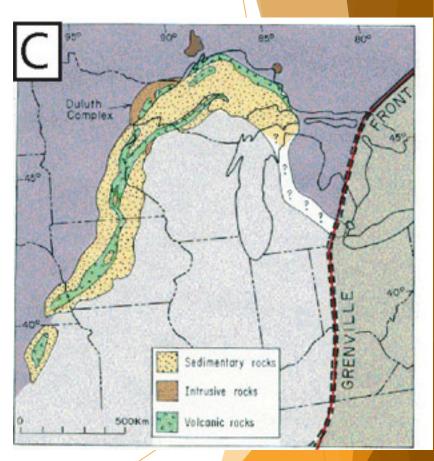


Presented by: Kathryn Klokstad and Kristen Lorenz
NDSU Petrology Geol 422
April 29, 2014

Background

- Midcontinent Rift System 1.1 Ga
- North Shore Volcanic Group
 - Majority of the rocks are mafic basalts, but approximately 10-25% are felsic (Green et al. 1993)
 - ► Palisade Rhyolite has been broken up by the Beaver Bay Complex (Miller et al. 1999)



http://fopnews.wordpress.com/2010/04/11/going-the-full-circle-a-walk-around-post-glacial-lake-superior/

Location



Palisade Rhyolite Outcrop

Day 6 of the North Shore Field Trip

Illgen City, near the intersection of Hwy 61 and Hwy 1



Photos from Google Earth

The Palisade Rhyolite

- Porphyritic with a brownish purple fine grained matrix, and angular phenocrysts of quartz and pumice.
- Shows light colored flow banding



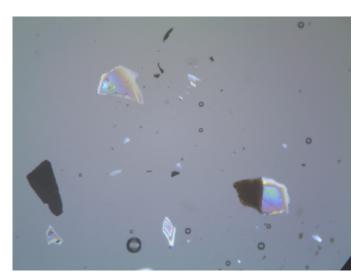


Research Interests

- Are the phenocrysts tridymite or a different form of quartz?
- Should this rock be identified as an ignimbrite or a rhyolite?

X-Ray Diffraction

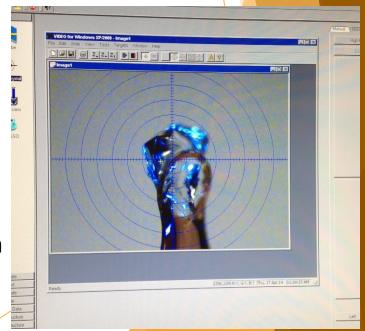
Single Crystal XRD Methods



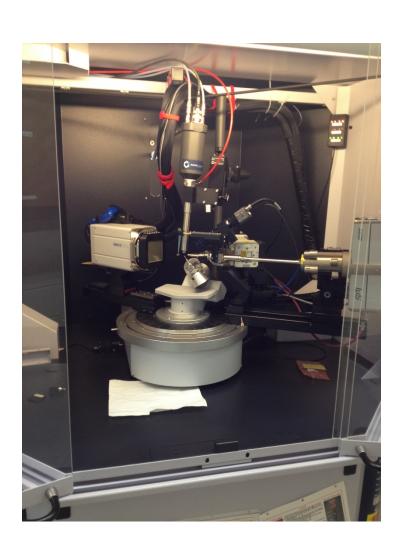
Cutting the SiO₂ crystals down to the correct size.

Centering the crystal.

