New Geochemical and Geophysical Data from the Western Wrangellia Minerals Assessment Area

Evan Twelker and Laurel Burns
Alaska Division of Geological & Geophysical Surveys

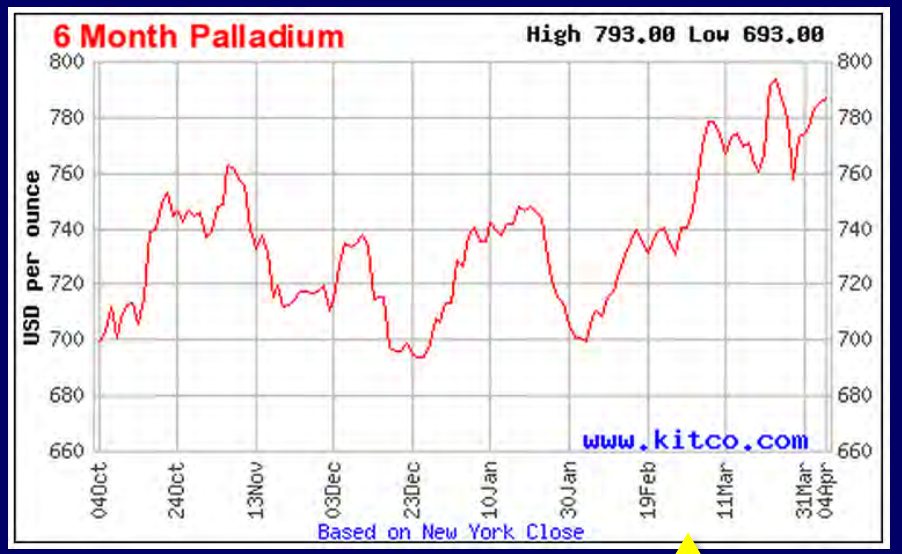
Alaska Miners Association 24th Biennial Mining Conference
April 7-13, 2014 – Fairbanks, Alaska

Acknowledgements

- Funded by the Legislature as part of the Governor's Strategic and Critical Minerals Assessment Capital Improvement Project which supplements the ongoing Airborne Geophysical/Geological Mineral Inventory
- The crew: Rainer Newberry, Larry Freeman, Karri Sicard, Erik Bachmann, David Reioux, Colby Wright, Amy Tuzzolino
- Alicja Wypych – petrologist/geochemist new at DGGS
- Gina Graham – geophysicist at DGGS
- Ken Severin and the UAF AIL
- Jon Findlay and the Pure Nickel crew
- Phil St. George and Millrock Resources
- The Prophecy Platinum crew at Wellgreen
- The USGS, USBM/BLM, and explorationists who have been building the Wrangellia Ni-Cu-PGE story over the years

Why are we interested in PGEs?

(PGEs = Platinum-group elements:
Pt, Pd, Rh, Ir, Os, Ru)



Crimean Crisis

Strategic & Critical Minerals

PGEs essential as catalysts

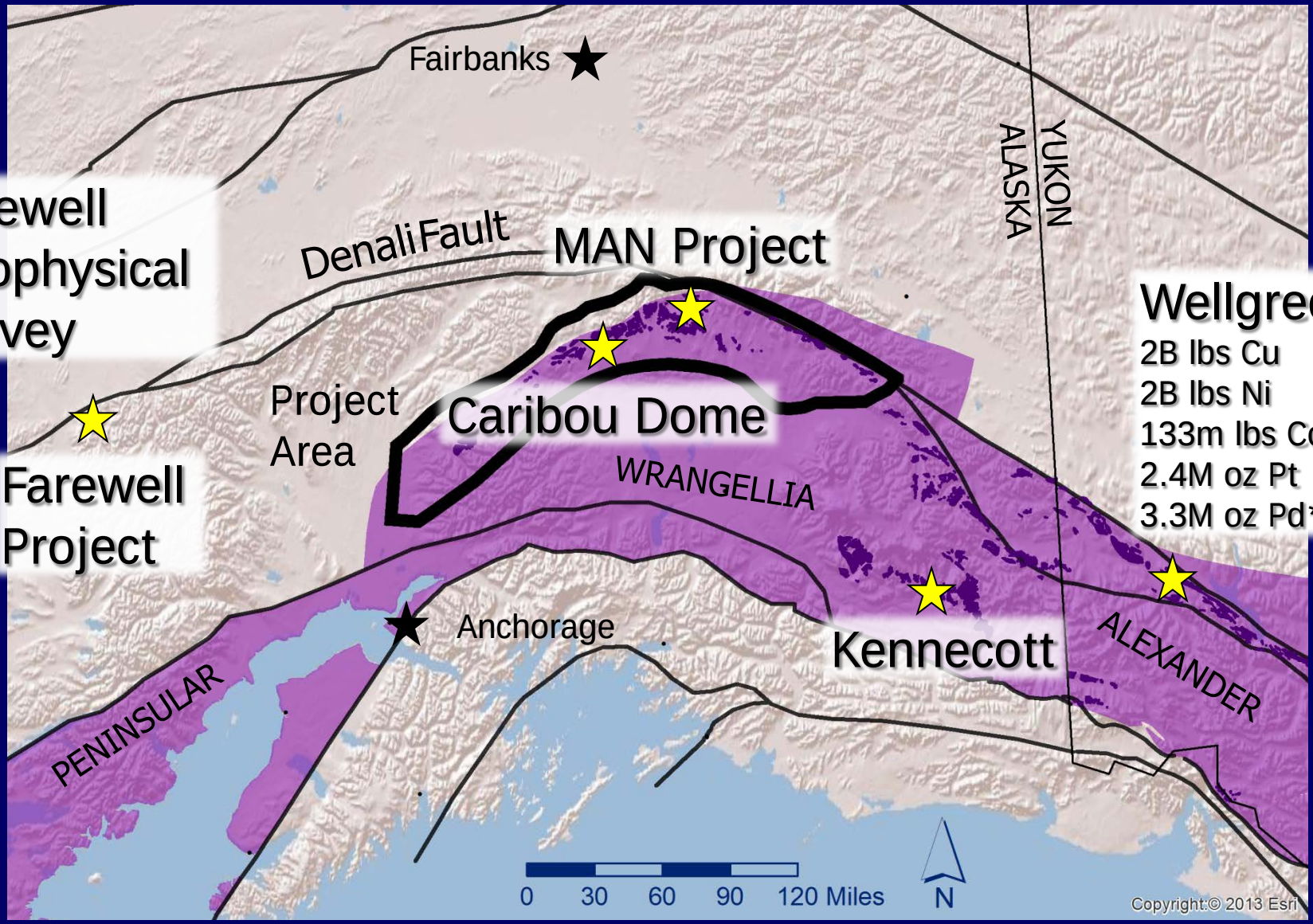
- Automotive
- Chemical industry
- Your new EPA woodstove

Heavy dependence on foreign sources:

- US Net import reliance: 91% of Pt, 56% of Pd[1]
- Mine production:
  - South Africa + Russia = 92% of Pt, 77% of Pd[1]

[1]USGS 2013 Commodity summary for Platinum-Group Metals

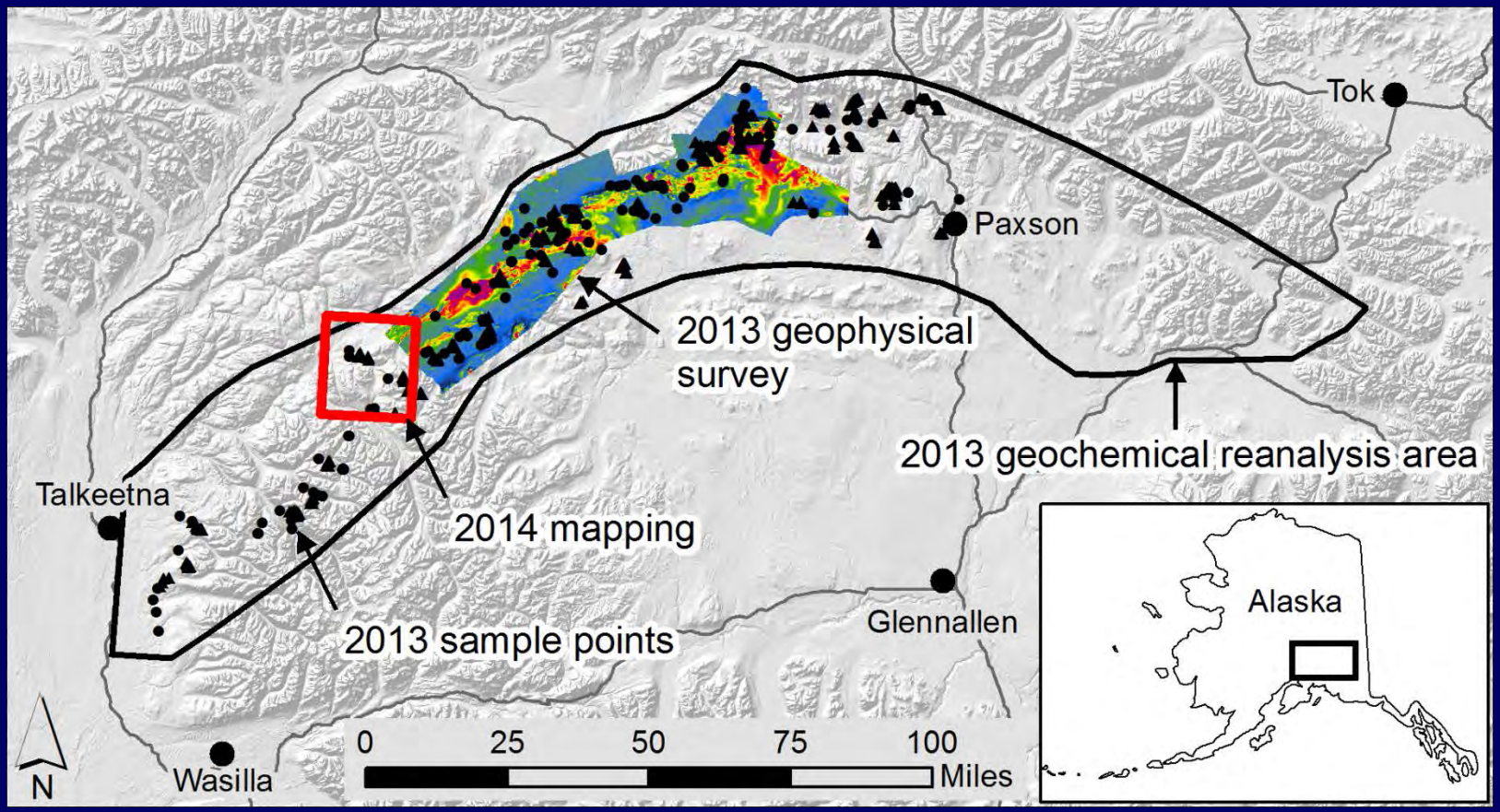
Where are we going to find PGEs in Alaska?



Terrane map modified from Colpron and Nelson, 2011

*Life-of-mine production under 2012 PEA (Tetra Tech Wardrop, 2012)

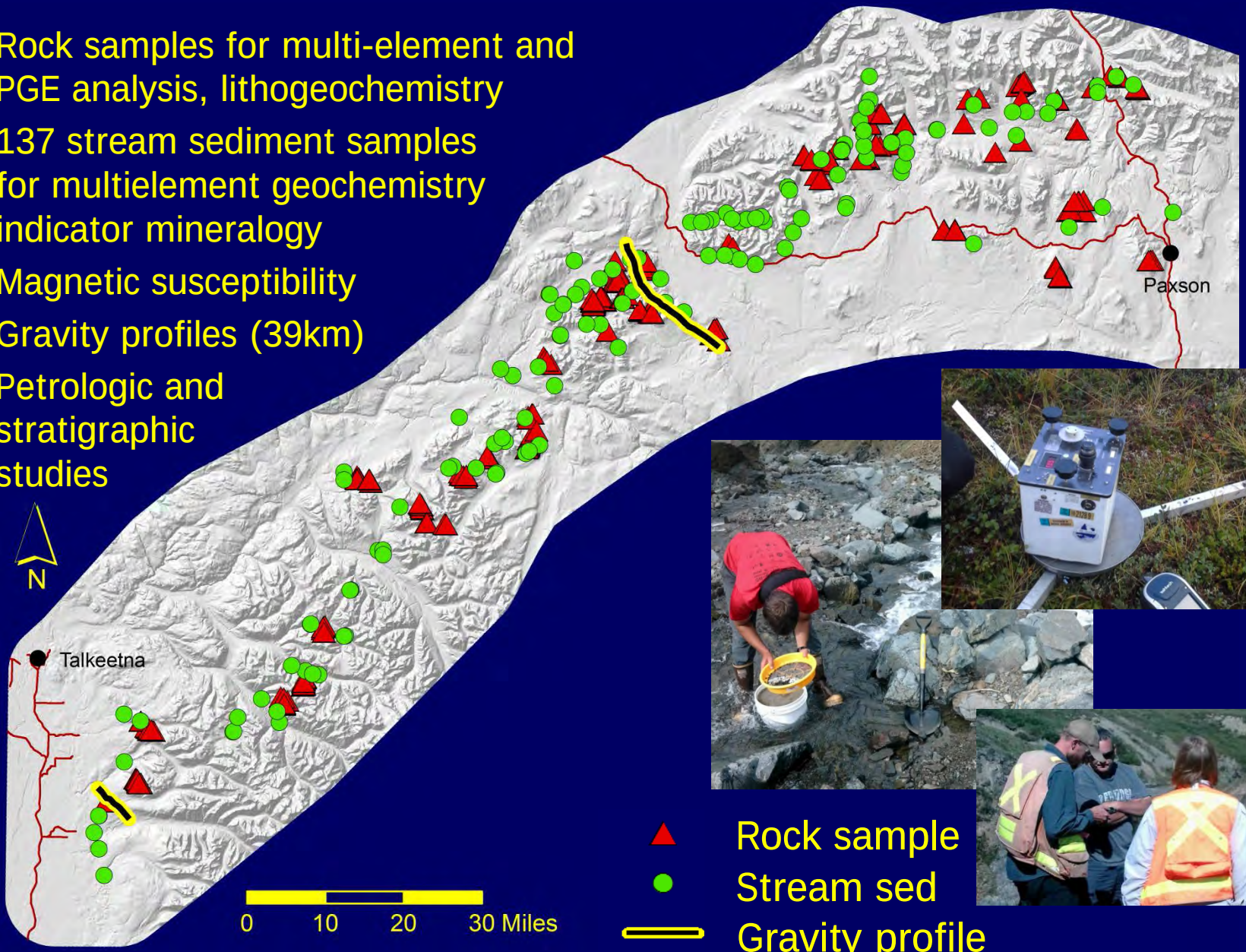
Project overview



1. New airborne magnetic and electromagnetic data
2. Geologic/geochemical evaluation of Ni-Cu-PGE potential
3. Reanalysis of existing pulps with modern techniques
   ~1600 USGS stream sediment re-analyses by June 30

