to the trend of faults mapped in Tok River area.

The age of mineralization at Shalosky is loosely constrained by partially reset metamorphic white mica from a wall rock inclusion within the vein. The lowest temperature fraction of the $^{40}Ar/^{39}Ar$ spectrum yielded an age of 83 Ma (Benowitz and others, 2017), which we interpret to be the maximum age of mineralization.

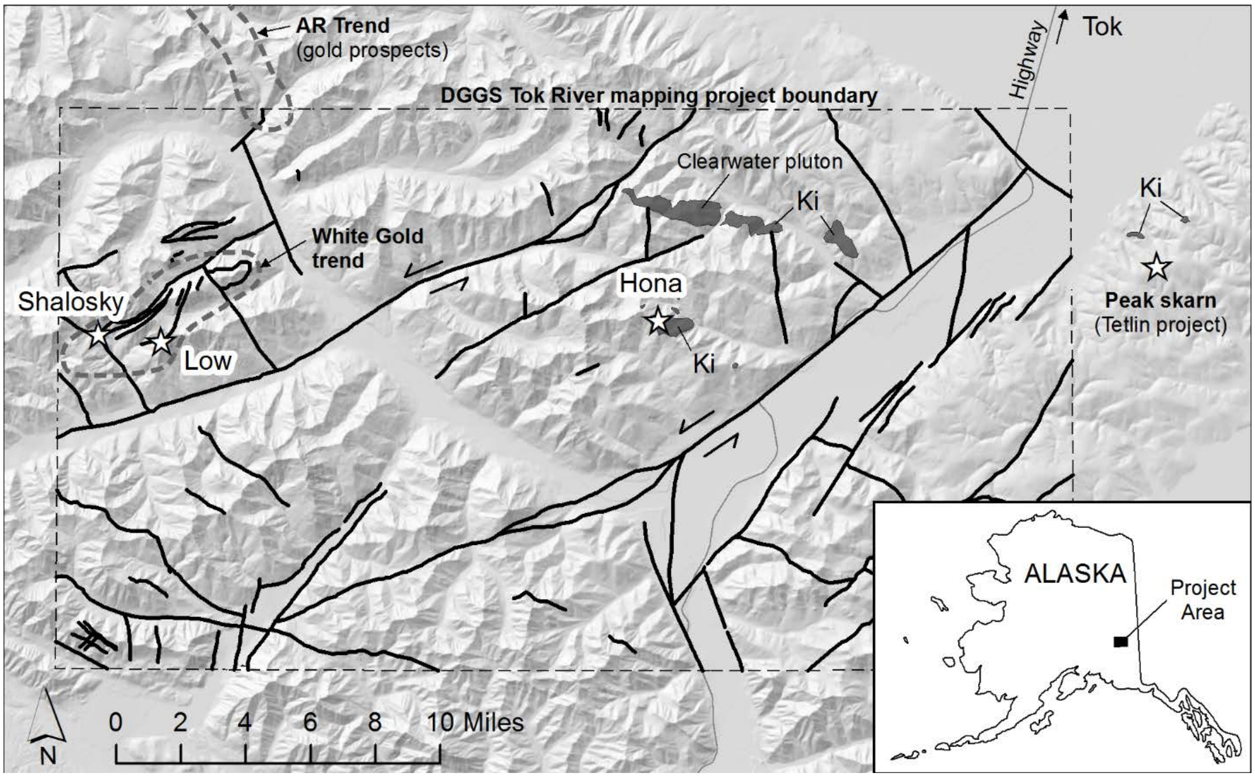

Figure 1. Overview of gold-bearing prospects in the DGGS Tok River map area. White stars indicate prospects mentioned in this abstract. Heavy black lines are faults. Late Cretaceous intrusions (labeled "Ki") are shown in dark gray.

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Benowitz, J.A., Sicard, K.R., Naibert, T.J., and Layer, P.W., 2017, $^{40}Ar/^{39}Ar$ data from the Tok River area, Tanacross A-5 and A-6 quadrangles and adjoining areas, eastern Alaska Range: Alaska Division of Geological & Geophysical Surveys Raw Data File 2017-5, 26 p. http://doi.org/10.14509/29727

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Sicard, K.R., Naibert, T.J., Hubbard, T.D., Twelker, Evan, Wypych, Alicja, Werdon, M.B., Willingham, A.L., Gillis, R.J., Lande, L.L., and Newberry, R.J., 2017, Geologic map of the Tok River area, Tanacross A-5 and A-6 quadrangles, eastern Alaska Range, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2017-3, 15 p., 1 sheet, scale 1:63,360. http://doi.org/10.14509/29722

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Alaska Division of Geological & Geophysical Surveys

Alaska Miners Association
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- Rhyolite Resources: Richard Graham
- Dave Szumigala
- John Hoppe
- John and Jill Rusyniak at Log Cabin Wilderness Lodge
- Soloy Helicopters: Sam Gawith, Frank Ross

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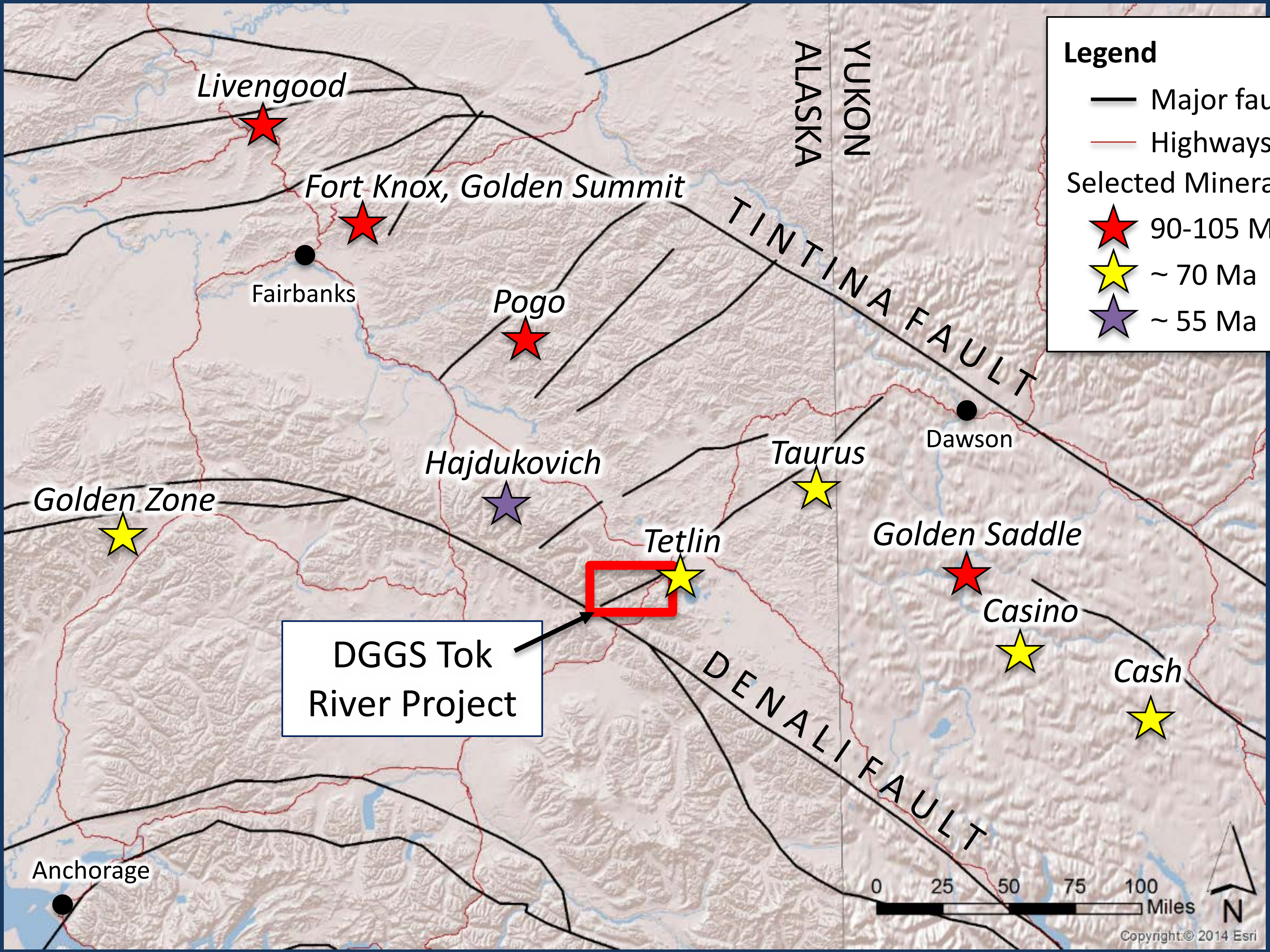
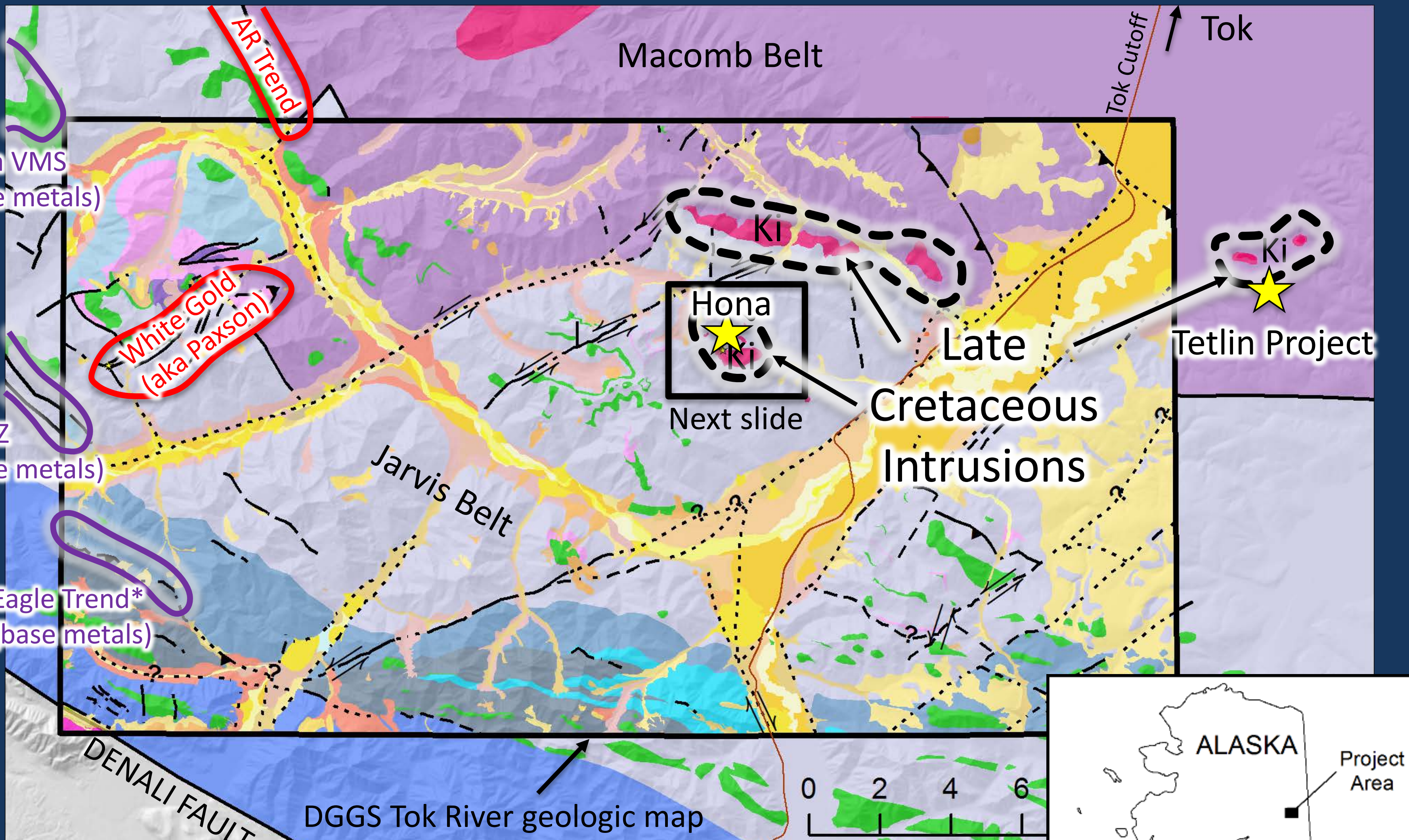
Project location and nearby deposits



Faults from Colpron and Nelson, 2011
Base DEM from ESRI
Deposit locations from DGGS and Yukon databases

How do Tok River area gold prospects fit into this picture?

