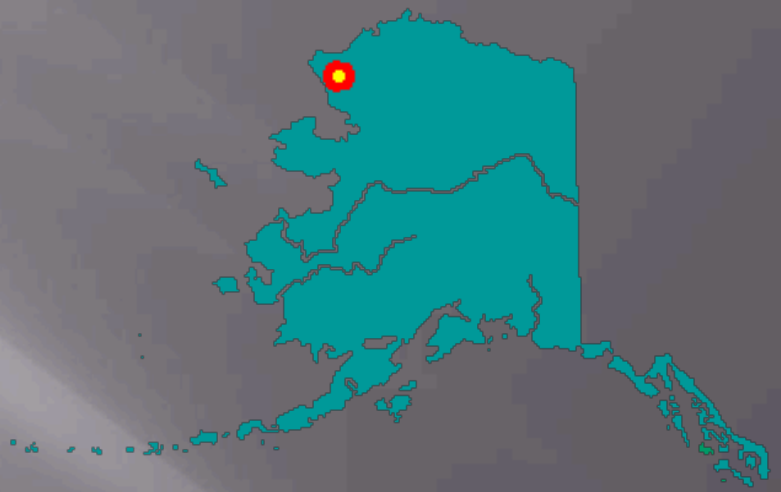
MINERALOGY OF THE TECK-COMINCO RED DOG MINE DEPOSIT

By Nick Hugo
Petrology
North Dakota State University
May 1, 2014

The Teck-Cominco Red Dog Mine

- Located in Northwestern Alaska near Kotzebue (Southwestern portion of the Brooks Range)



- One of the largest Zinc and Lead producers in the world
- Open-Pit Lead and Zinc Sulfide Mine

(Chance, n.d.)
(Air Quality, 2011)
(Red Dog Operations, 2009)

Regional Geology

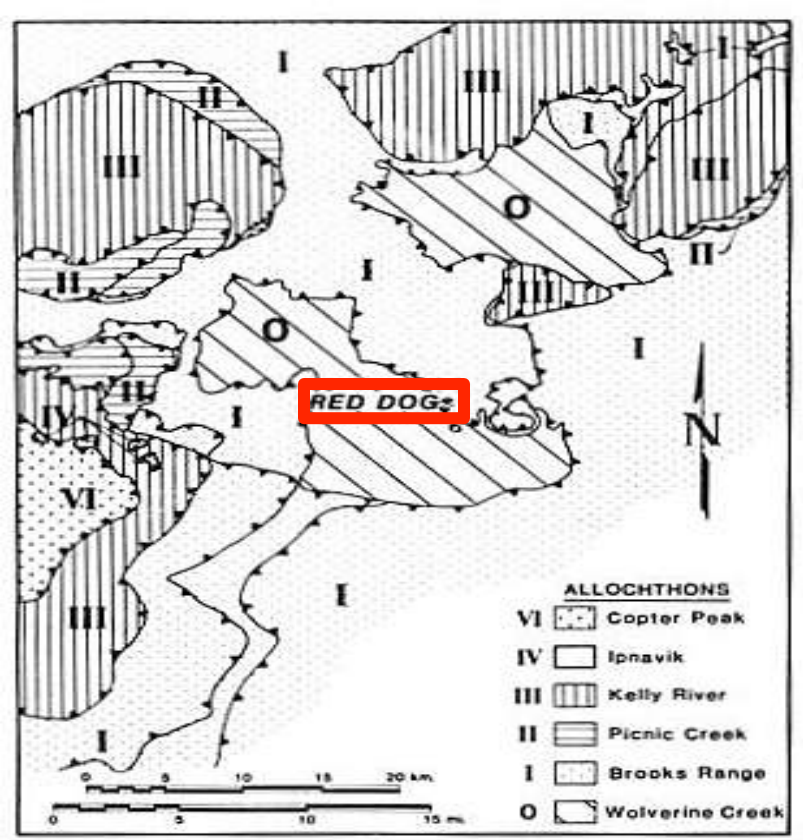


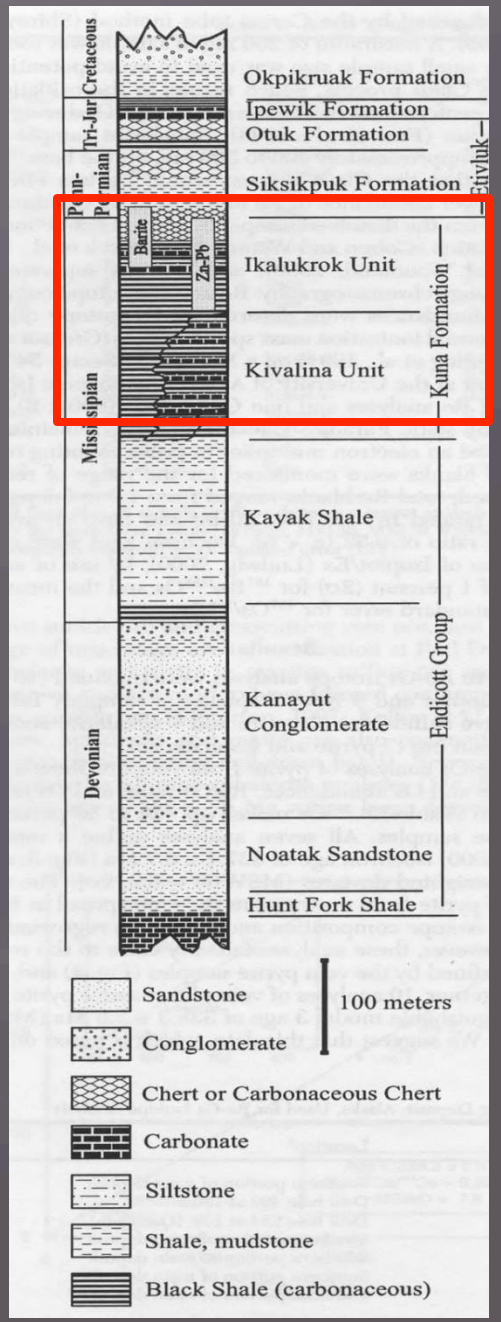
FIG. 3. Allochthon distribution map for a portion of the De Long Mountains.