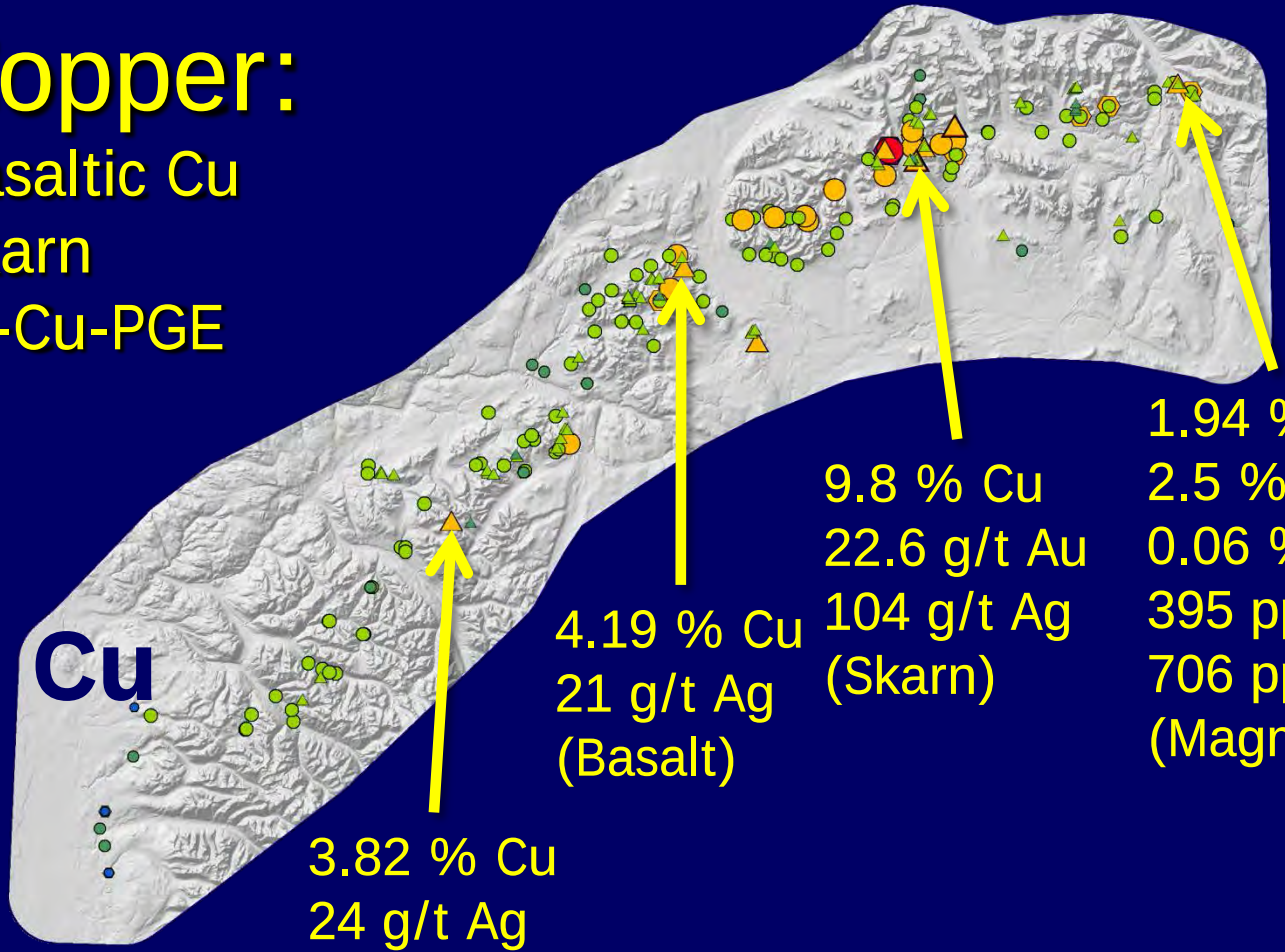
Geological/Geochemical Program

- Rock samples for multi-element and PGE analysis, lithogeochemistry
- 137 stream sediment samples for multielement geochemistry indicator mineralogy
- Magnetic susceptibility
- Gravity profiles (39km)
- Petrologic and stratigraphic studies



Copper:

Basaltic Cu
Skarn
Ni-Cu-PGE



Log transformed

$$z = \frac{\text{value - mean}}{\text{std dev}}$$

"anomaly map"
(no economic threshold implied)

1.94 % Cu
2.5 % Ni
0.06 % Co
395 ppb Pt
706 ppb Pd
(Magmatic sulfide)

9.8 % Cu
22.6 g/t Au
104 g/t Ag
(Skarn)

4.19 % Cu
21 g/t Ag
(Basalt)

3.82 % Cu
24 g/t Ag
(Skarn)

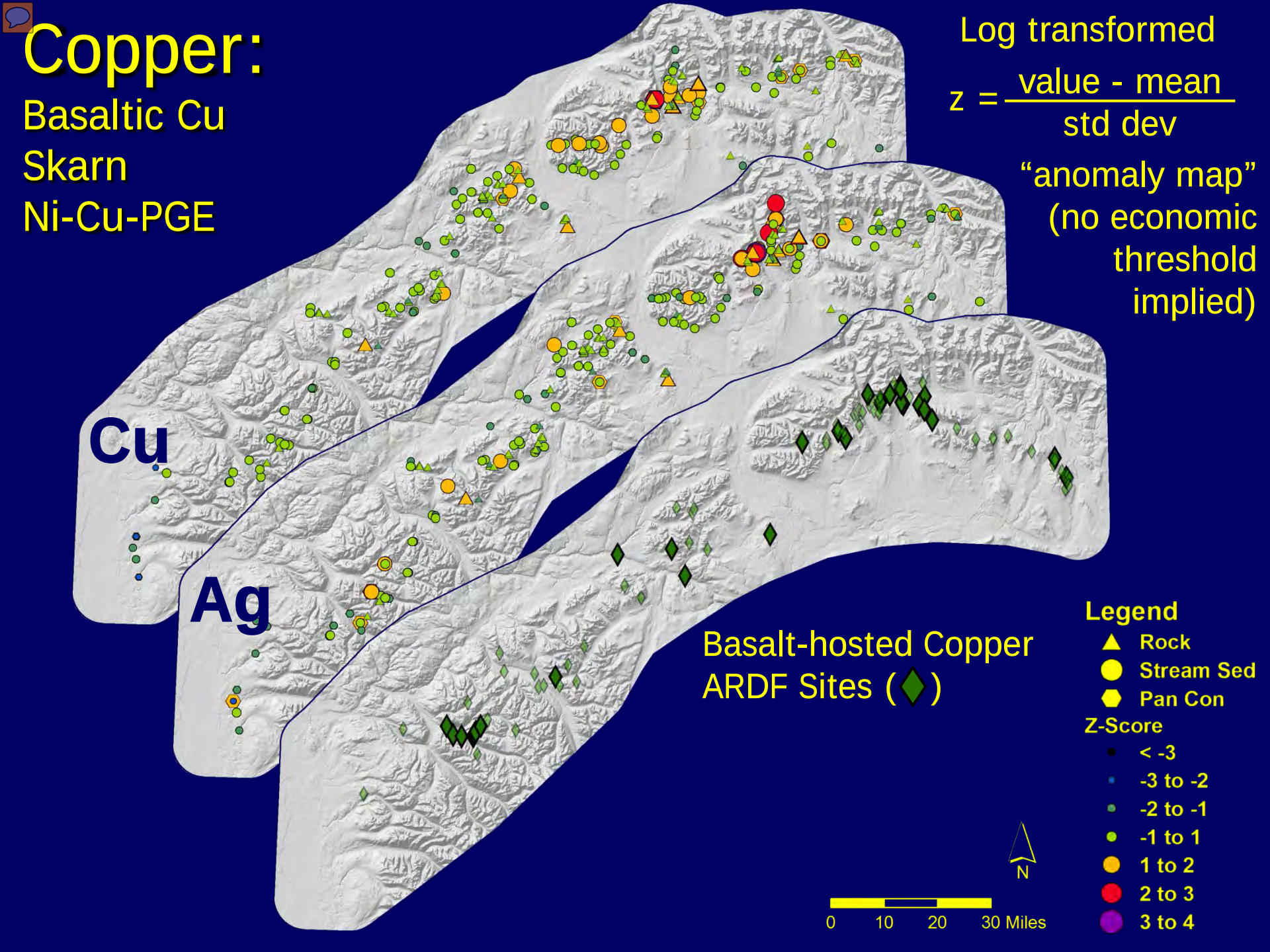
Legend
- Rock
- Stream Sed
- Pan Con

Z-Score
- < -3
- -3 to -2
- -2 to -1
- -1 to 1
- 1 to 2
- 2 to 3
- 3 to 4

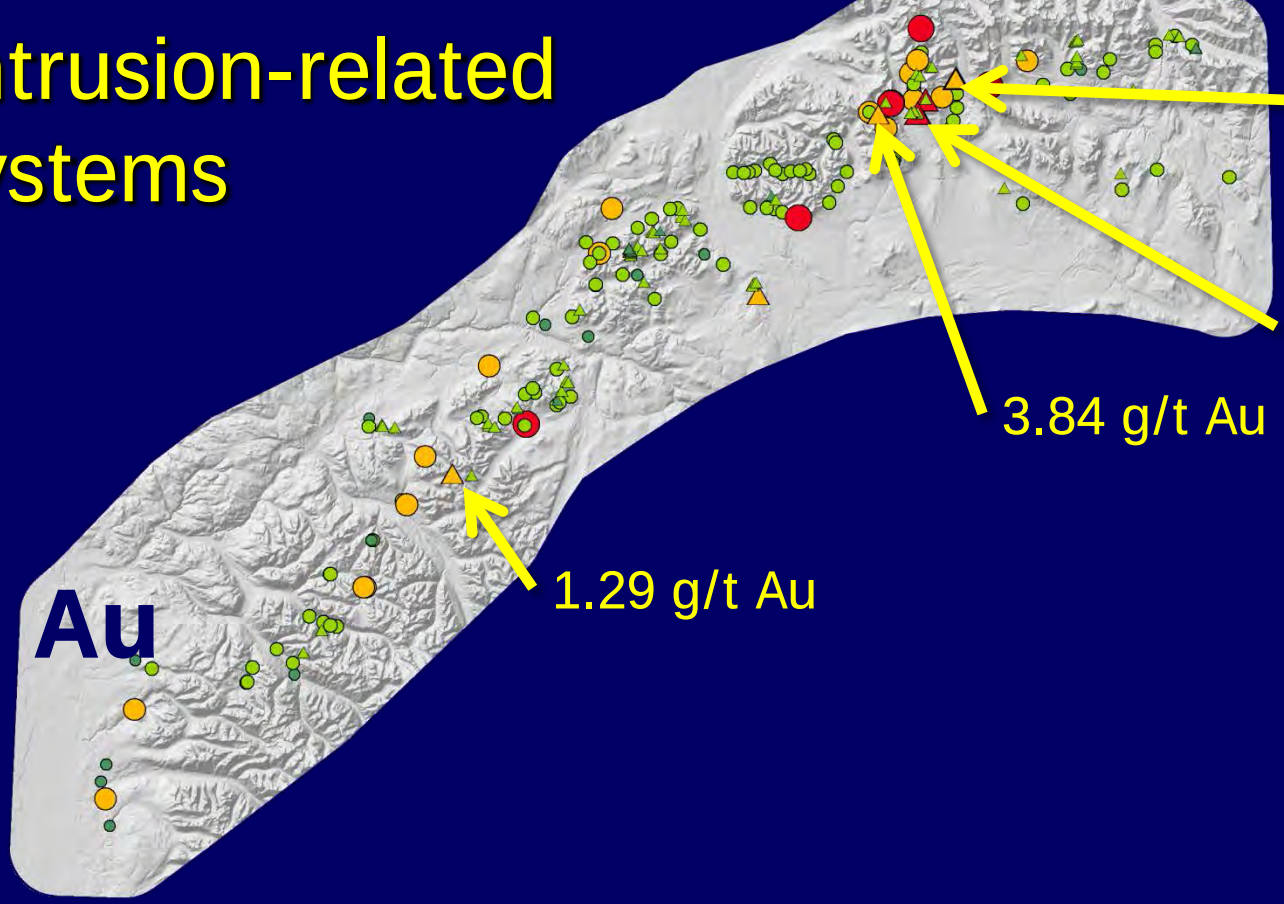
N

0 10 20 30 Miles

Data released on April 9th as RDF 2014-3:
http://www.dggs.alaska.gov/pubs/id/27181


Copper:
Basaltic Cu
Skarn
Ni-Cu-PGE
Log transformed
z = value - mean / std dev
"anomaly map"
(no economic
threshold
implied)
Cu
Ag
Basalt-hosted Copper
ARDF Sites ( )
Legend
Rock
Stream Sed
Pan Con
Z-Score
< -3
-3 to -2
-2 to -1
-1 to 1
1 to 2
2 to 3
3 to 4
N
0 10 20 30 Miles

