New geologic investigations of Northeast Tanacross

Alicja Wypych1 (speaker), Evan Twelker, Jennifer E. Athey, Trent Hubbard, Travis J. Naibert, Rainer J. Newberry, Karri R. Sicard, Melanie B. Werdon, Amanda L. Willingham, and Chris Wyatt

Alaska Division of Geological & Geophysical Surveys; 1alicja.wypych@alaska.gov

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:


New geologic investigations of Northeast Tanacross

Alicja Wypych, Evan Twelker, Jen Athey, Trent Hubbard, Travis Naibert, Rainer Newberry, Karri Sicard, Melanie Werdon, Mandy Willingham, Chris Wyatt

Alaska Division of Geological & Geophysical Surveys
Acknowledgments

• 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

This work is funded by Alaska DGGS general fund, and the USGS Statemap program Grant G18AC00137
Tectonic setting

Allochthonous Yukon-Tanana terrane – Fortymile assemblage
Parautochthonous North America – Lake George assemblage
Project location and nearby deposits

Legend
- Major faults
- Highways
- Selected Mineral Deposits
  - 90-105 Ma
  - ± 70 Ma
  - ± 55 Ma

Selected Mineral Deposits
- Pogo
- Golden Zone
- Hona
- Tetlin
-cash
- Golden Saddle
- Casino
- Livengood
- Fort Knox, Golden Summit
- Hajdukovich
- Taurus
- Tanacross
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

- ~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
Quaternary cover

(Photos by T. Hubbard)
Structures

Photo by: K. Sicard
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
• 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?
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.

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

Photo by E. Twelker
Stratigraphy

Photos by: E. Twelker
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)
Structurally emplaced?

Pma  Amphibolite and serpentinite

Photo by: A. Wypych
Fortymile assemblage

Photo by: A. Wypych

- **PFa**: amphibolite
- **DFag**: augen gneiss
- **DFog**: orthogneiss
- **DFpg**: paragneiss
- **mPzmb**: marble
- **DFms**: semischist and quartzite
Early Cretaceous igneous rocks

granite and pegmatite

$^{40}\text{Ar}/^{39}\text{Ar} \; 105.2 \text{ Ma}$

(17JEA005, Naibert et al. 2018)

Photo by: A. Wypych
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

Pringle volcano

Magnetic

non-magnetic
Late Cretaceous/Early Tertiary igneous rocks

andesites

hornblende porphyry

$^{40}\text{Ar}/^{39}\text{Ar}$ 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

Prindle volcano

Hornblende porphyry (Khfp)
mK granite
Timber Pluton

Lake George
Mineralization
Taurus, Bluff area porphyry systems

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

Age 68-70 Ma

Sericite-tourmaline alteration; silver

Potassic alteration, Cu-Mo-Au

Quartz-sericite-pyrite alteration

Taurus quartz-feldspar porphyry
Age 70-72 Ma
Copper, Molybdenum

**Copper**
- 0 - 200 ppm
- 201 - 600
- 601 – 1200
- 1201 - 2500
- 2501 - 4950

**Molybdenum**
- 0 - 30 ppm
- 31 - 100
- 101 - 150
- 151 - 250
- 250 - 597

**Pika & Fishhook:**
- quartz porphyry not mapped
- Low Cu, Mo

Wypych et al. 2017 and Wypych et al. 2018
Geochem results:

Silver

- **Bluff**
  - Taurus
  - Fishhook

Tourmaline-sericite altered porphyry intrusion
- 10.2 ppm Ag
- 1155 ppm Pb
- 34 ppm Bi

Banded sulfide-quartz vein
- 56.5 ppm Ag
- 3.5 % Pb
- 592 ppm Sb

Silver concentration ranges:
- 0 - 1 ppm
- 1 - 5 ppm
- 5 – 10 ppm
- 10 - 30 ppm
- 30 - 4420 ppm

Wypych et al. 2017 and Wypych et al. 2018
Silver (Pb-Bi-As) mineralization

- 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

Wypych et al. 2017 and Wypych et al. 2018
Geochem results:

Gold

Breccia: 2,150 ppb Au, 9 ppm Bi

Gneiss with pervasive sericite alteration

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

Wypych et al. 2017 and Wypych et al. 2018
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!
References cited


Larimer, David, 2016, Pogo mine exploration: The past, present, and the future!!!: Presentation given to the Alaska Miners Association Annual Convention, Anchorage, Alaska, November, 2016


