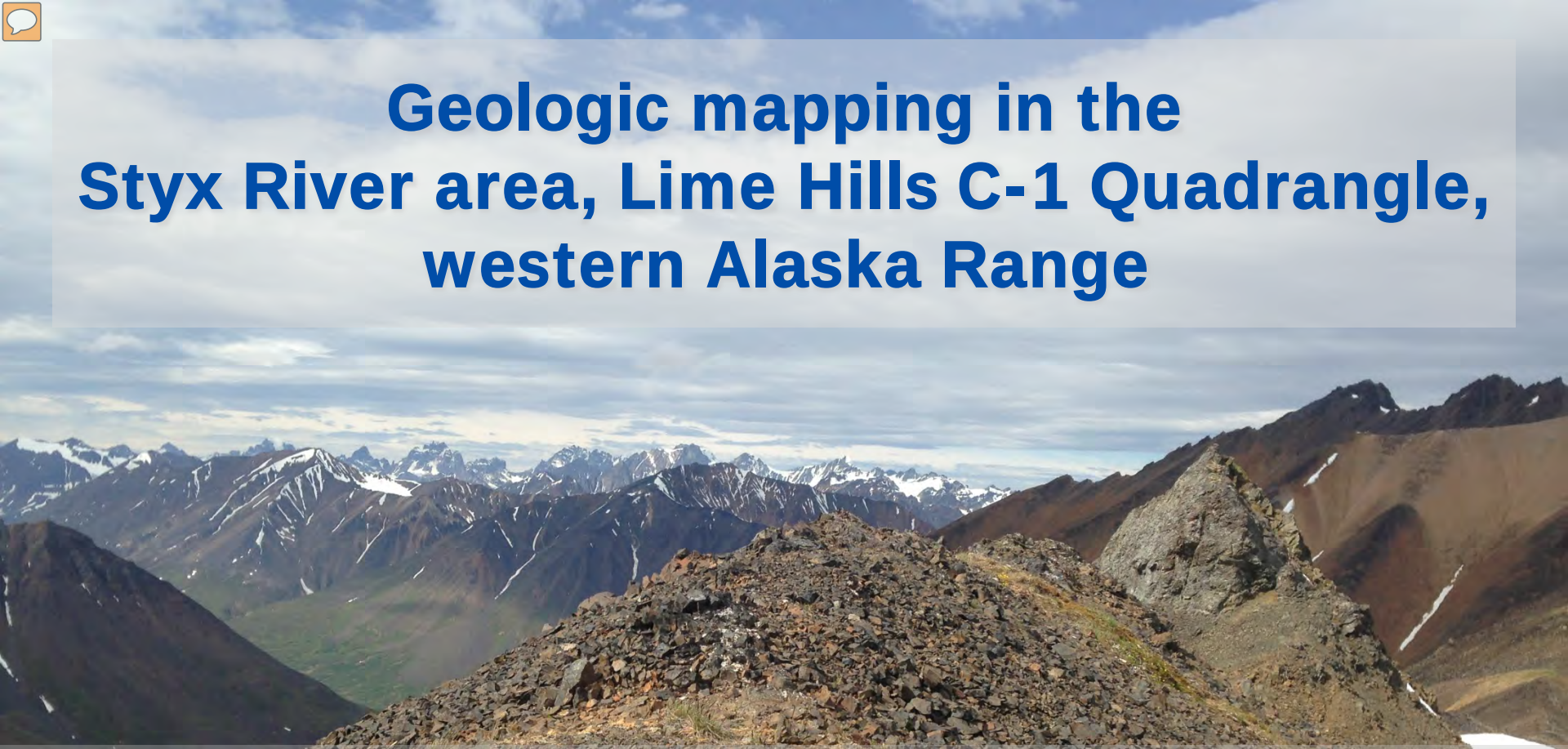
Geologic mapping in the Styx River area, Lime Hills C-1 Quadrangle, western Alaska Range



K.R. Sicard[1], E. Twelker[1], L.K. Freeman[1], E.N. Bachmann[1], D.A. Reioux[1], A.L. Tuzzolino[2,1] , T.C. Wright[2,1], R.J. Newberry[2], L.E. Burns[1], and M.B. Werdon[1]

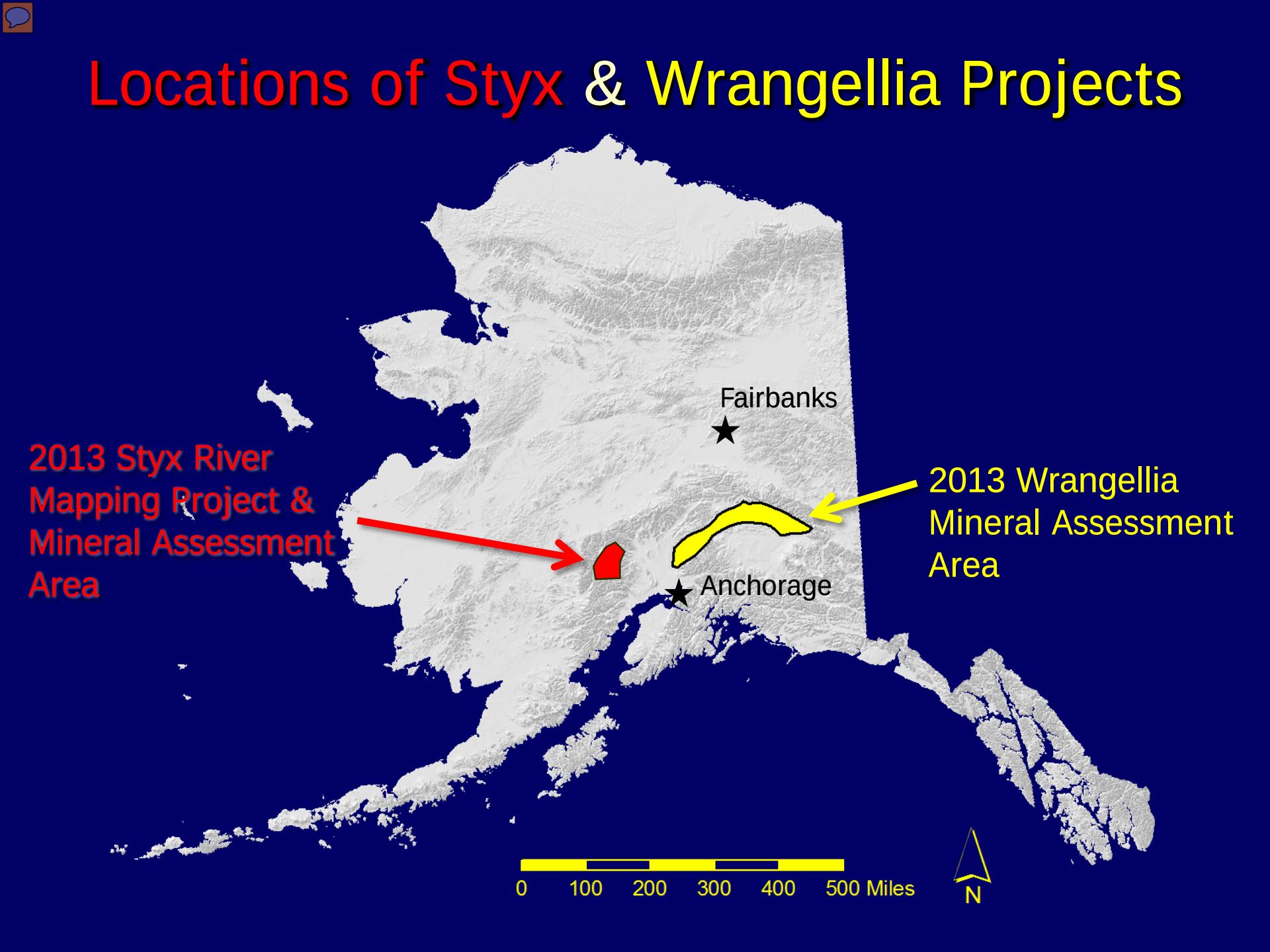
[1]Alaska Division of Geological & Geophysical Surveys

