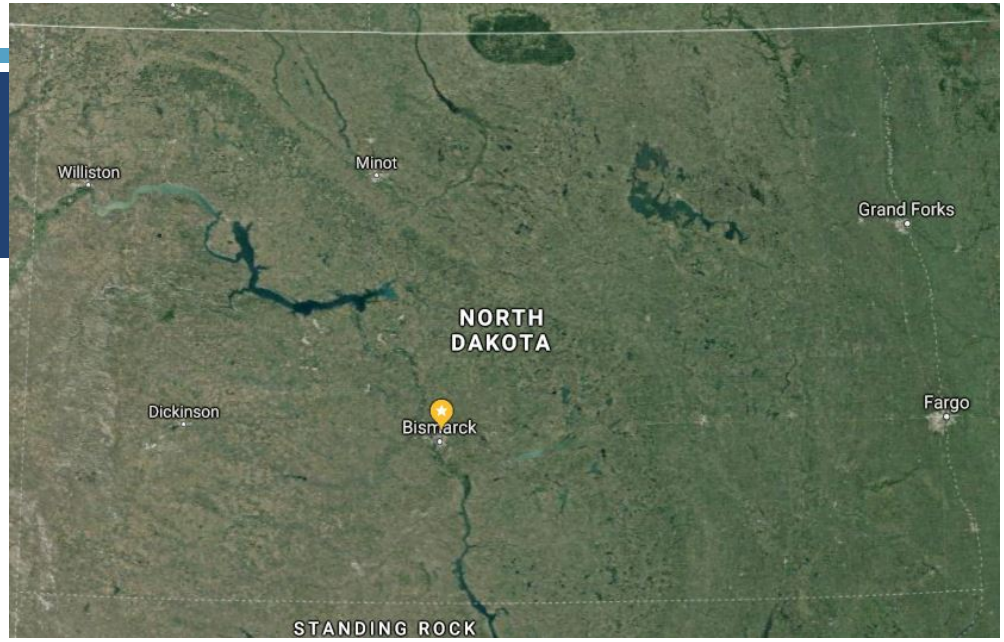
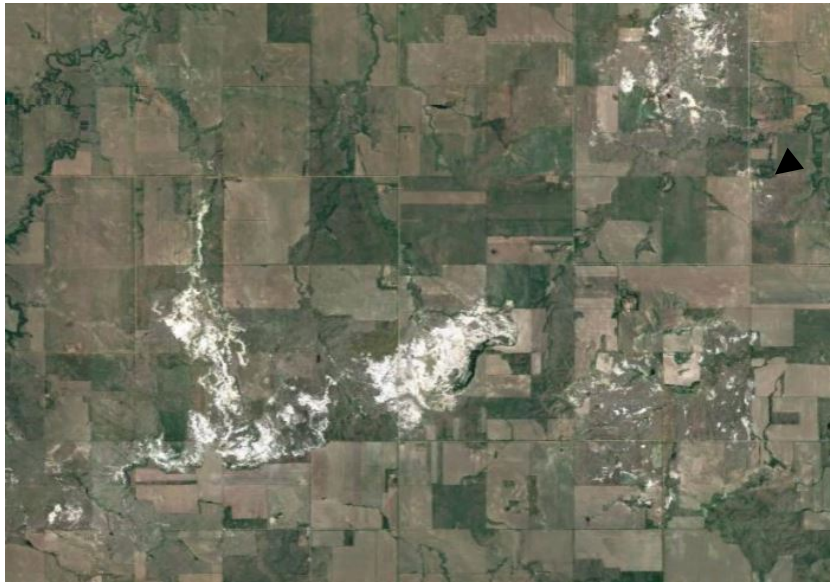
ANALYSIS OF VOLCANIC COBBLES FOUND IN CHADRON FORMATION, LITTLE BADLANDS ND

ANNA VANDERLAAN

NDSU PETROLOGY PROJECT 2018

LOCATION


Williston
Minot
Grand Forks
NORTH
DAKOTA
Dickinson
Bismarck
Fargo
STANDING ROCK



AREA STRATIGRAPHY

- White River Group
  - Chadron Formation
    - South Heart Member
    - Chalky Buttes Member
- Chalky Buttes
  - Ranges from 10-20ft thick
  - Eocene