- The Western Brooks Range area is divided into eight allochthons
  - Grouping of sequences that were moved by orogenic events
  - Range from the Paleozoic to Mesozoic in age
  - Each allochthon is divided into several sequences
- All were thrust northward during an orogeny that occured in the middle Jurassic
- Red Dog Sequence is located in the Brooks Range Allochthon

(Moore et. al., 1986)
(Lange et. al., 1985)

Ore Geology

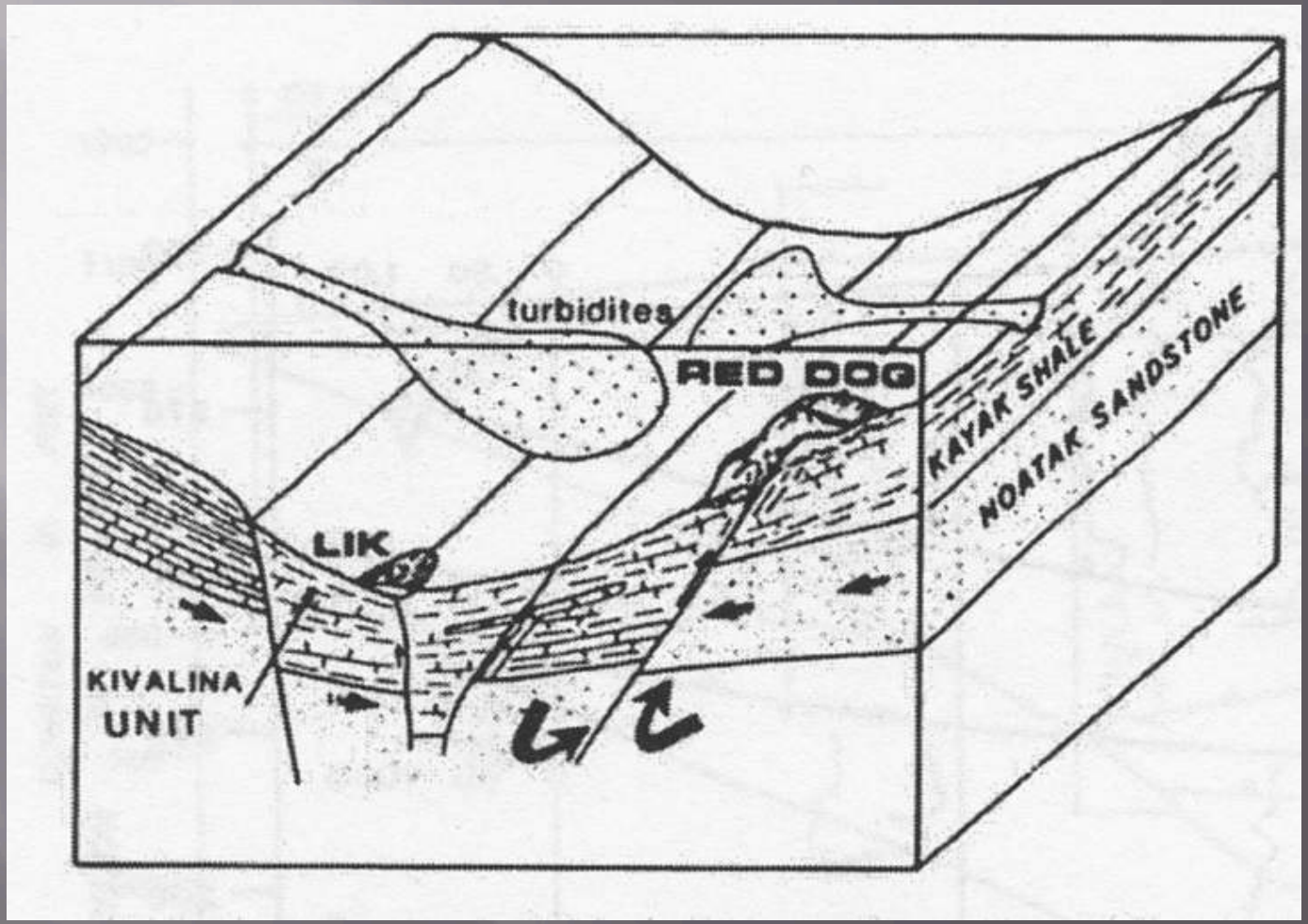
- The deposit is located in the Kuna Formation
- Host rock is primarily composed of chert, shale, quartz exhalite, tuff, tuffaceous sandstone, keratophyre (alkalai feldspar phenocrysts in fine grained alkalai feldpar matrix), and andesite
- Mississipian to Pennsylvanian in age



(Morelli et. al., 2004)
(Moore et. al., 1986)
(Lange et. al., 1985)

Ore Geology

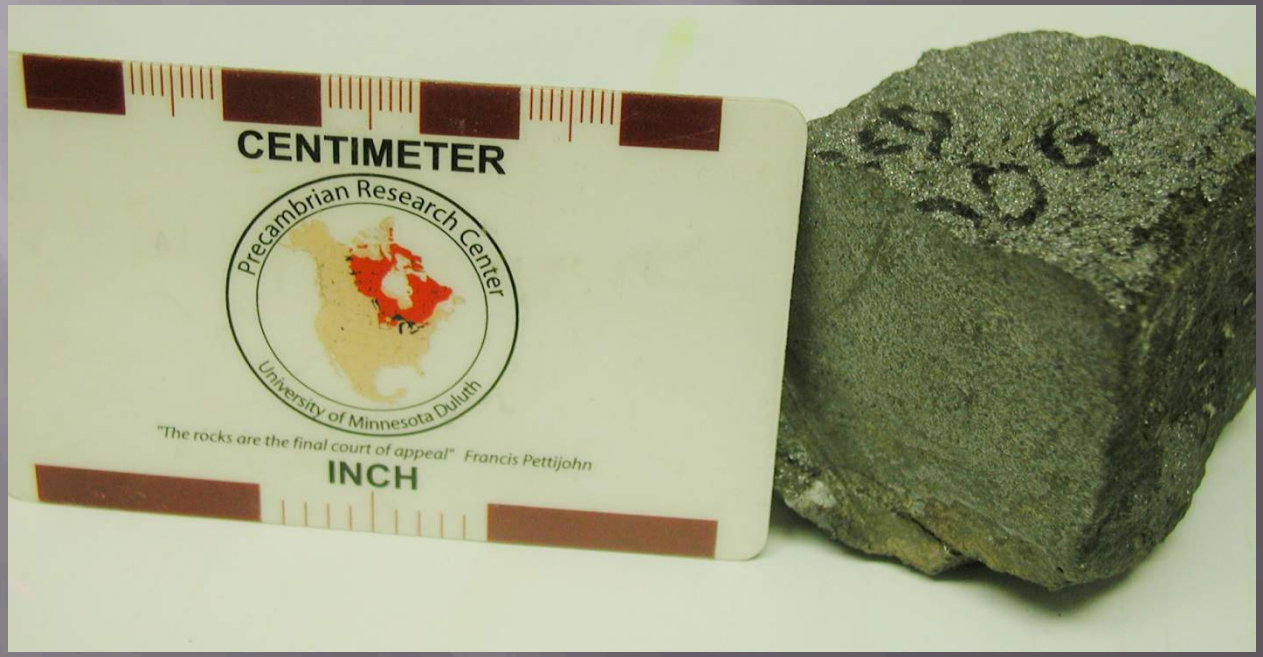
- **Deposited in a quiet, deep-water, marine environment**



