Characterization and Classification of Antarctic Granite Cobbles

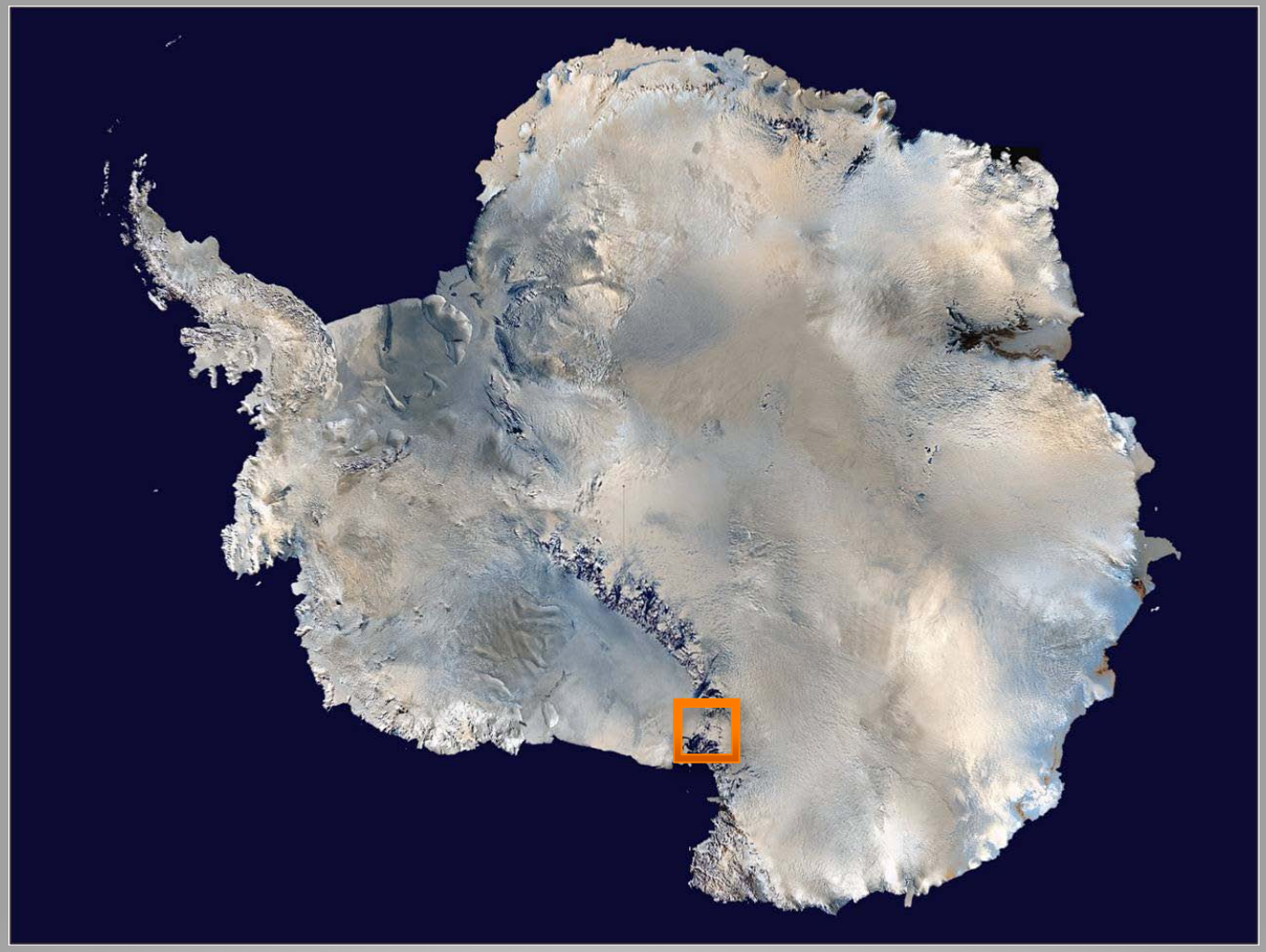
Alex Smith, Brian Hall, and Kelsey Forward

Project Goals

- Characterize
- Classify
- Compare to known data

Motivation

- *To determine ancient glacier drainage patterns in the Friis Hills of East Antarctica*



Geologic Background

Geologic Background

Friis Hills

Geologic Background

Methods

- Samples were brought back by Dr. Lewis in the fall of 2008
- Samples were cleaned and organized
- Using hand lens, divided based on:
  - Color
  - Grain size
  - Minerals
- Three distinct groups formed
- Rocks were photographed and cut for thin sections
- Powdered for XRF and XRD analysis
- Accumulated values (XRF, point count) were analyzed in Igpet and R (Geochemical Data toolkit)

3 Groups of Rocks

***Initial classification based on appearance** as determined by group members and Dr. Adam Lewis

- Alex's samples
  - Finer grained
  - Light gray colored
- Brian's samples
  - Coarser grained
  - Pale pink, gray colored
- Kelsey's samples
  - Coarser grained
  - Pink colored

Analyses Performed

- XRF
  - Courtesy of Macalester College
- XRD
  - Courtesy of Angel and NDSU
- Point counts
  - Courtesy of NDSU Geosciences and our own sweat and blood

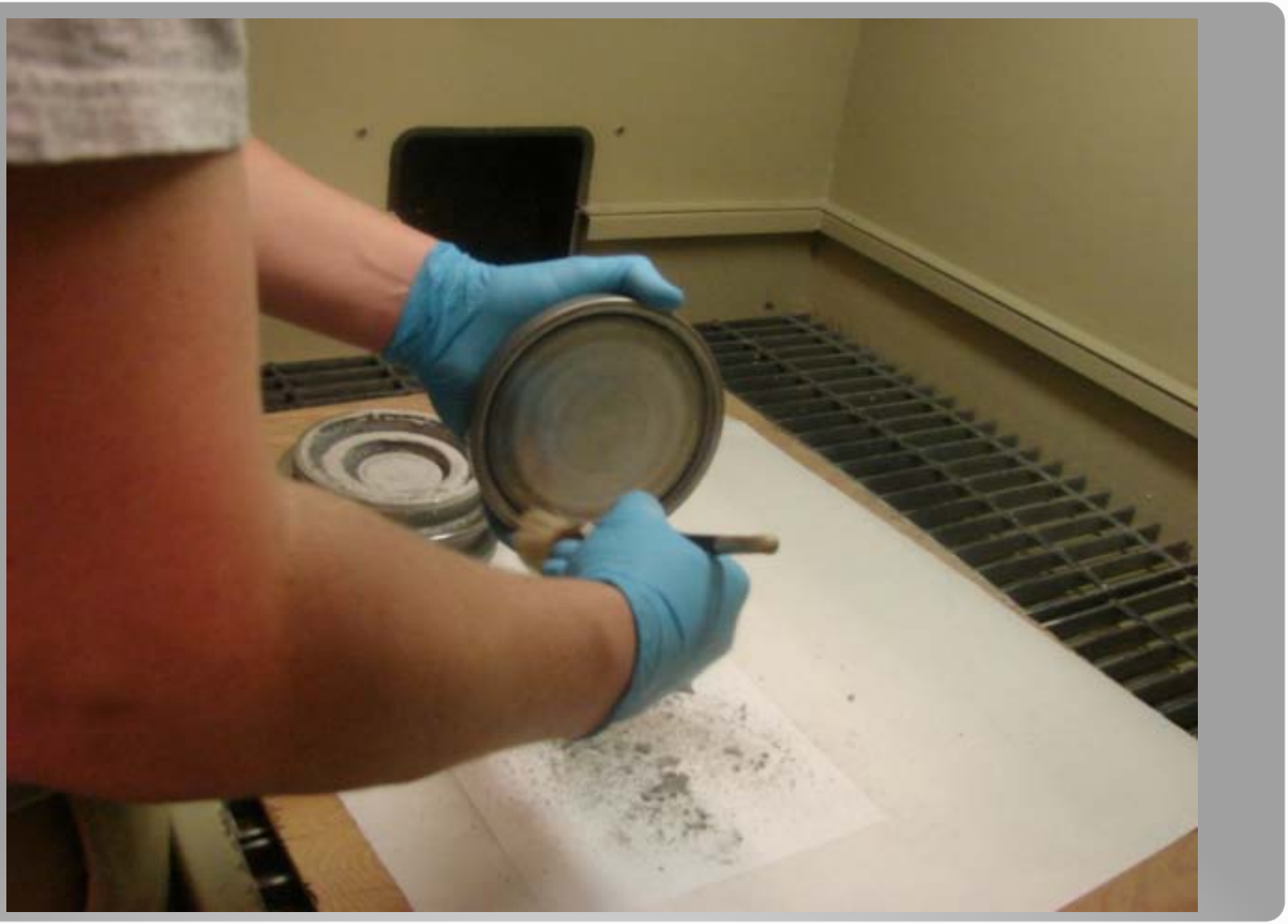
Methods - point count

- Thin sections were cut to a thickness of 30 μm
- Each petrologist point-counted their own rock samples, using a 4 mm by 2 mm grid pattern