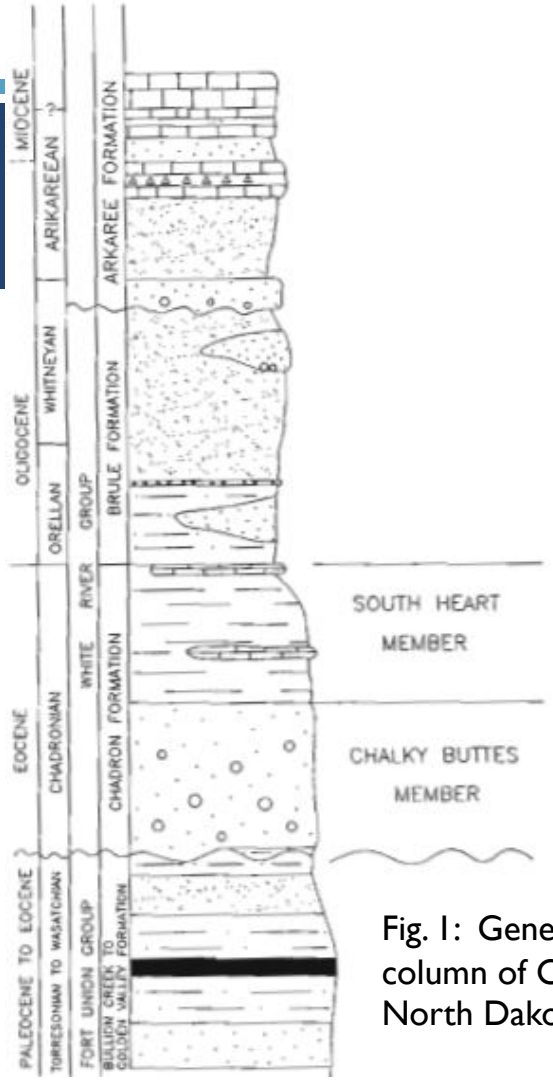


Fig. 1: Generalized stratigraphy column of Cenozoic strata of North Dakota

CHALKY BUTTES COBBLES OVERVIEW

- Variety of cobbles within member
- Igneous
  - Volcanic Porphyry
  - Ignimbrite
- Sedimentary
  - Quartz Sandstones
  - Conglomerates
  - Chert

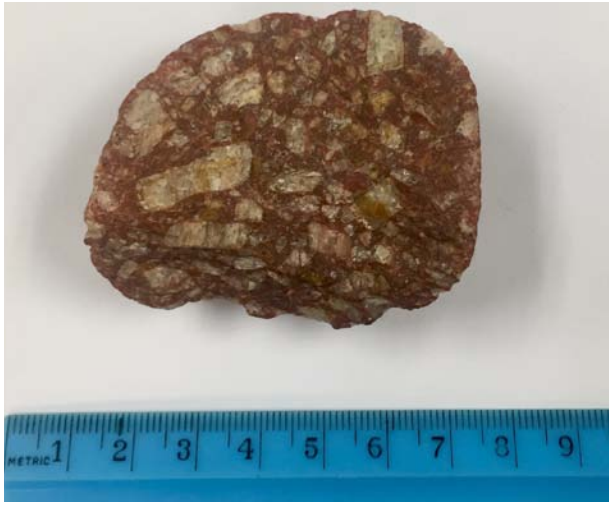
GUIDING QUESTIONS

- Classification of volcanic porphyry
- Classification of Ignimbrite
- Potential sources of volcanic cobbles using ignimbrite analysis

