

# Comparison of Chalky Buttes Porphyry and Porphyry Near Forsyth

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NDSU Petrology Geol 422

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# Outline

- ▶ Introduction
  - Chalky Buttes Member
  - Forsyth Cobble
- ▶ Background
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- ▶ Methods
  - XRF, SEM, Microscopy
- ▶ Results
- ▶ Conclusion

# Introduction



From: google maps

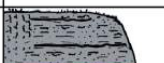
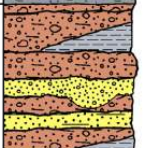


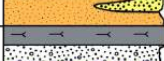







# Introduction to Chalky Buttes Fm.

- ▶ Part of the Chadron Formation
- ▶ In the White River Group
- ▶ Late Eocene in Age
- ▶ Consists of many cobbles including quartzite, sandstone, mudstones, petrified wood, and volcanic porphyry
- ▶ Cobbles were deposited by fluvial forces

# Introduction to Chalky Buttes Formation

## NORTH DAKOTA STRATIGRAPHIC COLUMN

by Edward C. Murphy, Stephan H. Nordeng, Bruce J. Juenker, and John W. Hoganson

AGE MILLIONS OF YEARS BEFORE PRESENT	ERATHEM	SYSTEM		SEQUENCE	ROCK UNIT			RESOURCE Proven <i>Potential</i>	ROCK COLUMN  EXPOSED UNITS SHOWN WITH IRREGULAR, ERODED RIGHT-HAND MARGIN	MAXIMUM THICKNESS  FEET (METERS)
			SERIES		GROUP	FORMATION	MEMBER			
0.01	CENOZOIC	QUATERNARY	Holocene	TEJAS		OAHE	RIVERDALE PICK CITY AGGIE BROWN MALLARD ISLAND	Salt Water Gravel		100 (30)
			Pleistocene		COLEHARBOR	WEST CENTRAL DAHLEN SNOW SCHOOL HORSESHOE VALLEY MEDICINE HILL	EASTERN RED RIVER VALLEY SHERACK POPLAR RIVER ERENNA FALCONER HUOT ARGUSVILLE WYLLIE RED LAKE FALLS ST. HILAIRE MARCOUX	Gravel Water Stone Peat Clay		1,000 (300)
2.6			Pliocene		(Unnamed Unit)		Gravel Water		300 (91)	
5.3		NEOGENE	Miocene			ARIKAREE		Rock		330 (101)
23.0			Oligocene		WHITE RIVER	BRULE				200 (61)
33.9		TERTIARY PALEOGENE	Eocene			CHADRON	SOUTH HEART CHALKY BUTTES	Clay Gravel		140 (43)
					GOLDEN VALLEY		CAMELS BUTTE			400 (122)
55.8							BEAR DEN	Clay		
			Paleocene		FORT UNION	SENTINEL BUTTE		Clinker Uranium Coal Leonardite Water		650 (198)
						BULLION CREEK		Water Stone Coal Clinker		650 (198)
						SLOPE		Clay Coal Clinker		270 (82)
						CANNONBALL		Clay		255 (78)
65.5						LUDLOW		Water Clinker Coal		300 (91)

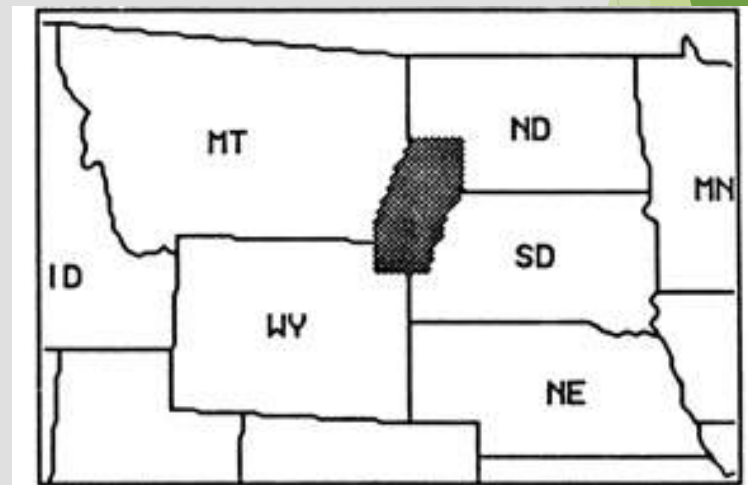
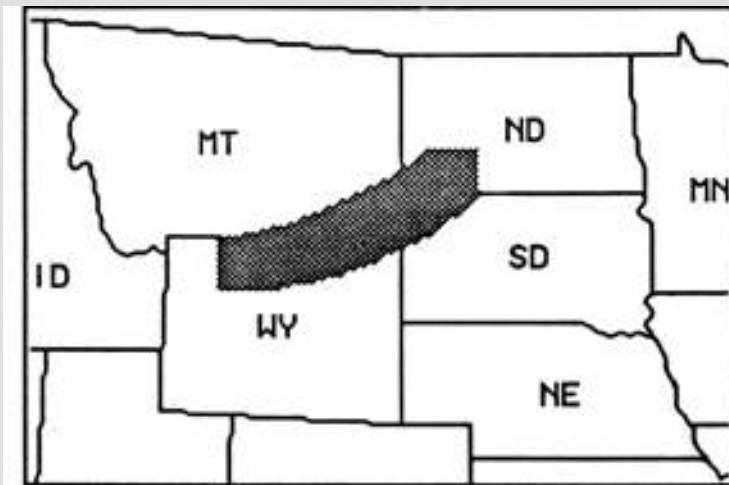