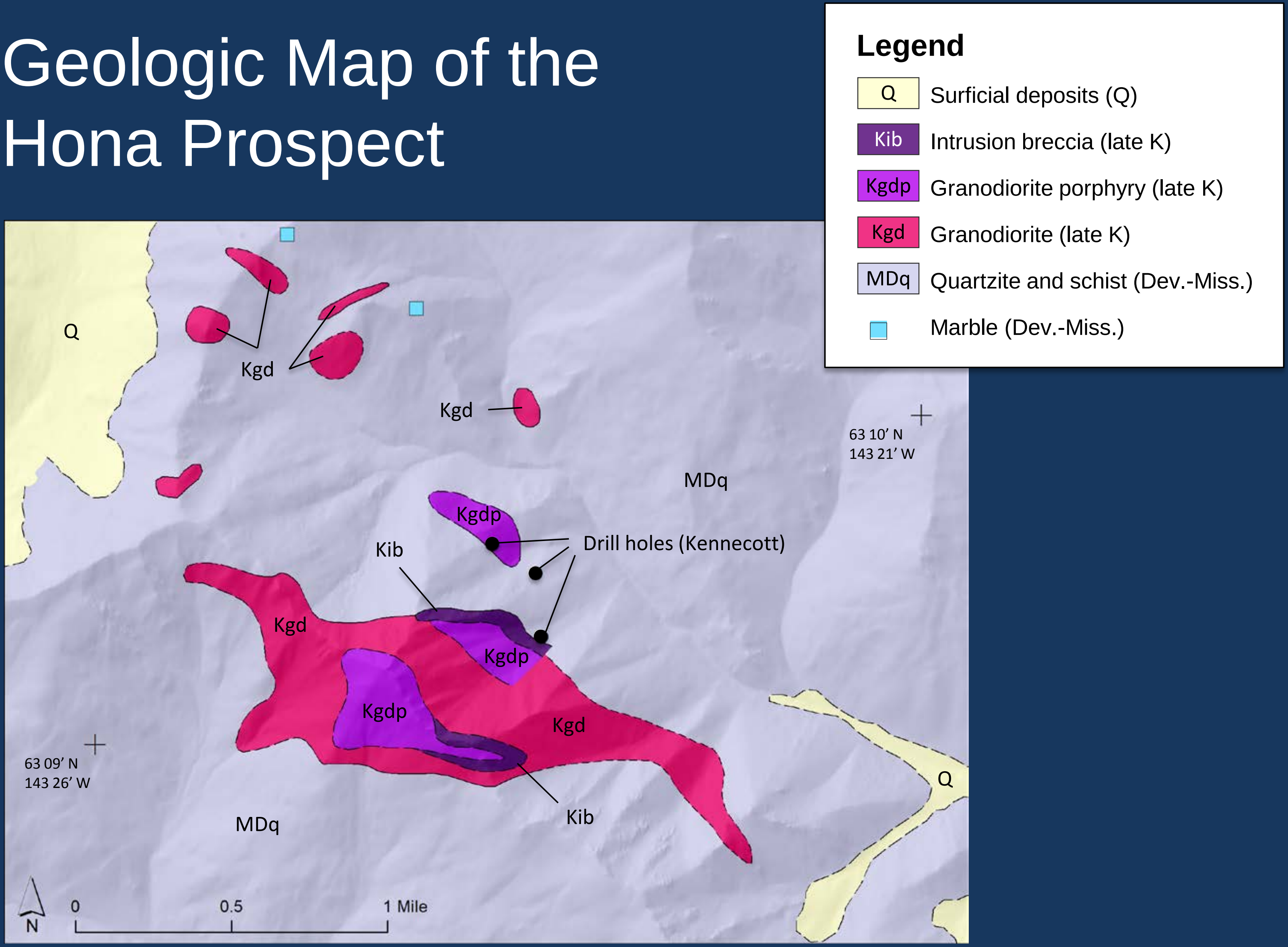
Tok River geology and prospects



DGGS Tok River map (Sicard and others, 2017); surroundings after Wilson and others (2015) and Illig (2015)

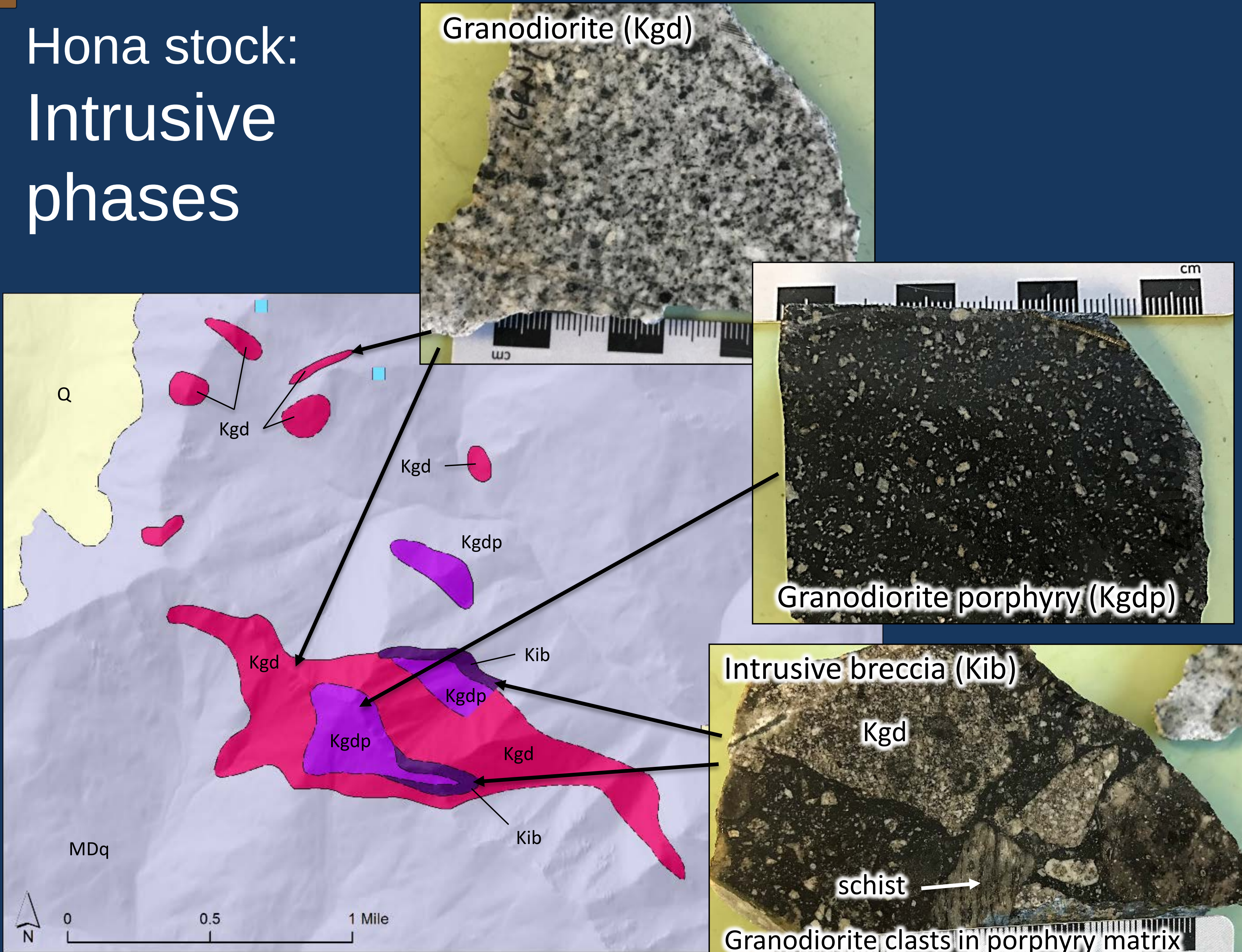
* The **Eagle Trend** was discussed in a previous presentation to the AMA (Newberry and Twelker, 2016)

Geologic Map of the Hona Prospect



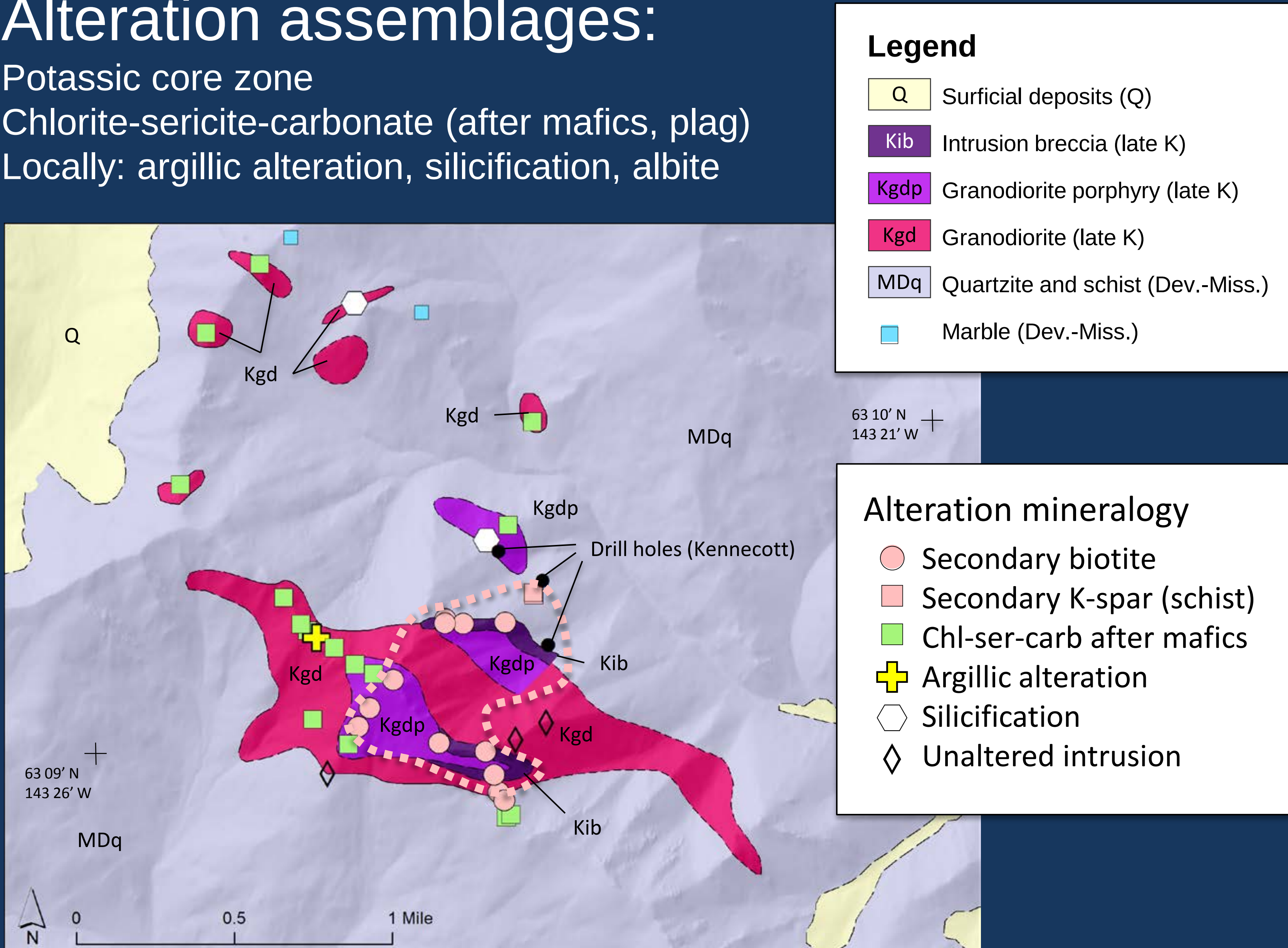
Draft 1:25,000-scale geologic map of the Hona prospect by DGGS