Intrusion-related systems



Legend

- Rock
- Stream Sed
- Pan Con

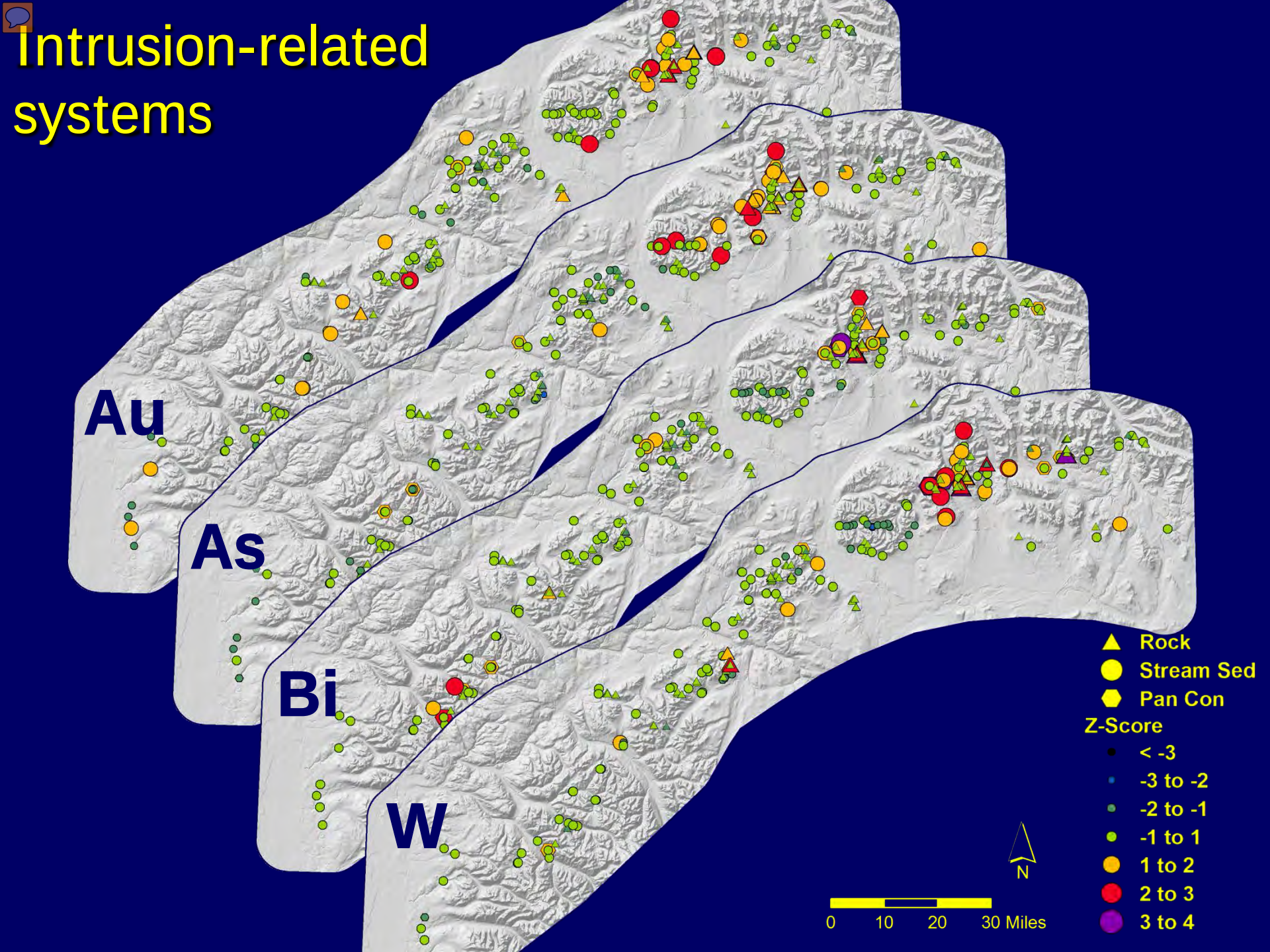
Z-Score

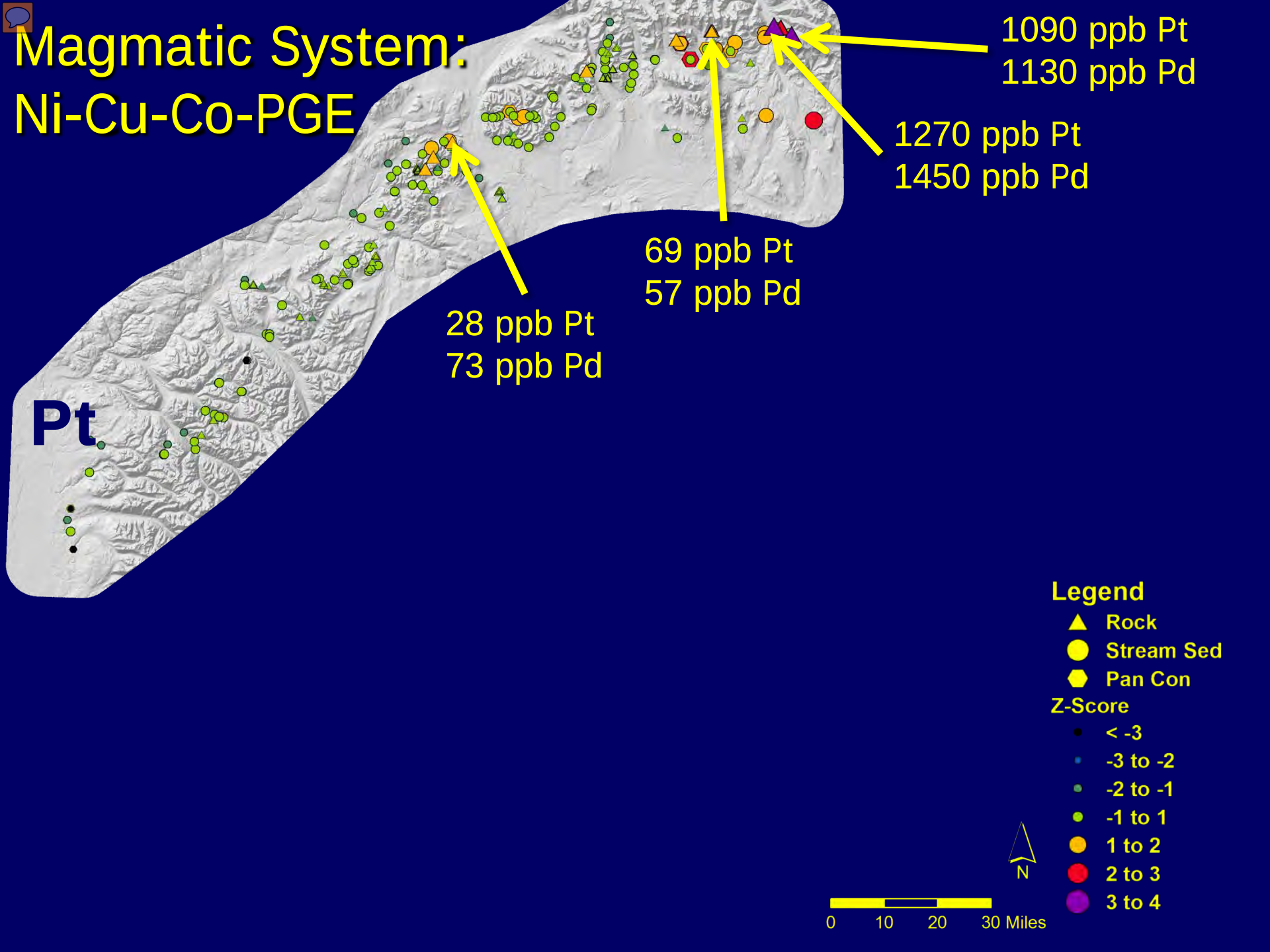
- < -3
- -3 to -2
- -2 to -1
- -1 to 1
- 1 to 2
- 2 to 3
- 3 to 4

N

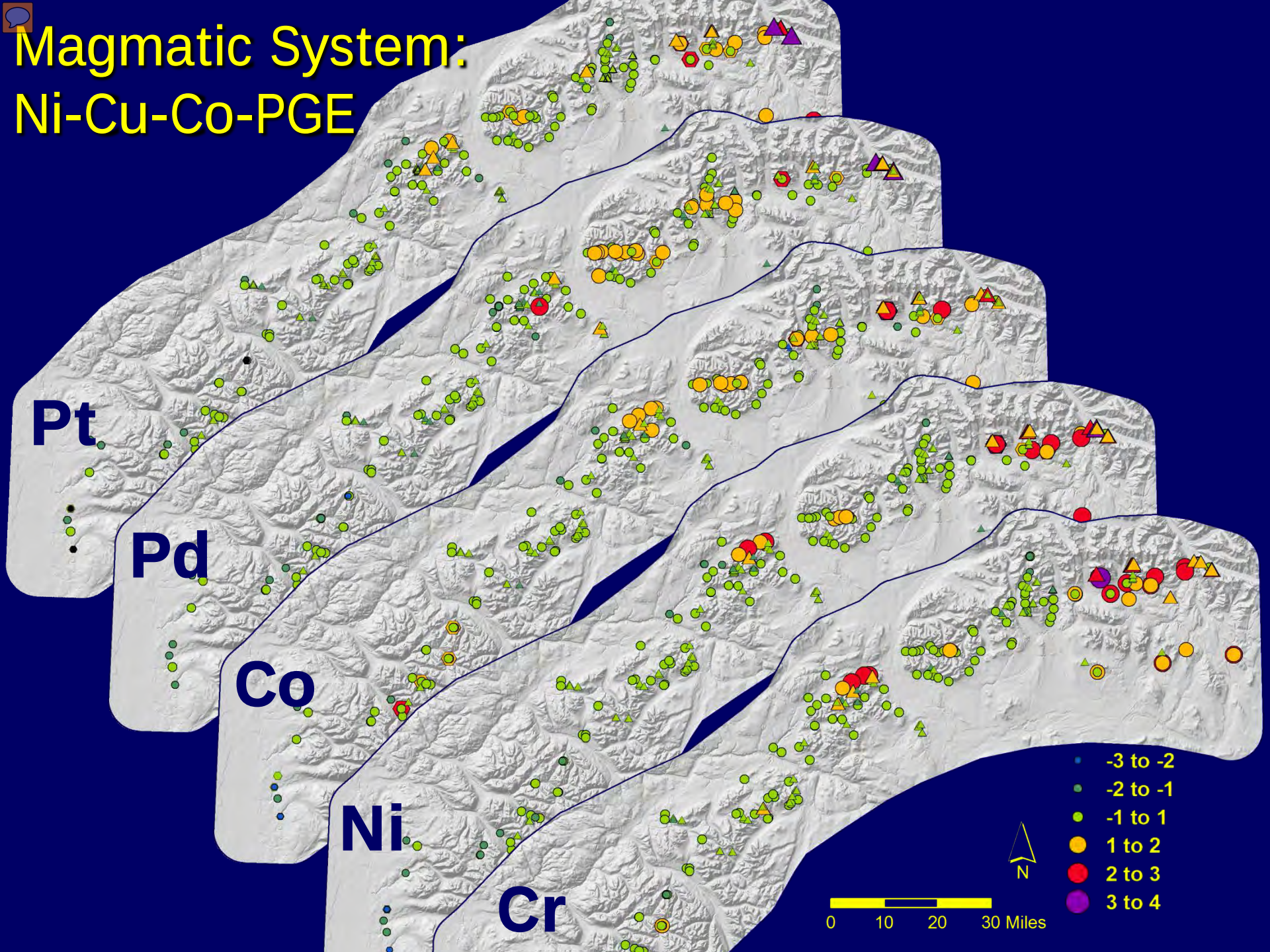
0 10 20 30 Miles

Intrusion-related systems




Magmatic System:
Ni-Cu-Co-PGE
1090 ppb Pt
1130 ppb Pd
1270 ppb Pt
1450 ppb Pd
69 ppb Pt
57 ppb Pd
28 ppb Pt
73 ppb Pd
Pt
Legend
Rock
Stream Sed
Pan Con
Z-Score
< -3
-3 to -2
-2 to -1
-1 to 1
1 to 2
2 to 3
3 to 4
N
0
10
20
30 Miles