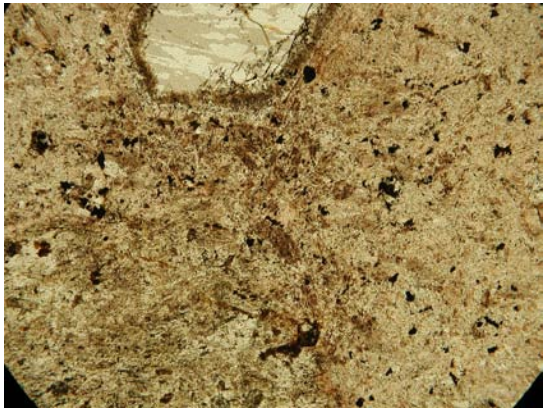
METHODS

- XRF
  - Used data from previous years
- XRD
  - Used data from previous years
- Petrographic Microscopy
- Plotting using Igpet

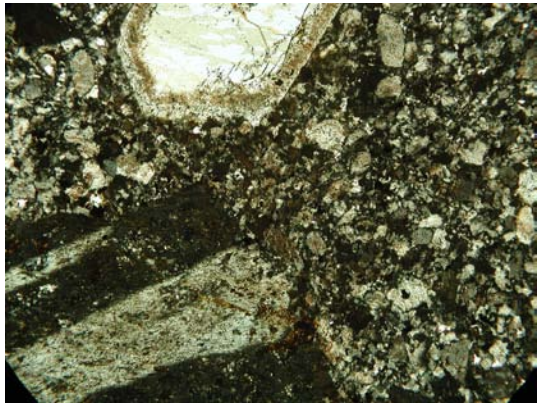
VOLCANIC PORPHYRY



Volcanic porphyry hand sample CB8 pictured above



2.5x magnification,
Right image ppl
Bottom image xpl



VOLCANIC PORPHYRY XRD ANALYSIS

- Matrix
  - Orthoclase
  - Microcline
- Phenocrysts
  - Orthoclase
  - Sanidine
  - Anorthoclase
  - Microcline

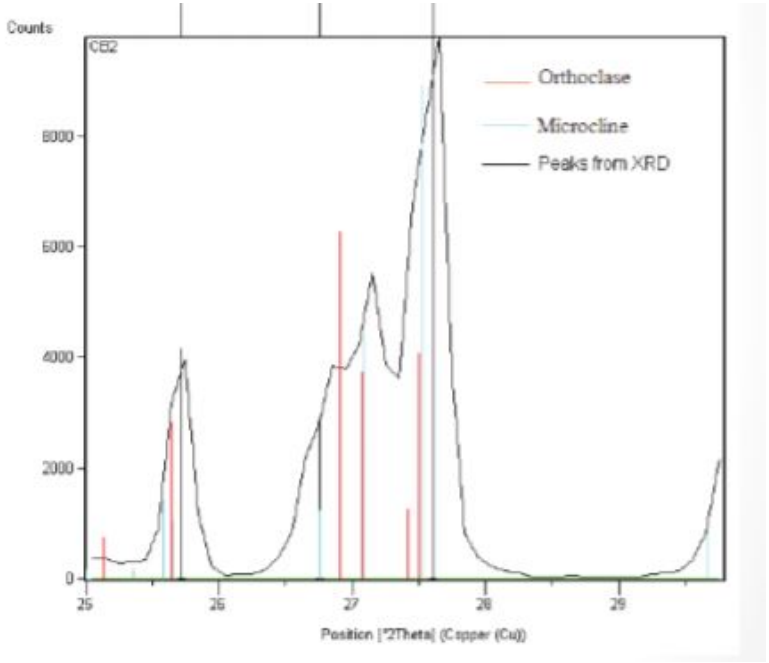
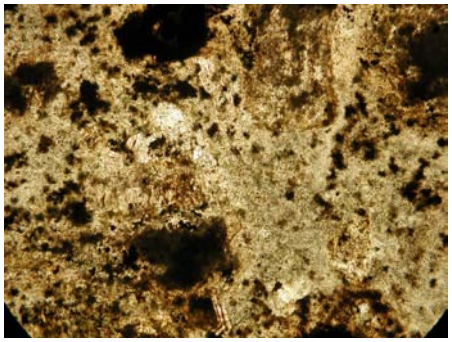