Crystal size: 430-560µm

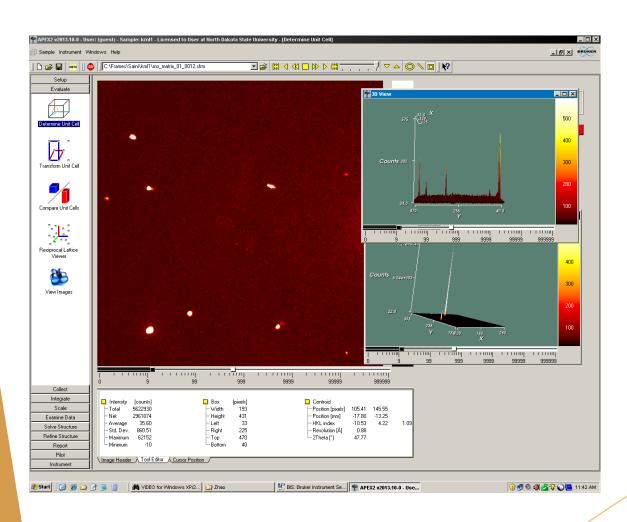


Single Crystal XRD Methods



- Three main components
 - X-ray tube
 - Sample holder
 - X-ray detector
- X-rays interact with the sample which diffracts the rays

Single Crystal XRD Methods

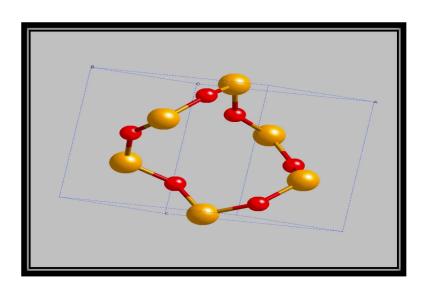


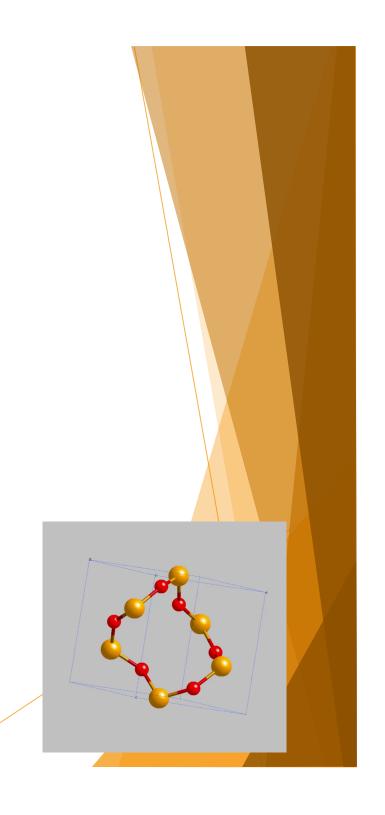
- Conducted 3 runs with 12 images in each
- Looking for large, bright, white spots

Single Crystal Data

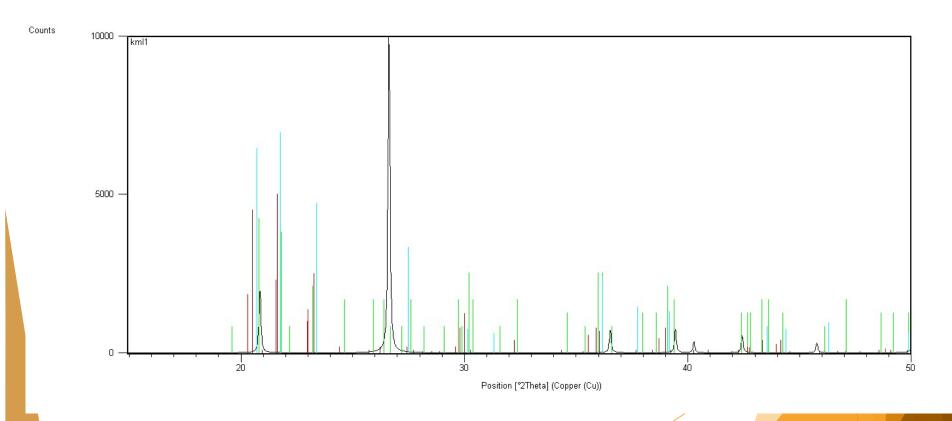
- Crystal System: Hexagonal
- ► Space Group: P3₁21
- Unit Cell Angles
 - ► Alpha= 90°
 - ▶ Beta= 90°
 - ► Gamma= 120°
- Unit Cell Dimensions
 - ► a= 4.9153Å
 - ▶ b= 4.9153Å
 - ► c= 5.4087Å