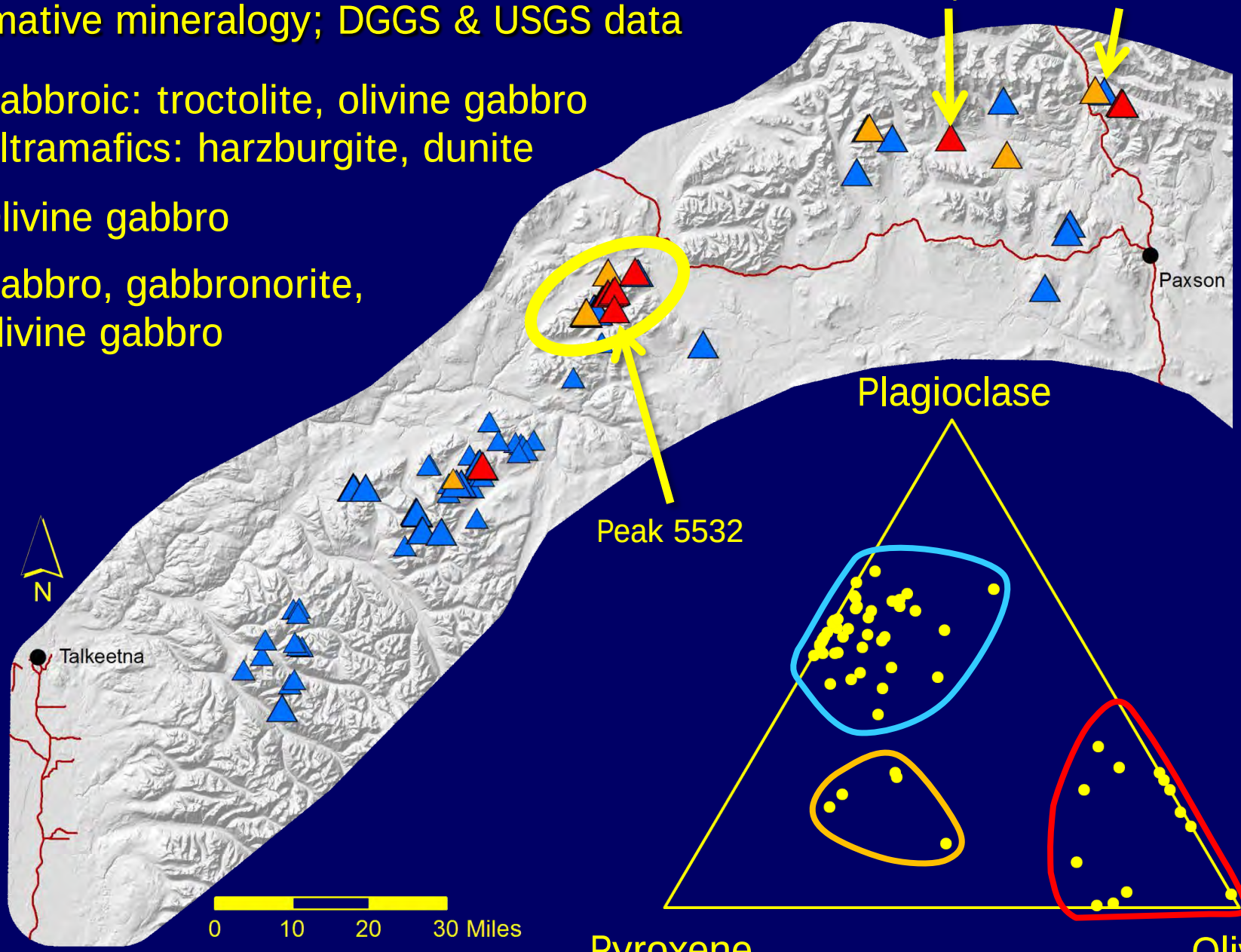
Magmatic System: Ni-Cu-Co-PGE



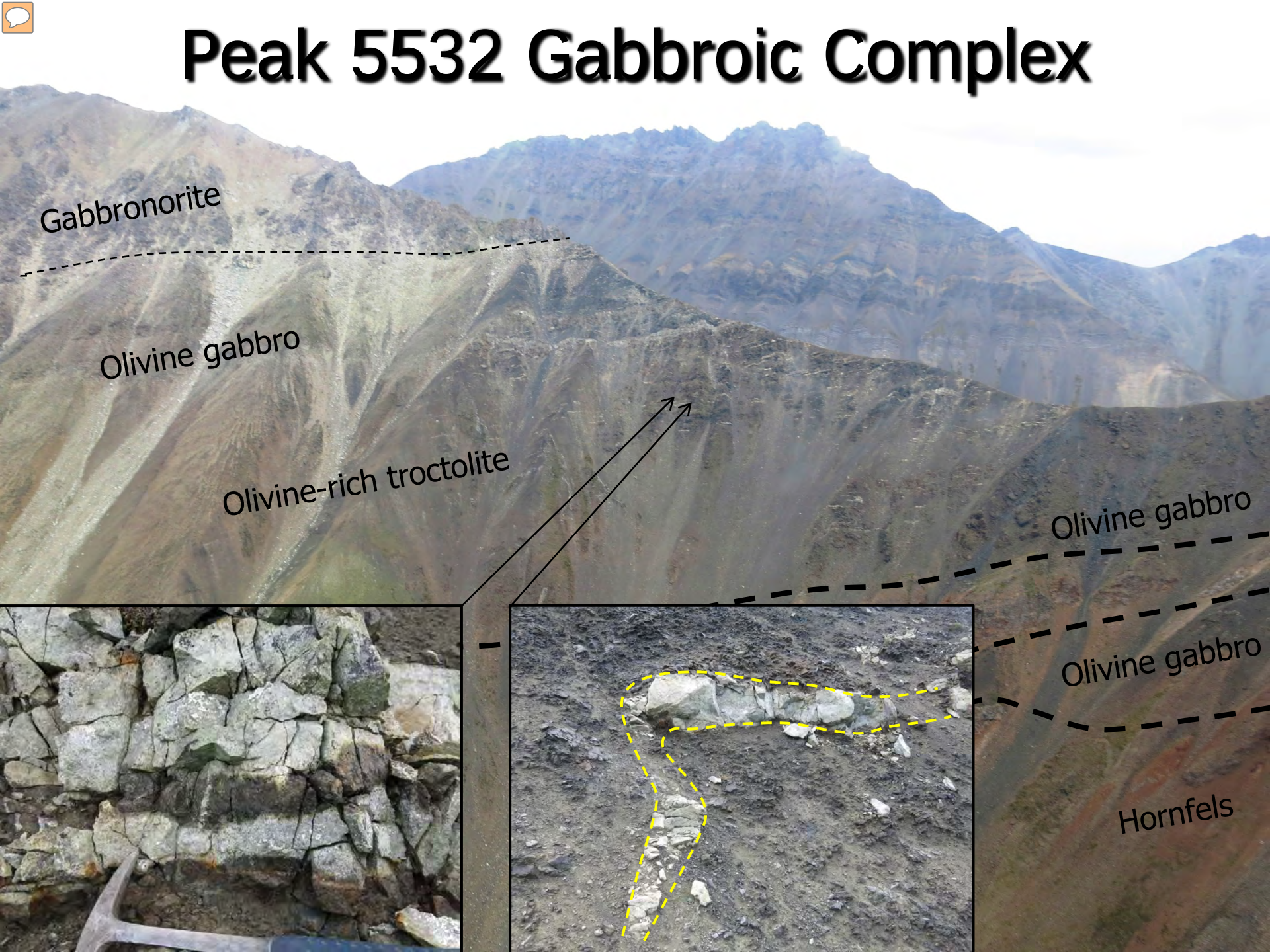
Mafic-Ultramafic intrusions

Normative mineralogy; DGGS & USGS data

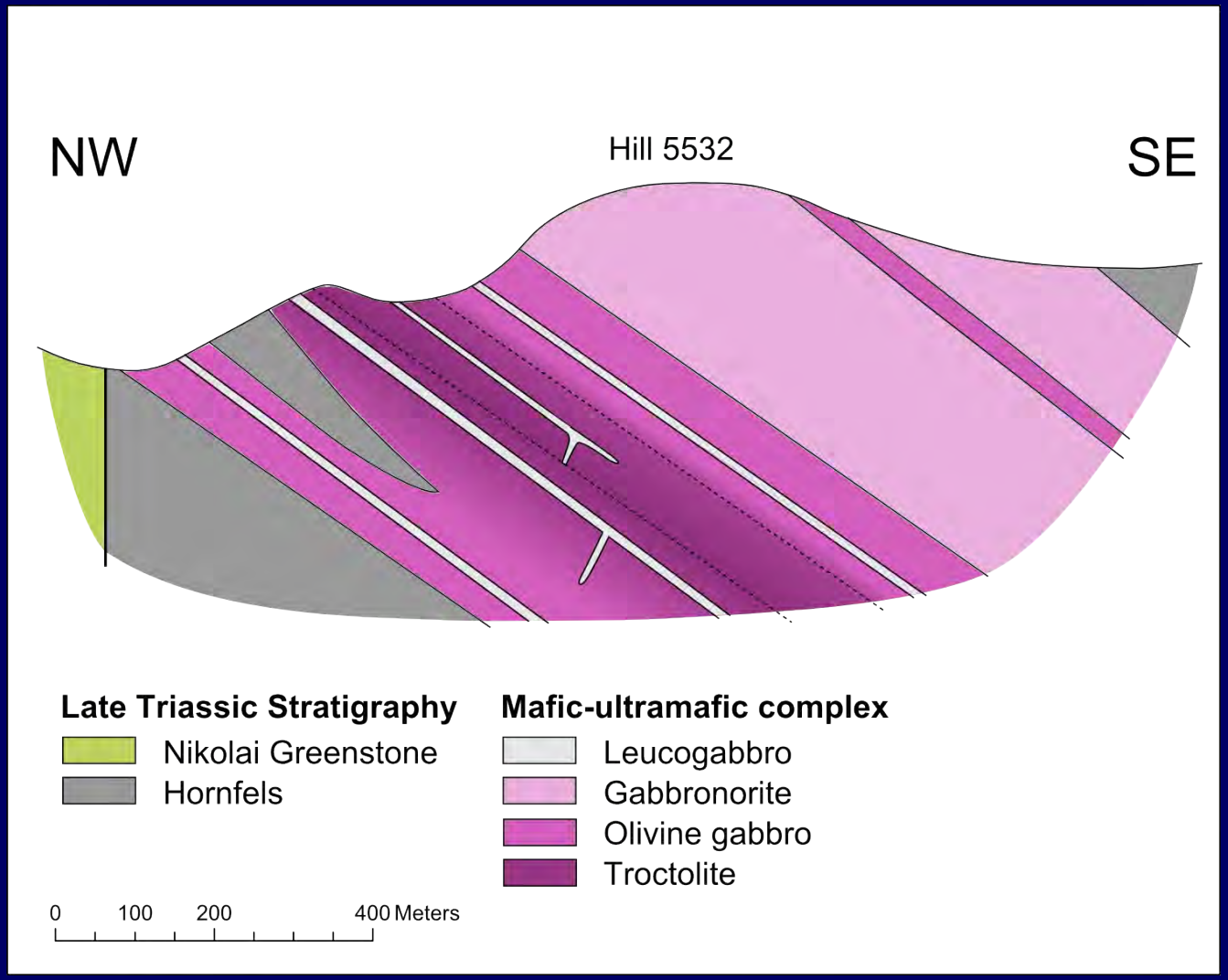
- Gabbroic: troctolite, olivine gabbro
  Ultramafics: harzburgite, dunite
- Olivine gabbro
- Gabbro, gabbronorite, olivine gabbro



Peak 5532 Gabbroic Complex

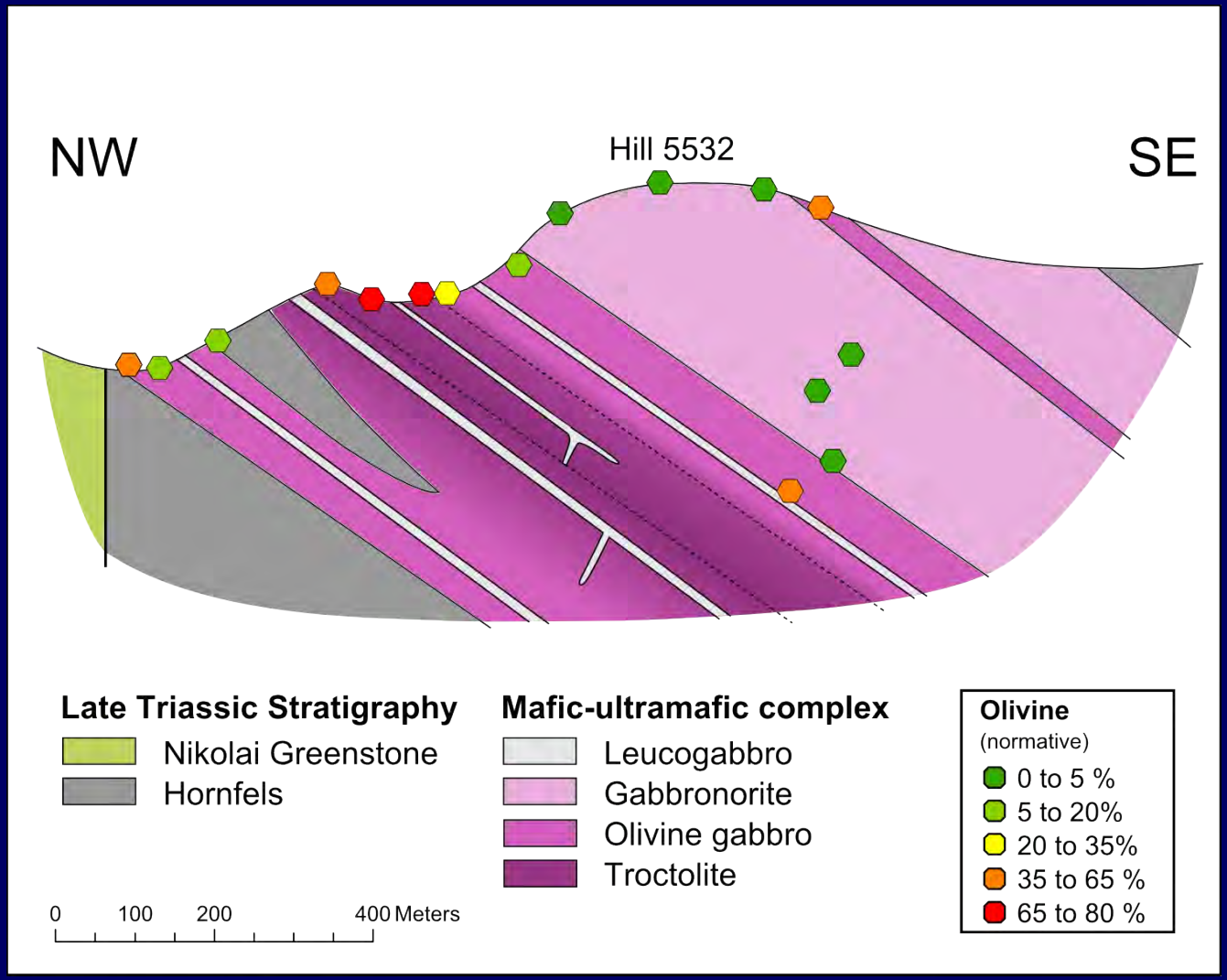


Peak 5532: Cross Section



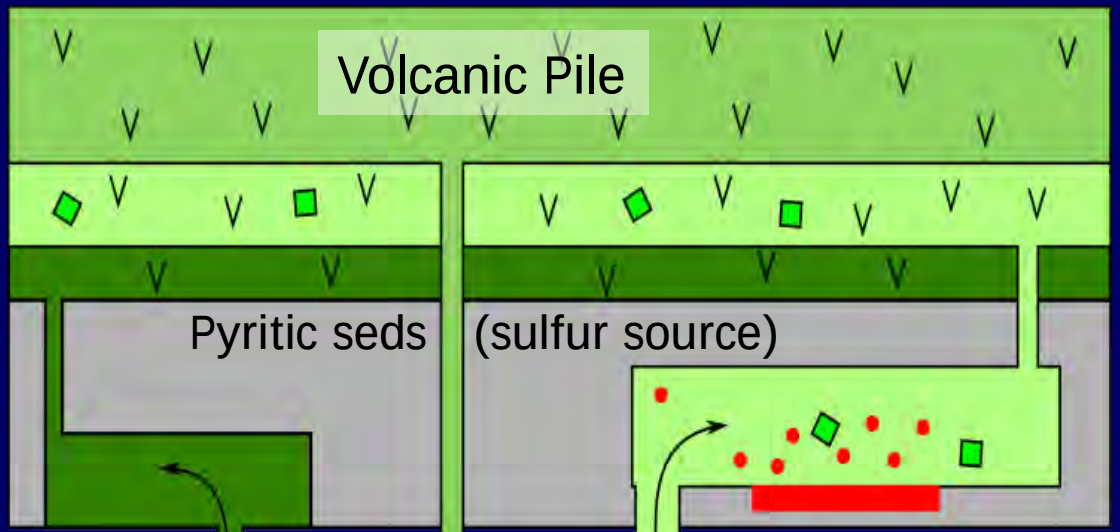
Based on measured dips, approximately 700 m (2300 feet) thick

Peak 5532: Modal Zonation

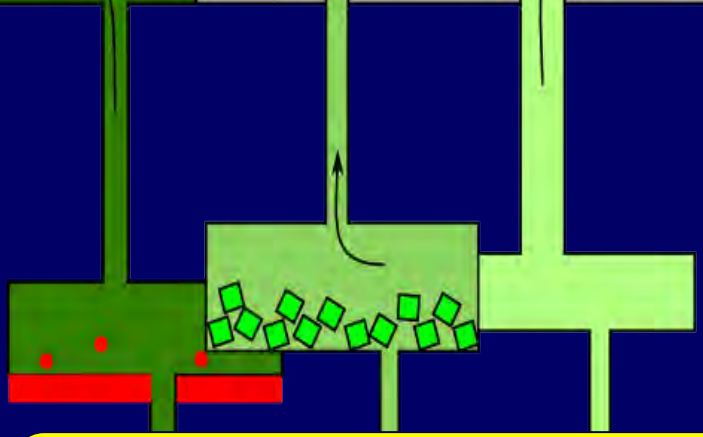


General pattern of more mafic, more olivine towards center of the most mafic phase of the complex

Ni-Cu-PGE deposit-forming processes



Near surface, i.e. accessible to mining



The Mantle: Elevated PGEs

Two Challenges:

1) Extract magma from the mantle <u>without losing the Ni-Cu-PGE</u>
2) Concentrate the Ni-Cu-PGE as <u>high grade ores</u>