# Introduction to the Forsyth Cobble

- ▶ Found in the Yellowstone River by NDSU Alumnus Levi Moxness
- ▶ Have been labeled as Flaxville Cobbles, although they are not in the Flaxville Formation, located in Northeastern Montana (Leckie, D. 2006).
- ▶ Source of the Cobbles in the Yellowstone River is believed to be the Absaroka Mountains

# Background

- ▶ Source of the Chalky Buttes cobbles is unknown
- ▶ Two main hypotheses are debated
  - ▶ Transport from the Absaroka-Beartooth region of Wyoming and Montana
  - ▶ Transport from the northern Black Hills



Photos from: Clausen, 1986

# What do We Want to Know?

- ▶ We want to determine if the cobbles have a similar composition
- ▶ If the cobbles are similar it is possible they could be from the same source



# Methods

- ▶ Microscopy
  - ▶ Cut samples, high precision saw, made thin sections, sanded them down to proper thickness (30 microns)
- ▶ XRF
  - ▶ Crushed samples, made them into powder, constructed pellets
- ▶ SEM
  - ▶ Cut samples, polished, then carbon coated them

# Microscopy

- ▶ Samples appeared similar
- ▶ Both contained K-spar phenocrysts, and many smaller grains surrounding them
- ▶ Phenocrysts indicate a period of slow cooling then finished cooling quickly, indicated by the smaller grains
- ▶ Some Plagioclase is also present, but the grains are primarily K-spar

# Microscopy

Yellowstone River



Scale: 1.3 mm

Smaller  
Grains

Phenocryst

Chalky Buttes



Phenocryst

# Methods in Action





# XRF Data

- ▶ Conducted XRF analysis on two similar looking porphyries from the Chalky Buttes Member and one belonging to the “Forsyth Cobble” found in the Yellowstone River



# XRF Results

Formula	AA-84-CB	Stat. error	LLD = lower limit of detection	Formula	LM-12060	Stat. error	LLD
SiO <sub>2</sub>	68.43%	0.05%	152.3 PPM	SiO <sub>2</sub>	67.01%	0.05%	147.3 PPM
Al <sub>2</sub> O <sub>3</sub>	15.72%	0.18%	407.7 PPM	Al <sub>2</sub> O <sub>3</sub>	15.46%	0.19%	384.8 PPM
Fe <sub>2</sub> O <sub>3</sub>	0.49%	0.20%	10.8 PPM	Fe <sub>2</sub> O <sub>3</sub>	1.31%	0.13%	13.4 PPM
CaO	1.03%	0.54%	205.2 PPM	CaO	1.32%	0.52%	216.3 PPM
MgO	0.33%	1.32%	379.8 PPM	MgO	0.23%	1.38%	358.3 PPM
MnO	0.02%		8.6 PPM	MnO	0.09%	0.72%	10.2 PPM
Na <sub>2</sub> O	1.60%	2.49%	627.0 PPM	Na <sub>2</sub> O	1.82%	2.25%	599.4 PPM
K <sub>2</sub> O	11.97%	0.18%	234.5 PPM	K <sub>2</sub> O	12.30%	0.19%	234.6 PPM
P <sub>2</sub> O <sub>5</sub>	0.01%		67.2 PPM	P <sub>2</sub> O <sub>5</sub>	0.02%		65.6 PPM
TiO <sub>2</sub>	0.11%		39.7 PPM	TiO <sub>2</sub>	0.16%		42.6 PPM
	99.71%				99.70%		

