ANTARCTICA XENOLITHS: ANALYSES OF VOLCANIC HOST ROCK

NOAH STROM


South Orkney Is
Signy (UK)
Antarctic Circle 66°34'S
KONG HÅKON VII HAV
SOUTHERN OCEAN
South Shetland Is
ANTARCTIC PENINSULA
WEDDELL SEA
BRUNT ICE SHELF
Halley (UK)
FIMBULISEN
Fimbulheimen
DRONNING MAUD LAND
Thorshavnheine
ENDERBY LAND
Scott Mtns
KEMP LAND
Anvers I
Palmer (USA)
LARSEN ICE SHELF
COATS LAND
Dome Fuji (Valkyrie)
Adelaide I
Rothera (UK)
FILCHNER ICE SHELF
Berkner Island
Shackleton Range
MACROBERTSON LAND
Prince Charles Mtns
AMERY ICE SHELF
Prydz Bay
PALMER LAND
RONNE ICE SHELF
Alexander I
EAST ANTARCTICA
Pensacola Mts
Vinson Massif 4892m
Ellsworth Mtns
Dome Argus 4000
PRINCESS ELIZABETH LAND
BELLINGSHAUSEN SEA
Peter I Øy
Thiel Mtns
South Pole
Amundsen-Scott (USA)
WILHELM II LAND
Davis Sea
ELLSWORTH LAND
Whitmore Mtns
Transantarctic Mountains
WEST ANTARCTICA
Queen Maud Mtns
Queen Elizabeth Range
Subglacial Lake Vostok
QUEEN MARY LAND
SHACKLETON ICE SHELF
3000
AMUNDSEN SEA
Executive Committee Range
MARIE BYRD LAND
Queen Alexandra Range
80°S
WILKES LAND
ROSS ICE SHELF
Dome Circe
2000
McMurdo (USA)
Mt Erebus
VICTORIA LAND
70°S
TERRE ADÉLIE
GEORGE V LAND
ROSS SEA
OATES LAND
Dumont d'Urville Sea
Balleny Is
60°S

LOCALITY

- McMurdo Volcanic Group composed of four different provinces
- Balleny Volcanic, Hallett Volcanic, Melbourne Volcanic, Erebus Volcanic
- Ross Island
- Mt. Erebus Province
- Rift System

(Orlando et al., 2000)

LOCAL GEOLOGY

- Series of Faults between Transarctic Mountains and Ross Sea
- Alkali volcanics found in intra-plate environments
- Continental Rift System
- Active Volcanism at Mount Erebus today
- Ultramafic Xenoliths common in the Erebus Province
- Composed of the mineral Olivine

(Kyle et al., 1987) (Kyle and Cole, 1974)

GUIDING QUESTION

- WHAT IS THE COMPOSITION OF THE MATRIX THAT THESE OLIVINE XENOLITHS ARE FOUND?

SAMPLES

- Collected by Allan Ashworth and Spencer Salmon
- Ross Island, Antarctica
- Late Cenozoic
- Near McMurdo Research Station
- GPS: 77.84◦ S 166.67◦ E
- Hand Samples: Large green xenoliths in black porous matrix