(Moore et. al., 1986)

Research Questions

- What is the depositional story of this deposit?
  - What is the observed mineral assemblage?
  - What was the process of crystallization (hydrothermal, igneous, etc.)?



Methods of Research

- Incident (Reflected) Light Microscopy
  - Sample Preparation
  - Mineral Identification
- Scanning Electron Microscopy (SEM) Analysis
  - Mineral Identification
  - Mineral Chemistry

Reflected Light Microscopy - Background

- Light is emitted from a singular source and is focused on the sample surface
  - Can be equipped with a glass plate reflector or with a half field prism
- Light is then reflected upwards (from the sample) towards the ocular piece

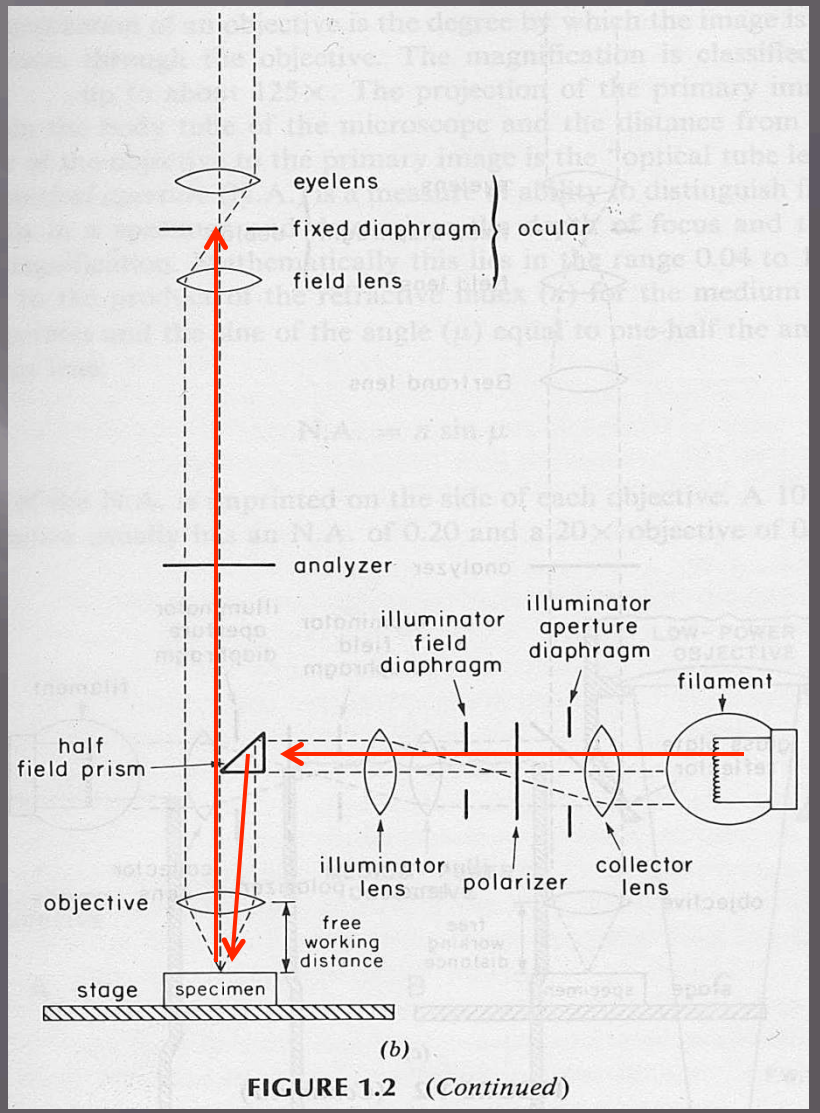
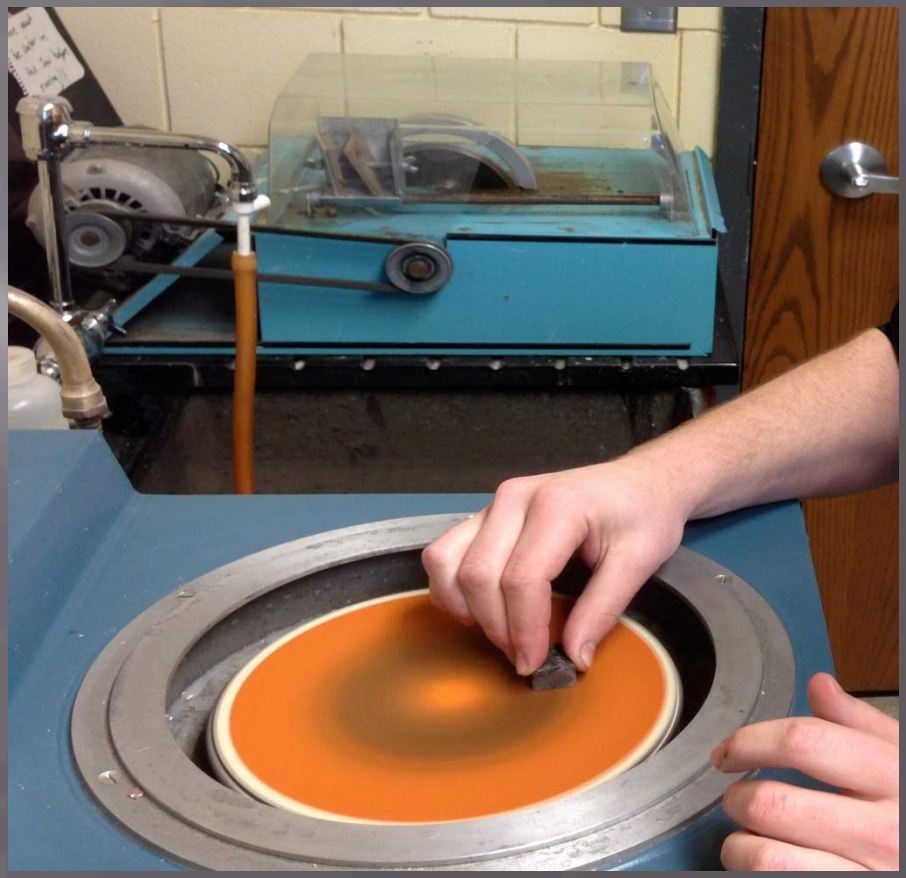