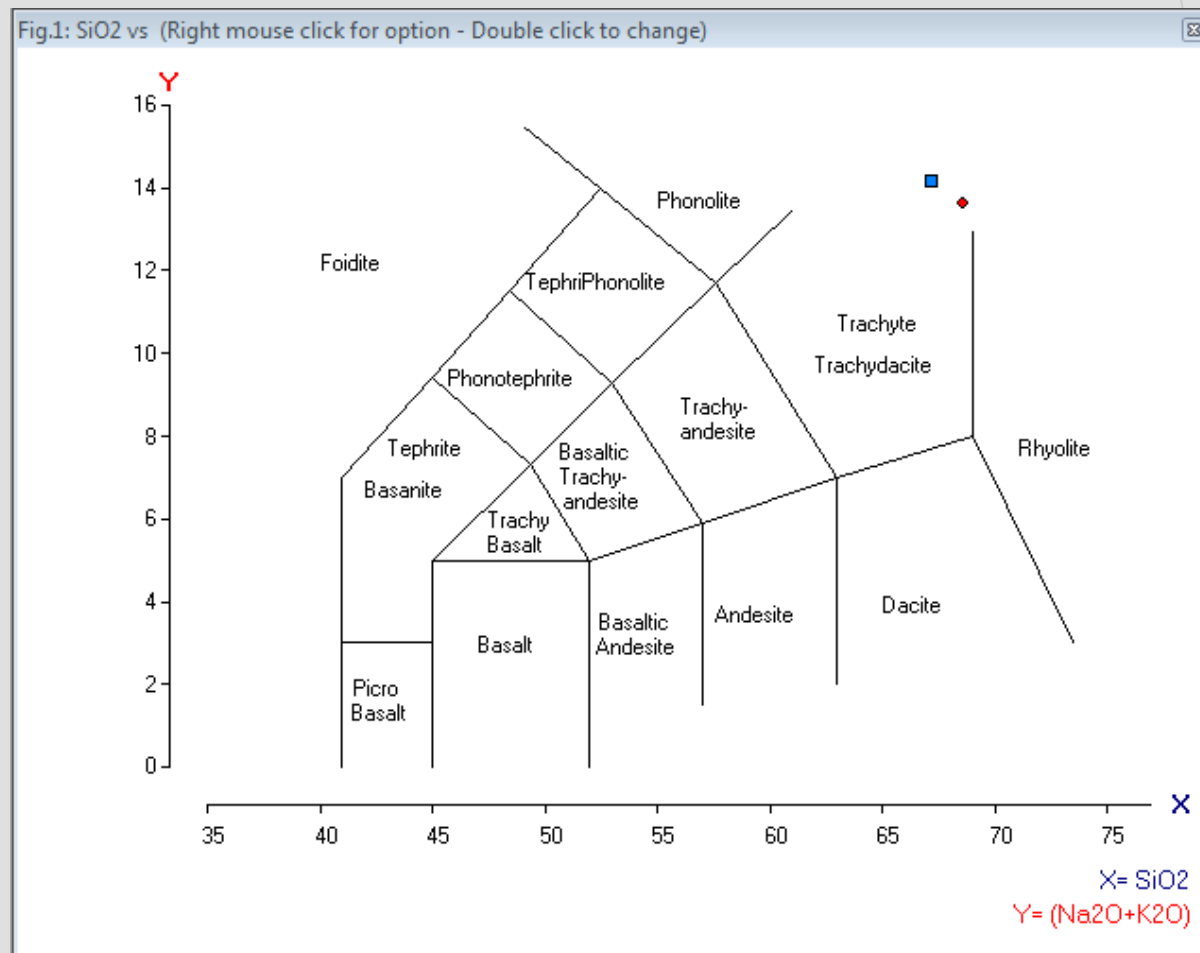
(K,Na)(Si,Al)4O8					
Molecular Weight = 274.30 gm					
<u>Potassium</u>	10.69 %	K	12.88 %	K <sub>2</sub> O	
<u>Sodium</u>	2.10 %	Na	2.82 %	Na <sub>2</sub> O	
<u>Aluminum</u>	9.84 %	Al	18.59 %	Al <sub>2</sub> O <sub>3</sub>	
<u>Silicon</u>	30.72 %	Si	65.71 %	SiO <sub>2</sub>	
<u>Oxygen</u>	46.66 %	O			
	<hr/>		<hr/>		
	100.00 %		100.00 %	= TOTAL OXIDE	
K <sub>0.75</sub> Na <sub>0.25</sub> AlSi <sub>3</sub> O <sub>8</sub>					