Unit Cell



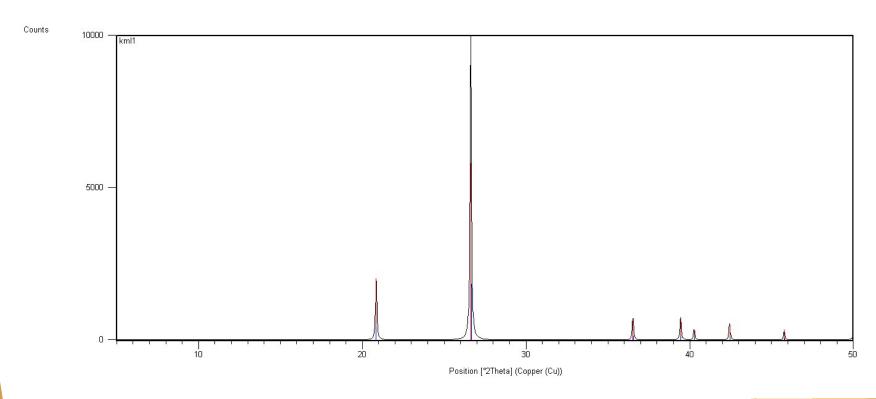


Simulated Single Crystal Powder Diffraction



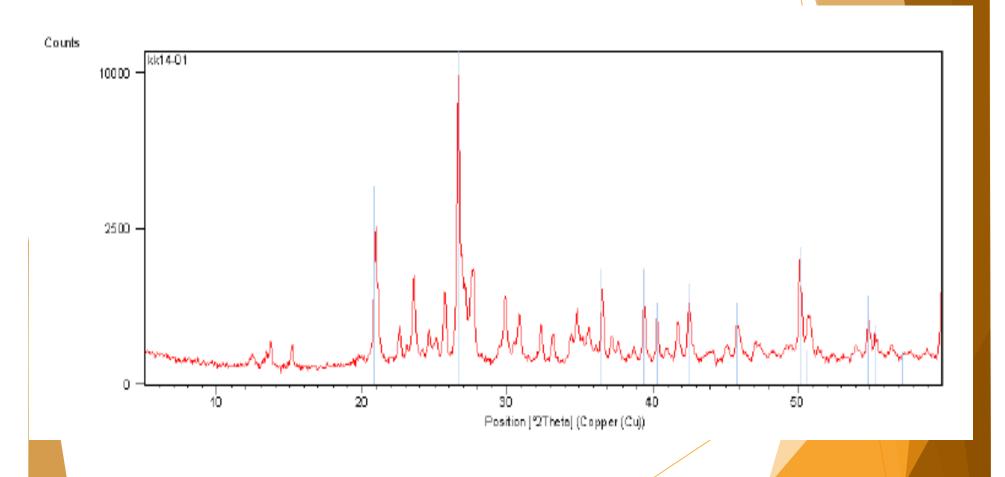
Our sample compared to database data of Tridymite