Methods: XRF

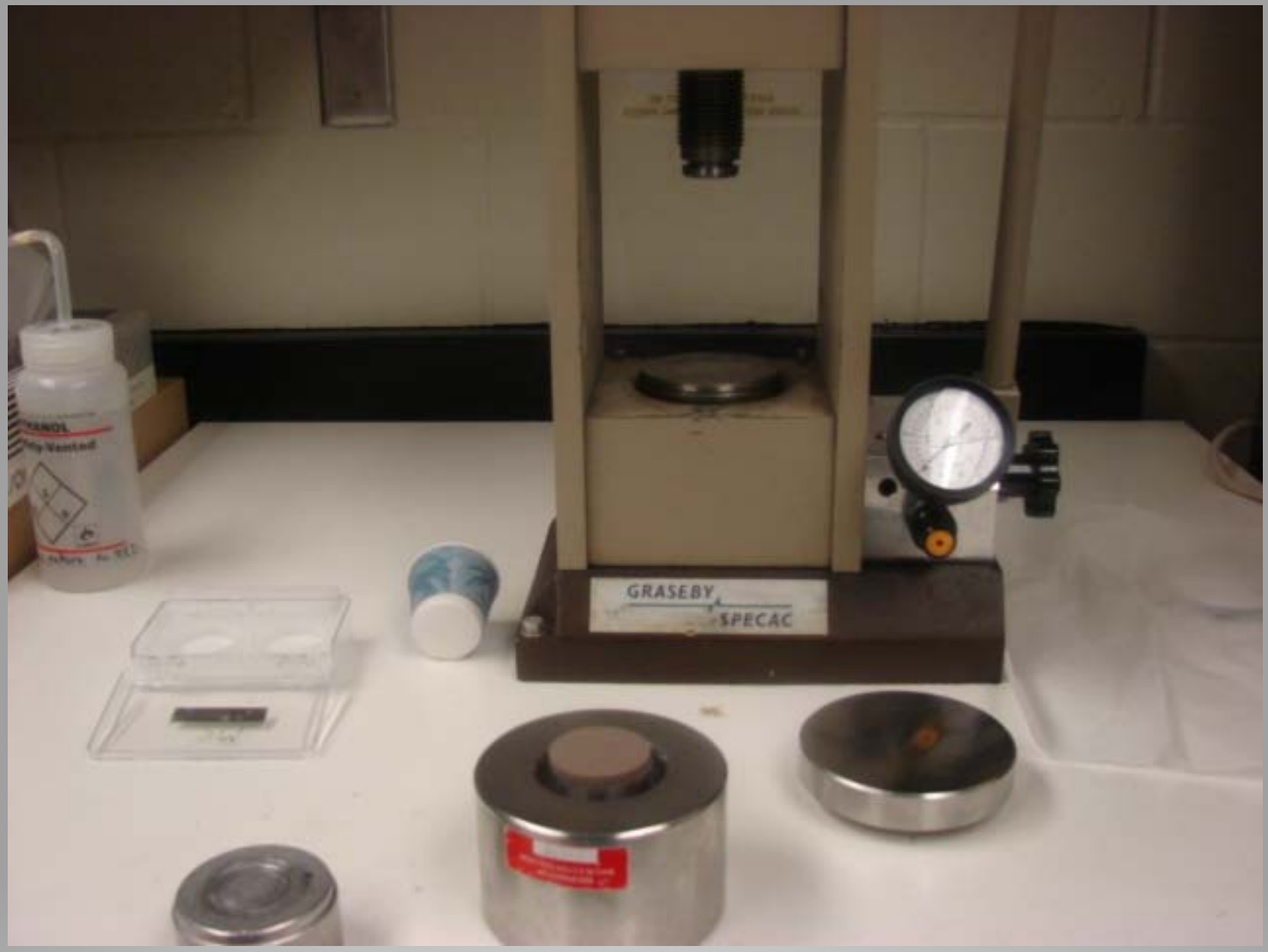
- Samples placed in a sterilized iron drum
- Added 15 mL of “Go-Juice”

•The iron drum was inserted and clamped down in a rock pulverizer for 2 or 3 minutes, depending on sample size

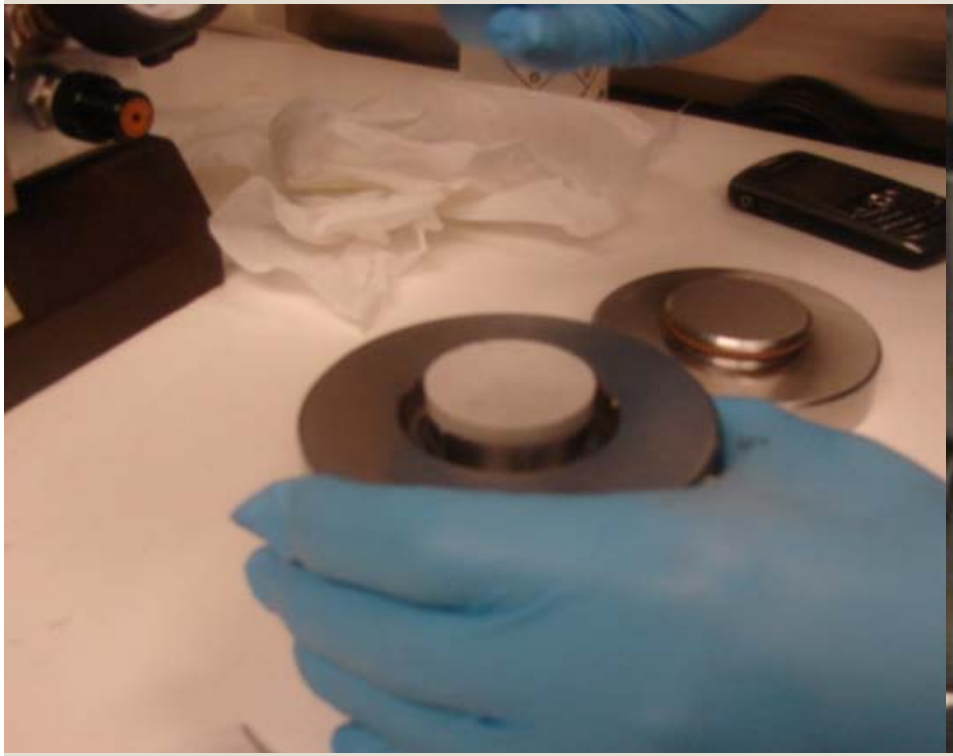


•Collection and transportation of samples to station 2

•10g of rock flour were measured out and 17 drops of E75 were mixed in thoroughly



•Samples were placed into the pellet press, where 3 tons of pressure (Pa) compressed the sample into disks

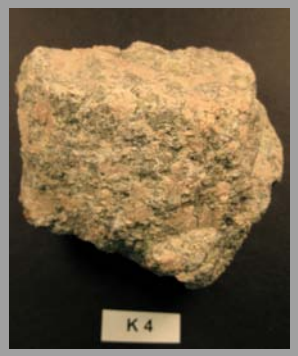


- Disks were dried and labeled for XRF analysis
- XRF performed on one side of the sample
- Results may be slightly skewed due to lack of data

Methods: XRD

- XRD was performed on specific grains of questionable content
- Sample crushed
- Individual grains selected
- Pulverized using mortar and pestle
- Sample mixed with ethanol on glass slide
- XRD was performed
- Results analyzed using X'pert HighScore

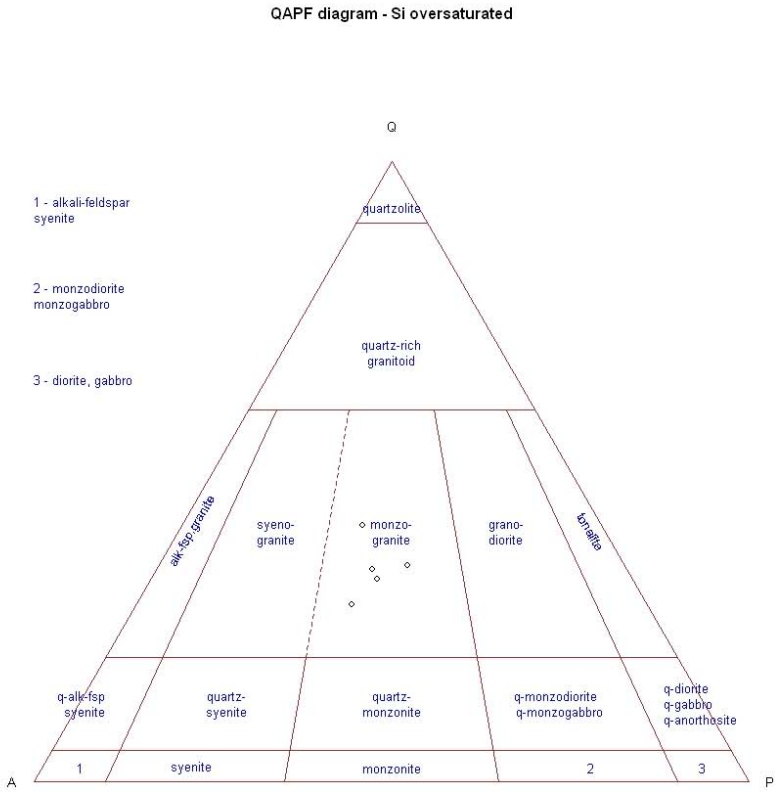
Methods: XRD



Note: each label is **1 cm** in length

Kelsey's Samples

- Pink in overall color
- Pink, green, and white crystals
- Some contain purple crystals
- Medium to large grains



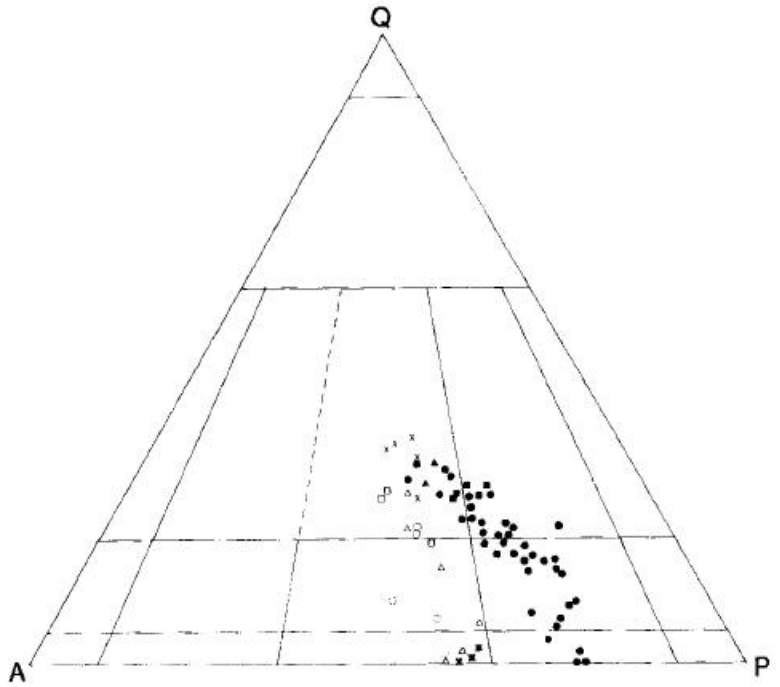
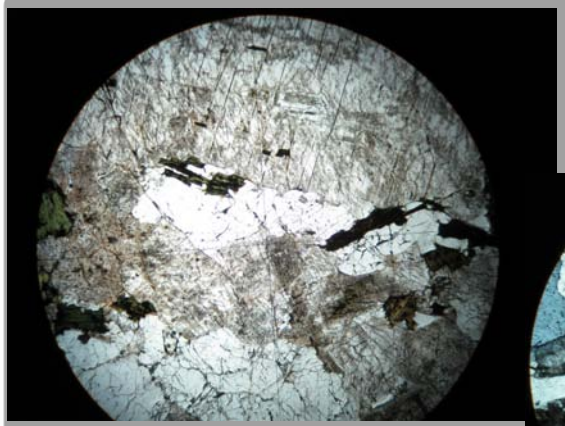
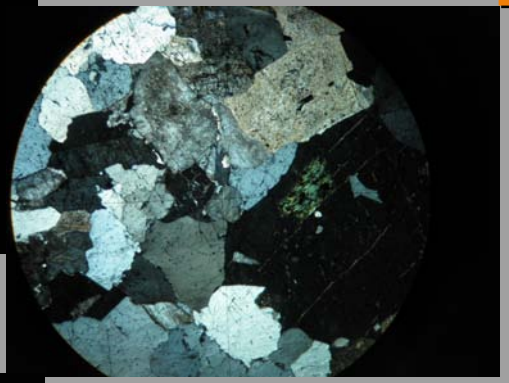