Sanidine

From: Webmineral.com

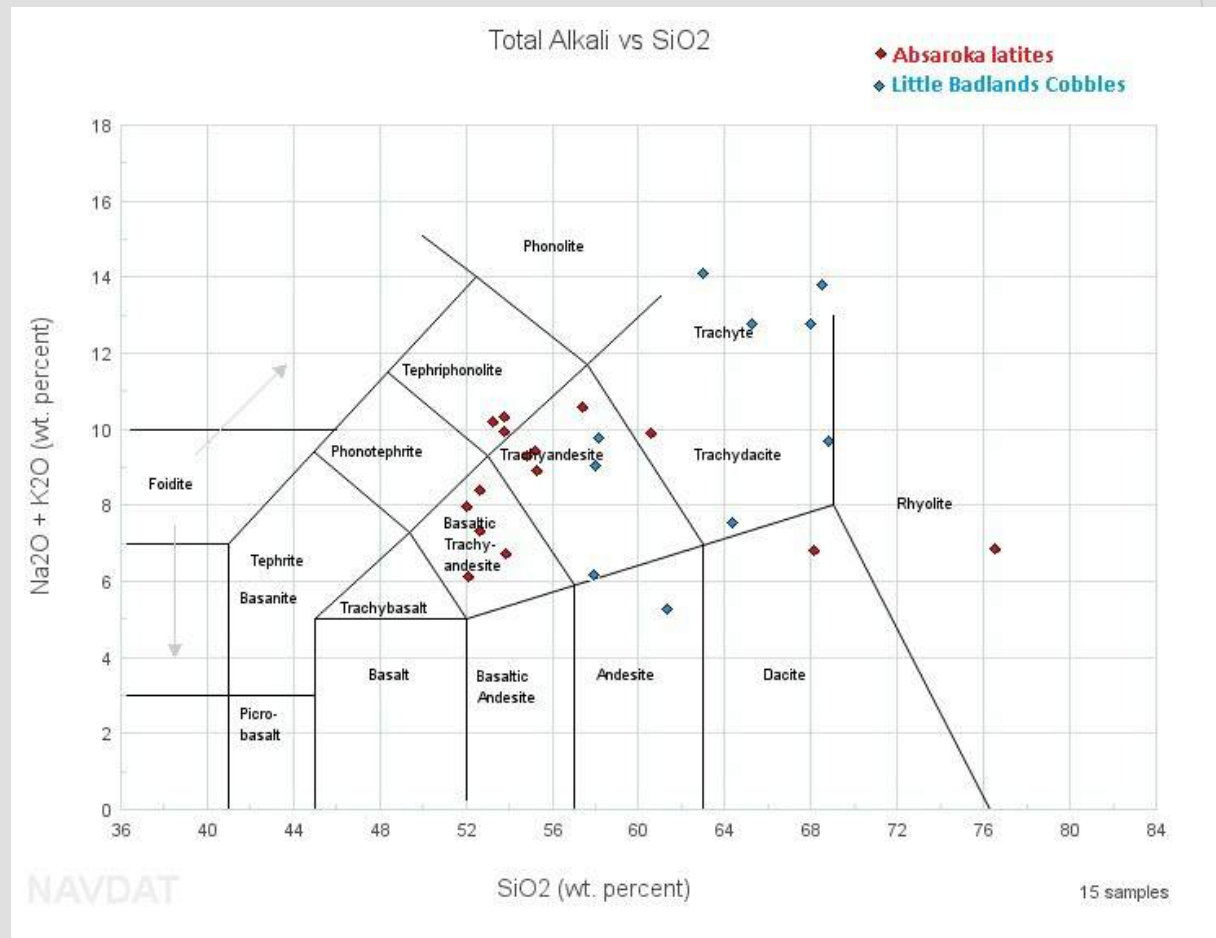


# TAS Diagram



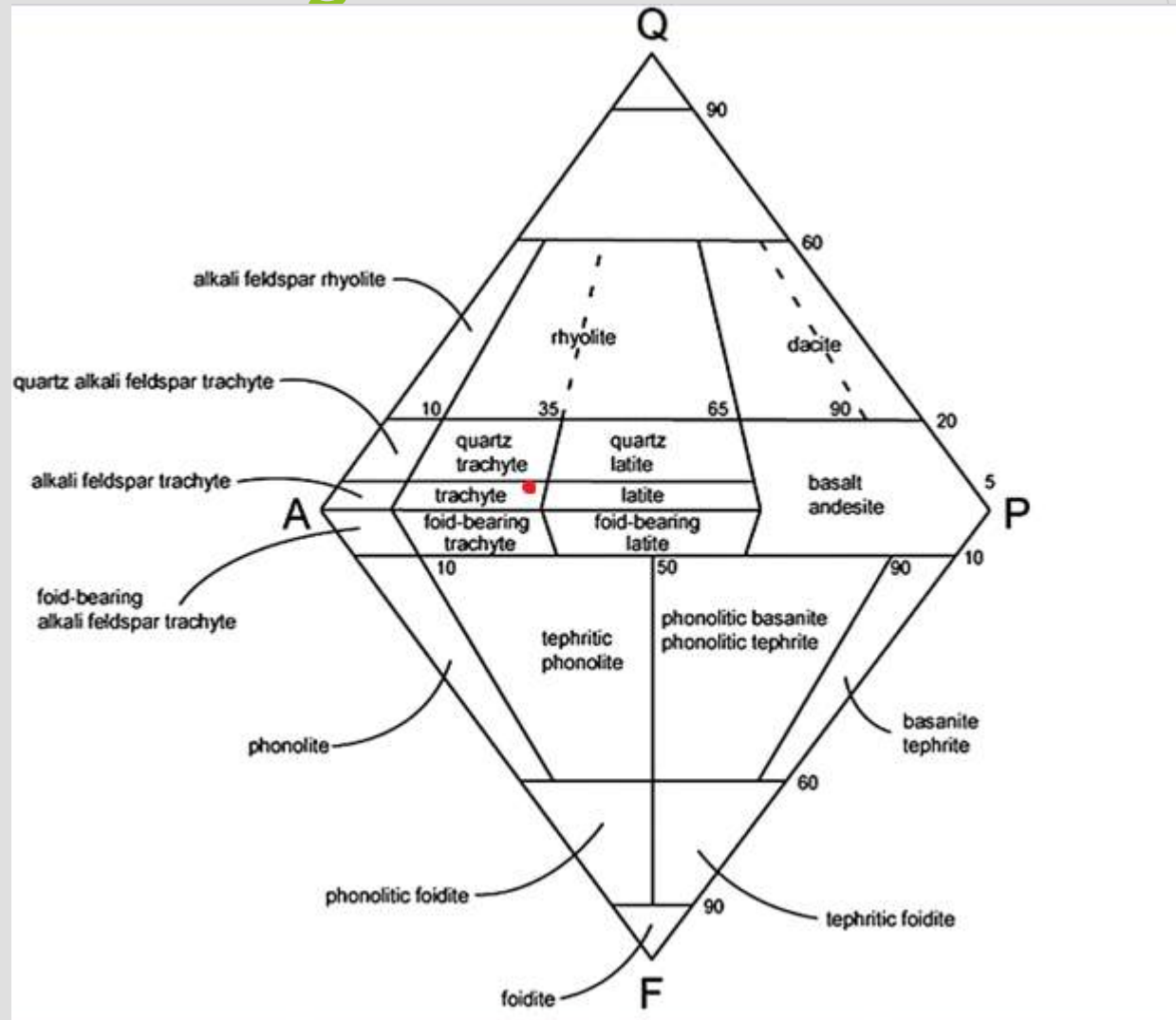
Red- Chalky Buttes Blue- Forsyth

# Data From Previous Research

