New geologic investigations of Northeast Tanacross

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In 2017 and 2018 field season, Alaska Division of Geological & Geophysical Surveys (DGGS) geologists carried out helicopter-supported geologic mapping and sampling in the Tanacross D-1 and parts of C-1, C-2 and D-2 quadrangles. We present our preliminary 1:63,360-scale geologic map of the region, including the Pika, Fishhook, Taurus, and Bluff prospects, and the results of geochemical and geochronological sampling.

The NE Tanacross project area lies ~15 miles southeast of Chicken, Alaska, adjacent to the Alaska-Canada border. It contains the Pika, Fishhook, and Baggage mineral occurrences, current industry exploration projects at the Taurus and Bluff Cu-Mo-Au porphyry prospects, and multiple placer operations on Liberty Creek.

Reconnaissance, 1:250,000-scale, USGS mapping (Foster, 1970; Wilson and others, 2015) provides a general guide to the area's geology but lacks sufficient geologic and structural detail to guide industry mineral exploration efforts. The lack of detailed geologic mapping, high mineral potential, current industry interest, and interpretations of newly published geophysical data prompted the DGGS Mineral Resources section to work in this area.

The NE Tanacross project area is underlain by two major geologic assemblages: Lake George assemblage in the south and the Fortymile assemblage in the north, as well as minor Nasina assemblage in the NE corner of the map. The Devonian to Mississippian Lake George metamorphic assemblage is composed of paragneiss and interlayered massive quartzite and semischist intruded by augen orthogneiss and minor amphibolite. The Devonian to Mississippian Fortymile metamorphic assemblage is characterized by widespread quartzite, chloritic schist, paragneiss, orthogneiss and very common amphibolite and garnet-bearing amphibolite. Both metamorphic assemblages are intruded by ~ 110 Ma pegmatites and granitoids (often bearing garnet), and ~70 to 68 Ma porphyry intrusions; they are overlain by intermediate to siliceous lava flows and Quaternary basanites (Naibert and others, 2018). In the SW and ENE corner of the Fortymile assemblage we have mapped a Cretaceous to Tertiary conglomerate, sandstone, and gravel overlaying the metamorphic assemblage.

Multiple stages of mineralization are present in the region. The Pika and Fishhook prospect area is characterized by mainly structurally controlled mineralization including Ag (Pb-Bi-As) and locally Au. One sample from nearby Pika Canyon assayed 4,420 ppm Ag and more than 30% Pb (17MLW002; Wypych and others, 2017). A sample of mineralized breccia assayed 2.15 ppm Au (17MBW119). Broadly distributed tourmaline-sericite alteration occurs around both the Pika-Fishhook prospect area and the Taurus-Bluff area. In the Taurus-Bluff area, the tourmaline-bearing alteration style carries elevated Ag-Pb-Bi-As; we postulate that this style of mineralization may be related to a suite of intermediate, magnetite-bearing intrusions with ages of 68 to 70 Ma (Naibert and others, 2018) that are observed in both areas. The slightly older (70 to 72 Ma) Cu-Mo-Au systems (present in both Taurus and Bluff) are related to potassic and sericitic altered quartz feldspar porphyry. Samples from this system assayed up to 1.19 ppm Au (Bluff prospect; 18RN373), 4770 ppm Cu, and 597 ppm Mo (Taurus prospect; Wypych and others, 2018).

The region is cut by numerous NE-striking, high-angle, oblique faults with generally sinistral sense of movement; they cut through the older, low-angle, detachment between the Lake George and Fortymile assemblages. Less pervasive NW- and E–W-striking, high-angle faults also cut the region.

References:

Foster, H.L., 1970, Reconnaissance Geologic Map of the Tanacross Quadrangle, Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map 593, 1 sheet, scale 1:250,000.

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Wilson, F.H., Hults, C.P., Mull, C.G., and Karl, S.M., 2015, Geologic map of Alaska: U.S. Geological Survey Scientific Investigations Map 3340, 197 p., 2 sheets, scale 1:1,584,000.

Wypych, A., Naibert, T.J., Athey, J.E., Newberry, R.J., Sicard, K.R., Twelker, E., Werdon, M.B., Willingham, A.L., and Wyatt, W.C., 2018, Major-oxide and trace-element geochemical data from rocks collected in 2018 for the Northeast Tanacross project, Tanacross C-1, C-2, D-1, and D-2 quadrangles, Alaska: Alaska Division of Geological & Geophysical Surveys Raw Data File 2018-4, 4 p. http://doi.org/10.14509/30113.

Wypych, A., Twelker, E., Athey, J.E., Lockett, A.C., Naibert, T.J., Sicard, K.R., Werdon, M.B., and Willingham, A.L., 2017, Major-oxide and trace-element geochemical data from rocks collected in the Tanacross C-1, D-1, and D-2 quadrangles, Alaska in 2017: Division of Geological & Geophysical Surveys Raw Data File 2017-10, 4 p. http://doi.org/10.14509/29778.

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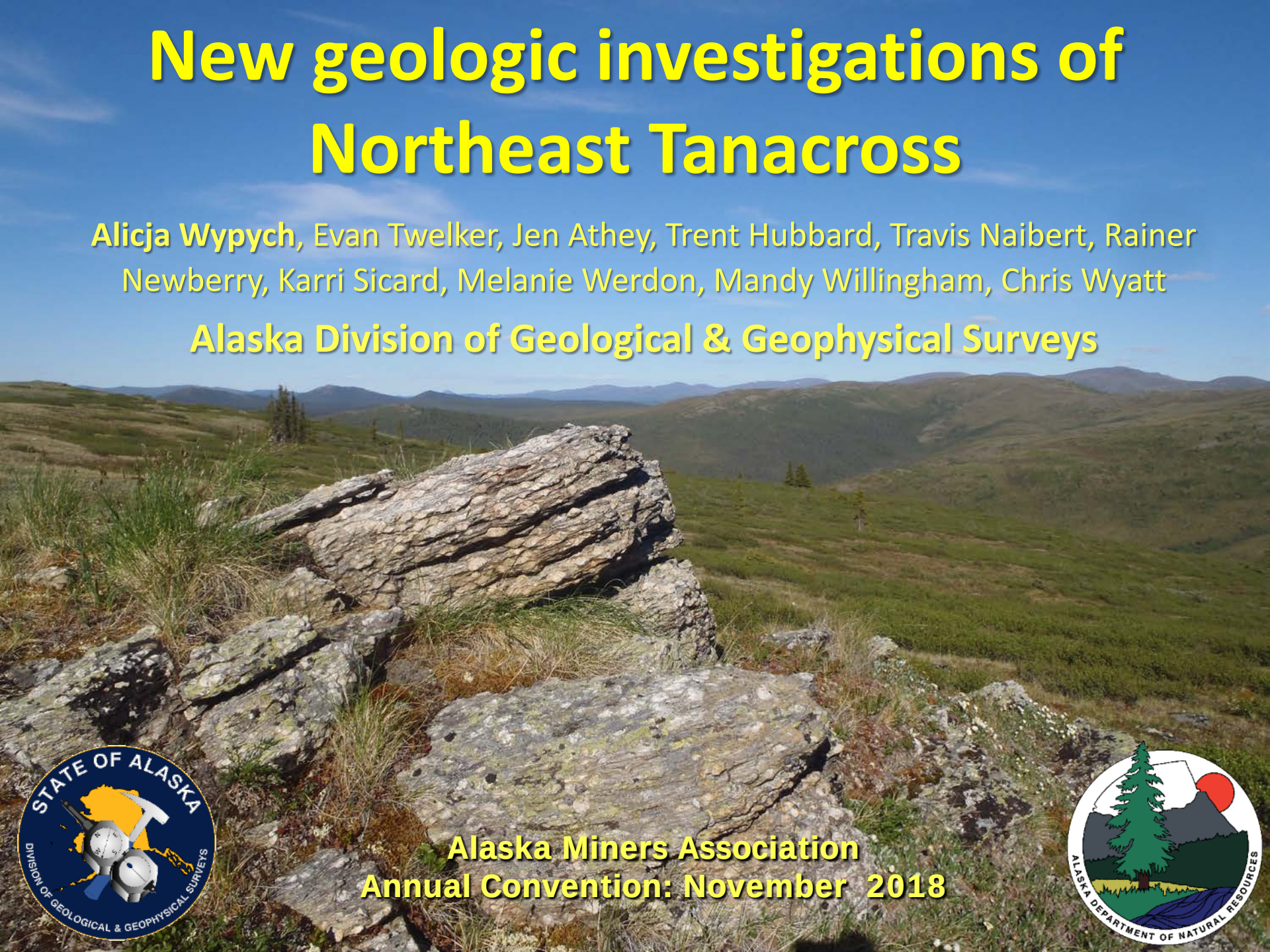

Alaska Miners Association
Annual Convention: November 2018

Acknowledgments

Photo by E. Twelker

- Kenorland Minerals
- USGS collaborators: Erin Todd, Jamey Jones, Doug Kreiner, George Case
- Aurora Aviation LLC and Matt (Mojo) Morris
- Bronk Jorgensen (Alpine Holdings Inc.)
- Behind-the-scenes work by DGGS staff

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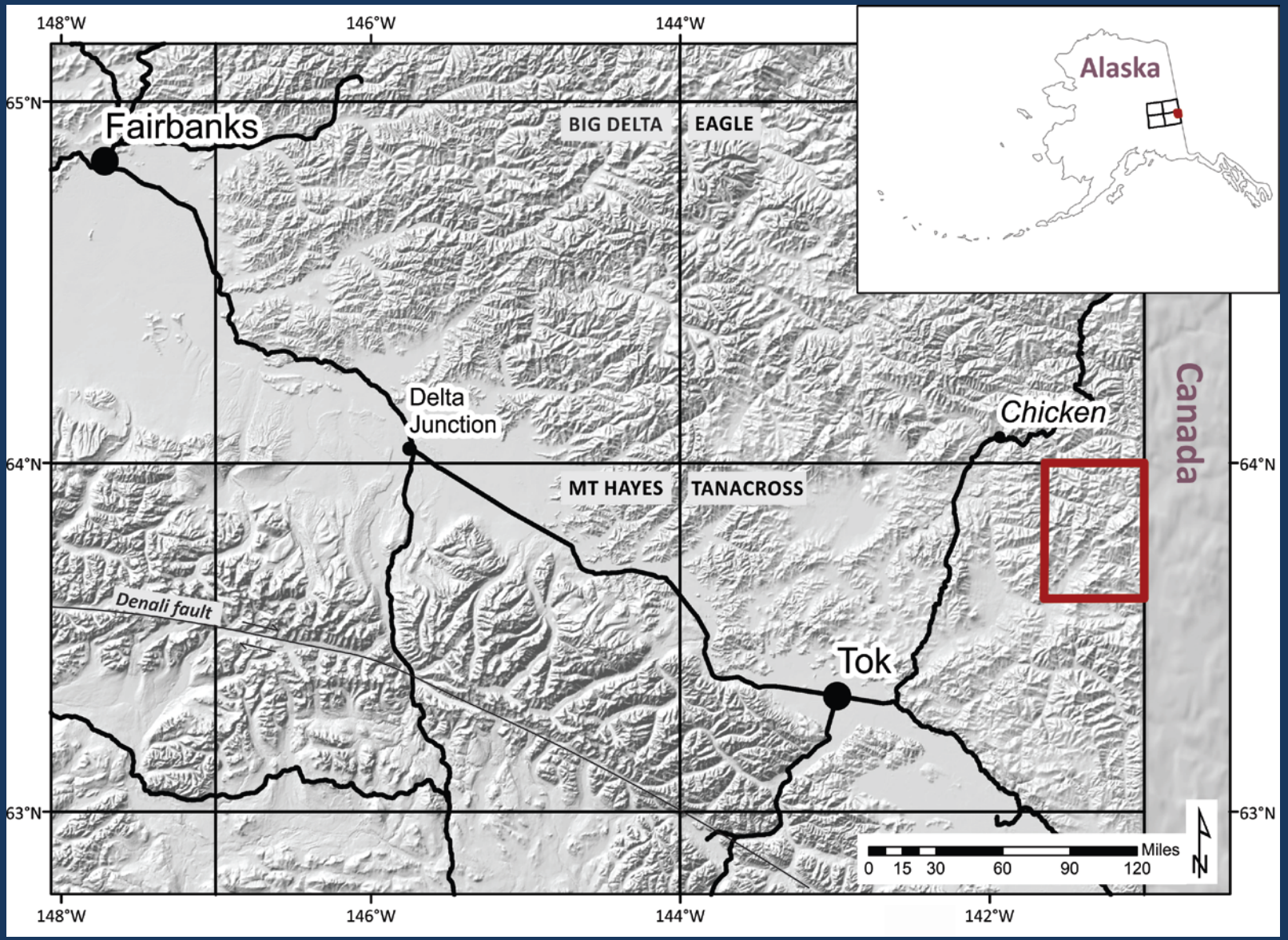
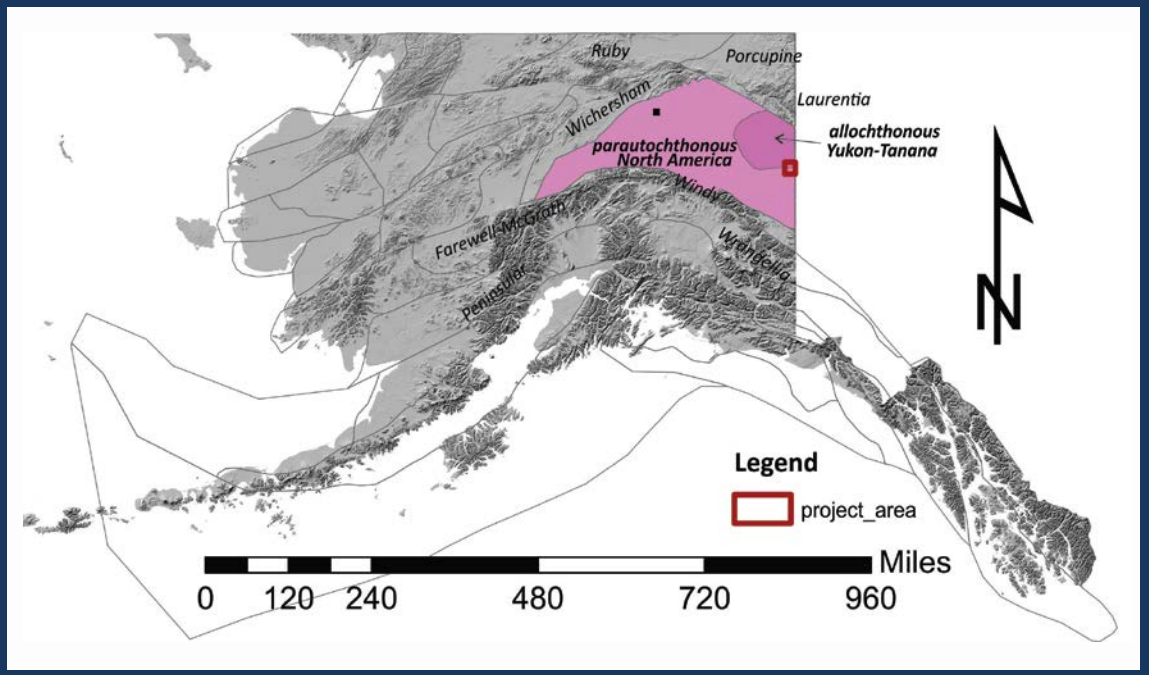
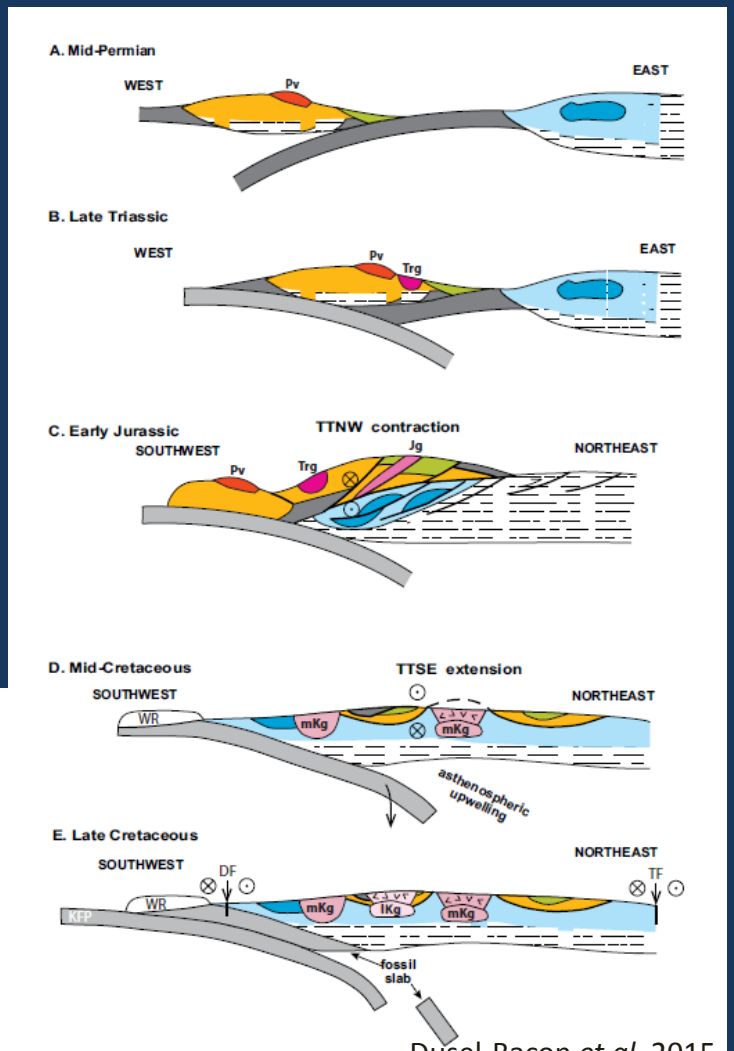
Project Area