Simulated Single Crystal Powder Diffraction

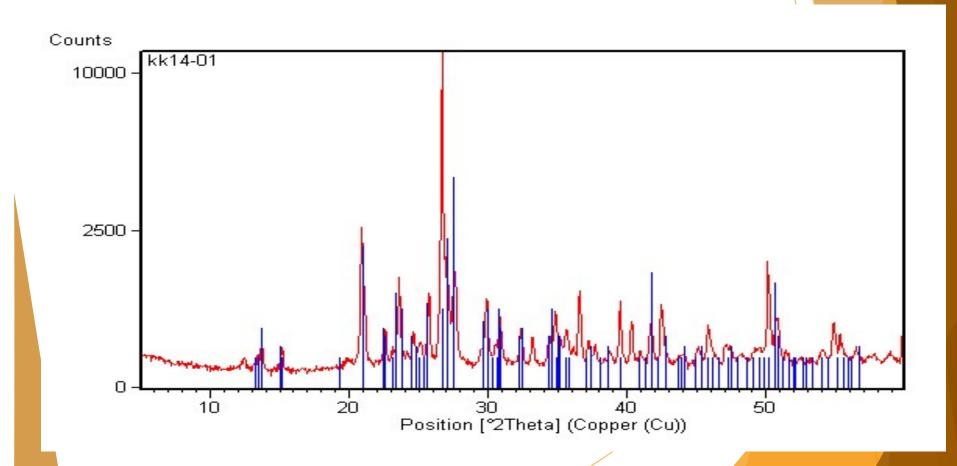


Low quartz database data plotted over our sample

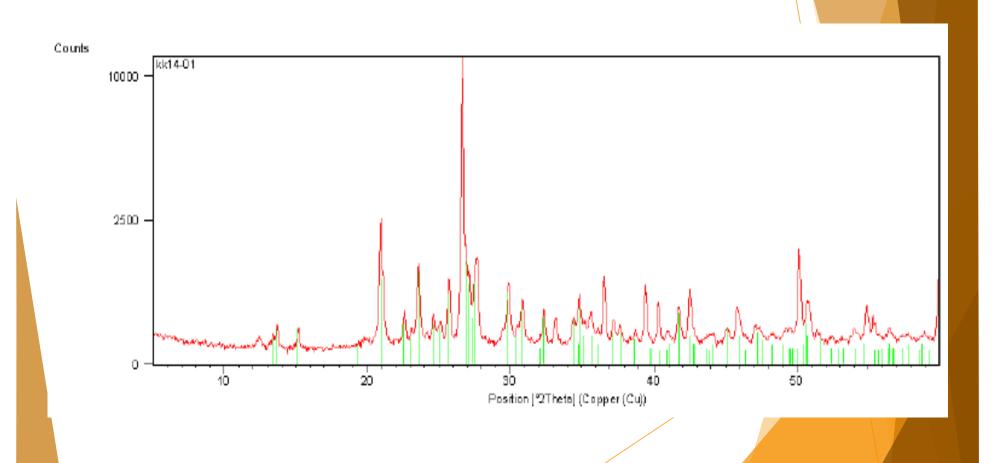
Whole Rock Powder Diffraction Low Quartz



Whole Rock Powder Diffraction Microcline



Whole Rock Powder Diffraction Orthoclase



Comparison

Palisade Rhyolite Phenocrysts

- Crystal System: Hexagonal
- Space Group: P3₁21
- Unit Cell Angles
 - ► Alpha= 90°
 - ► Beta= 90°
 - ► Gamma= 120°
- Unit Cell Dimensions
 - ► a= 4.9153Å
 - ▶ b= 4.9153Å
 - ► c= 5.4087Å

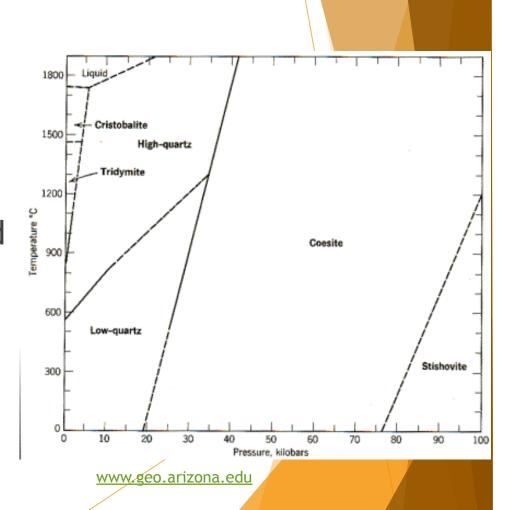
Alpha Quartz

- Crystal System: Hexagonal
- ► Space Group: P3₁21
- Unit Cell Dimensions
- Unit Cell Angles
 - ► Alpha = 90°
 - ▶ Beta= 90°
 - ► Gamma= 120°
- ▶ Unit Cell Dimensions
 - ► a= 4.9130Å
 - ▶ b= 4.9130Å
 - ► c= 5.4050Å