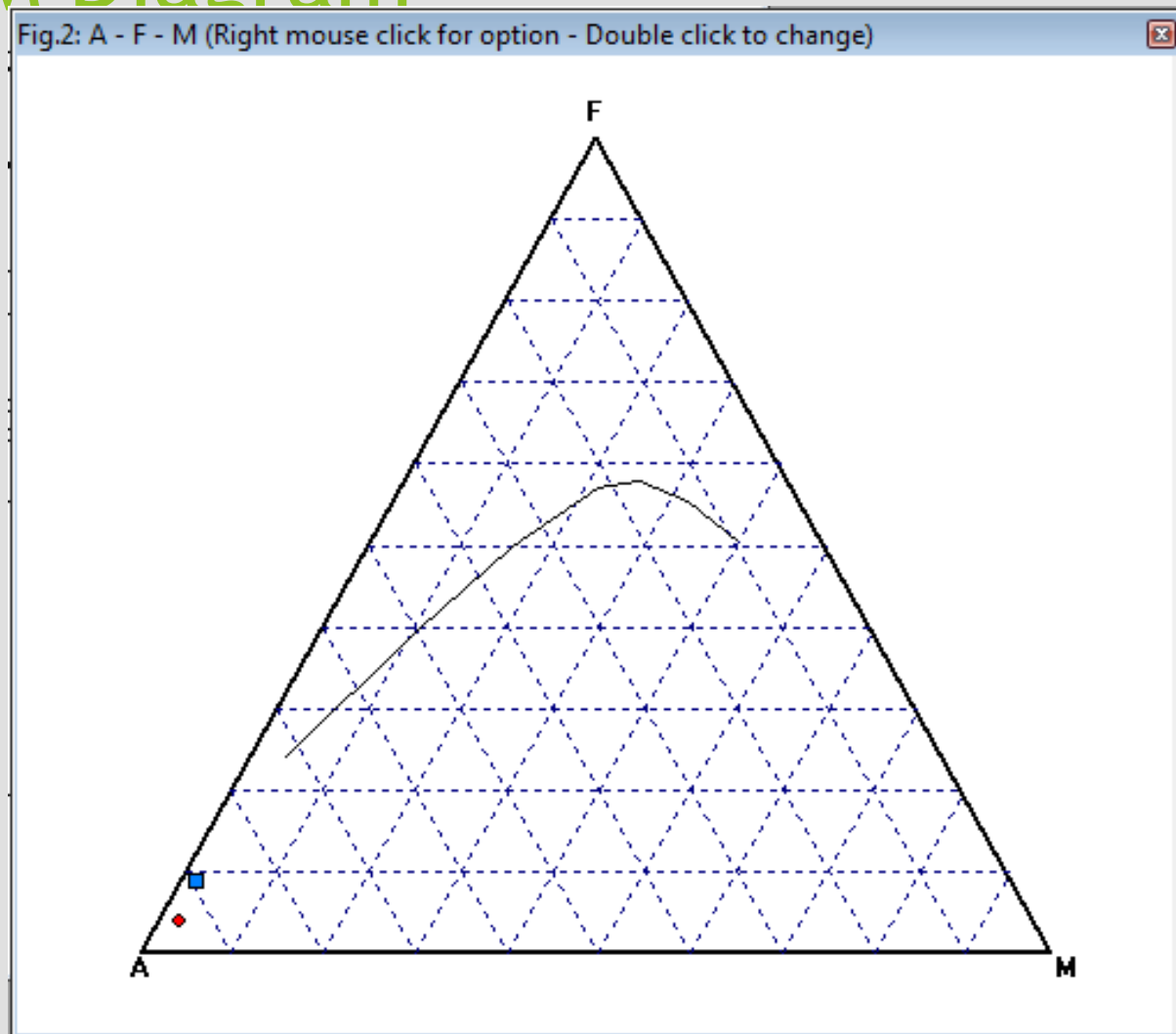


Taken from: Moxness, Levi, 2012

# QAPF Triangle



# AFM Diagram

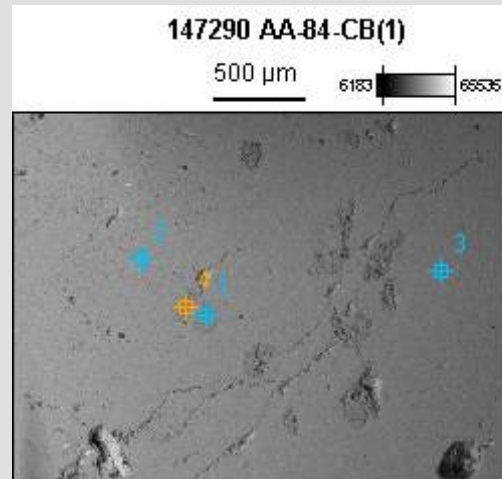


Red- Chalky Buttes

Blue- Forsyth