FIGURE 1.2 (*Continued*)

(Craig, J. R., & Vaughan, D. J., 1981)

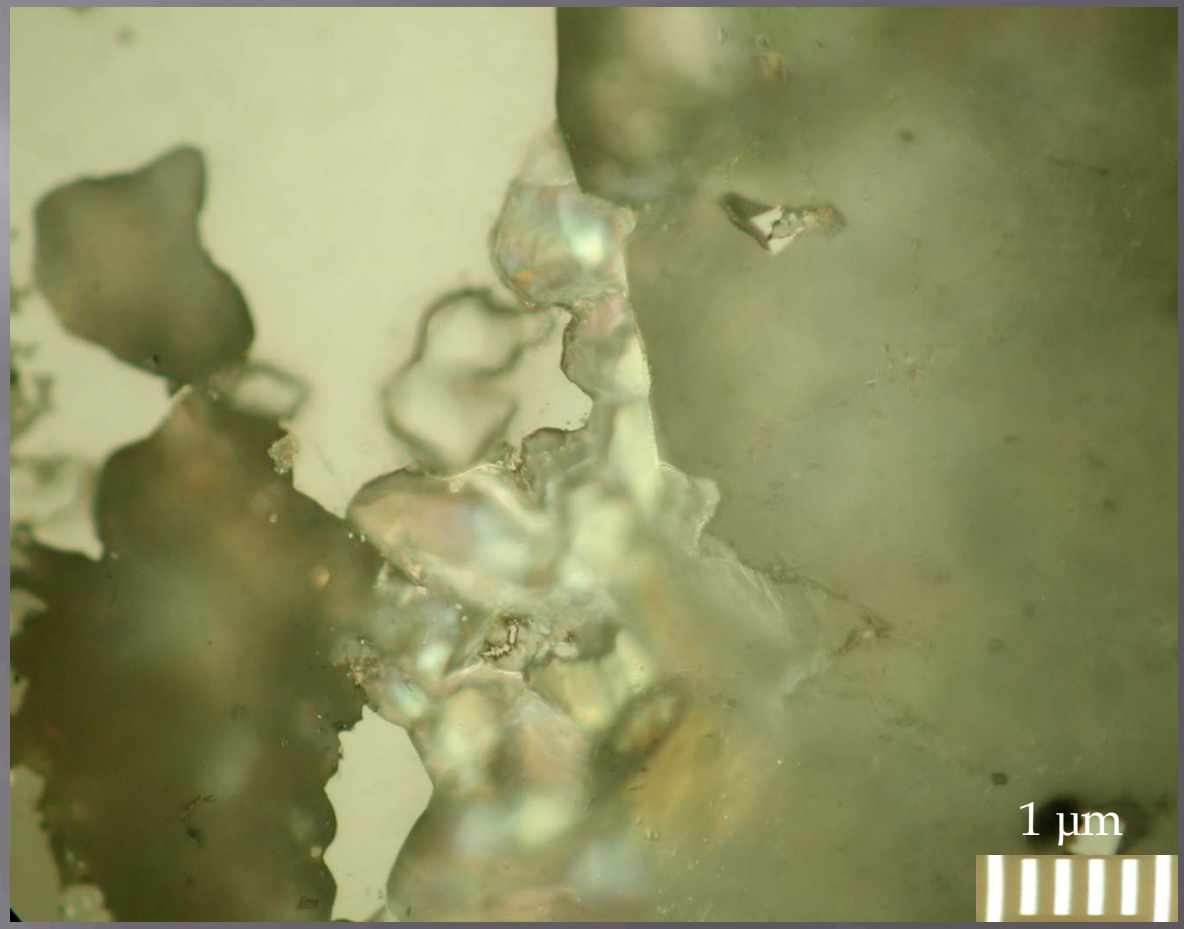
Reflected Light Microscopy - Sample Preparation

- Cut hand sample to approximate thin section length and width (for this sample 1.75cm wide by 2.5cm long)
- Grind sample starting with 400 grit on a glass plate and continue to finer grades (600grit, 1000grit)
- Polish sample using 1micrometer grit continuing to finer grades (0.25 micrometer grit and ending at 0.05 micrometer grit)

