Updates on DGGS Geologic Mapping Efforts in Eastern Interior Alaska

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Alaska Division of Geological & Geophysical Surveys

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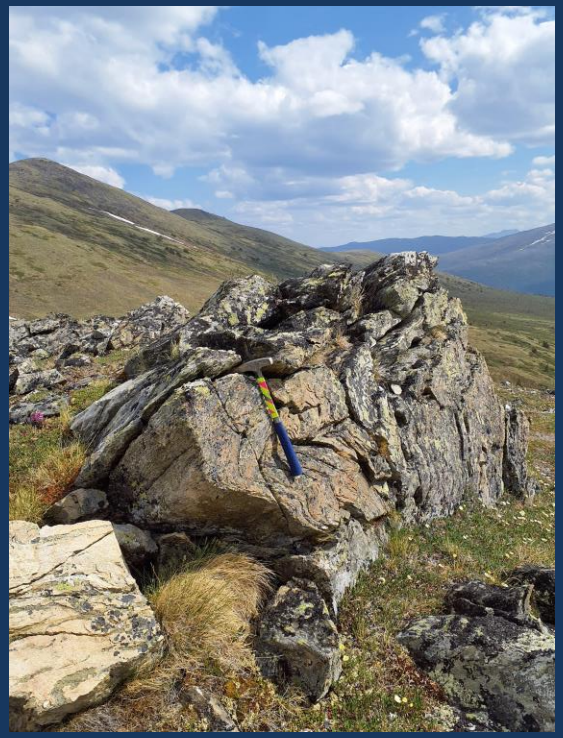
- Northern Star Pogo exploration team
- Millrock Resources



- Kenorland Minerals
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- New Mexico Geochronology Research Lab
- Arizona Laserchron
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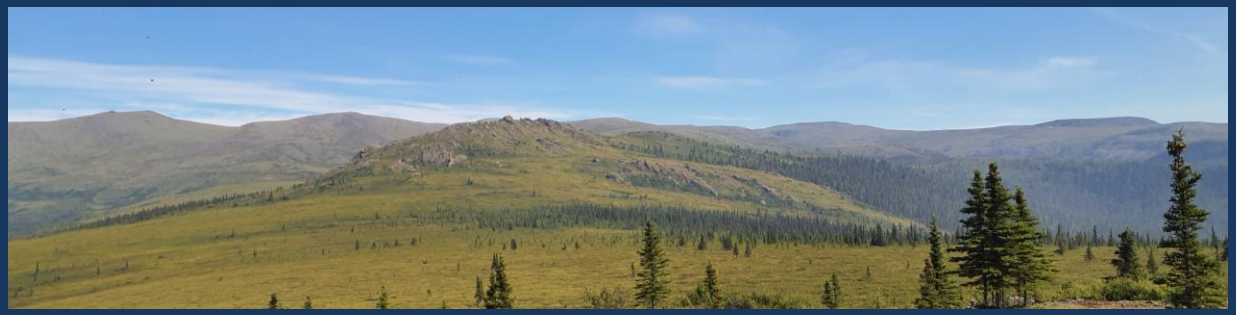
- Assistance from other DGGS staff including Melanie Werdon, Simone Montayne, Chris Wyatt, Noel Blackwell, Dylan Avirett, Angie Hubbard, Izzy Muller, David Harvey, Steve Masterman, Felisa Childress, and others!

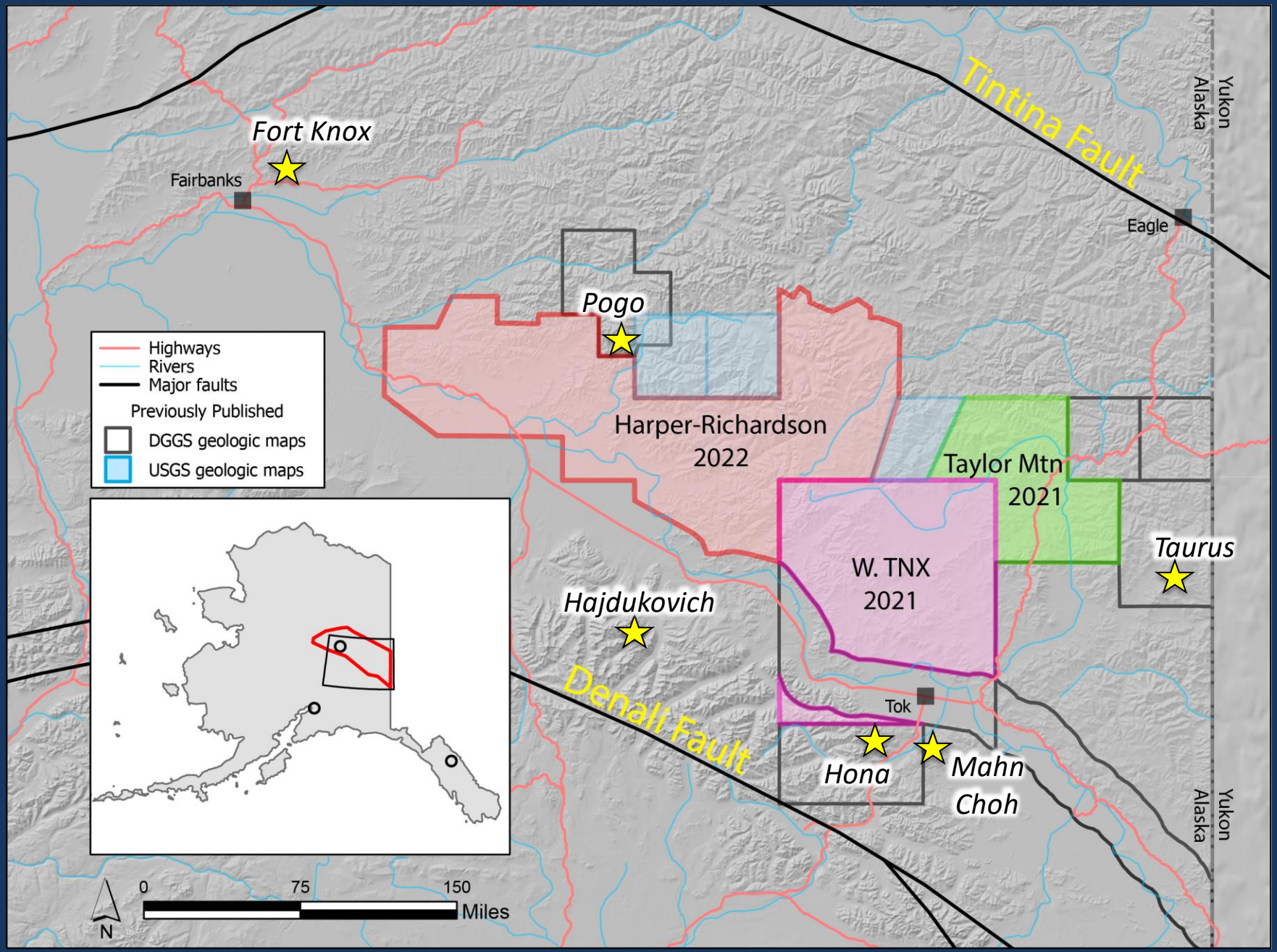
Where have we been mapping?



What have we learned?

- Distinguishing terranes and assemblages
- Investigating shear zones and faults
- Au mineralization in the map areas

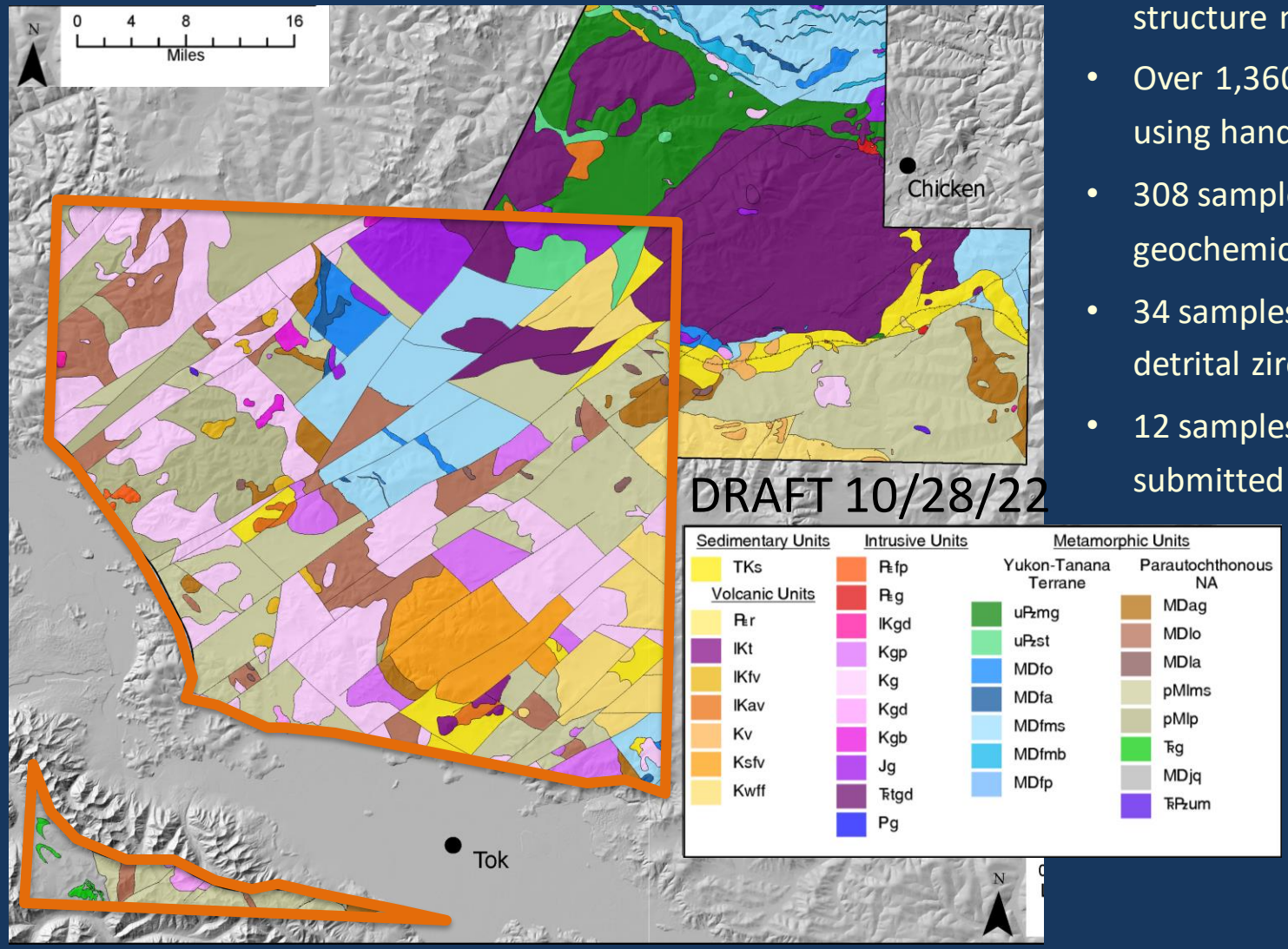
Where have we been mapping?



Where have we been mapping?