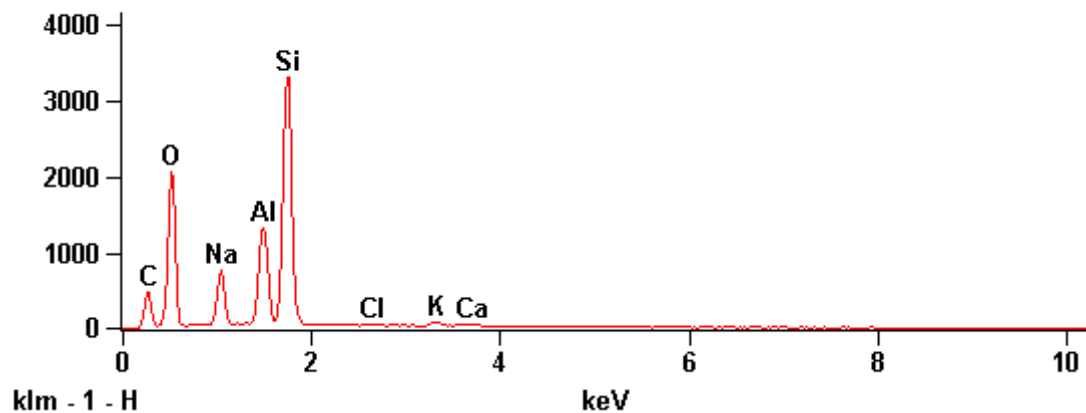
# SEM Results (AA-84-CB)

(Chalky Buttes)



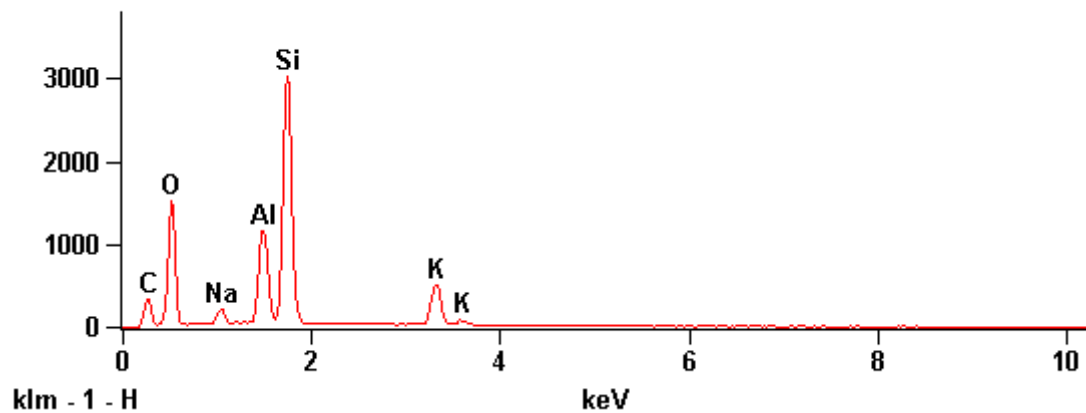
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147290 AA-84-CB(1)\_pt1