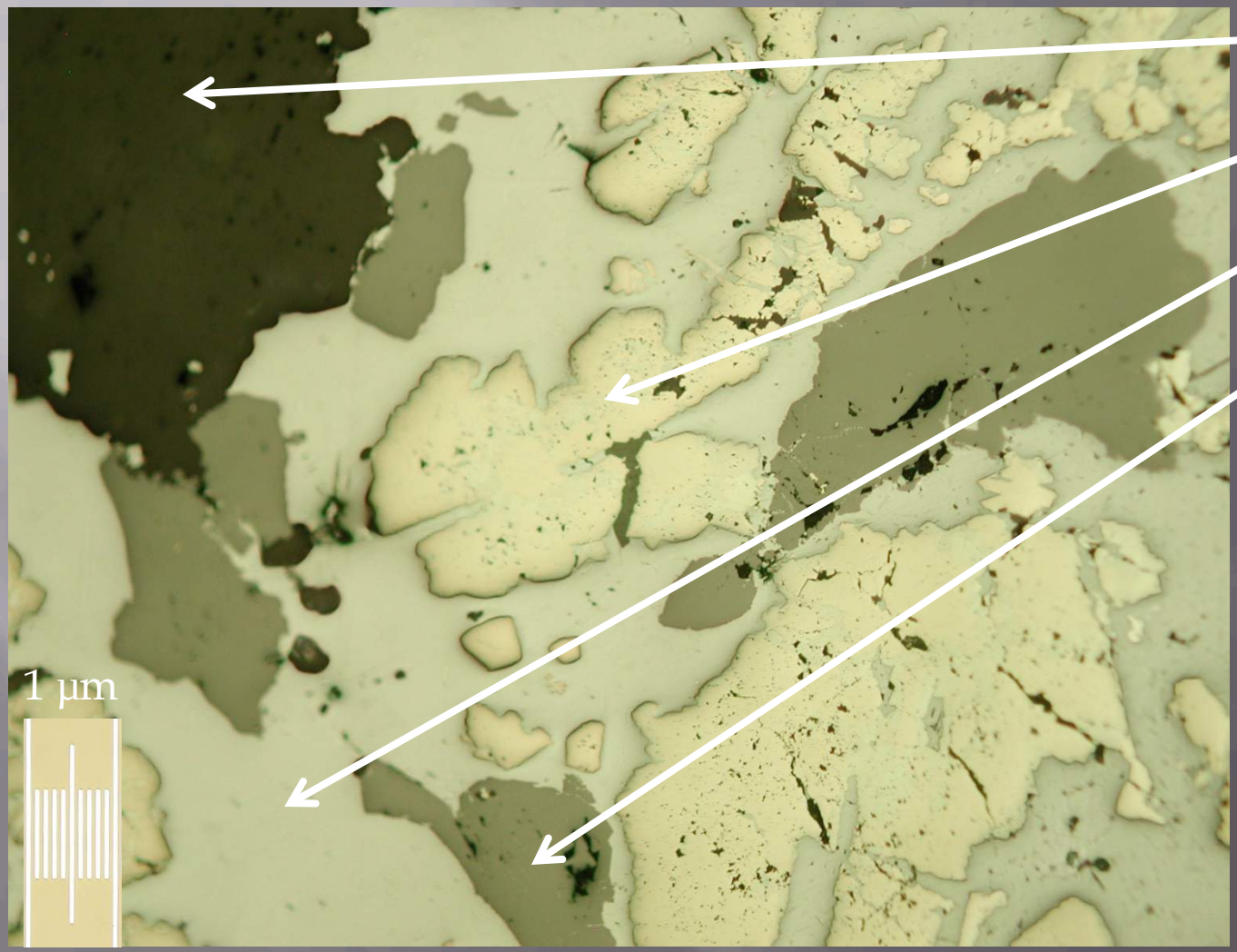


Reflected Light Microscopy – Mineral Identification

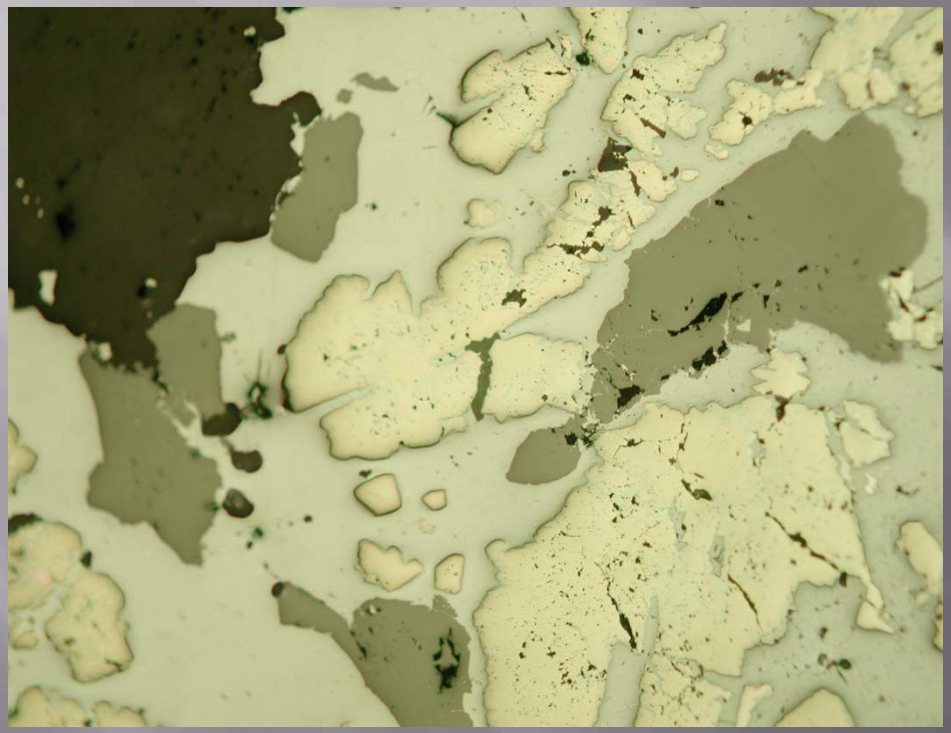
- Color of reflection
- Hardness
- Presence of internal reflections
- Pleochroism
- Anisotropy