Western Tanacross Project

4,451 km^2 (1,718 mile^2)



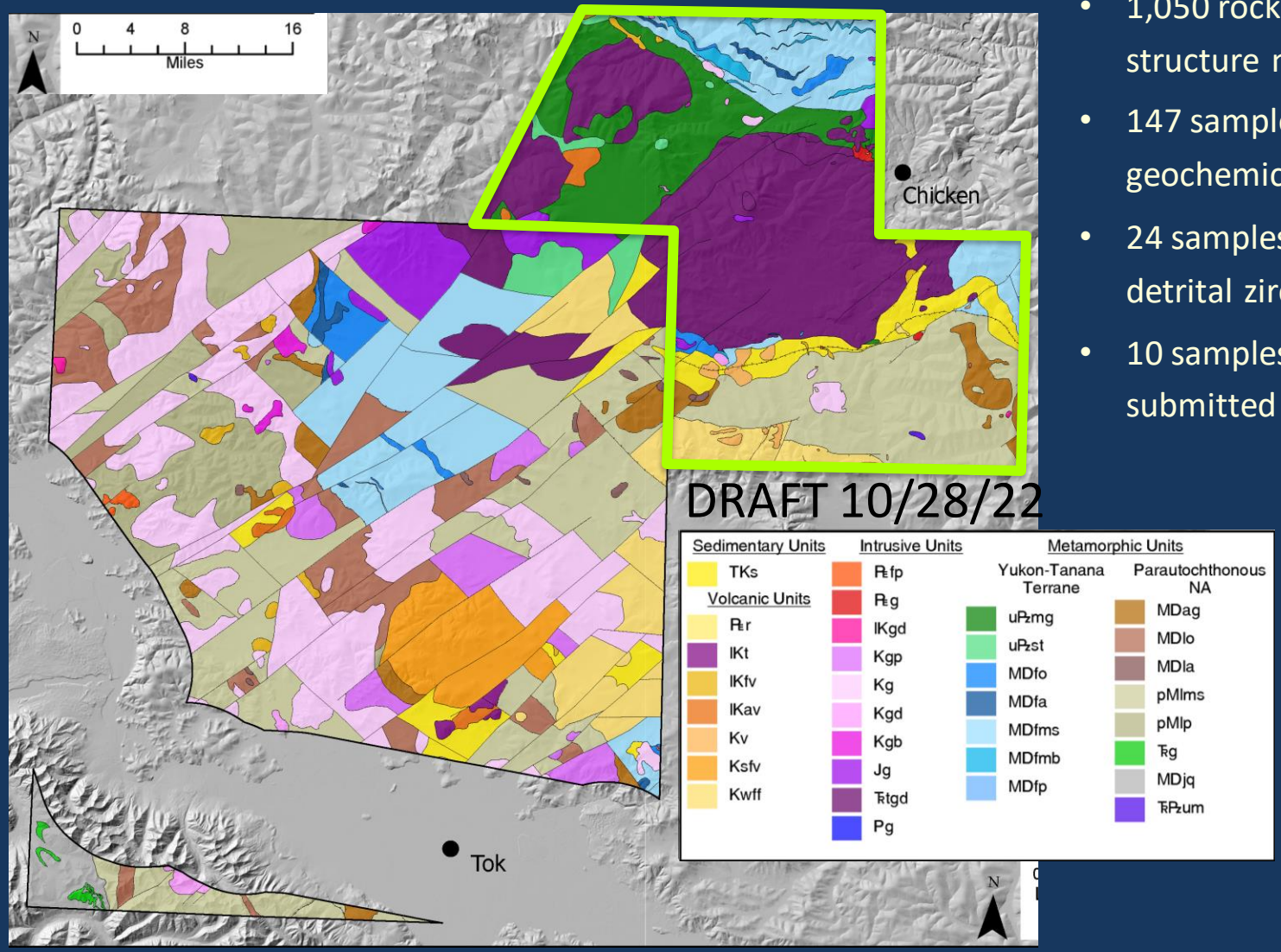
Five weeks – summer 2021

- 1,729 rock stations and 398 structure measurements
- Over 1,360 samples analyzed using hand-held XRF
- 308 samples analyzed for geochemical composition
- 34 samples analyzed for U/Pb or detrital zircon (DZ)
- 12 samples selected and submitted for Ar/Ar analysis

Where have we been mapping?

Taylor Mountain Project

2,320 km^2 (900 mile^2)

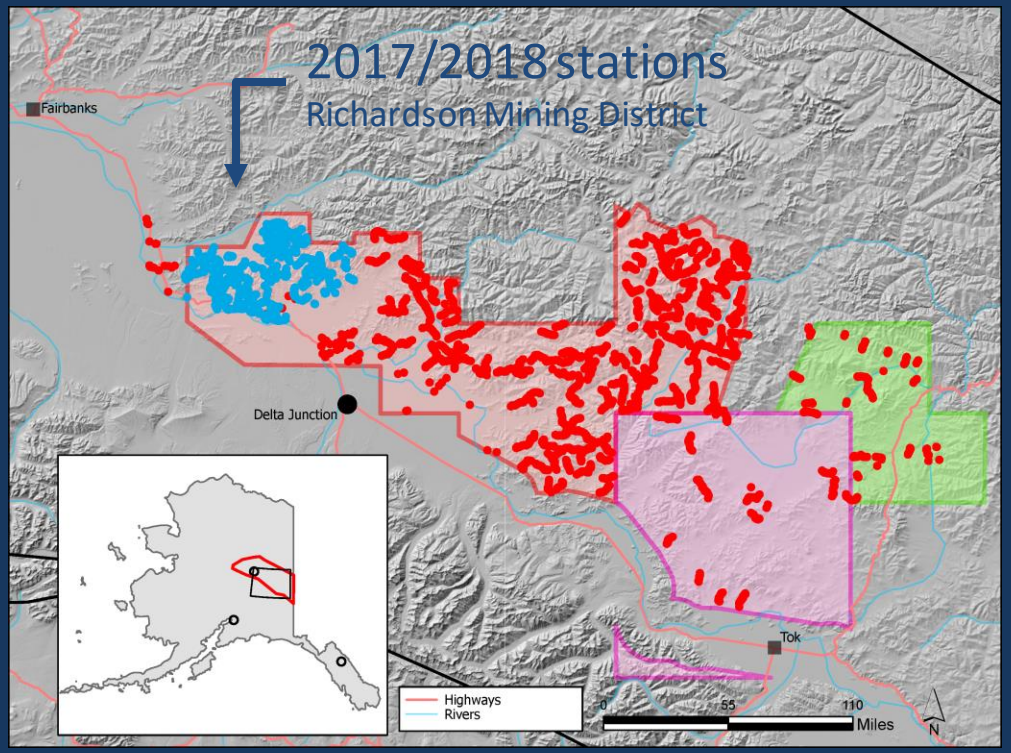


Two+ weeks – summer 2021

- 1,050 rock stations and 255 structure measurements
- 147 samples analyzed for geochemical composition
- 24 samples analyzed for U/Pb or detrital zircon (DZ)
- 10 samples selected and submitted for Ar/Ar analysis

Where have we been mapping?

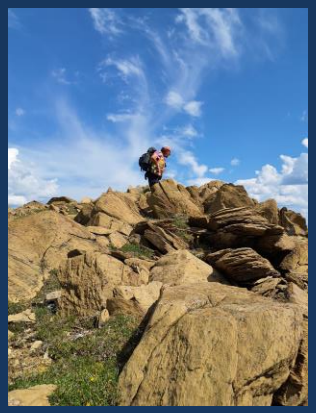
Harper-Richardson Project

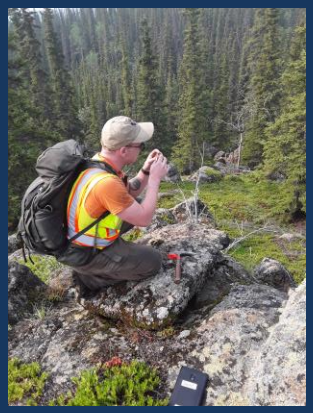


Two weeks revisiting 2021 field areas

Eight weeks mapping the Harper-Richardson area

- ~8,000 km^2 (3,100 mile^2)
- 3,057 rock stations and 661 structure stations
- ~370 geochemical samples to analyze
- 60 U/Pb or DZ samples to analyze
- 24 Ar/Ar samples to analyze





Distinguishing terranes and assemblages

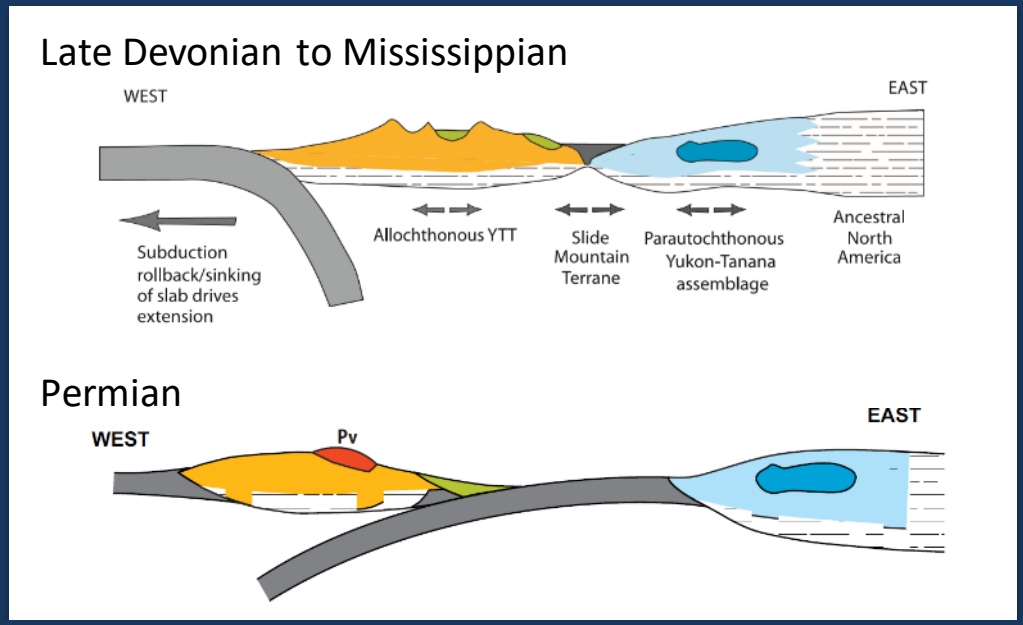
Metamorphic assemblages

- Klondike Schist (Permian volcanic arc)
- Fortymile River assemblage, Chicken assemblage, and Ladue River unit (Miss. volcanic arc and pre-Miss. crust)
- Nasina assemblage (Miss-Permian arc basin)

Yukon Tanana Terrane

- Lake George assemblage, Jarvis Belt, (pre-Miss. North American margin)
- Divide Mountain augen orthogneiss (Dev-Miss. Within-plate)

Parautochthonous NA



- Yukon-Tanana Terrane rifted away from North America in the Late Devonian.
- Rift-related plutons intrude both terranes.
- Subsequent volcanic arcs are built on YTT but not pNA

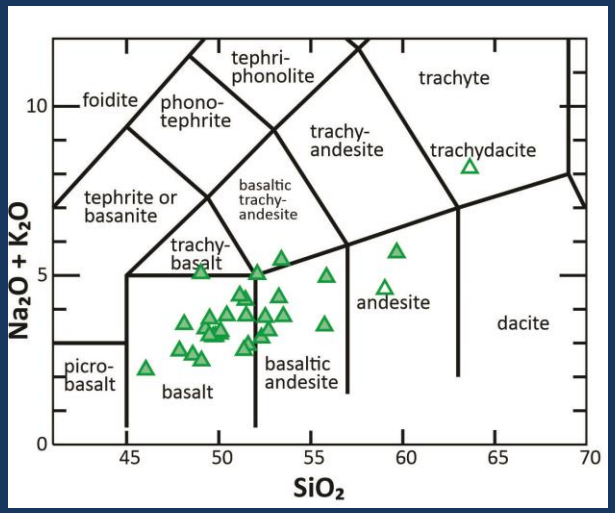
Adapted from Dusel-Bacon and others, 2015

