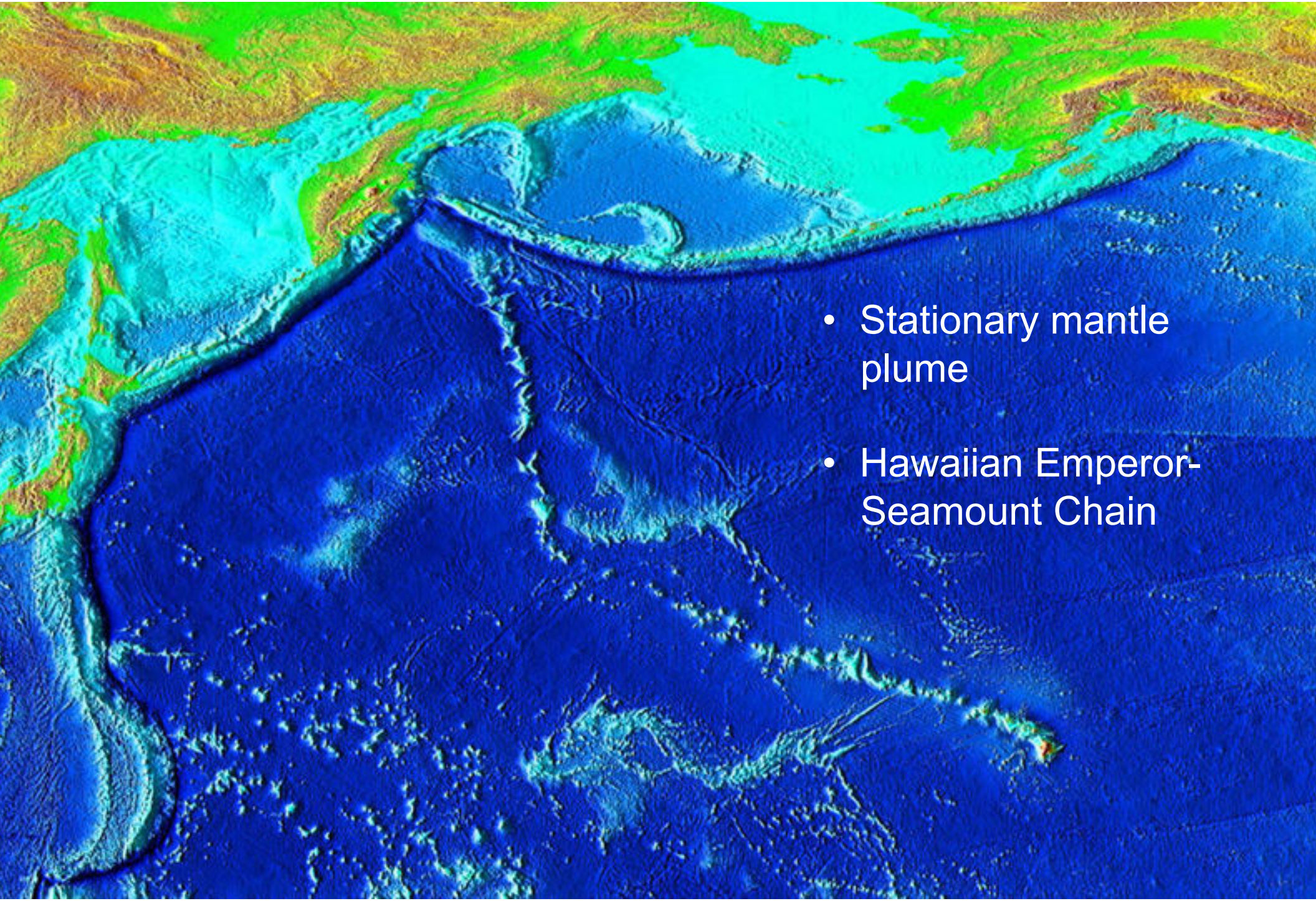
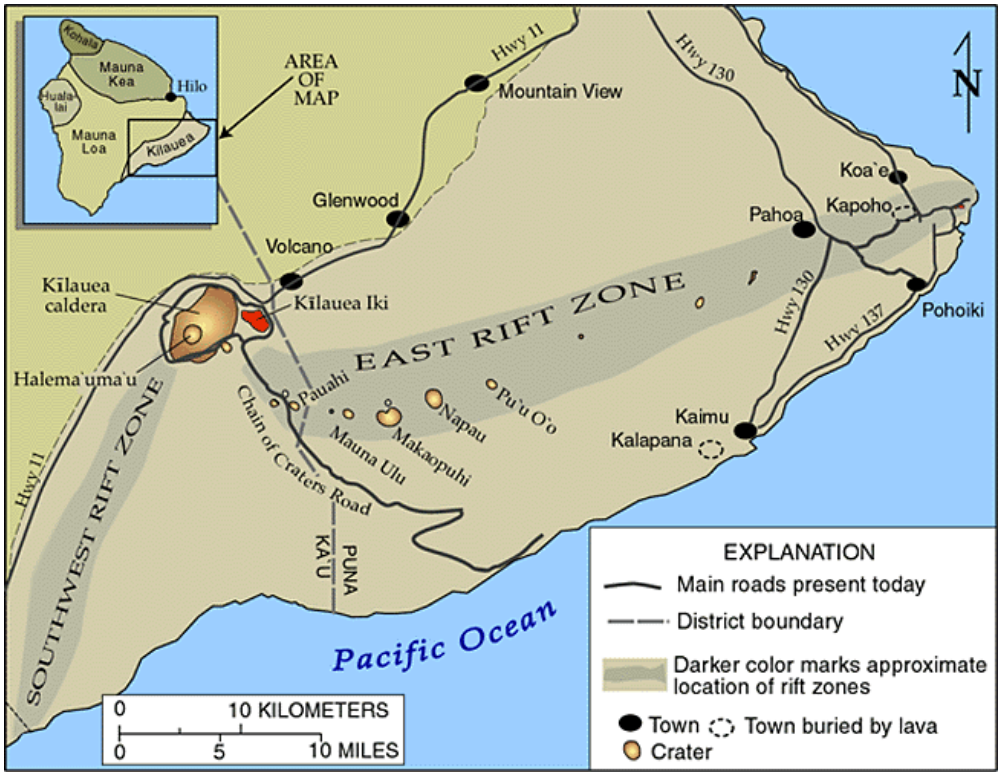
GEOCHEMICAL ANALYSIS OF FRESH KĪLAUEAN BASALT

