Crystal Size Distribution of Saganaga Tonalite, MN

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PETROLOGY PROJECT 2018

Regional Setting

Saganaga Tonalite is situated to the north of the Duluth complex within the Archean Superior Craton

Named after Saganaga Lake

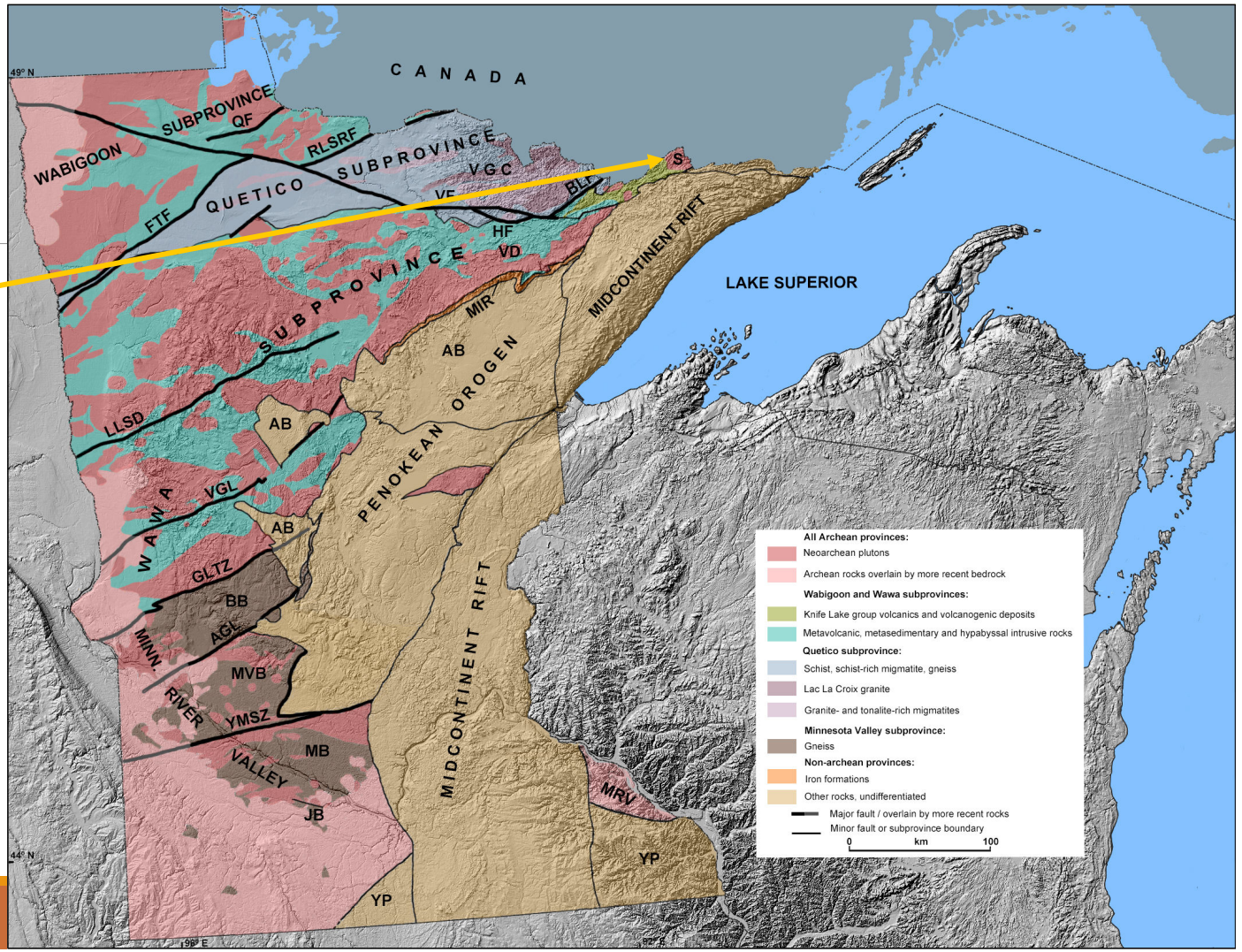
Archean in Age: ~2700 ± 50 m.y.a

- Rb-Sr, K-Ar, and U-Pb dating methods were used

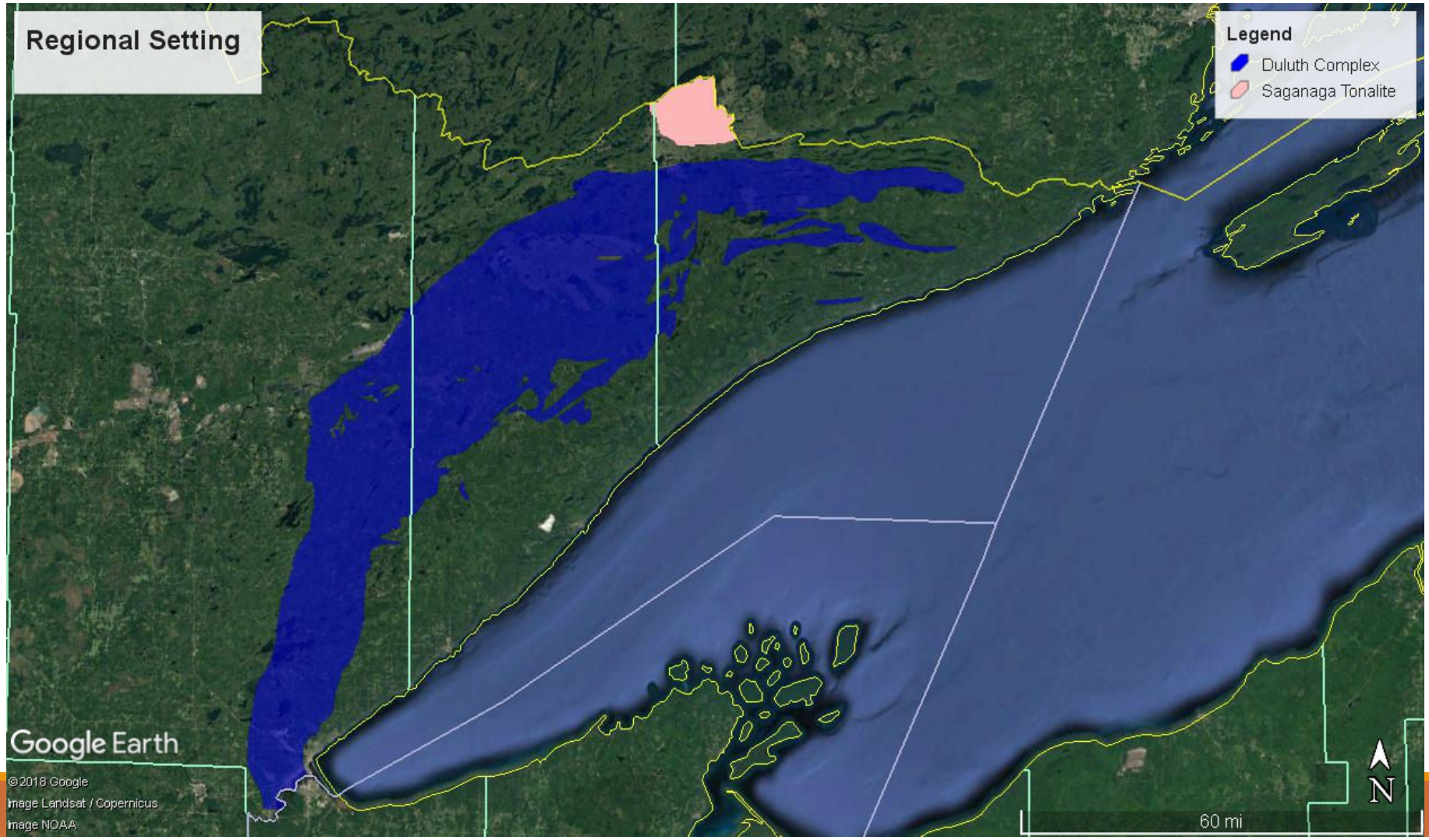
Originated from the Algoman Orogeny (Kenoran Orogeny in Canada) before the Mid-continental rift