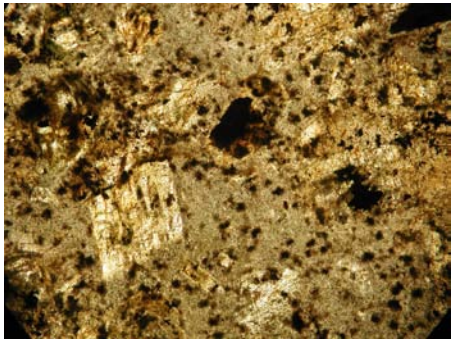
Fig. showing XRD pattern of volcanic porphyry, taken from Moxness petro project (2012)

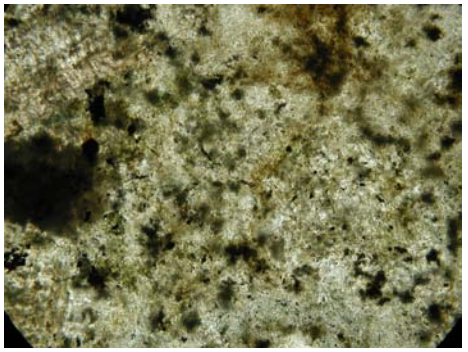
IGNIMBRITES

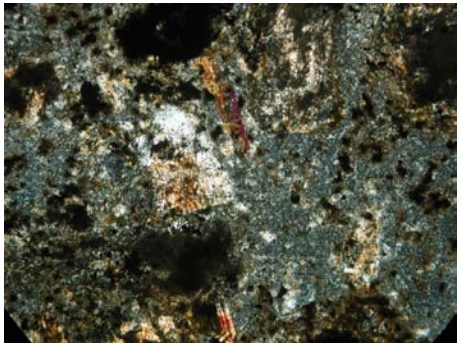
- Pyroclastic rocks that were extremely hot following their deposition, causing the individual clasts to become "welded" together or compact under the weight of overlying flow
  - Originally only referred to welded tuffs
  - Includes all pyroclastic flow deposits, welded and non-welded
- Consist of larger phenocrysts surrounded by smaller matrix
- Chemistry dependent on magma chemistry

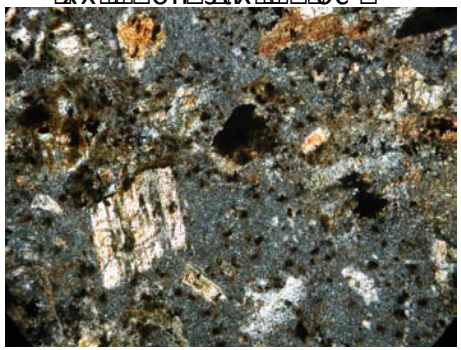
CHALKY BUTTES IGNIMBRITE

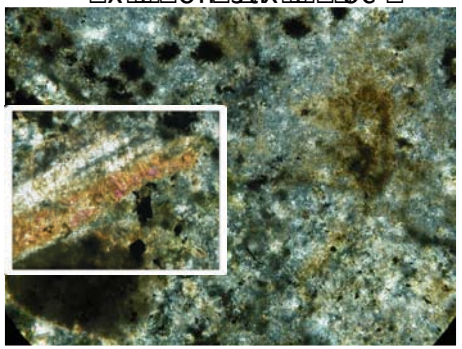










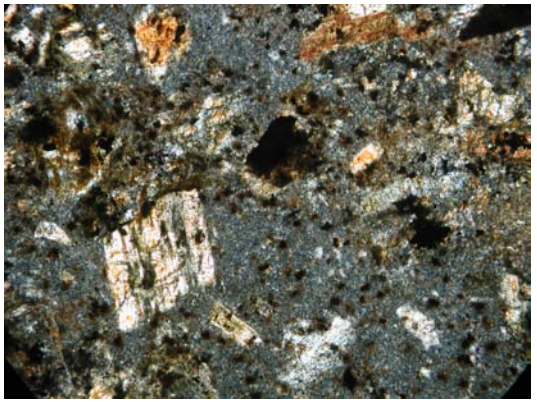


CHALKY BUTTES IGNIMBRITES

- Phenocrysts mainly feldspars
  - Anorthite
  - Sanidine
- Matrix mostly unidentifiable
- Classified as ignimbrite from presence of fragmented material and formed by consolidation of material from a pyroclastic flow