PHOTOS OF THE THIN SECTION AND HOST SAMPLE

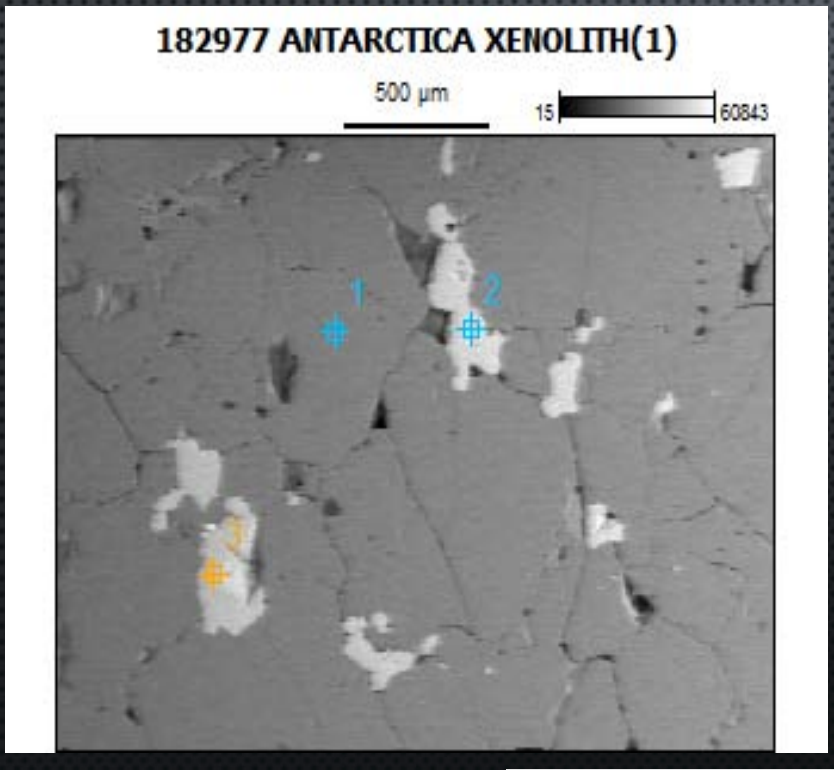
METHODS – PREPARATION FOR SEM

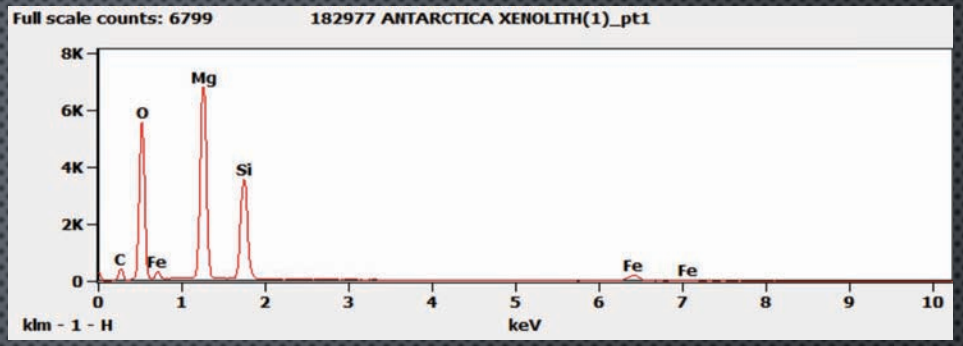
- 1 thin section was made
- Sample was cut with the NDSU Rock Saw
- Impregnated with epoxy
- Heated to 105◦ C to reduce viscosity for 5 minutes
- Placed in a vacuum to saturate the sample further
- Glued onto a thin section slide with epoxy (10:3 ratio)