Saganaga Tonalite

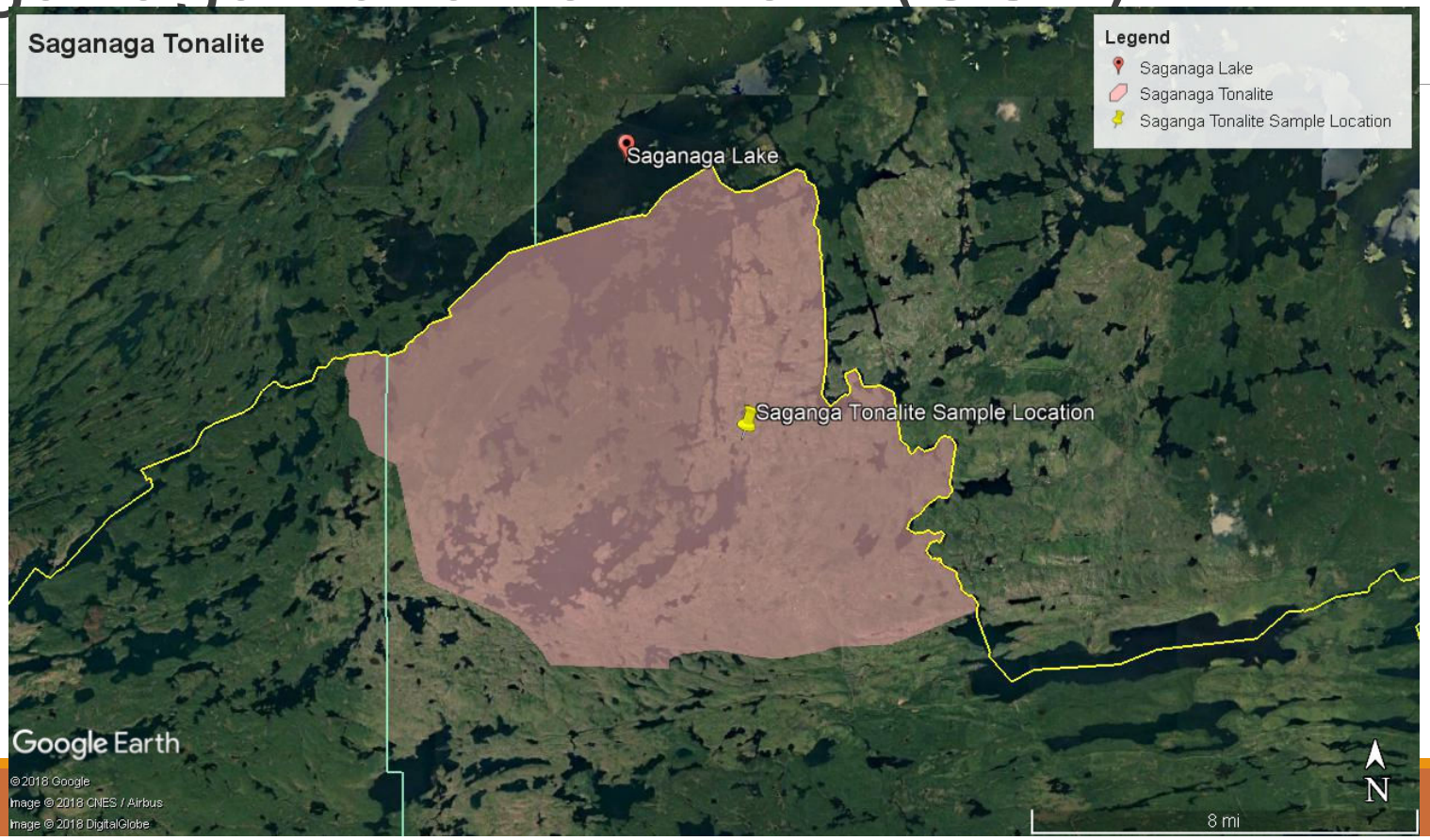
Map of Achean terranes of Minnesota



Map: usgeologymorphology.com

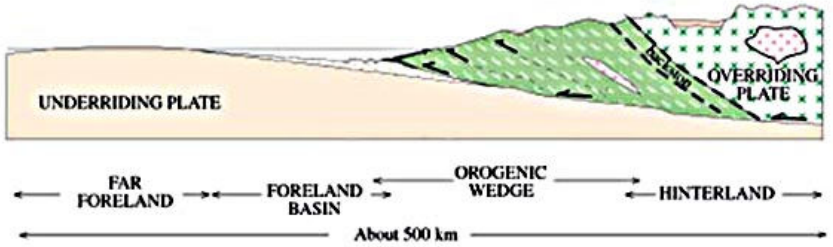

Regional Setting
Legend
Duluth Complex
Saganaga Tonalite
Google Earth
© 2018 Google
Image Landsat / Copernicus
Image NOAA
60 mi
N

Saganaga Tonalite Extent (USA)



Algoman Orogeny

Repeated episodes of Late Archean continental collisions, compressions, and subductions



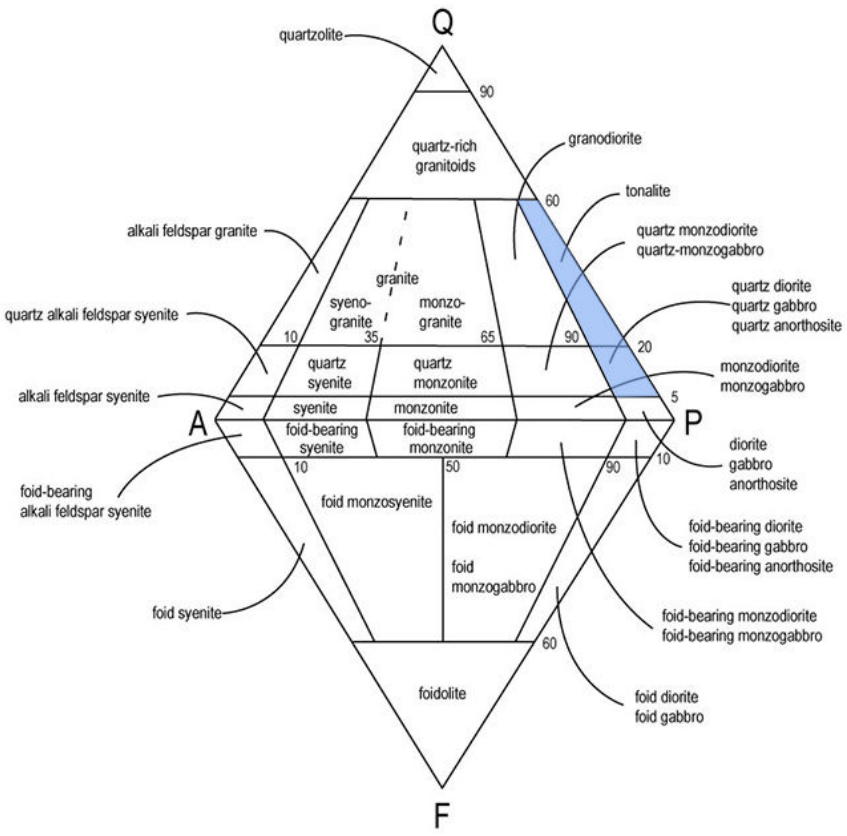
Saganaga Tonalite

Homogenous, composite Intrusive body

Intrudes Greenstone and Northern Light Gneiss and overlain by metasedimentary rocks of Knife Lake Group (Hanson,1962)

Composition

- Felsic
  - 20-60% Quartz
  - 50-90% Plagioclase (Oligoclase or Andesine)
  - <10% Alkali Feldspar



Mineral Approximation

	Sample	Plagioclase (%)	K-spar (%)	Quartz (%)	Other (%)
Saganaga Tonalite	ACR18 - 1	55	5	35	5
	ACR18 - 2	65	5	25	5
	ACR18 - 3	65	0	30	5
Average		61.67	3.33	30.00	5.00

- Mineral Approximations were made via petrographic microscope for three different thin sections.
- Average mineral percentage for the bulk rock sample is shown.