Distinguishing terranes and assemblages

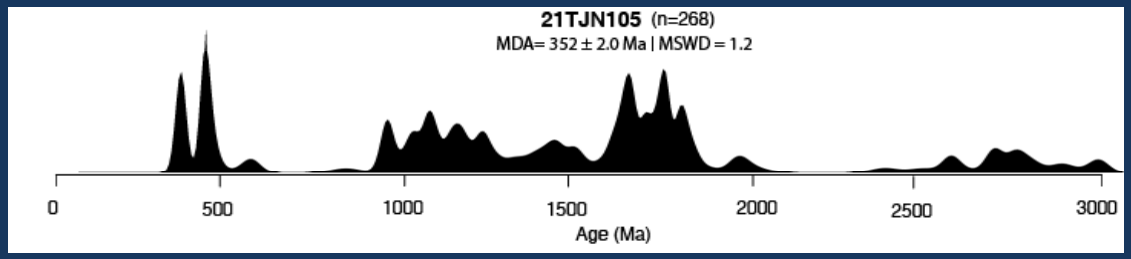
Chicken assemblage

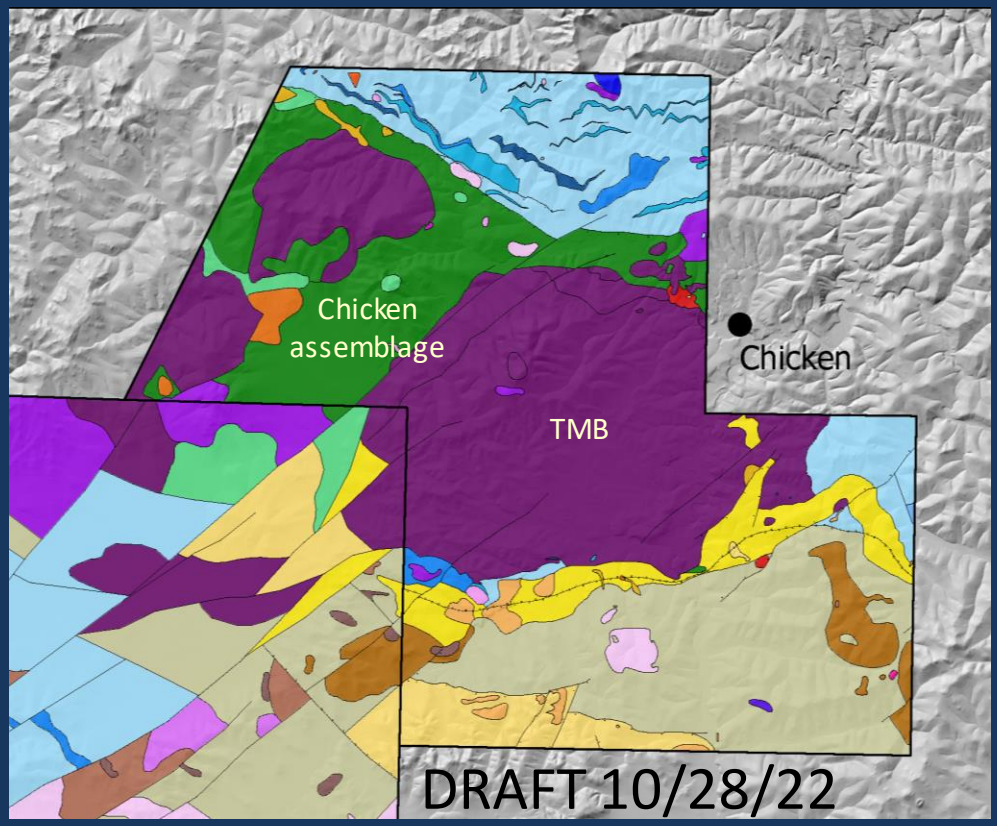
What is it?

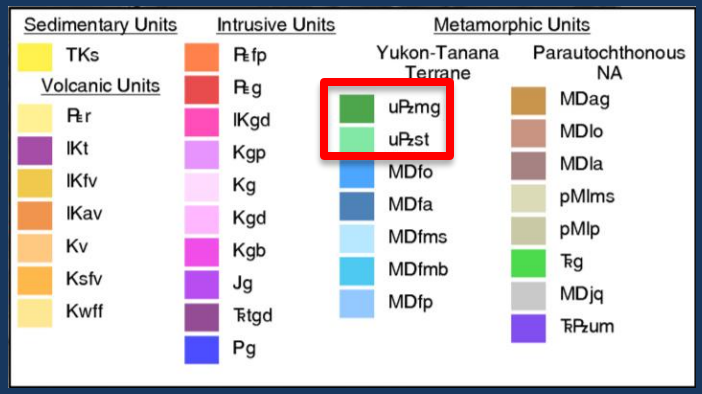
- Greenstones and metagabbros



- Interlayered metasediments suggest mafic rocks are volcanic or dikes/sills



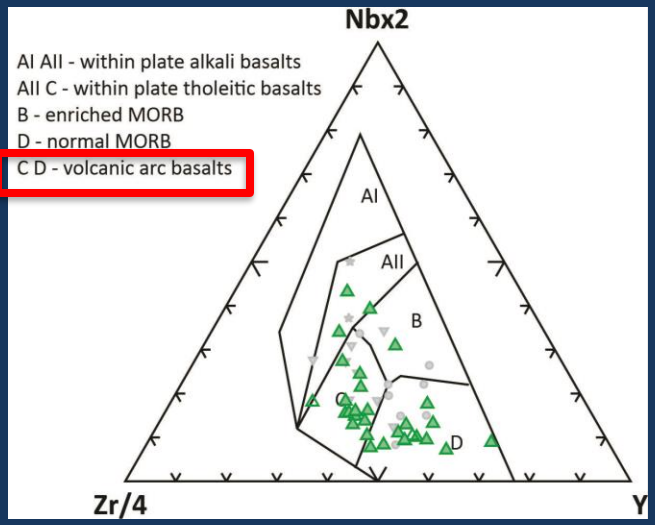


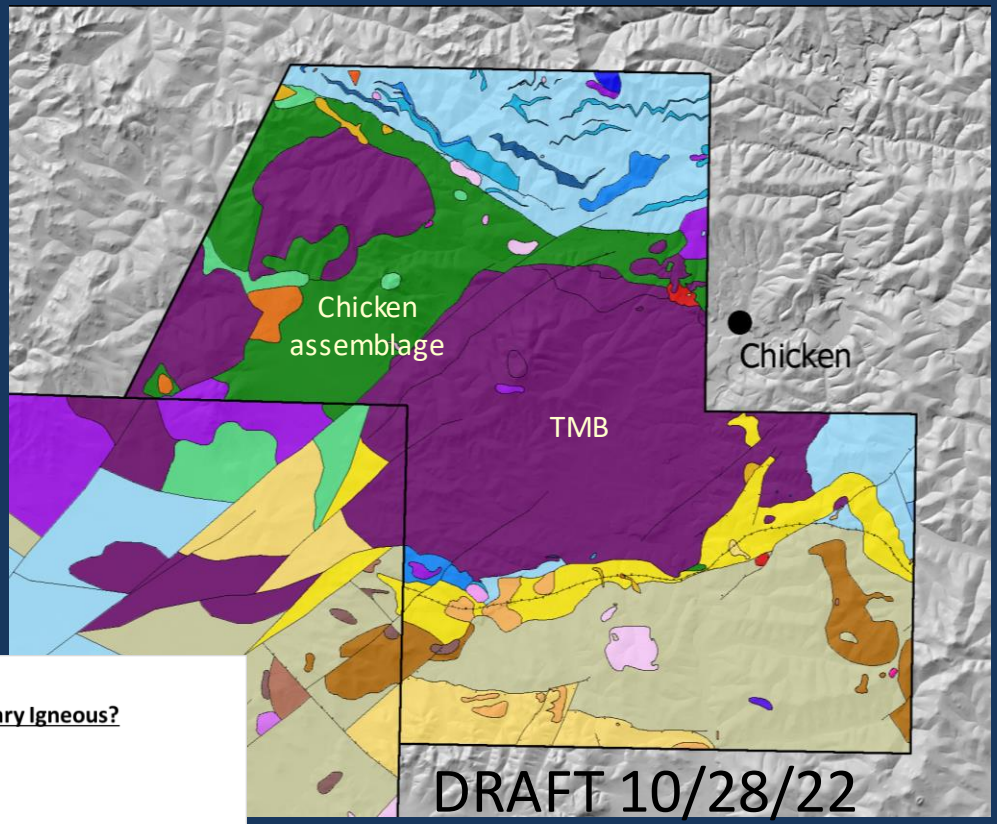


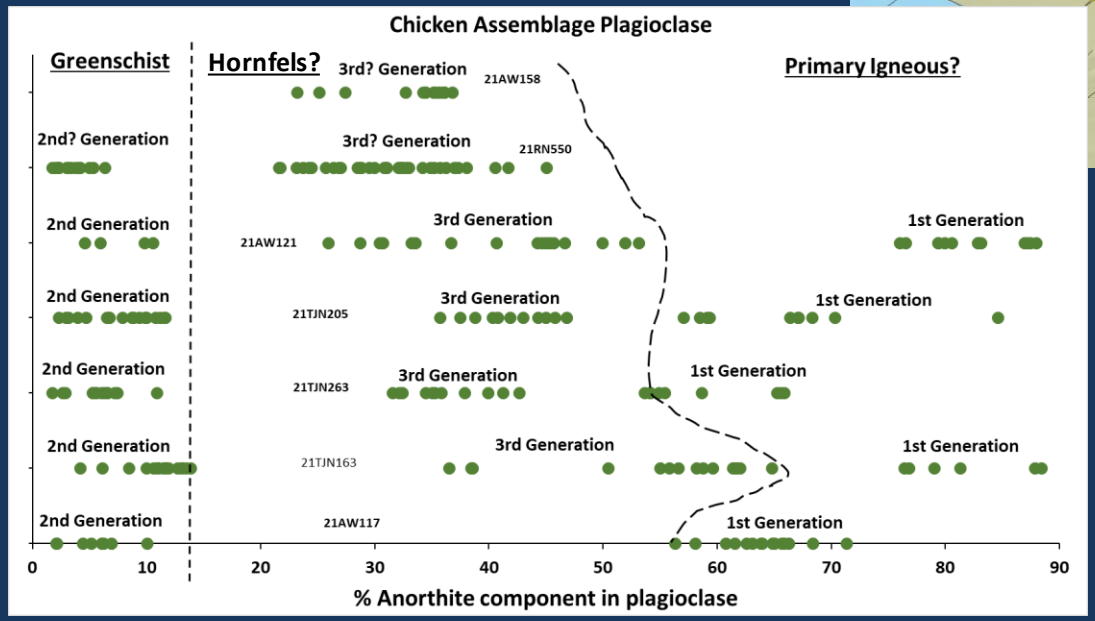
MDA: 352 Ma (quartzite) U-Pb: 346 Ma (metagabbro)