Discussion

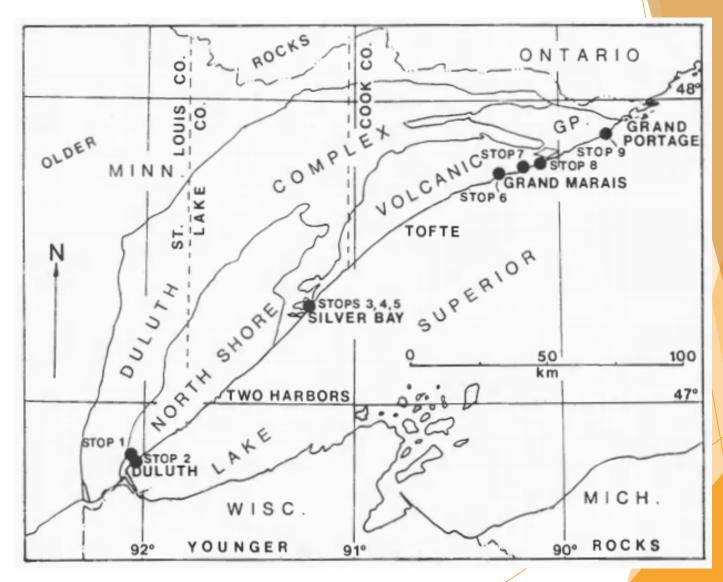
The quartz is a low quartz, determined through a single crystal analysis

Could possibly have formed as tridymite, then the temperature dropped and low quartz was the result



Whole Rock Chemistry

Location of the Palisade and Devil's Track Rhyolites



Generalized geologic map of western Lake Superior area. (Green 1979)

Whole Rock XRF Methods

X-ray Fluorescence

- X-rays excite sample
- Secondary X-rays are read by detector

Procedure determines chemical composition of sample



(Klein 2002)

Whole Rock XRF Methods

Major Components:

- X-ray tube
- Sample holder
- Diffracting Crystal
- Detector

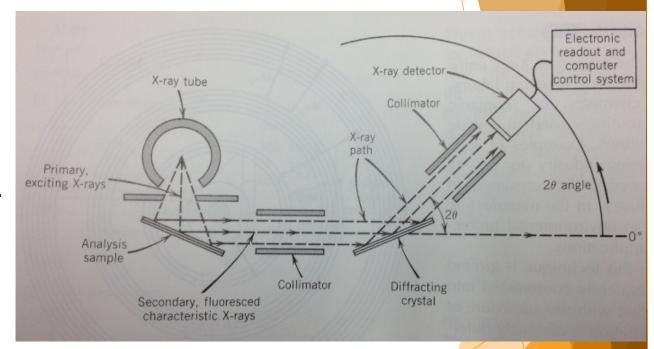
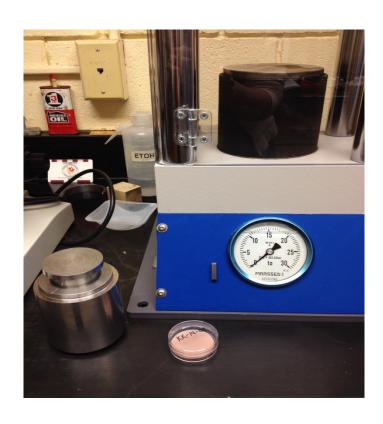


Diagram of major components of XRF (Klein 2002)