[2]Department of Geology & Geophysics, University of Alaska Fairbanks

Alaska Miners Association – 2013 Annual Convention

November 4 - 10, 2013 – Anchorage, Alaska

Locations of Styx & Wrangellia Projects



Styx Project Goals

- Collect sufficient data to produce a detailed map of the Lime Hills C-1 Quadrangle
- Identify and characterize mineralization
- Determine appropriate ore deposit models
- Understand the timing and character of faulting
- Evaluate the geochemistry of different plutons

2013 Styx Program Accomplishments

- ~4 weeks: 207 person-days

Samples collected:

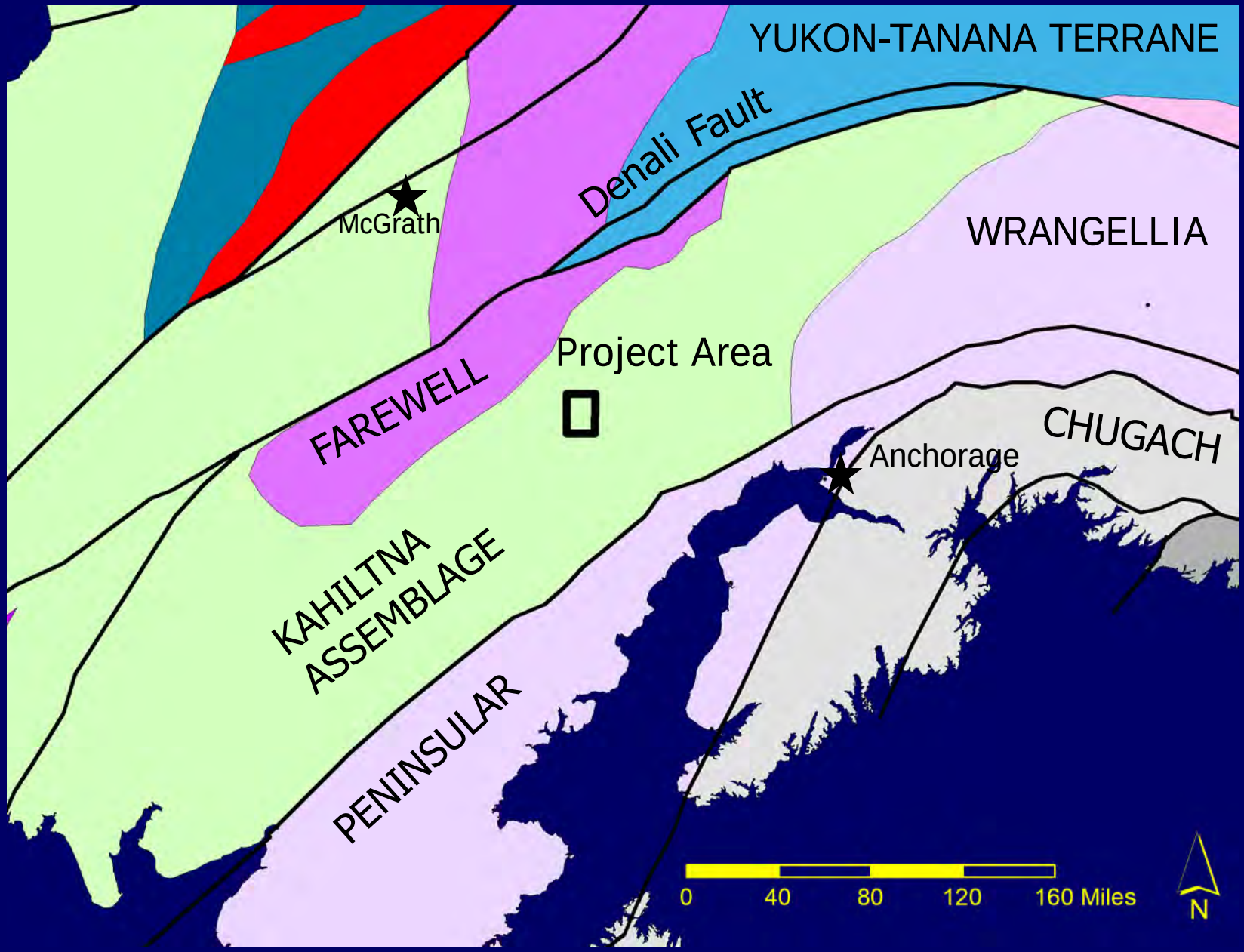
- 70 for major oxide rock geochem
- 197 for thin sections (18 oriented)
- 157 for geochem/trace elements
- 460 for broad lens XRF analyses
- 98 for stained slabs
- 53 for age analysis

- 740 rock stations
- 564 structural observations
- In total: 1863 stations with geologic observations

Previous Work

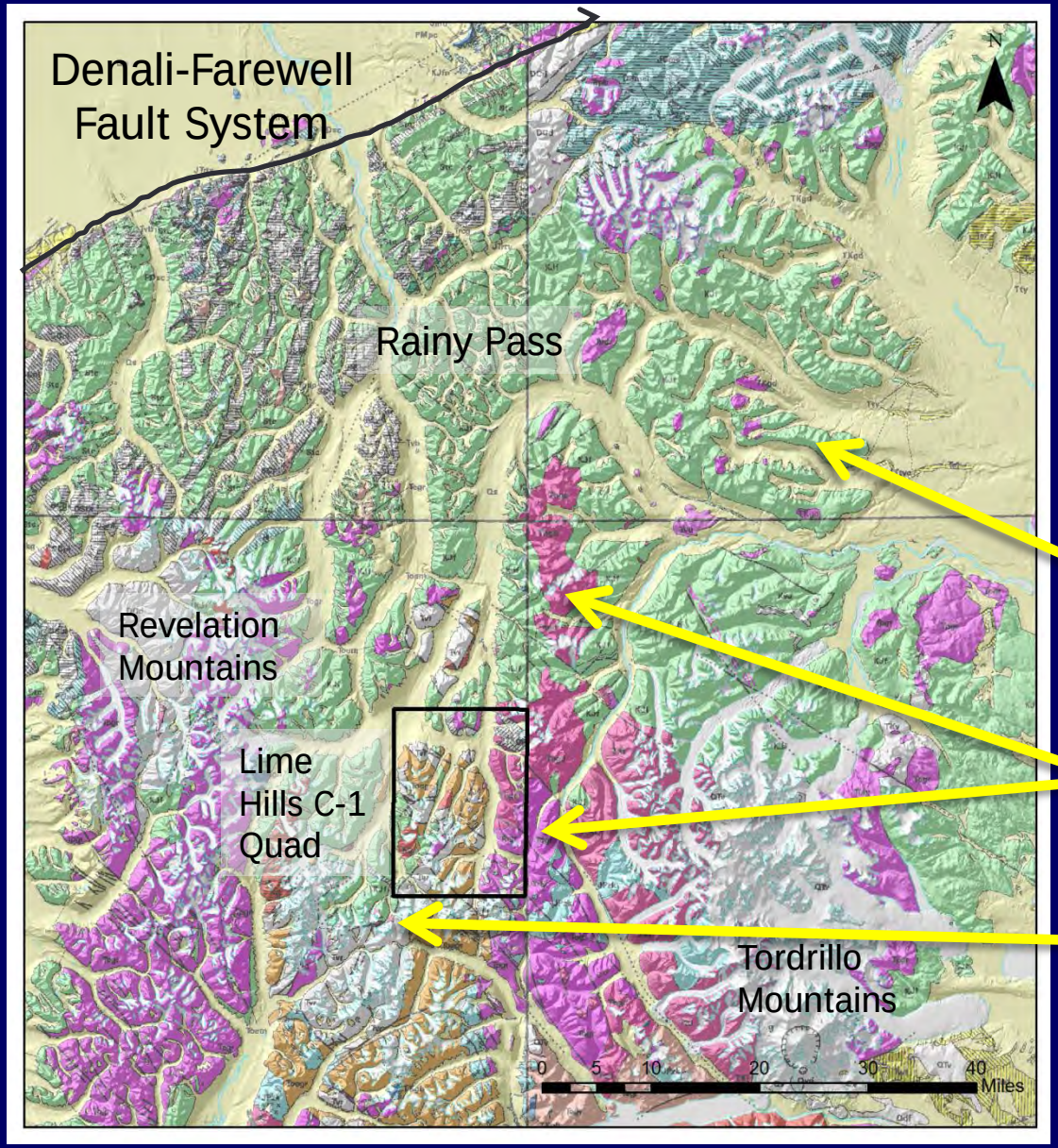
- 1970s: USGS regional mapping/sampling
- 1970s—80s: US Bureau of Mines Strategic Mineral Assessment
- 1980s—90s: DGGS Mapping-McGrath Quadrangles
- 1990s to present: Mineral Exploration by WestMountain, Millrock, Kiska, Alaska Earth Sciences and others
- 2011—present: USGS Western Alaska Range Project (WARP)
- 2008—present: Geophysical Surveys flown by DGGS