Tyler Kuehn
Petrology 422
NDSU
April 27, 2016


• Stationary mantle plume
• Hawaiian Emperor-Seamount Chain

Kīlauea

- 1 of 5 on the Big Island
- 300,000 to 600,000 years old
- Most active
- Current eruptive center of mantle plume
- Pu'u O'o
  - Erupting since 1983



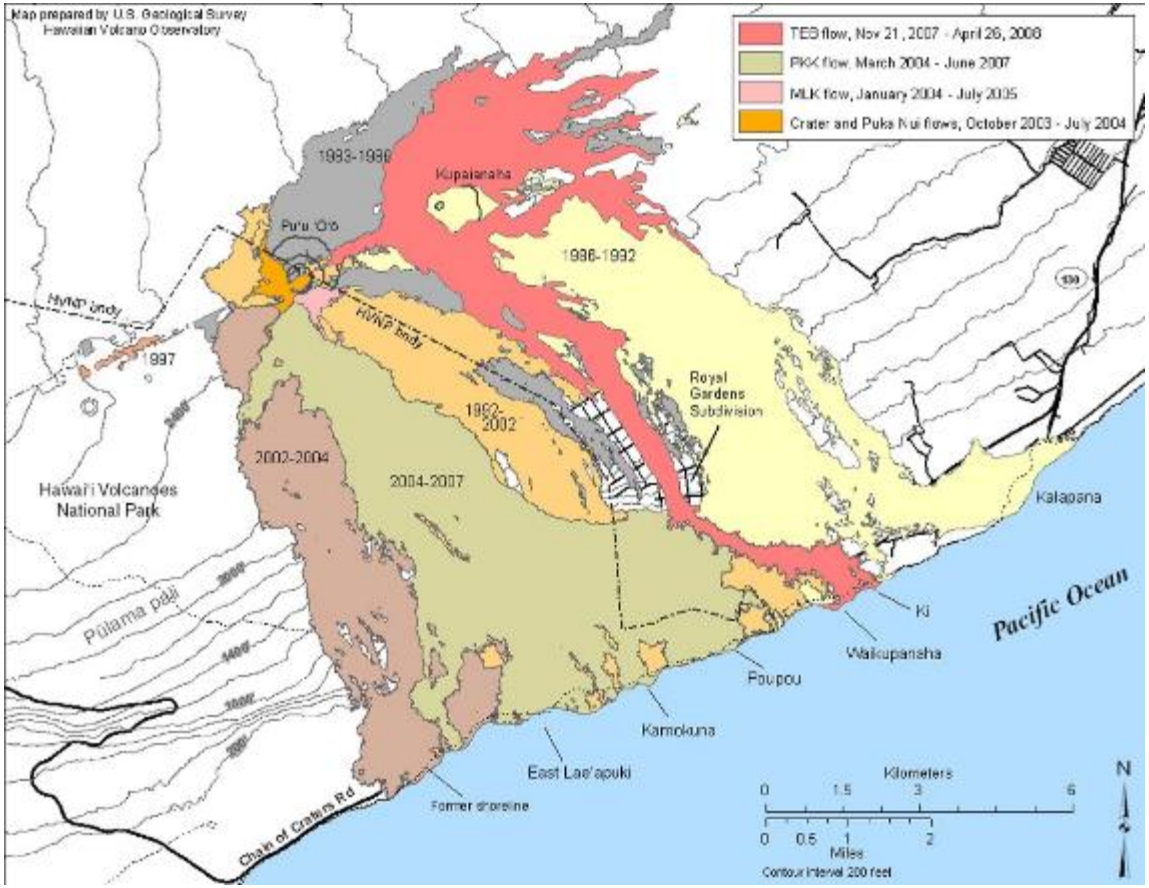
HVO/USGS

Pu'u Ō'ō - Kūpa'ianahā Eruption

- Pu'u O'o
  - Started erupting in 1983
  - High fountaining
    - 460m
- Kupa'ianaha
  - Conduit ruptured in 1986
  - Allowed for a lava lake and tube to form
  - Quiet lava flows ever since
  - Died in 1992
- Flank vents

Prince Kuhio Kalaniana'ole

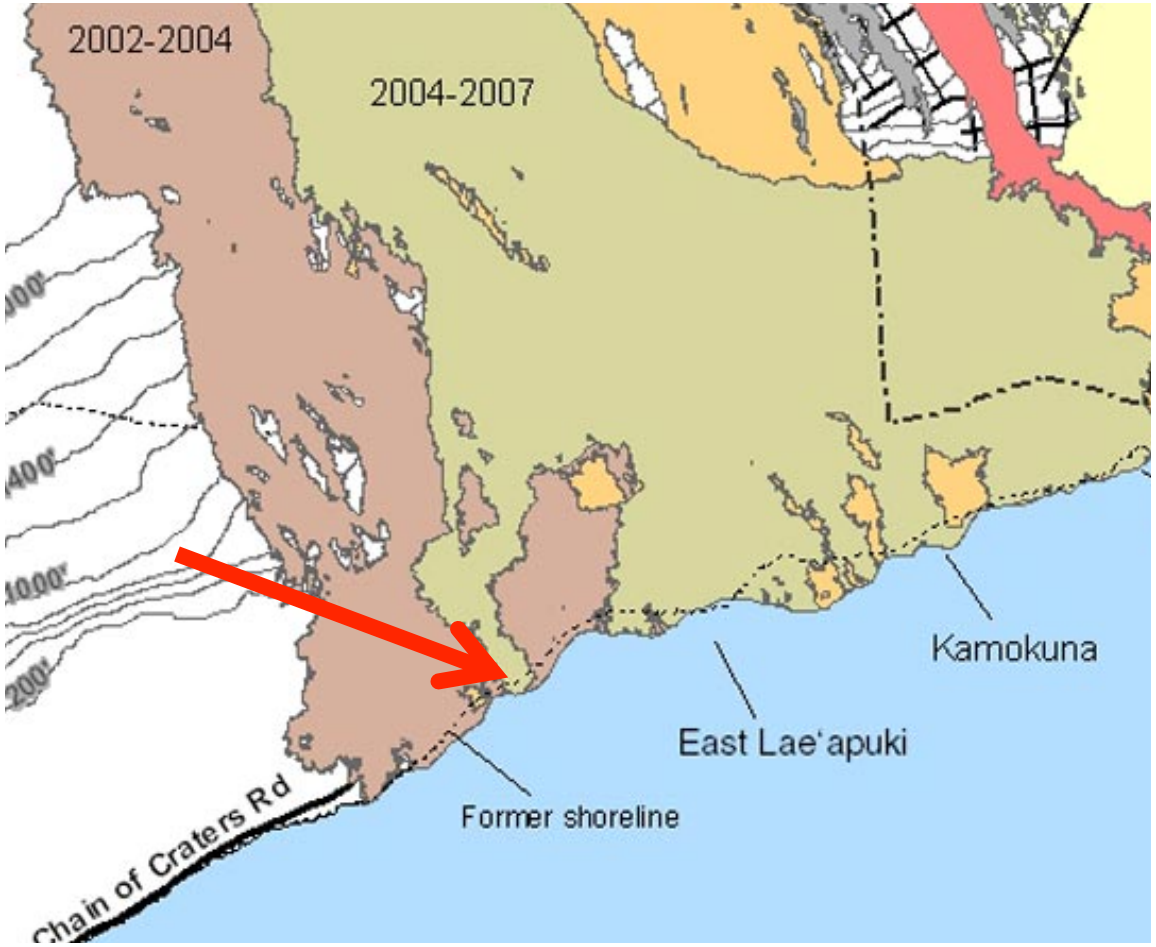
- Renewed activity in Pu'u O'o
  - March 2004
  - June 2007
  - Another breakout
- PKK event
  - Sample taken



HVO/USGS

Sample Information

- Collected in 2006
- Approximately 1-2 months old
- Side note: Pele's curse



HVO/USGS

Sample Information

- Pahoehoe
  - Thin ropy surface flow lava
  - Less viscous than A'a flows
- 4.5 cm thick
- Displays iridescence at glassy surface
- S-type pahoehoe
  - spongy

- Displays 3 zones as outlined by Winter, 2004
  - Outer glass selvage (1)
  - Transition zone (2)
  - Interior zone (3)
  - Bottom (4)

Sample Information

- Part of a gas blister
- Fourth zone
- Zoning relates to
  Cooling rates

Fig. 5. Giant gas blister forming just within the outer glassy selvage of the dense pahoehoe near the terminus of a sheet flow.