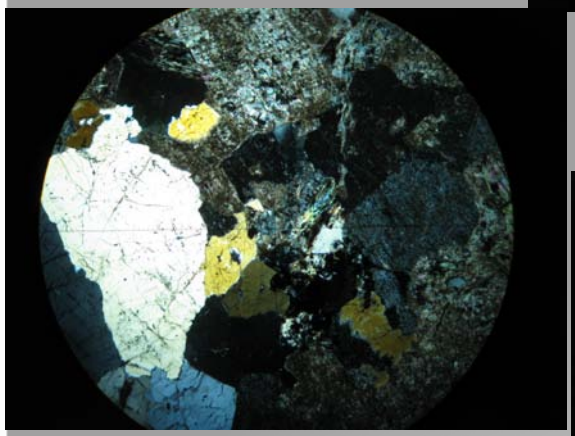
Fig. 9. CIPW normative mineral contents plotted on the QAP Streckeisen diagram (from Le Maitre 1989) showing the division of the granitoids into two suites.

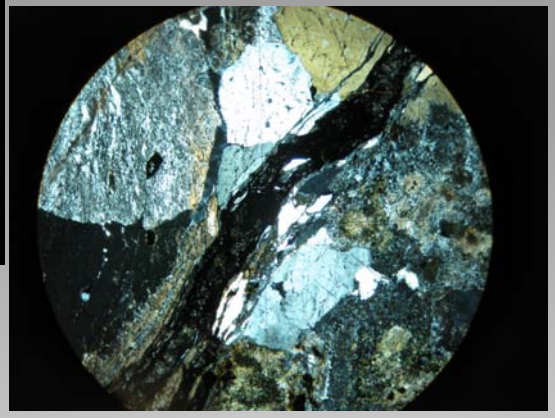
(Smillie, 1992)

- Point Count QAP diagram
- Monzo-granite composition
- Similar composition to Smillie's more siliceous samples





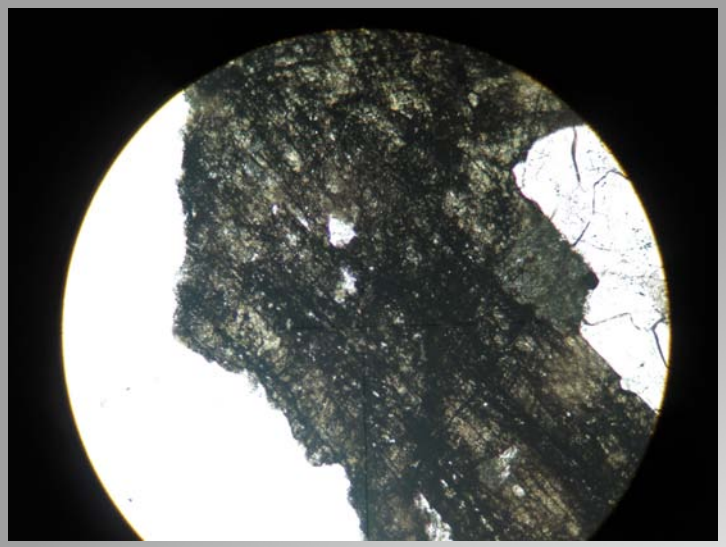




Point Count Data

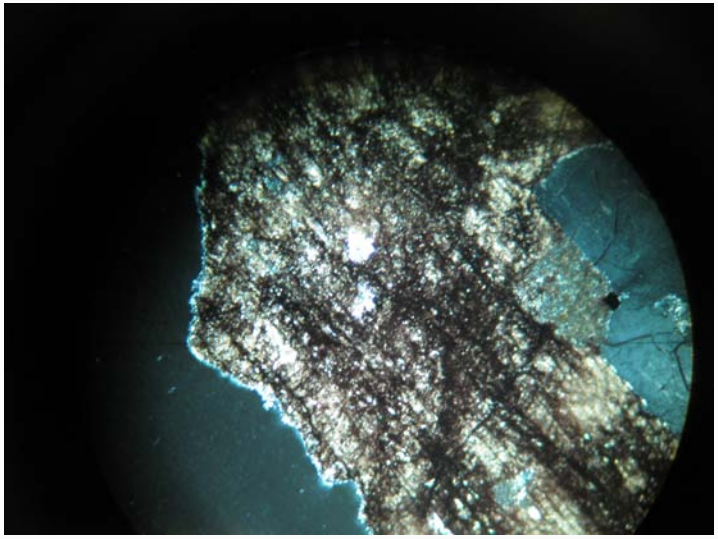
Minerals observed

- Quartz
- Kspar
- Plagioclase
- Muscovite
- Biotite
- Hematite
- Illite
- Hornblende