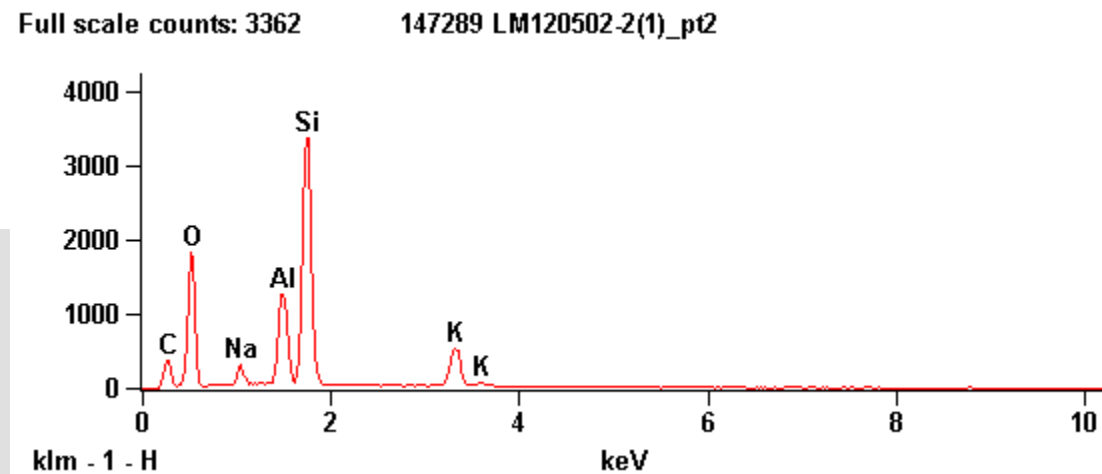
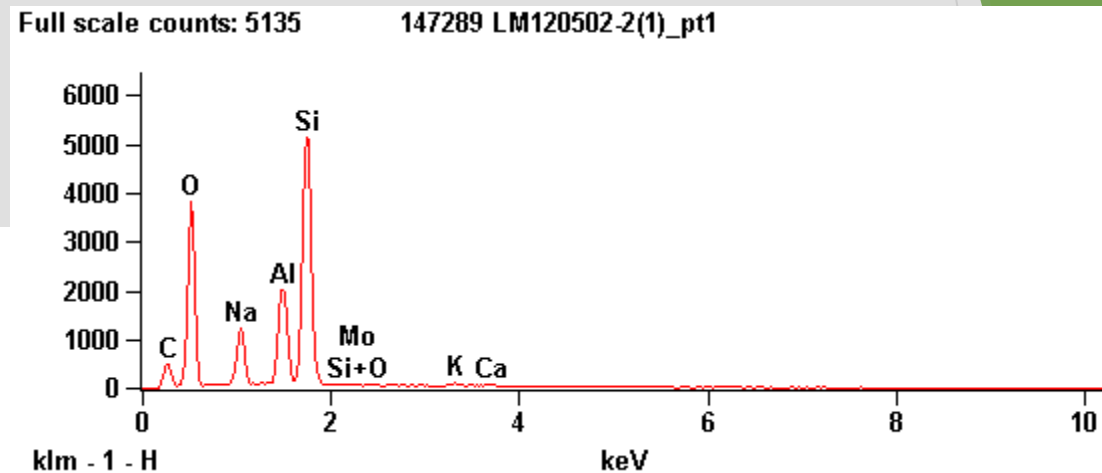
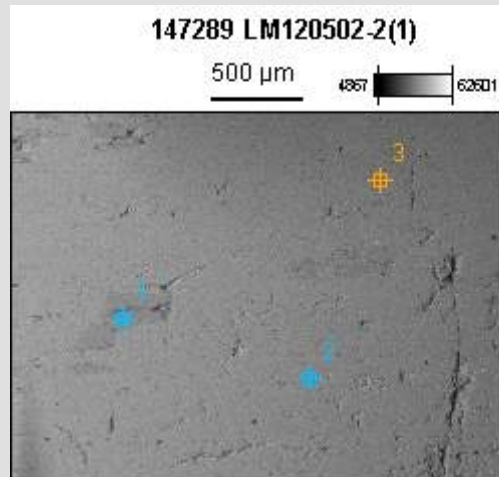
Full scale counts: 3021

147290 AA-84-CB(1)\_pt3



# SEM Results (LM-120602-2)

(Yellowstone River)