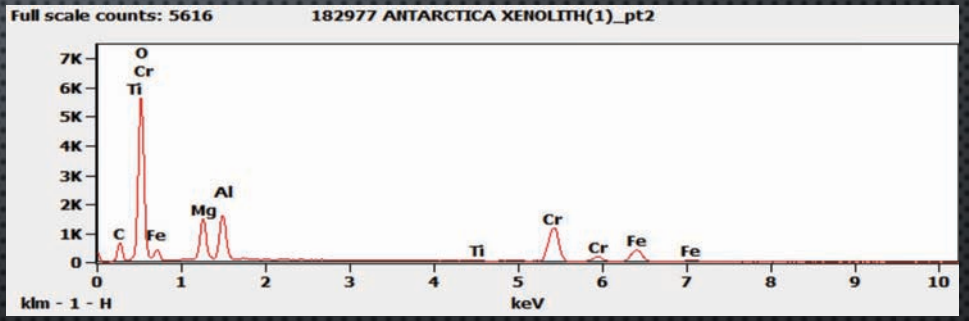
METHODS – PREPARATION FOR SEM

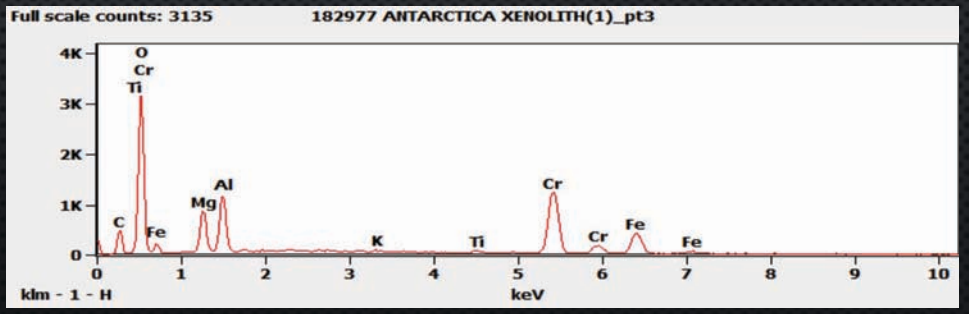
- Was cut and grounded down even further with the Buehler machine at NDSU Soil Sciences
- Polished with 600 grit and 1000 grit
- Polished even further to 1 micron and 0.25 microns with water and diamond grit added
- Cleaned with the Ultra Sonic Machine
- Thin section was polished enough to move on to the SEM machine
- Carbon coated with coating machine