Guiding Question

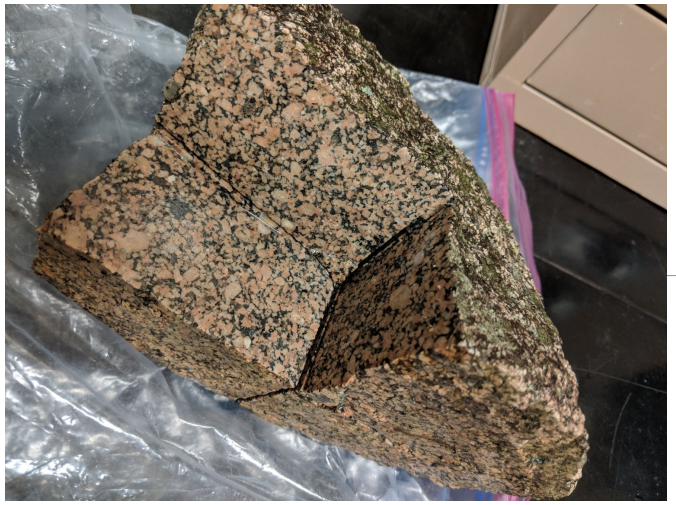
Determine if the cooling rate of the Saganaga Tonalite can be estimated based on 2-D crystal size distribution of Plagioclase

Methods

Produced 3 thin sections

Analyzed general mineral composition and identified Plagioclase crystals

Import image, taken on Dr. Tackett's microscope, of thin sections into an image analysis software (Digimizer) for crystal size distribution analysis



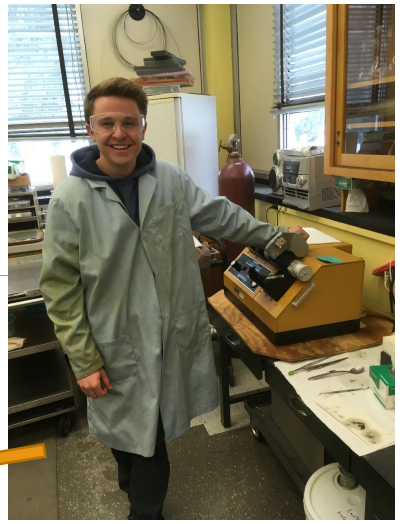
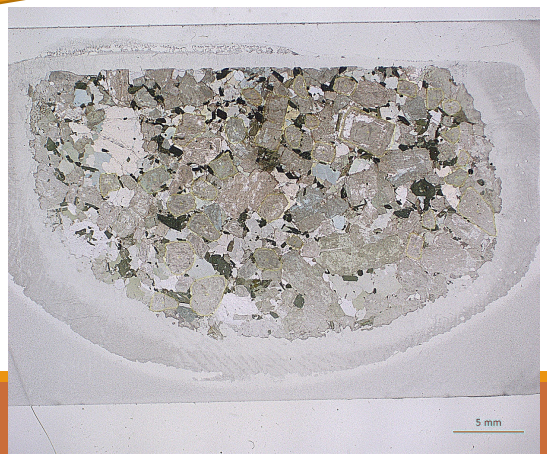
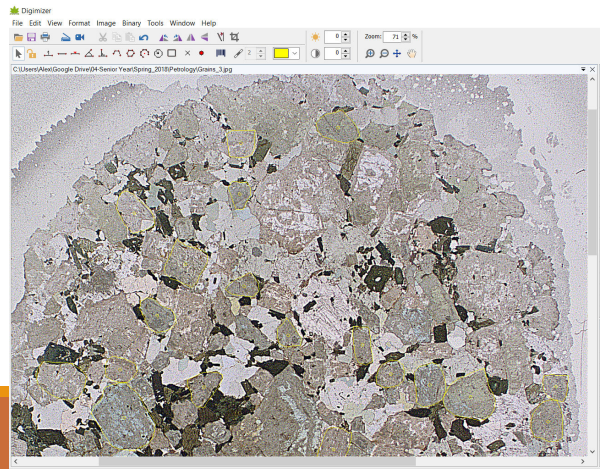


Photo courtesy of Dr. Eidukat





Crystal Size Distribution (CSD)

Crystal size and number density are intricately linked to the rates of crystal growth and nucleation, which change in response to variations in magma temperature, vapor pressure, and melt composition.

