

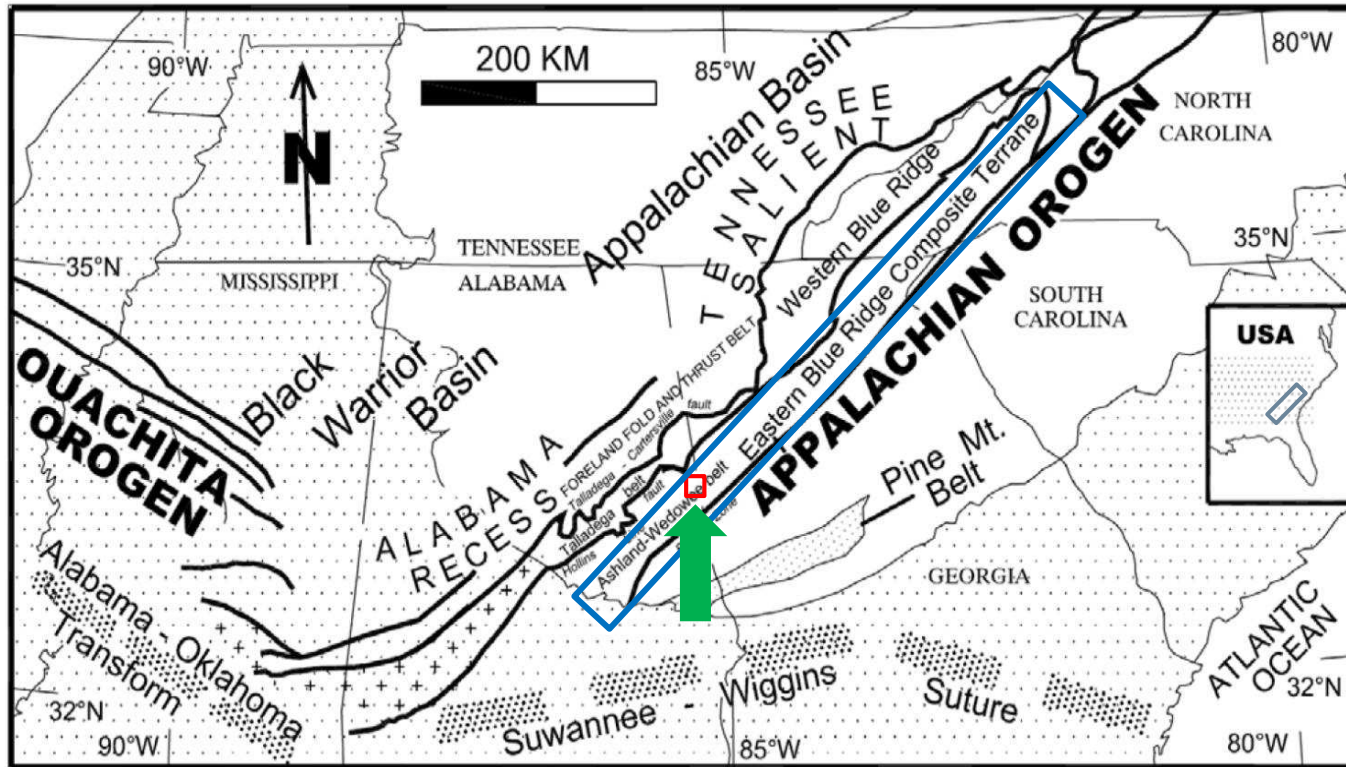
# SOUTHERN BLUE RIDGE OF EAST CENTRAL ALABAMA: A STUDY OF THE WEDOWEE AND EMOCKFAW GROUPS OF THE ASHLAND-WEDOWEE-EMOCKFAW BELT

Valarie J Smith

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Earth, Ocean, Atmospheric Science