Right: Ignimbrite hand sample CB1

Below: Sample CB1 thin section in XPL, 10x magnification

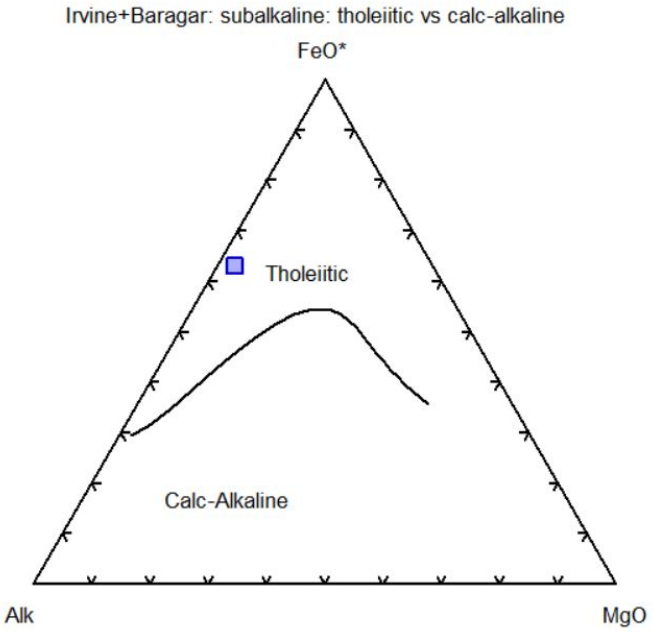


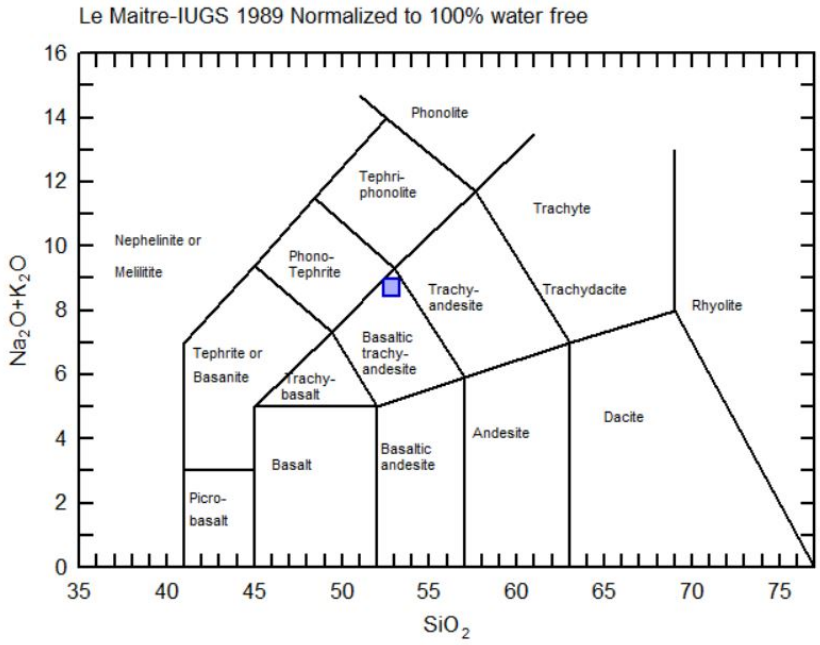
CHALKY BUTTES IGNIMBRITES XRF ANALYSIS

	SiO2	TiO2	Al2O3	Fe2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	H2O
CB1	57.96	0	19.77	19.77	0	0.03	0.86	3.64	4.62	4.92	0.06	0