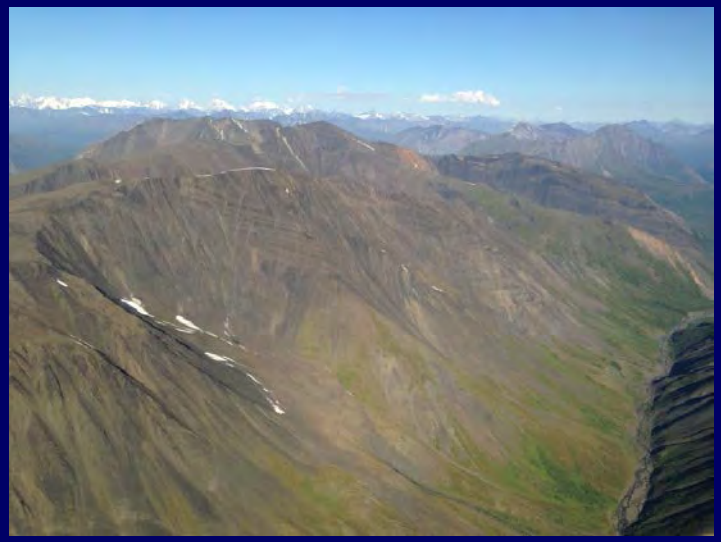
Styx Project Geologic Setting: Terrane Map