SEM DATA - XENOLITH

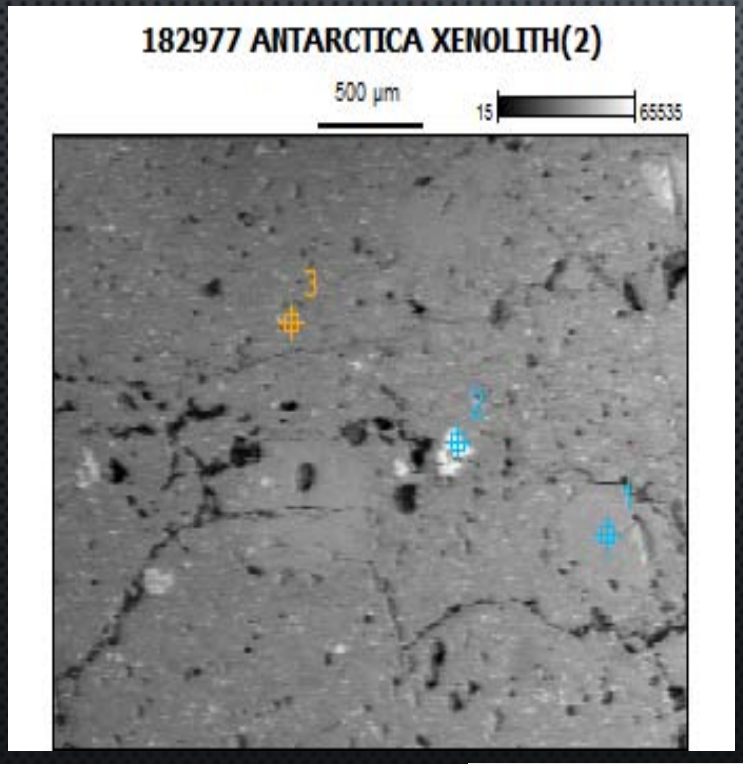


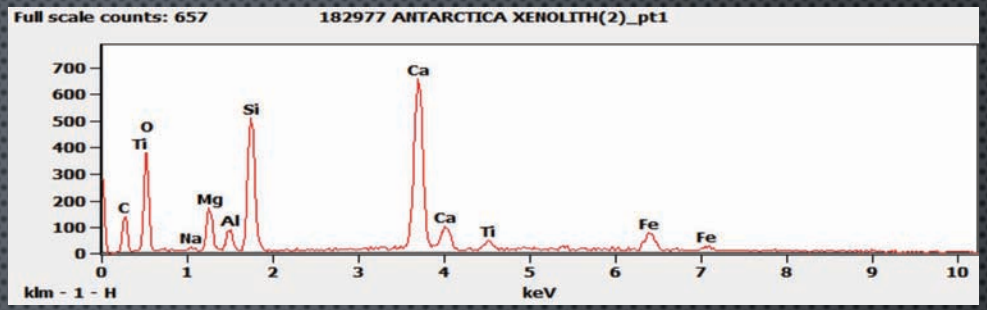


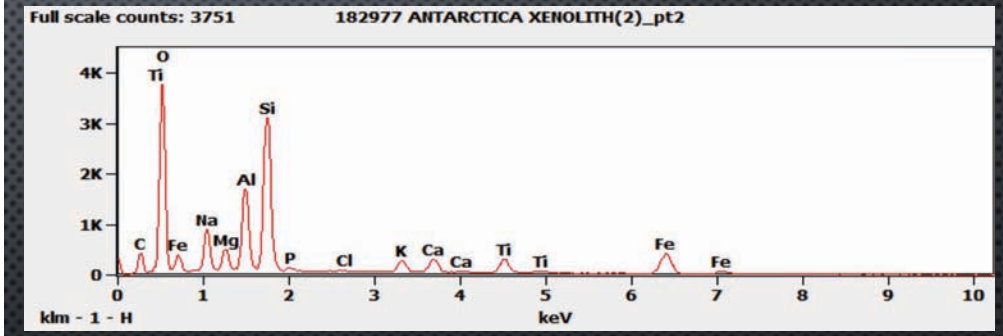


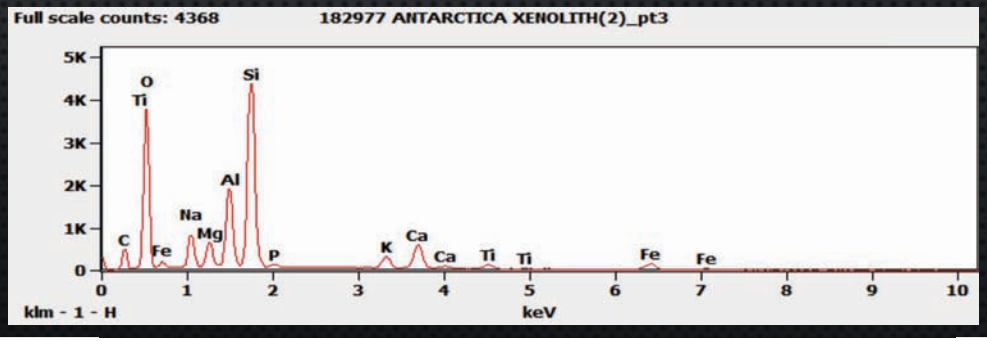


SEM DATA - MATRIX

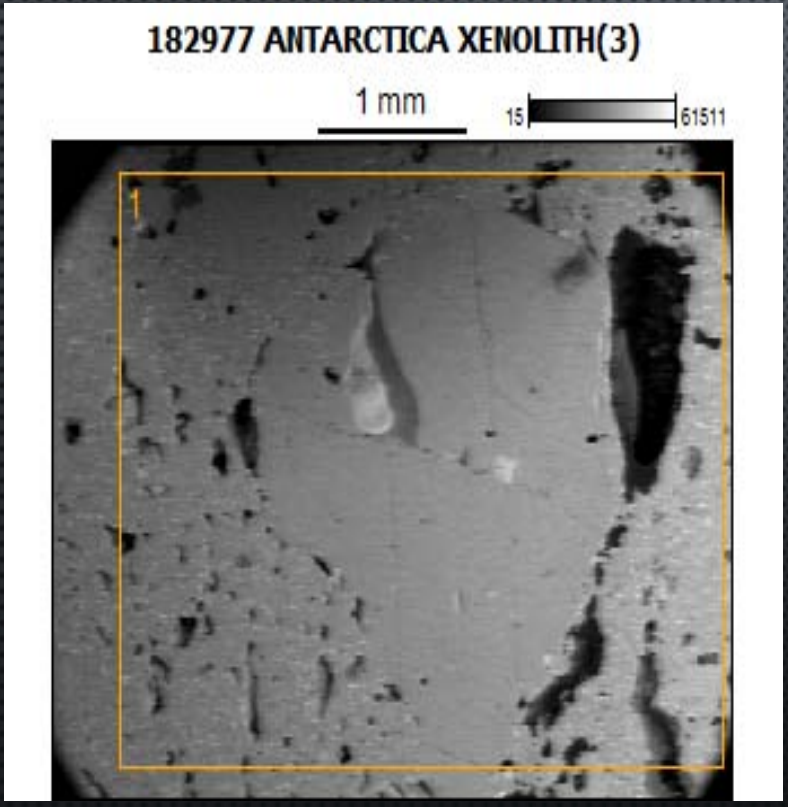