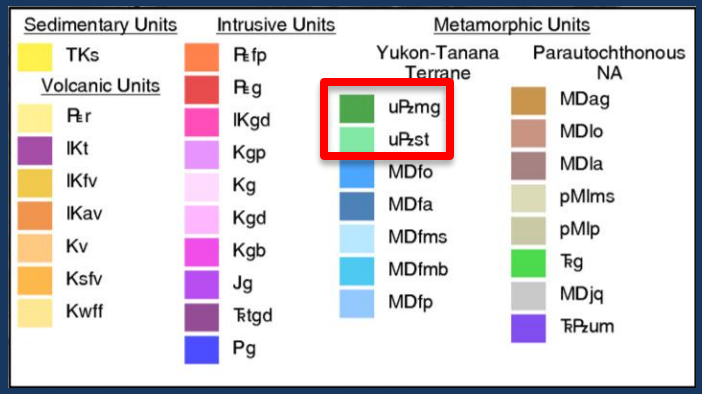
Distinguishing terranes and assemblages

Chicken assemblage

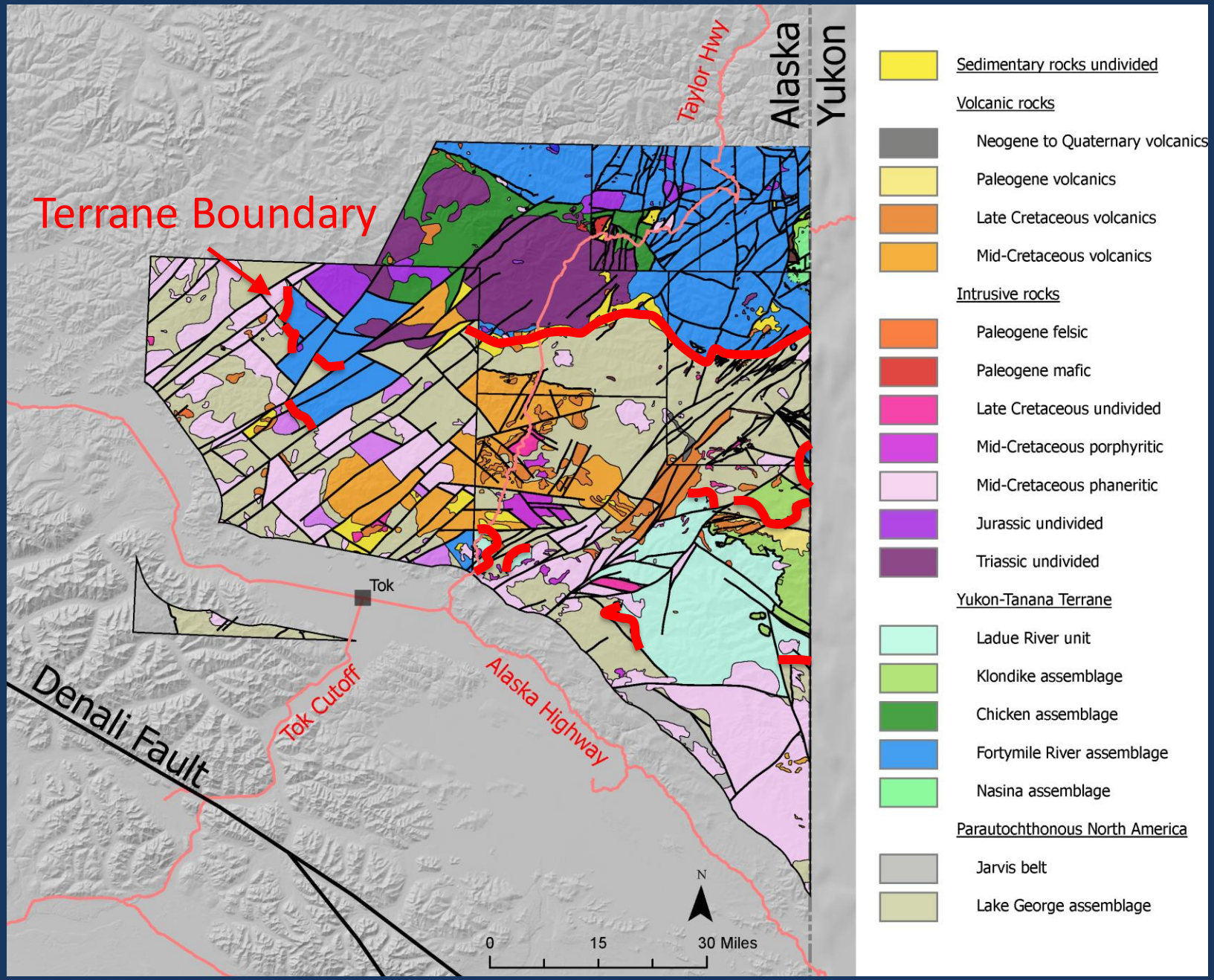








Distinguishing terranes and assemblages

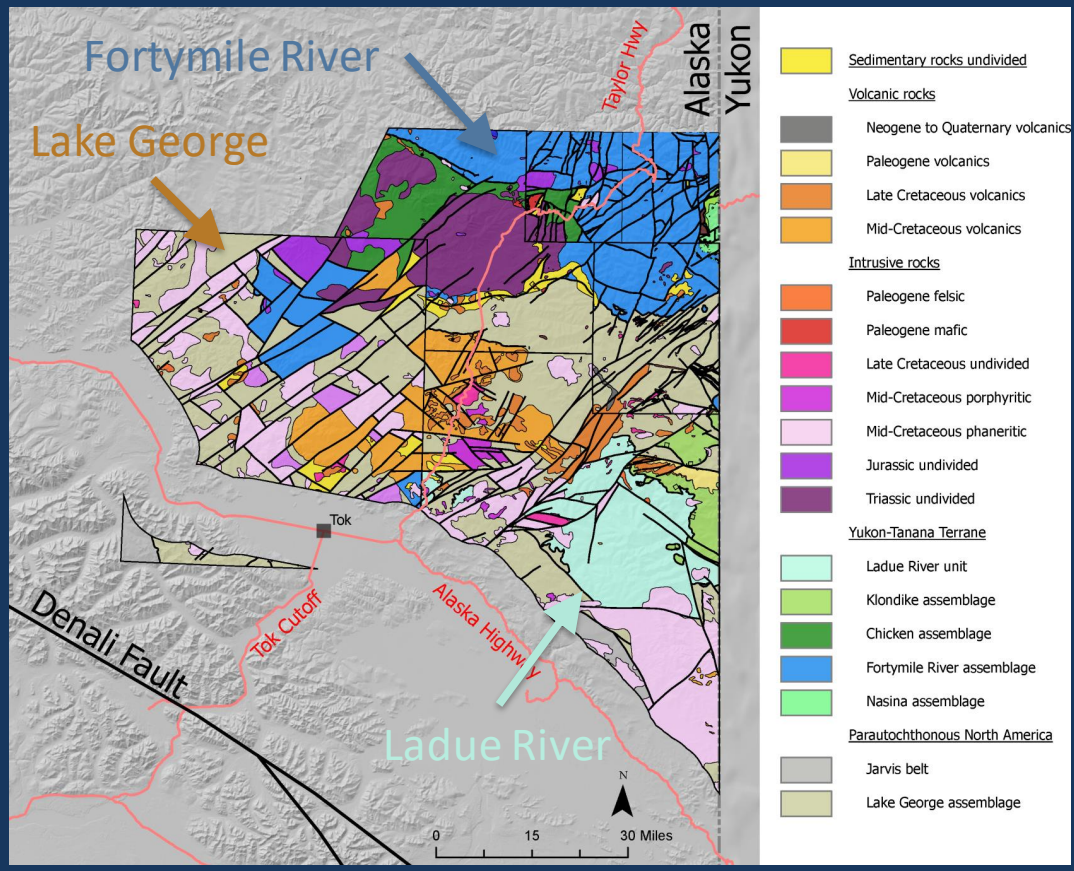


Differentiating YTT and pNA assemblages

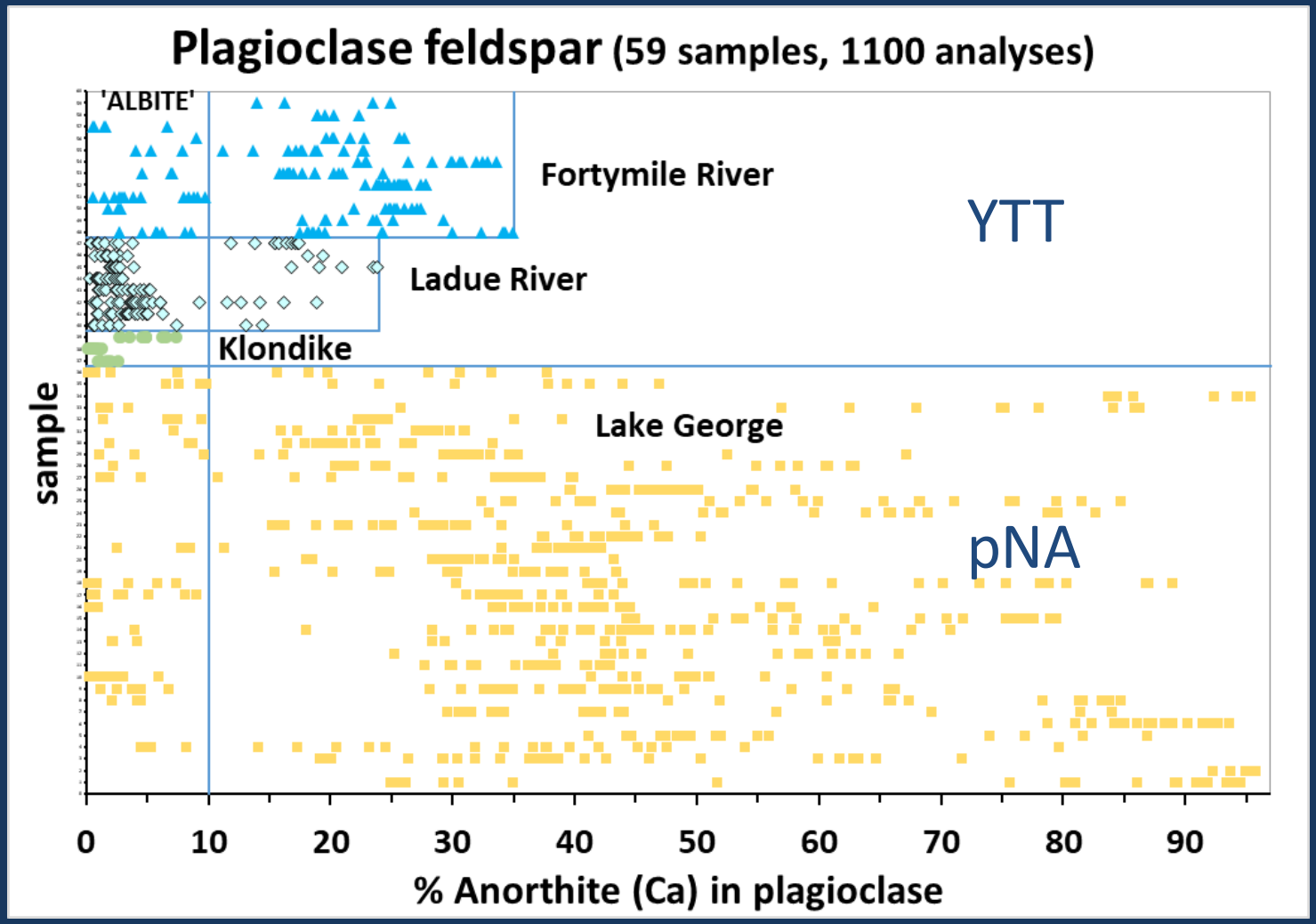
- The Lake George assemblage (pNA), Fortymile River assemblage and the Ladue River Unit (YTT) all include pre-Miss. metasedimentary units and metaigneous units with similar compositions, mineralogy, and appearance.
- LG, FMR, Ladue all were metamorphosed to amphibolite-facies.

Previously known differences:

- Triassic and Jurassic plutons only in YTT units.
- $^{40}Ar/^{39}Ar$ cooling ages:
  - Triassic to Jurassic in YTT
  - Cretaceous in pNA