Modified from Colpron and Nelson, 2011

Styx Project Geologic Setting





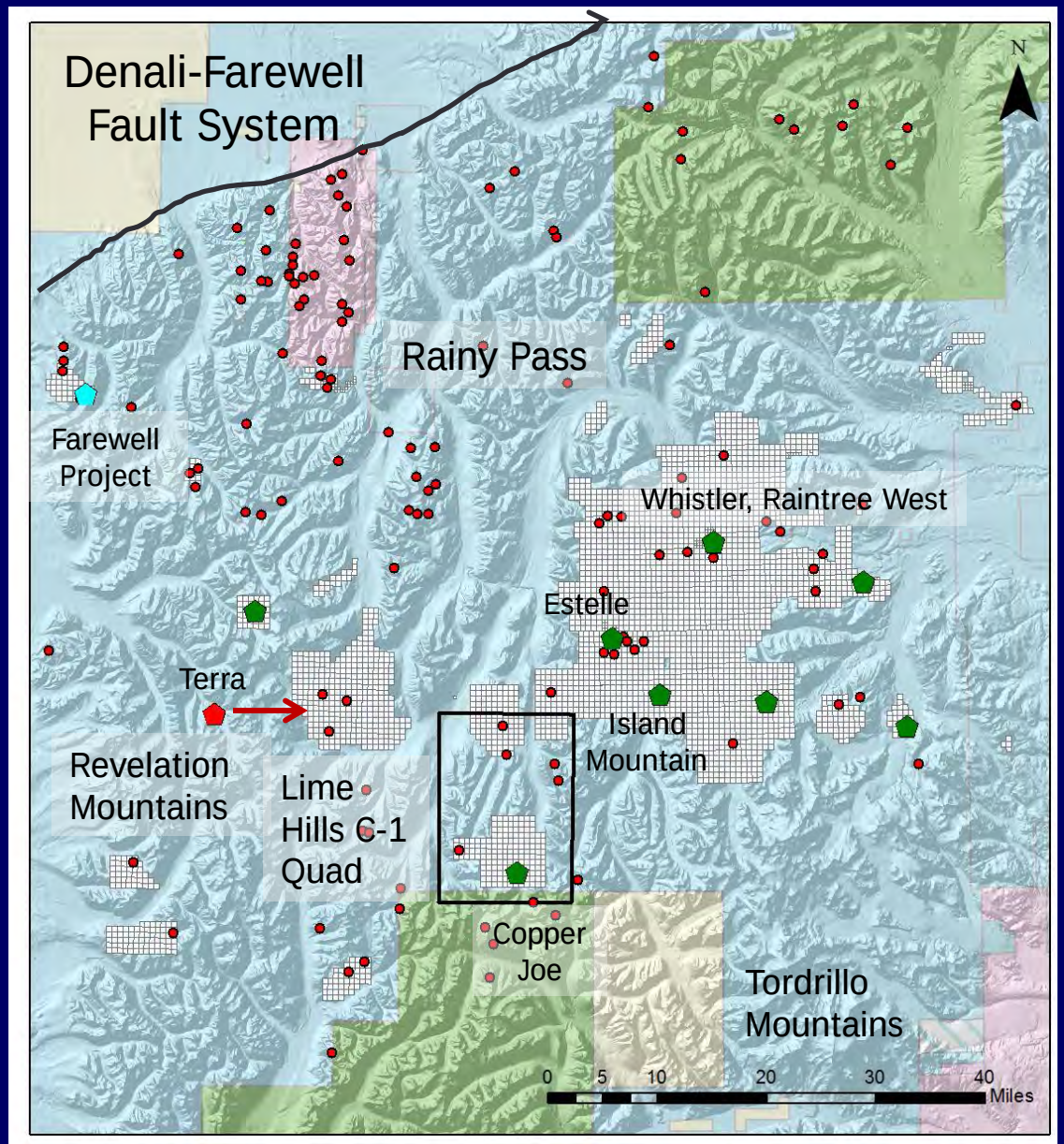
Jurassic-Cretaceous
flysch

Cretaceous and Tertiary
plutonic rocks

Tertiary **volcanics**

Map modified from Wilson and others, 1998

Land Status and Mining Claims



LEGEND

Land ownership

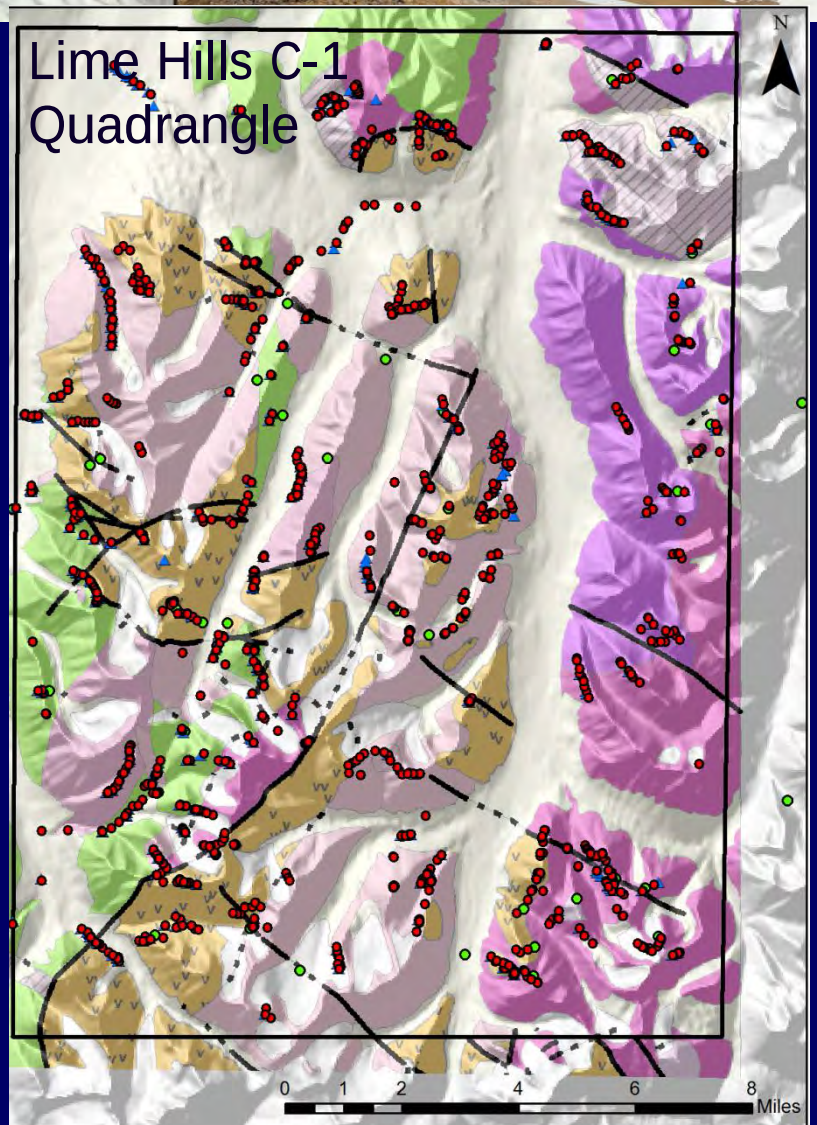
- Bureau of Land Management
- National Park Service
- Native Patent or IC
- State Patent or TA
- State Selected

LEGEND

Mineral Exploration

- Cr, Ni, PGE
- Au
- Porphyry (Cu, Au, Mo)
- ARDF lode deposits
- State Mining Claims

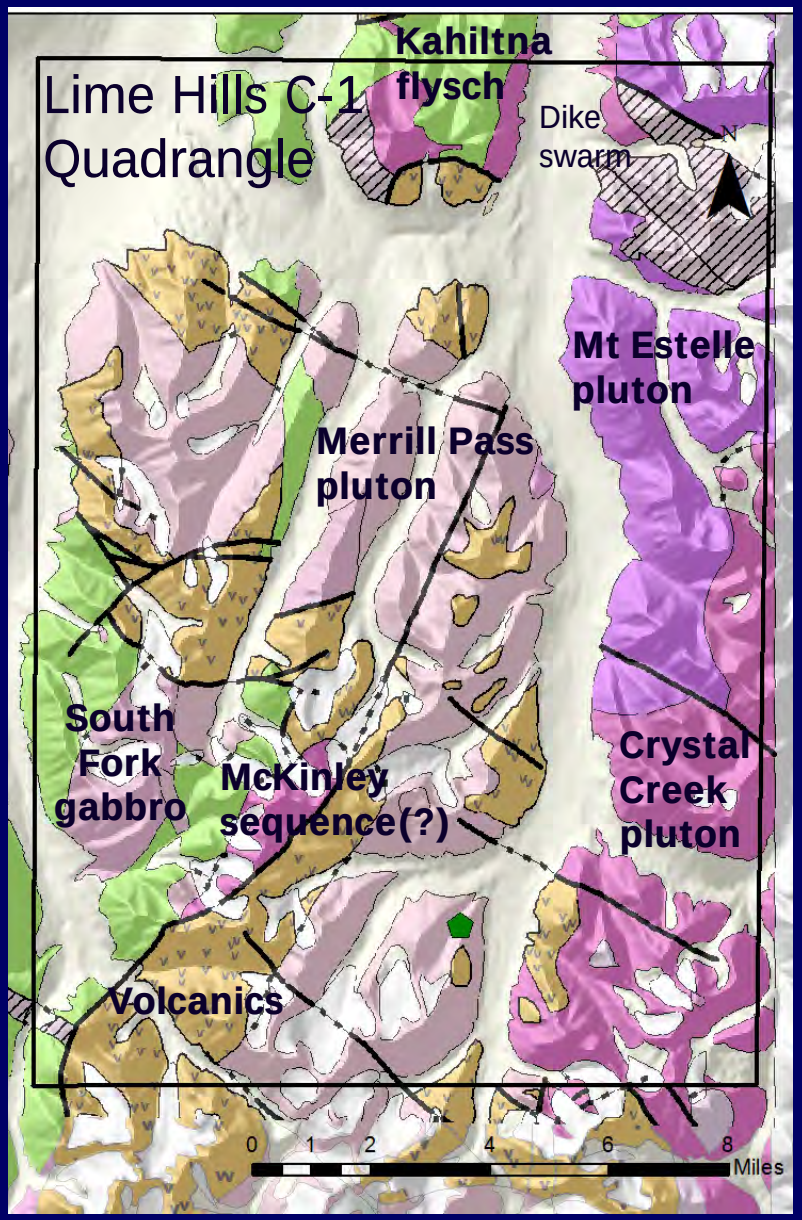
2013 Field Program Accomplishments



- 740 geologic observations
- 564 structural observations
- TOTAL: 1863 stations with geologic observations

Geologic map modified from Gamble and others, 2013

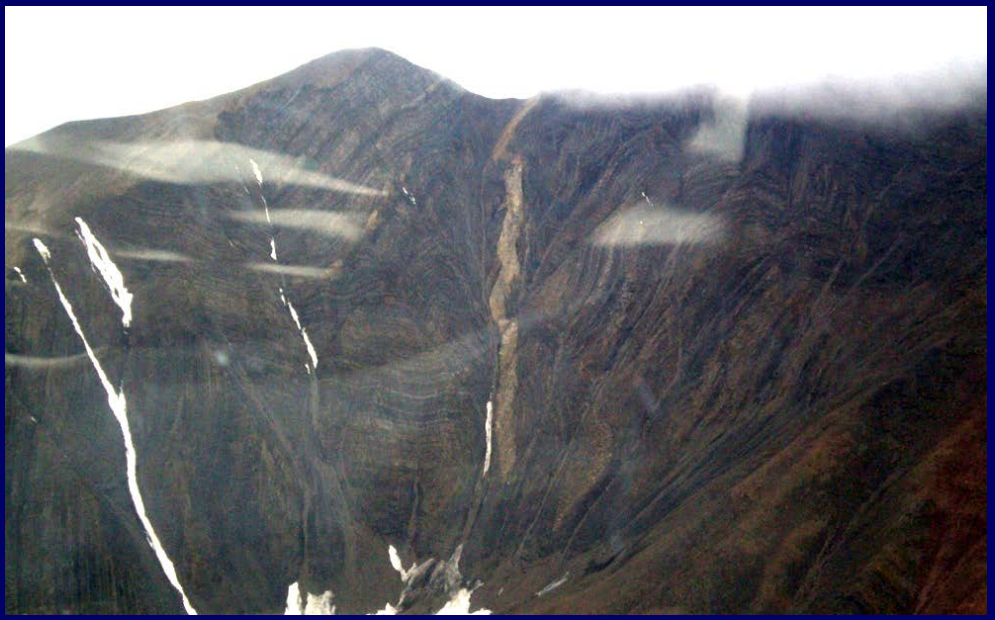
Mapping Accomplishments



- Sedimentary host rock
- 5 Major plutonic rocks
- Volcanic and hypabyssal rocks
- Mafic to felsic dike swarms

Geologic map modified from Gamble and others, 2013

Sedimentary rocks, undifferentiated (Ks)



- Dark grey to black, interbedded mudstone, siltstone, and graywacke turbiditic sequences
- Roughly Cretaceous age
- Large-scale folding and faulting, layer parallel slip
- Intruded by felsic and mafic dikes, plutons, and hornfelsed
- Samples collected for detrital zircon and thin section studies to help locate within detailed USGS framework of Kahiltna assemblage