# Purpose and Scope



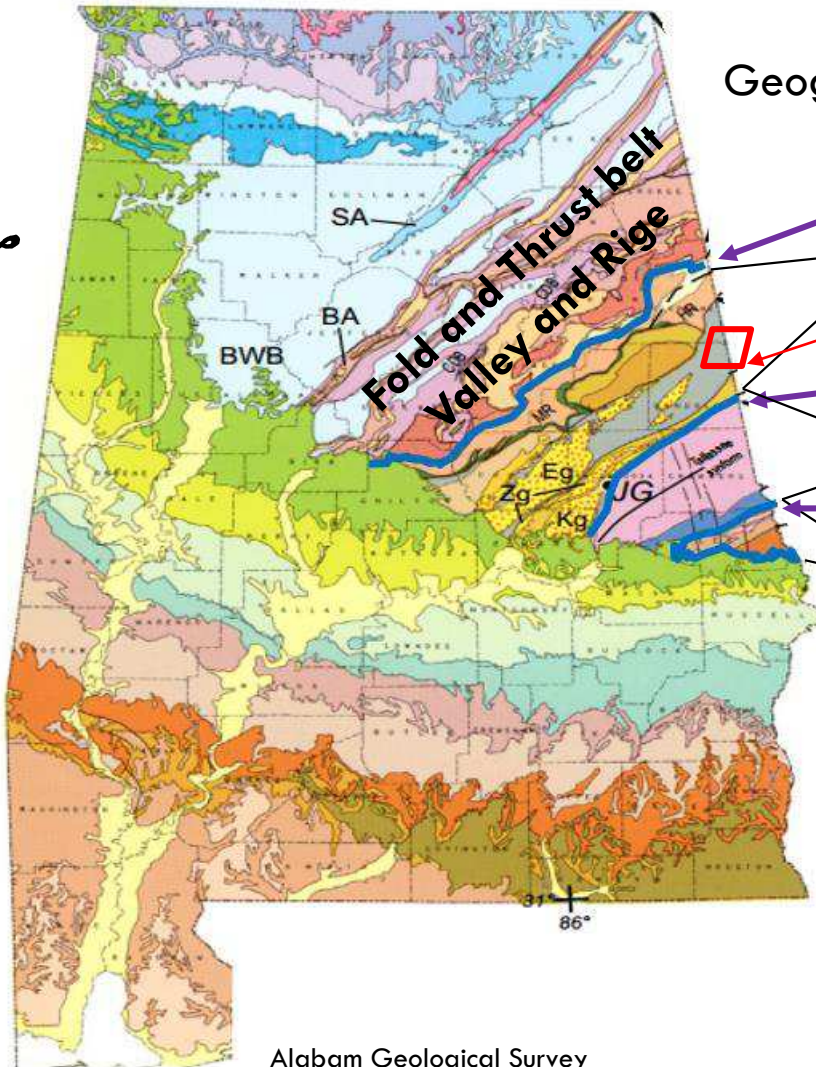
Tull et al., 2007

Determine the structural Geometry and relationship Between the Wedowee and Emuckfaw Groups in the Graham 7.5 Minute Quadrangle