Winter, 2004

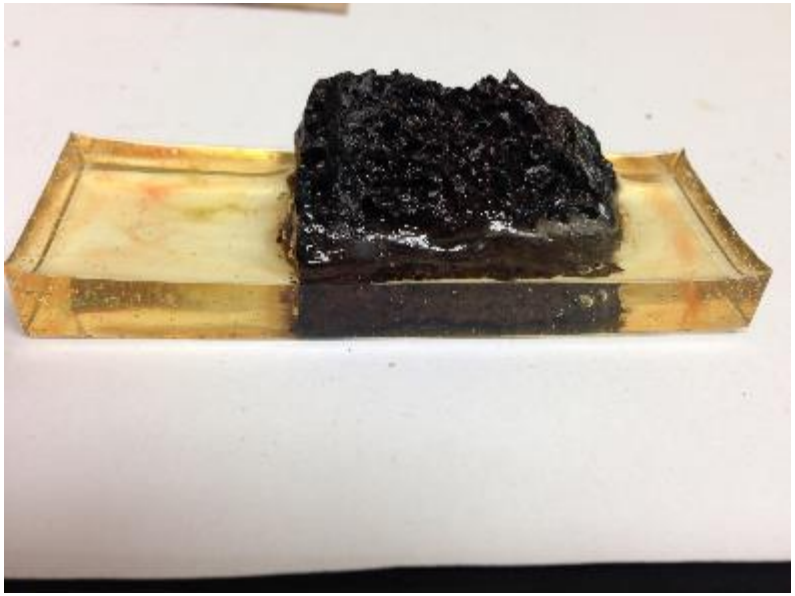
Questions

- What is the cause of the iridescence at the glassy surface?
  - Winter proposed that a higher concentration of Fe-Mg oxides could be the cause (2004)
- At what temperatures did the zones cool?
  - Geothermometry methods outlined by Winter (2004)

- Determine the mineral composition of the sample

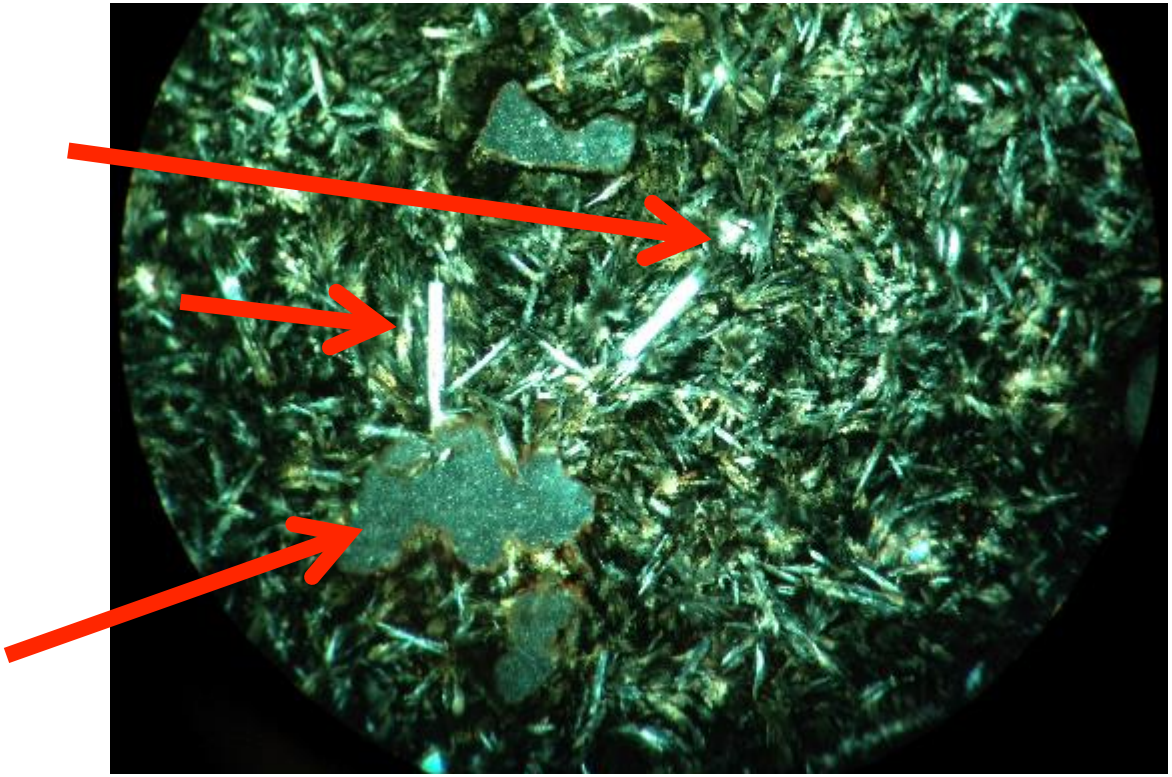
Methods

- Prepared a thin section to determine the mineral composition
  - First attempt was a failure
    - Porous, friable nature
  - 2nd attempt by impregnation of the sample of epoxy
    - Filled in void space