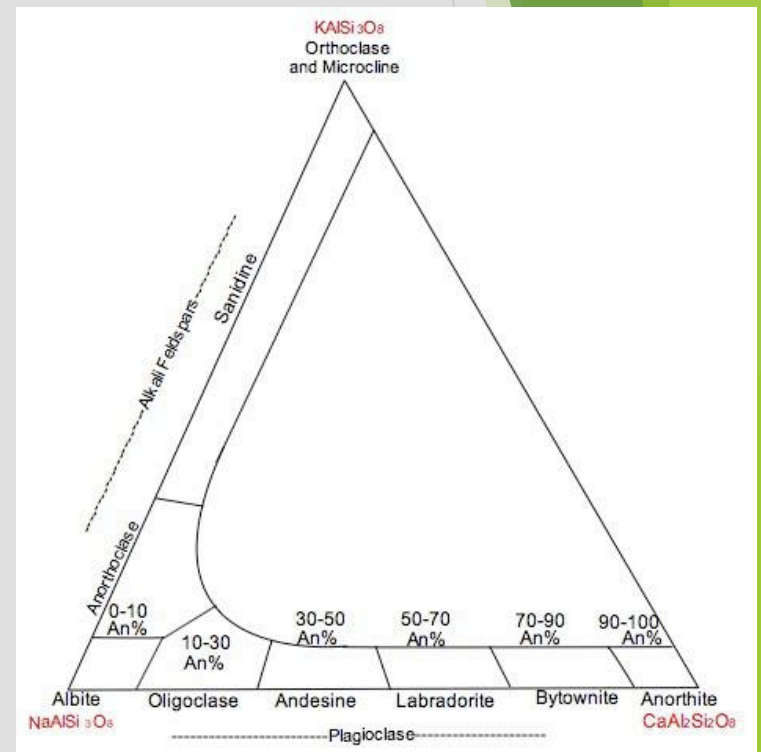
# SEM Results Comparison

	Basis of 8 Oxygens											
	Si	2.90	2.99	2.97	2.90	3.02	2.97	4.00	2.75	2.50	2.98	2.36
	Al	1.03	0.99	1.04	1.04	0.95	1.01	0.00	1.53	1.85	1.01	2.07
	MgO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.04	0.00	0.02
	Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00
Totals		3.93	3.99	4.00	3.94	3.97	3.98	4.00	4.57	4.40	3.99	4.46
	Na	1.11	0.34	0.32	1.07	0.00	0.38	0.00	0.00	0.00	0.40	0.06
	K	0.07	0.70	0.70	0.07	1.06	0.71	0.00	0.25	0.44	0.66	0.28
	Ca	0.07	0.00	0.00	0.06	0.00	0.00	0.00	0.08	0.00	0.00	0.00
Totals		1.24	1.04	1.02	1.21	1.06	1.09	0.00	0.33	0.44	1.07	0.34
Monty												

Basis of 8 Oxygens						
Si	2.91	3.00	3.00	2.95	2.98	2.98
Al	1.02	0.99	0.97	1.01	0.99	0.99
Totals	3.94	3.98	3.98	3.96	3.97	3.98
Na	1.15	0.38	0.45	1.09	0.44	0.38
K	0.05	0.68	0.61	0.09	0.66	0.70
Ca	0.04	0.00	0.00	0.00	0.00	0.00
Totals	1.24	1.06	1.06	1.18	1.10	1.09
Wilcox						

# SEM Results Comparison

- ▶ Both contained Alkali feldspar, most likely Sanidine
- ▶ Within the Sanidine there was also Albite
- ▶ Commonly form together



# Results

- ▶ Microscopy, XRF, and SEM data are all quite similar
- ▶ Not perfect, but we would not expect them to be
- ▶ Could make the argument that they come from the same source

# Conclusions

- ▶ It is possible they come from the same source material
- ▶ Can not say for sure
- ▶ The Yellowstone cobble could have simply been reworked by the Yellowstone River
- ▶ It does help to rule out the Black Hills as a source
- ▶ Further research needed

# Further Research

- ▶ Age dating on the cobbles using Zircon crystals
- ▶ These are just two cobbles, need to compare many more

# Sources

- ▶ Clausen, E. 1986. Origin of Quartz Latite Porphyry Cobbles found at base of White River Group Sediments in Southwestern North Dakota. NDGS 1986 Fieldtrip Guidebook. pp. 41-45.
- ▶ Leckie, D. A., 2006. Tertiary fluvial gravels and evolution of the Western Canadian Prairie Landscape. Elsevier, Amsterdam.
- ▶ Moxness, L. 2012. Provenance of cobbles from the Chalky Buttes Member of the Chadron Formation, southwestern North Dakota. (unpublished)
- ▶ Web Mineral. Sanidine Mineral Data. [webmineral.com](http://webmineral.com)



**ARE THERE**



**ANY QUESTIONS?**

[DFTLOL.COM](http://DFTLOL.COM)