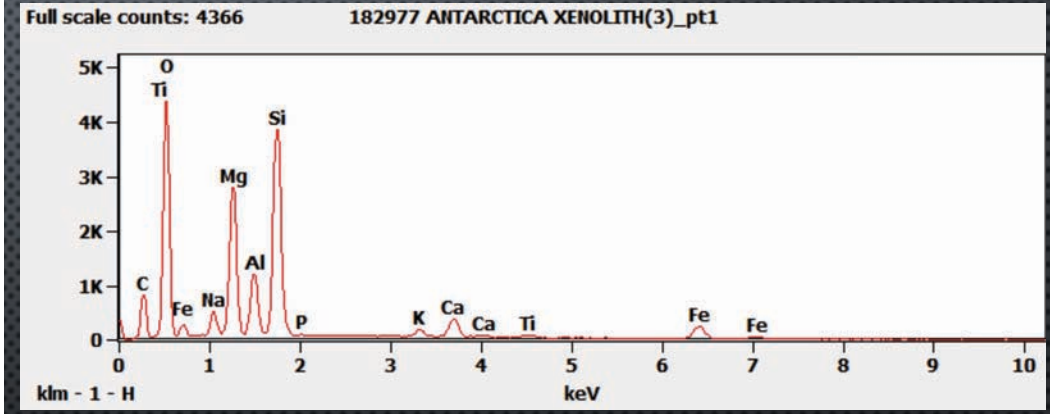






SEM DATA – CRYSTAL AND MATRIX





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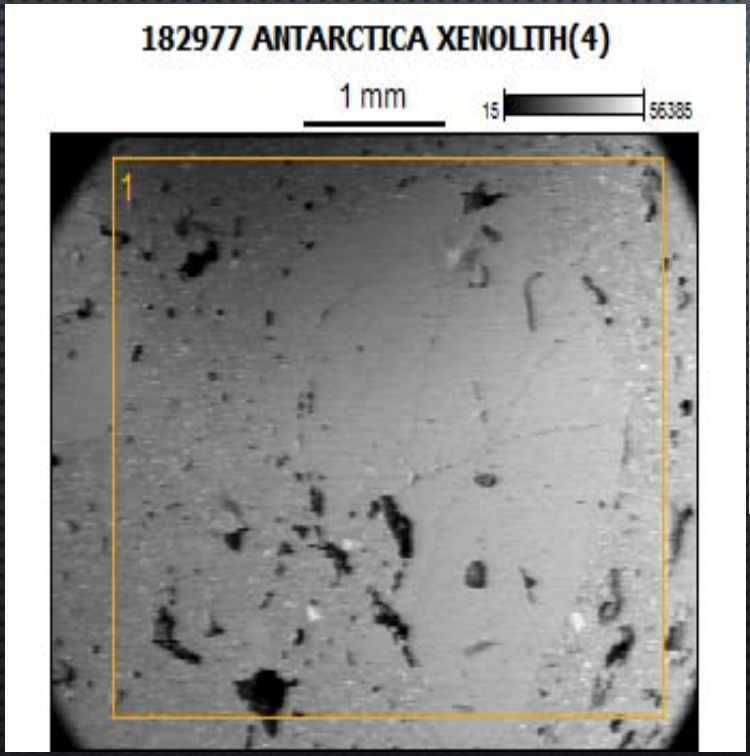
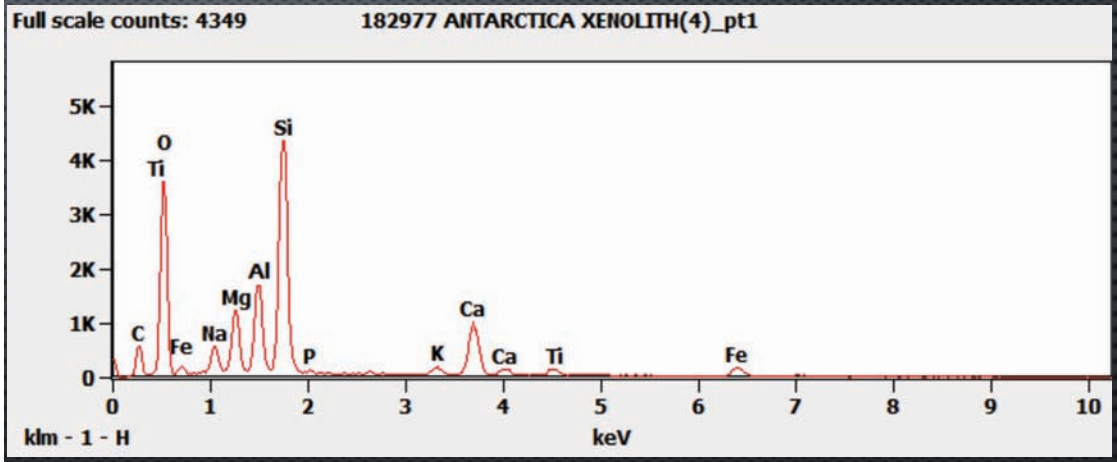