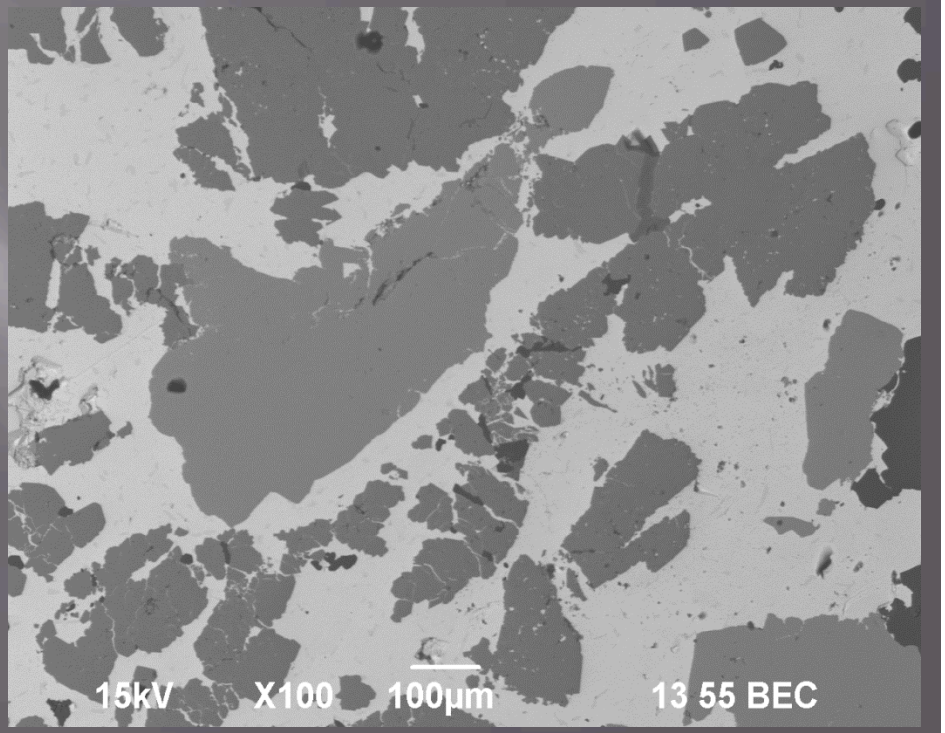


Results – Reflected Light Microscopy

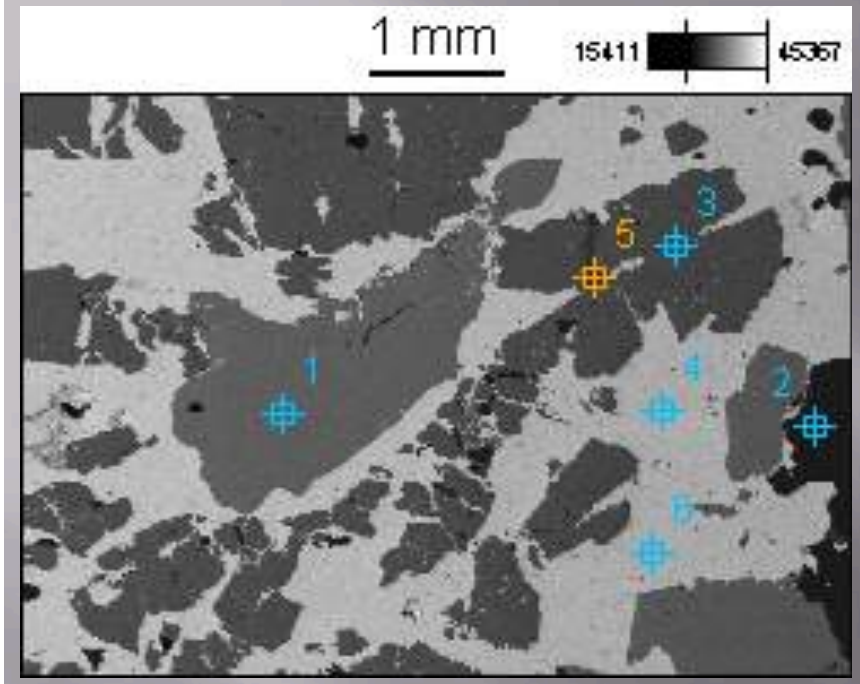


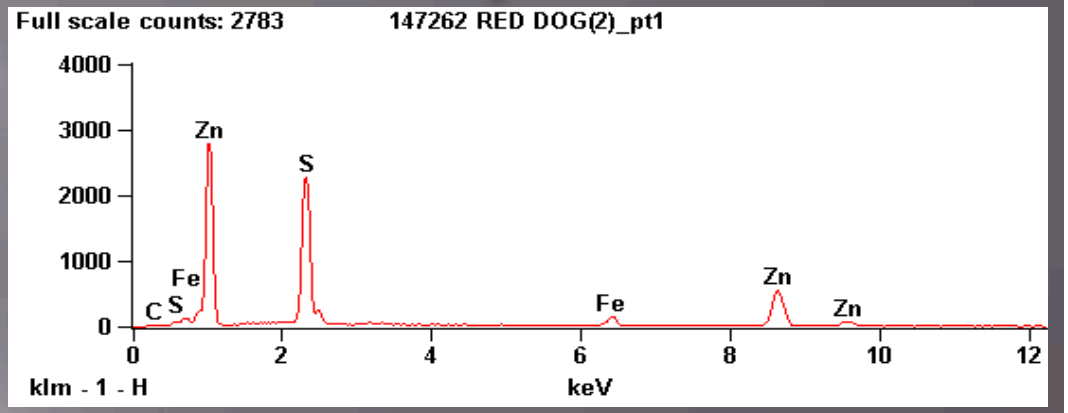
Reflected Light Image Vs. SEM Image

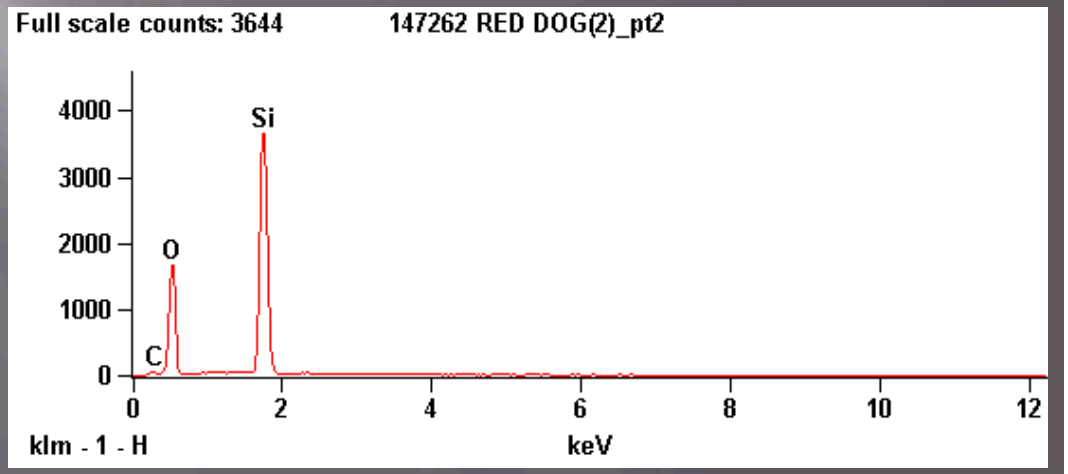




Results - SEM Analysis





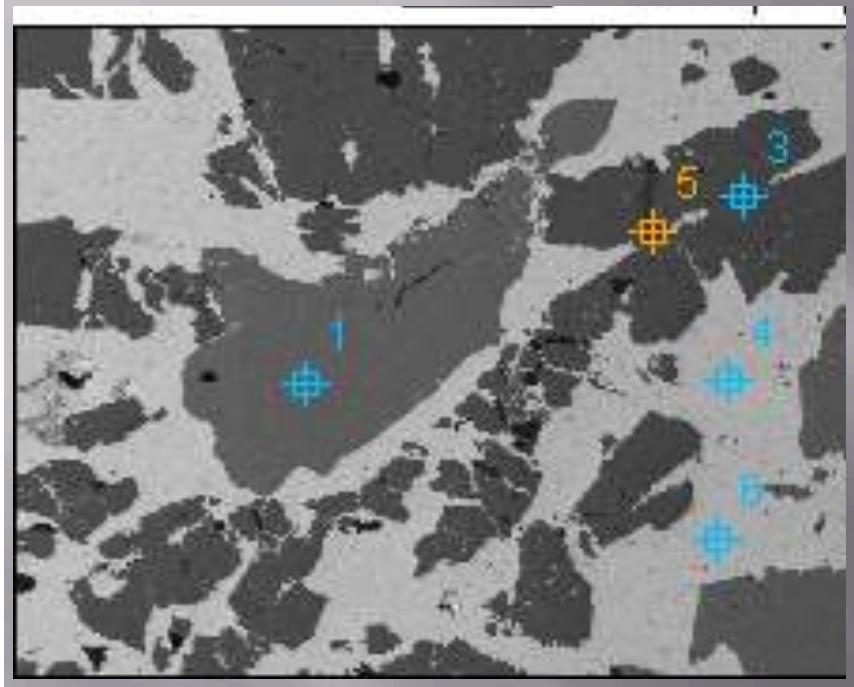


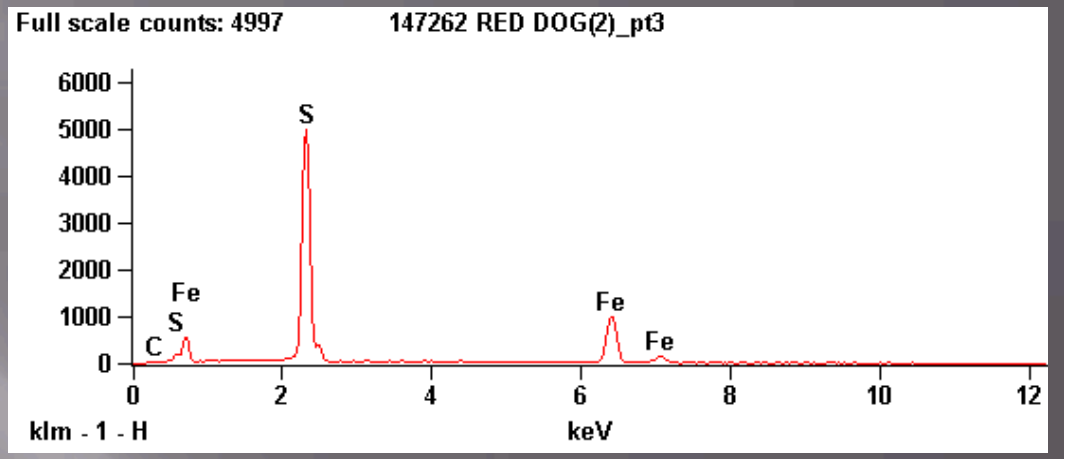