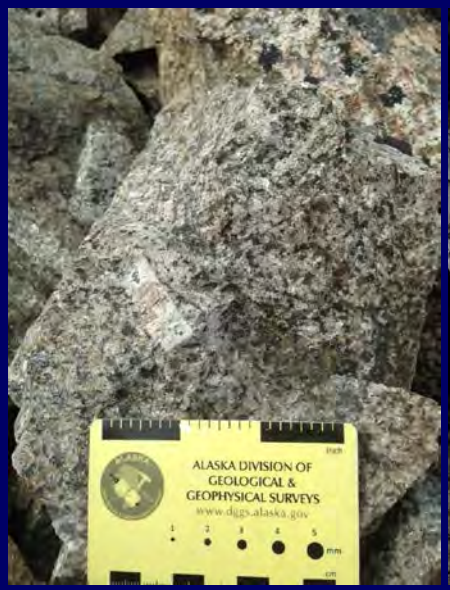
Merrill Pass pluton (Tmp)

- Chiefly biotite granite grading into granodiorite and alkali-feldspar granite
- Hypidiomorphic granular textures with miarolitic cavities
- Tertiary: 40.0-41.6 Ma (Ar/Ar)
- Highly magnetic phases and weakly magnetic phases
- Intrudes upwards into Tertiary volcanics (Tv)
- Seems to pre-date and post-date Tv
- Ar/Ar ages will support cross-cutting relationships

Crystal Creek pluton (Tcc)

- Biotite-hornblende alkali-feldspar granite to granodiorite
- Medium to coarse-grained, seriate to porphyritic, hypidiomorphic-granular
- Tertiary: 60.0 Ma (K/Ar)
- May correlate with Chilligan porphyry (unpublished data)

McKinley sequence(?) granites (Tms)



- Biotite granite
- Fine- to coarse-grained seriate, hypidiomorphic-granular or porphyritic
- Tertiary: 65.0 Ma (Ar/Ar) on porphyritic phase
- Does not correlate with other ages for this plutonic sequence

Mount Estelle pluton (Tme)

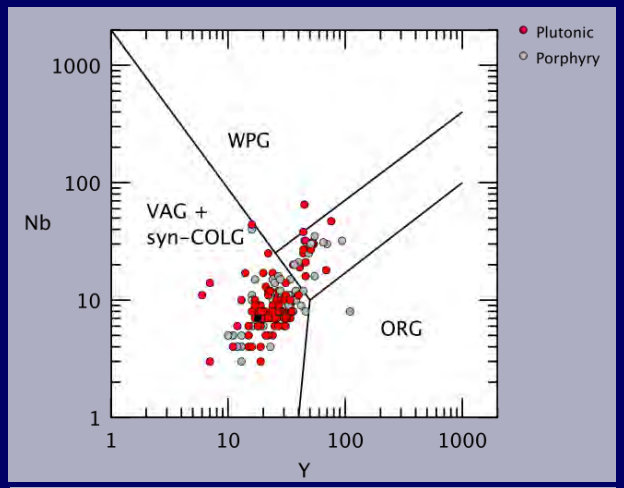
- Biotite-hornblende granodiorite
- Chiefly medium- to coarse-grained, seriate, hypidiomorphic-granular
- Tertiary: 62.1 Ma, 64.1 Ma (K-Ar), 69.7 Ma (U/Pb) from Millrock's Stoney prospect
- Contain aplite and lamprophyre dikes (NW trending) with quartz, arsenopyrite, chalcopyrite, and magnetite veins

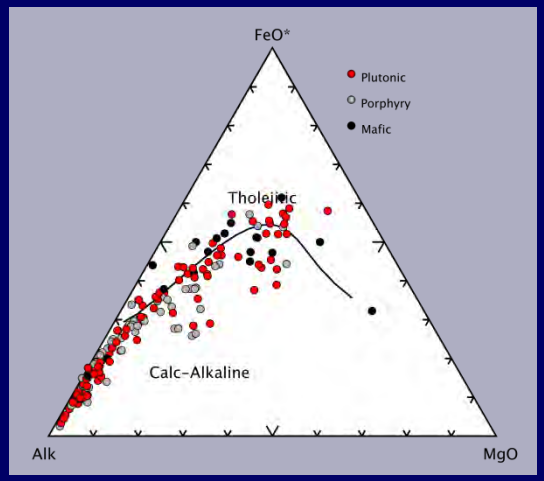
South Fork pluton (Kgb)

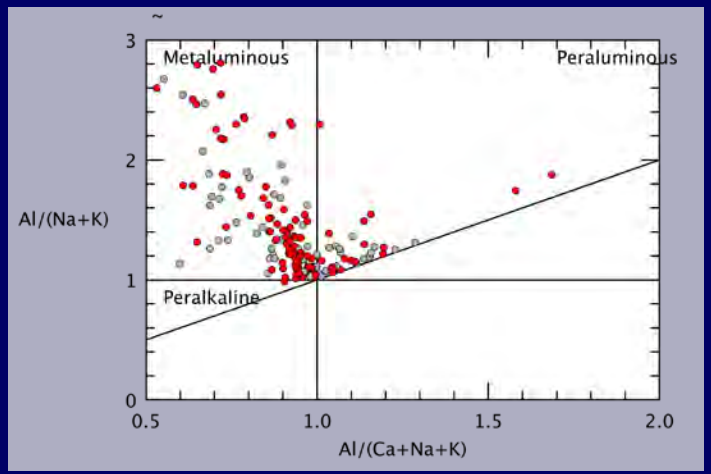
- Hornblende-pyroxene-biotite gabbro
- Fine- to medium-grained, seriate, hypidiomorphic-granular
- Cretaceous 71.4 Ma (K-Ar)
- Copper mineralization

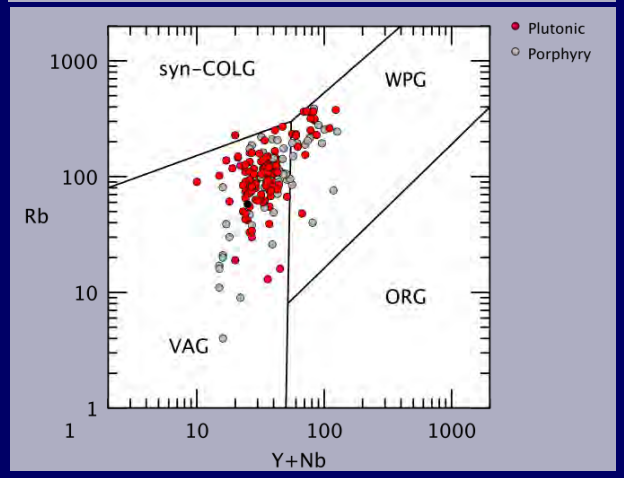
Plutonic Rocks Preliminary Geochemical Results

- Broad lens XRF analyses (University of Alaska Fairbanks, Dr. Rainer Newberry)
  - Fast, economical, assists mapping
- Fine-grained intrusive rocks
- Dominantly calc-alkaline
- Mostly metaluminous
- Mainly volcanic arc granites (VAG) or within plate granites (WPG)