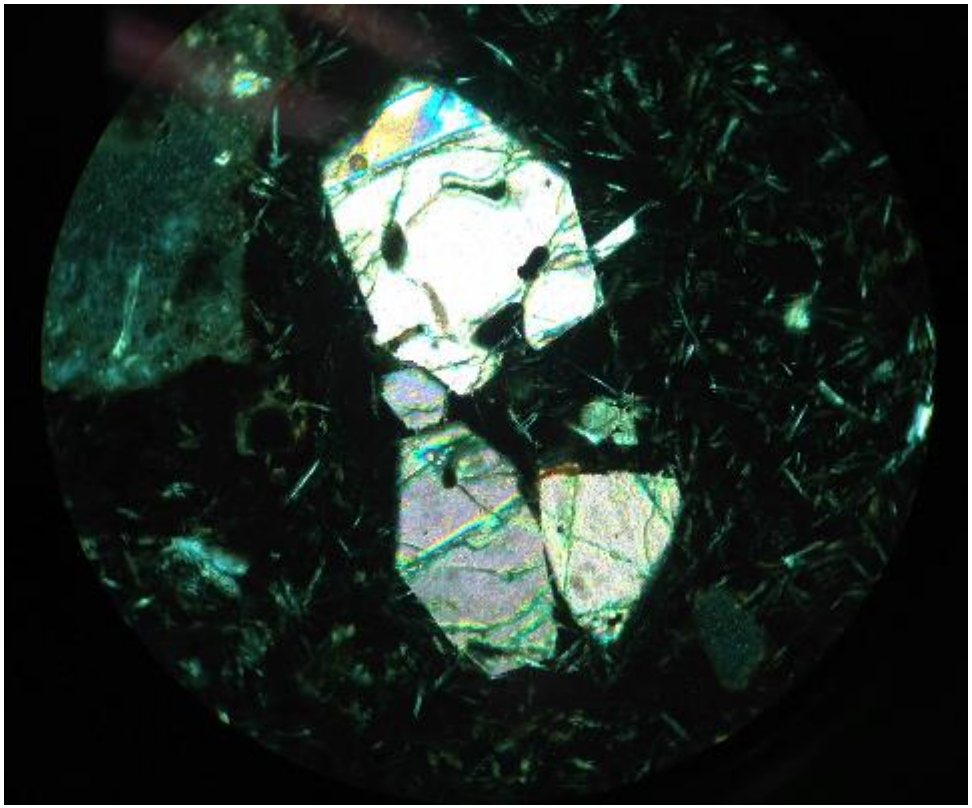
Thin Section Results

- Groundmass composed almost entirely out of plagioclase laths
- Some minor olivine crystals
- Opaque areas likely magnetite
- FOV: 2mm