Diagram modified from Arndt et al, 2005

Ni-Cu-PGE deposit-forming processes

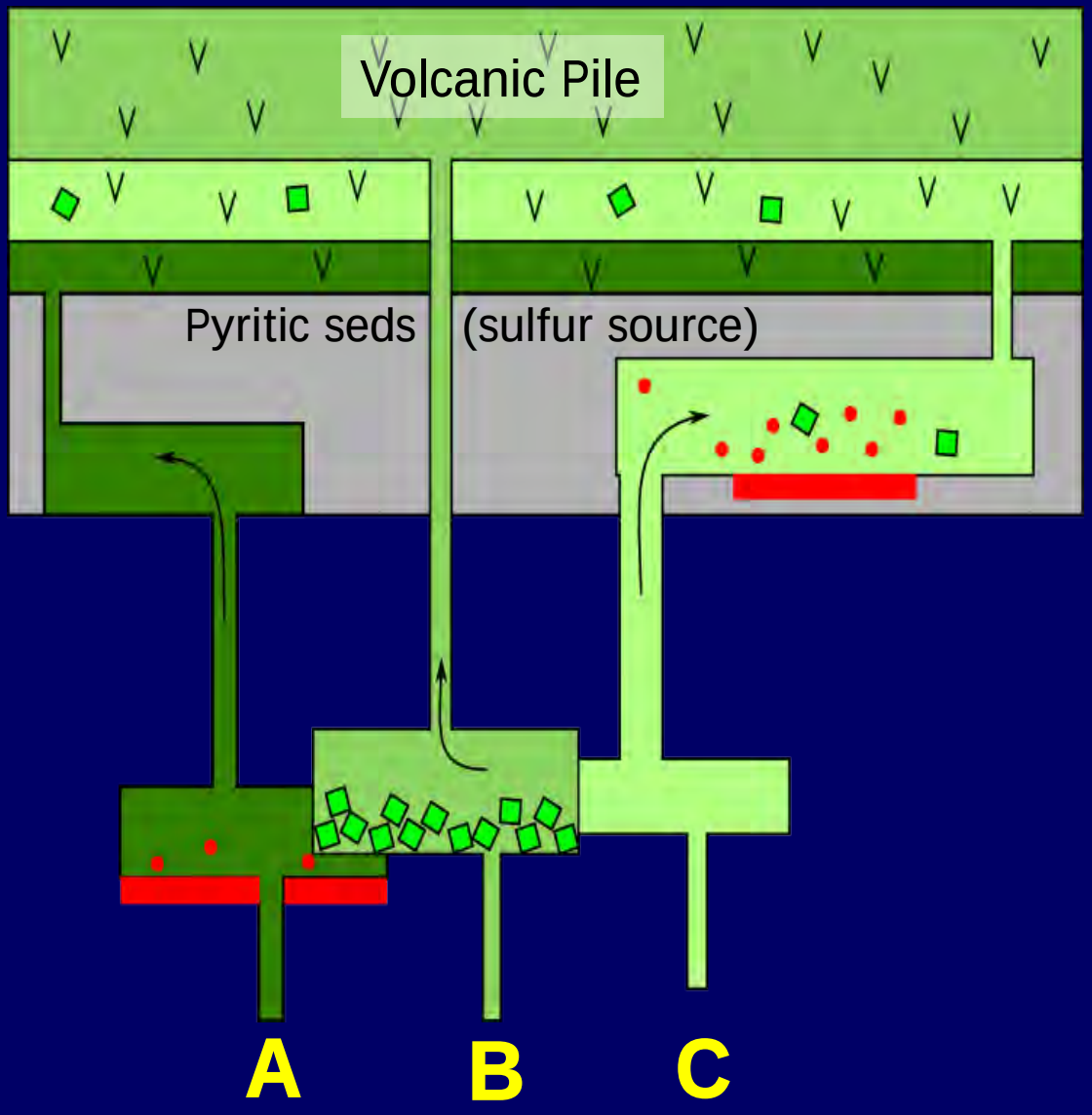


Diagram modified from Arndt et al, 2005

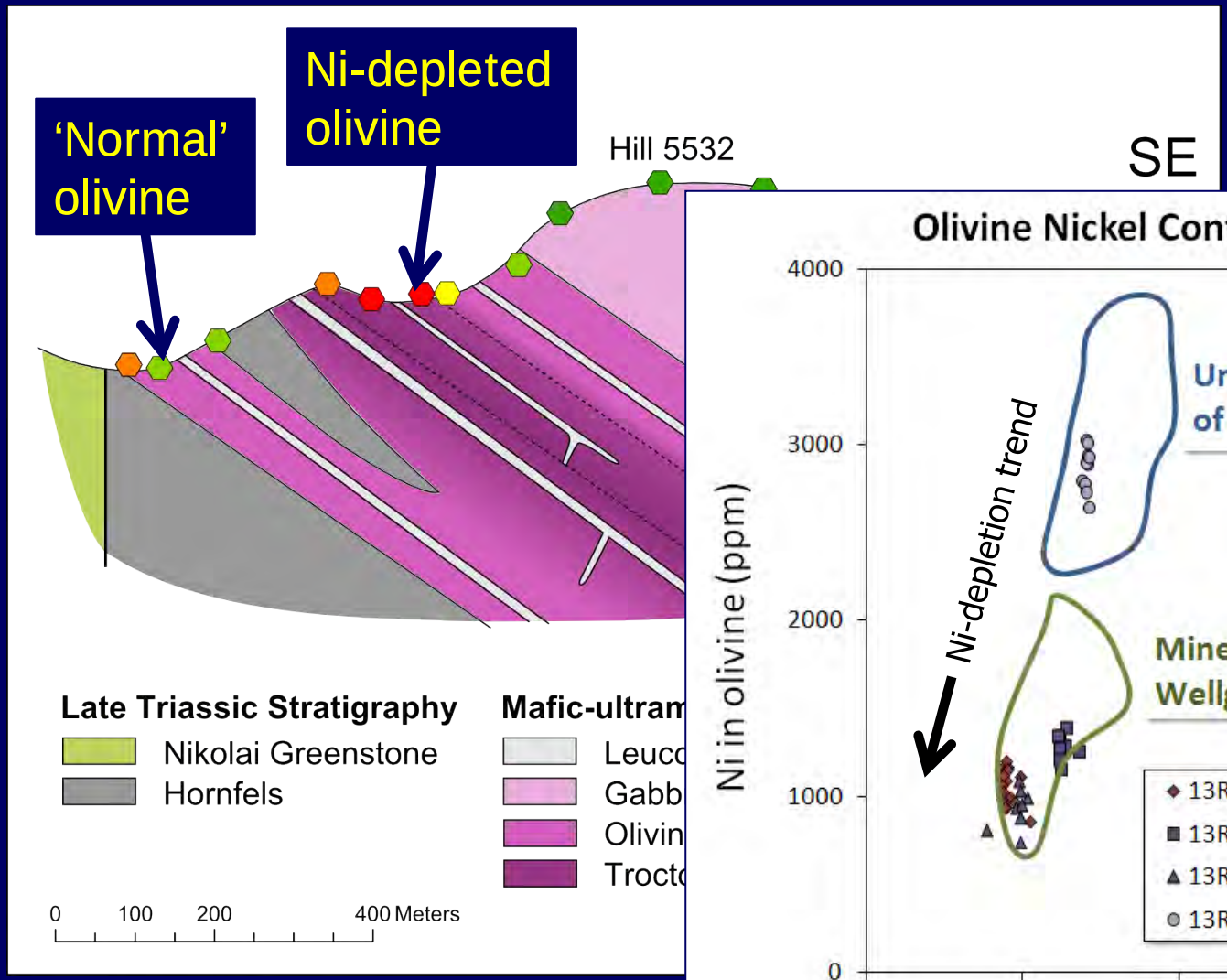
Scenarios:

A. Sulfide saturation at a deep level: PGE, Cu, Ni not extracted with melt

B. Olivine saturation at a deep level: Ni not extracted

C. Sulfide, olivine are undersaturated until high level emplacement: Sulfide melt can separate, interact, and accumulate in economic quantities

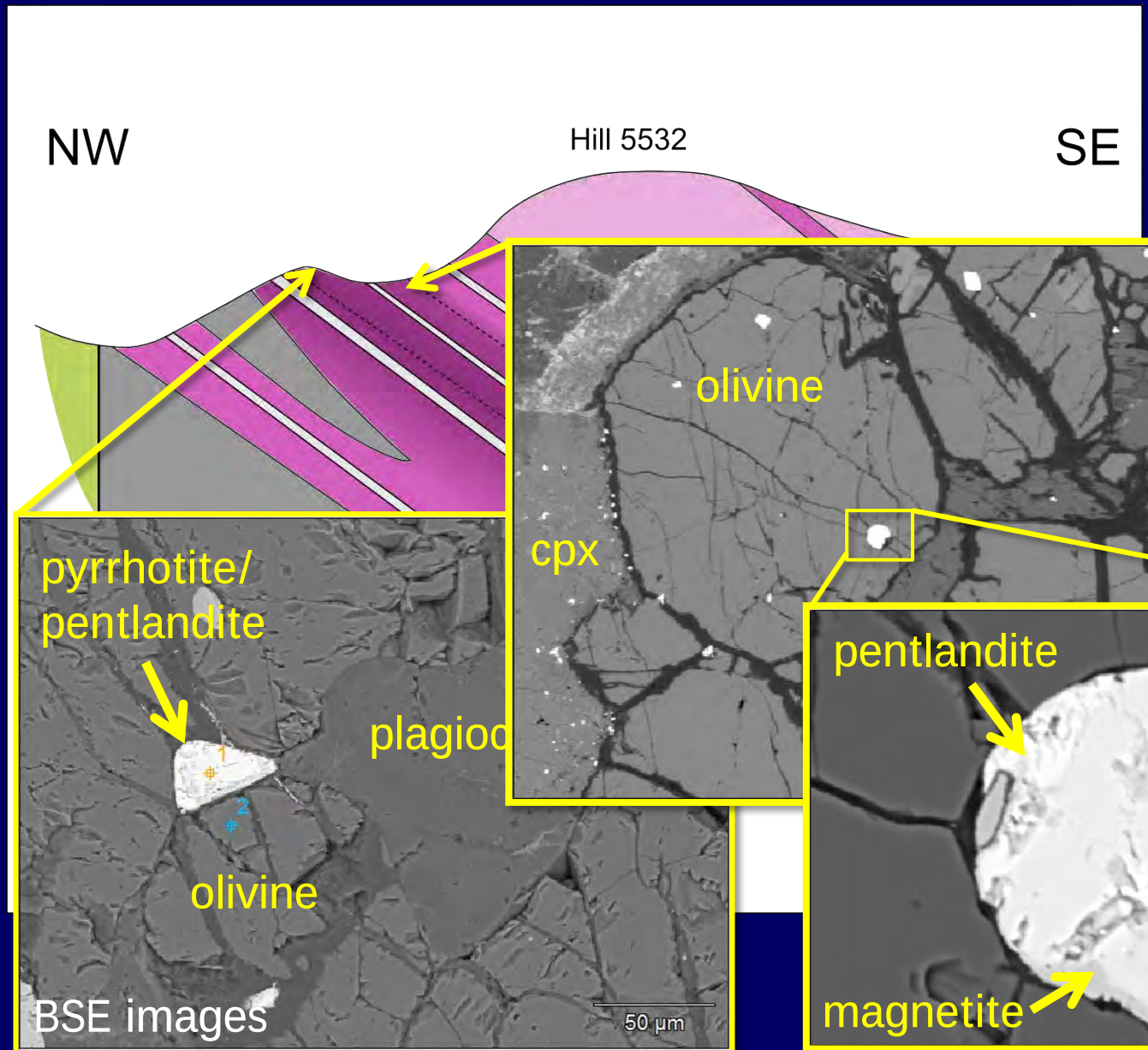
Peak 5532: Olivine Compositions



Microprobe data (WDS) collected at UAF's Advanced Instrumentation Laboratory

Yukon data from Hulbert, 1997

Peak 5532: Magmatic Fe-Ni Sulfides



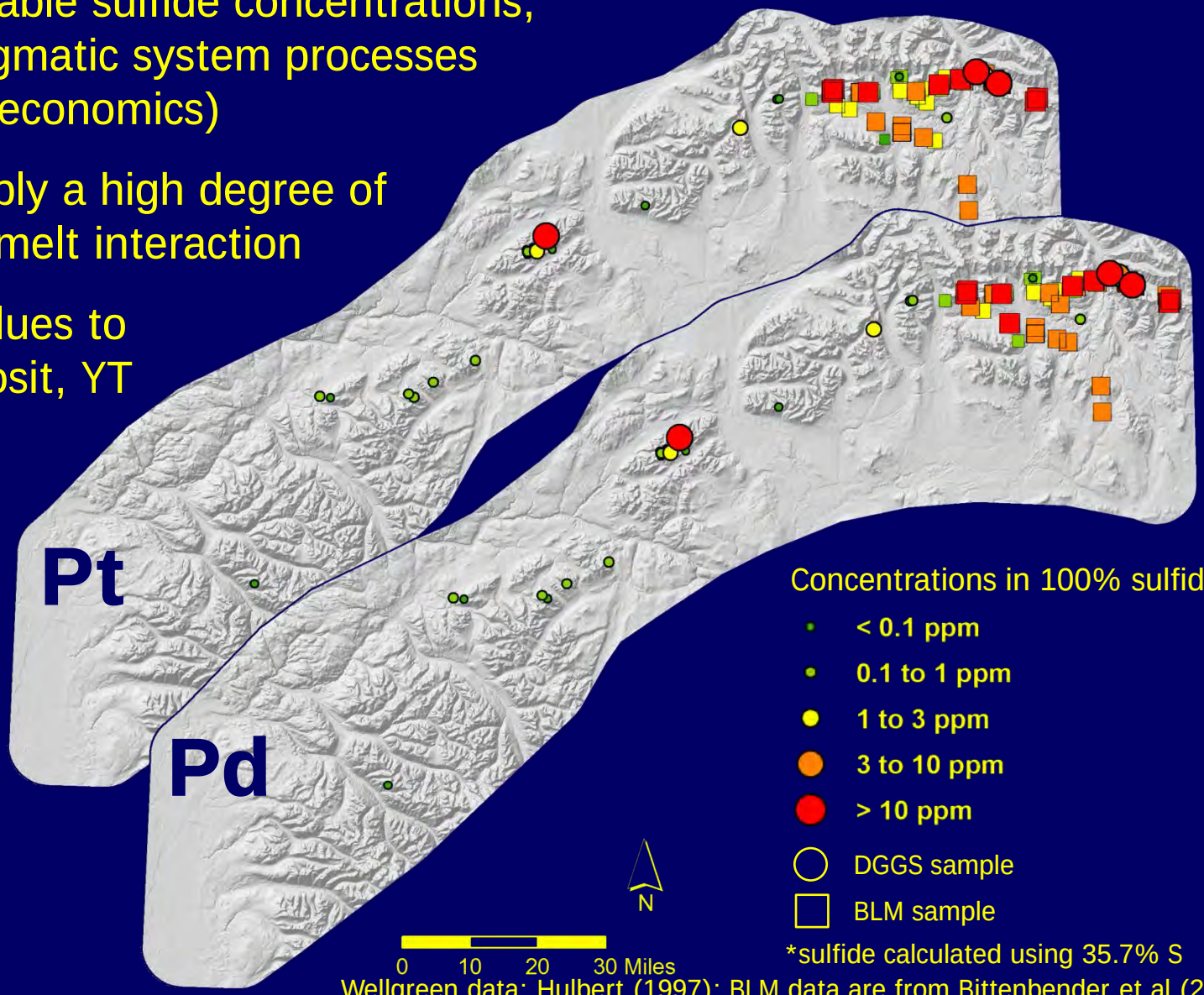
PGE content of sulfide

Disregards variable sulfide concentrations, focuses on magmatic system processes (no relation to economics)

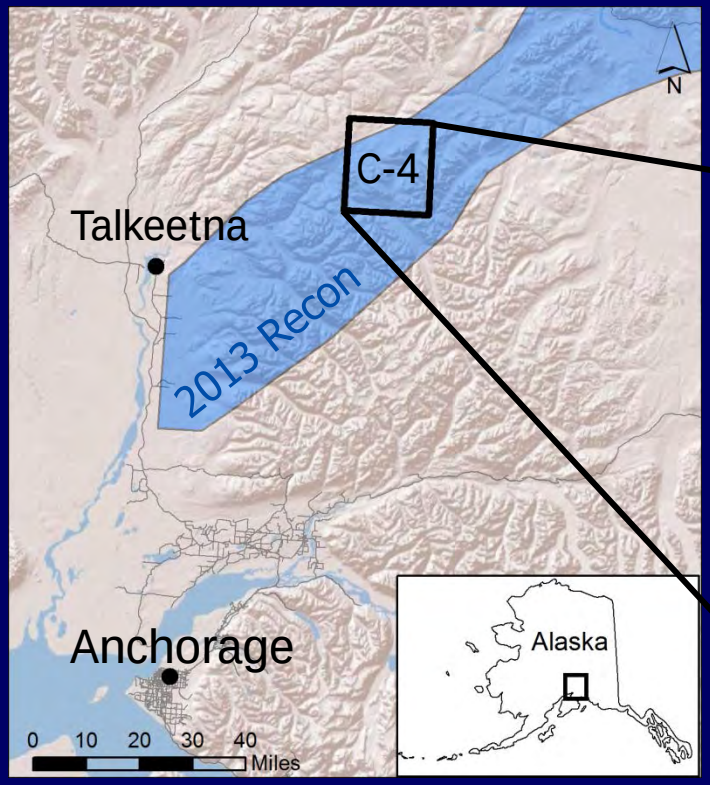
High values imply a high degree of sulfide-silicate melt interaction

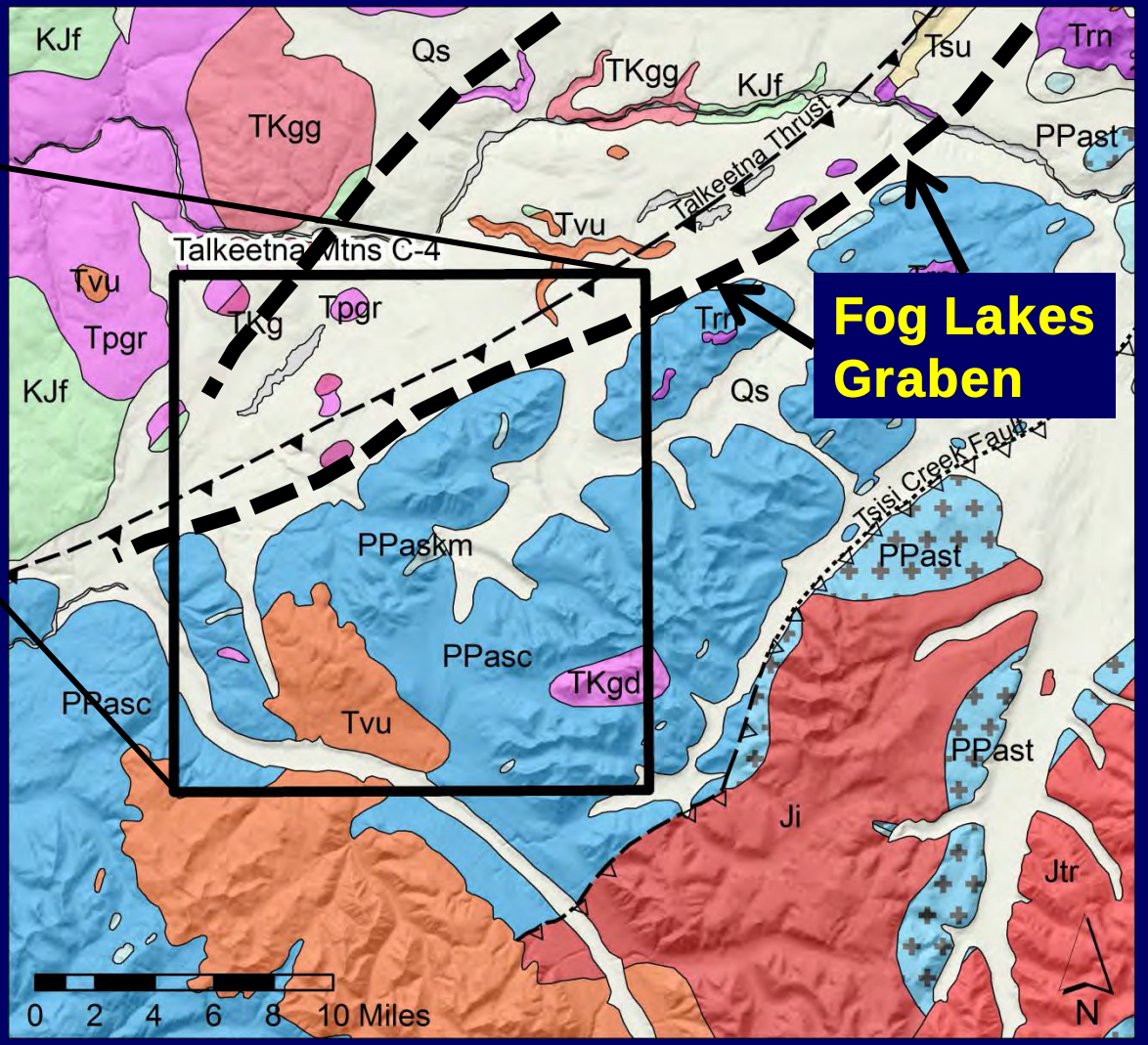
Comparable values to Wellgreen deposit, YT
Norilsk, Russia