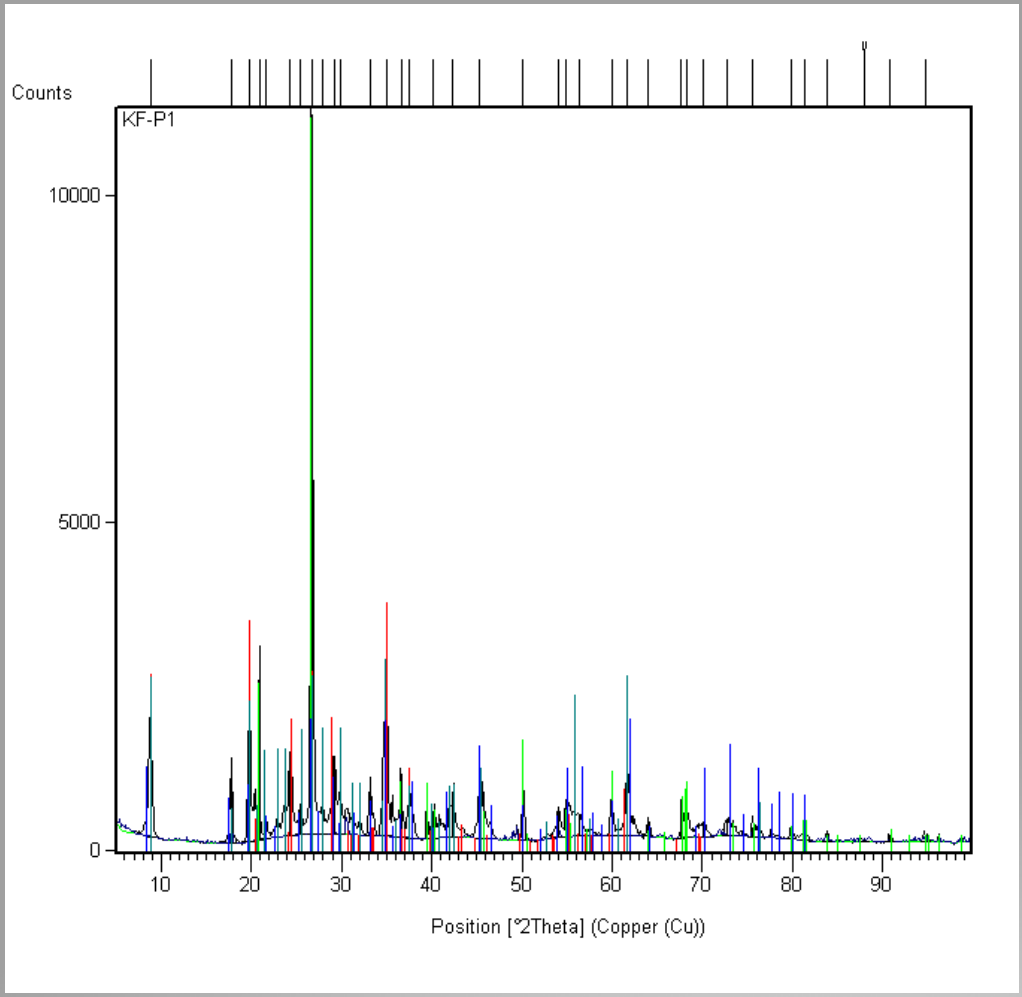
Plane
Polarized
Light
10x

Purple Crystals



Crossed
Polars
10x

XRD Data

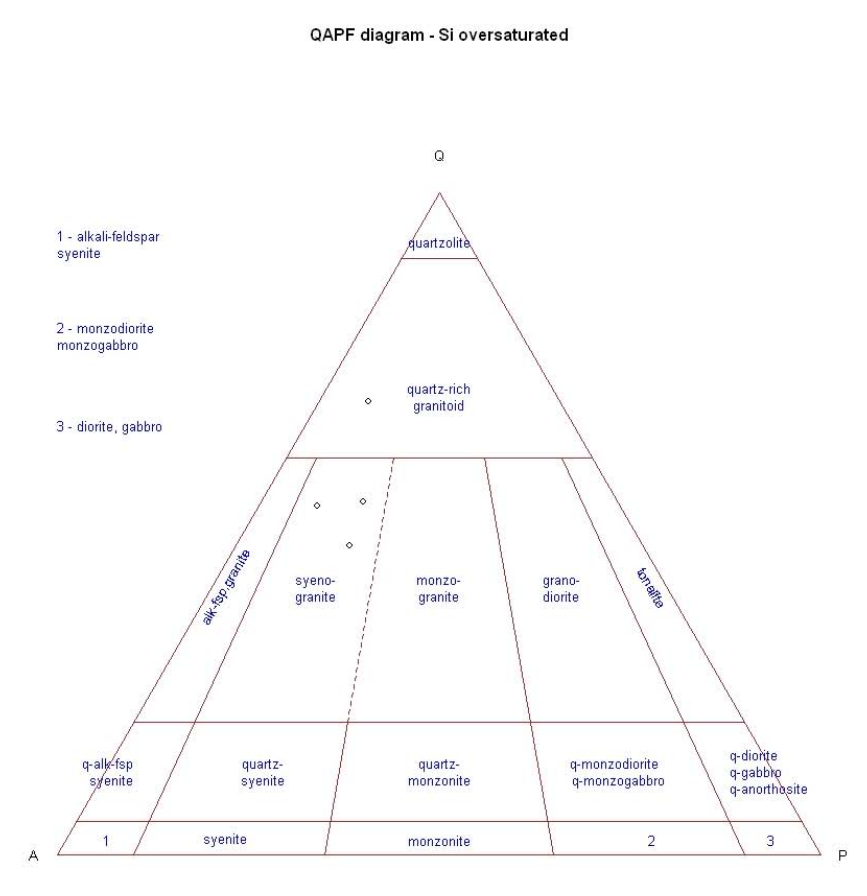


- Identify unusual purple mineral
- Determined background and smoothed it
- Stripped K alpha 2
- Results
  - Quartz- Green
  - Muscovite-Blue
  - Illite- Teal
  - Hematite- Red

Alex's Sample

- Gray and white in color
- Medium to fine grains
- Very consistent characteristics through out samples

Note: each label is **1 cm** in length



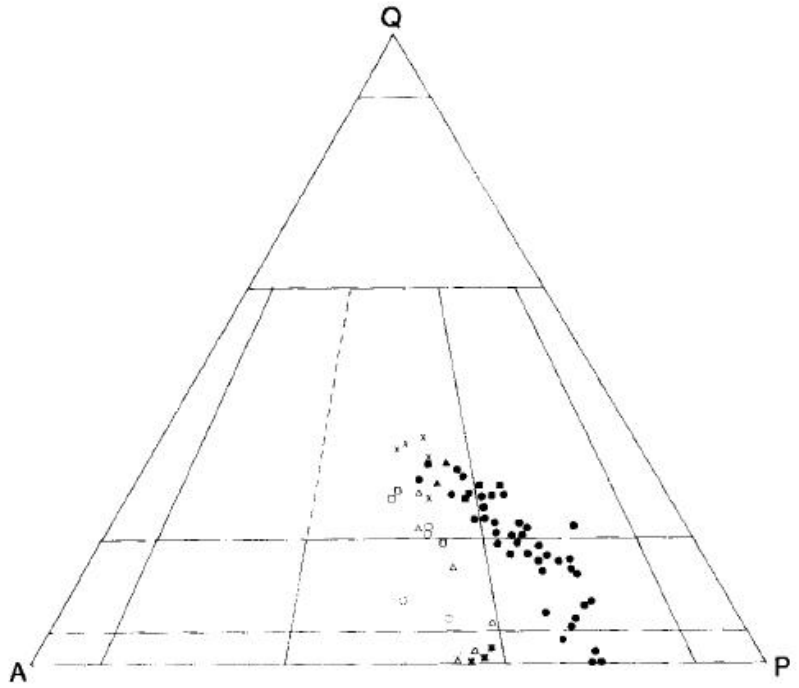
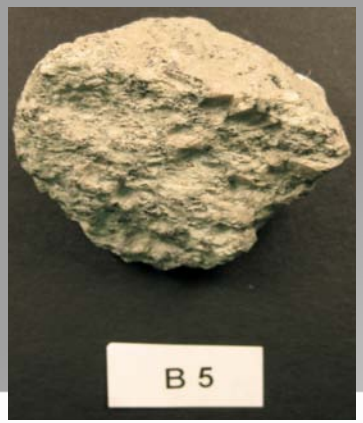


Fig. 9. CIPW normative mineral contents plotted on the QAP Streckeisen diagram (from Le Maitre 1989) showing the division of the granitoids into two suites.

(Smillie, 1992)

•Point counts resulted with my samples plotting in syeno-granite and one sample in quartz-rich granitoid.

•Comparing Smillie's results with my QAP diagram show that my samples have a higher concentration of quartz. This could be due to the fact that Smillie's samples were from a different pluton



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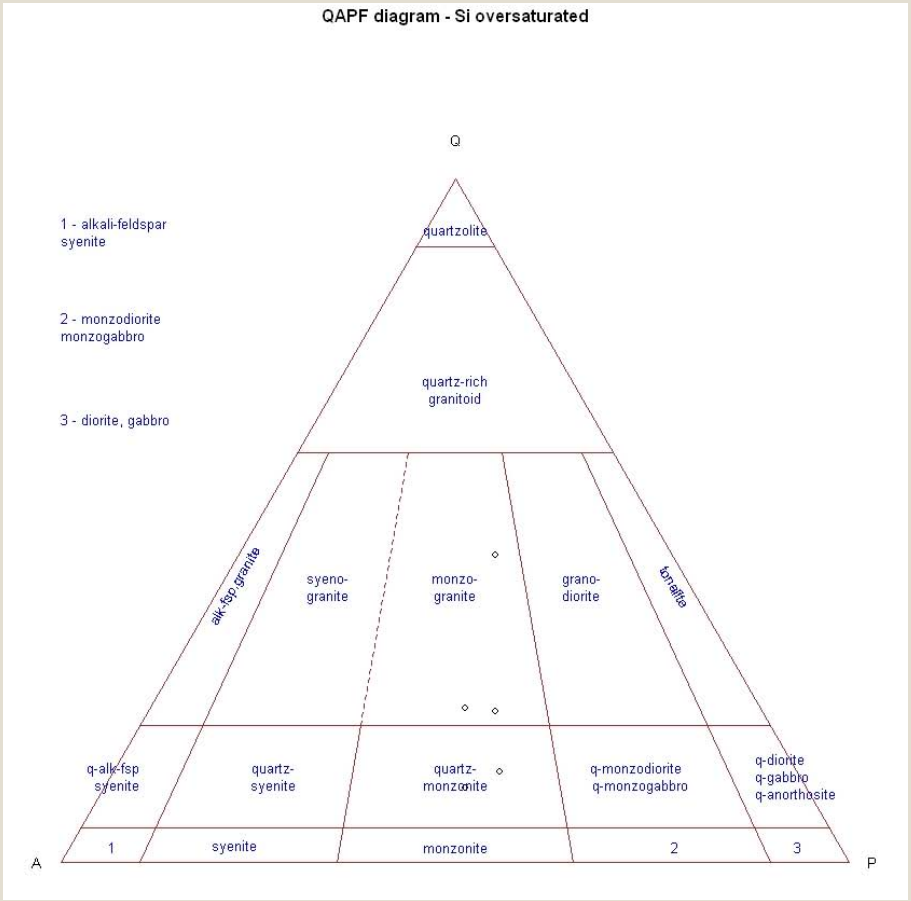
Brian's Samples

- Primarily coarse grained
- Light pink to gray color
- Mineral composition varied between samples



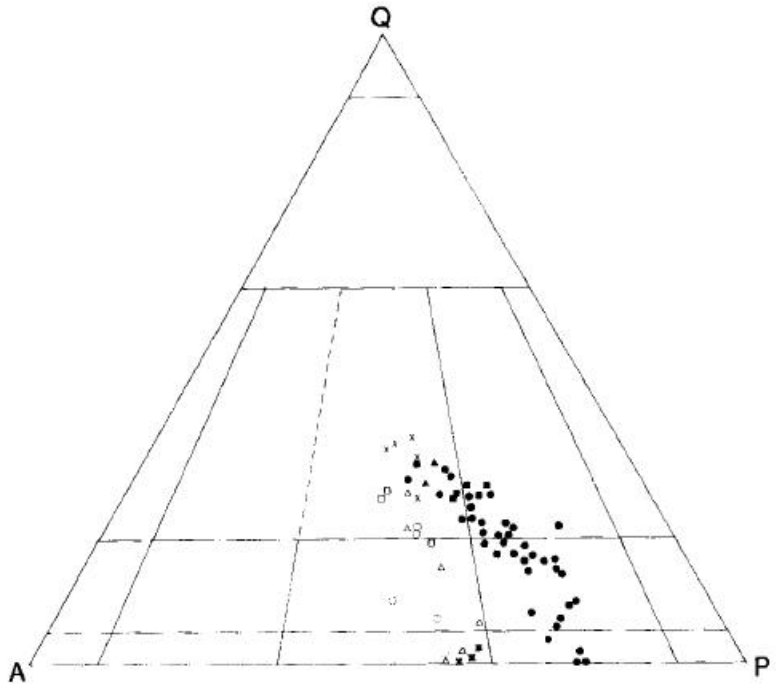


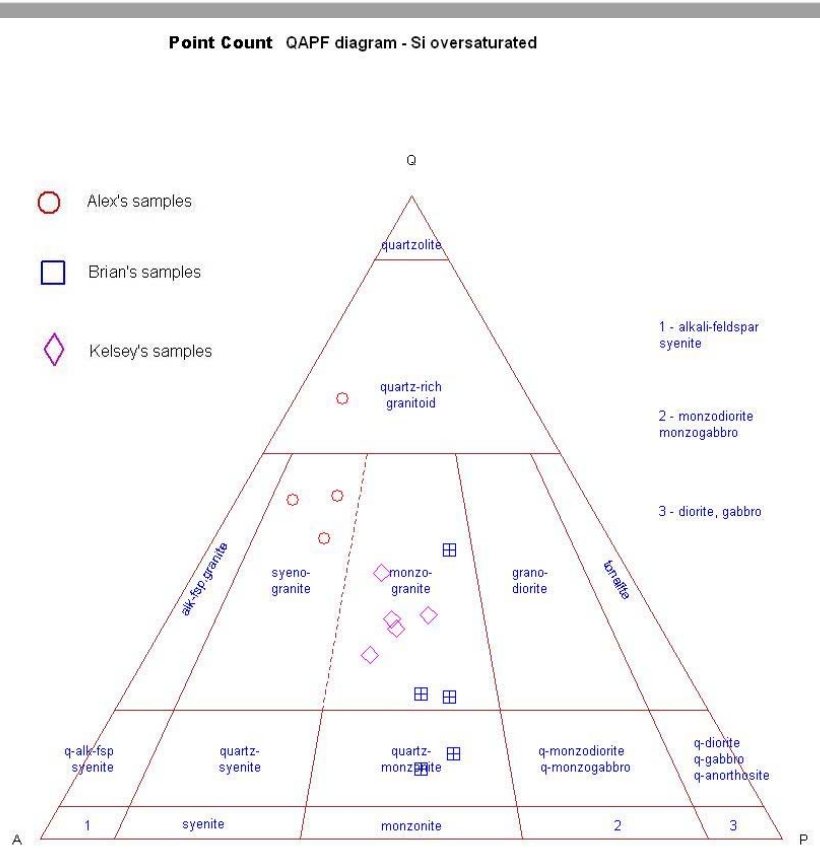
Fig. 9. CIPW normative mineral contents plotted on the QAP Streckeisen diagram (from Le Maitre 1989) showing the division of the granitoids into two suites.