Hona stock: Intrusive phases



Alteration assemblages:

Potassic core zone
Chlorite-sericite-carbonate (after mafics, plag)
Locally: argillic alteration, silicification, albite

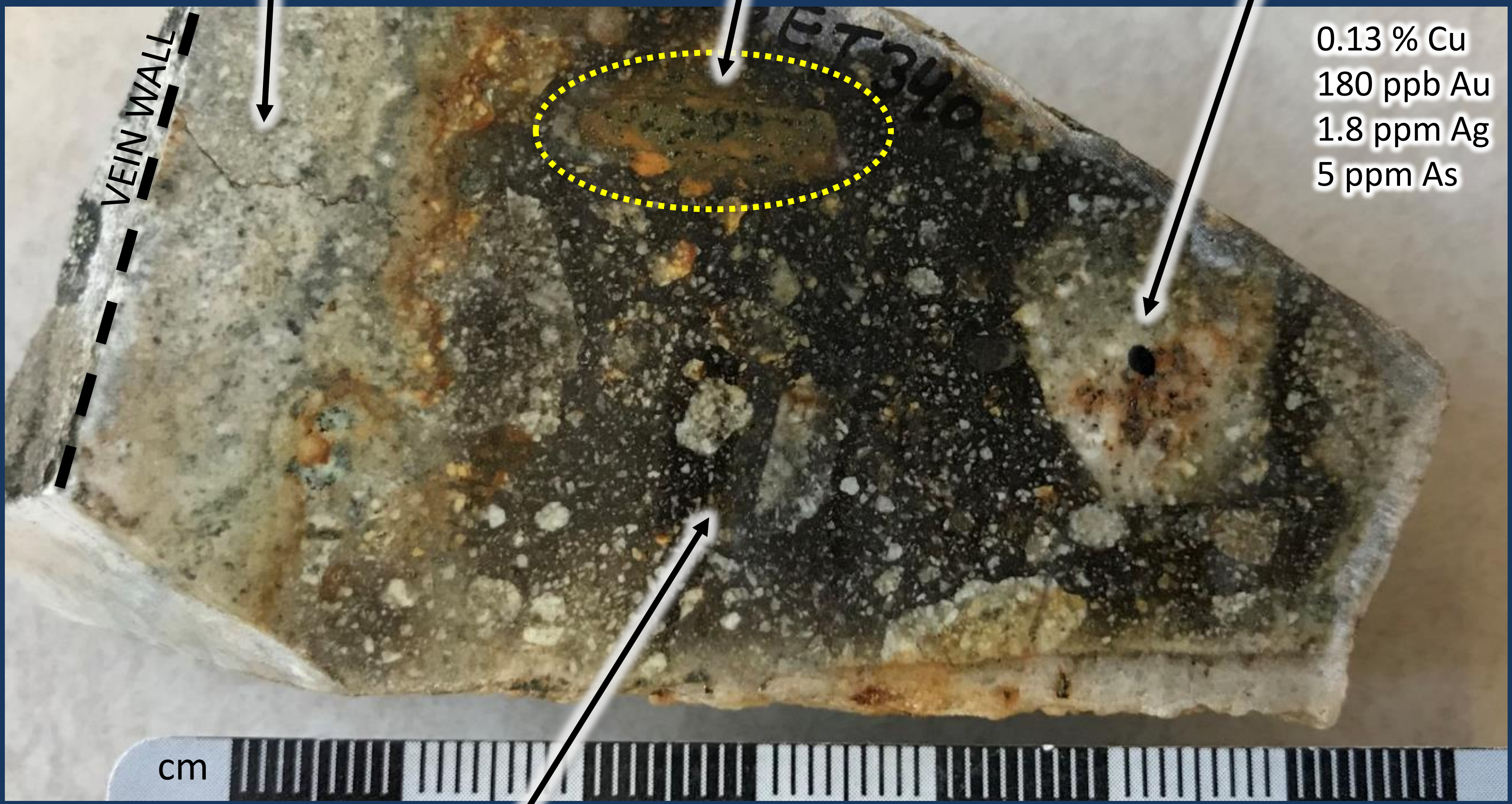


Potassic alteration of intrusion breccia

Vein selvage (sodic alteration)
5.5 % Na_2O, 1.7 % K_2O

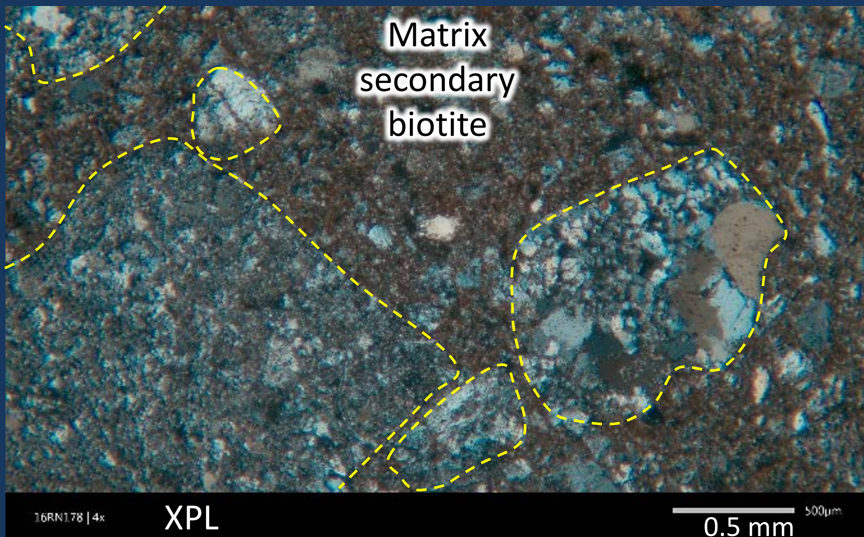
Chalcopyrite-mineralized schist

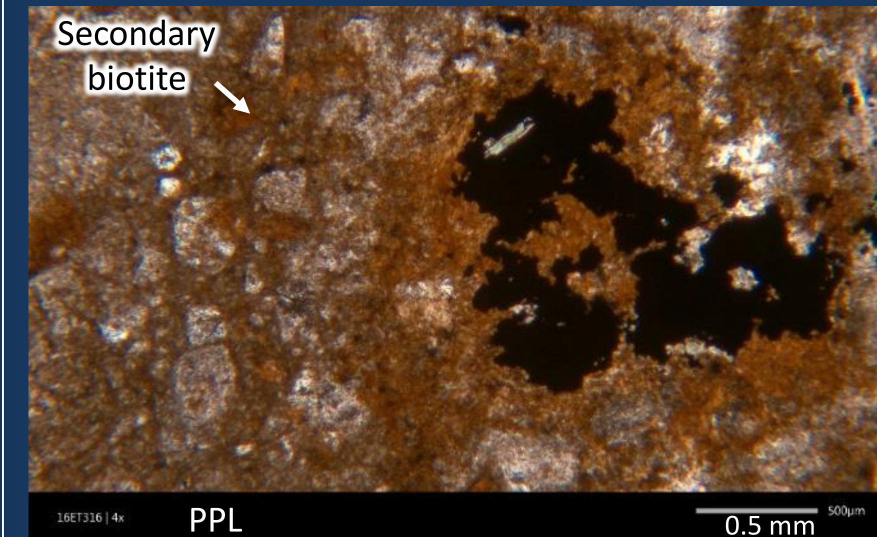
Potassic alt'd clast:
11% K_2O, 1.8 % Na_2O

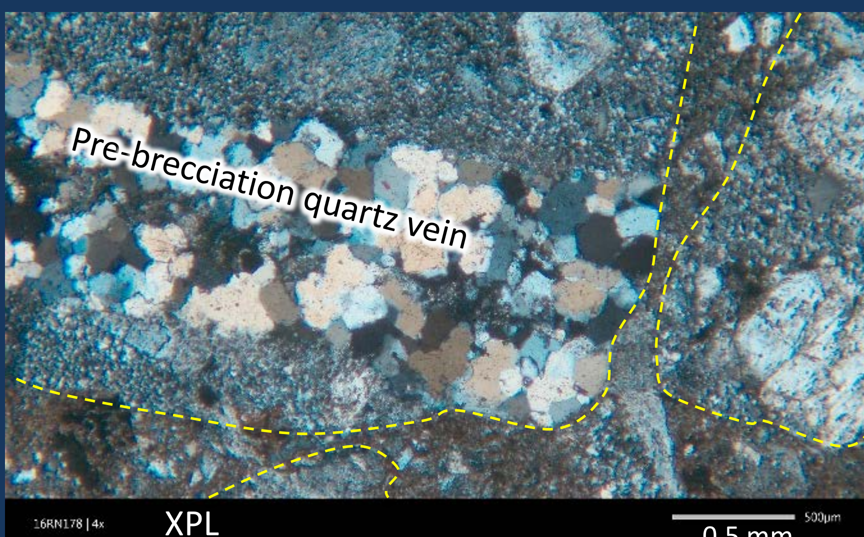


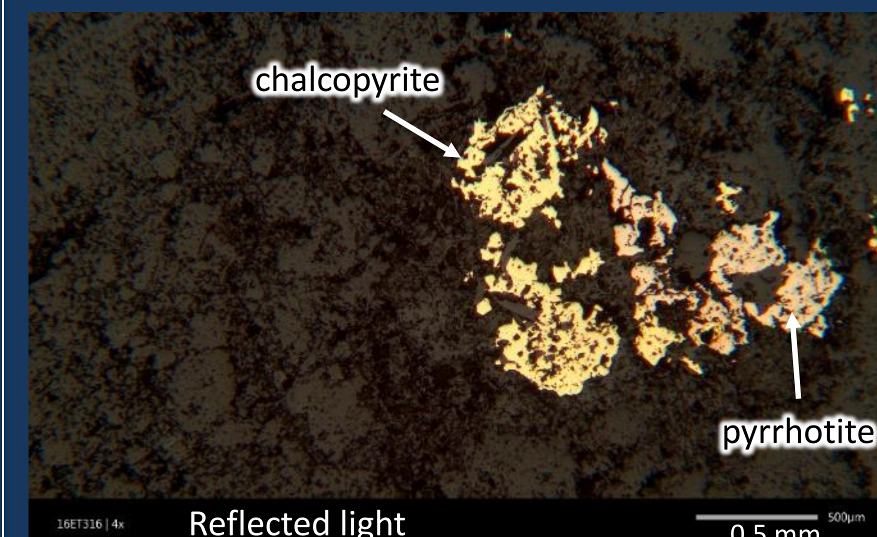
Potassic breccia groundmass:
7.7% K_2O, 2.4 % Na_2O
Disseminated chalcopyrite