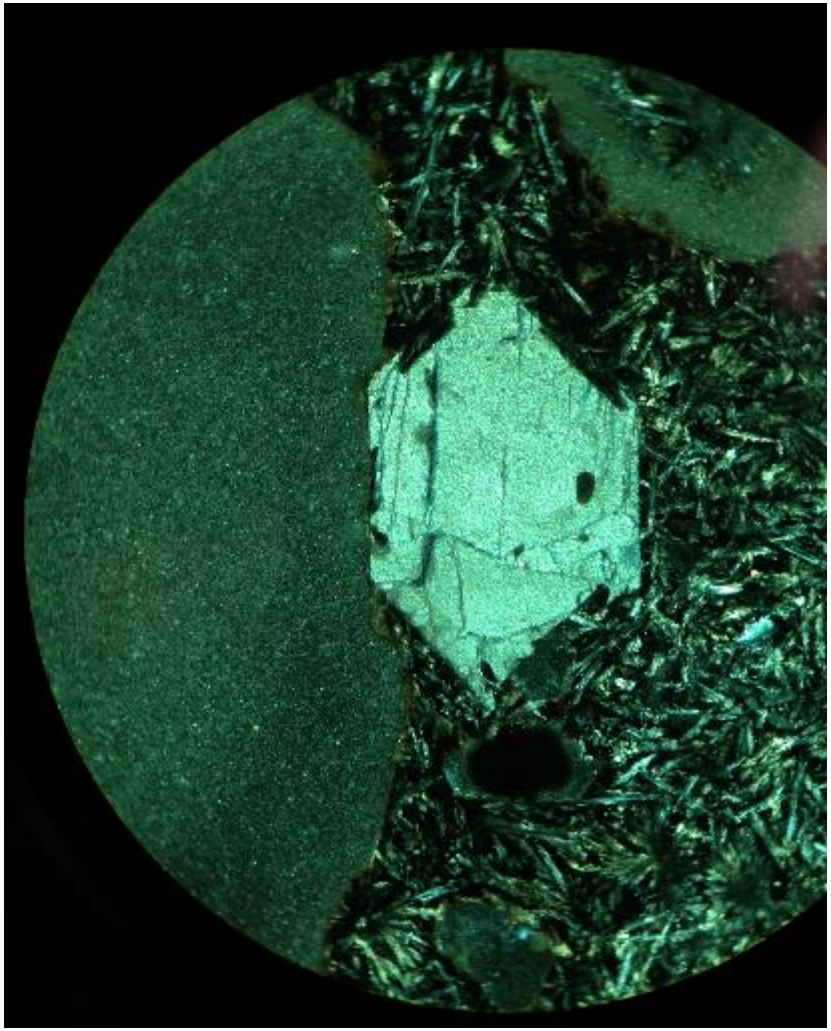
Thin Section Results

- Large Hornblende phenocrysts present
- FOV: 2mm



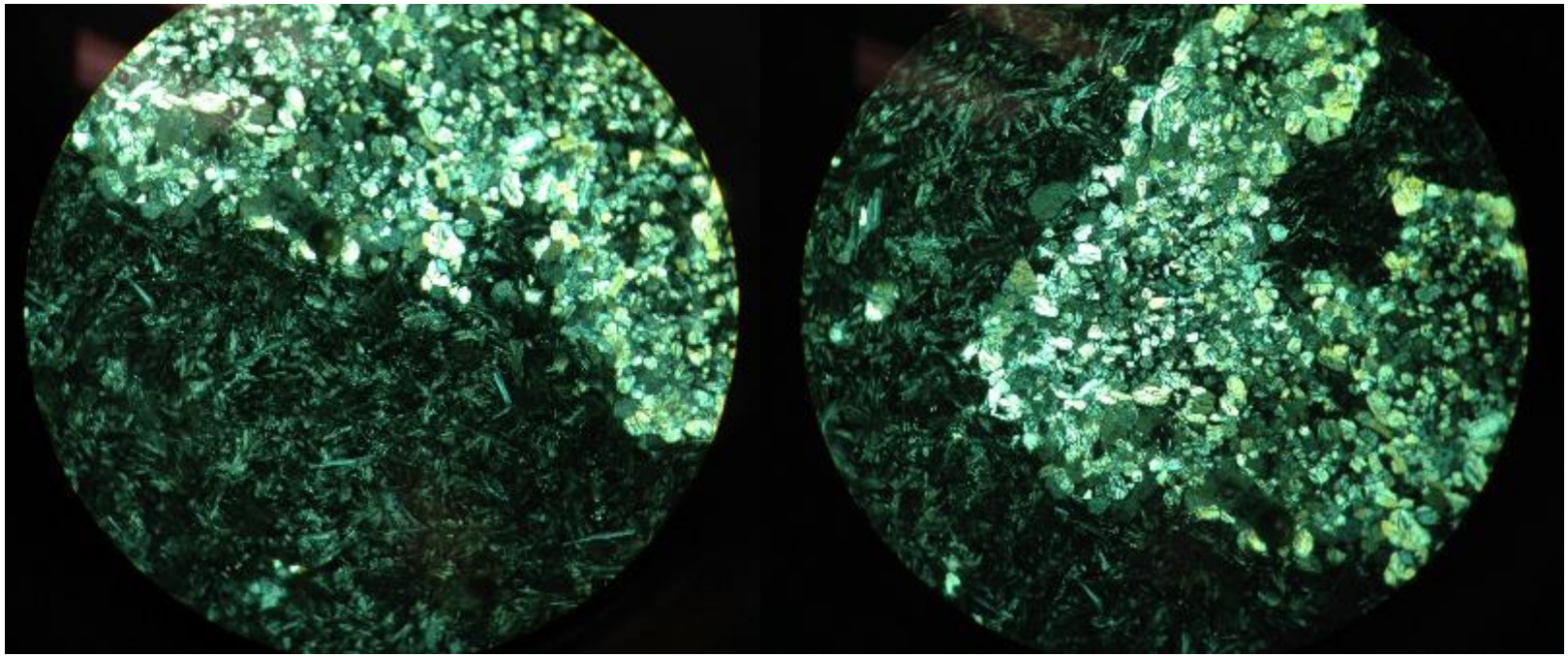
Thin Section Results

- No Spatial relationship with pore space or the 4 zones
- FOV: 2mm



Thin Section Results

- Large cluster of smaller hornblende crystals



Thin Section Summary

- Composed almost entirely out of plagioclase ~75%
- Small olivine crystals present ~5%
- Magnetite present ~5%
- Large and small prismatic hornblende crystals ~15%