Much less than Stillwater J-M



Stay Tuned: 2014 STATEMAP Project:
Talkeetna Mountains C-4

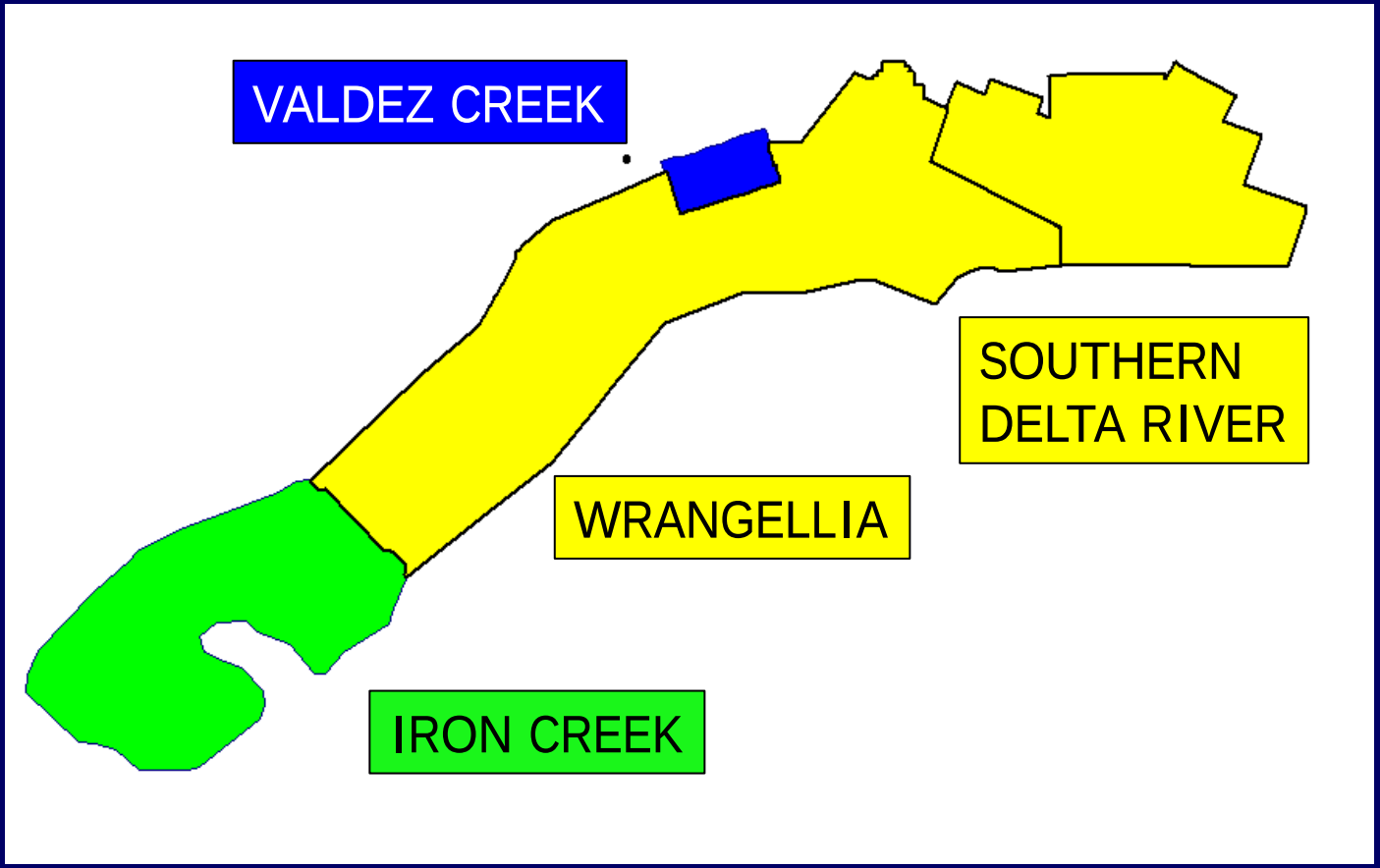




- 1:50,000
- Bedrock & surficial maps
- Structural history
- Ni-Cu-PGE potential
- USGS STATEMAP matching grant

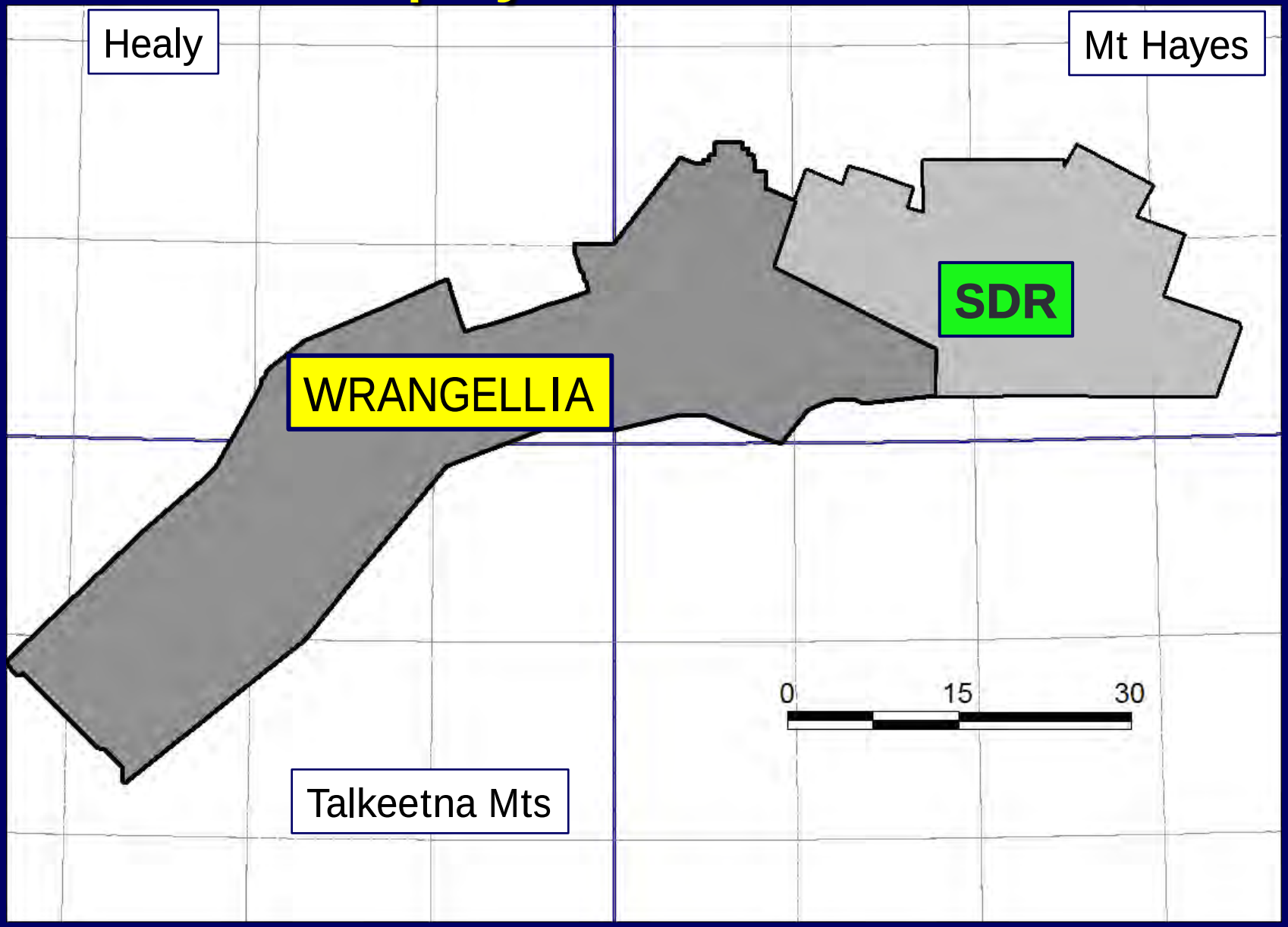
Geology after Wilson and others, 1998

Four Mag & EM Surveys

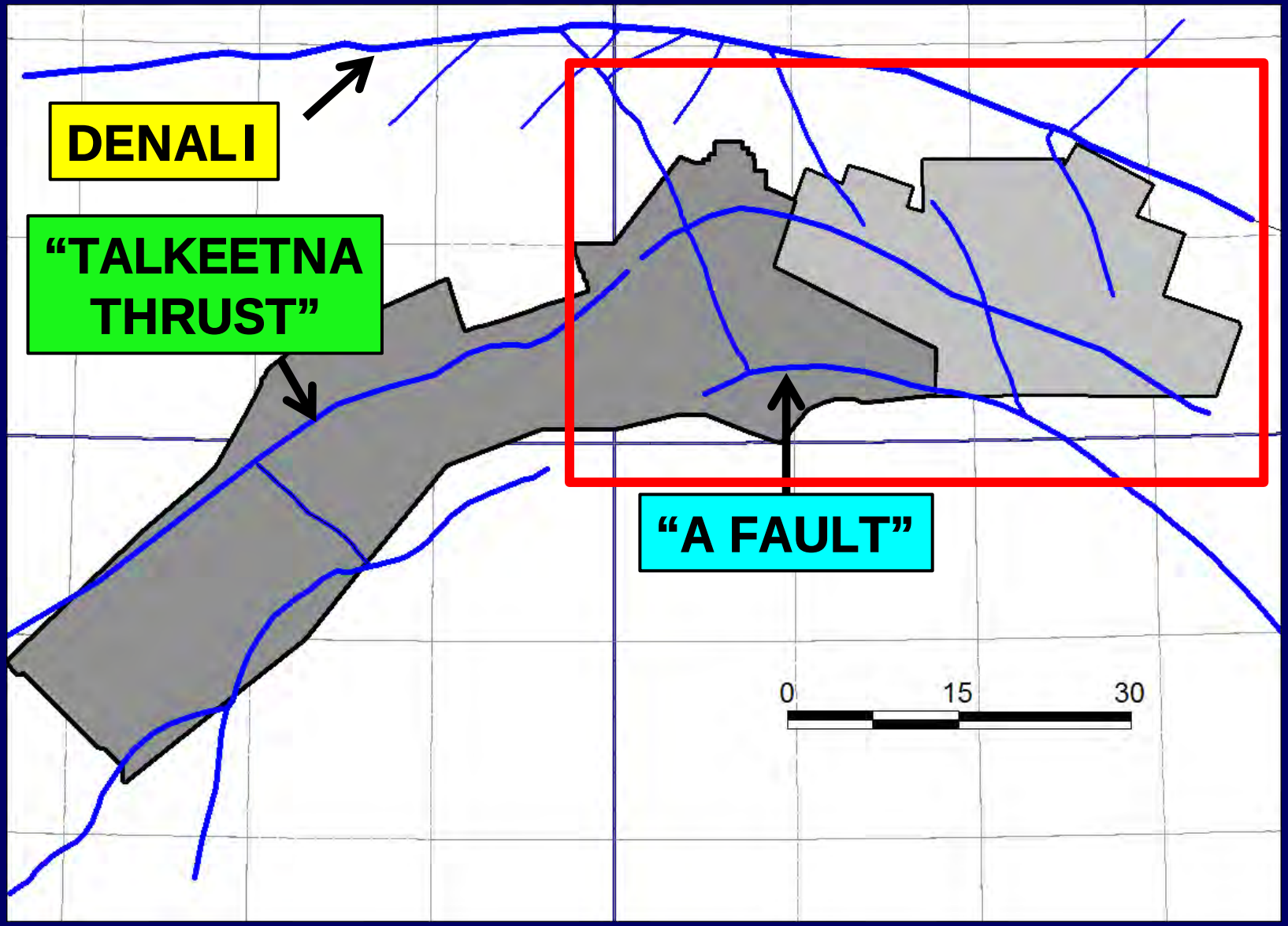


Wrangellia survey released January 2014 as GPR 2014-1
Online at: http://www.dggs.alaska.gov/pubs/id/27022