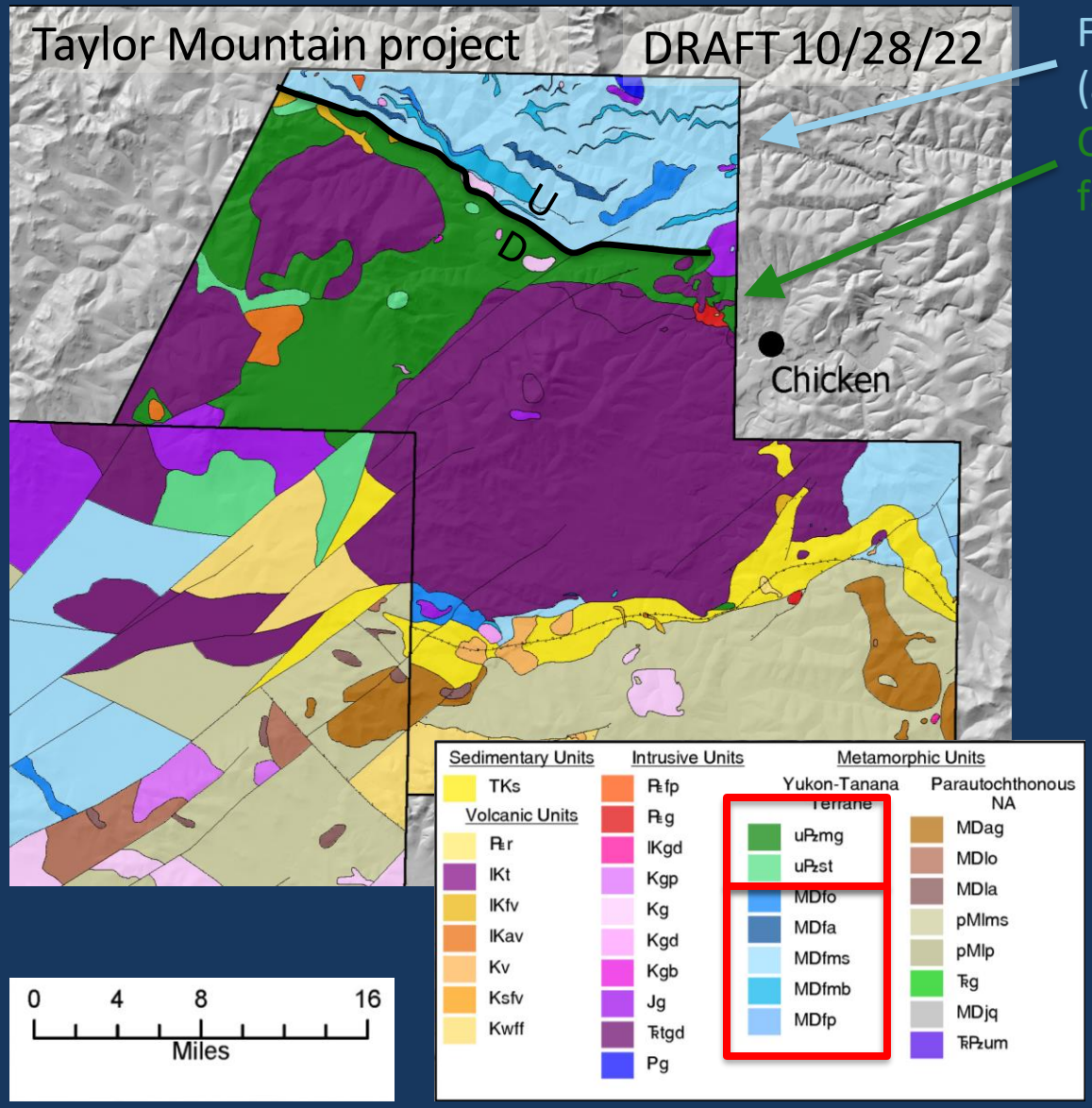
A new method - calcium in plagioclase



Feldspar compositions measured on the microprobe from metamafic rocks in the Eastern Tanacross, Western Tanacross, and Taylor Mountain areas

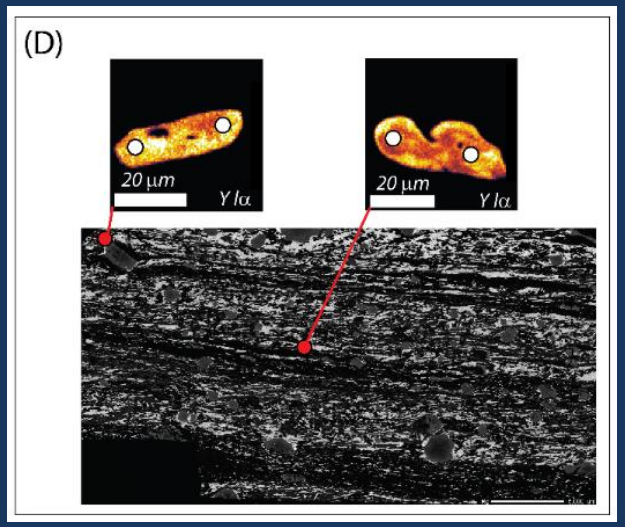
Investigating shear zones and faults

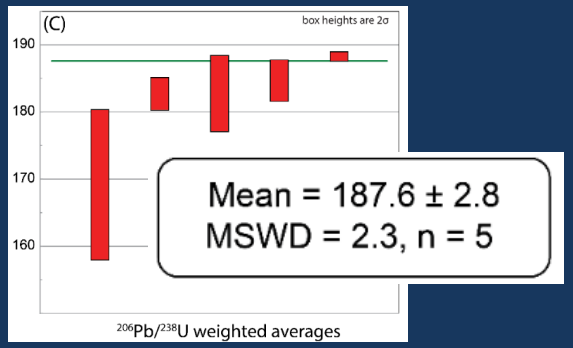
A Jurassic(?) assemblage boundary



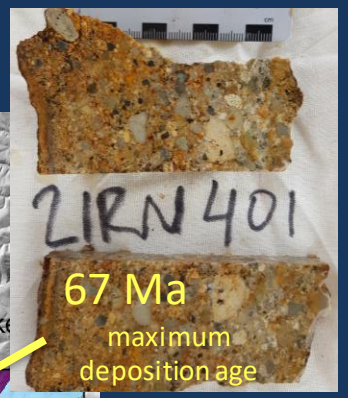
Fortymile River assemblage (amphibolite-facies)

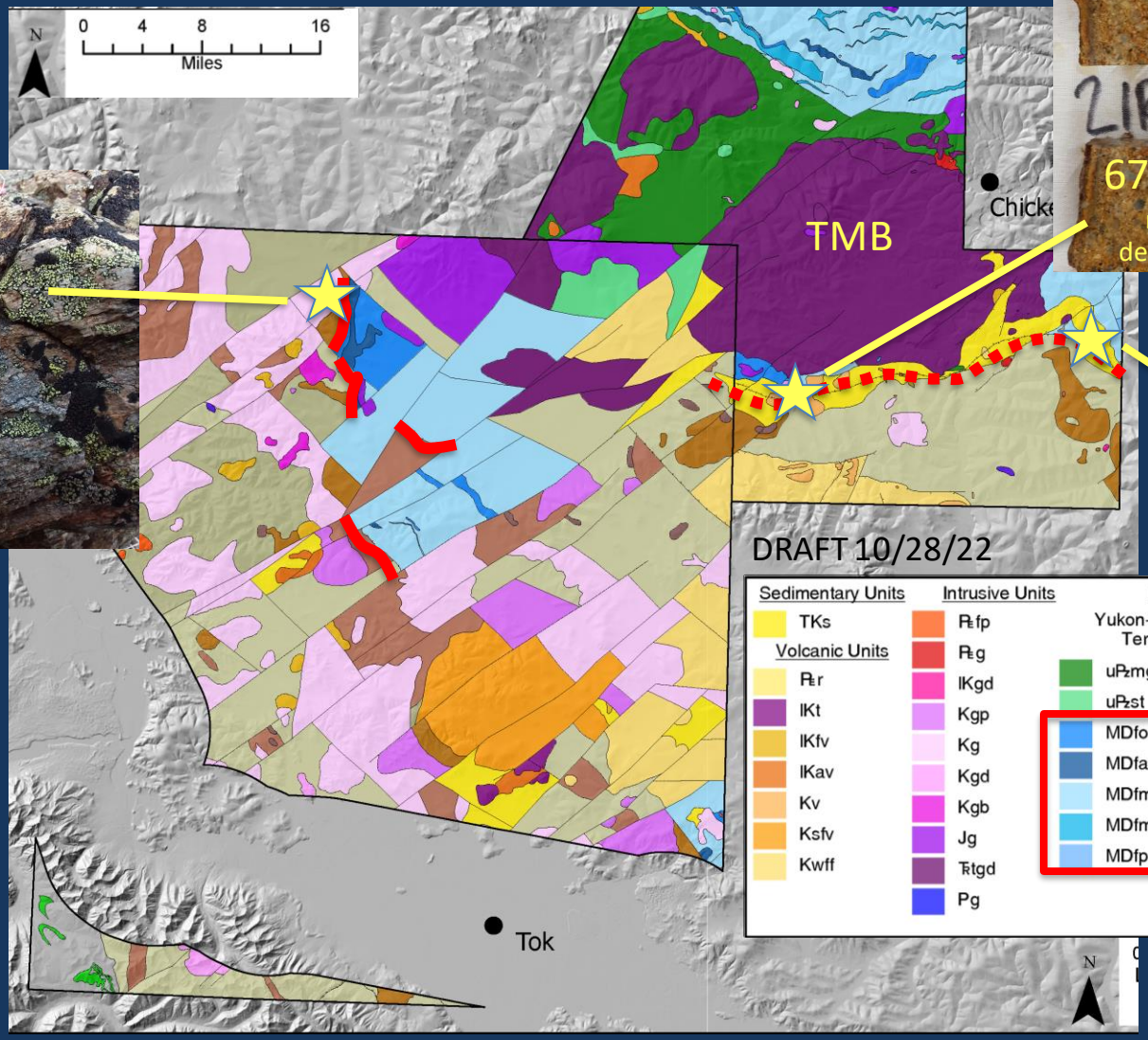
Chicken assemblage (greenschist-facies ± hornfels)





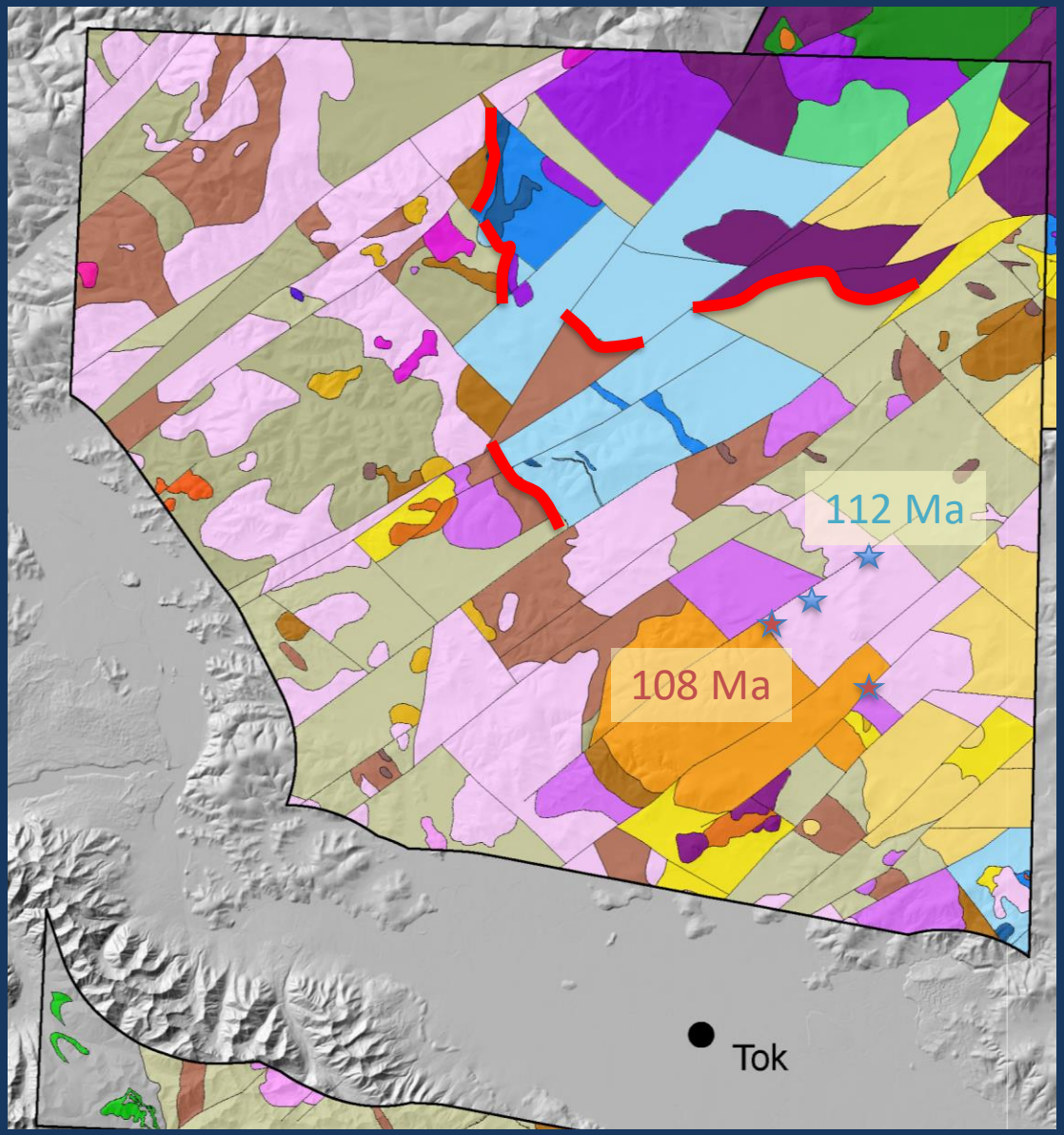
Two types of terrane boundary: shear zones and sediment-filled grabens