Altered breccia in thin section

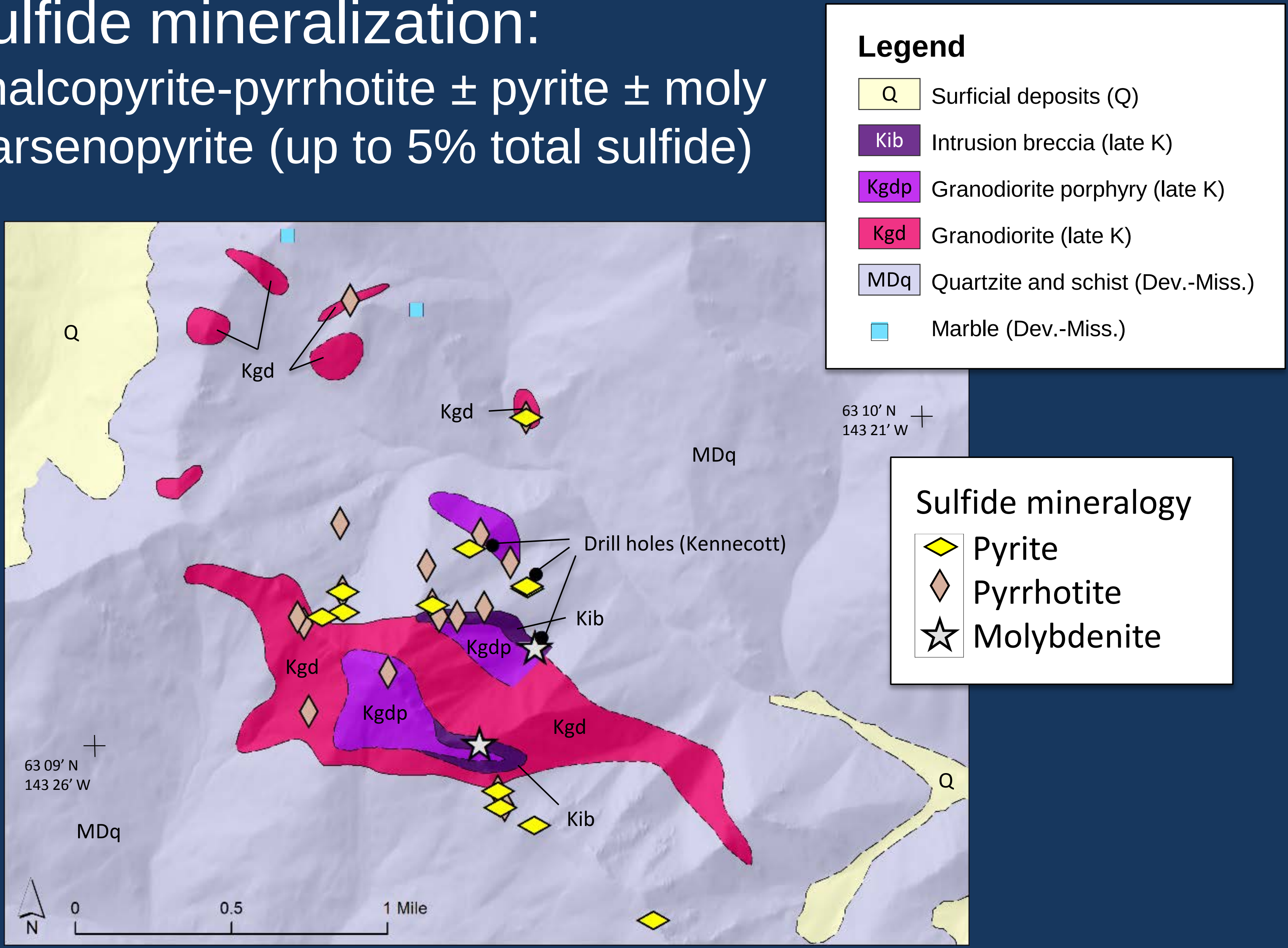






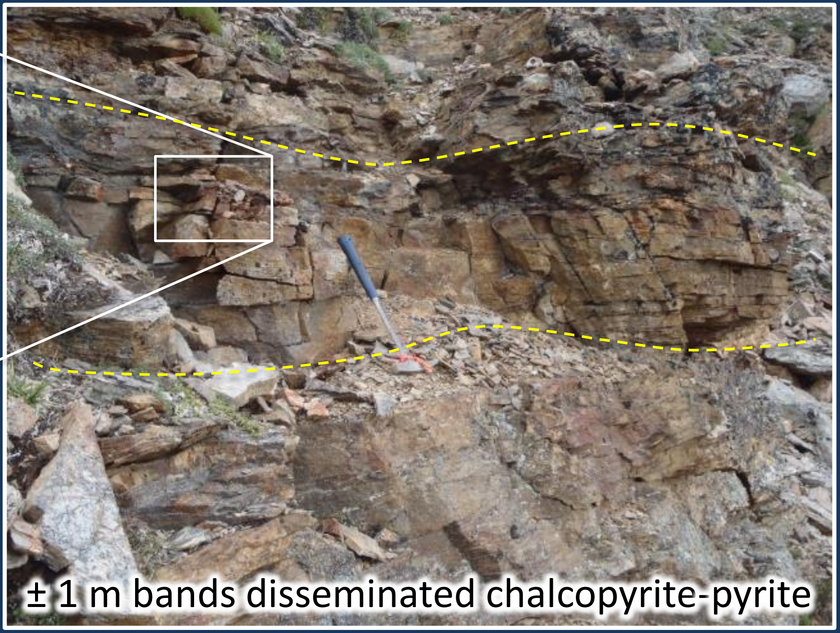


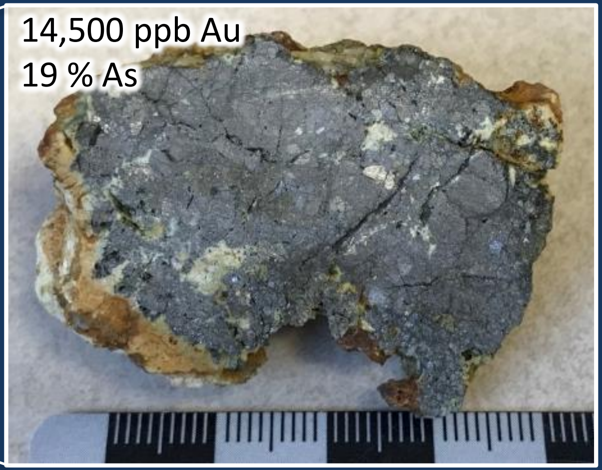
Sulfide mineralization:
Chalcopyrite-pyrrhotite ± pyrite ± moly ± arsenopyrite (up to 5% total sulfide)



Pyrrhotite is widespread; pyrite is restricted to the metamorphic country rock

Mineralization in country rock

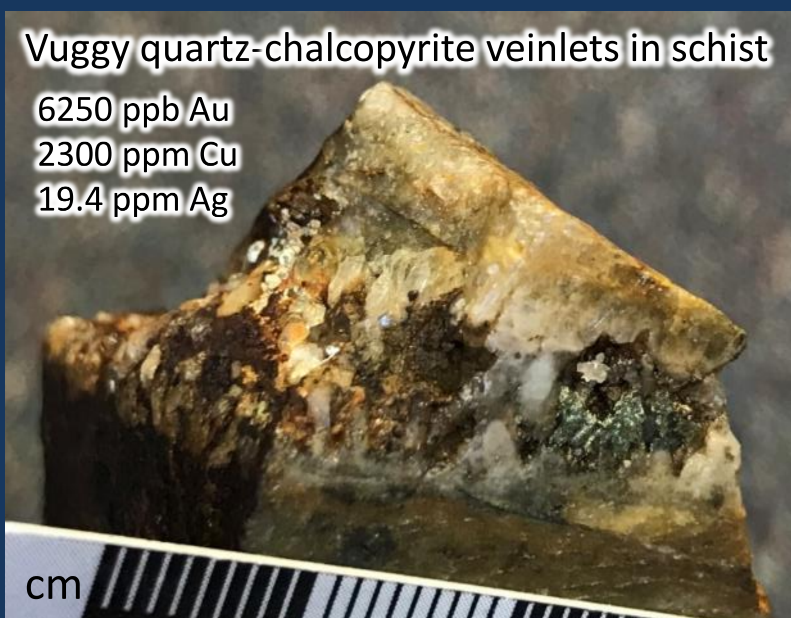




Mineralized veinlets

- Cut both schist and intrusion
- Vuggy or druzy types common
- Selvages: mafics destruction, silicification, albitization
- Late, low pressure overprinting style
- Gold-copper-silver, same as disseminated mineralization

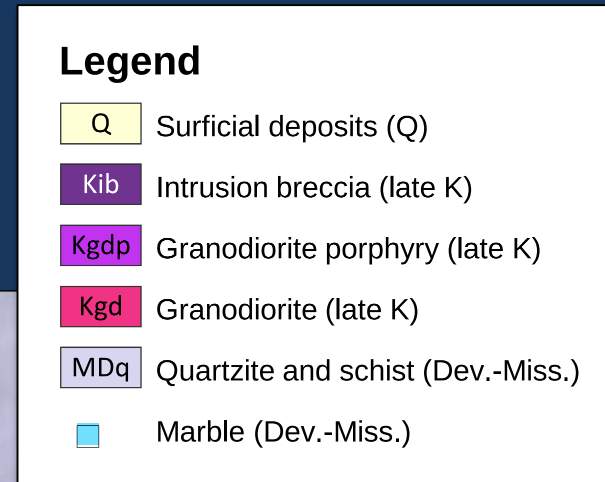

Locally vuggy bleached-selvage veinlets with chalcopyrite, molybdenite

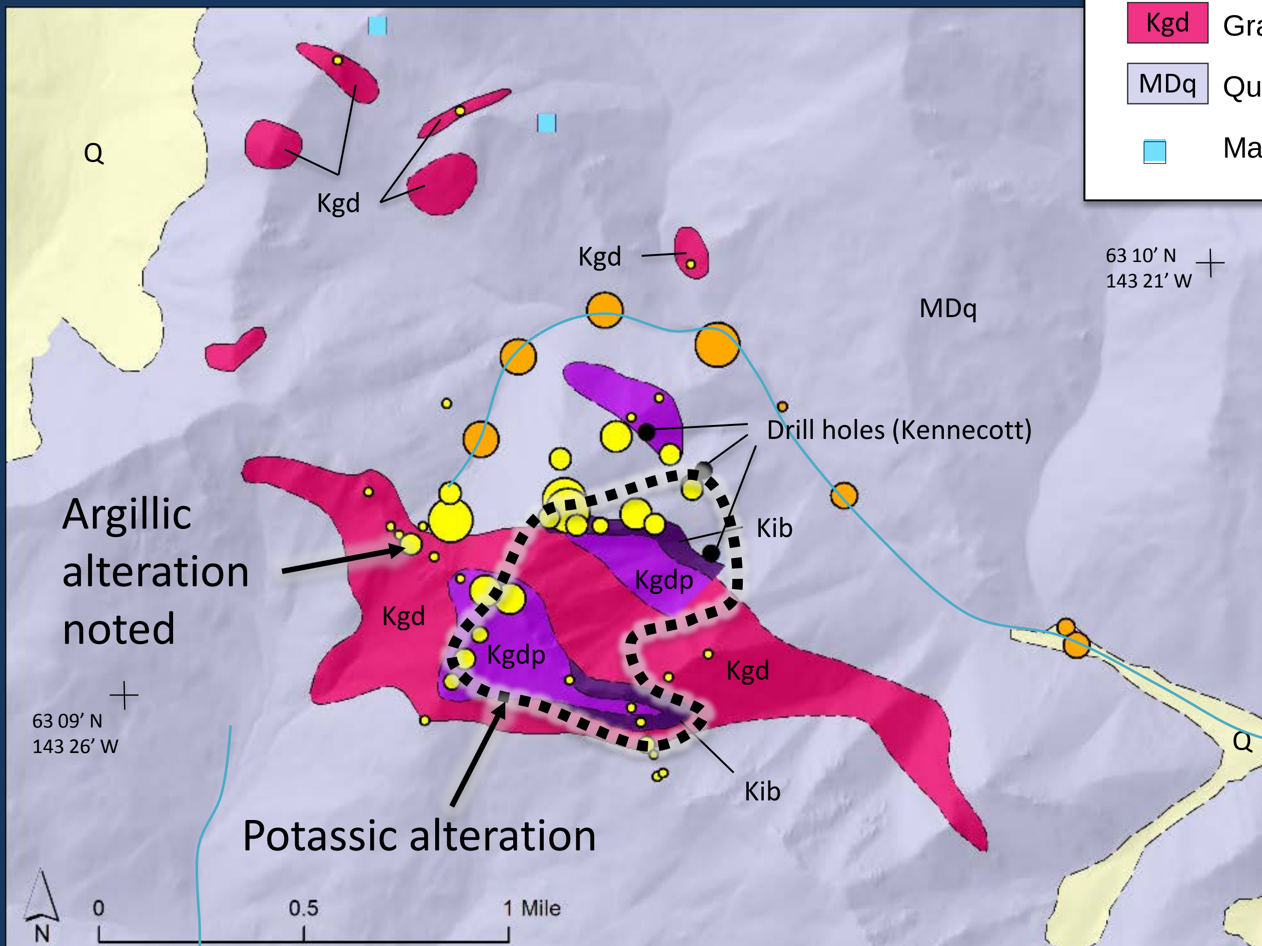


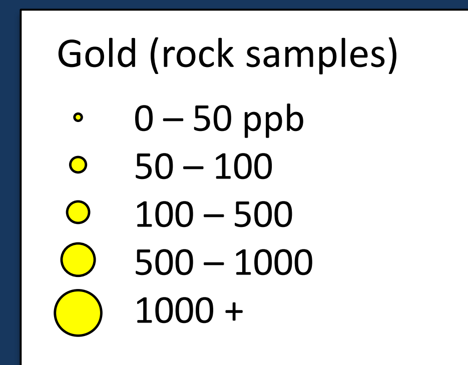
Vuggy quartz-chalcopyrite veinlets in schist