Na2O	4.62
K2O	4.92
Fe2O3	19.77
MgO	0.86
Total	30.17

IGNIMBRITE AFM AND TAS DIAGRAM





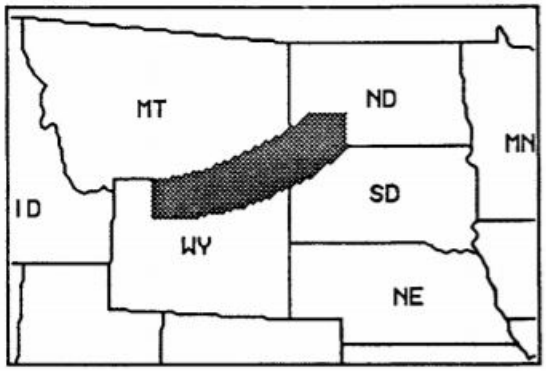
POTENTIAL SOURCES FOR VOLCANIC ROCKS

- Various potential sources for volcanic rocks
  - Black Hills
  - Bear Tooth Mountain
  - Yellowstone Basin
  - Absaroka Mountains

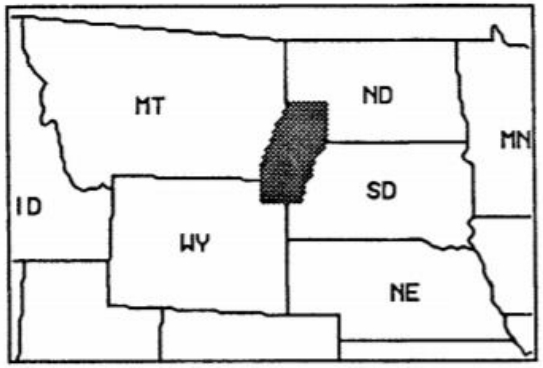
  (Ashworth, 1986) (Clausen, 1986)
- Pumpkin Buttes River
  - Oligocene drainage pattern in northern Great Plains region
  - Allows for multiple sources
  - Connects previously argued sources together

  (Seeland, 1985)

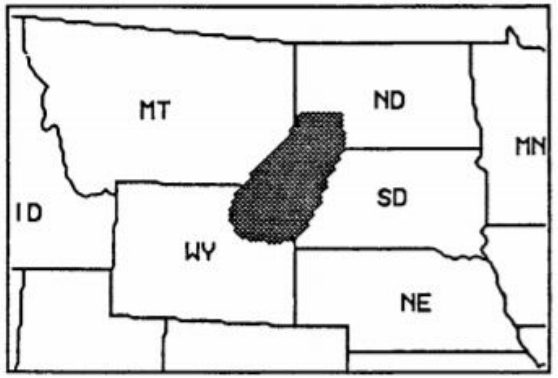
SOURCE AREAS



From Absaroka-Beartooth region transported northeast (Clausen, 1986)



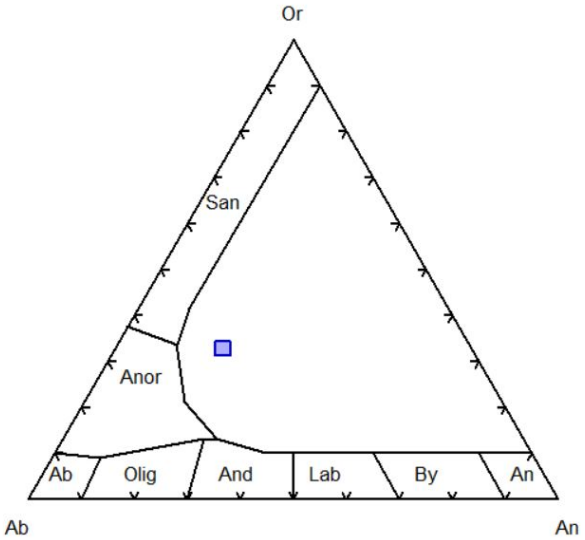
From northern Black Hills transported northwards (Clausen, 1986)