XRF Analysis

- Conducted XRF to determine the cause of iridescence and geothermometry

Sample	KPP-1__18777	KPP-2__18778	KPP-3__18779	KPP-4__18780
Date	4/20/16	4/20/16	4/20/16	4/20/16
SiO2 (%)	51.4	51.9	51.9	51.9
Al2O3 (%)	11.5	11.9	12.2	12.2
Fe2O3 (%)	12.8	12.1	12.0	11.6
CaO (%)	12.6	11.8	11.8	11.5
MgO (%)	6.3	6.9	6.6	7.0
MnO (%)	0.2	0.1	0.1	0.1
Na2O (%)	2.3	2.5	2.6	2.9
K2O (%)	0.5	0.4	0.4	0.5
P2O5 (%)	0.2	0.2	0.2	0.2
TiO2 (%)	2.3	2.2	2.2	2.1

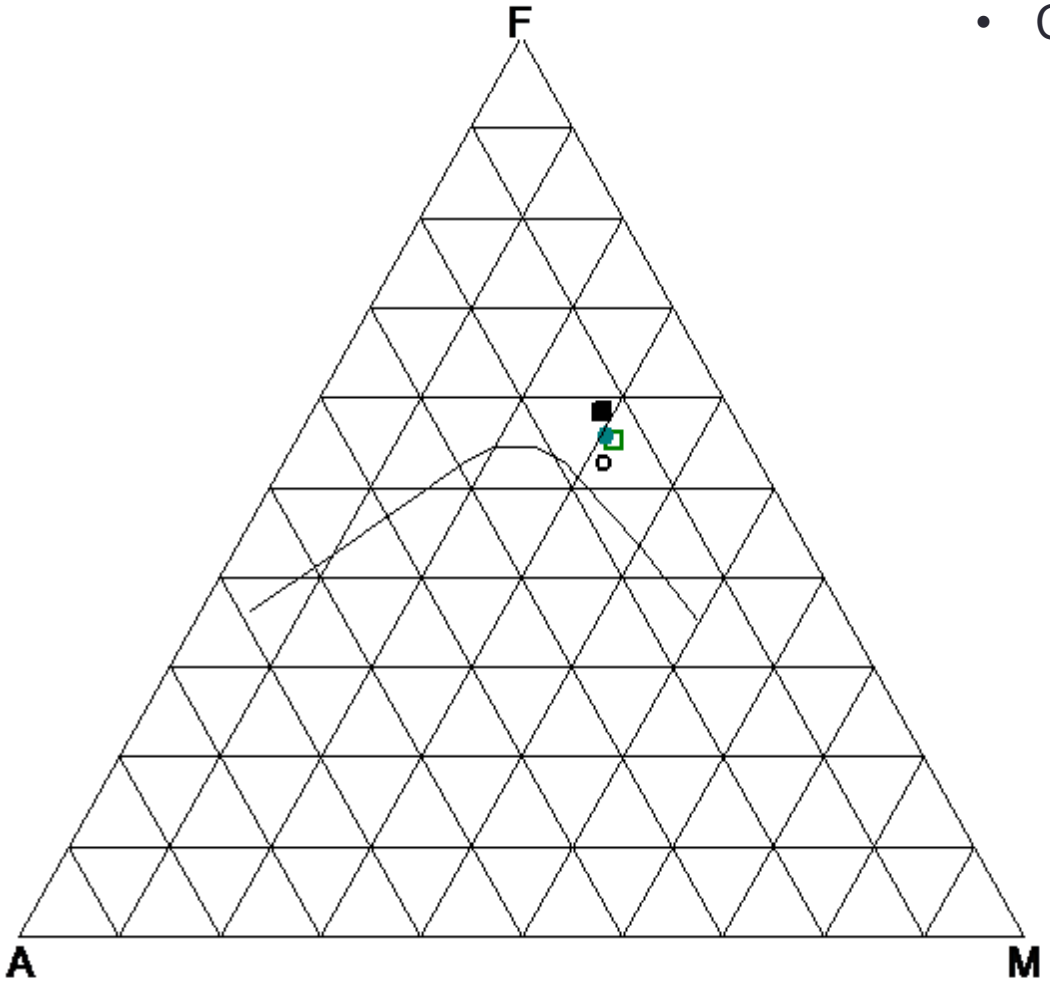
XRF Data Trends

- Difference of composition between layers is negligible
  - Glass layer was around 1% more concentrated in iron and calcium oxides compared to the bottom layer
  - Glass and bottom layer most similar in K_2O composition
  - Transition zone and Interior zone most similar