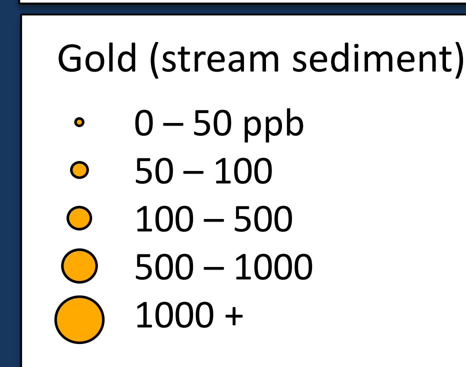

Molybdenite in quartz veinlets (drill core)

Gold Mineralization at Hona



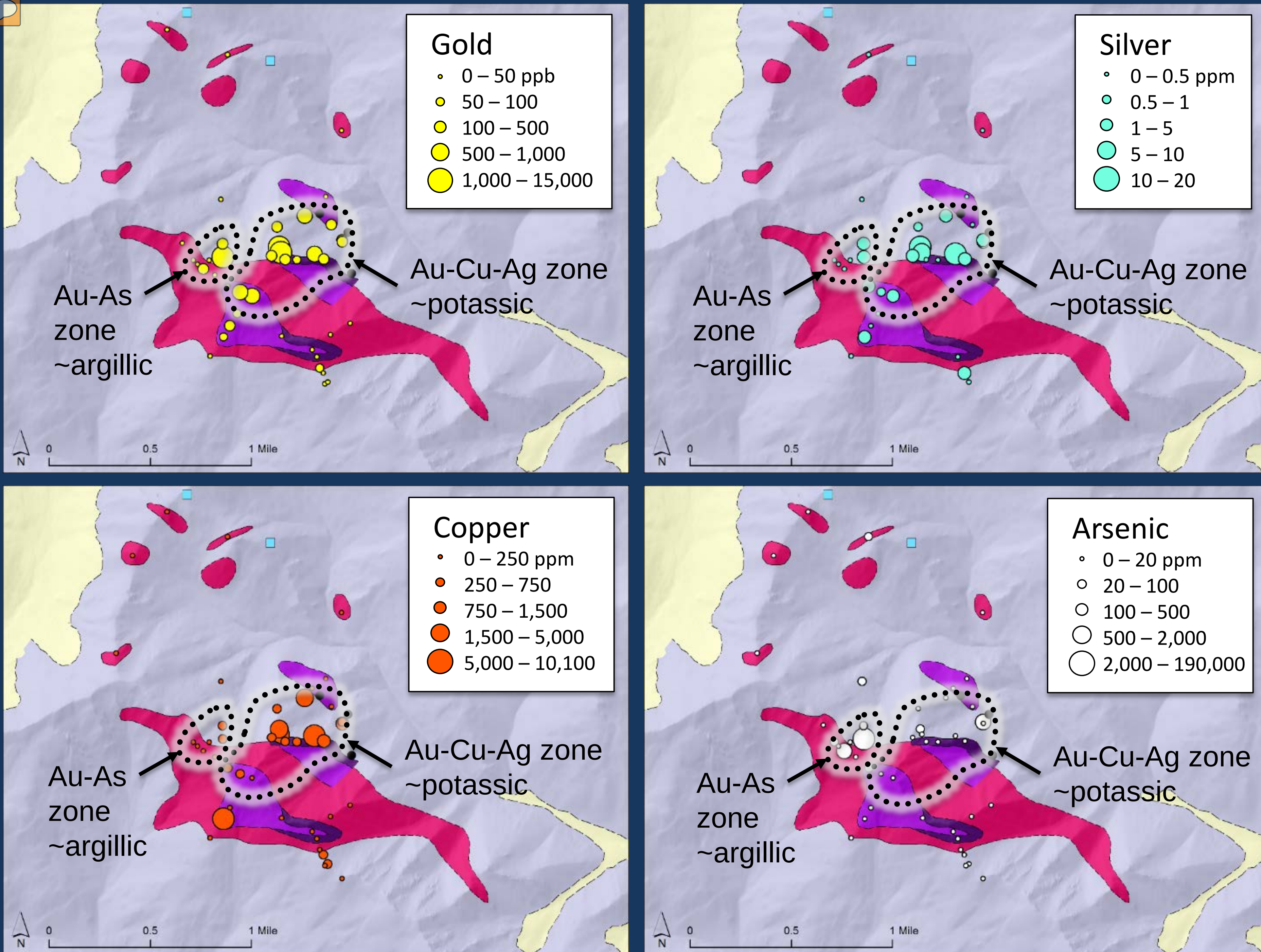




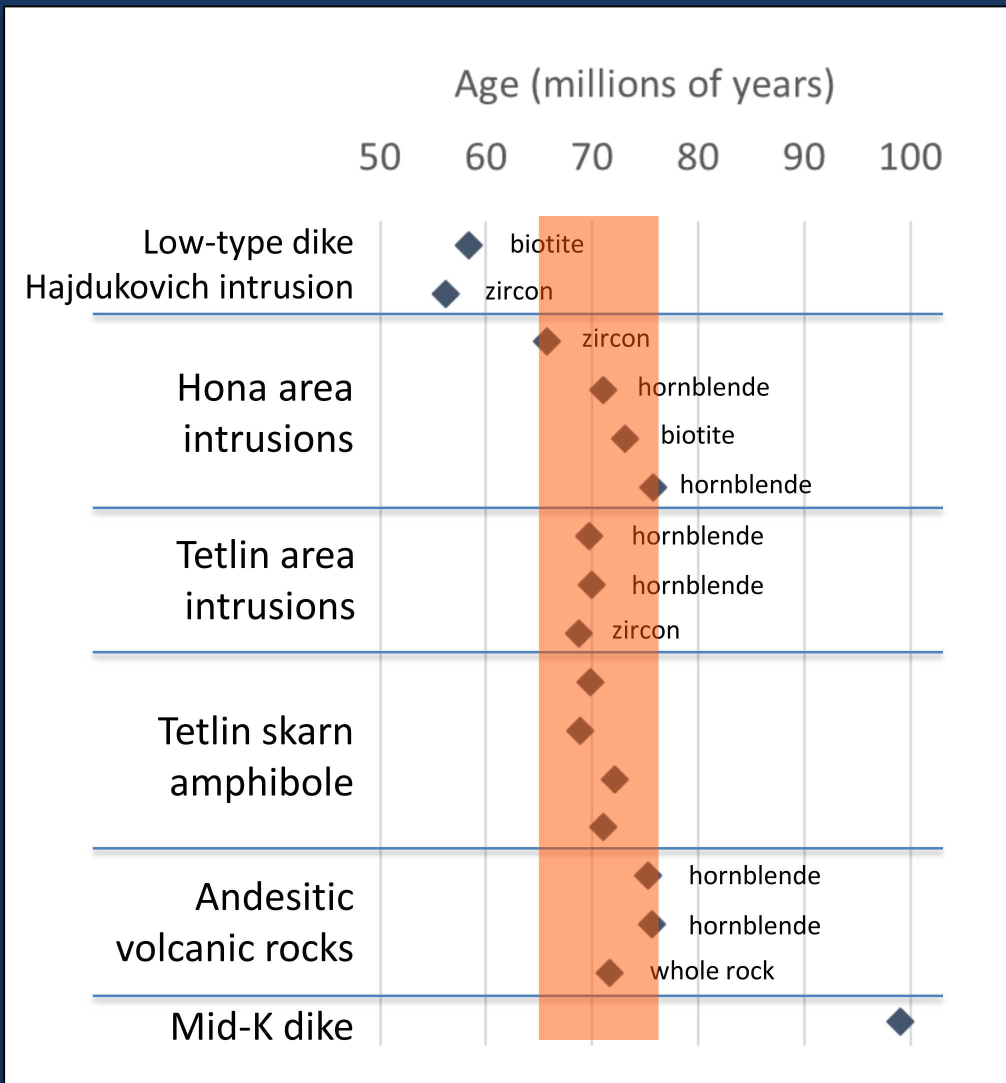


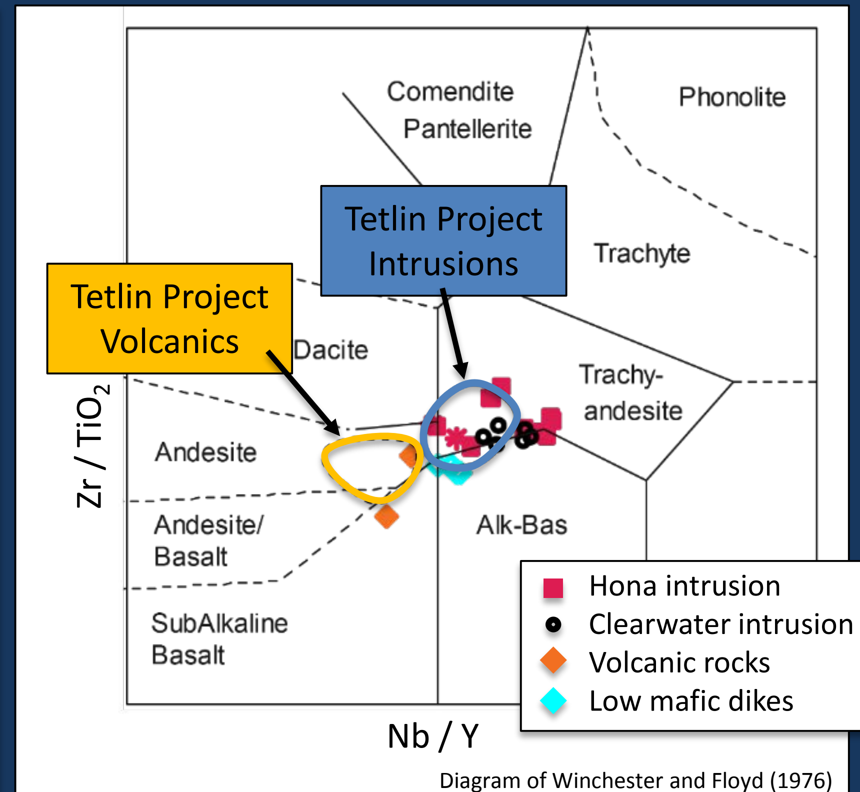
Download the geochemical data at dggs.alaska.gov

Wypych and others (2015, 2016); Naibert and others (2016)


Gold
0 – 50 ppb
50 – 100
100 – 500
500 – 1,000
1,000 – 15,000
Au-As zone ~argillic
Au-Cu-Ag zone ~potassic
0
0.5
1 Mile
N
Silver
0 – 0.5 ppm
0.5 – 1
1 – 5
5 – 10
10 – 20
Au-As zone ~argillic
Au-Cu-Ag zone ~potassic
0
0.5
1 Mile
N
Copper
0 – 250 ppm
250 – 750
750 – 1,500
1,500 – 5,000
5,000 – 10,100
Au-As zone ~argillic
Au-Cu-Ag zone ~potassic
0
0.5
1 Mile
N
Arsenic
0 – 20 ppm
20 – 100
100 – 500
500 – 2,000
2,000 – 190,000
Au-As zone ~argillic
Au-Cu-Ag zone ~potassic
0
0.5
1 Mile
N