CALCULATIONS

- Xenolith point 1
- Olivine (Mg_2SiO_4)

	Atomic %	Ideal
Mg	26.72	2/7 = 28%
Fe	3.56	2/7 = 28%
Si	15.01	1/7 = 14.3%
O	54.71	4/7 = 57.1%

ANALYSES

	Volcanic host rocks				Granulite xenoliths	
wt%	BUH	HM34A	SC21A	FOC71B	HM31B	MH31C
SiO_2	43.17	43.34	42.28	43.29	48.36	47.58
TiO_2	3.45	3.74	4.36	3.74	0.25	0.41
Al_2O_3	13.98	15.26	15.36	14.39	13.85	21.20
FeO^*	11.56	12.48	13.05	11.98	4.79	3.74
MnO	0.19	0.26	0.22	0.19	0.10	0.07
MgO	9.42	5.11	5.84	8.63	14.88	8.33
CaO	11.48	9.60	9.84	11.19	16.23	15.71
Na_2O	3.17	4.62	4.20	3.00	1.07	2.41
K_2O	1.04	2.24	2.15	1.24	0.07	0.15
P_2O_05	0.66	1.52	1.36	0.56	0.01	0.035
l.o.i.	0.04	−0.58	−0.57	0.13	−0.06	0.08
Total	98.16	97.59	98.09	98.34	99.55	99.74

- Samples from Hut Point Peninsula
- XRF Data (Kyle et al., 1987)
- Analyses of volcanic host rocks to granulite xenoliths from McMurdo Sound, Antarctica.

CALCULATIONS

Element	Weight %	Atomic Weig	Moles/Eleme	Ratio	Moles/Oxy	Grams Oxy	Wt % Oxide	Oxide
Na	4.66	22.99	0.2026968	0.50	0.1013484	1.6215746	6.2815746	Na2O
Mg	2.93	24.305	0.1205513	1	0.1205513	1.9288212	4.8588212	MgO
Al	8.74	26.98	0.3239437	1.50	0.4859155	7.7746479	16.514648	Al2O3
Si	23.78	28.09	0.8465646	2	1.6931292	27.090068	50.870068	SiO2
P	0.64	30.97	0.0206652	2.50	0.0516629	0.8266064	1.4666064	P2O5
K	2.86	39.1	0.0731458	0.50	0.0365729	0.5851662	3.4451662	K2O
Ca	6.51	40.08	0.1624251	1	0.1624251	2.5988024	9.1088024	CaO
Ti	2.1	47.87	0.0438688	2	0.0877376	1.403802	3.503802	TiO2
Fe	6.51	55.845	0.1165727	1	0.1165727	1.8651625	8.3751625	Feo