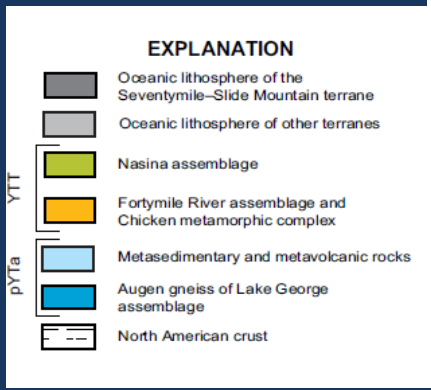


Tectonic setting

Allochthonous Yukon-Tanana terrane – Fortymile assemblage
Parautochthonous North America – Lake George assemblage

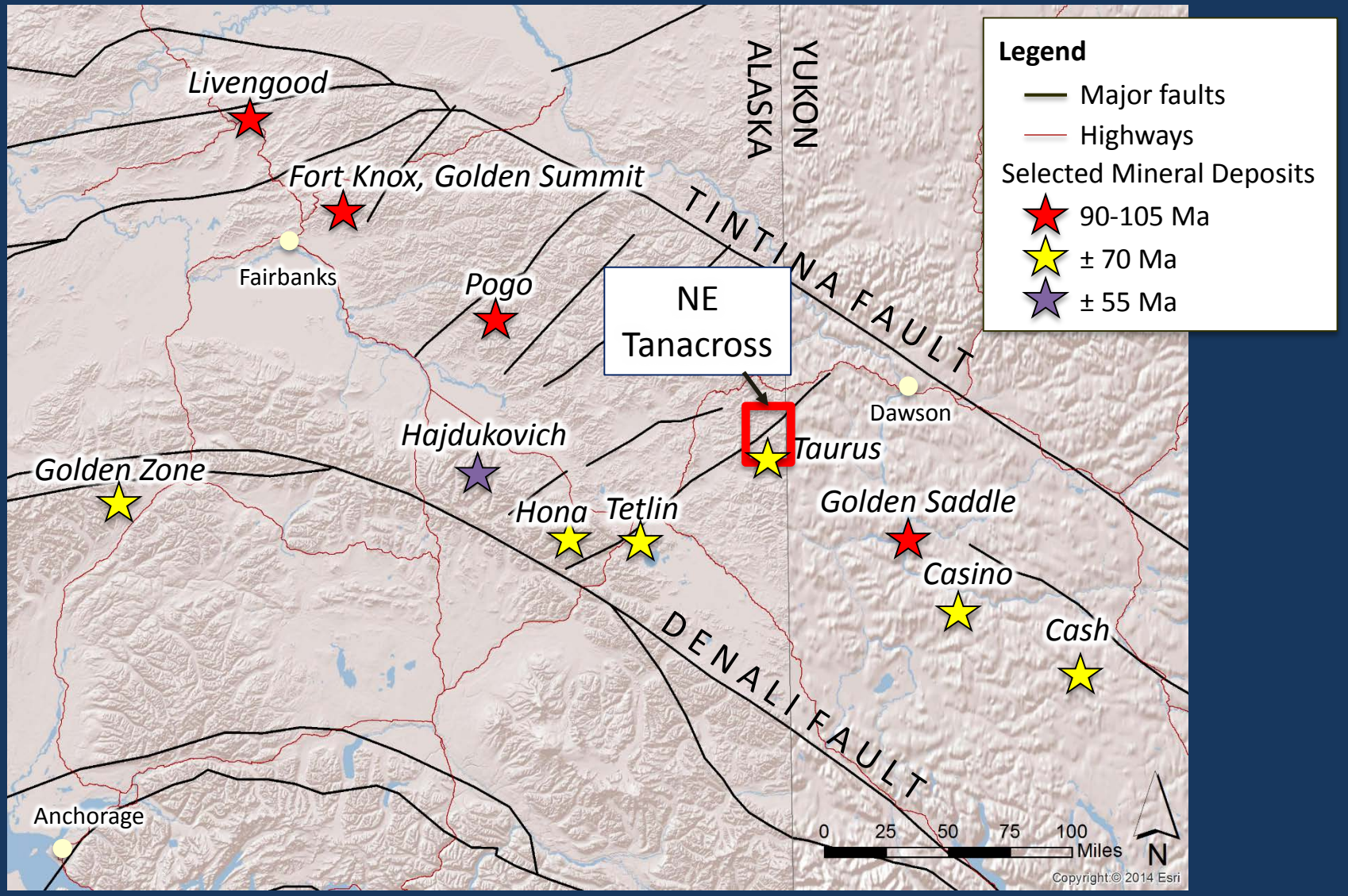






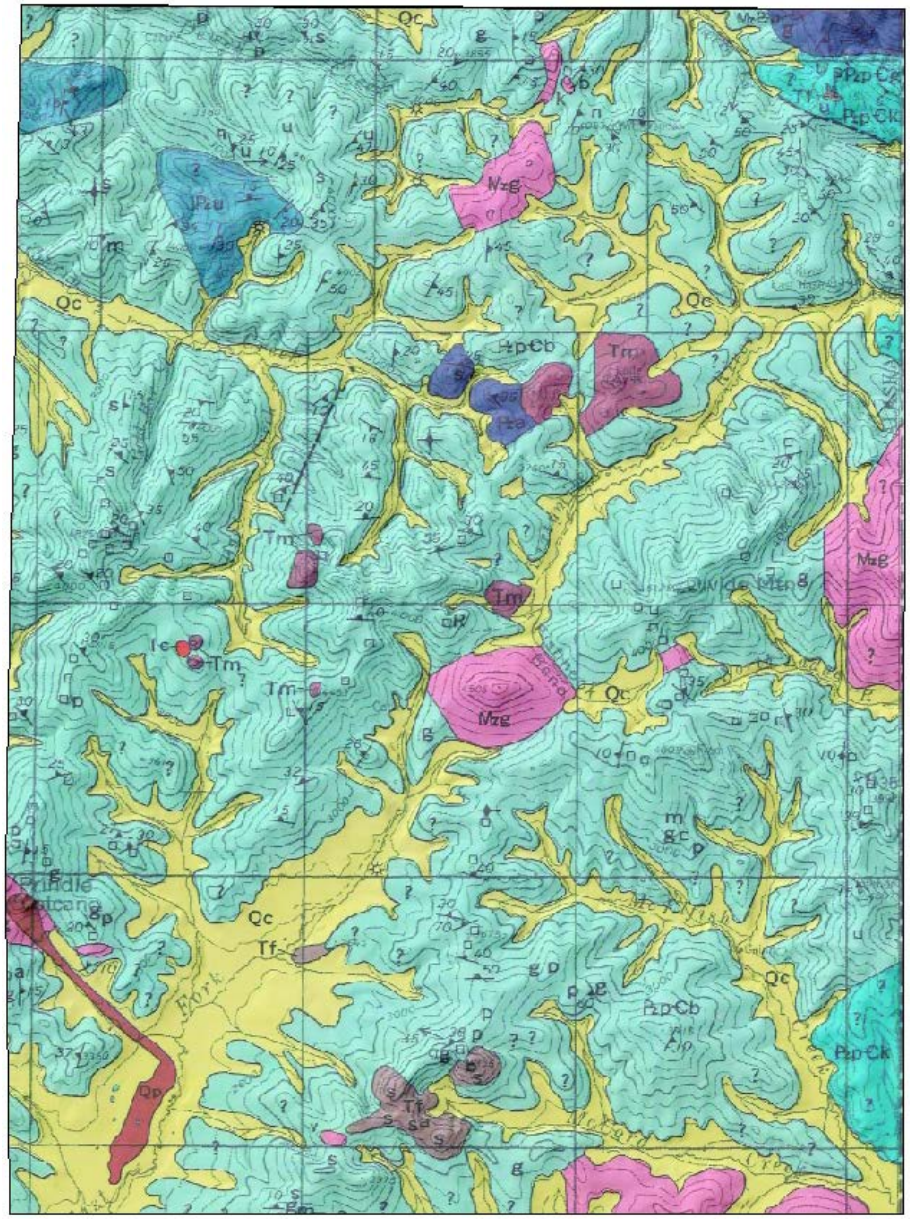
Dusel-Bacon *et al.* 2015

Project location and nearby deposits

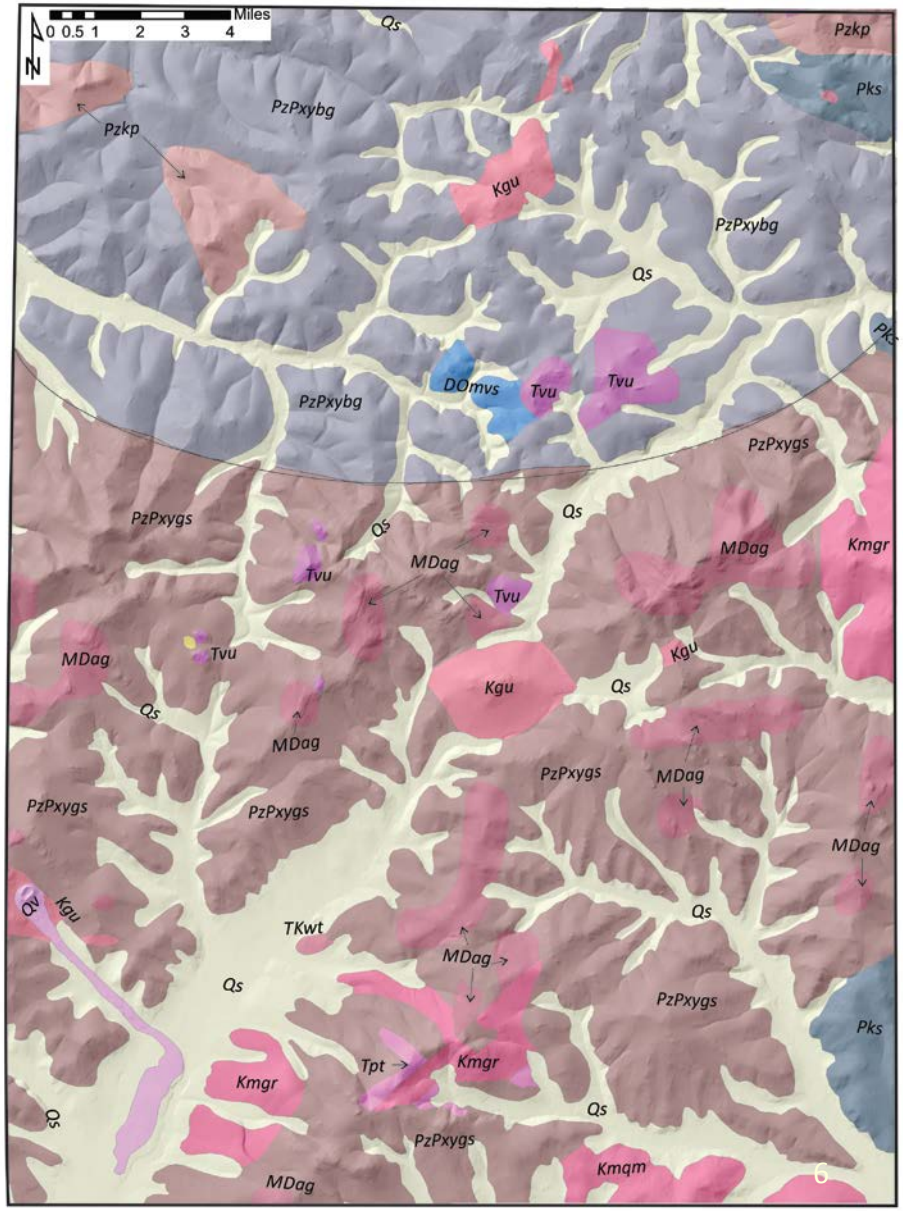


Previous reconnaissance maps

Foster, 1970

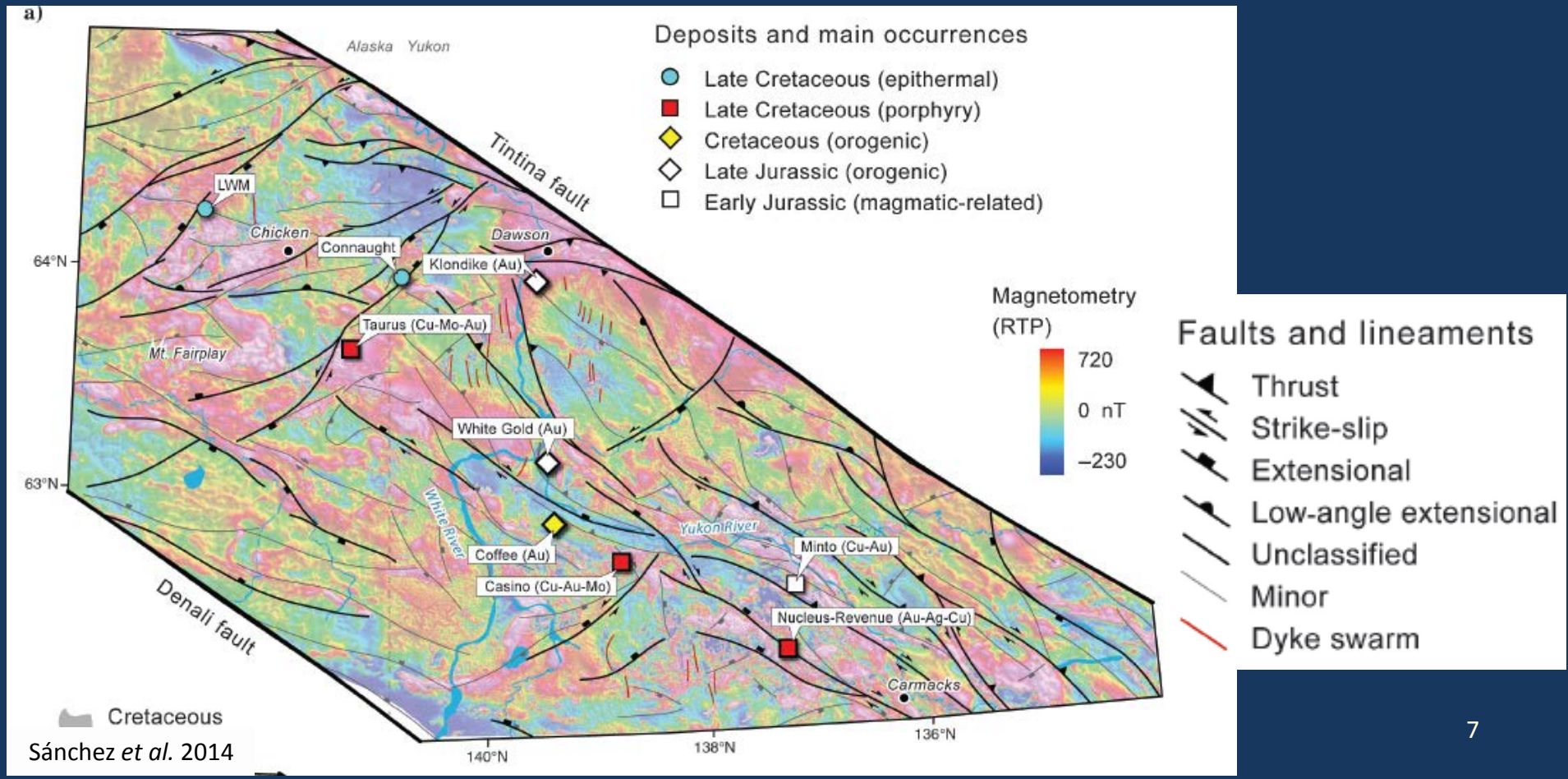


Wilson *et al.*, 2015



Mapping goals

- Recognize and find geologic features controlling mineralization:
  - High angle structures (example: controlling mineralized Late Cretaceous porphyry systems – Casino, Taurus)
  - Mineralized plutons: Tetlin/Hona
  - Other: dikes, mineralized veins



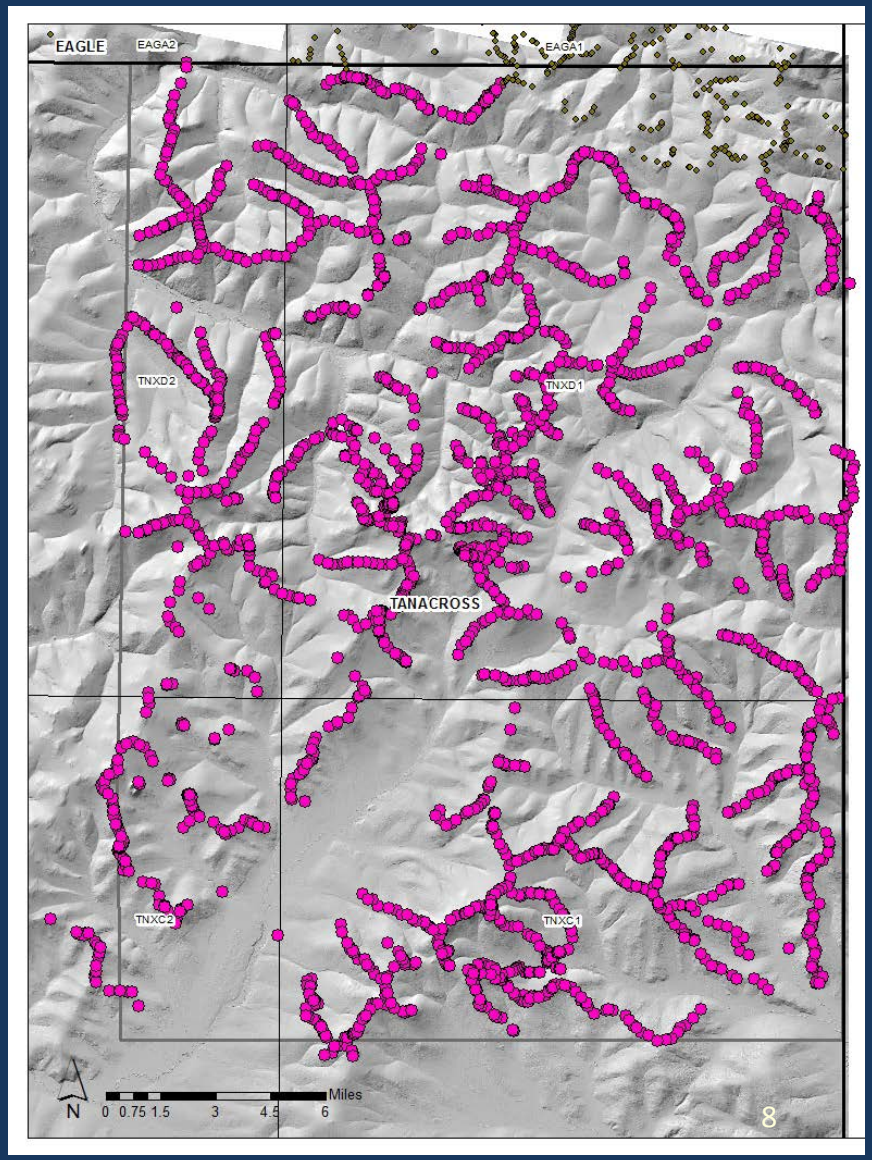
Sánchez *et al.* 2014

2017-2018 NE Tanacross field work