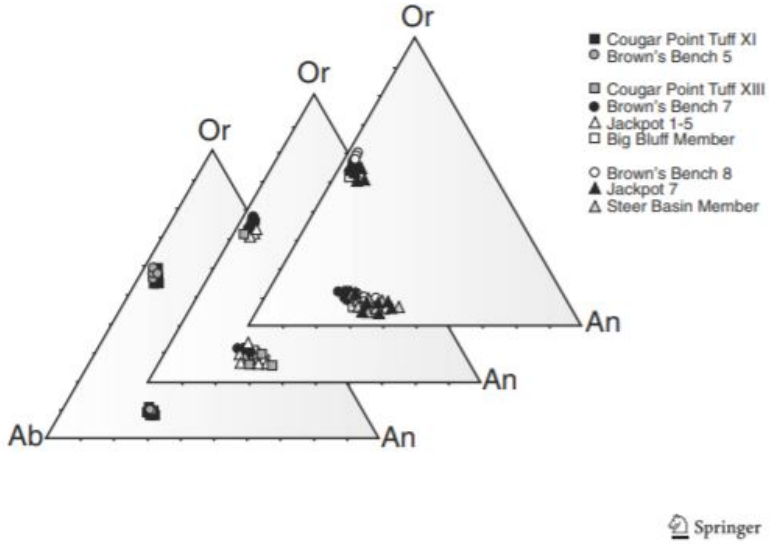


Northeast transport through Powder River Basin (Clausen, 1986)

IGNIMBRITE COMPARISONS

- Ignimbrites found in Yellowstone Basin
  - Slightly similar abundance of feldspars





Left image: Shows distribution of feldspars from sample CB1
Above image: Samples from Yellowstone Basin feldspars distribution (Ellis et al., 2011)

IGNIMBRITE COMPARISON

- Large volumes of ignimbrites are found within the Wyoming batholith (Bagdonas et al., 2016)
  - Higher Potassium
  - Silicic ignimbrites
  - Vary in specific composition throughout batholith
- Little Badlands ignimbrites
  - Some Potassium
  - Silicic ignimbrites

CONCLUSIONS

- Various sources for volcanic cobbles
- Ignimbrites from Yellowstone Basin could be considered similar feldspar distribution
- Not enough evidence to determine source location
- Potential future work
  - Collecting ignimbrites from various source areas and analyze
  - Compare to ignimbrites from Chalky Buttes

REFERENCES

- Ashworth, A., 1986. The Oligocene age and fluvial origin for the Chadron Formation reaffirmed by observations in the Little Badlands, Stark County, North Dakota. Geology Department, North Dakota State University.
- Bagdonas, D., Frost, C., Fanning, M., 2016. The origin of extensive Neoarchean high-silica batholiths and the nature of intrusive complements to silicic ignimbrites: Insights from the Wyoming batholith, U.S.A.: American Mineralogist, v. 101, No. 6, pp. 1132-1347.
- Clausen, E., 1986, Origin of Quartz Latite Porphyry Cobbles found at base of White River Group Sediments in Southwest North Dakota: North Dakota Geological Society Volume.
- Ellis B., Branney, T., Barry, T., Barfod, D., Bindeman, I., Wolff, J., Bonnichsen, B., 2011. Geochemical correlation of three large-volume ignimbrites from the Yellowstone hotspot track, Idaho, USA: Bulletin of Volcanology, v. 74, No. 1, pp.261-277
- Ellis, B., Cordonnier, B., Szymanowski, D., Backmann, O., Andrews, G., 2015. Groundmass crystallization and cooling rates of lava-like ignimbrites: the Grey's Landing ignimbrite, southern Idaho, USA: Bull Volcanol, v. 77 No. 87.
- Murphy, E., Hoganson, J., and Forsman, N., 1993. The Chadron, Brule, and Arikaree Formations in North Dakota. *North Dakota Geological Survey*, no. 96.
- Seeland, D., 1985. Oligocene paleogeography of the Northern Great Plains and adjacent mountains, In (Flores, R.M. and Kaplan, S.S., eds.) Cenozoic Paleogeography of West Central United States. SEMP, Rocky Mountains section.
- Winter, J., 2010. Principles of Igneous and Metamorphic Petrology. Pearson Education Inc.