3-D analysis must be done to get truly accurate data, however, this study will analyze a 2-D surface, so there is error built it

The focus of this study is to see if CSD will work on a Tonalite using a 2-D analysis

(Brugger & Hammer, 2010)

Digimizer: Image Analysis Program

Digimizer allows you to:

- Manipulate an Image
  - Contrast & brightness
  - **Background correction**
  - **Despeckle**
  - Convert to color or grayscale
  - **Sharpen**
  - Negative
  - Filters
  - Etc.

- Make Manual Measurements
  - **Define unit of measurement**
  - **Distances**
  - Perimeters
  - **Areas**
  - Measure Angles
  - **Mark and Count Objects**
  - Etc.

- Image Analysis
  - Binarization
  - Overlay binary Layer
  - Noise reduction
  - Object detection

Digimizer
image analysis software

www.digimizer.com

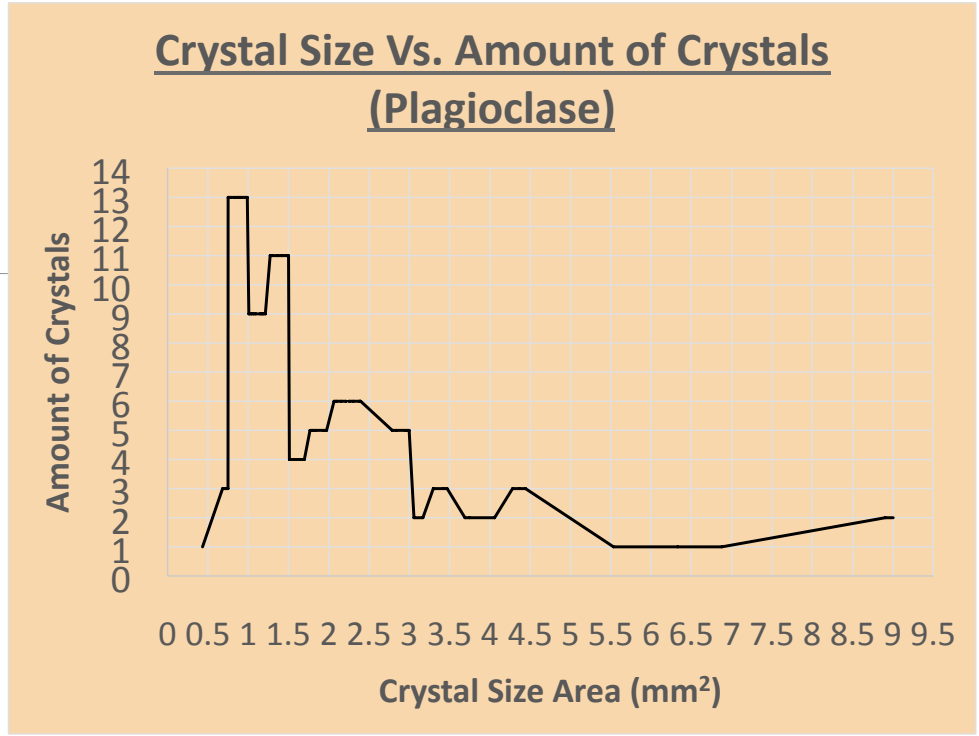
Analysis of Plagioclase Minerals

Interpretation

CSD analysis shows that the majority of plag. grains are between 0.75 – 3 mm^2 in area

Distribution shows some outliers and has a high variance

- Could be misidentified minerals (quartz and not plag)
- Whole rock could have been slightly metamorphosed and some crystals didn't melt entirely



Conclusion

Saganaga Tonalite is composed of approximately 61% Plag, 3% K-spar, 30% quartz, 5% Other

Plag. crystals are approximately 30% longer than they are wide

Plag. crystal size distribution is highly variable (0.43 – 9mm^2) with the majority of crystals between (0.75 – 3mm^2)

CSD to determine cooling rate in 2-D analysis was not determined because of extreme error in size distribution because of the cut-section effect