(Smillie, 1992)

- Point Count QAP diagram
- General Monzo-granite composition
- Similar composition to Smillie's

Discussion

- Did our three general hand specimen classifications match the results of Smillie?
- Do we see similar results when comparing point count data with Smillie's QAP?
- How does the XRF data compare with the compositions of Smillie and Allibone et al.?



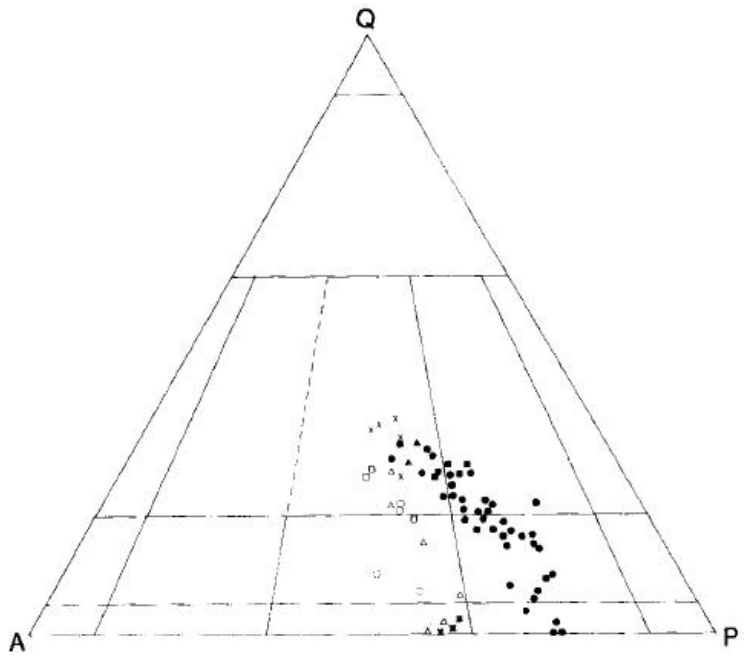
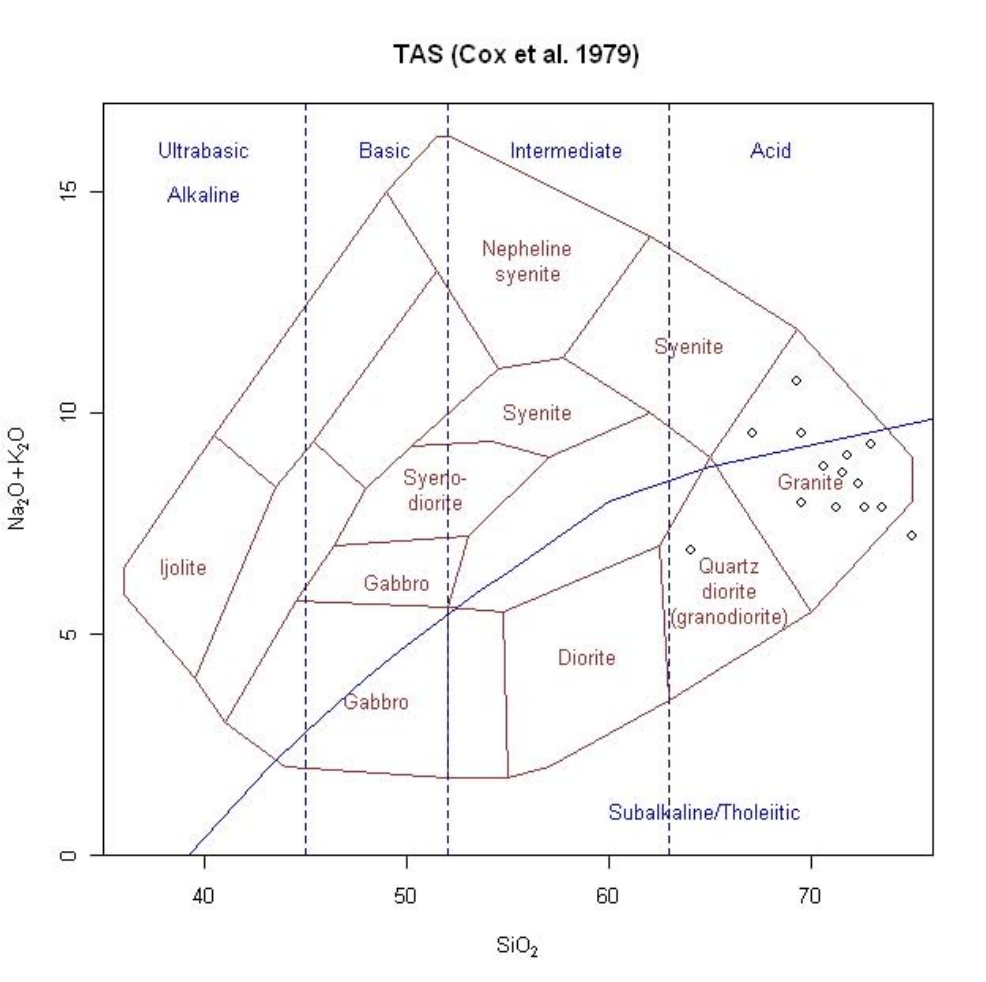


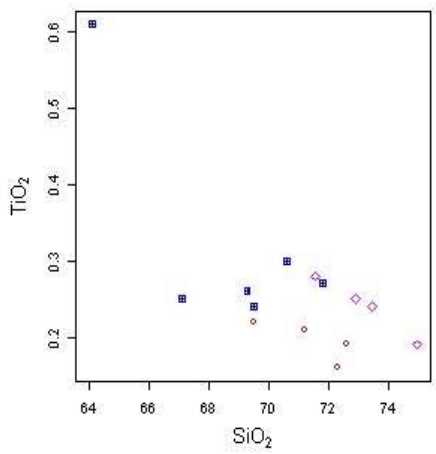
Fig. 9. CIPW normative mineral contents plotted on the QAP Streckeisen diagram (from Le Maitre 1989) showing the division of the granitoids into two suites.

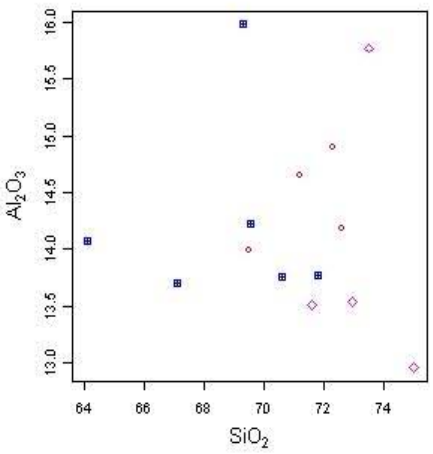
(Smillie, 1992)

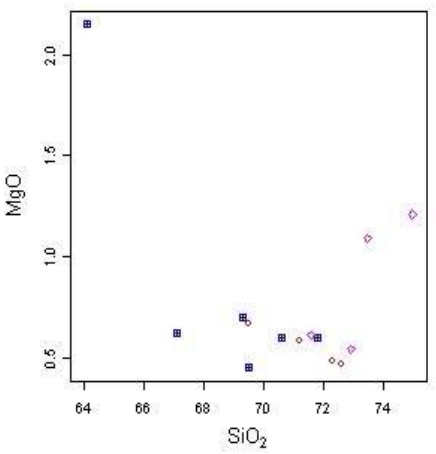
Point count classifications indicate general similarities, but as you can Alex's samples are off to the side, which could indicate that his granites are from another pluton.

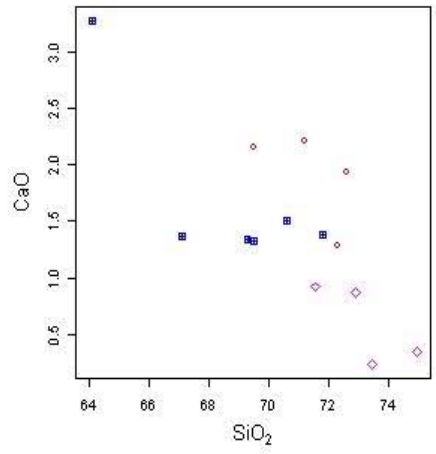
- XRF data was limited due to the one sided analysis