Similarities between Hona and Tetlin



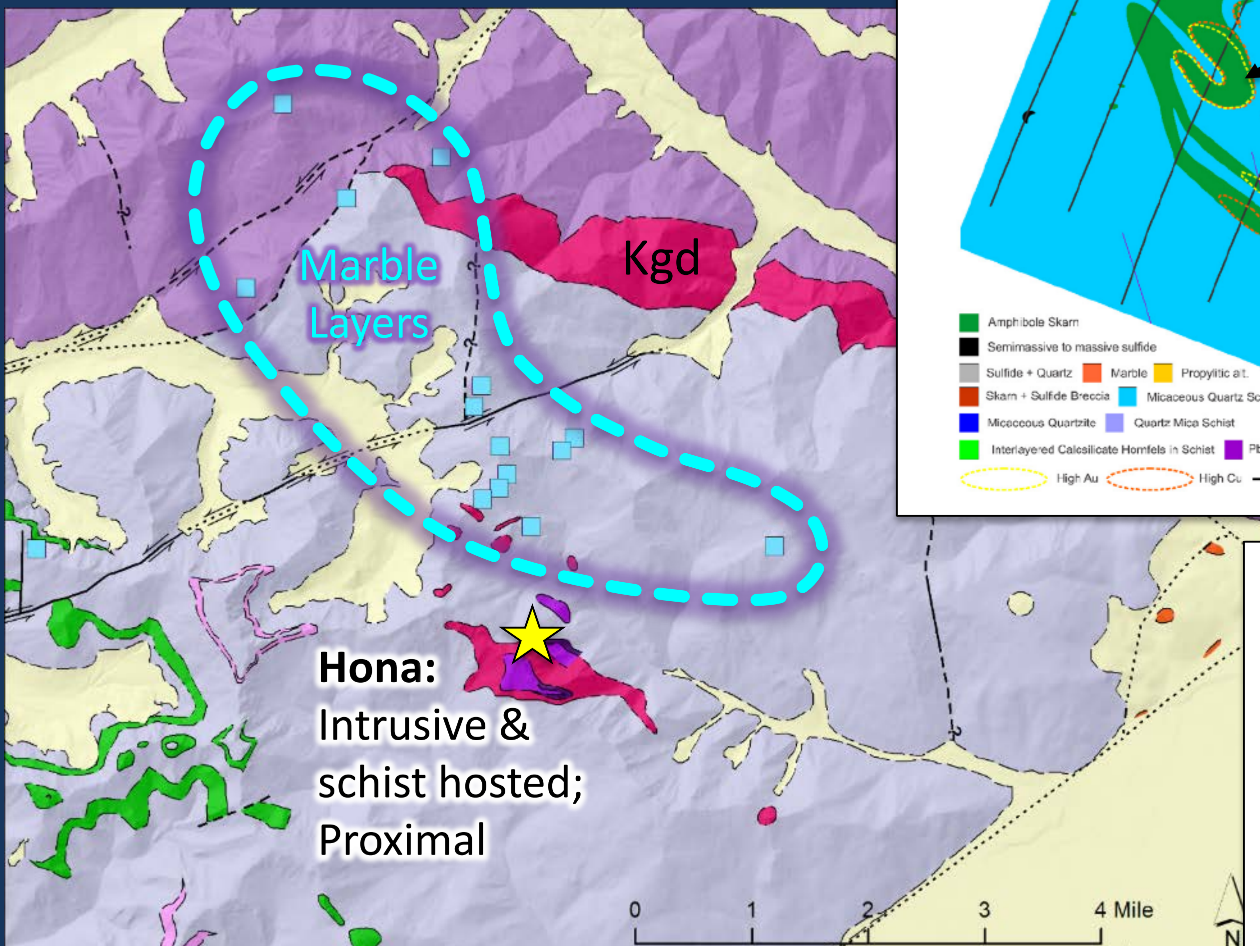


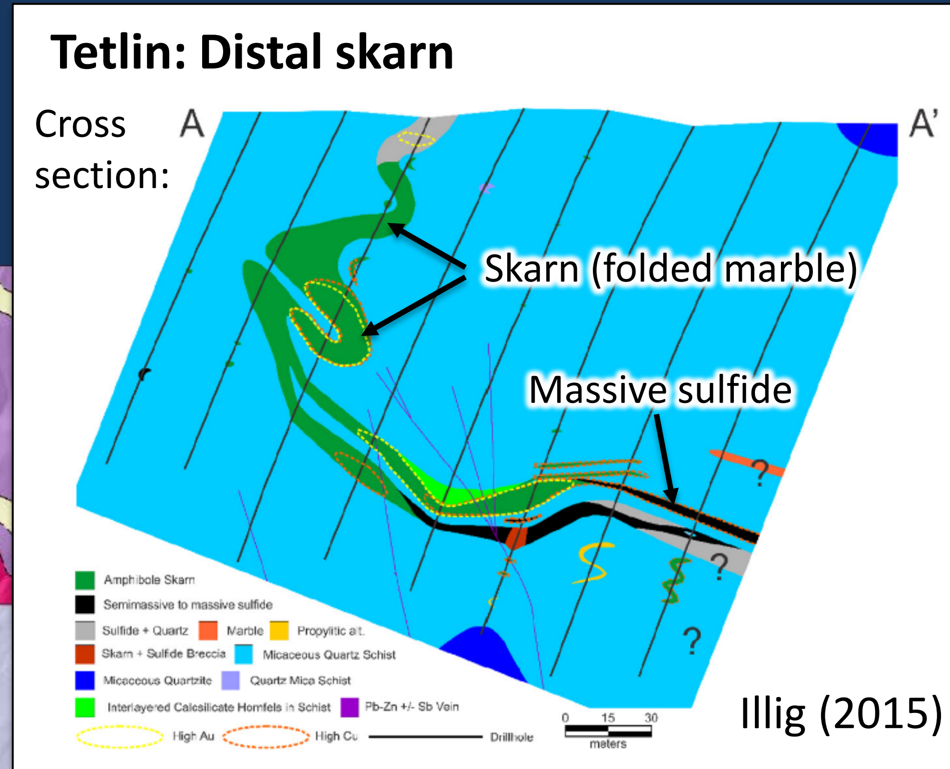
Other similarities:

- Au-Cu-Ag, minor Bi
- Pyrrhotite ± chalcopyrite ± arsenopyrite

Tetlin age, geochem from Illig (2015); Hajdukovich age from Avalon Development
Other Ar/Ar: Benowitz and others, 2017; U-Pb Holm-Denoma and others, *in prep.*

Hona-Tetlin differences



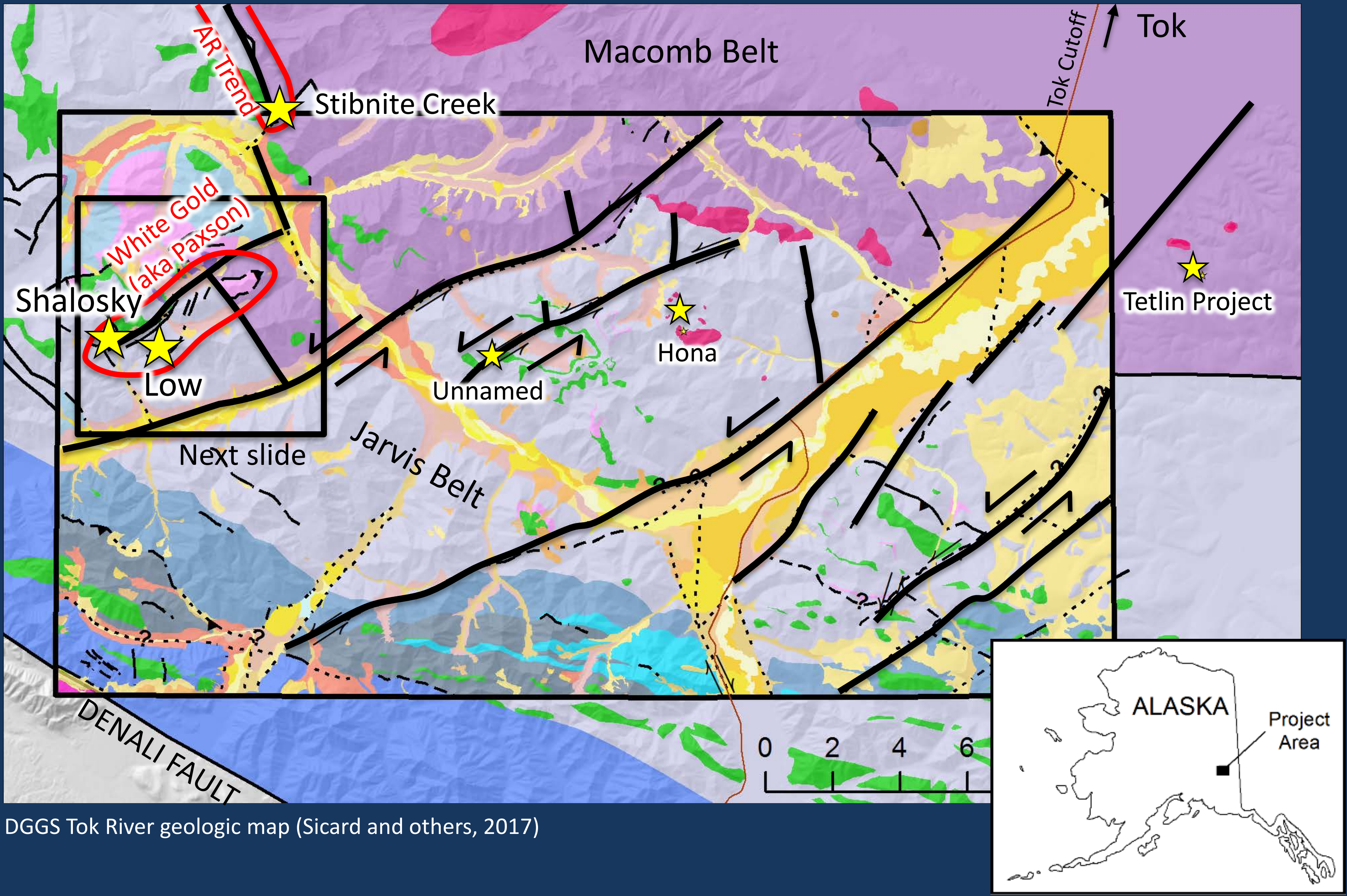


Legend

Q	Surficial deposits (Q)
Kib	Intrusion breccia (late K)
Kgdp	Granodiorite porphyry (late K)
Kgd	Granodiorite (late K)
MDq	Quartzite and schist (Dev.-Miss.)
	Marble (Dev.-Miss.)

Skarn upside in Hona-Clearwater area?