(Photo by K. Sicard)

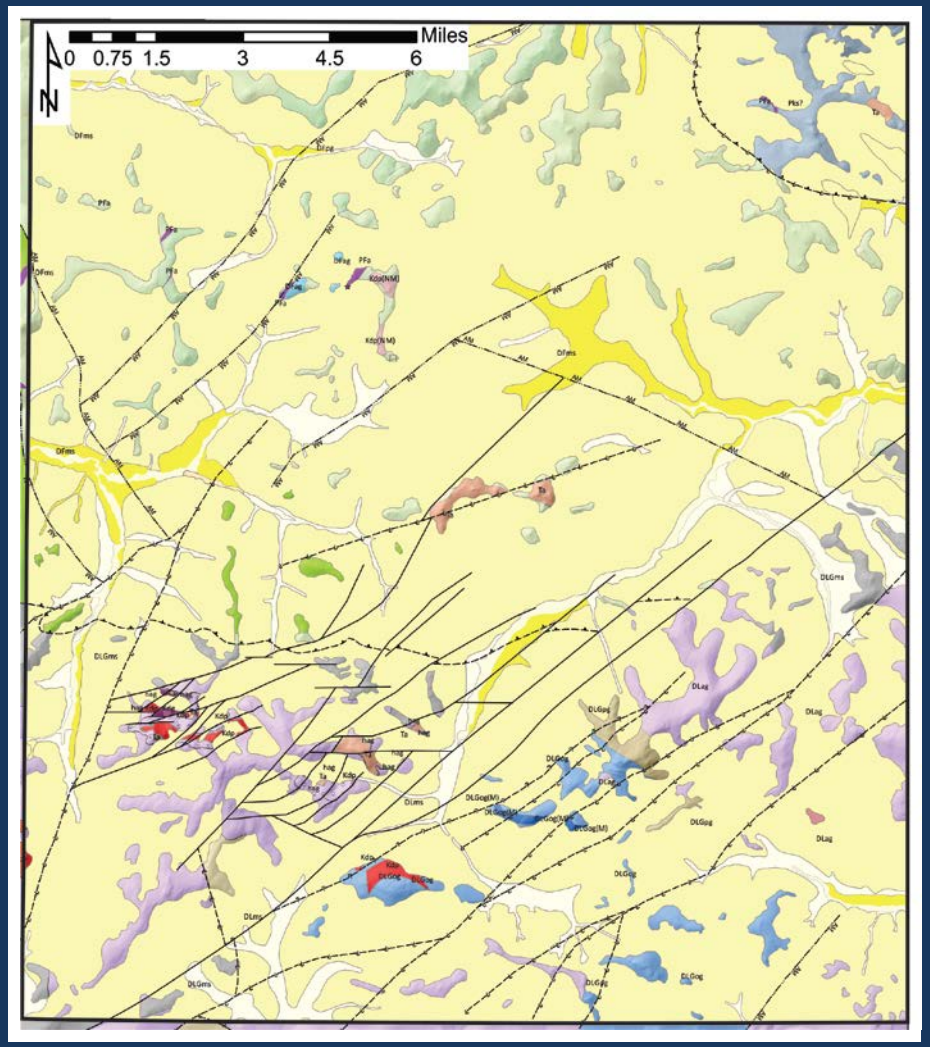
(Photo by E. Twelker)

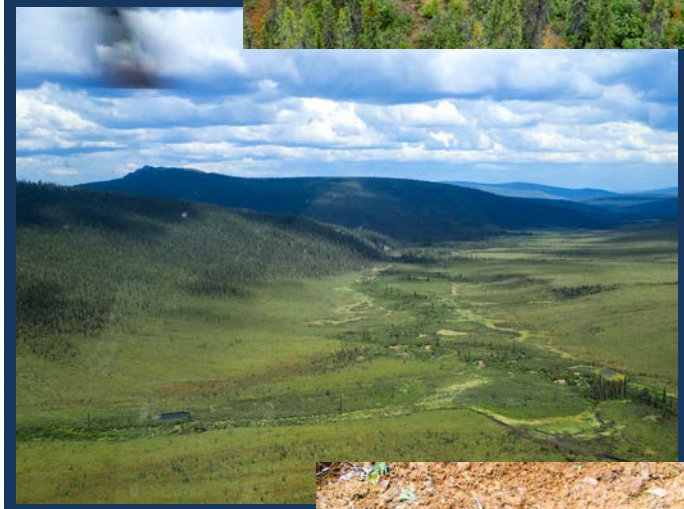
- ~40 days in the field, ~8 person crew
- 2852 field stations, 966 rock samples analyzed on HHXRF
- 771 structure measurements
- 236 samples analyzed for major oxide and trace elements
- 217 samples analyzed for trace elements
- 5 samples analyzed for Ar-Ar - more to be submitted
- 6 samples analyzed for U-Pb - more to come



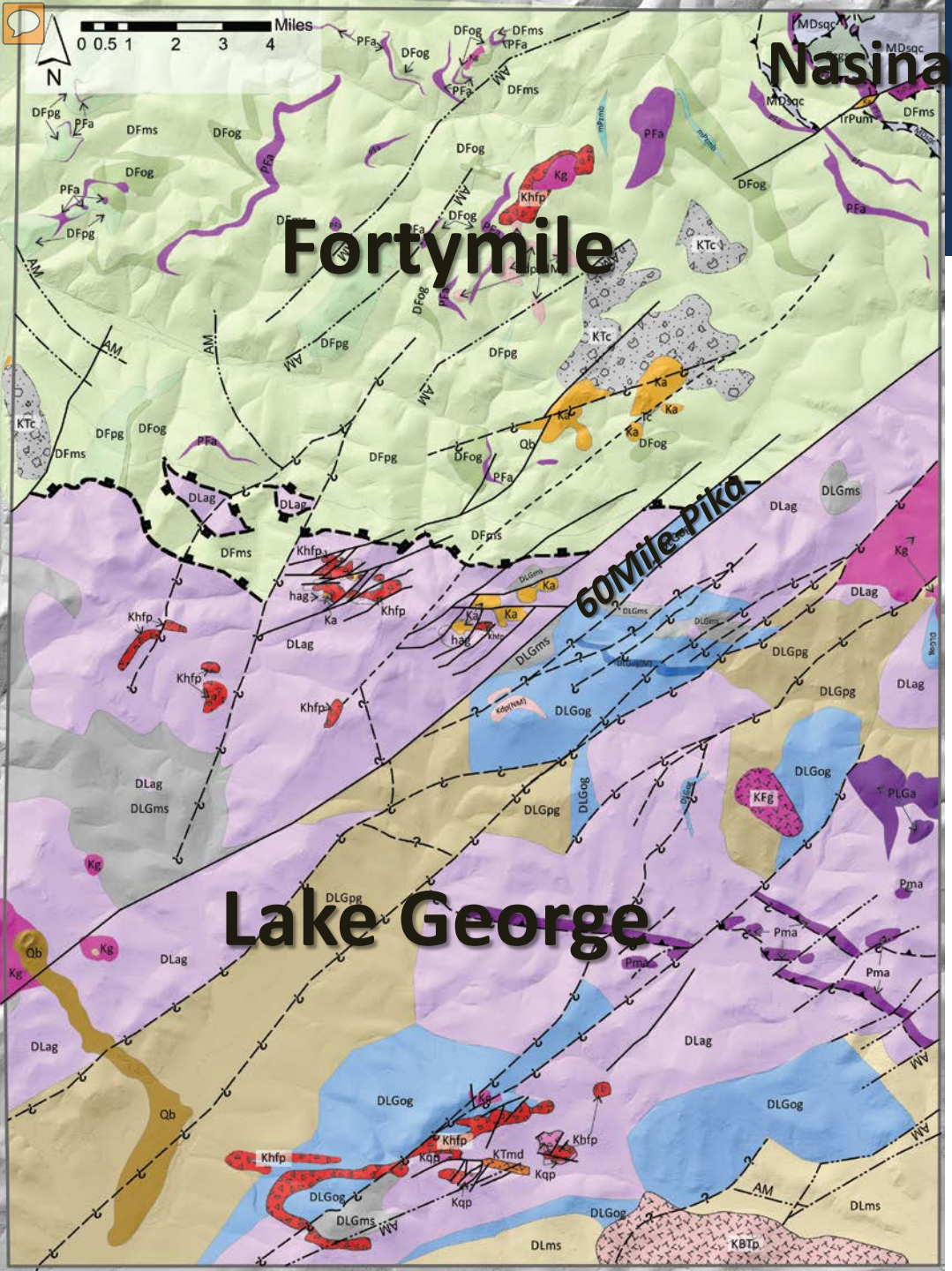
(Photos by T. Hubbard)

Quaternary cover





Draft Geologic Map



Legend

Sedimentary Rocks

- KTc — conglomerate

Igneous Rocks

- Qb — basalt
- Ka — andesite
- Kdg — gabbro
- Khfp — hornblende-feldspar porphyry
- Kqp — quartz-feldspar porphyry
- Kdp(NM) — diorite porphyry
- KFg — Frank granite
- Kg — granite
- KBTp — Big Timber granite