Geophysics Outlines



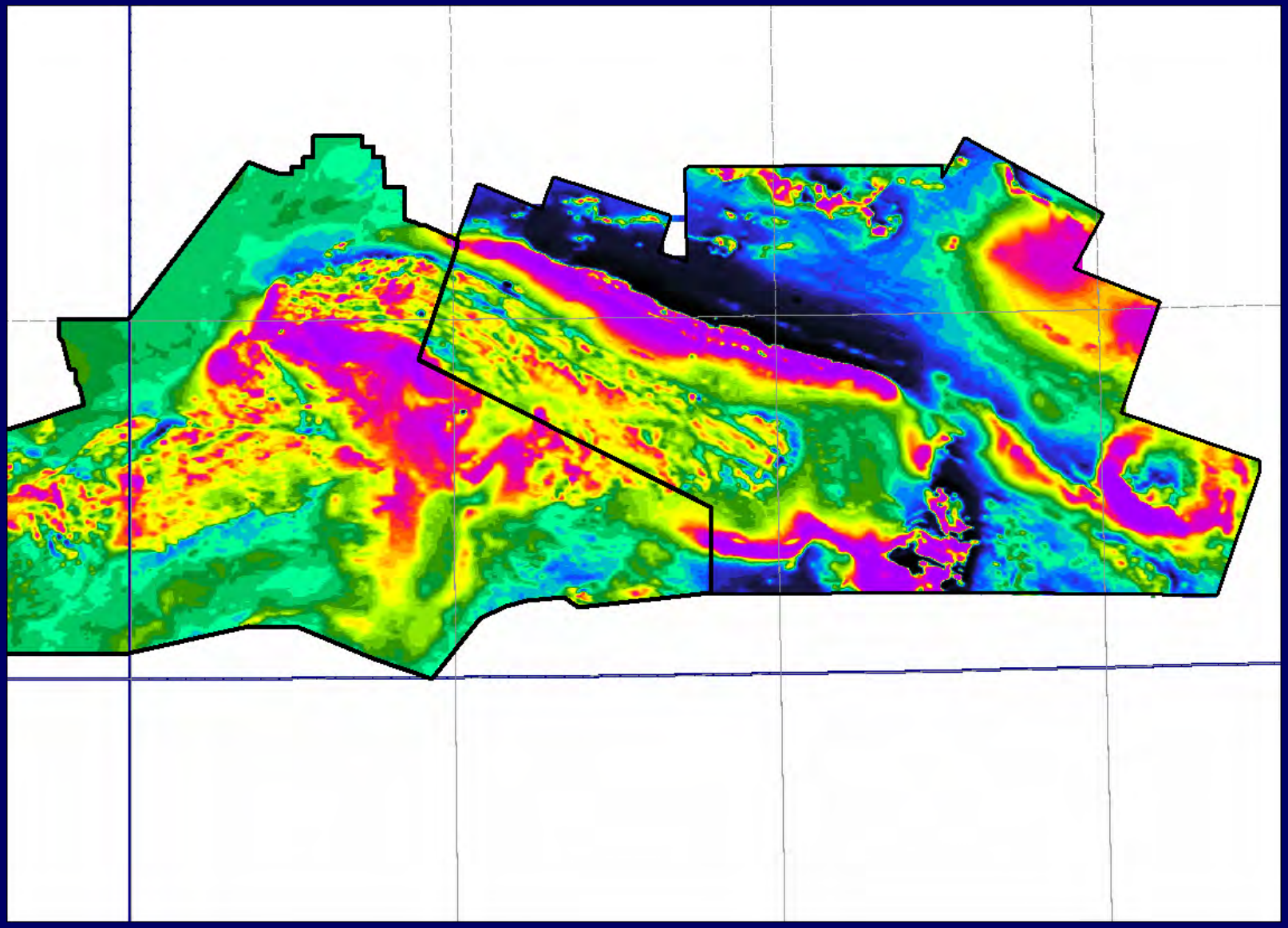
“Major” Mapped Faults



NE area Magnetics

High values

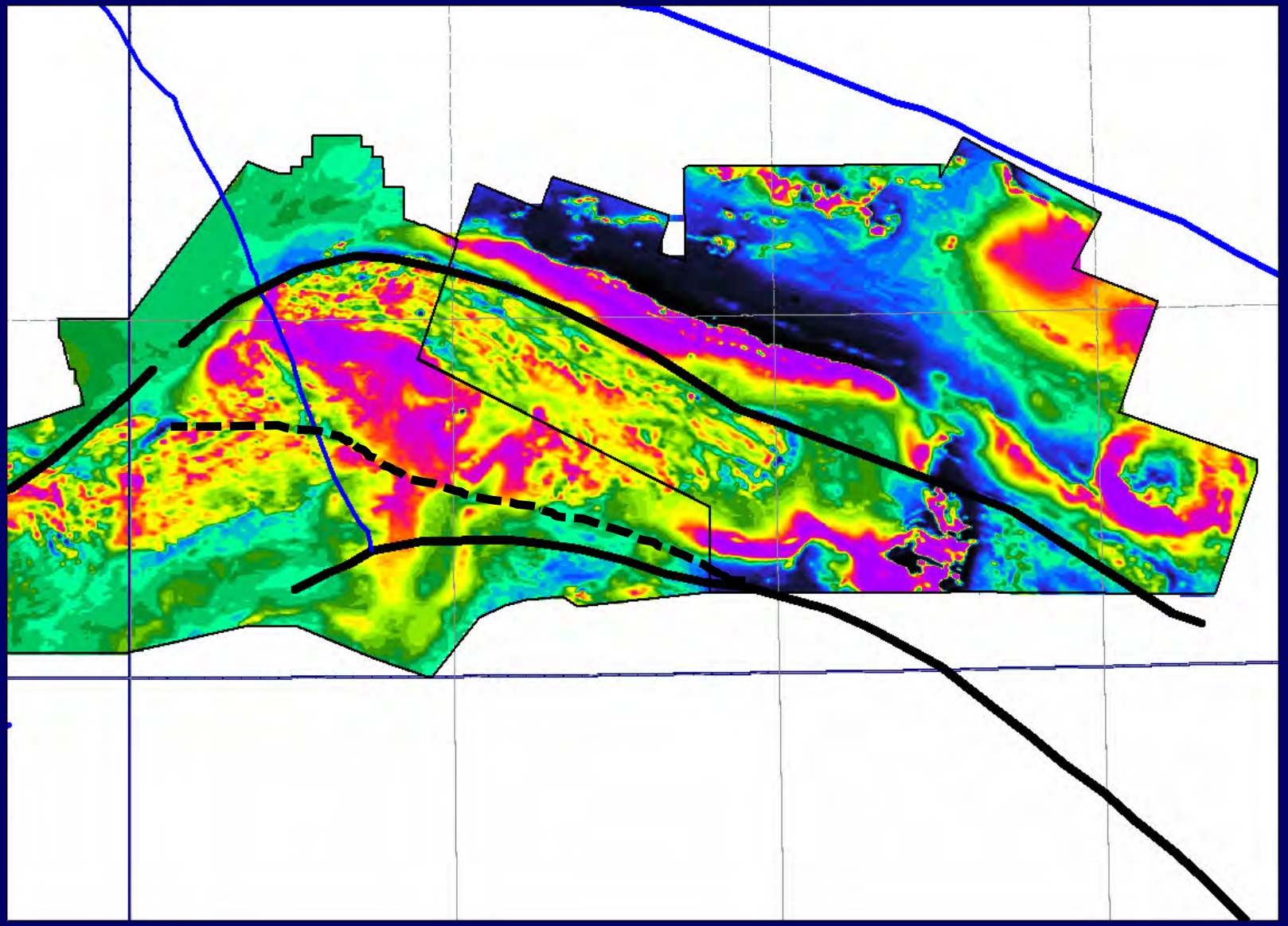
Low values



NE area Magnetics

High values

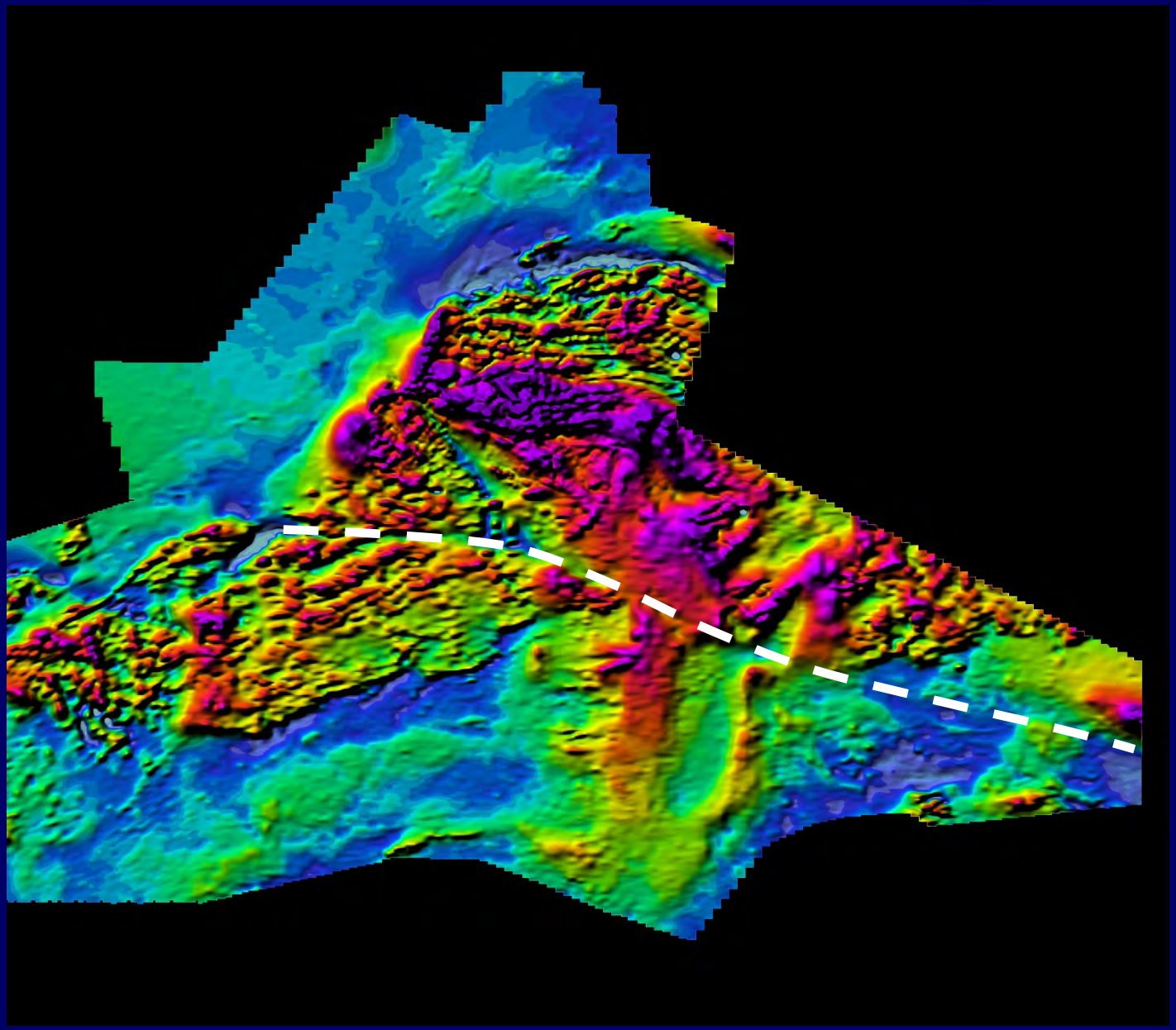
Low values



NE area Shadow Mag

High values

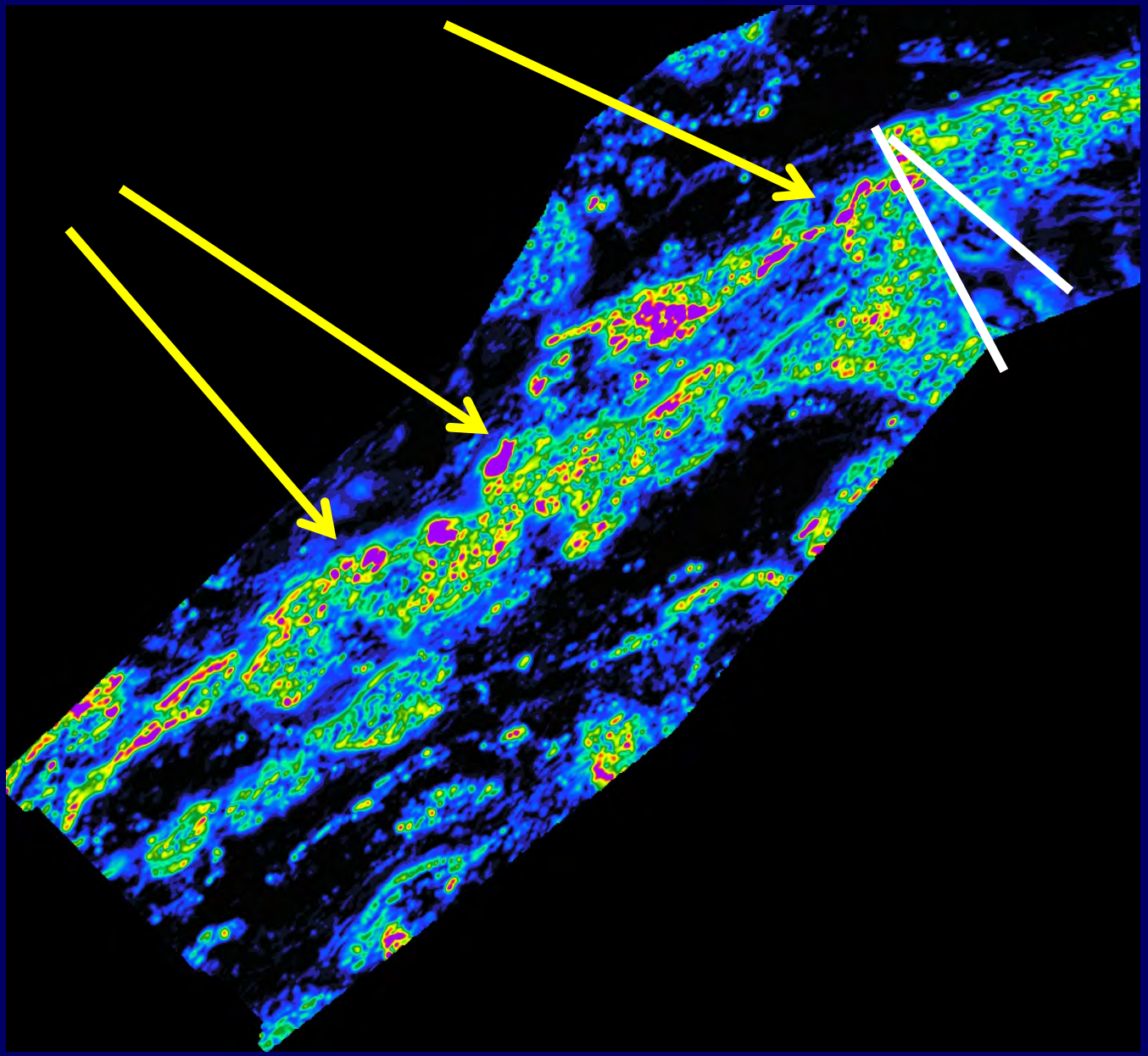
Low values



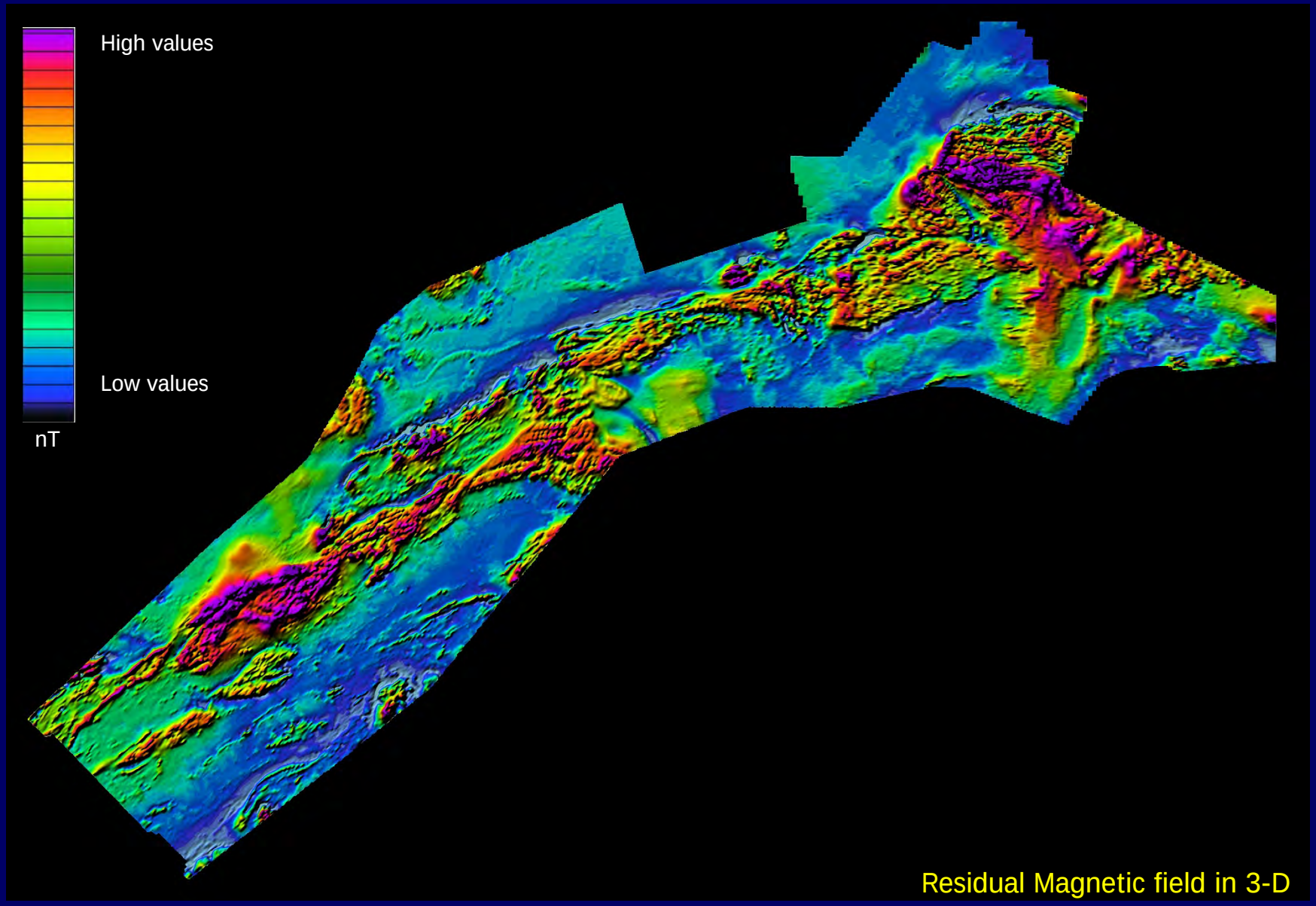
Analytic Signal

High values

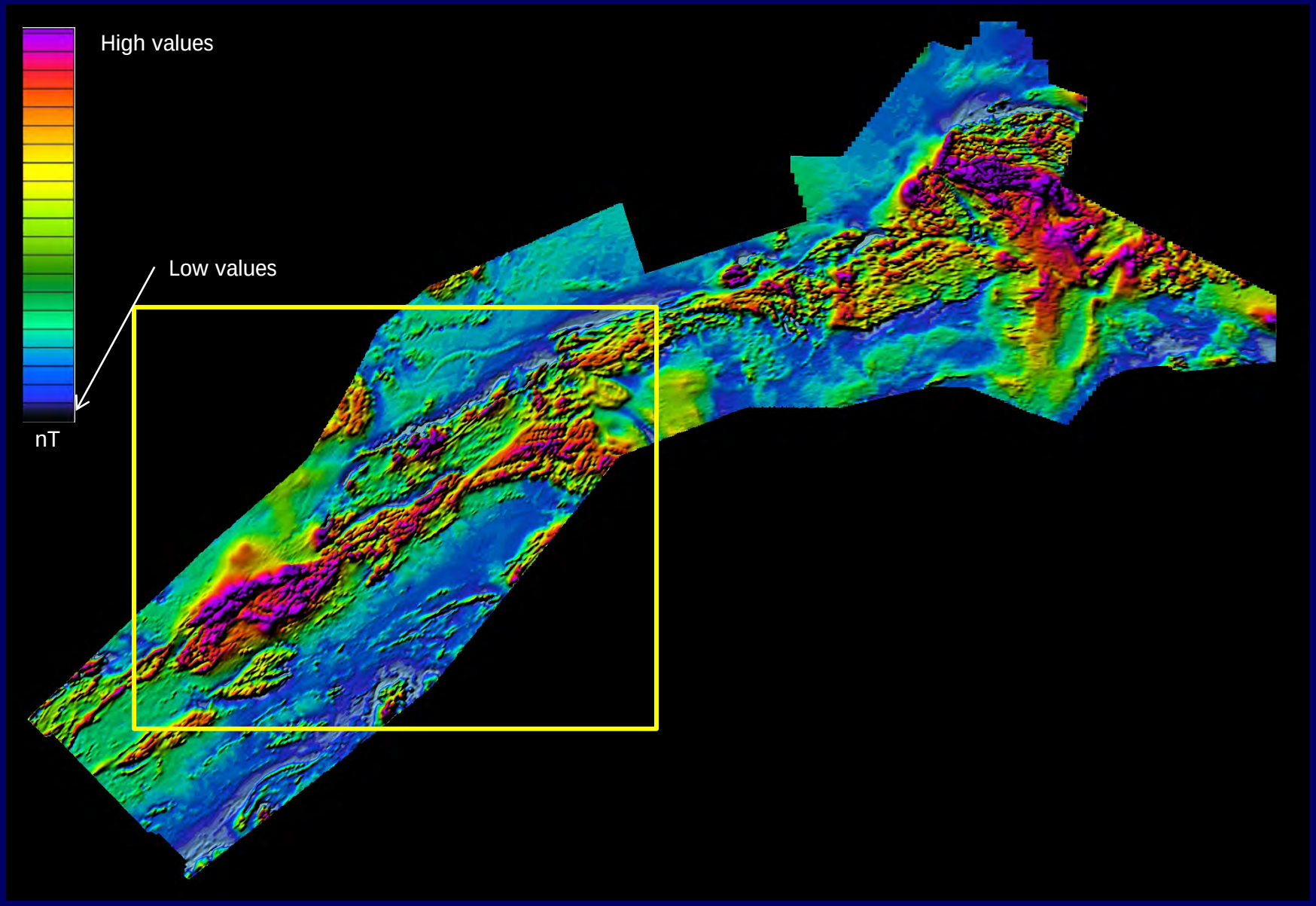
Low values



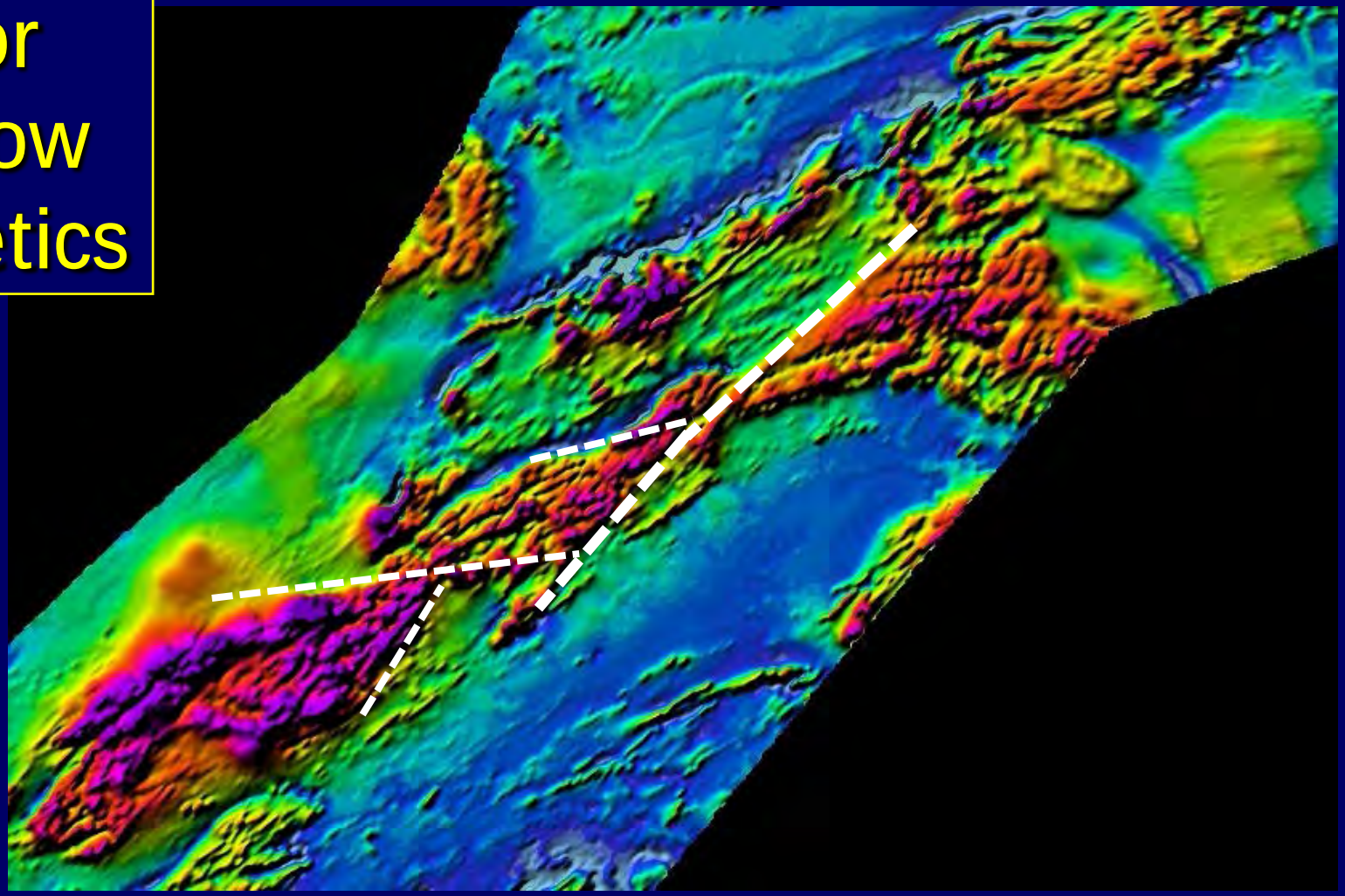
Color Shadow Magnetics



Color Shadow Magnetics



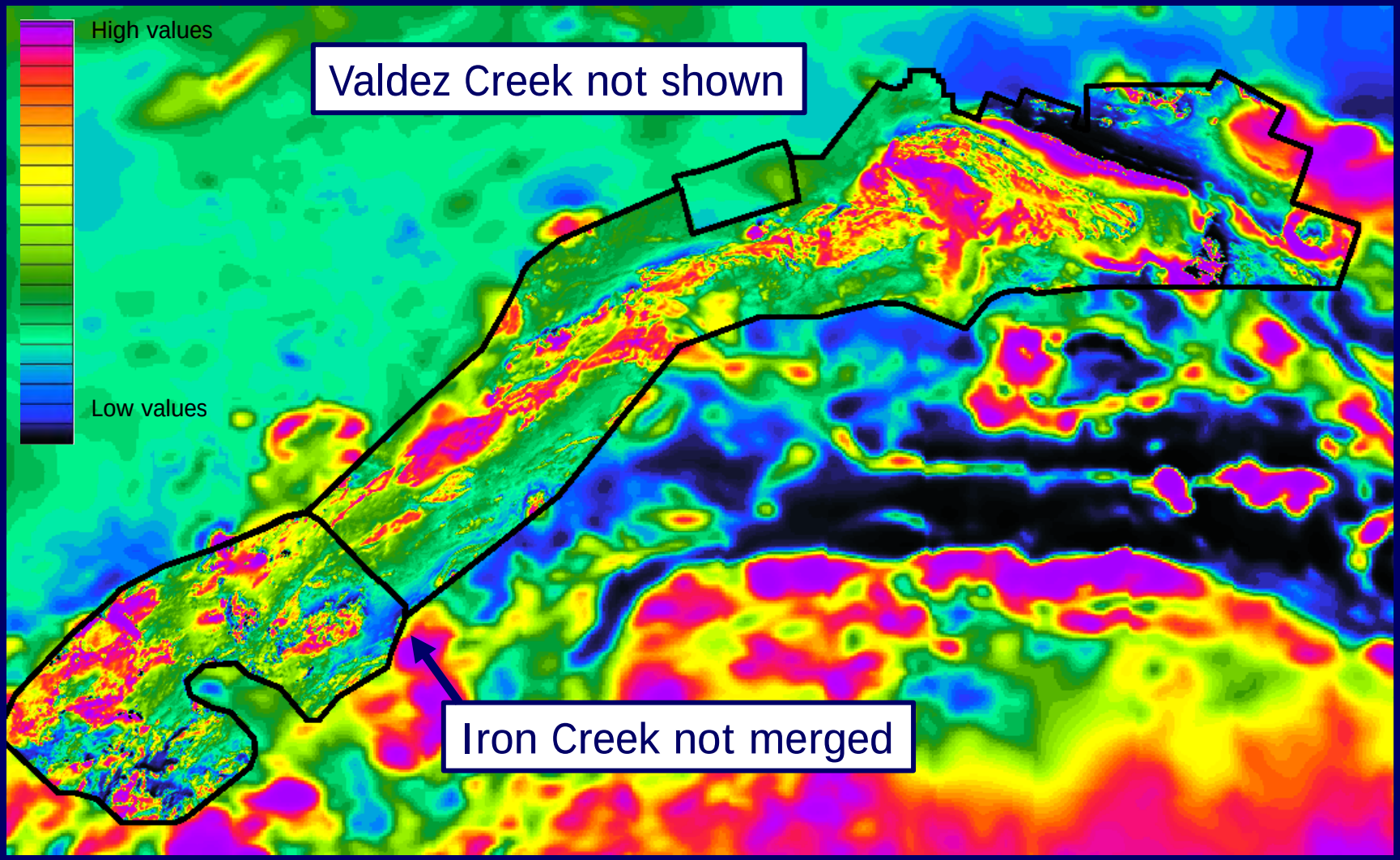
Color Shadow Magnetics



High values

Low values

Detailed and Regional Magnetics



References Cited

Arndt, N.T., Lesher, C.M., Czamanske, G.K., 2005, Mantle-Derived Magmas and Magmatic Ni-Cu-(PGE) Deposits, in: Hedenquist, J.W., Thompson, J.F.H., Goldfarb, R.J., Richards, J.P. eds., Economic Geology One Hundredth Anniversary Volume 1905-2005: Society of Economic Geologists, p. 5-23.

Bittenbender, P.E., Bean, K.W., Kurtak, J.M., Deininger, J., 2007, Mineral Assessment of the Delta River Mining District Area, East-central Alaska: BLM Alaska Technical Report 57, 697p.

Burns, L.E., CGG, and Fugro GeoServices, Inc., 2014, Wrangellia survey area: Airborne magnetic and electromagnetic data in line (point), grid, vector, and map formats, Talkeetna Mountains, Healy, and Mt. Hayes quadrangles, south-central Alaska: Alaska Division of Geological & Geophysical Surveys Geophysical Report 2014-1, 56 sheets, 1 DVD, scale 1:63,360. Available online at: http://www.dggs.alaska.gov/pubs/id/27022

Burns, L.E., U.S. Bureau of Land Management, Fugro Airborne Surveys, and Stevens Exploration Management Corp., 2003, Plot files of the airborne geophysical survey data of the southern Delta River area, east-central Alaska: Alaska Division of Geological & Geophysical Surveys Geophysical Report 2003-5, 1 DVD. Available online at: http://www.dggs.alaska.gov/pubs/id/2904

Burns, L.E., Fugro Airborne Surveys Corp., and Stevens Exploration Management Corp., 2004, Line, gridded, and vector data, and selected plot files of the airborne geophysical survey data of the Valdez Creek mining district, central Alaska: Alaska Division of Geological & Geophysical Surveys Geophysical Report 2004-3, 1 DVD. Available online at: http://www.dggs.alaska.gov/pubs/id/3337