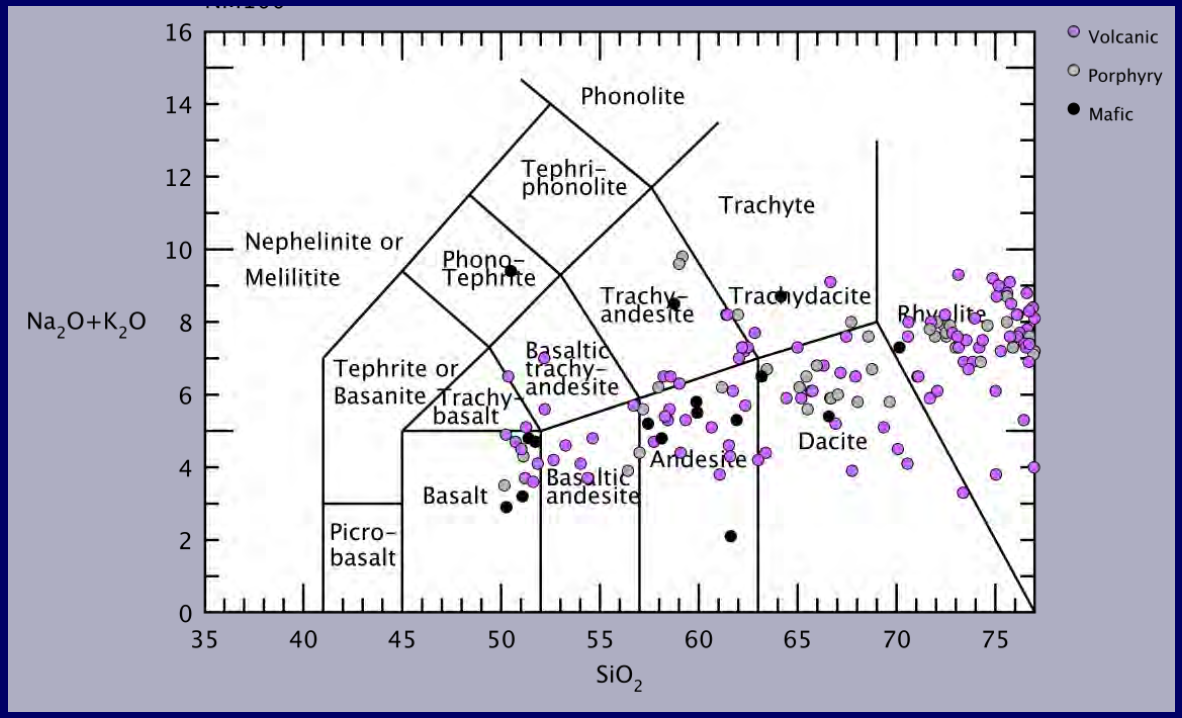




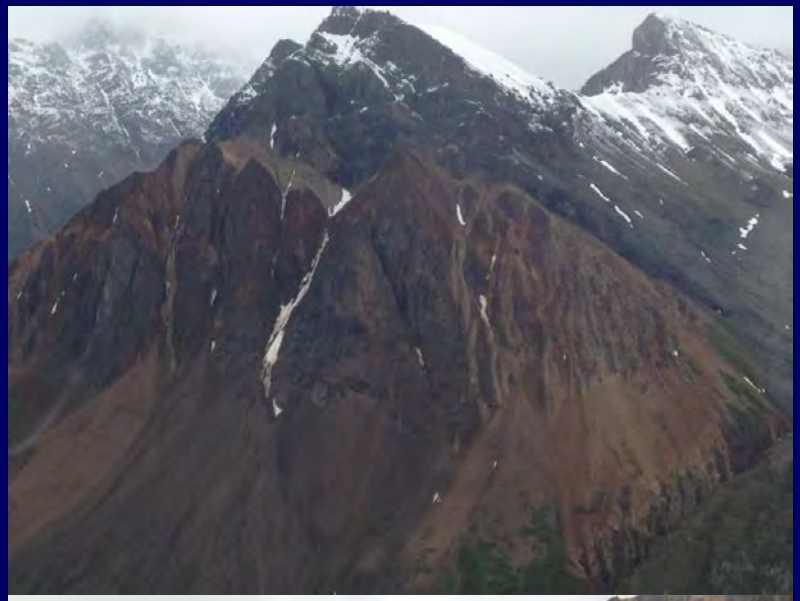




Volcanic and Hypabyssal Rocks

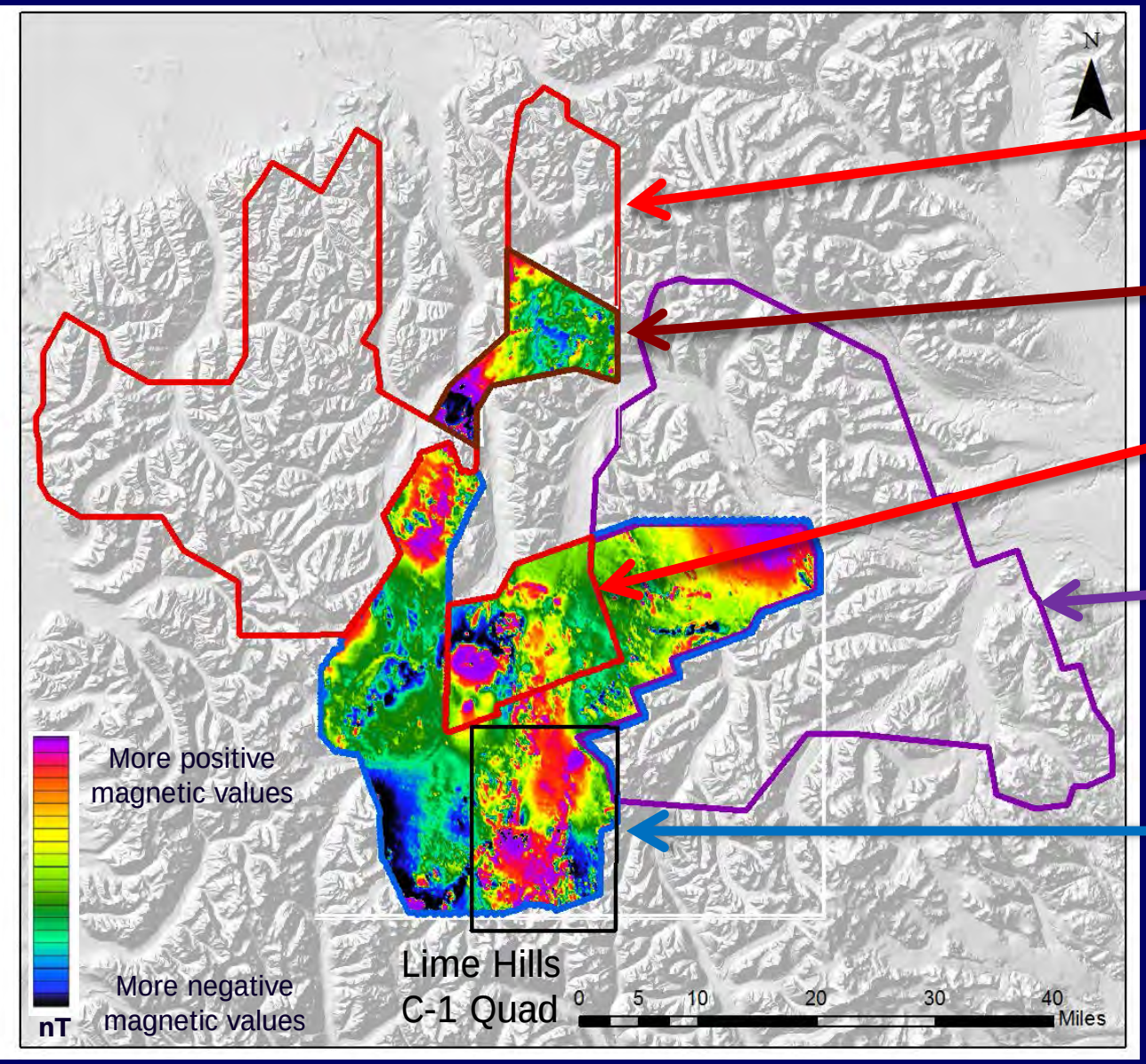


Dike Swarms



- Mafic to felsic compositions
- Aphanitic to porphyritic
- Cutting through sedimentary rocks and the Mt Estelle pluton
- Locally contain py and sericite alt'n
- Mafic dikes dated by USGS as 51-58 Ma, NNW striking, W dipping