Metamorphic Rocks

Nasina assemblage

- TrPum — serpentinized ultramafic
- Pzgs — gneiss and schist
- MDsqc — carbonaceous schist and quartzite

Fortymile assemblage

- PFa — amphibolite
- DFag — augen gneiss
- DFog — orthogneiss
- DFpg — paragneiss
- mPzmb — marble
- DFms — semischist and quartzite

Metamafic

- Pma — serpentinite and amphibolite

Lake George assemblage

- PLGa — amphibolite
- DLag — augen gneiss
- hag — hornfels zone (sericitized)
- DLGog(M) — orthogneiss, magnetite rich
- DLGog — orthogneiss
- DLGpg — paragneiss
- DLGms — quartzite
- DLms — semischist and quartzite (conductive)

ContactsAndFaults

- high angle fault
- high angel fault, questionable
- thrust fault
- thrust fault, questionable
- AM — geophysical boundary
- detachment

Structures

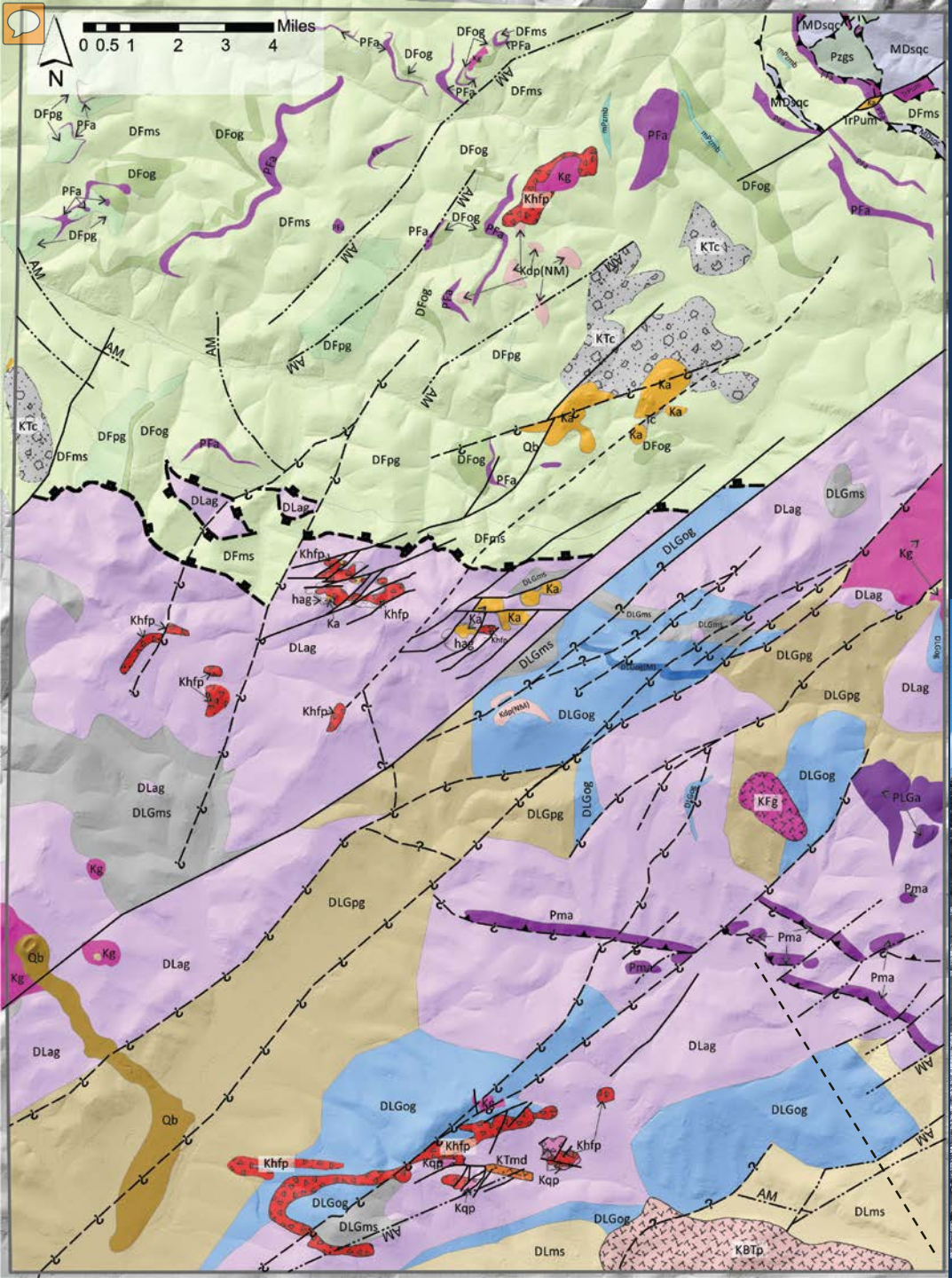
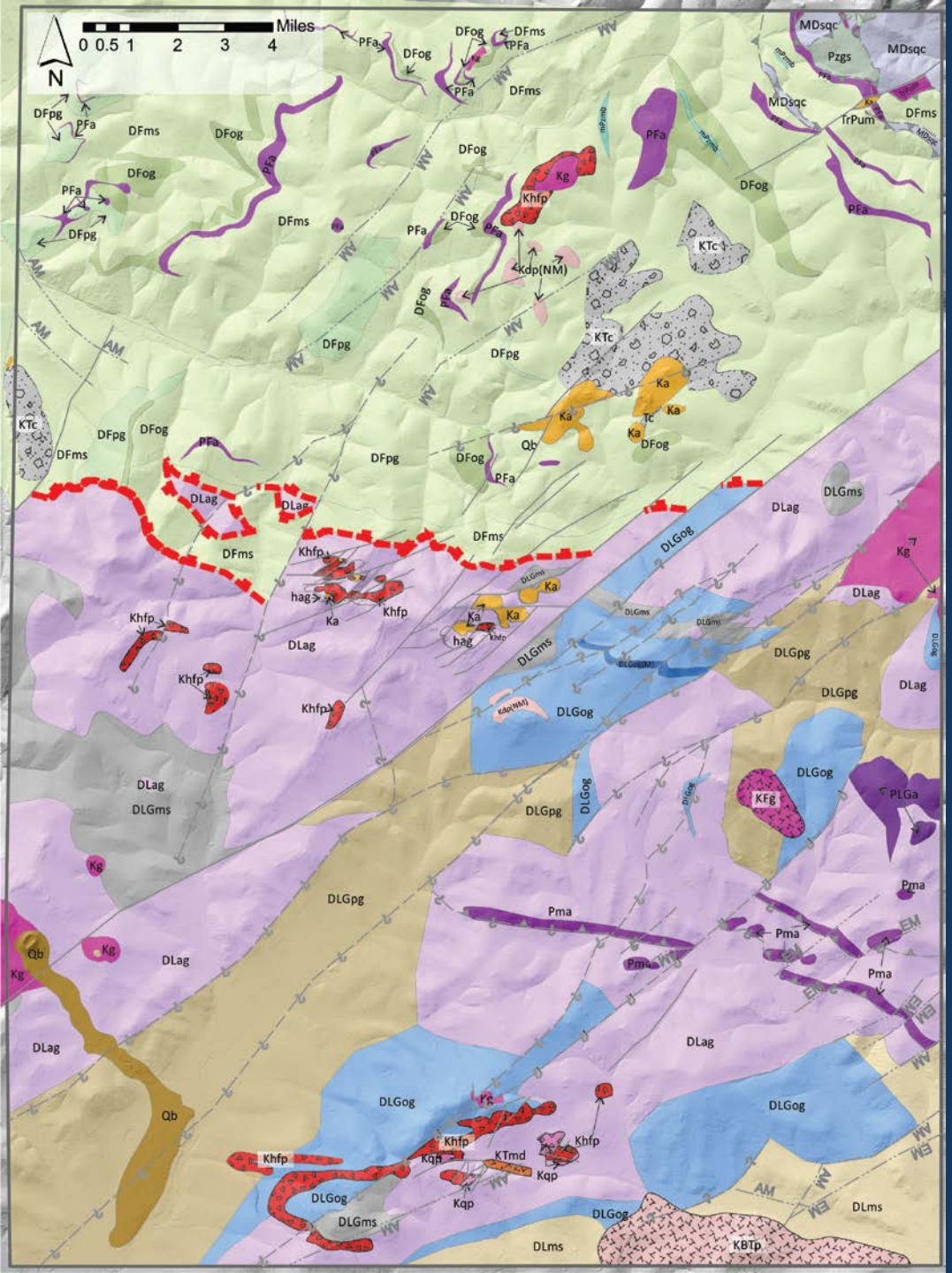


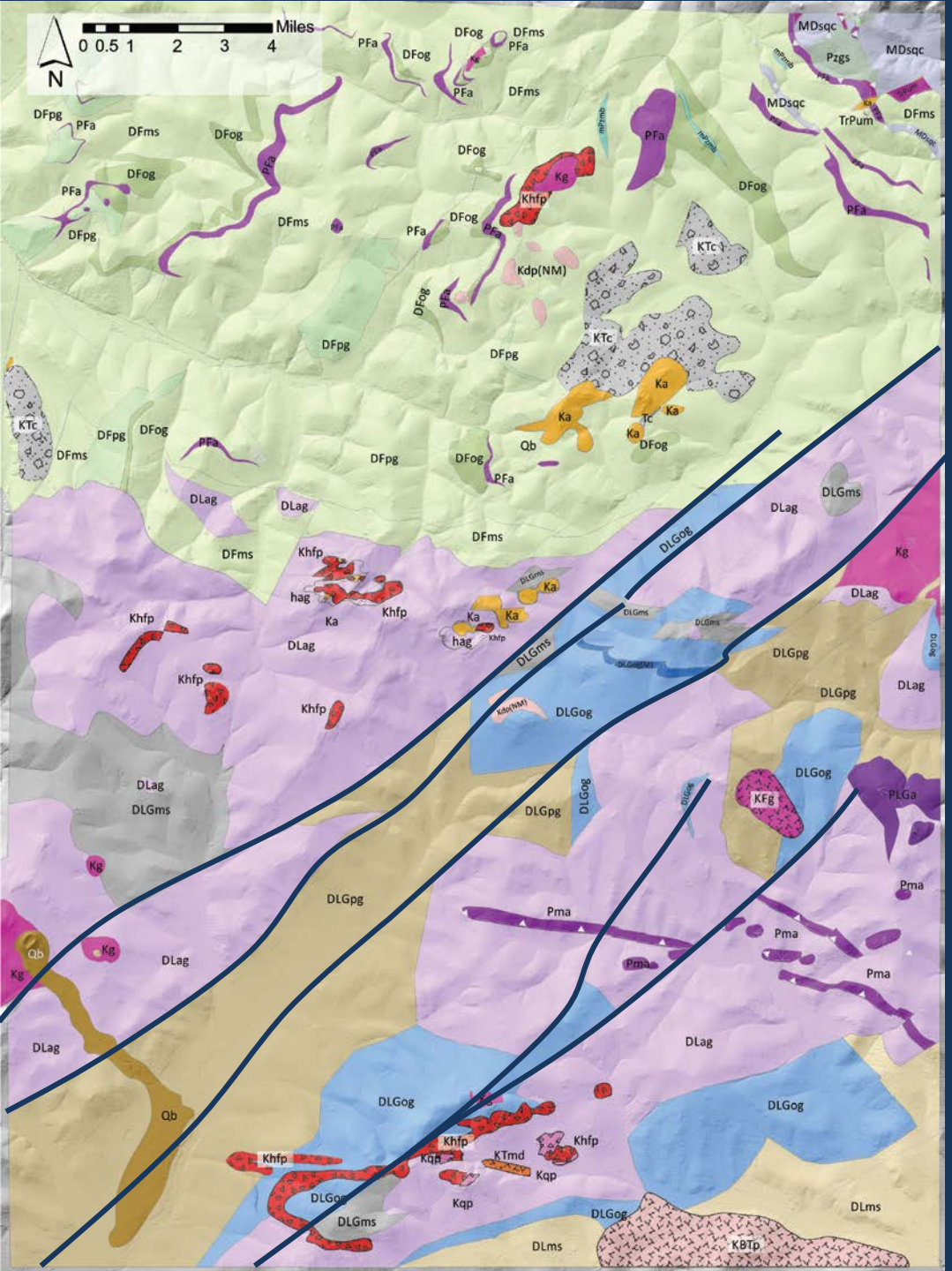
Photo by: K. Sicard



Structures

Fortymile-Lake George boundary

- Fortymile-Lake George boundary (Red) has been previously interpreted as a thrust fault or as a low angle detachment (north dipping).
  - LL-normal oblique fault slip indicators on west striking faults above and below the detachment.
- Na-enrichment north of the fault
- Graphitic zones that likely encouraged or focused slip
- Different argon cooling ages between upper and lower plate (USGS)
- Distinctive packages of rock
- Changes in foliation and lineation
- Age constrained by Ar/Ar dating ~102 Ma



Structures

Sixtymile-Pika fault zone

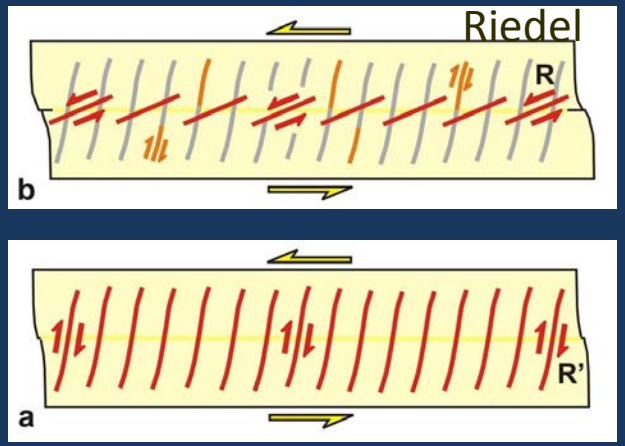
- Multiple, parallel high-angle, strike slip faults with LL oblique motion
- Much larger zone than originally mapped
- LL shear sense that offsets the low-angle extensional detachment fault(s)
- Cuts serpentinites mapped in the field and in geophysical surveys.
- Age constrained by Late Cretaceous intrusions?

Structures

Sixtymile-Pika fault zone

- NNE striking faults (black) could be riedel shears or extensional faults related to the Sixtymile-Pika fault. They are 25-40 degrees from the main fault.