- Contact Relationship
- Tectonic Setting/History

# Geologic Setting

1  
N



Geographical Setting/Geologic Setting

Talladega-Cartersville fault

**Northern Piedmont**

Research area

Brevard fault zone

**Inner Piedmont**

Tawliga fault

**Southern Piedmont**

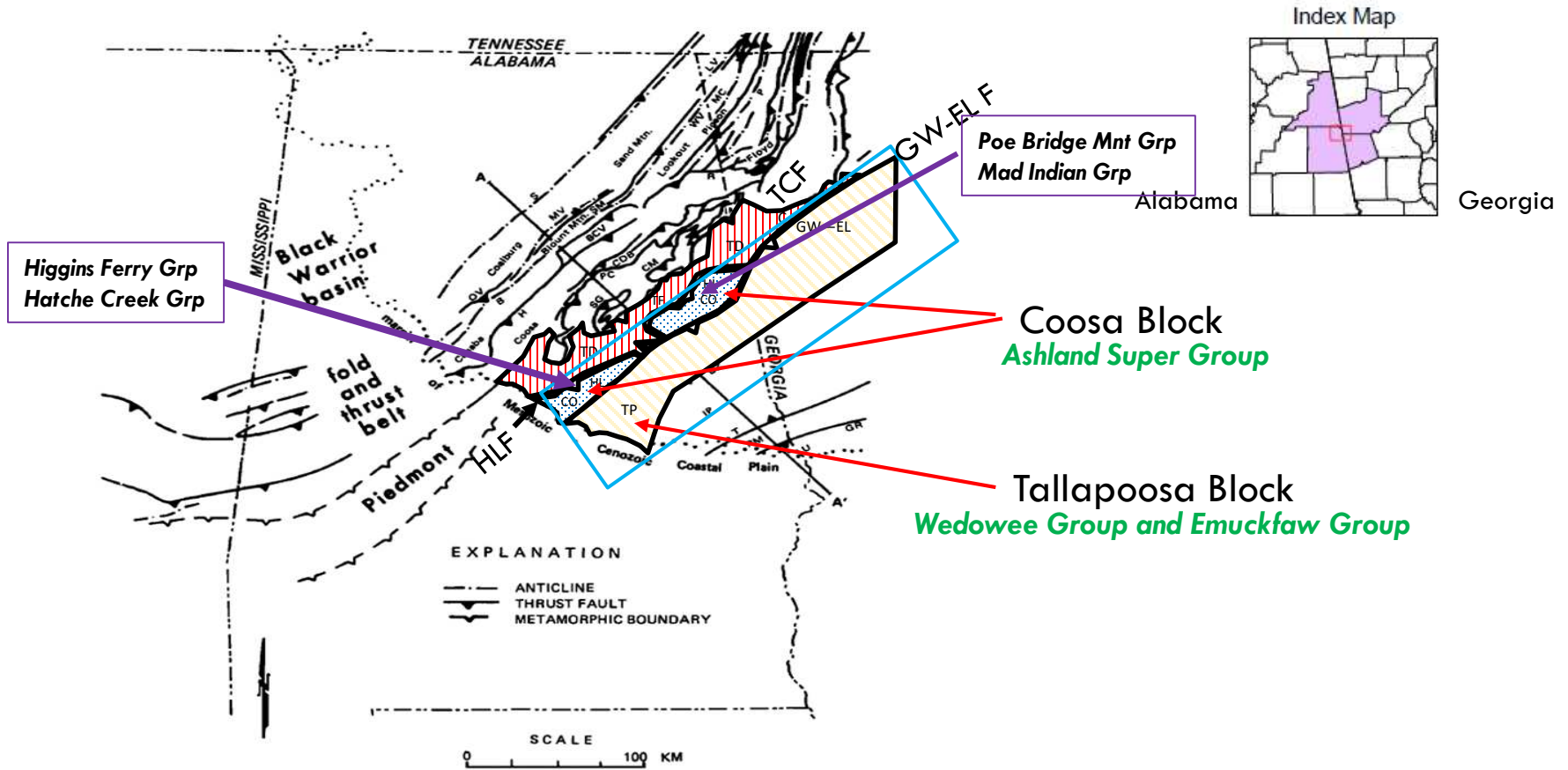
Index Map



Alabama

Georgia

# Geologic Setting

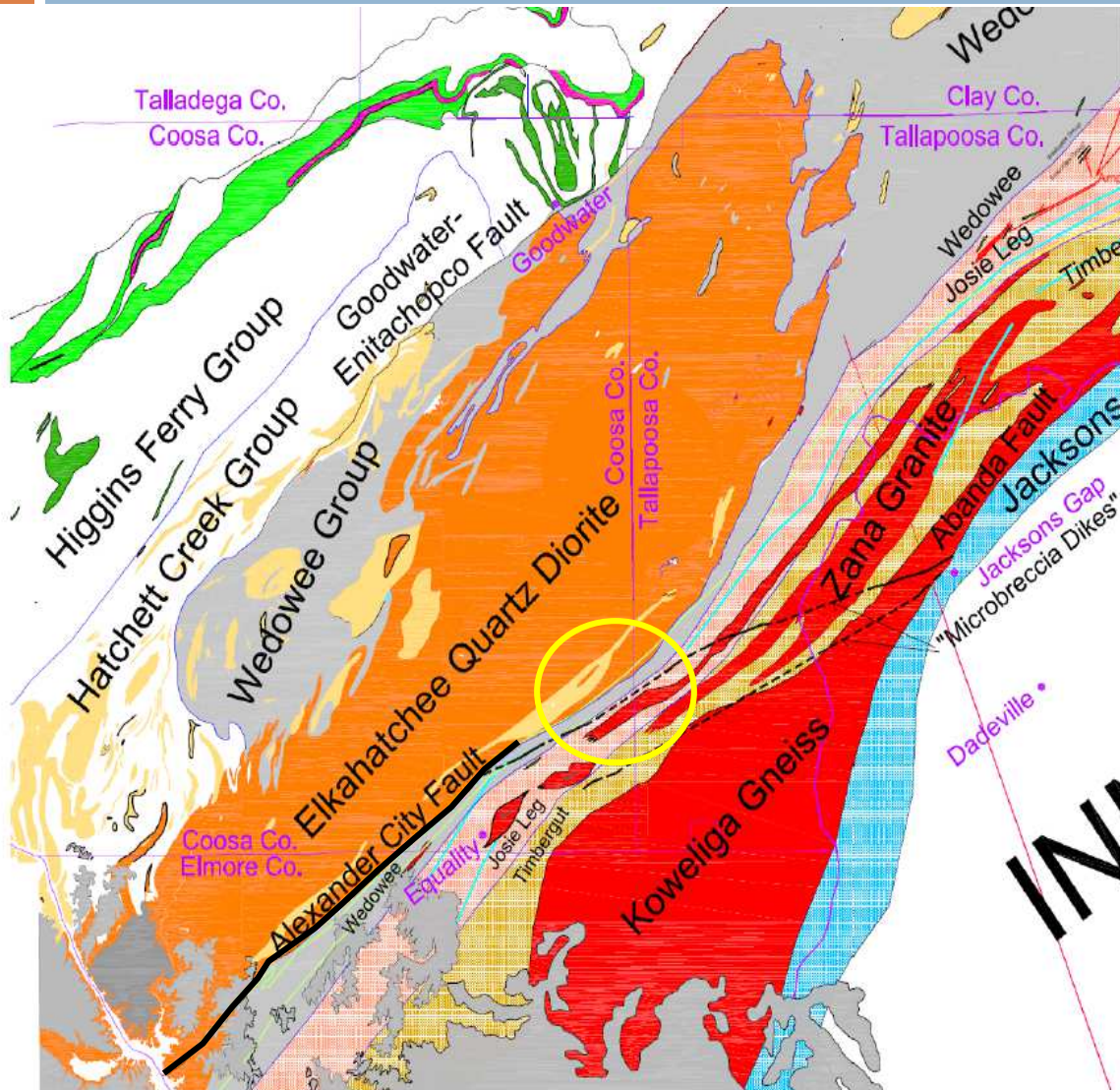


TCF – Talladega-Cartersville fault  
 HLF – Hollins Line fault  
 GW-EL – Goodwater-Enitachopoca fault