Geophysical Surveys



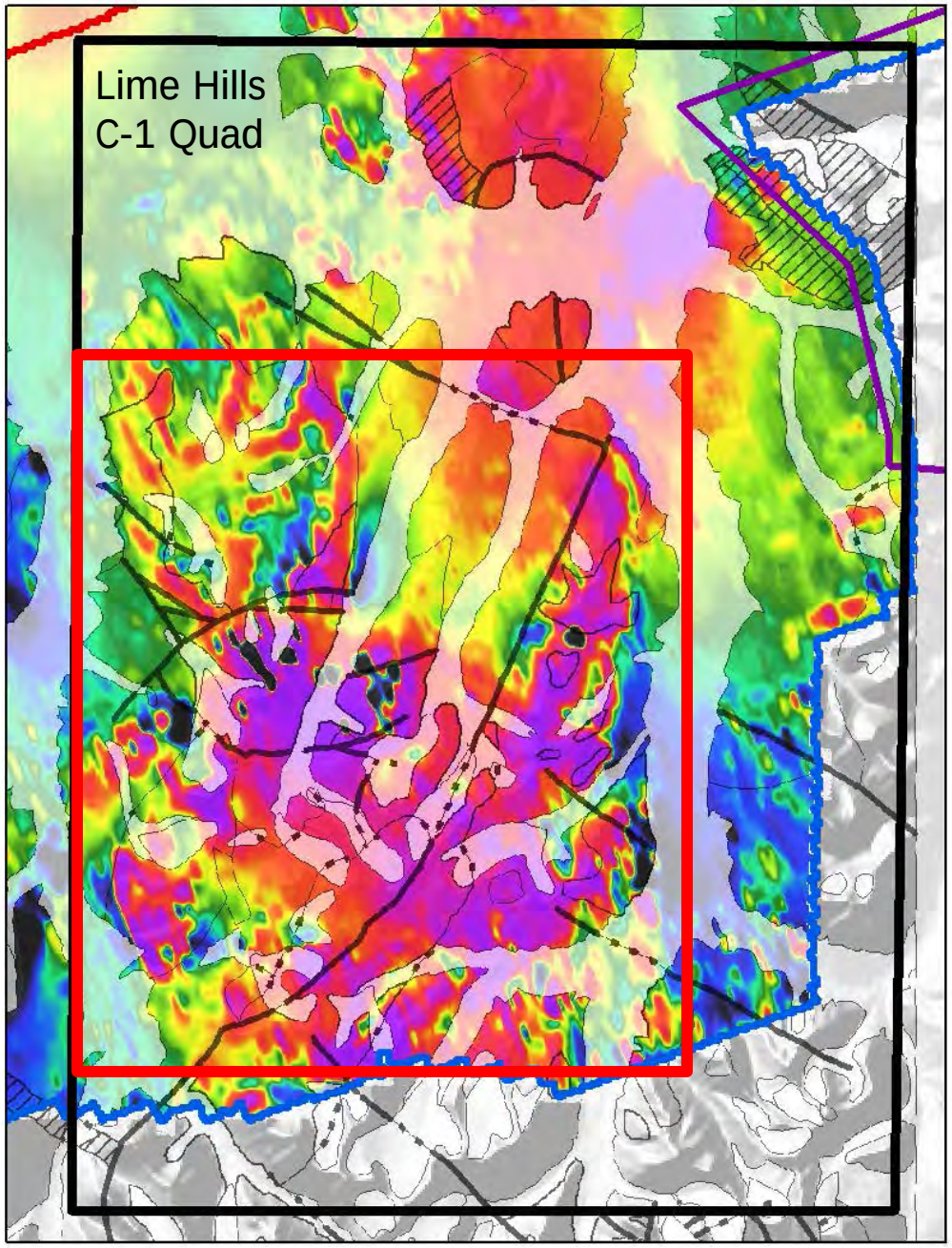
Farewell Survey (2014)

Dalzell Creek Survey (2013)

Middle Styx Survey (2013)

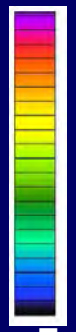
East Styx Survey (2014)

Styx River Survey (2008)



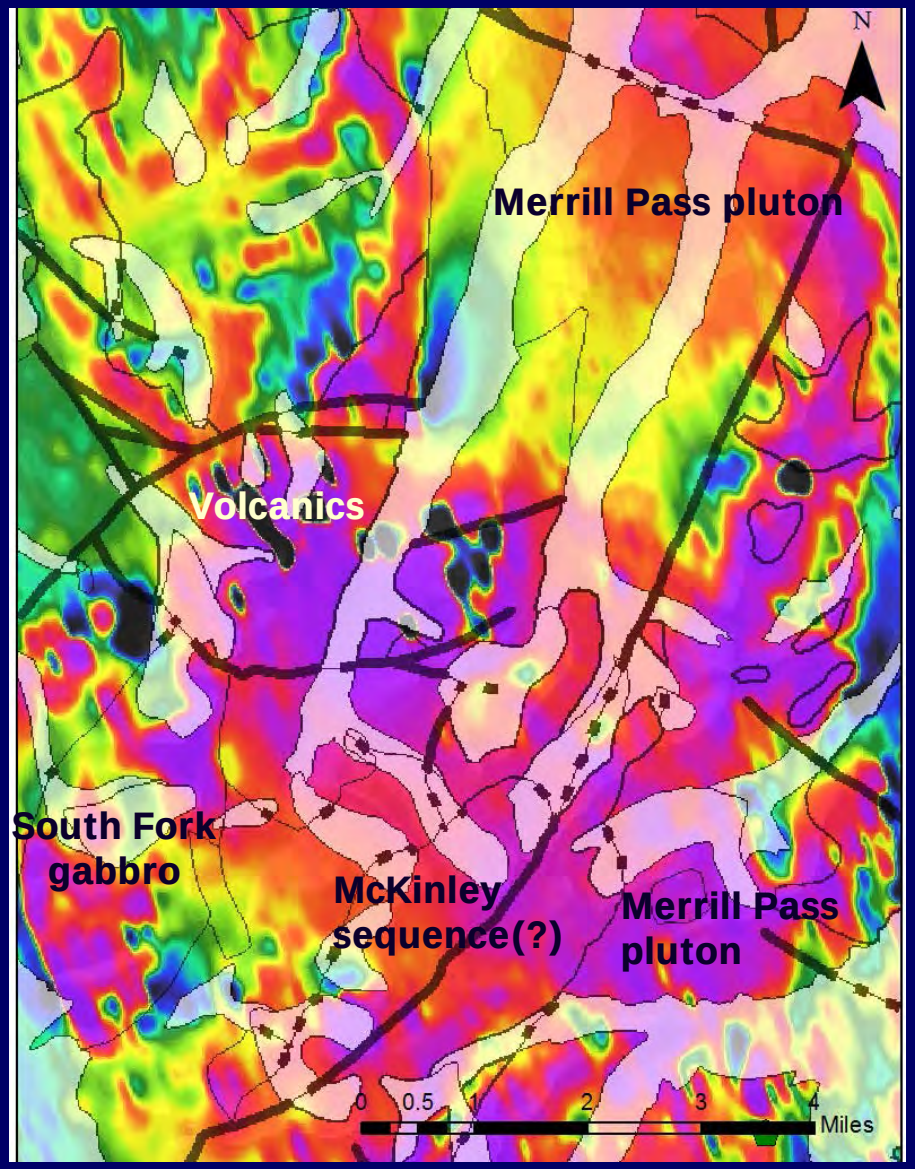
Detailed Geophysical Datasets

- Improves geologic unit contacts by helping to distinguish plutons from volcanic and sedimentary units
- Highlights faults and regional structures