Weight % /
Atomic Weight

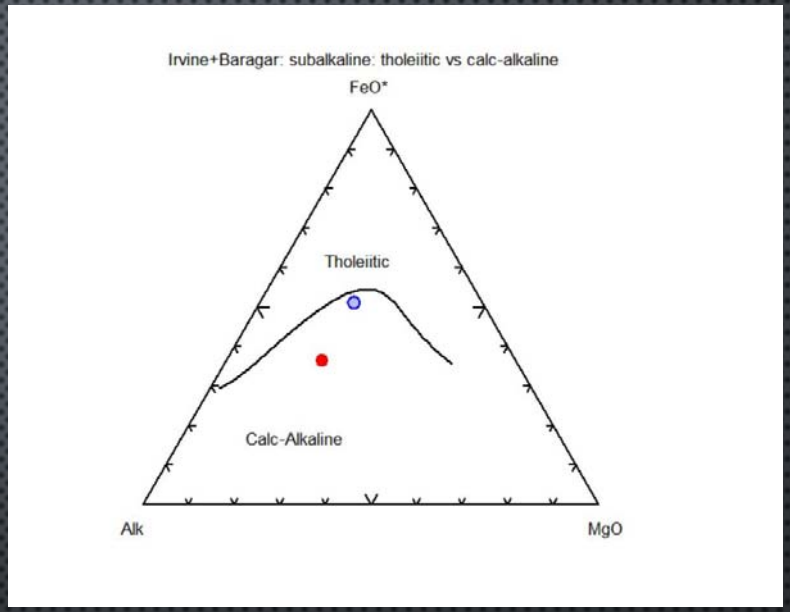
Moles * Ratio

Moles O * 16.00

Weight % + Grams

AFM DIAGRAM

- Red Dot: SEM data from Ashworth sample
- Blue Dot: Kyle and others (1987) sample
- Magma series that is high in Mg and Fe and as it fractional crystallizes becomes lower in these
- Calc-Alkaline are rich in MgO and CaO

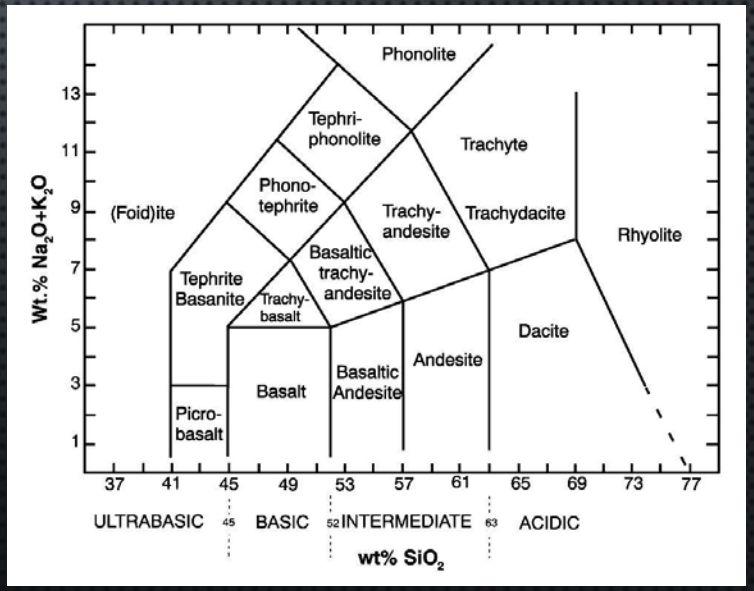


Comparison of Oxide Weight %

Sample#	SiO2	TiO2	Al2O3	FeO	MgO	CaO	Na2O	K2O	P2O5	TOTAL
red	50.8700676	3.50380196	16.5146479	8.3751625	4.85882123	9.1088024	6.2815746	3.44516624	1.46660639	104.424651
blue	43.34	3.74	15.26	12.48	5.11	9.6	4.62	2.24	1.52	97.91

SOURCE OF VOLCANIC HOST ROCK

- Alkali magmas form much deeper in the mantle
- Contain a higher amount of K_2O and Na_2O
- Rising magma interacts with continental crust through assimilation
- Continental crust contains K and Na
- Common at Intra continental Rift Systems
- Kyle and others (1987) label this to be a basanite at the Hut Point Peninsula
- Through microprobe analyses the olivine Xenoliths and basanite did not have same host magma (kyle et al., 1987)



FUTURE WORK

- XRF analyses of a bulk powder sample of the matrix
- Get more data points to plot on the AFM diagram
- Learning Experience: would have done more point and box analyses on the xenoliths

ACKNOWLEDGEMENTS

- Dr. Hopkins and NDSU Soil Sciences
- Dr. Ashworth for samples
- NDSU Electron Microscopy Lab
- Dr. Saini-Eidukat for tremendous amount of guidance

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