Tok River geology: Northeast and north-south fault sets (Tertiary)



DGGS Tok River geologic map (Sicard and others, 2017)

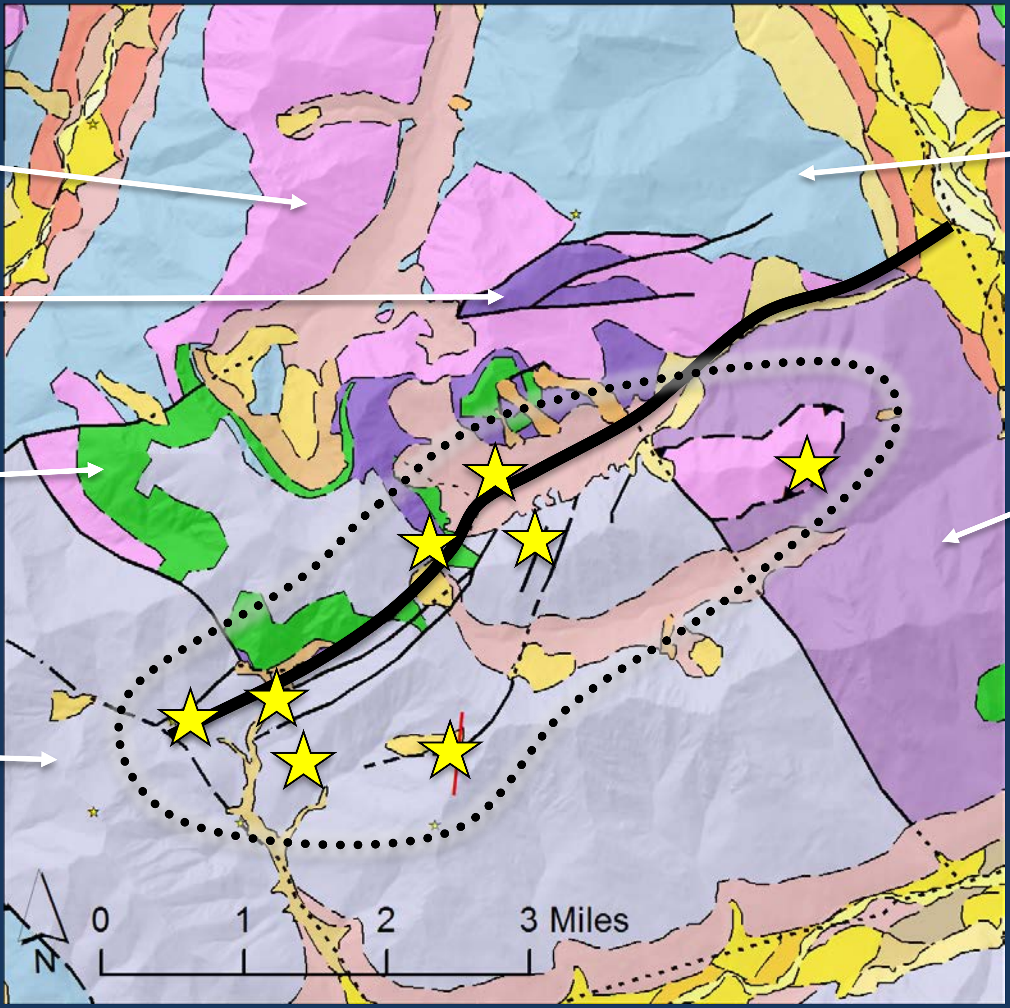
White Gold trend geologic map

Jarvis metarhyolite (greenschist grade)

Drum metarhyolite (greenschist grade)

Triassic metagabbro (greenschist grade)

Jarvis quartzite (greenschist grade)



Jarvis belt (Lagoon unit; greenschist grade)

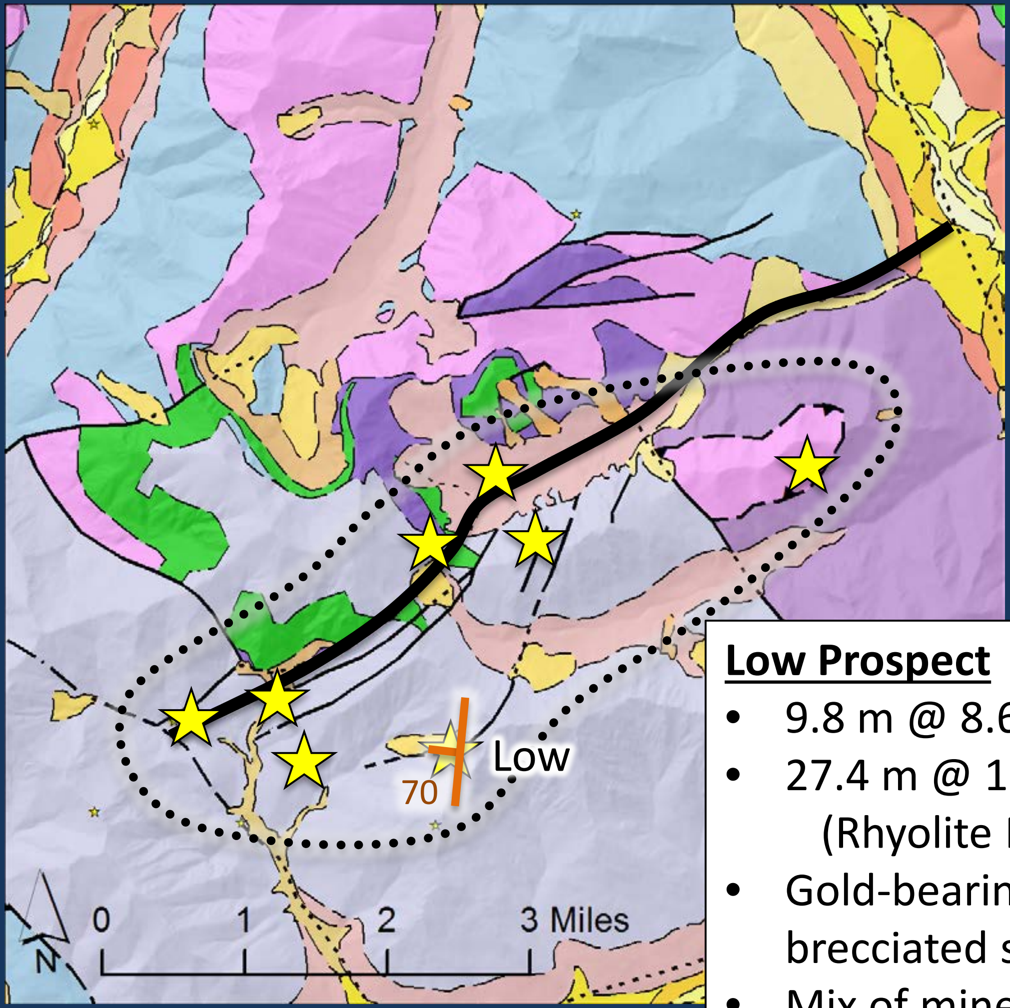
Macomb gneiss (amphibolite facies)

DGGS Tok River map (Sicard and others, 2017)

→ This area mostly adapted RAA, ACNC, etc. (Dashevsky and others [2003]) plus additional mapping courtesy Northern Associates

White Gold trend

How do these prospects fit into the "Tintina Gold Belt"?



DGGS Tok River map (Sicard and others, 2017)

Low Prospect

- 9.8 m @ 8.6 ppm gold
- 27.4 m @ 1.9 ppm gold (Rhyolite Resources, 2015)
- Gold-bearing, quartz-veined, brecciated schist
- Mix of mineralized, unmineralized dikes present
- Gold-arsenopyrite ± stibnite

Detour:
"Sam's Slab" prospect

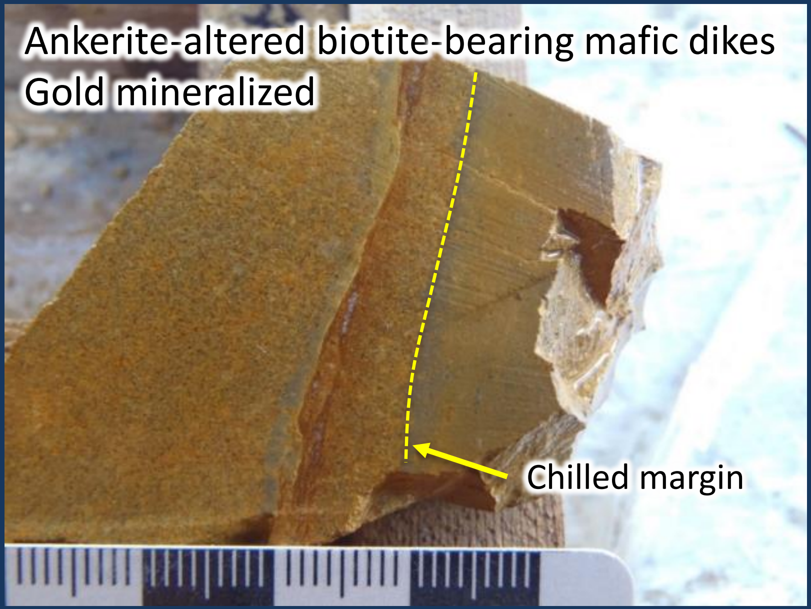
- Gold-bearing quartz vein
- Mafic dike, weakly altered to ankerite ± clay

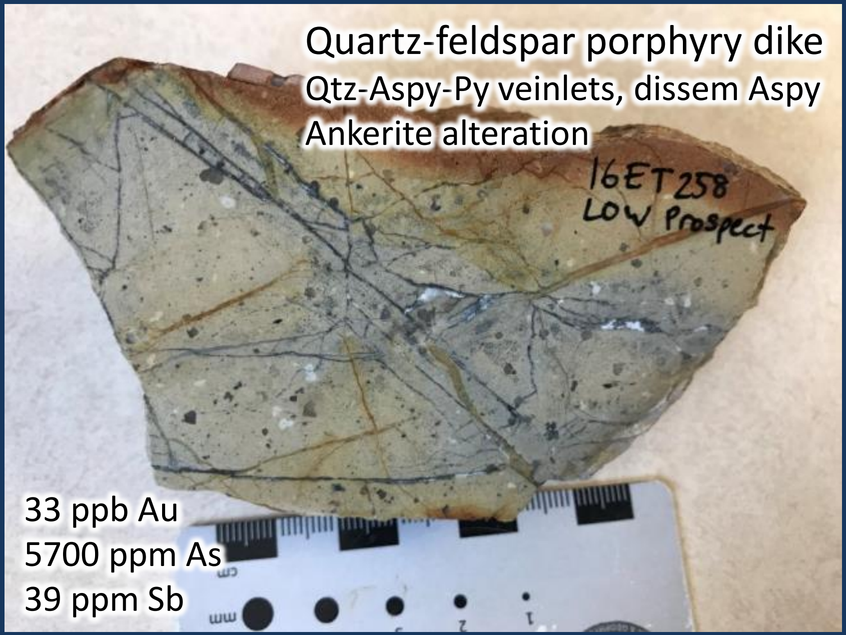
Simply sharing an existing structure?

- or -

Is there a genetic relationship between gold and intrusions?

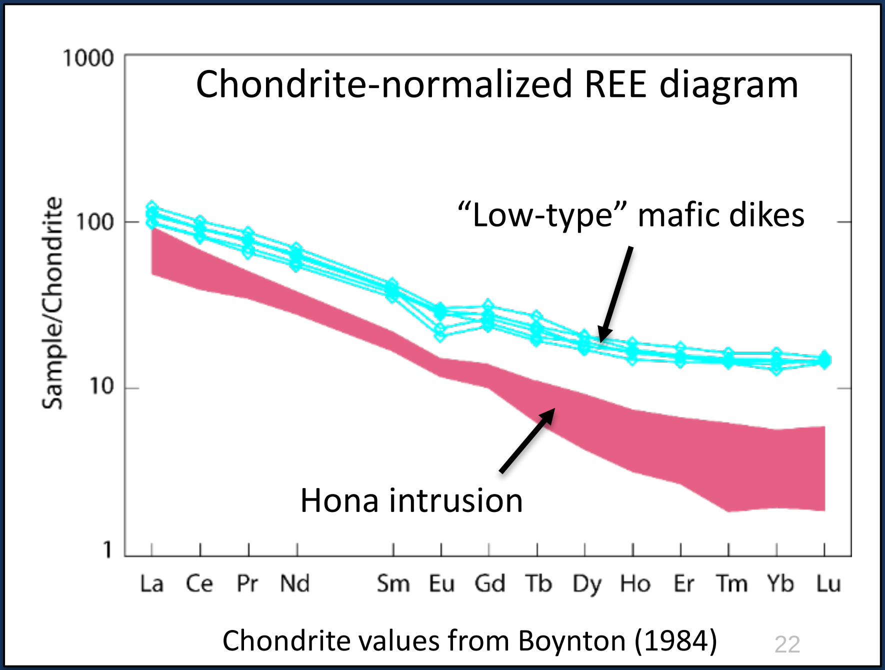
Low prospect dikes

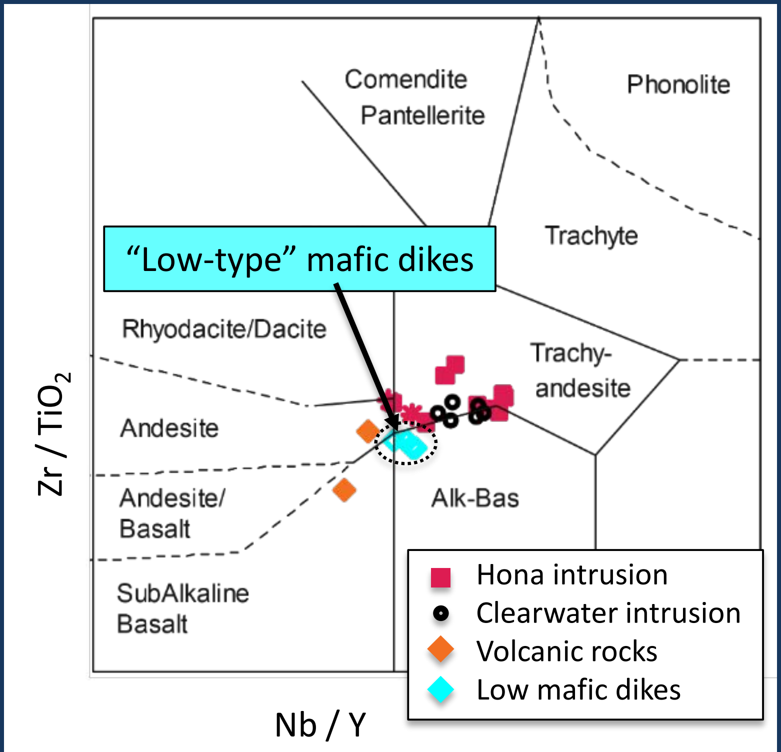




“Low-type” biotite-bearing mafic dikes

Biotite-bearing mafic dikes at Low (and nearby) form a tight compositional cluster (immobile trace elements)