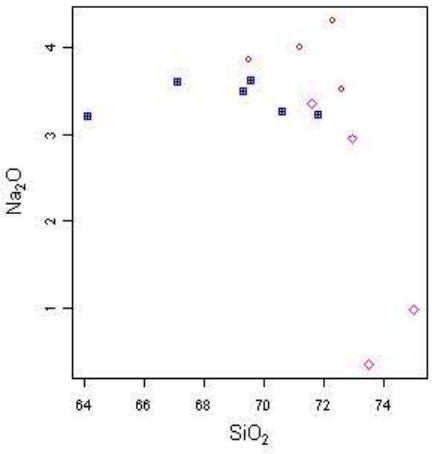


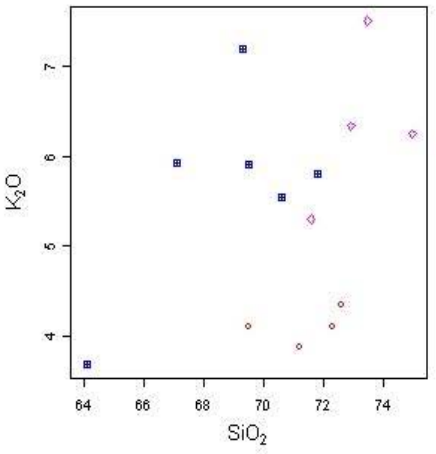

TiO2
SiO2

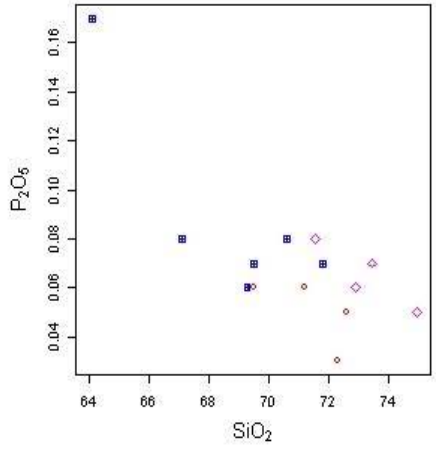

Al2O3
SiO2

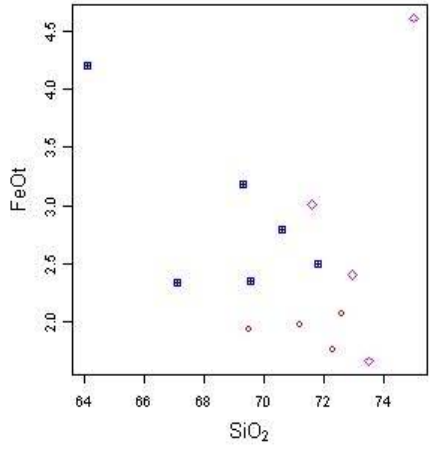

MgO
SiO2

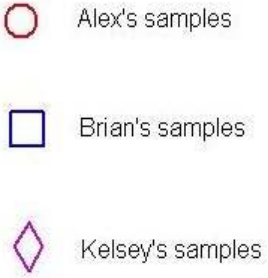

CaO
SiO2

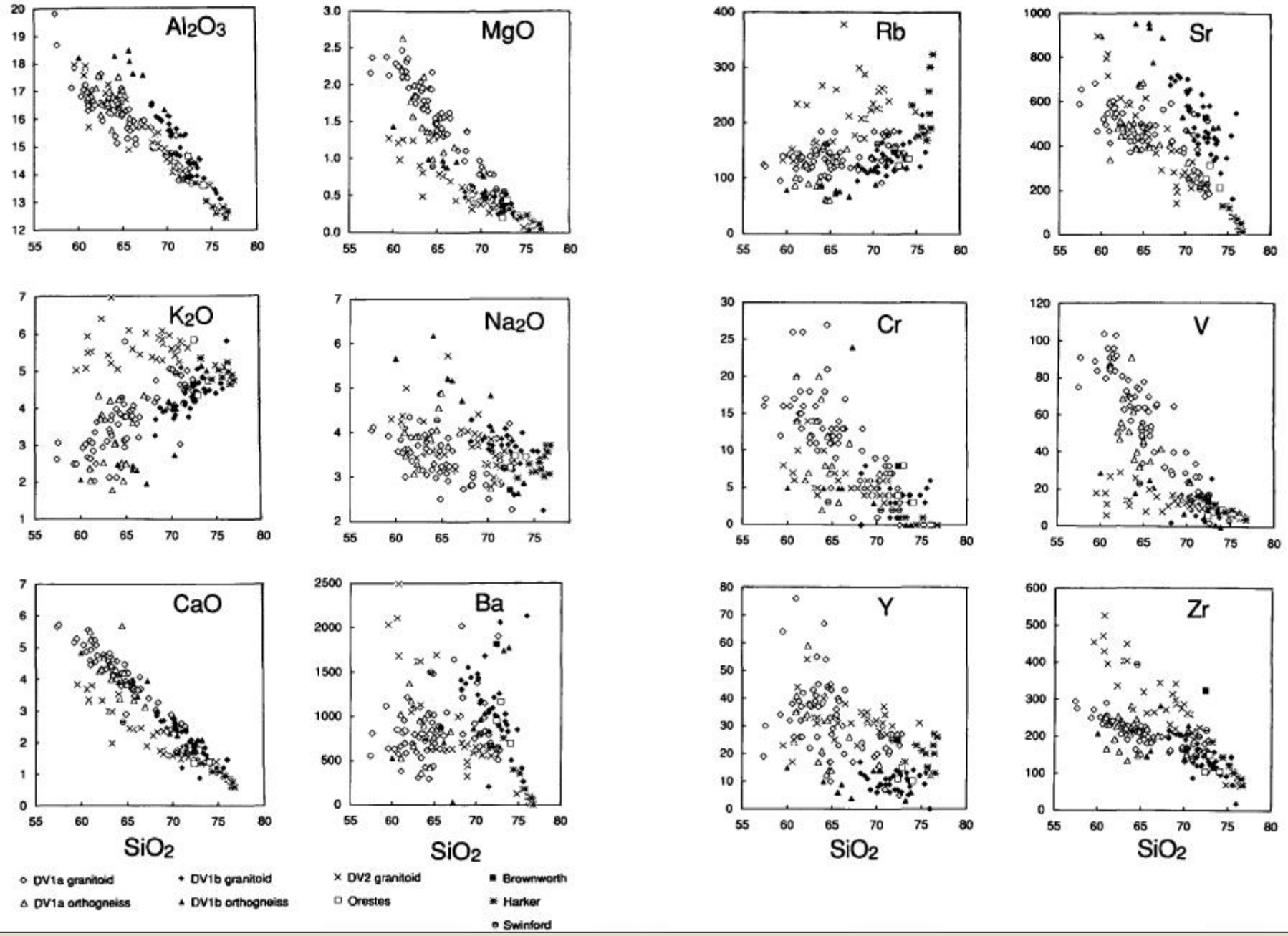

Na2O
SiO2

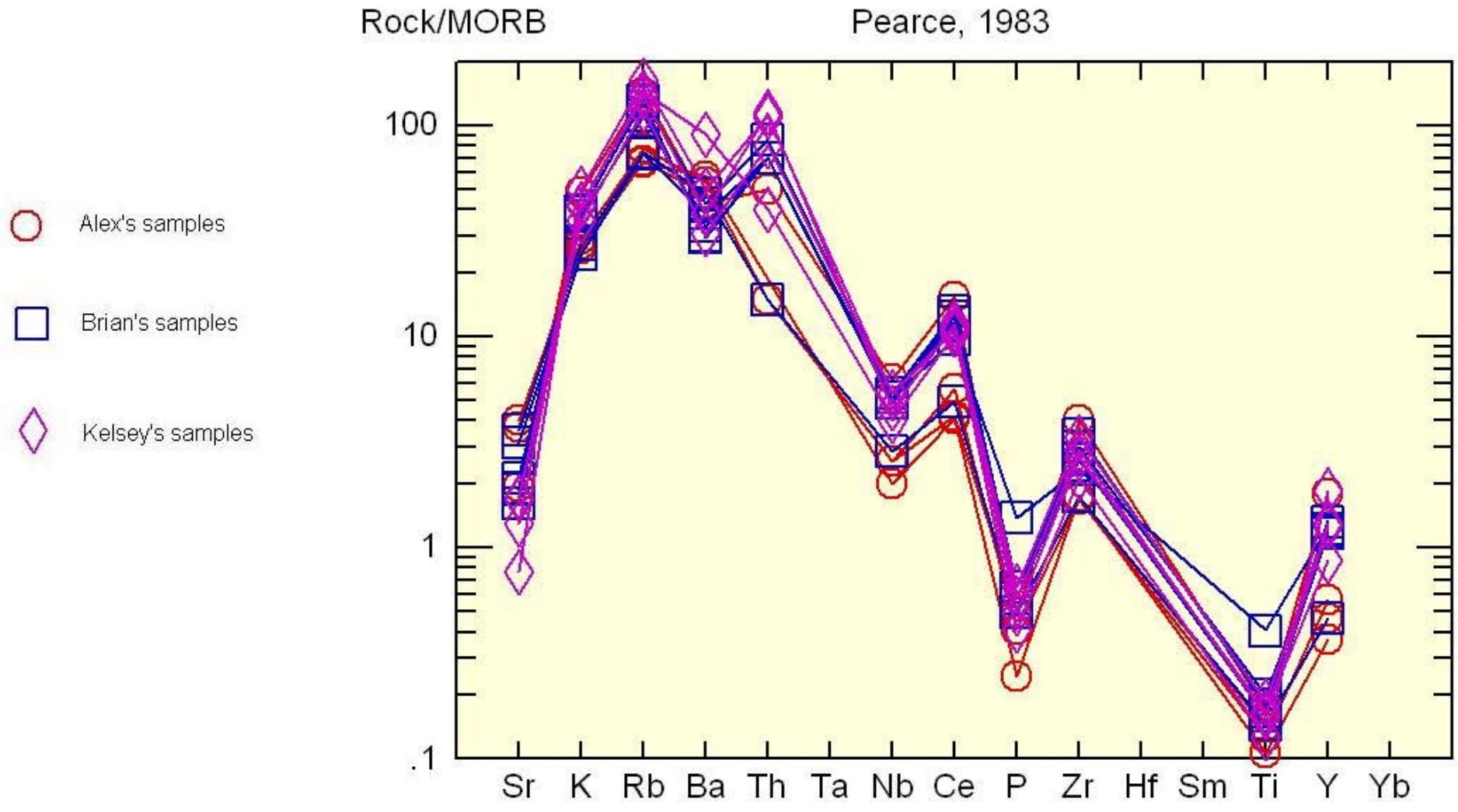

K2O
SiO2

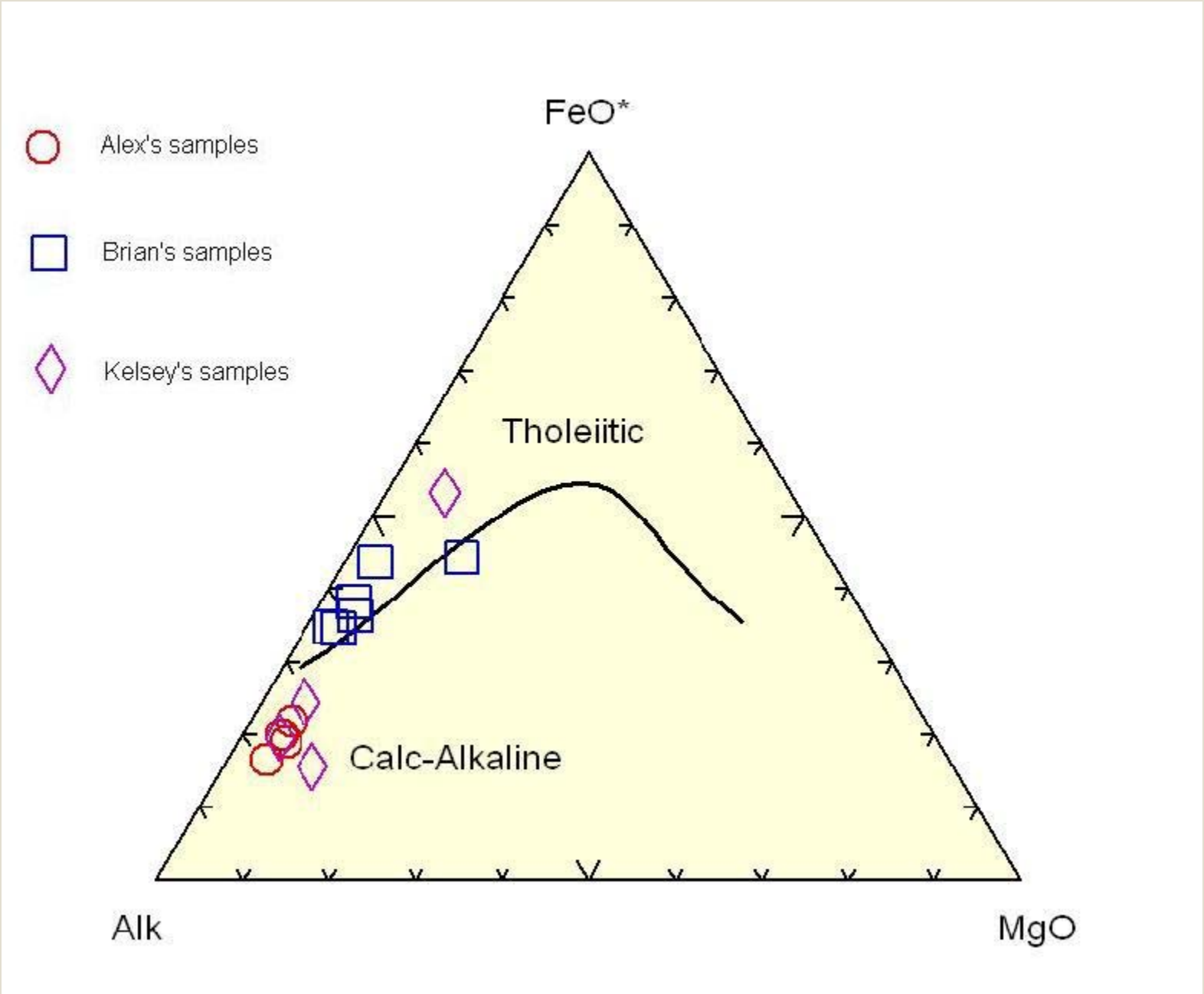

P2O5
SiO2


FeOt
SiO2