Colpron, M., and Nelson, J.L., 2011, A digital atlas of terranes for the Northern Cordillera: British Columbia Ministry of Energy, Mines, and Petroleum Resources, GeoFile 2011-11, http://www.empr.gov.bc.ca/Mining/Geoscience/PublicationsCatalogue/GeoFiles/Pages/2011-11.aspx

DGGS Staff, Dighem, and WGM, Inc., 1998, CD-ROM containing profile and gridded data and section lines of the 1997 geophysical survey data for Iron Creek area, Talkeetna Mountains Quadrangle, southcentral Alaska: Alaska Division of Geological & Geophysical Surveys Public Data File 98-9, 1 DVD. Available online at: http://www.dggs.alaska.gov/pubs/id/1822

Granitto, M., Bailey, E.A., Schmidt, J.M., Shew, N.B., Gamble, B.M., Labay, K.A., 2011, Alaska Geochemical Database (AGDB)—Geochemical Data for Rock, Sediment, Soil, Mineral, and Concentrate Sample Media: U.S. Geological Survey Data Series 237.

Hulbert, L.J., 1997, Geology and Metallogeny of the Kluane mafic-ultramafic belt, Yukon Territory, Canada—Eastern Wrangellia: A New Ni-Cu-PGE metallogenic terrane: Geological Survey of Canada Bulletin 506, 265 p.

Tetra Tech Wardrop, 2011, Wellgreen Project Preliminary Economic Assessment, Yukon, Canada. Report Prepared for Prophecy Platinum by Tetra Tech Wardrop, August 1, 2012.

Twelker, Evan, Bachmann, E.N., Freeman, L.K., Newberry, R.J., Reioux, D.A., Sicard, K.R., Tuzzolino, A.L., Wright, T.C., and Wypych, Alicja, 2014, Major-oxide, minor-oxide, and trace-element geochemical data from rocks and stream sediments in the Wrangellia mineral assessment area, Gulkana, Healy, Mount Hayes, and Talkeetna Mountains quadrangles, Alaska: Alaska Division of Geological & Geophysical Surveys Raw Data File 2014-3, 6 p. Available online at: http://www.dggs.alaska.gov/pubs/id/27181

United States Geological Survey, 2013, Mineral Commodity Summaries 2013: U.S. Geological Survey, Reston Virginia. 198p.

Werdon, M.B., Riehle, J.R., Schmidt, J.M., Newberry, R.J., and Pessel, G.H., 2000, Major oxide, minor oxide, trace element, and geochemical data from rocks collected in the Iron Creek area, Talkeetna Mountains B-5 Quadrangle, Alaska in 1999: Alaska Division of Geological & Geophysical Surveys Raw Data File 2000-2, 31 p., 2 sheets, scale 1:63,360

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.