- Point 1 = Sphalerite (ZnS)
  - There is a relationship between zinc and iron in Sphalerite for percentage substitution
  - Can be used to identify type of Sphalerite

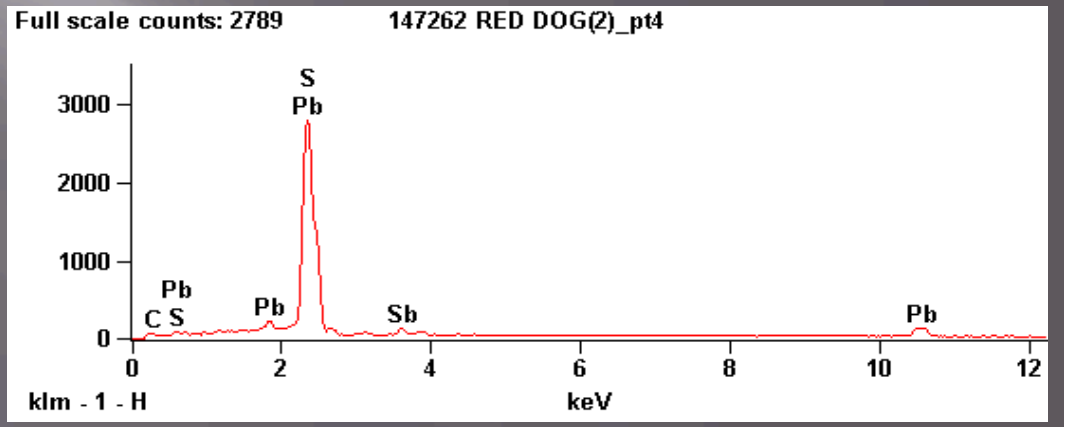
- Point 2 = Quartz (SiO_2)
  - Distinctive Si and O peaks
- The carbon peaks are most likely residue left form polishing

(Kelley et. al., 2004)