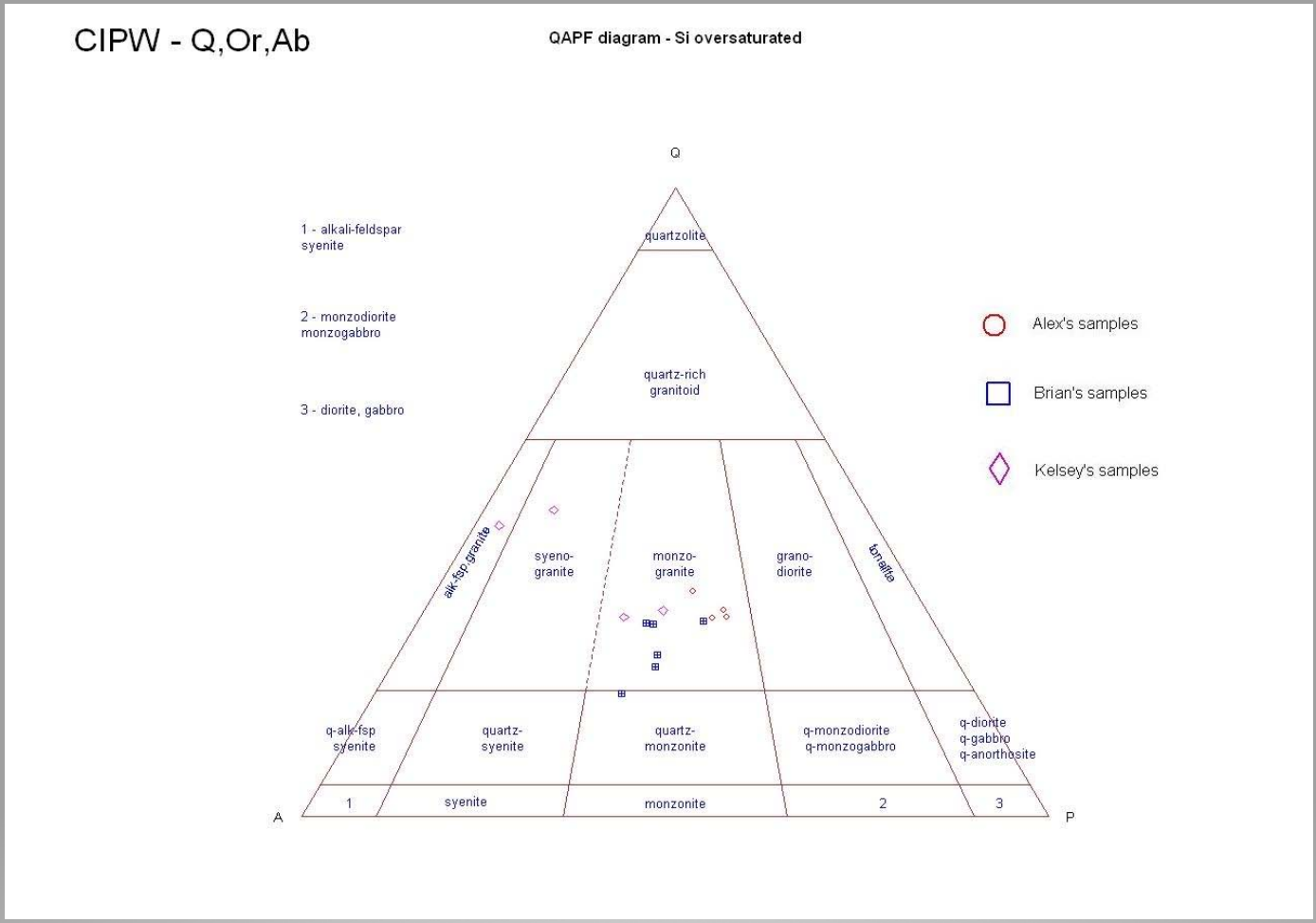

Alex's samples
Brian's samples
Kelsey's samples


Al2O3
MgO
Rb
Sr
K2O
Na2O
Cr
V
CaO
Ba
Y
Zr
SiO2
SiO2
SiO2
DV1a granitoid
DV1b granitoid
DV2 granitoid
Brownworth
DV1a orthogneiss
DV1b orthogneiss
Orestes
Harker
Swinford

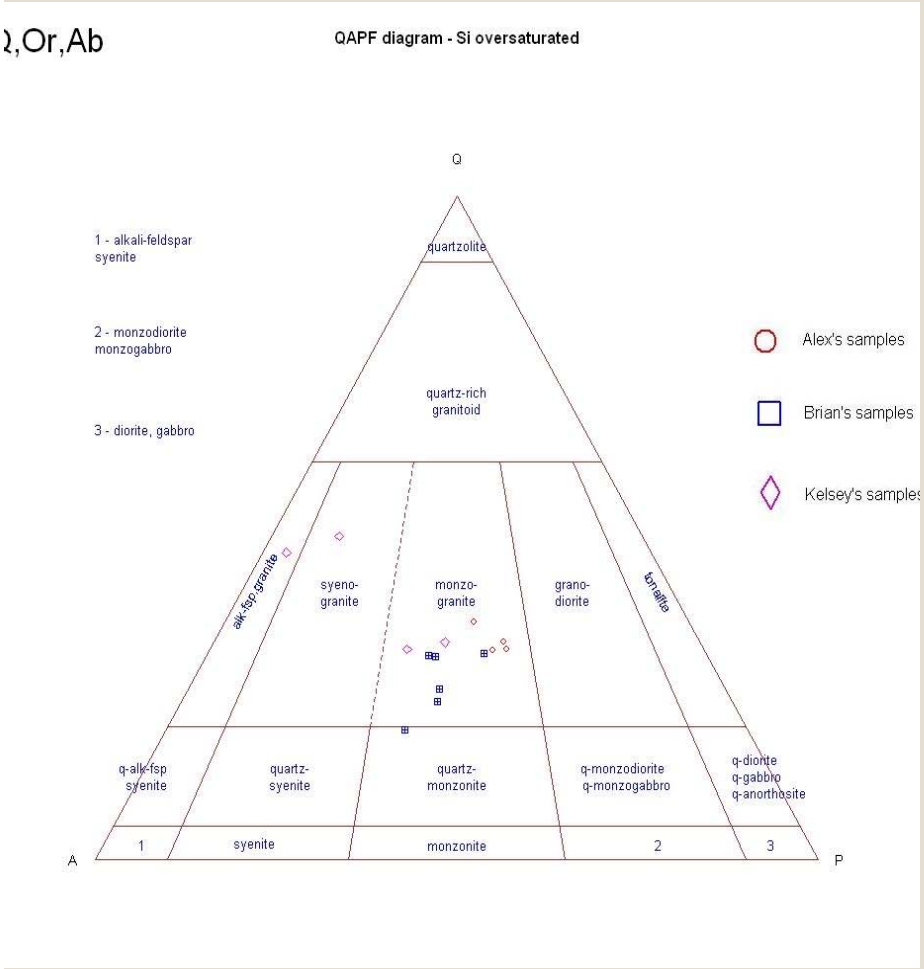

Rock/MORB
Pearce, 1983
Alex's samples
Brian's samples
Kelsey's samples
100
10
1
.1
Sr
K
Rb
Ba
Th
Ta
Nb
Ce
P
Zr
Hf
Sm
Ti
Y
Yb