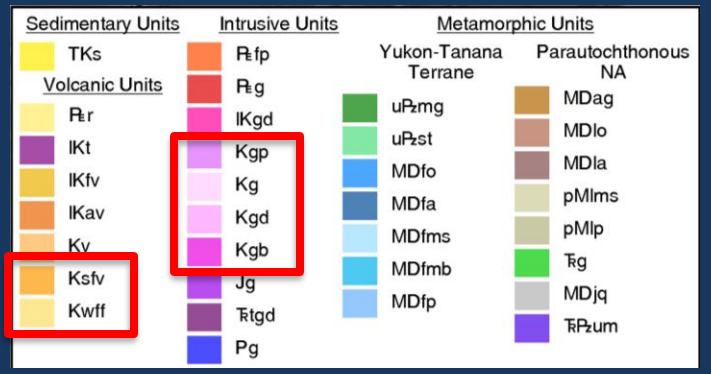




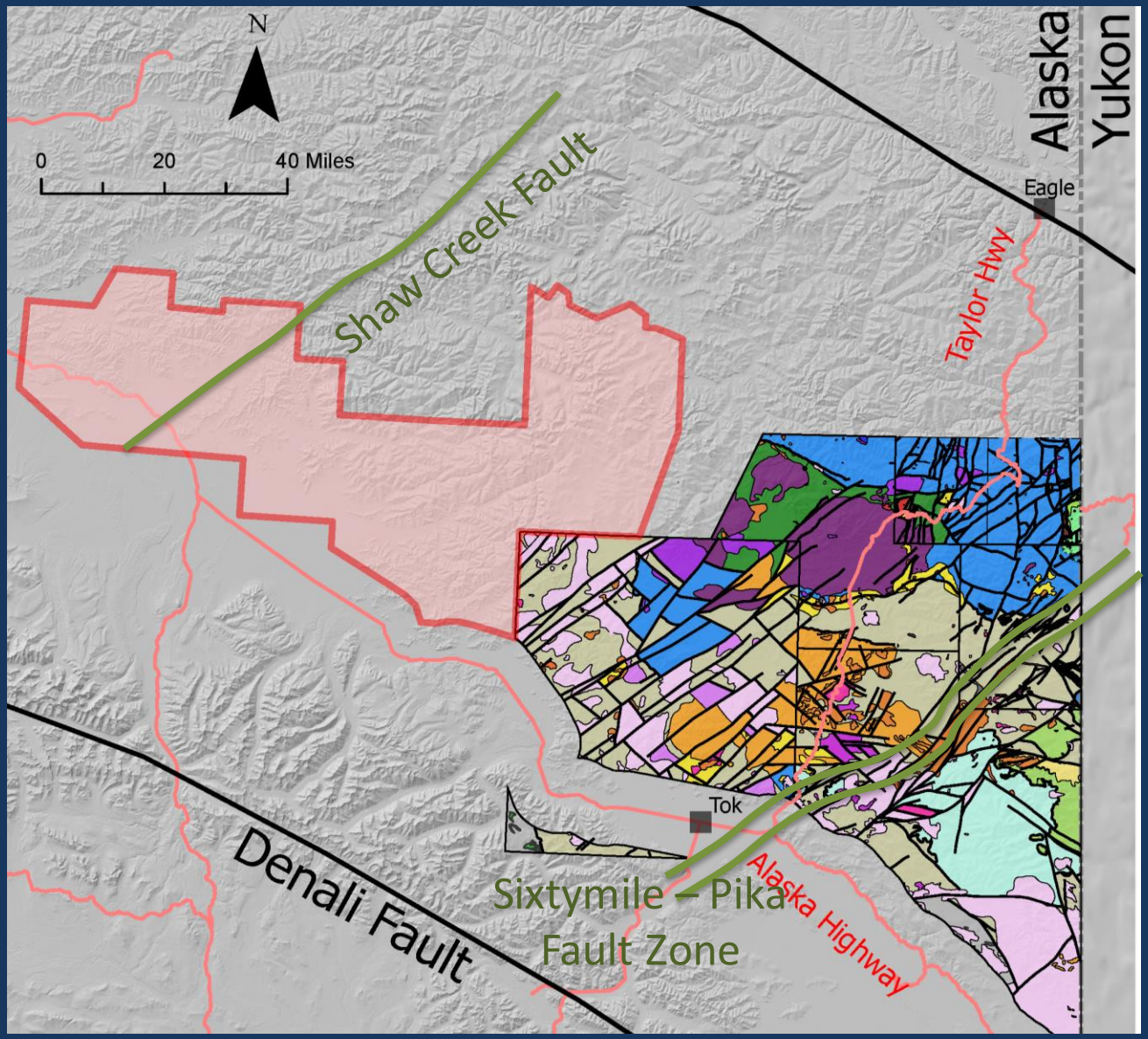
108 Ma
maximum
deposition age
USGS sample
18AJJ038

High-angle faults complicate the story



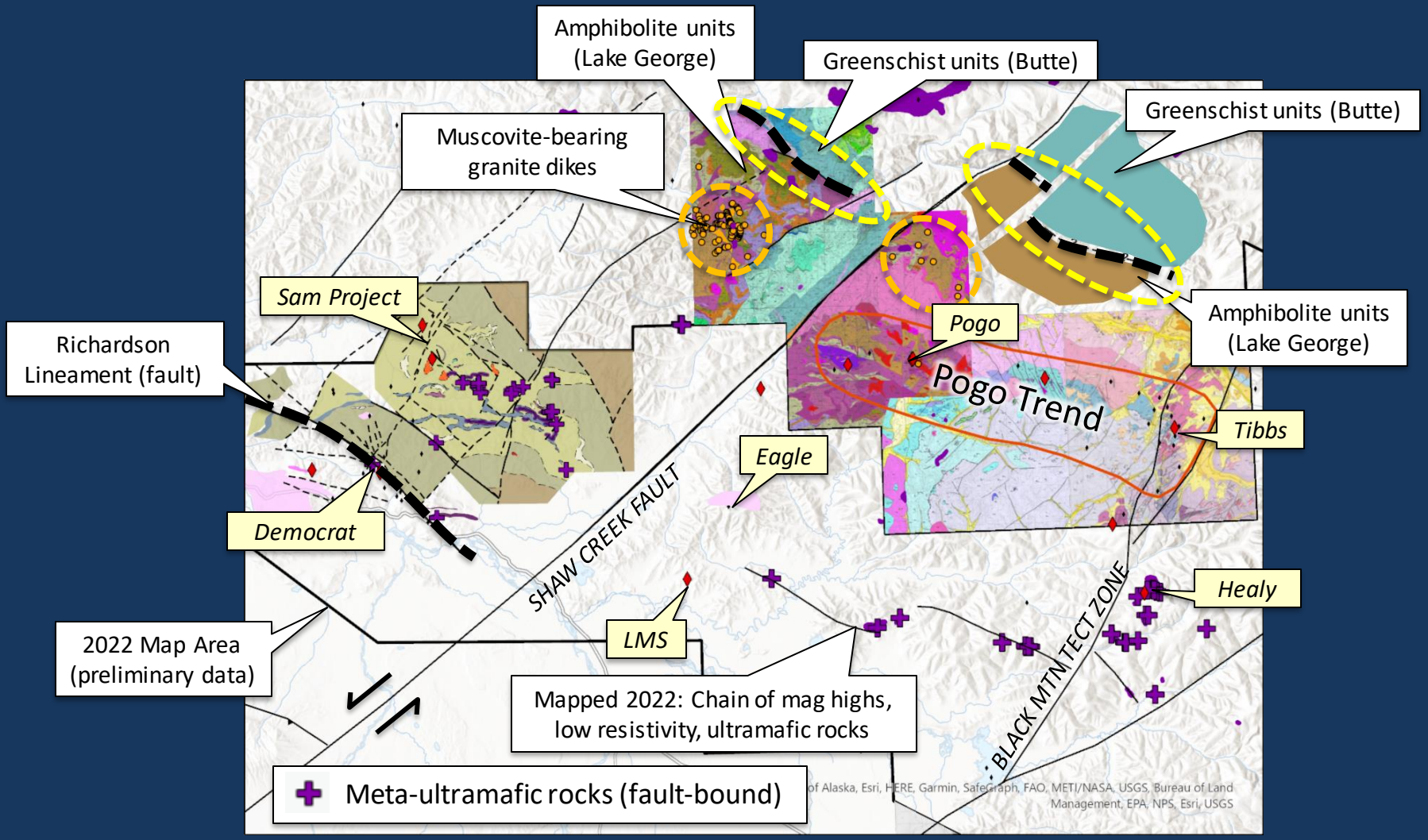


NE-striking faults – How much displacement occurred?



Investigating shear zones and faults

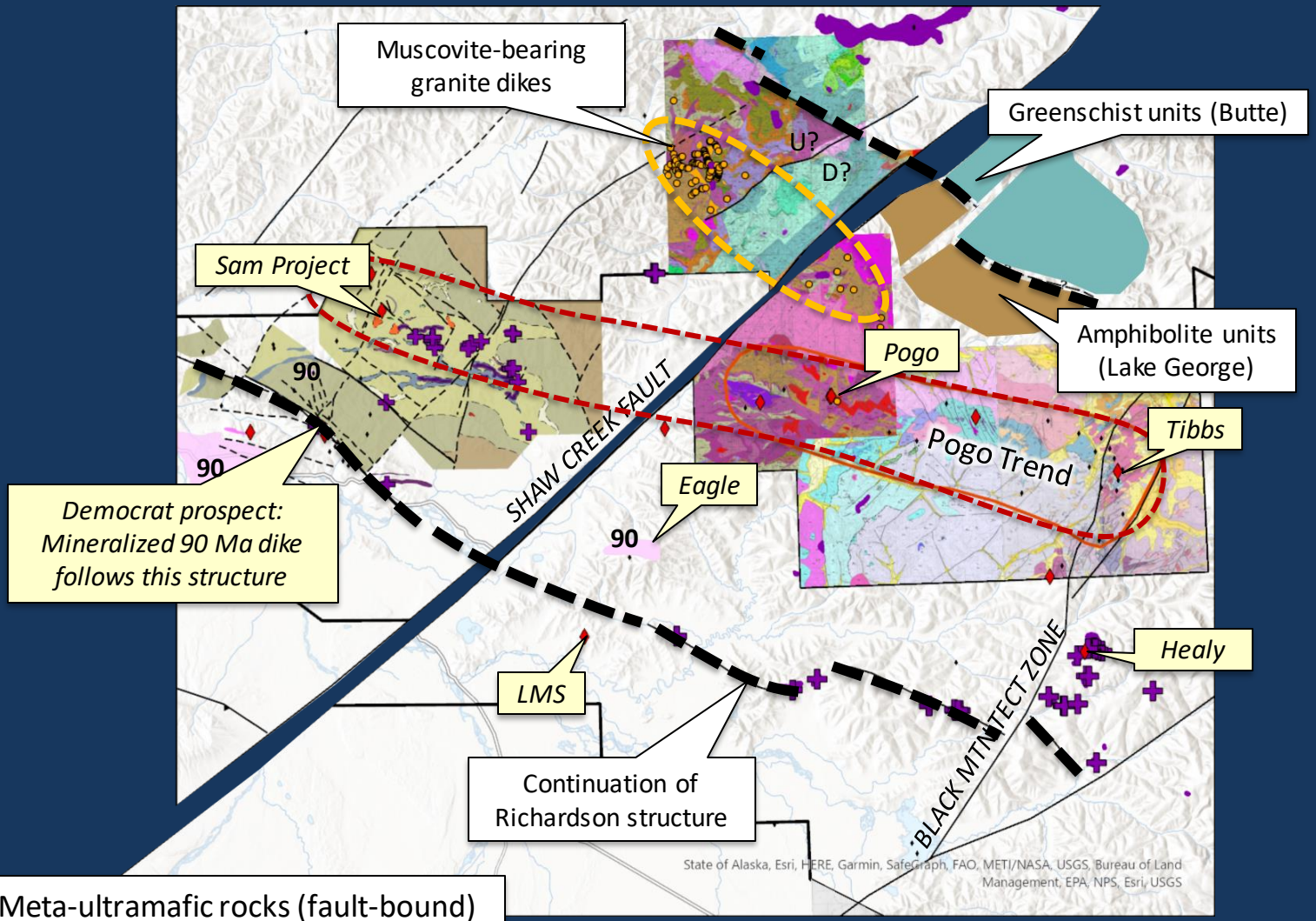
Shaw Creek fault: 15 km left-lateral motion