Iridescence

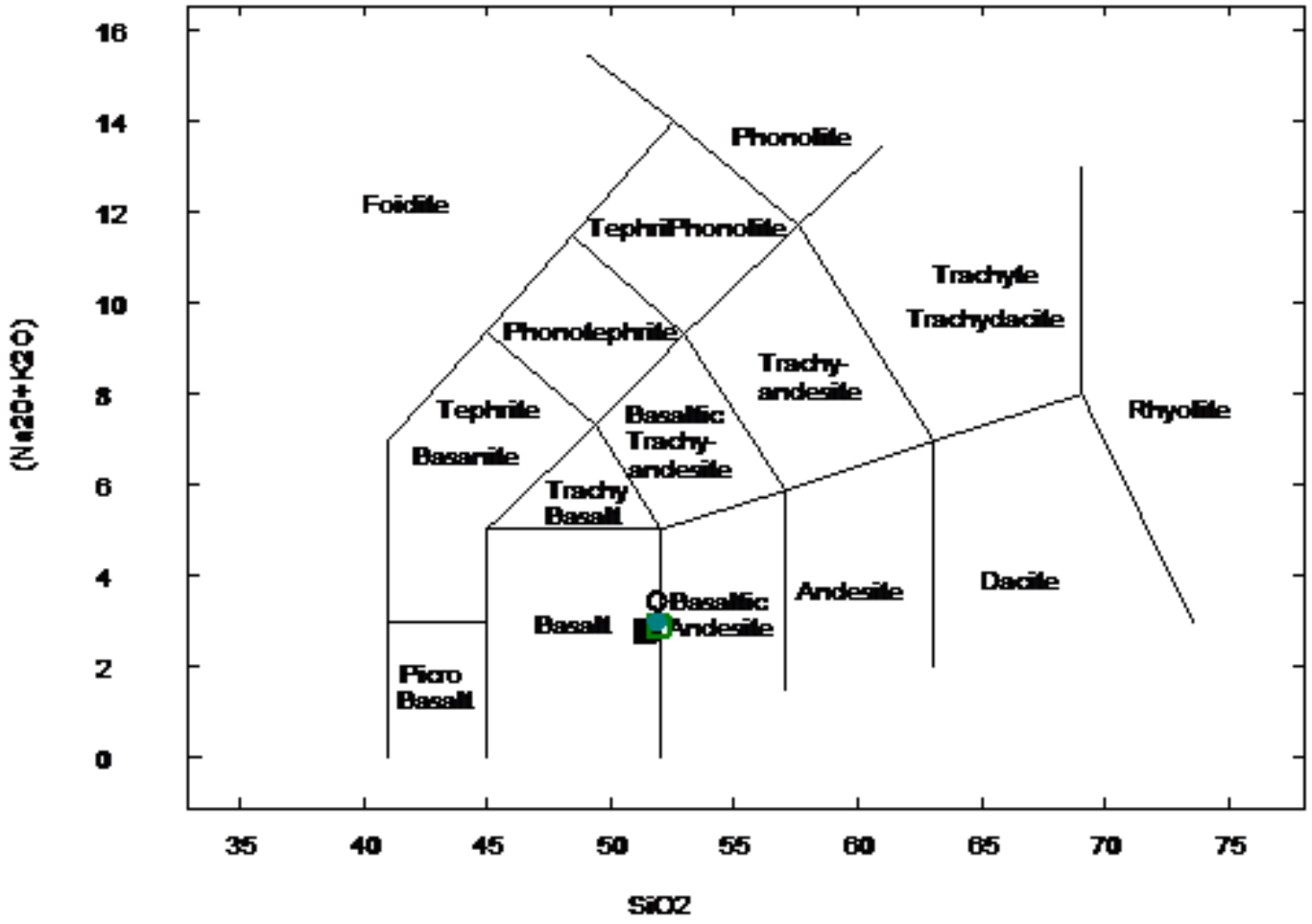
- After the observed XRF data, the glassy layer:
  - Insignificant amount of more Iron oxides
  - Actually had less Mg oxides than the rest
  - So concentration of Fe-Mg oxides is likely not the cause
  - Still a mystery

AFM Diagram



- Classified as Tholeiitic

TAS Diagram



- Tholeiitic Basalt

Geothermometer

- Basaltic glass geothermometer by Helz and Thornber (1987)
  - Mg and Ca oxides have a linear relationship with temperature
  - Glass needs to coexist with olivine and plagioclase

  - T_{Mg} = 20.1 x (wt. % MgO) + 1014° C
  - T_{ca} = 16.6 x (wt. % CaO) + 968° C

  - T_{Mg} = 1140.6° C ± 3°
  - T_{Ca} = 1177.2°C ± 5°
  - Range for eruptive temperatures
  - Winter observed that these temperatures were 23 degrees above measured values

Conclusions

- Sample was determined to be a tholeiitic basalt
- Had an eruptive temperature between 1140 -1177°C
- Cause of iridescence is still unknown

Acknowledgements

- The assistance of Dr. Eidukat for sample preparation and project guidance
- Dr. Hopkins for providing access to the thin section equipment