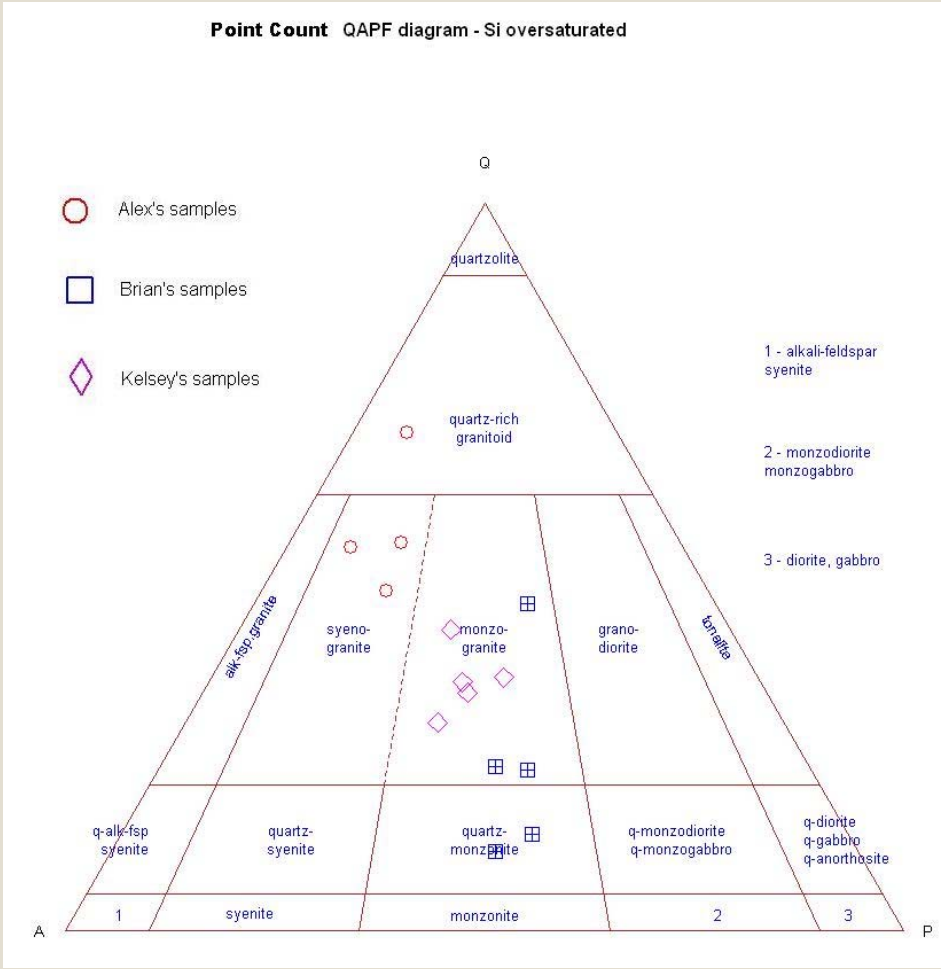

Alex's samples
Brian's samples
Kelsey's samples
FeO*
Tholeiitic
Calc-Alkaline
Alk
MgO

- CIPW norm: “The typical minerals that might be expected to mineralize from an anhydrous melt at low pressure.”

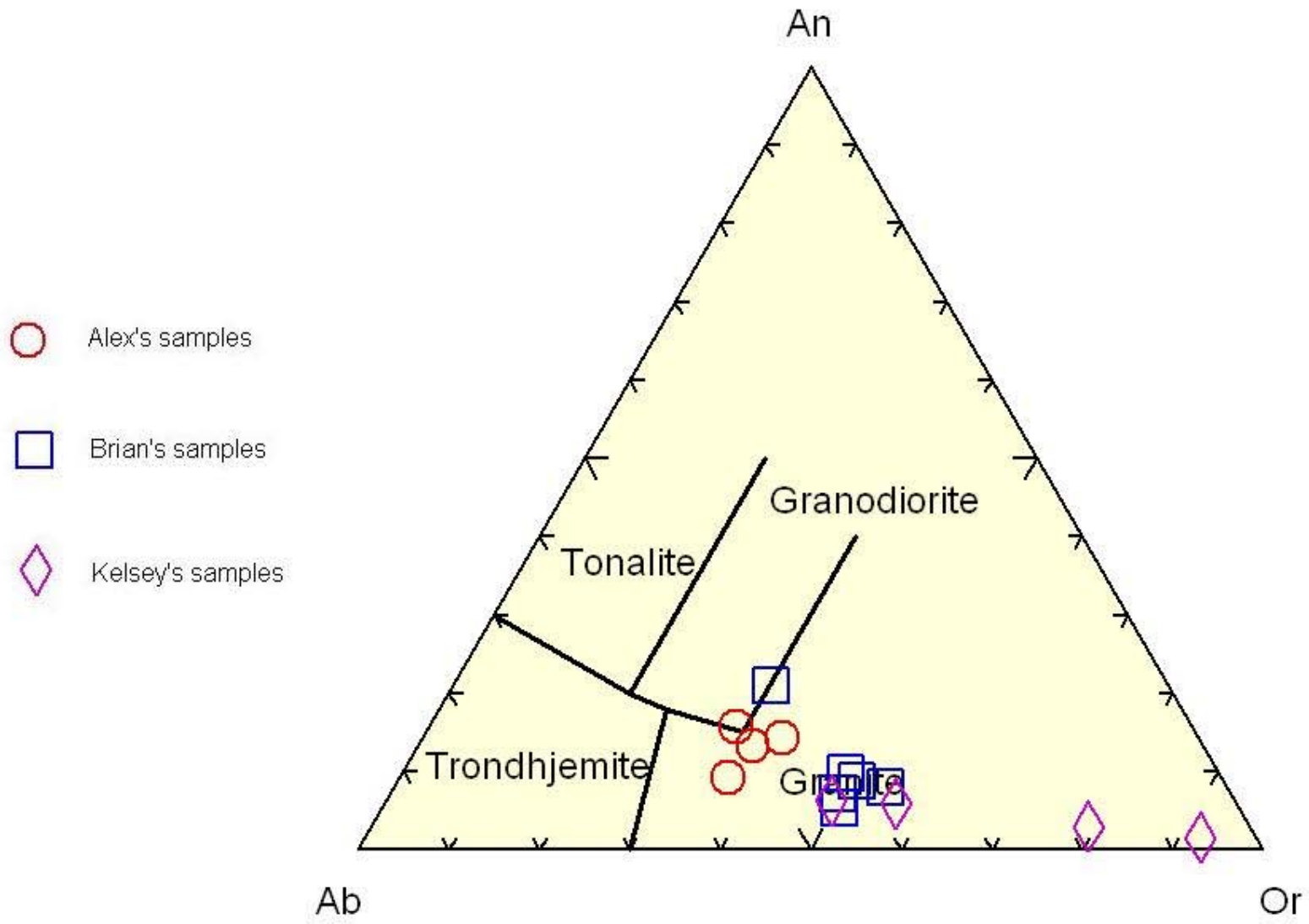


CIPW vs. point count





CIPW normalization figure



Previous Classification

As determined by Allibone, Cox, and Smillie (1993)

Dry Valleys Suite 1

- Calc-alkaline
- I-type
- Varies in composition
- Generally depleted in:
  - K_2O, Rb, Pb, and Zr
- Generally enriched in:
  - TiO_2, MgO, CaO, V, Sc, and Cr

Dry Valleys Suite 2

- Alkali-calcic
- I-type
- Varies in composition

Conclusion

- We are satisfied with the majority of our point count results
- Our XRF analysis, although probably not completely accurate, did correlate with other published data
- Sample groups based off of the hand specimen characterizations appear to be displaying similar patterns within our diagrams.

Conclusion

- Unfortunately, a few samples did not correlate with published results
- Identification of thin section minerals proved to be difficult
- CIPW normalization diagrams were not as similar as the published results
  - Possibly due to skewed XRF data

References cited

Allibone, A.H., and Cox, S.C., 1993, Granitoids of the Dry Valleys area, southern Victoria Land: geochemistry and evolution along the early Paleozoic Antarctic Craton margin, New Zealand Journal of geology and Geophysics, v. 36, p. 299-316.

Allibone, A.H., Cox, S.C., Graham, I.J., Smillie, R.W., Johnstone, R.D., Ellery, S.G., and Palmer, K., 1993, Granitoids of the Dry Valleys area, southern Victoria land, Antarctica: plutons, field relationships, and isotopic dating, New Zealand Journal of Geology and Geophysics, v. 36, p. 281-297.

Perkins, D., and Henke, K.R., 2004, Minerals in Thin Section: New Jersey, Pearson Prentice Hall.

Smillie, R.W., 1992, Suite subdivision and petrological evolution of granitoids from the Taylor Valley and
Ferrar Glacier region, south Victoria Land, Antarctic Science, v. 4, p. 71-87.

Winter, J.D., 2010, Principles of Igneous and Metamorphic Petrology: New Jersey, Pearson Prentice Hall, p. 27-688.

Software used:
Igpet2000 for Win95/98/NT, 2000, Terra Softa Inc.

R2.7.0, Released April 22nd, 2008. Geochemical Data Tool kit, version 2.3, released May 11th, 2008, written by V. Jaynousek, C.M. Farrow, V. Erban, and J. Smid.

Group member participation

- Kelsey
  - Photographed/classified hand samples
  - XRD analysis
  - Thin section point counts
  - Abstract
  - Five rock samples
- Brian
  - Five rock samples
  - Classified hand samples
  - XRF preparation and analysis
  - Thin section point count
  - CIPW analysis
  - Software wizard
- Alex
  - Cleaned and classified hand samples
  - XRF preparation and analysis
  - Thin section point count
  - CIPW analysis
  - Software apprentice
  - Four rock samples