Results - SEM Analysis



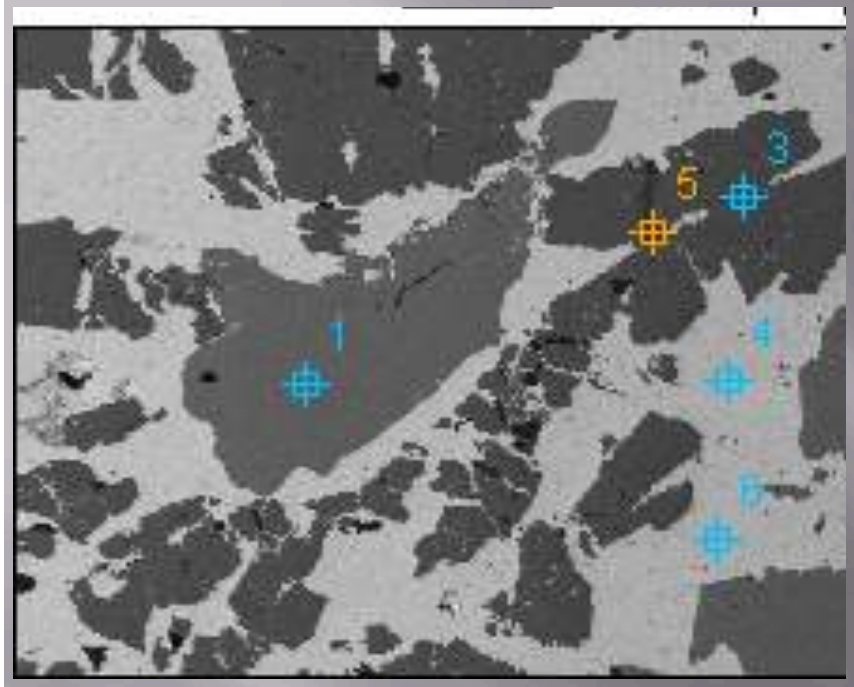


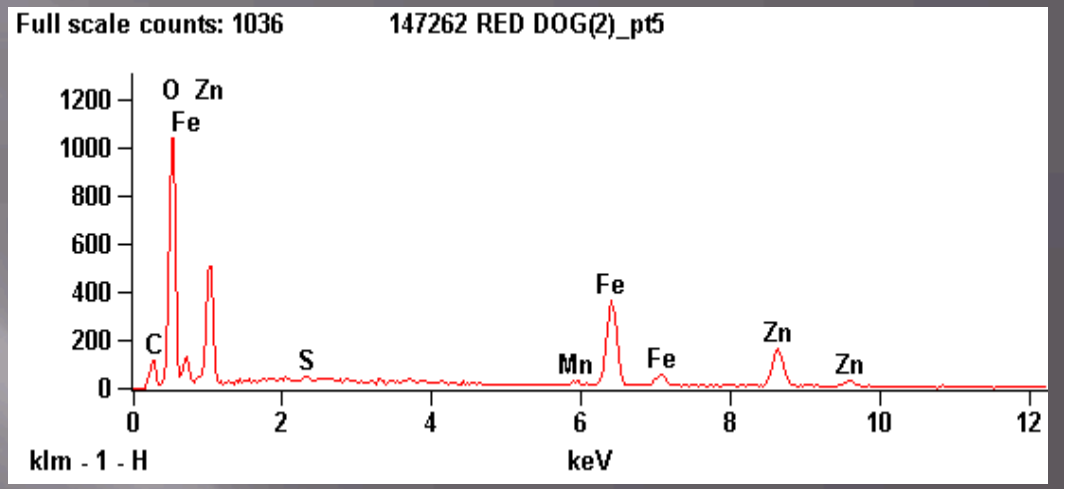


- Point 3 = Pyrite (FeS_2)
  - Determined through observation of distinctive characteristics using reflected light microscopy

- Point 2 = Galena (PbS)
  - Same as Point 6

Results - SEM Analysis





- Point 5 = Example of what not to do
- Interaction between three separate minerals
- Make sure of accurate point placement before running the analysis

Conclusions

- What is the depositional story of this deposit?
  - What is the observed mineral assemblage?
    - Quartz, Pyrite, Sphalerite, and Galena
  - What was the process of crystallization (hydrothermal, igneous, etc.)?
    - Based on literature research this deposit was hydrothermally deposited
      - Sea-floor derived fluid creates vents within the formation causing deposition of deposit minerals
    - All the minerals observed can be deposited in hydrothermal environments

(Edgerton, 1997)
(Kelley et. al., 2004)
(Pracejus, 2008)

QUESTIONS?

References

- Air Quality - Red Dog Mine Information. (2011). *Air Quality - Red Dog Mine Information*. Retrieved April 15, 2014, from http://dec.alaska.gov/air/reddog.htm
- Chance, N. (n.d.). Contamination at Red Dog Mine, Alaska. *Contamination at Red Dog Mine, Alaska*. Retrieved April 15, 2014, from http://arcticcircle.uconn.edu/SEEJ/RedDog/
- Craig, J. R., & Vaughan, D. J. (1981). *Ore microscopy and ore petrography*. New York: John Wiley and Sons. Print.
- Edgerton, D. (1997). Reconstruction of the Red Dog Zn–Pb–Ba orebody, Alaska: implications for the vent environment during the mineralizing event. *Canadian Journal of Earth Sciences*,*34*, 1581-1602. Print.
- Kelley, K., Leach, D., Johnson, C., Clark, J., Fayek, M., Slack, J., et al. Textural, Compositional, and Sulfur Isotope Variations of Sulfide Minerals in the Red Dog Zn-Pb-Ag Deposits, Brooks Range, Alaska: Implications for Ore Formation. *Economic Geology*, *99*, 1509-1532. Print.
- Lange, I., Nokleberg, W., Plahuta, J., Krouse, H., & Doe, B. Geologic setting, petrology, and geochemistry of stratiform sphalerite-galena-barite deposits, Red Dog Creek and Drenchwater Creek areas, northwestern Brooks Range, Alaska. *Economic Geology*, *80*, 1896-1926.Print.
- Moore, D., Young, L., Modene, J., & Plahuta, J. Geologic setting and genesis of the Red Dog zinc-lead-silver deposit, western Brooks Range, Alaska. *Economic Geology*, *81*, 1696-1727. Print.
- Morelli, R., Creaser, R., Selby, D., Kelley, K., Leach, D., & King, A. Re-Os Sulfide Geochronology of the Red Dog Sediment-Hosted Zn-Pb-Ag Deposit, Brooks Range, Alaska.*Economic Geology*, *99*, 1569-1576. Print.
- Pracejus, B. (2008). *The ore minerals under the microscope an optical guide*. Amsterdam: Elsevier. Print.
- Red Dog Operations. (2009). Retrieved April 15, 2014, from http://www.reddogalaska.com/http://www.reddogalaska.com/Generic.aspx?PAGE=Red+Dog+Site%2fAbout+Red+Dog&portalName=tc