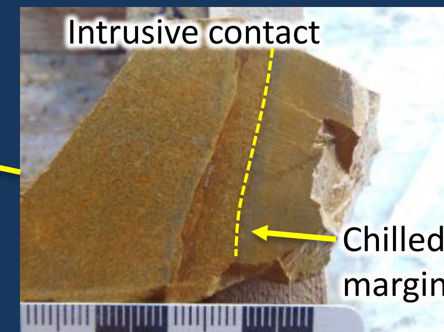


Unaltered “Low-Type” dike from 10 km south of Low: **58.4 Ma** (Ar/Ar biotite)

Geochemistry from Wypych and others, 2016
Ar/Ar age from Benowitz and others, 2017

Low prospect dikes

Altered "Low-type" dike:
220 ppb gold
250 ppm Arsenic
9 % CO_2 (ankerite-clay)



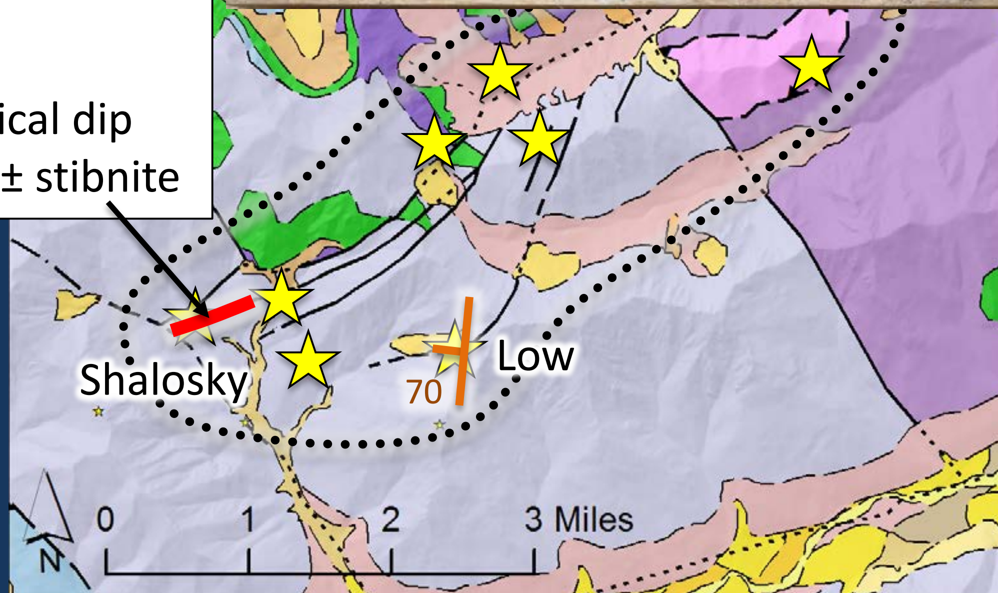
Unaltered "Low-type" dike :
1 ppb gold
45 ppm Arsenic
5 % CO_2 (calcite alteration)

- Dikes of *same composition* seem to be *both* pre/syn- and post-mineral
- Dike emplacement (± 58 Ma) and mineralization ± coeval?

White Gold trend: Shalosky vein

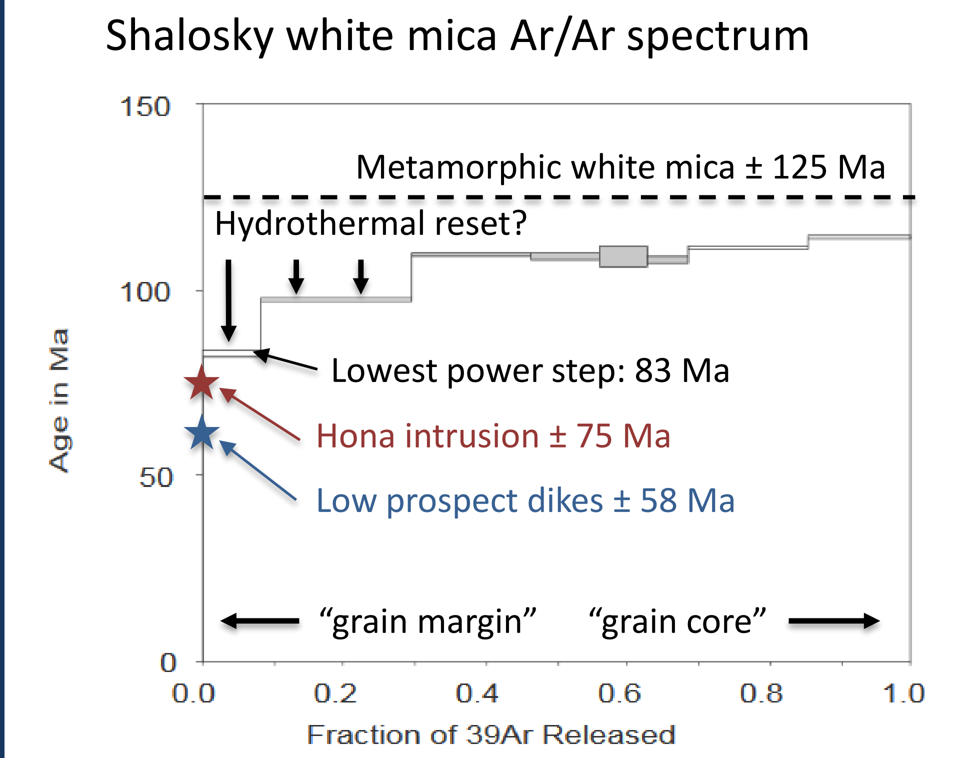
Shalosky

- 16.4 m @ 3.9 ppm gold
- 13.2 m @ 5.4 ppm gold
  (Rhyolite Resources, 2015)
- Shear-type vein
- Up to 35 m thick
- ENE-trending, vertical dip
- Gold-arsenopyrite ± stibnite



Age of mineralization at Shalosky

- Metamorphic mica occurs in bleached wall rock slivers within the vein
- Ar/Ar spectra shows a *partial* reset of regional metamorphic age
- Reset event is younger than 83 Ma
- Age could be similar to Hona or Low



Modified from figure of Benowitz and others, 2017

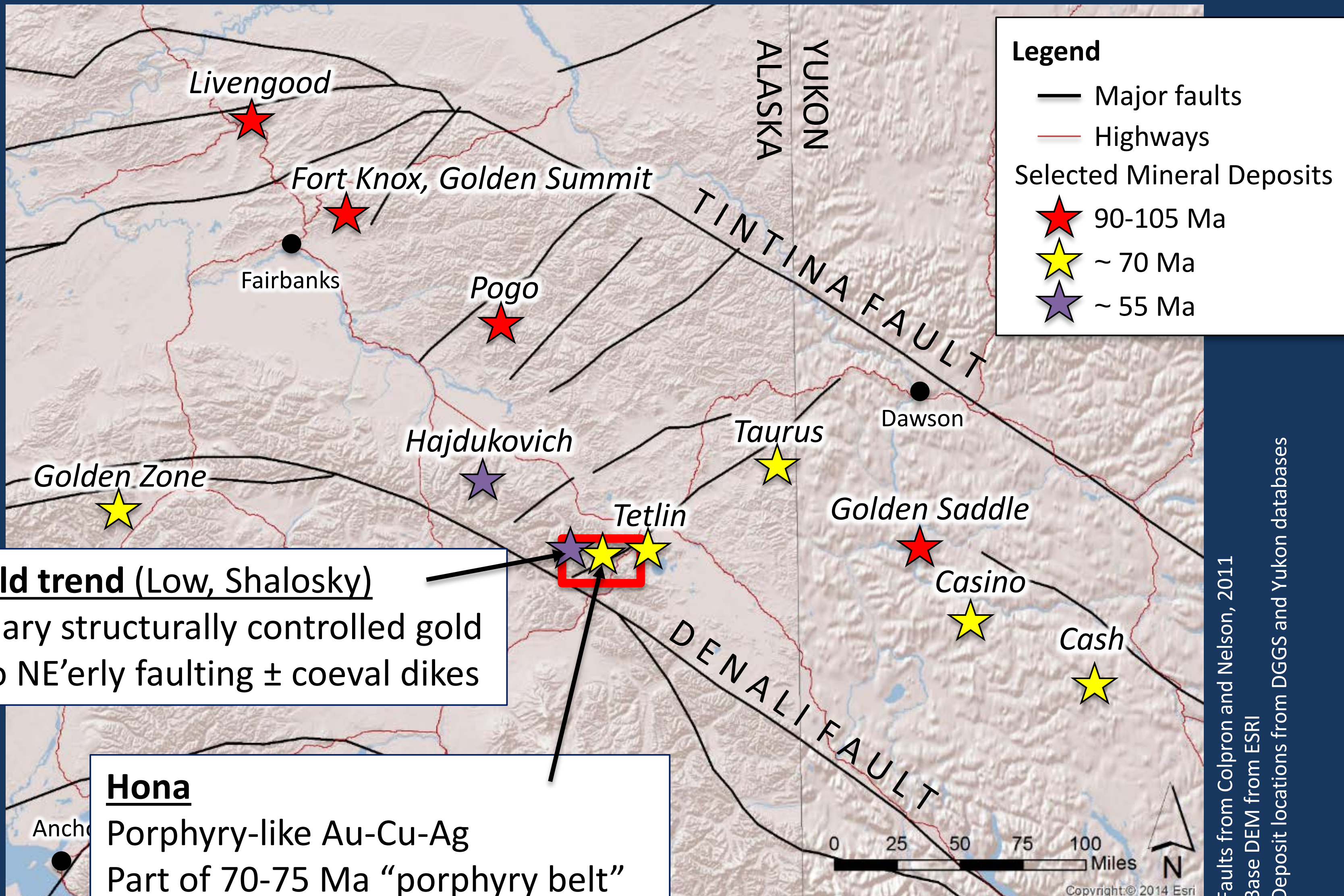
Photomicrograph (cross-polarized light)

White Gold Conclusions

- Likely age is Early Tertiary, ± 58 Ma
  - Major activity on the Tintina, Denali, and linking northeasterly faults
  - Magmatism throughout Interior
- Different/separate from Hona, Tetlin
- Possible analog: Hajdukovich

  (45 miles to northwest; Avalon Dev. Corp., 2015)
  - Gold-bearing low sulfide quartz veins, breccias
  - NE trends, may be associated with regional scale NE faults
  - Cutting and associated with 56 Ma alkalic intrusive complex

Conclusions: Two phases of gold mineralization



White Gold trend (Low, Shalosky)
Early Tertiary structurally controlled gold
Related to NE'erly faulting ± coeval dikes

Hona
Porphyry-like Au-Cu-Ag
Part of 70-75 Ma "porphyry belt"
Likely related to Tetlin skarns

Faults from Colpron and Nelson, 2011
Base DEM from ESRI
Deposit locations from DGGS and Yukon databases

Thanks!

Altered intrusion breccia, Hona Prospect

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