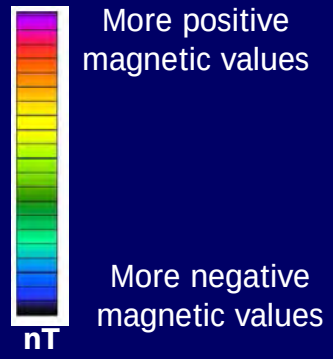


Geologic Map contacts from Gamble and others, 2013

Fault and Contact Improvements

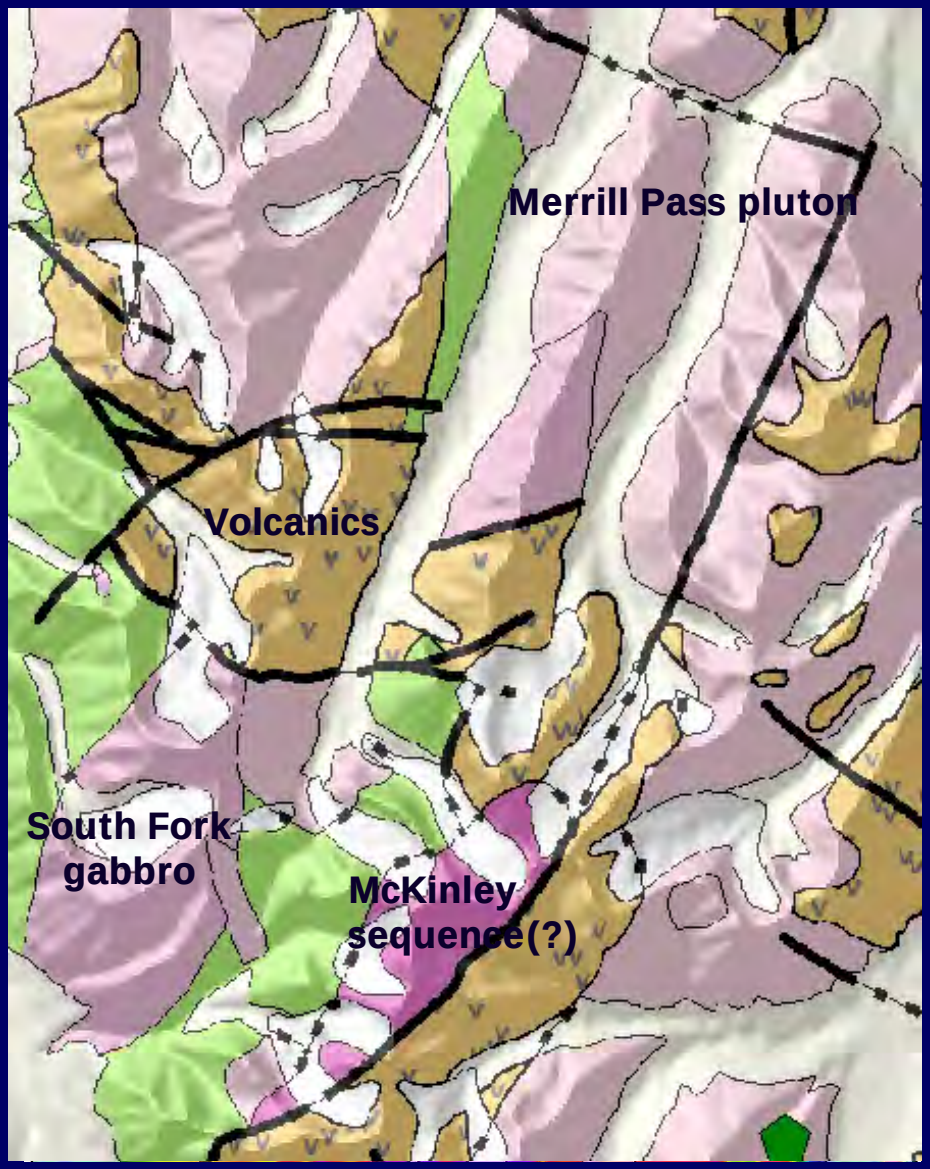


- Changed caldera interpretation with geophysics and ground checking
- Changed fault contacts with magnetics and resistivity
- Differentiated the highly magnetic Merrill Pass pluton from the weakly magnetic unit

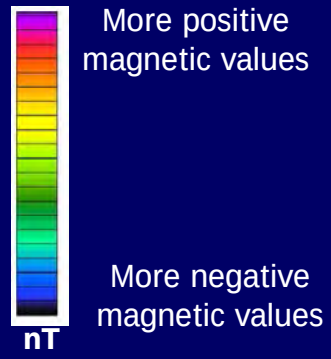


Geologic Map contacts from Gamble and others, 2013

Fault and Contact Improvements



- Changed caldera interpretation with geophysics and ground checking
- Changed fault contacts with magnetics and resistivity
- Differentiated the highly magnetic Merrill Pass Pluton from the low magnetic unit



Geologic Map contacts from Gamble and others, 2013

Mineralization Highlights

- Copper Joe porphyry system: impressive qtz-sericite-py alteration zone
  - Is it related to the **Tertiary** Merrill Pass pluton as mapped?
- Cretaceous Mt Estelle granodiorite with Qtz-Cpy veins, Au?
- Jimmy Lake epithermal system, related to NW trending dikes,
  - Alteration and mineralization (gossan)
- Many samples collected for analysis

Ongoing Investigations

Follow-up lab work:

- Submit samples for geochemistry, geochronology, and thin sections
- Conduct petrographic and geochemical studies of rocks
- Analyze structural data

Products:

- Detailed geologic map of the Lime Hills C-1 Quadrangle with explanatory text
- Geochemical data report
- Geochronologic data report


Thanks for your attention

Works Cited

Box, S.E., Ayuso, R.A., Bradley, D.C., Haeussler, P.J., Saltus, R.W., Karl, S.M., Jones, J.V., Dumoulin, J.A., Graham, G.E., Todd, E., Lease, R.O., 2012, A geologic transect across the western Alaska Range [abs.], *in* Alaska Mining Association 2012 Annual Convention & Trade Show; The Business of Mining Abstracts, 2012 Nov 5-11, Anchorage, Alaska, p. 24-25.

Bundtzen, T.K., Harris, E.E., and Gilbert, W.G., 1997, Geologic Map of the eastern McGrath quadrangle, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigations 97-14, 34 p., 1 sheet, scale 1:125,000.

Burns, L.E., Fugro Airborne Surveys Corp., and Stevens Exploration Management Corp., 2008, Line, grid, and vector data, and plot files for the airborne geophysical survey of the Styx River Survey, southcentral Alaska: Alaska Division of Geological & Geophysical Surveys Geophysical Report 2008-3, 27 sheets, scale 1:63,360, 1 DVD.

Colpron, M. and Nelson, J.L., 2011, A Digital Atlas of Terranes for the Northern Cordillera: British Columbia Ministry of Energy and Mines, BCGS GeoFile 2011-11.

Gamble, B.M., Reed, B.L., Richter, D.H., Lanphere, M.A., 2013, Geologic Map of the East Half of the Lime Hills 1:250,000-scale Quadrangle, Alaska, U.S. Geological Survey Open-File Report 2013-1090.

Haeussler, P.J., Bradley, D., Ayuso, R., Layer, P.W., Friedman, R.M., O'Sullivan, P., Jones, J.V.III, Karl, S.M., Box, S.E., Todd, E., Magmatic history of the Tordrillo Mountains and western Alaska Range and tectonic implications [abs.], *in* The Geological Society of America Annual Meeting; Abstracts with Programs, 2013 Oct 27-30, Denver, Colorado, v. 45, p. 77.

Hults, C.P., Wilson, F.H., Donelick, R.A., O'Sullivan, P.B., 2013, Two flysch belts having distinctly different provenance suggest no stratigraphic link between the Wrangellia composite terrane and the paleo-Alaskan margin: Geological Society of America, Lithosphere,

Karl, S.M., Box, S.E., Jones, J.V III, Lease, R.O., Bradley, D.C., Haeussler, P.J., Hults, C.P., Graham, G., 2013, Petrographic and detrital zircon data from the Kahiltna basin suggest early Cretaceous juxtaposition of the continental margin and the Peninsular Terrane in the western Alaska Range [abs.], *in* The Geological Society of America Annual Meeting; Abstracts with Programs, 2013 Oct 27-30, Denver, Colorado, v. 45, p. 78.

Wilson, F.H., Dover, J.H., Bradley, D.C., Weber, F.R., Bundtzen, T.K., and Haeussler, P.J., 1998, Geologic map of Central (Interior) Alaska: U.S. Geological Survey Open-File Report 98-133-A, 62 p., 3 sheets.