- NNW striking faults (red) are less common, but could be right-lateral R-prime shears to the Sixtymile-Pika fault



Structures
foliation and lineation

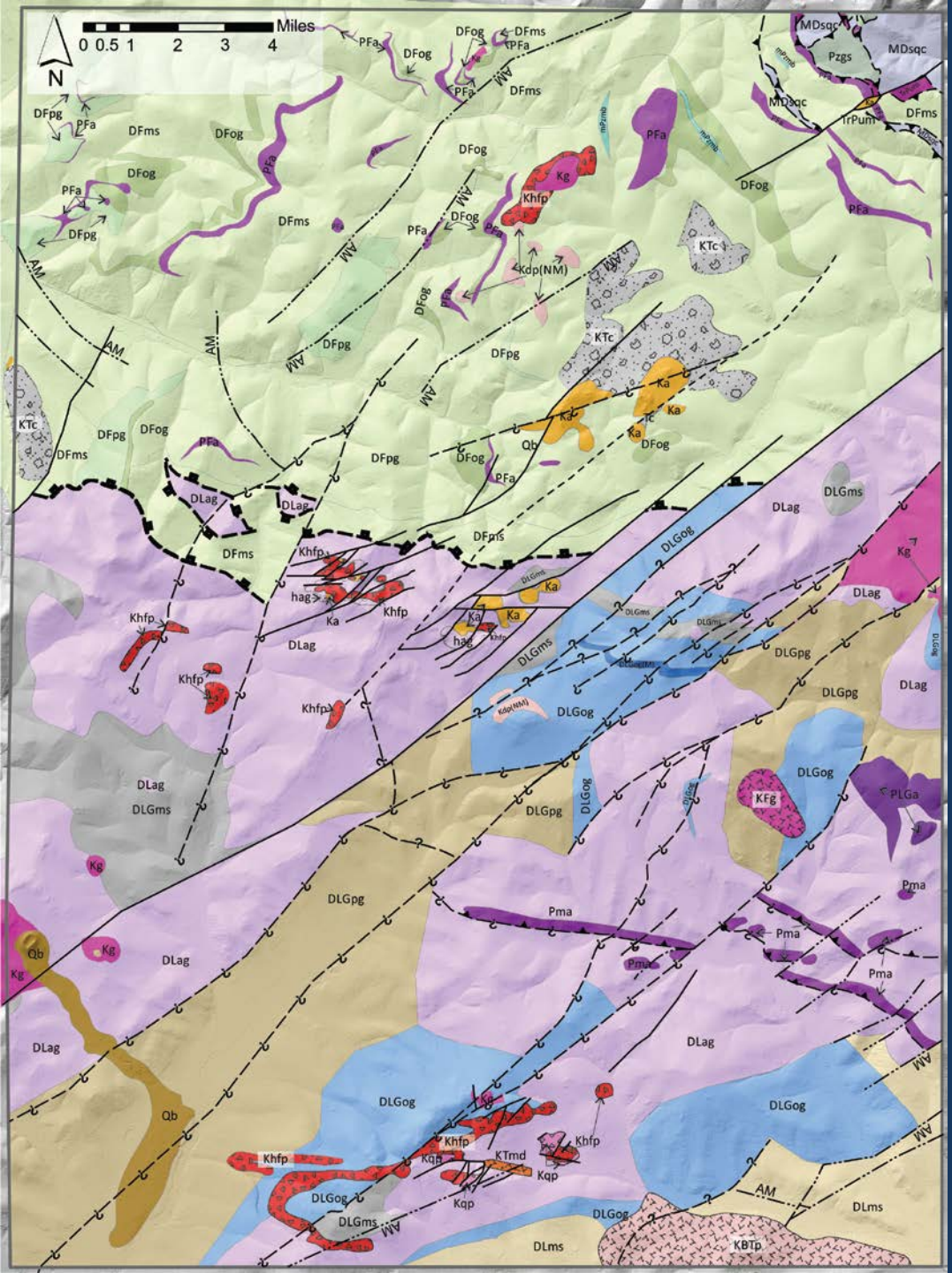
Foliations vary, but are dominantly shallow with NE or SW dip directions, consistent with NE vergent folding at various scales.

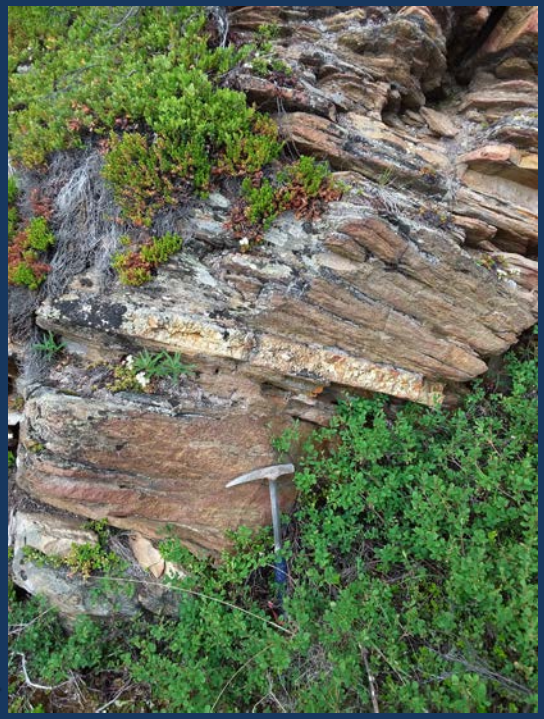
Asymmetric fold axial planes strike NW-SE, indicating NE shortening direction

Photo by E. Twelker

Foliations are locally subparallel to the Sixtymile-Pika fault strike (Black boxes).

Stratigraphy





Photos by: E. Twelker

Lake George assemblage

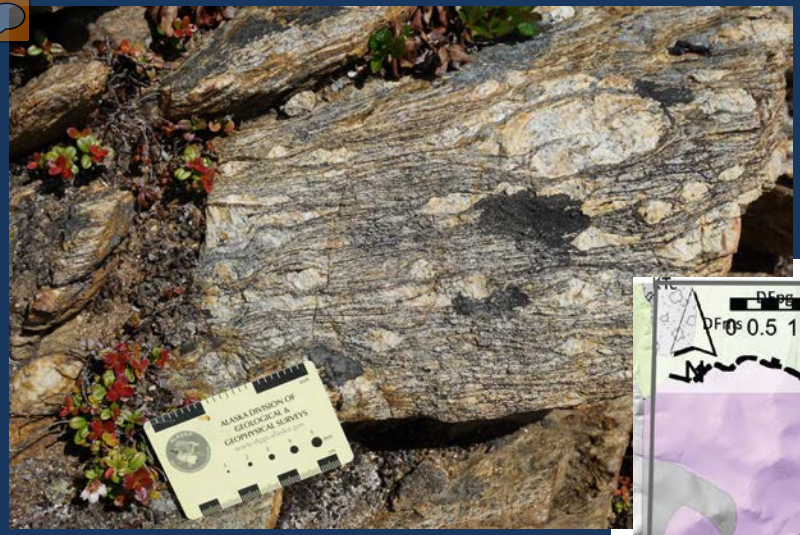


Photo by: M. Willingham

PLGa	amphibolite
DLag	augen gneiss
hag	hornfels zone (sericitized)
DLGog(M)	orthogneiss, magnetite rich
DLGog	orthogneiss
DLGpg	paragneiss
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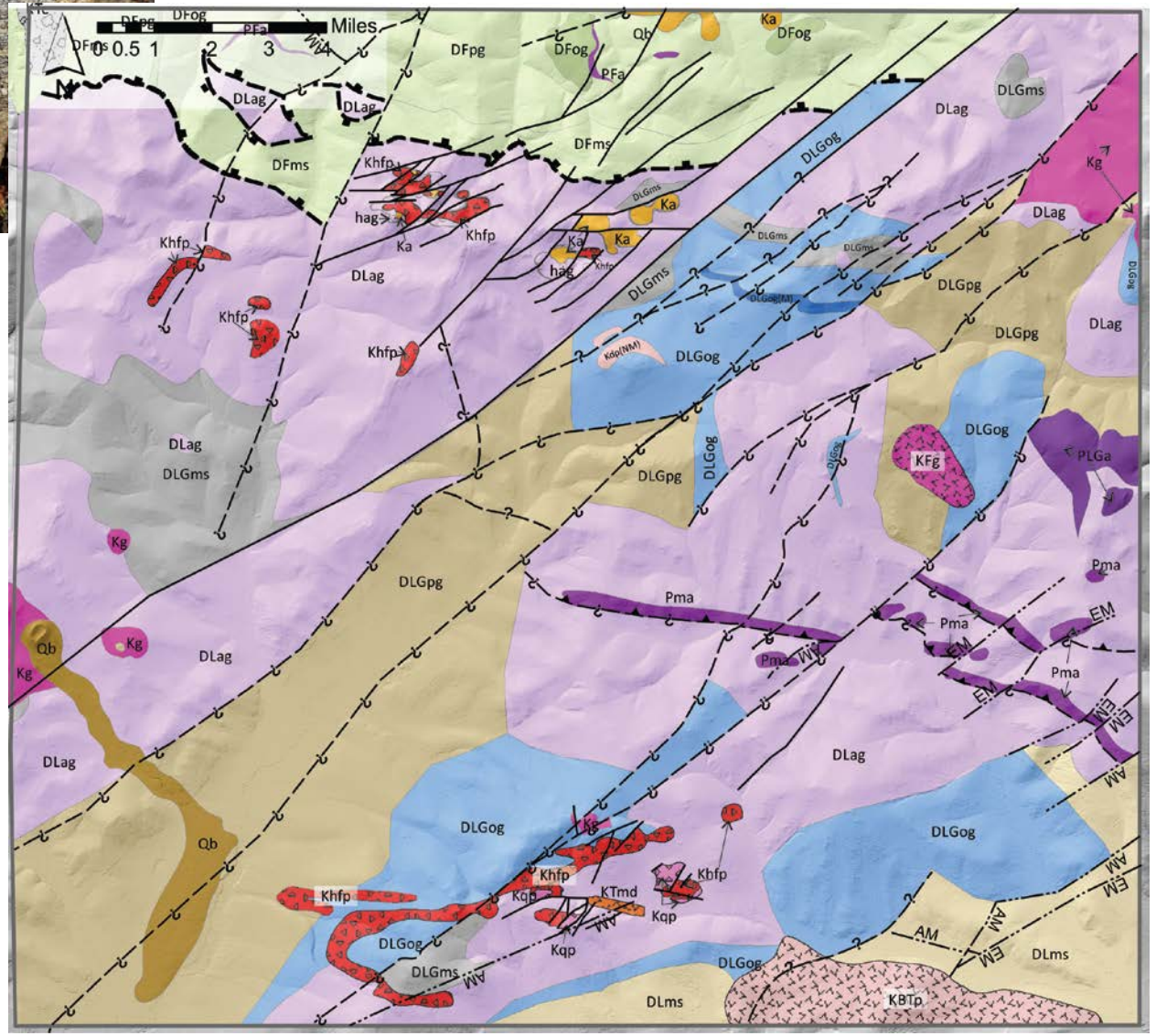
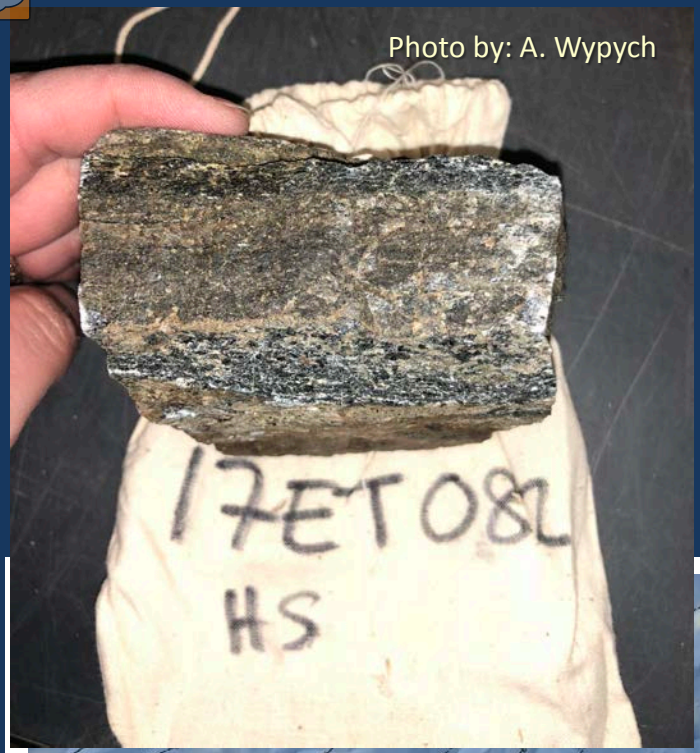
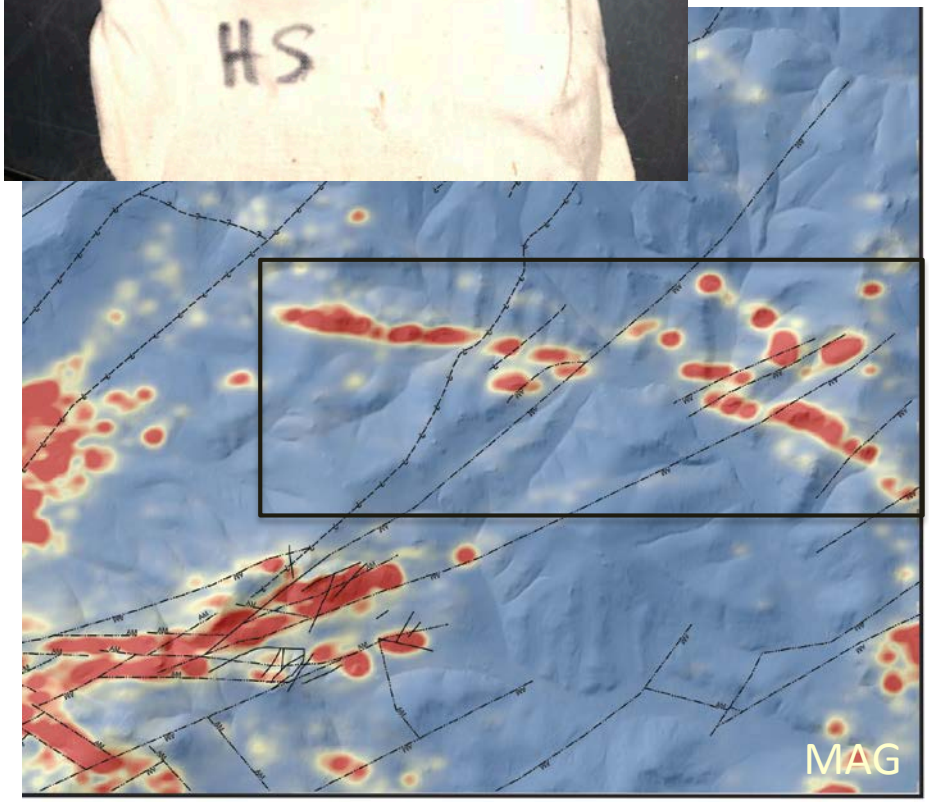
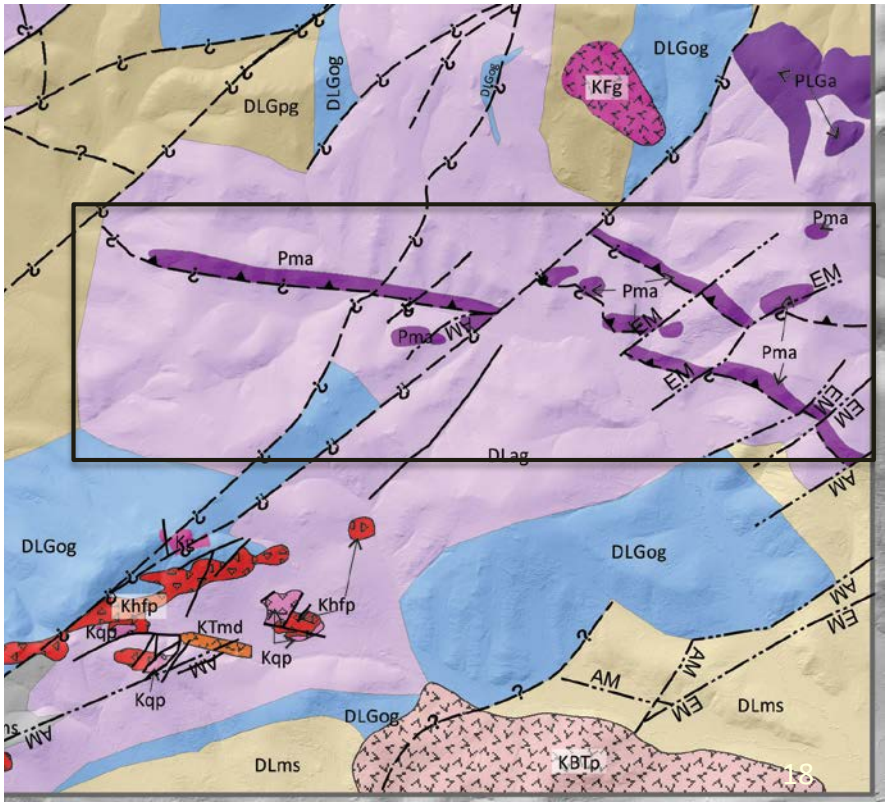