Investigating shear zones and faults

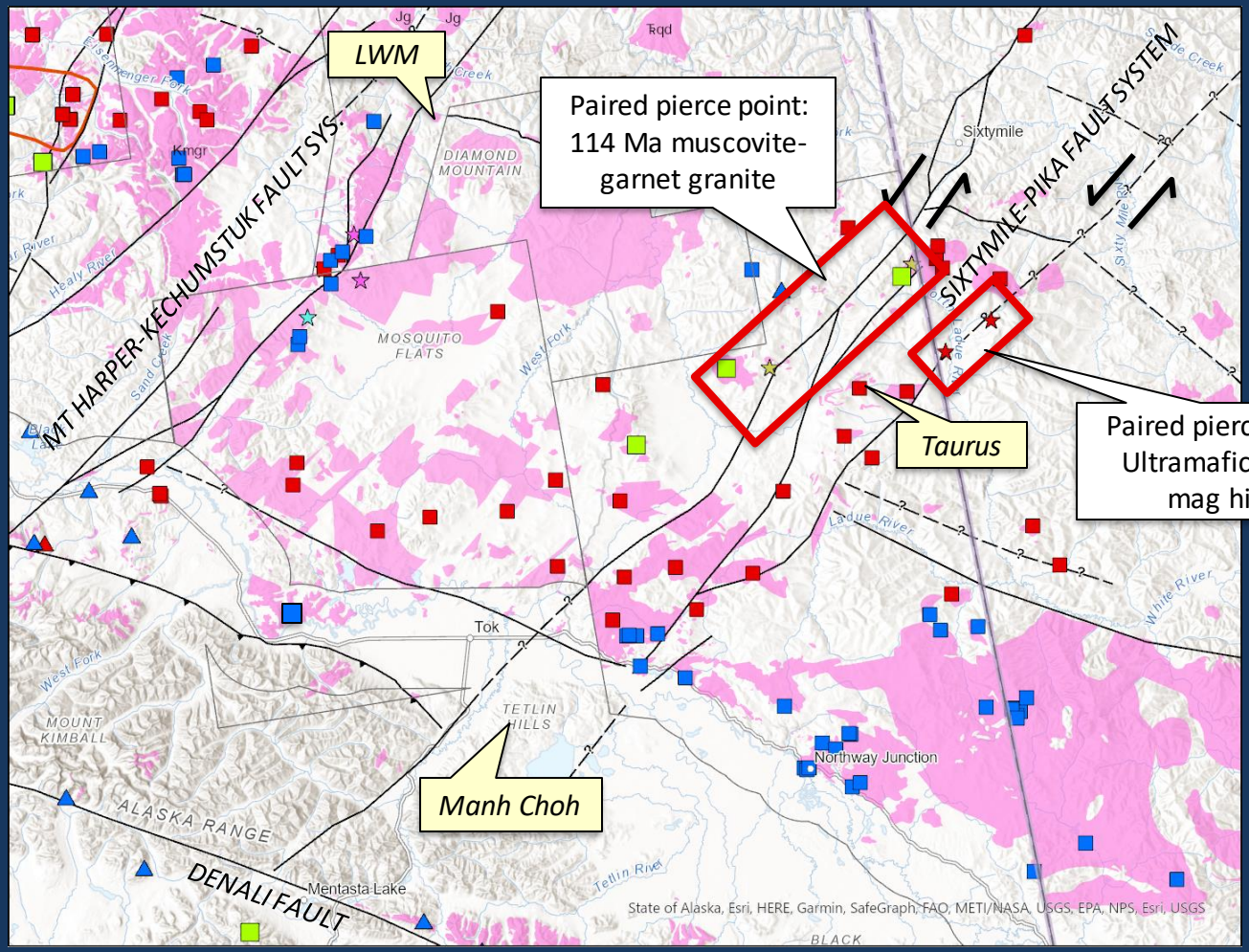
Shaw Creek fault: 15 km left-lateral motion

- Increased continuity of earlier (mid-K?) northwesterly-striking structures
- Greater ties between Richardson and Goodpaster mineralization



Two Mid-Cretaceous plutonic belts

While mapping suggests a continuous mid-Cretaceous plutonic belt, U-Pb results show difference of about 10 Ma on either side of the Sixtymile-Pika fault system



Geochronology
(higher T only)

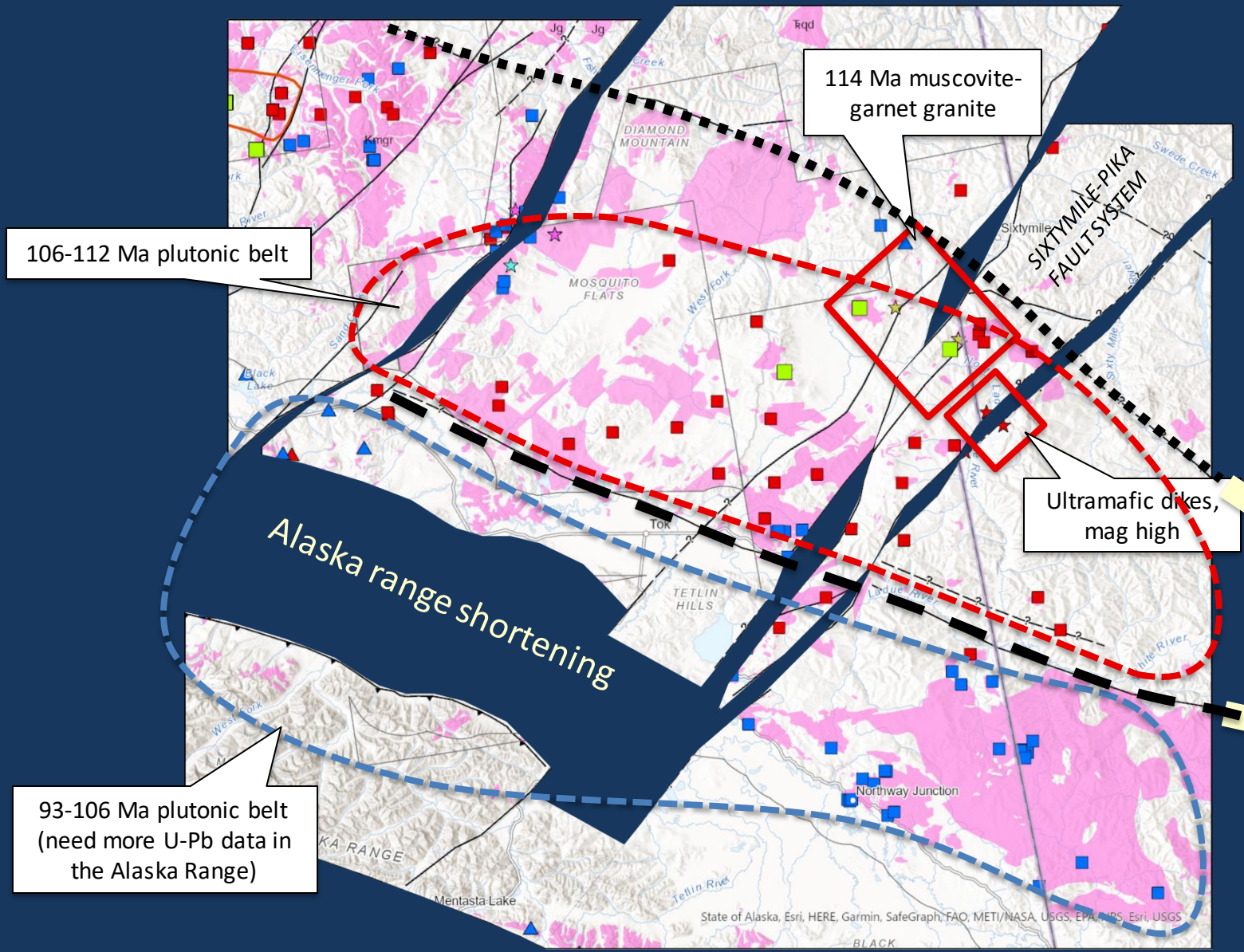
- 93-106 Ma
- 106-112 Ma
- 112-115 Ma

Method:

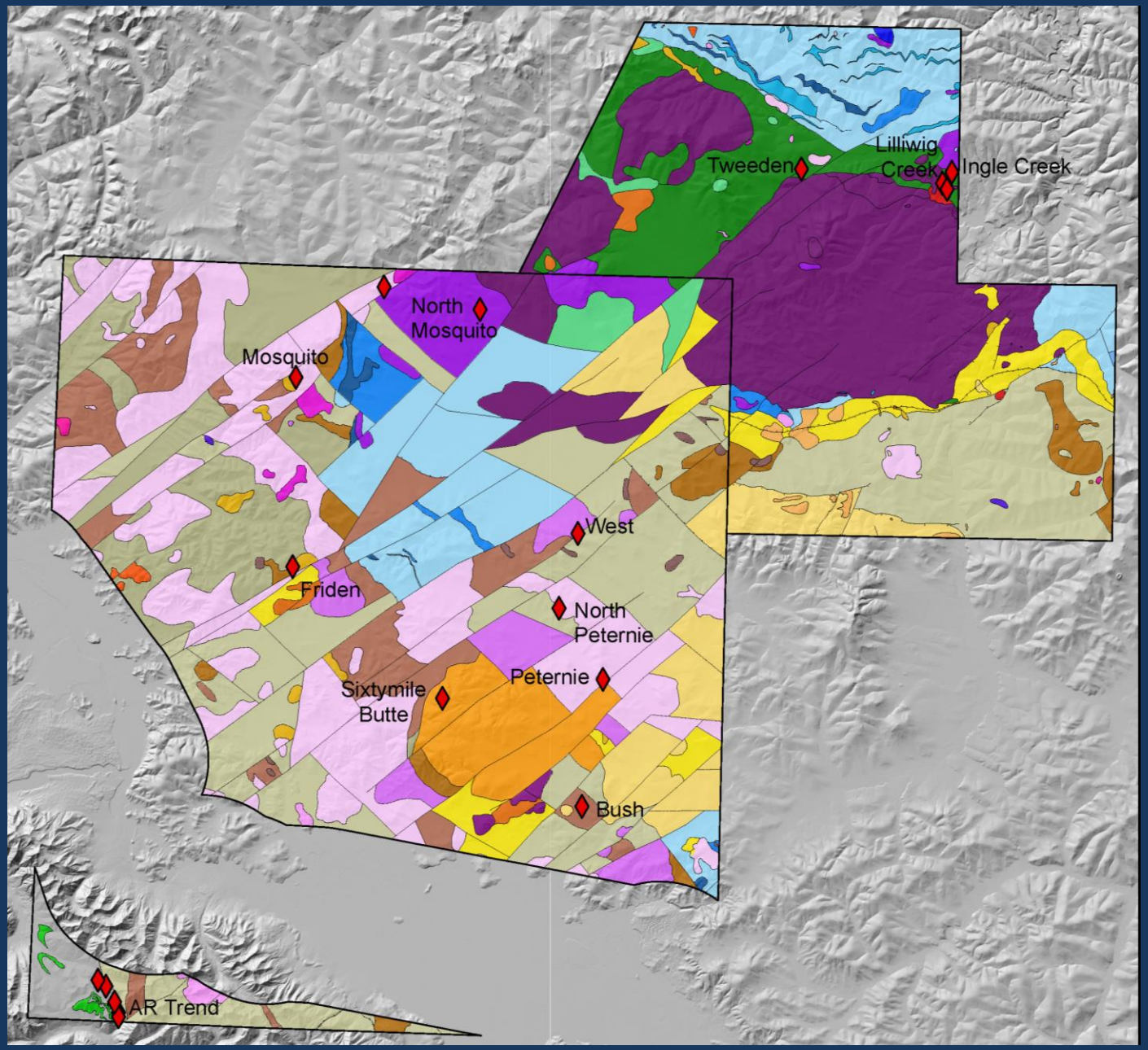
- □ U-Pb zircon
- △ Ar/Ar hornblende

Data sources: Preliminary 2021 DGGS U-Pb results; USGS and DGGS data releases

Restoration of Sixtymile-Pika fault system



Au mineralization in the map areas



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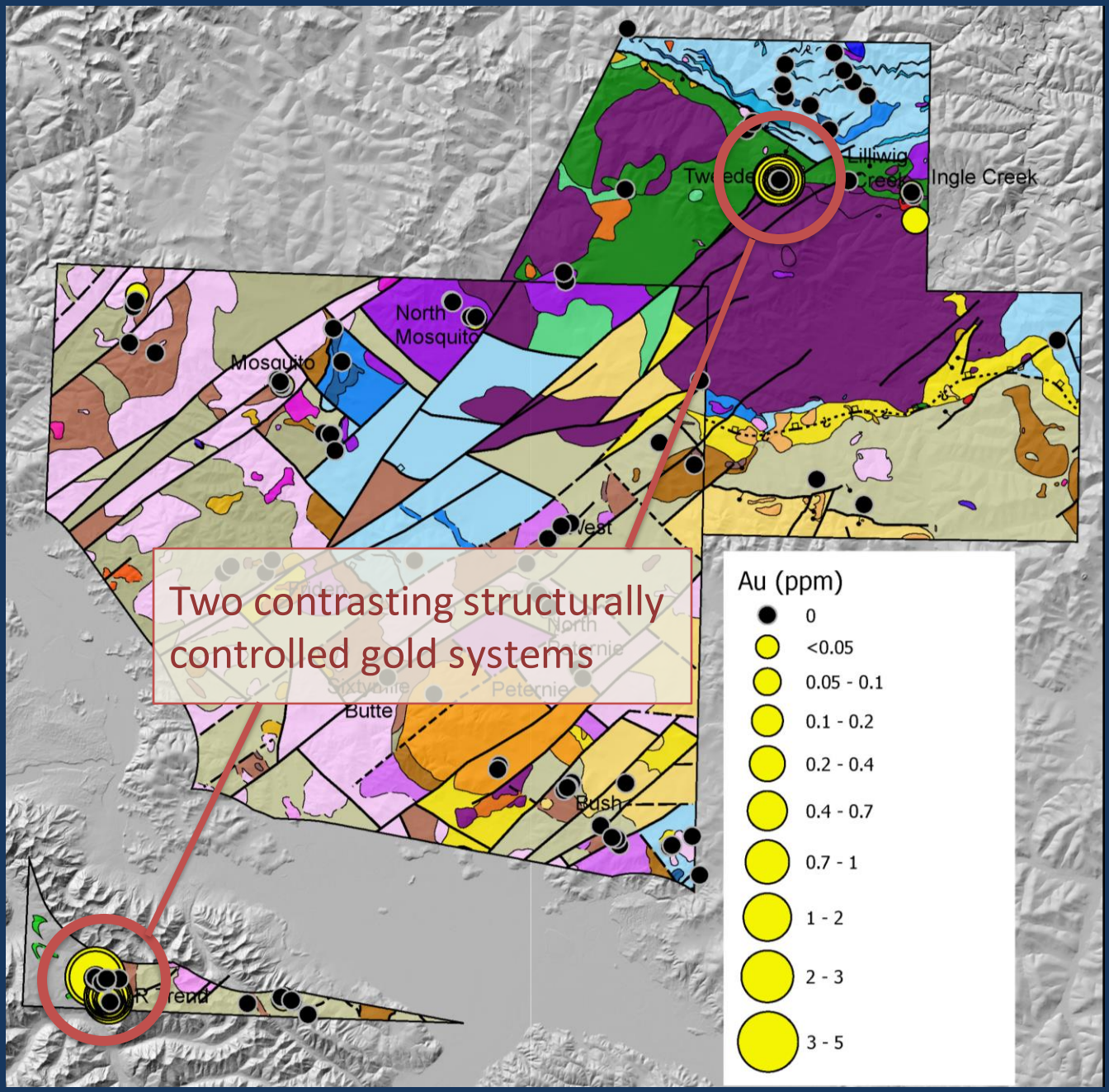
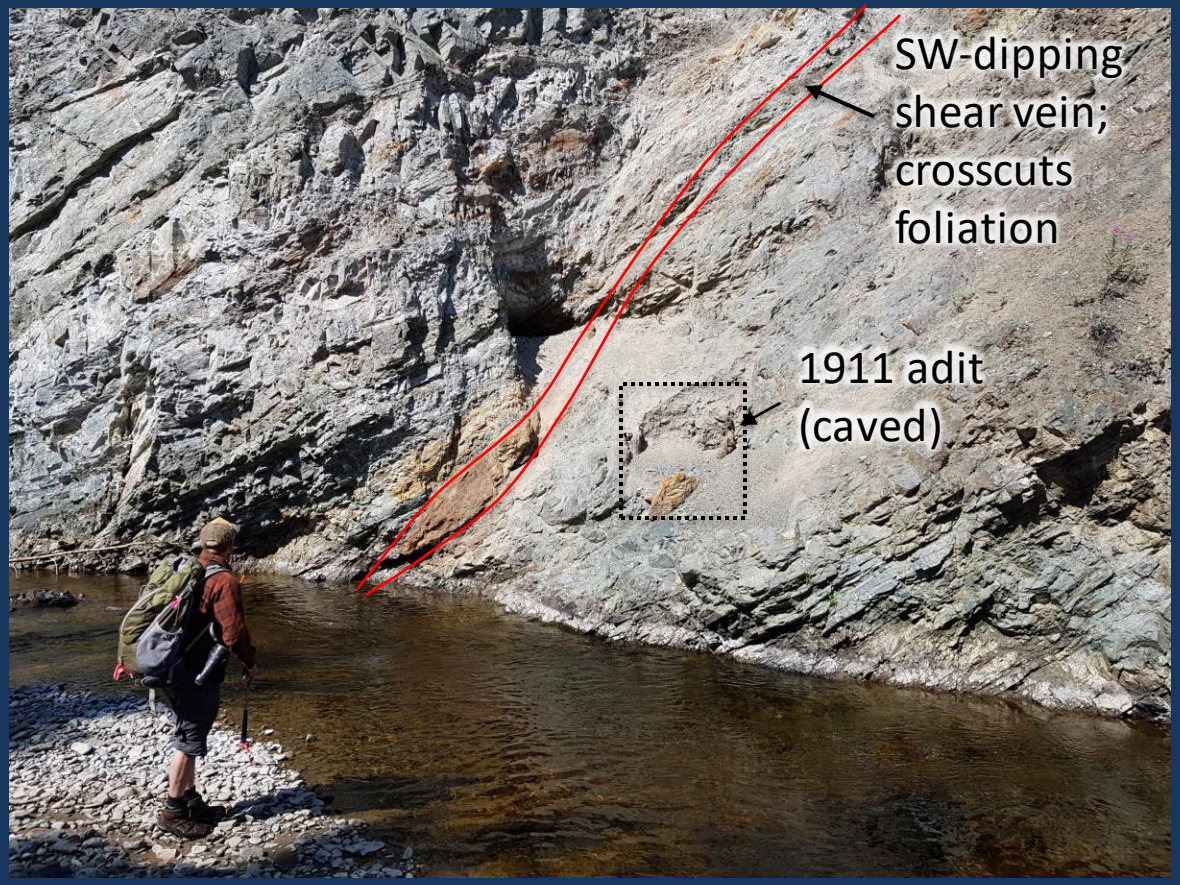


Two contrasting structurally controlled gold systems

Au mineralization in the map areas

Tweeden: Gold-bearing quartz-calcite-pyrite veins; chlorite-albite

- Comparable to Chicken-area veins—but not hosted by Jurassic plutons
- Ar/Ar sericite age from vein material: 191 Ma (preliminary)
- Predates Middle Jurassic orogenic type gold in Klondike and White Gold, Yukon



Contrasting trace-element fingerprints

ppm	**AR Trend** (avg; n=8)	**Tweeden** (avg; n=10)
Au	1.6	0.9
Ag	**11.3**	1.8
As	**5526**	260
Sb	**92**	11
Pb	**1039**	9
Zn	**508**	41
Bi	0.6	**5.9**
Te	0.0	**1.1**

Au mineralization in the map areas

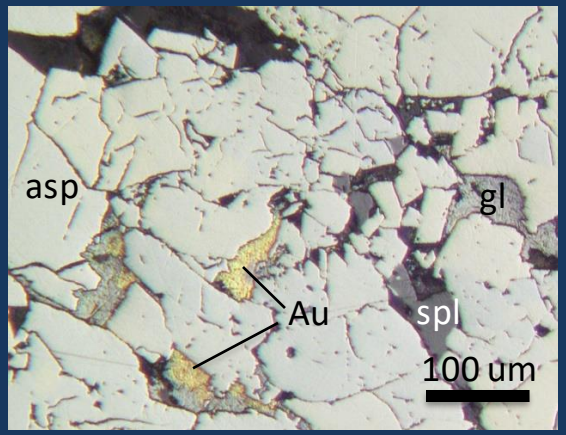
AR Trend gold prospects

- Epithermal / distal intrusion-related gold system
- Structurally controlled
- Post-metamorphic, crosscuts foliation
- Arsenopyrite-sphalerite-pyrite geothermometer: ~325 ± 15 C
- Gold fineness (450-480) is more typical of epithermal deposits than of metamorphic or plutonic systems

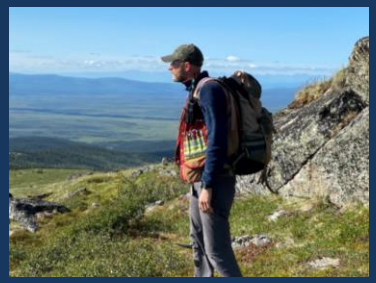
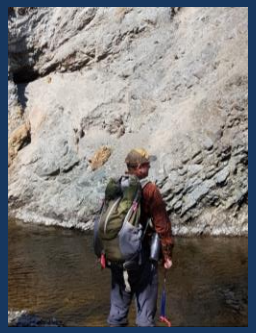
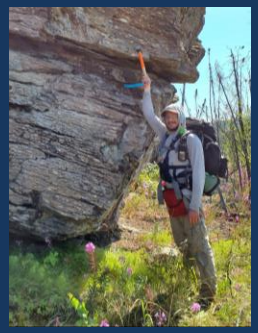
<u>Preliminary Ar/Ar geochron:</u>

- Randomly oriented, very fine-grained sericite: 114 Ma
- White mica slivers in quartz arsenopyrite vein: 120 Ma

Reflected light image, AR Discovery



Concluding points

- DGGS Mineral Resources Section continues to map the geology of the Yukon Tanana Uplands in interior Alaska.
- Mapping leads to better understanding of:
  - Metamorphic assemblages and terranes
  - Terrane boundaries, shear zones, and high-angle faults
  - Mineralization in interior Alaska
- Stay tuned for more geochemistry, geochronology, and geologic map publications! dggs.alaska.gov

References

- Dusel-Bacon, Cynthia, Aleinikoff, J.N., Day, W.C., and Mortensen, J.K., 2015, Mesozoic magmatism and timing of epigenetic Pb-Zn-Ag mineralization in the western Fortymile mining district, east-central Alaska: Zircon U-Pb geochronology, whole-rock geochemistry, and Pb isotopes: Geosphere, v. 11, no. 3, p. 786-822.

- Werdon, M.B., Newberry, R.J., and Szumigala, D.J., 2001, Bedrock geologic map of the Eagle A-2 Quadrangle, Fortymile mining district, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2001-3B, 1 sheet, scale 1:63,360. https://doi.org/10.14509/2670