Whole Rock XRF Methods

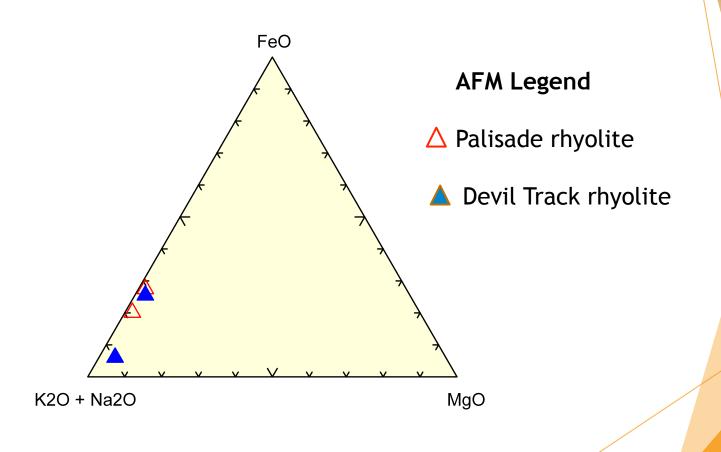
Prepared sample as a pressed pellet



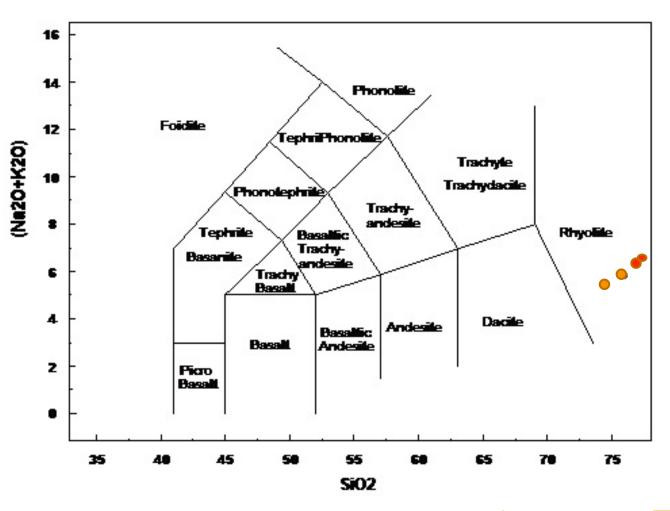


Substituted with data from Green 1979 and 1993

Results - AFM Diagram



Results - TAS Diagram



- Palisade Rhyolite
- Devil Track Rhyolite

Discussion

- Chemical composition is rhyolitic
- Rhyolites are also present in the Great African Rift Valley (Nelson 2011)
- ► How are felsic rocks produced in a predominantly mafic environment?

Rheoignimbrites

Produced when ash and debris are extruded from a rift, then the internal heat causes the material to flow and become welded.

Indicators of this process in hand specimen:

- ► Flow banding
- Glass fragments
- Brecciated pumice
- ► Elongated vesicles (Henry et al. 1999)

Conclusion

- ► Palisade rhyolite was not formed by typical magmatic processes, but as voluminous ash deposits which were remobilized and welded
- Internal temperatures associated with this formation support the crystallization of tridymite initially, then a temperature decrease changed the crystal structure to that of low quartz



References

- Green, J.C., 1979, Field trip guidebook for the Keweenawan (upper Precambrian)
 North Shore Volcanic Group, Minnesota Geological Survey Guidebook ser. 11, 22 p.
- ► Green, J.C., & Fritz, T.J. 1993. Extensive felsic lavas and rheoignimbrites in the Keweenawan Midcontinent Rift plateau volcanics, Minnesota: petrographic and field recognition. Journal of Volcanology and Geothermal Research 54: 177-196.
- Henry, C. D., Price, J. G., Rubin, J. N., Parker, D. F., Wolff, J. A., Self, S., Franklin, R., and Barker, D. S., 1999, Widespread, lavalike silicic volcanic rocks of Trans-Pecos Texas: Geology, V. 16, p. 509-512.
- ▶ Klein, C., 2002. Mineral Science 22nd Edition. John Wiley & Sons, Inc..
- Miller, J.D., Jr., Tipping, B., and Green, J., 1999., Geology and geohydrology of the North Shore and Gunflint Trail: St. Paul, MN, AIPF-MGWA-AWG Fall Field Trip Guidebook. Minnesota Geological Survey.
- Nelson, S.A., 2011. Igneous Rocks of the Continental Lithosphere. http://www.tulane.edu/~sanelson/eens212/cont_lithosphere.htm