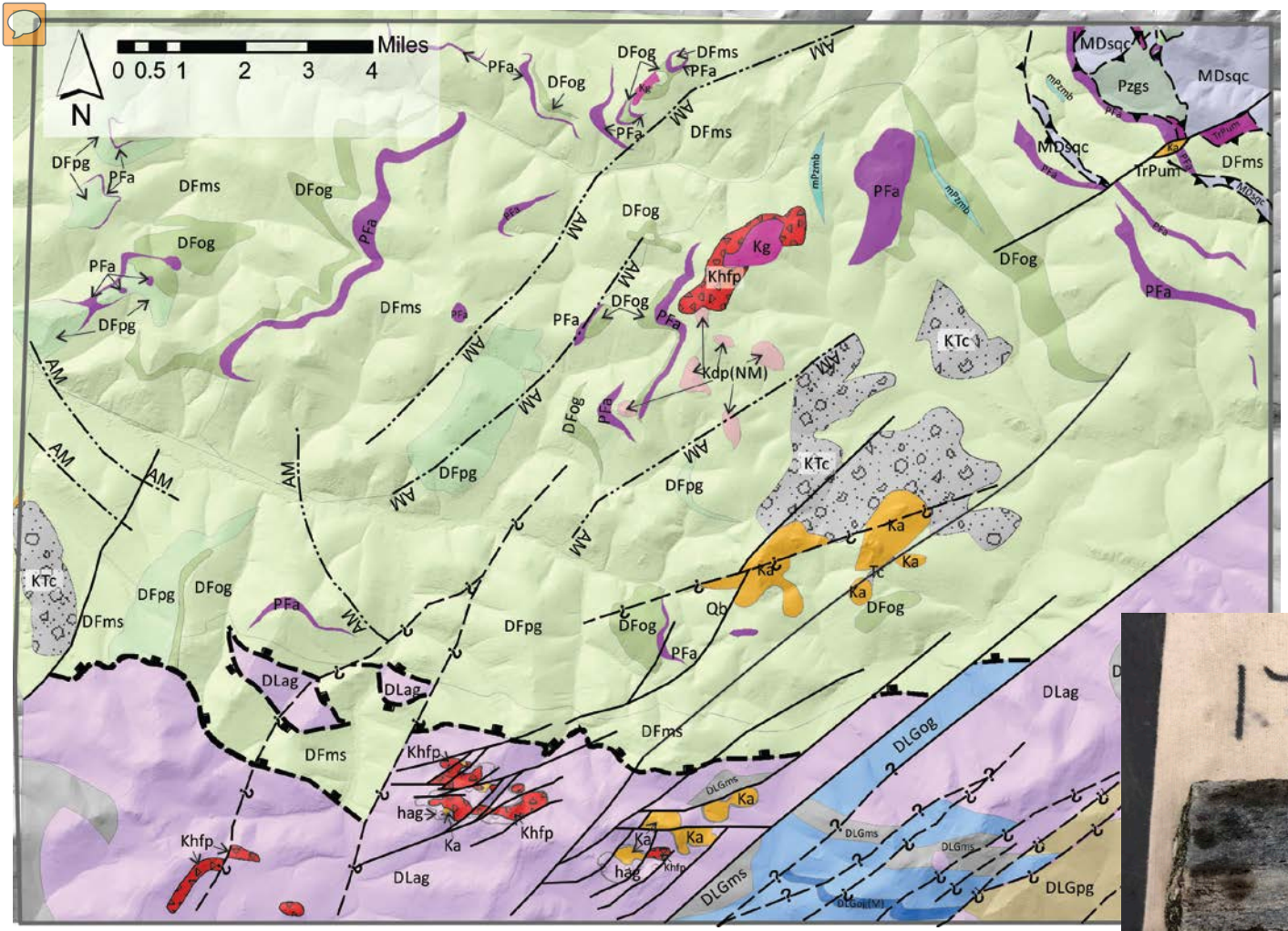
Structurally emplaced?

Pma Amphibolite and serpentinite





Fortymile assemblage



PFa	amphibolite
DFag	augen gneiss
DFog	orthogneiss
DFpg	paragneiss
mPzmb	marble
DFms	semischist and quartzite

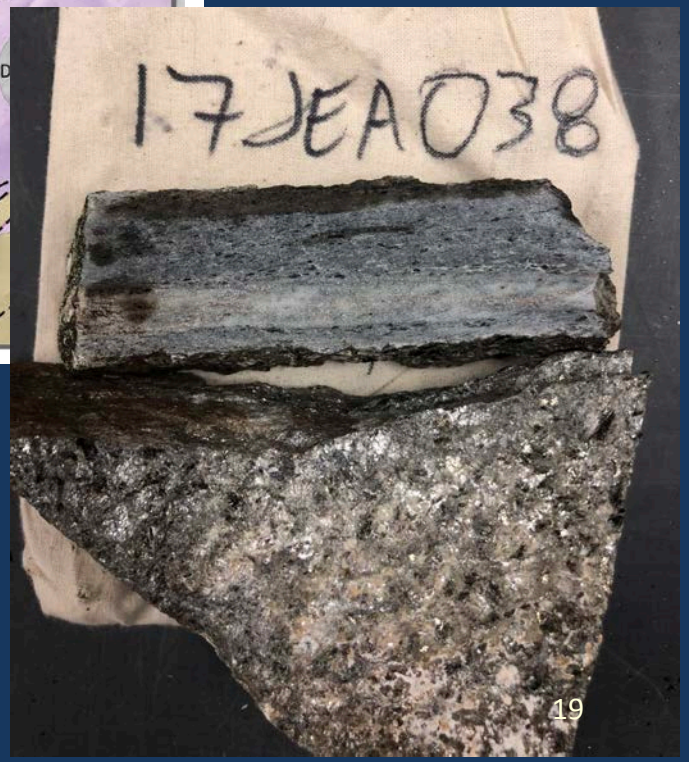


Photo by: A. Wypych

Early Cretaceous igneous rocks

granite and pegmatite

$^{40}Ar/^{39}Ar$ **105.2 Ma**
(17JEA005, Naibert et al. 2018)

Late Cretaceous/ Early Tertiary igneous rocks

dioritic porphyry (non-magnetic)

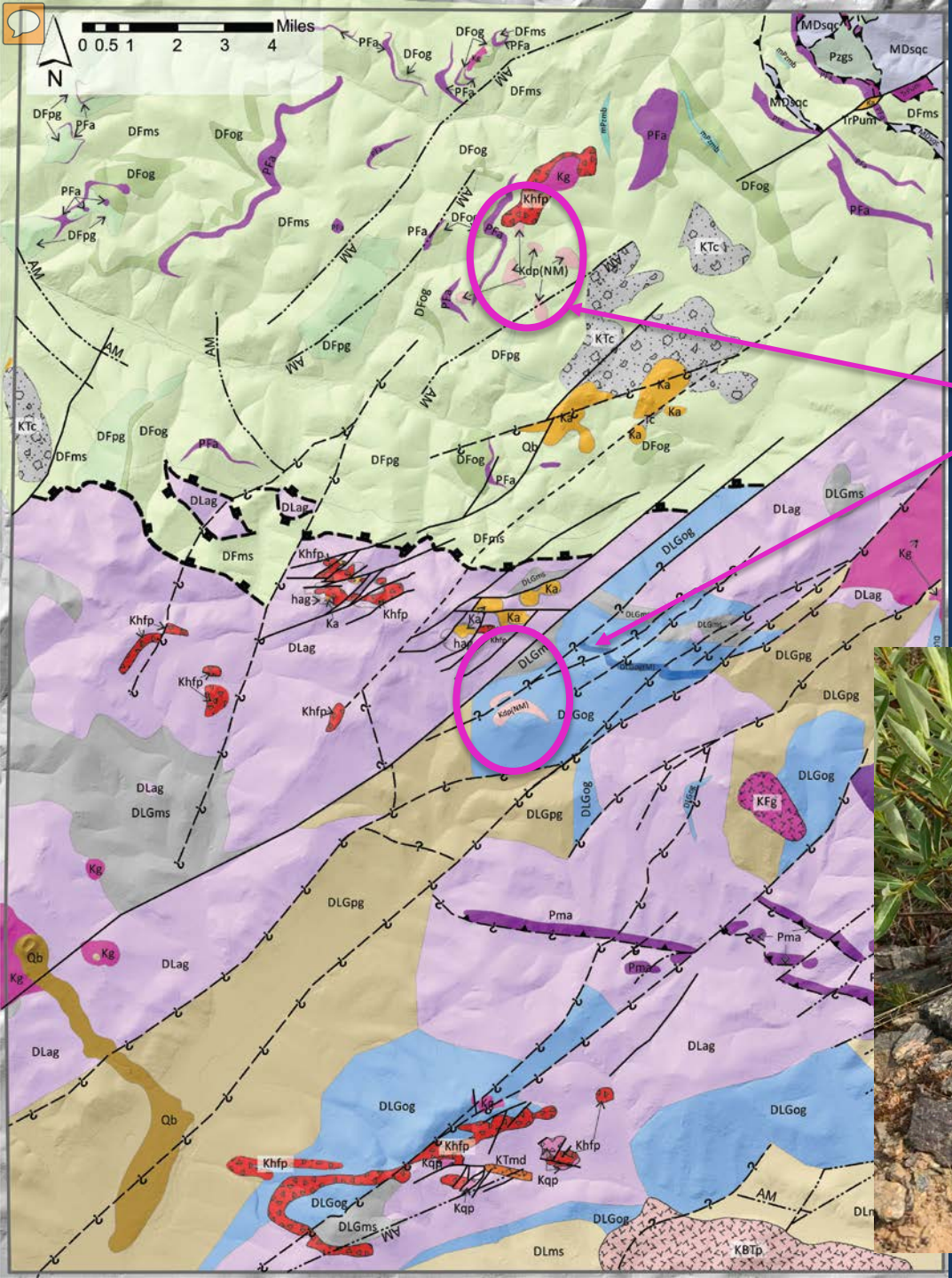


Photo by: K. Sicard

Late Cretaceous/ Early Tertiary igneous rocks

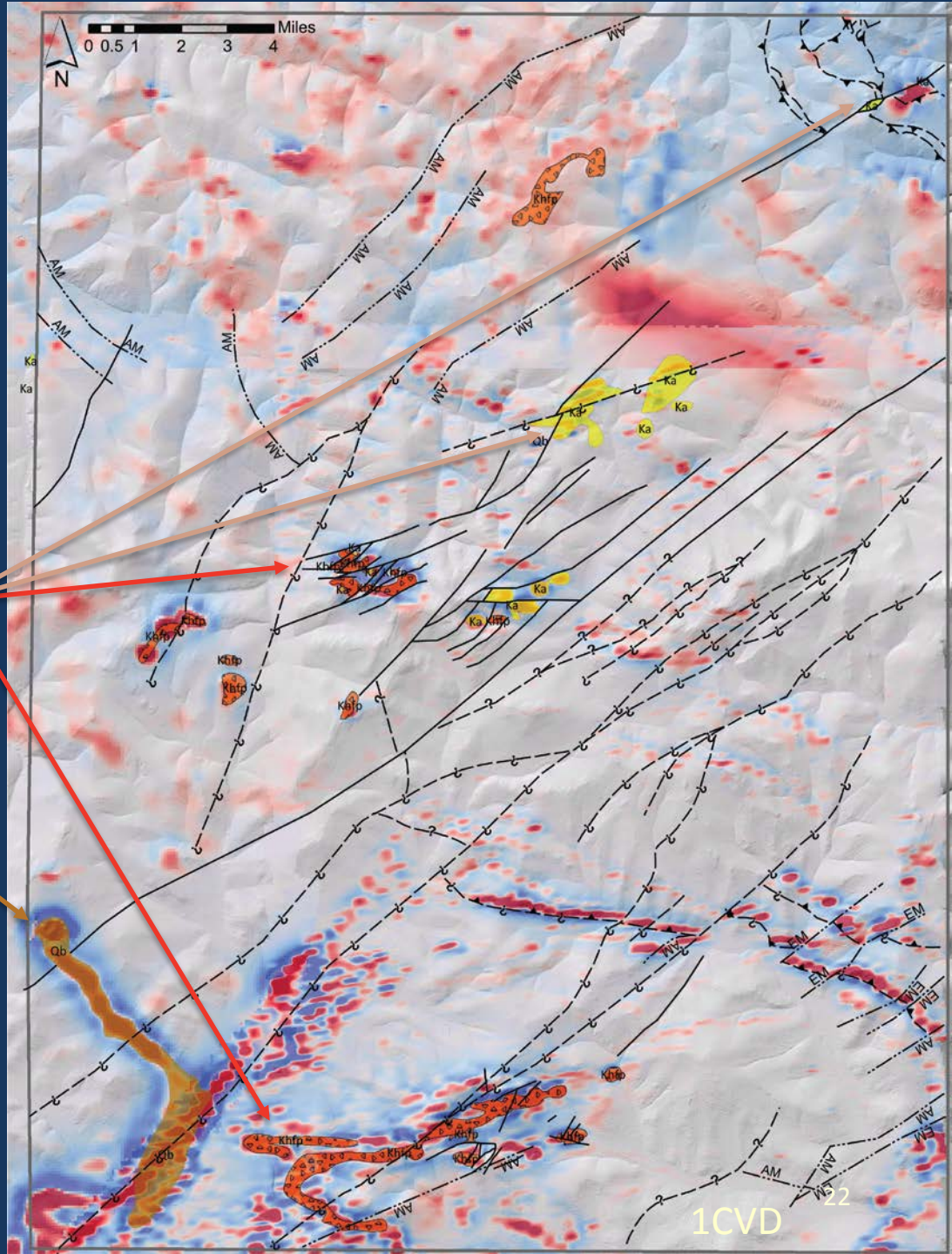
Total Magnetic Field

Magnetic porphyries and lava flows

Prindle volcano

magnetic

non-magnetic

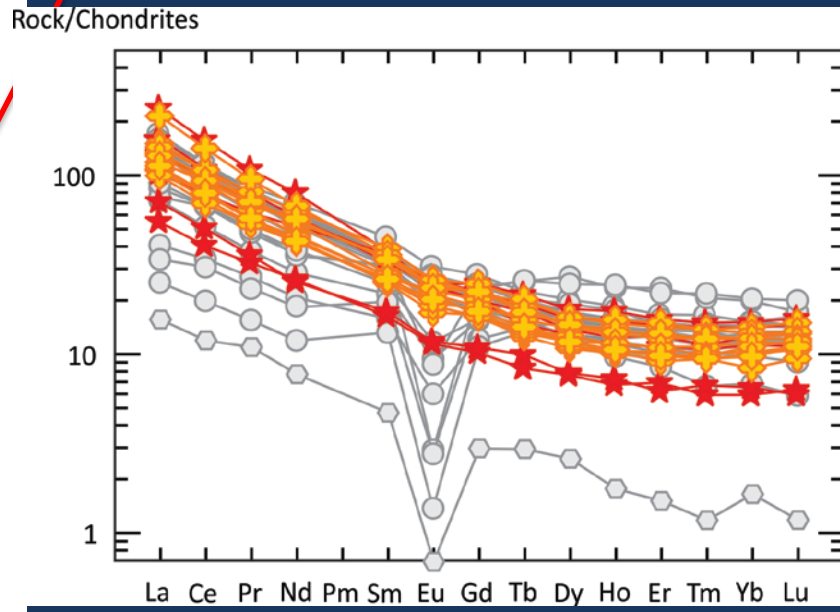


Late Cretaceous/ Early Tertiary igneous rocks

andesites

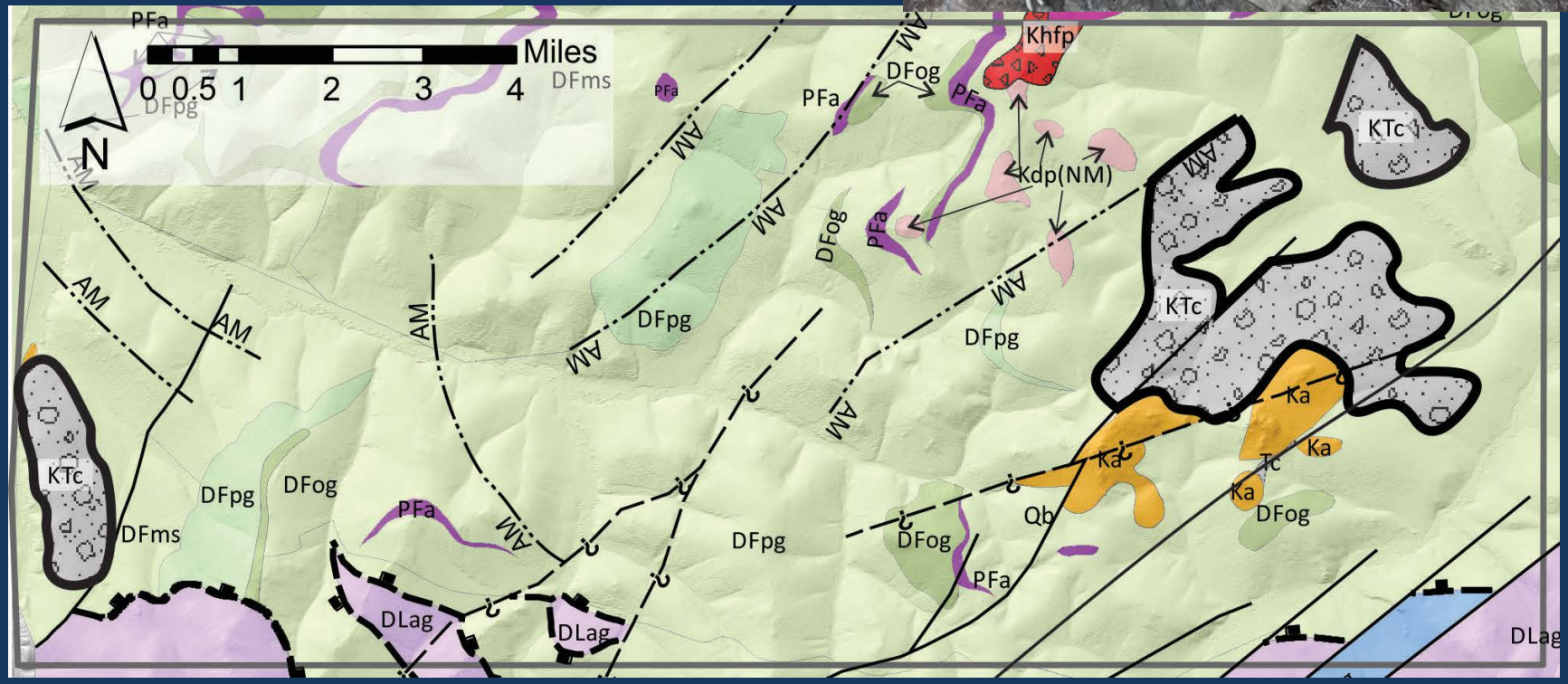
hornblende porphyry

$^{40}Ar/^{39}Ar$ **66.3 Ma**
(17MBW213, Naibert et al. 2018)

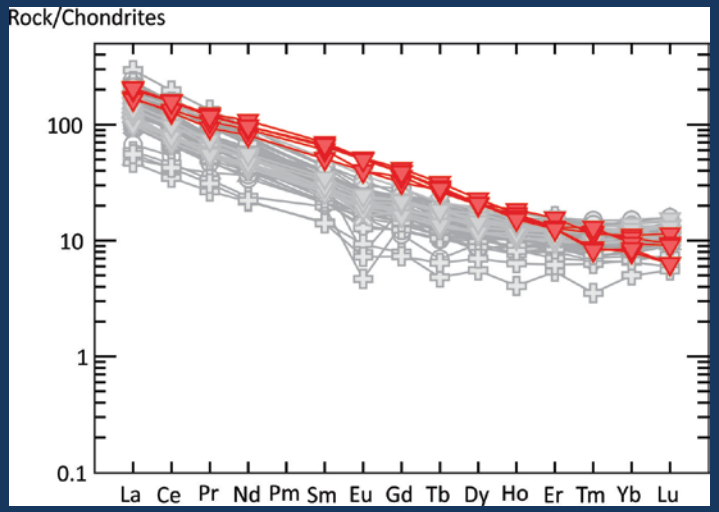


Wypych et al. 2017 and Wypych et al. 2018

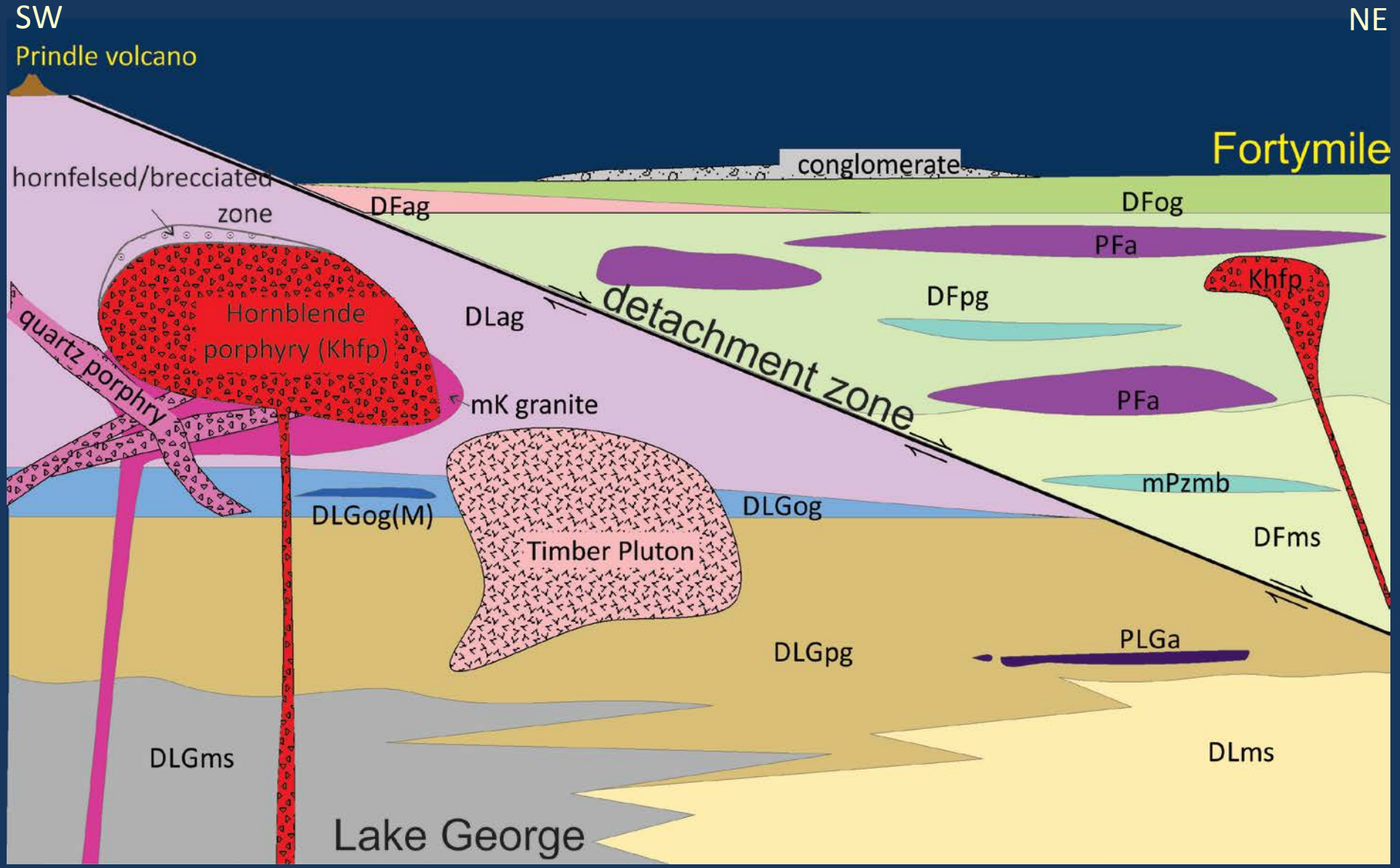
Cretaceous or Tertiary Conglomerates



Quaternary basanites

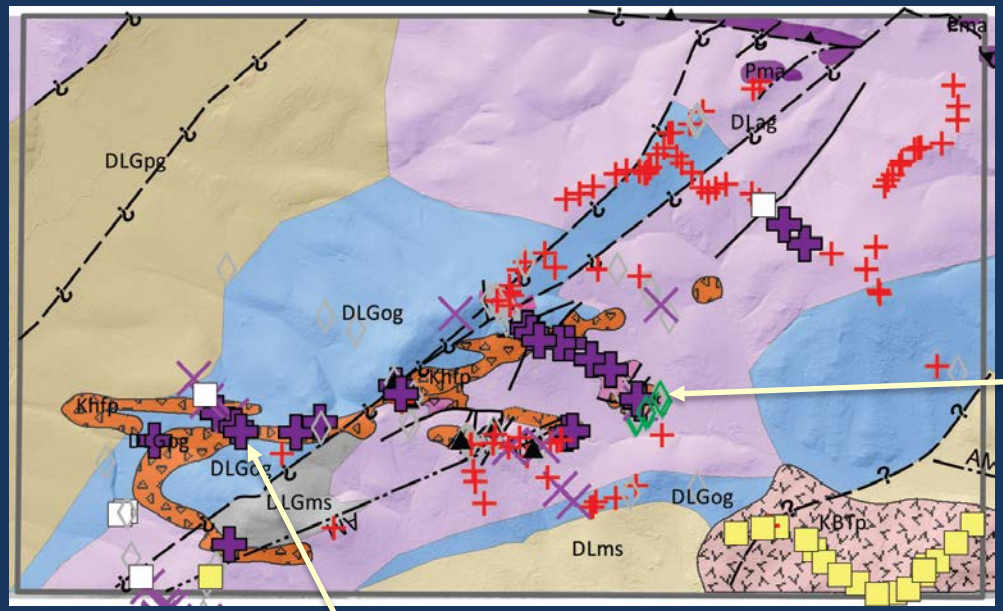


Cartoon cross section



Mineralization

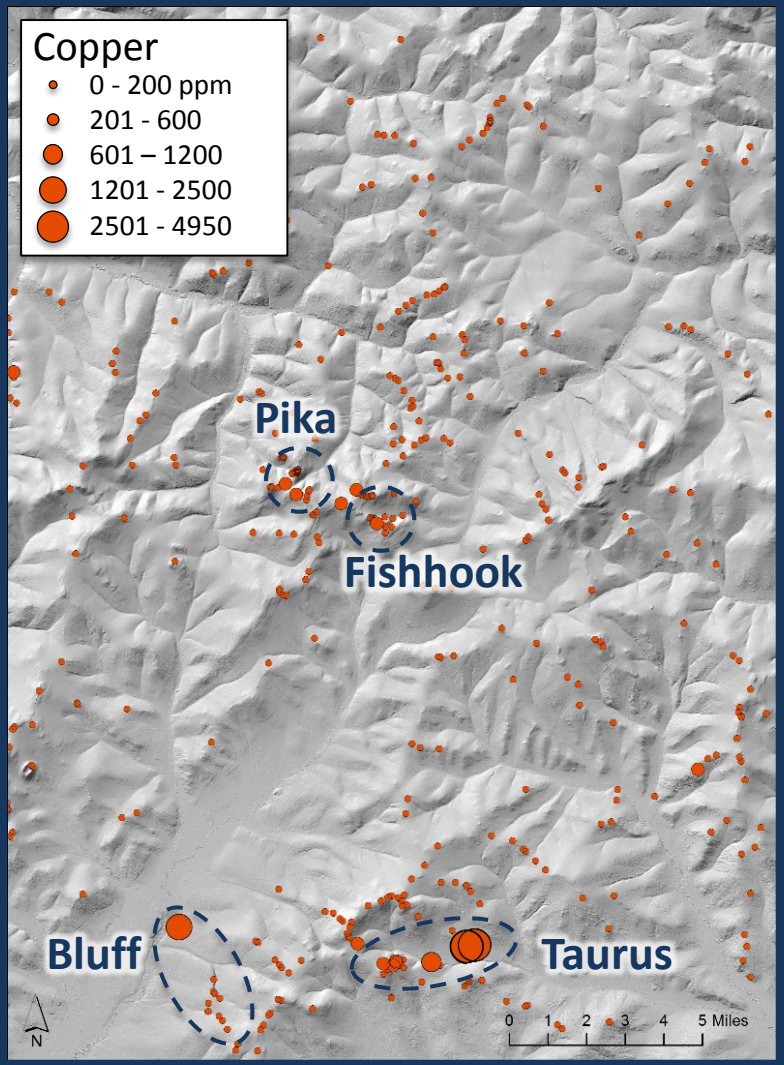
Taurus, Bluff area porphyry systems

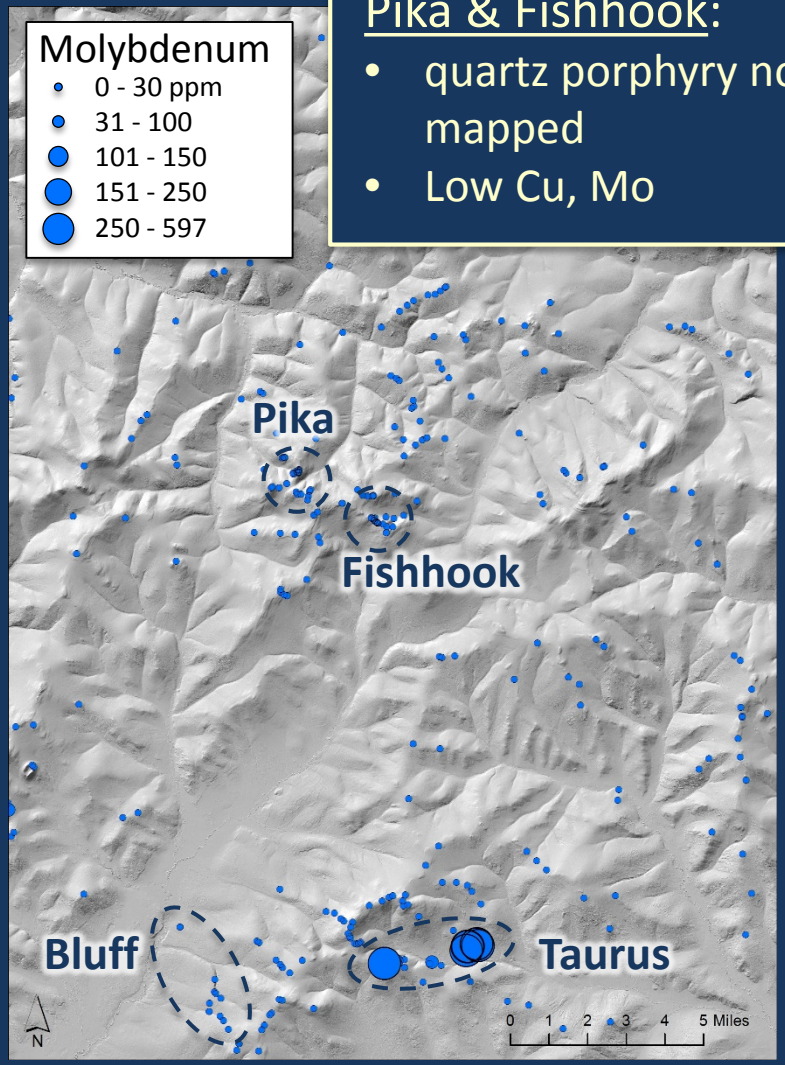


Taurus quartz-feldspar porphyry
Age 70-72 Ma

Late/post-mineral, magnetite-rich quartz monzonite, hornblende-feldspar porphyry

Copper, Molybdenum



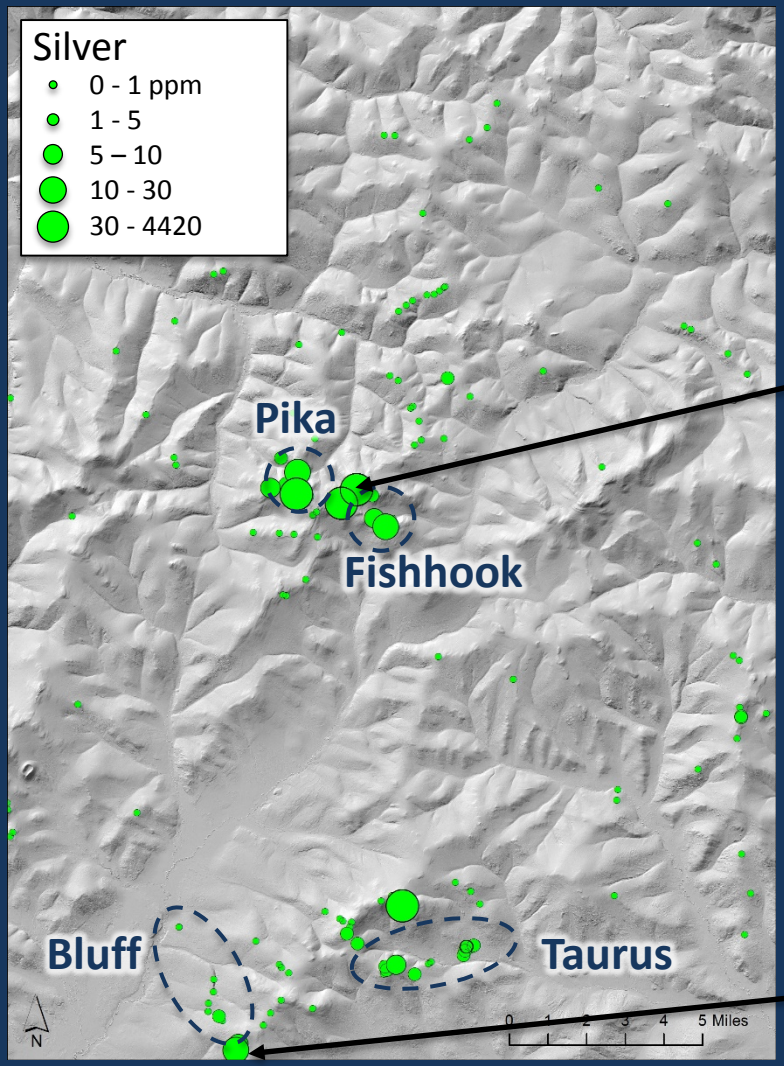


Pika & Fishhook:

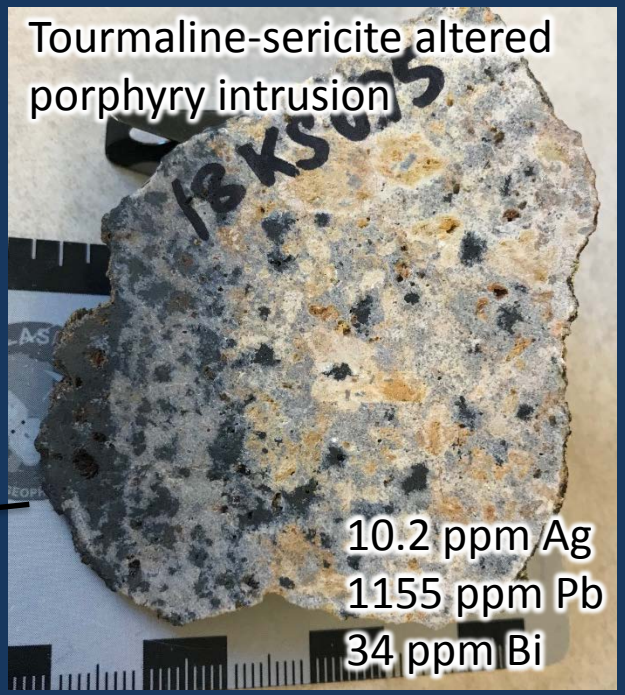
- quartz porphyry not mapped
- Low Cu, Mo

Wypych et al. 2017 and Wypych et al. 2018

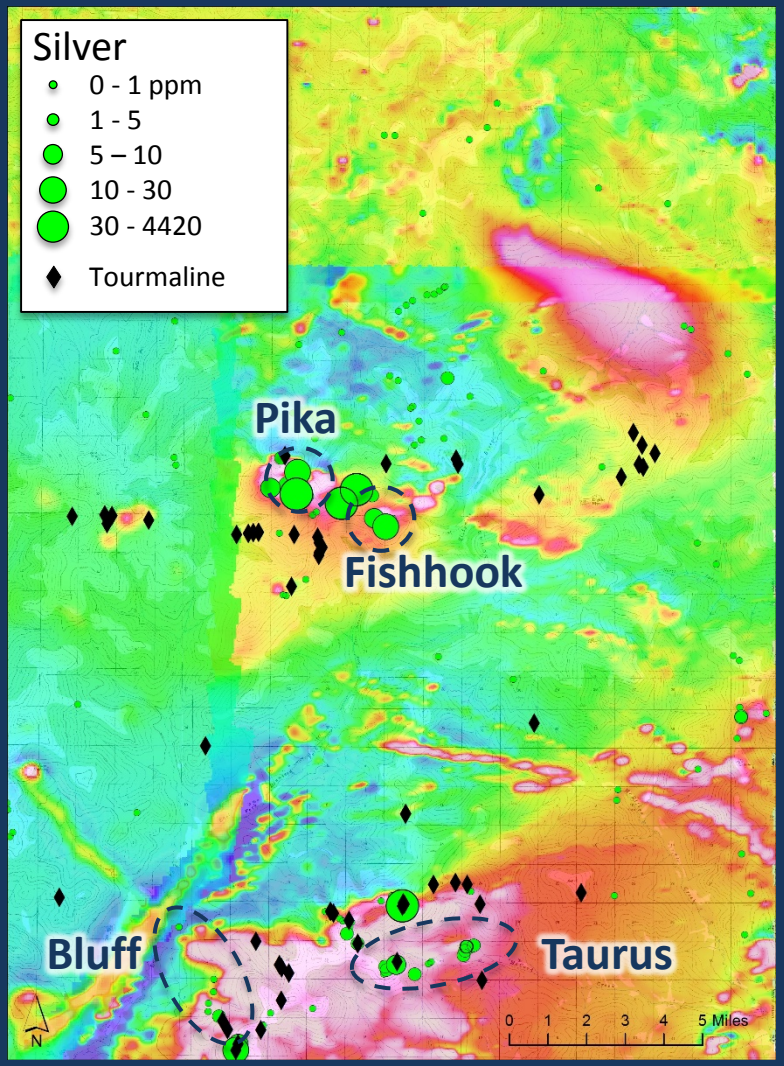
Geochem results: Silver



Wypych et al. 2017 and Wypych et al. 2018



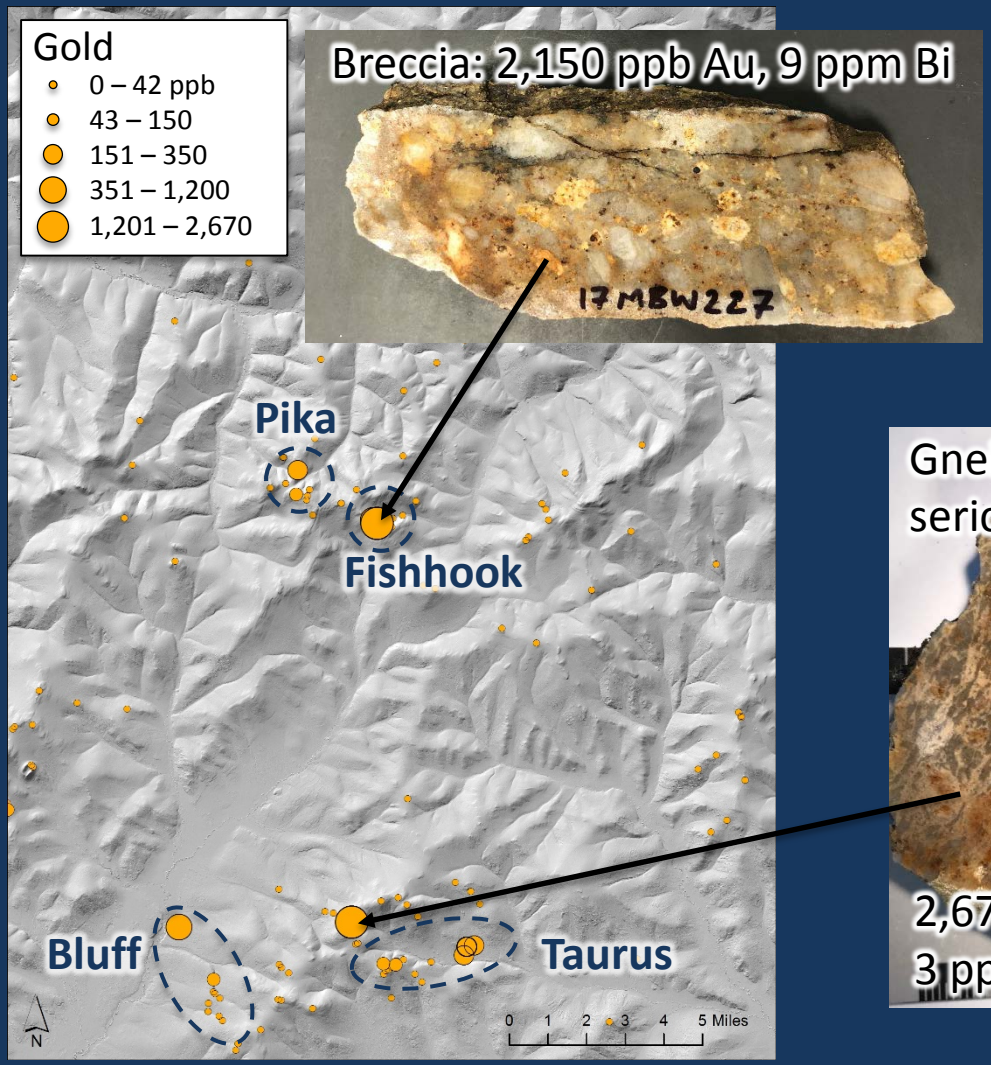
Silver (Pb-Bi-As) mineralization

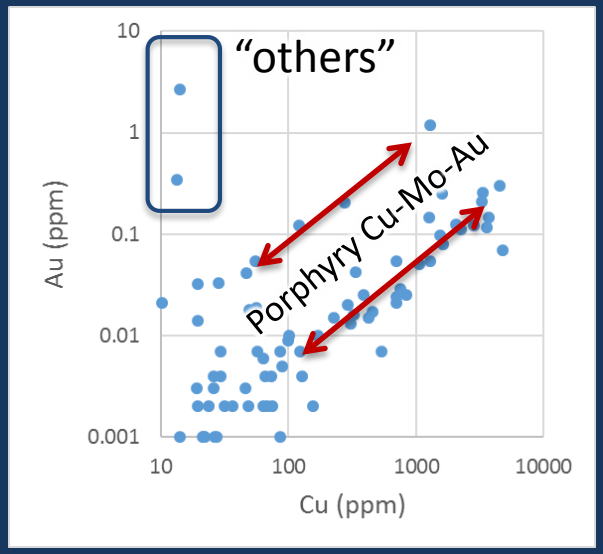


Wypych et al. 2017 and Wypych et al. 2018

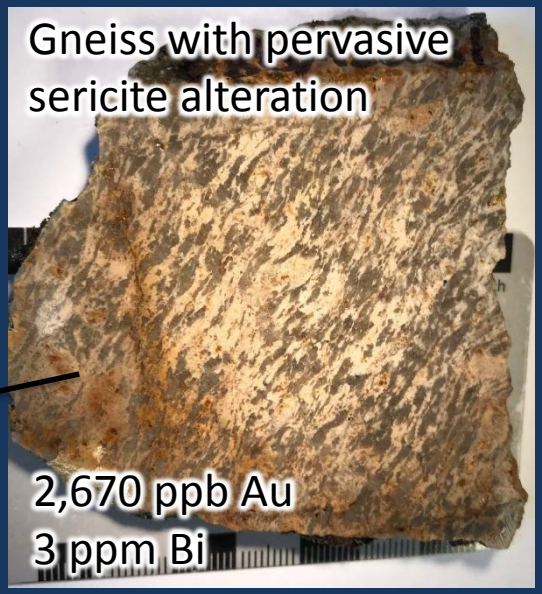
- Younger (68-70 Ma) series of magnetite-rich intrusions appear to be related to silver mineralization
  - Pika hornblende porphyry
  - Taurus post-mineral quartz monzonite
- **Tourmaline** alteration:
  - Assoc. mag highs
  - Assoc. silver mineralization
  - Not found with Taurus Cu-Mo-Au system alteration
- Silver (Pb-Bi-As) could represent a separate, slightly later metallogenic event

Geochem results: Gold





Wypych et al. 2017 and Wypych et al. 2018



1) Porphyry-type Cu-Mo-Au and 2) distal, gold-only systems are present here
Both related to intrusive centers

Finishing Stages Work

- Map completion and delivery to USGS for Statemap Grant deliverables
- Further Ar/Ar dating of existing samples
- Further U-Pb dating
- Transmitted and reflected light petrographic analysis of existing samples
- Microprobe analysis

Thank you!

Top Gun III ?

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