Ashland-Wedowee-Emuckfaw  
 Metamorphic belt



# Geologic Setting

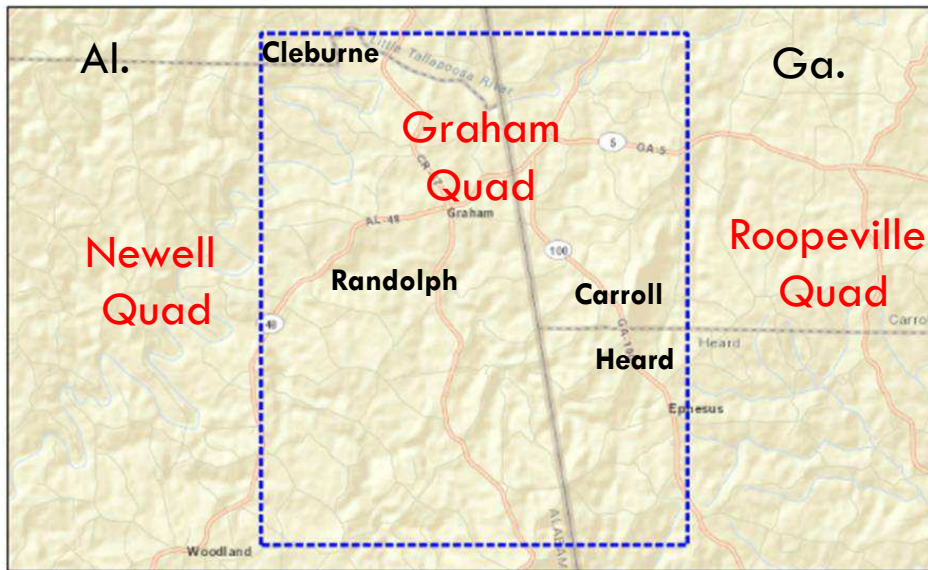


Wedowee – Emuckfaw  
Contact along the Alexander  
City fault

# Methods Overview

USGS, 2011

Bowden West  
Quad



- Detailed Mapping of the Graham 7.5 Minute Quadrangle and the surrounding quadrangles to the west, north, and east
- Supported by EDMAP
- Supporting Analysis:
  - Mesoscopic and Microscopic
  - Stereographic
  - Geochemical
  - Integrated Geochemistry and Geochronology

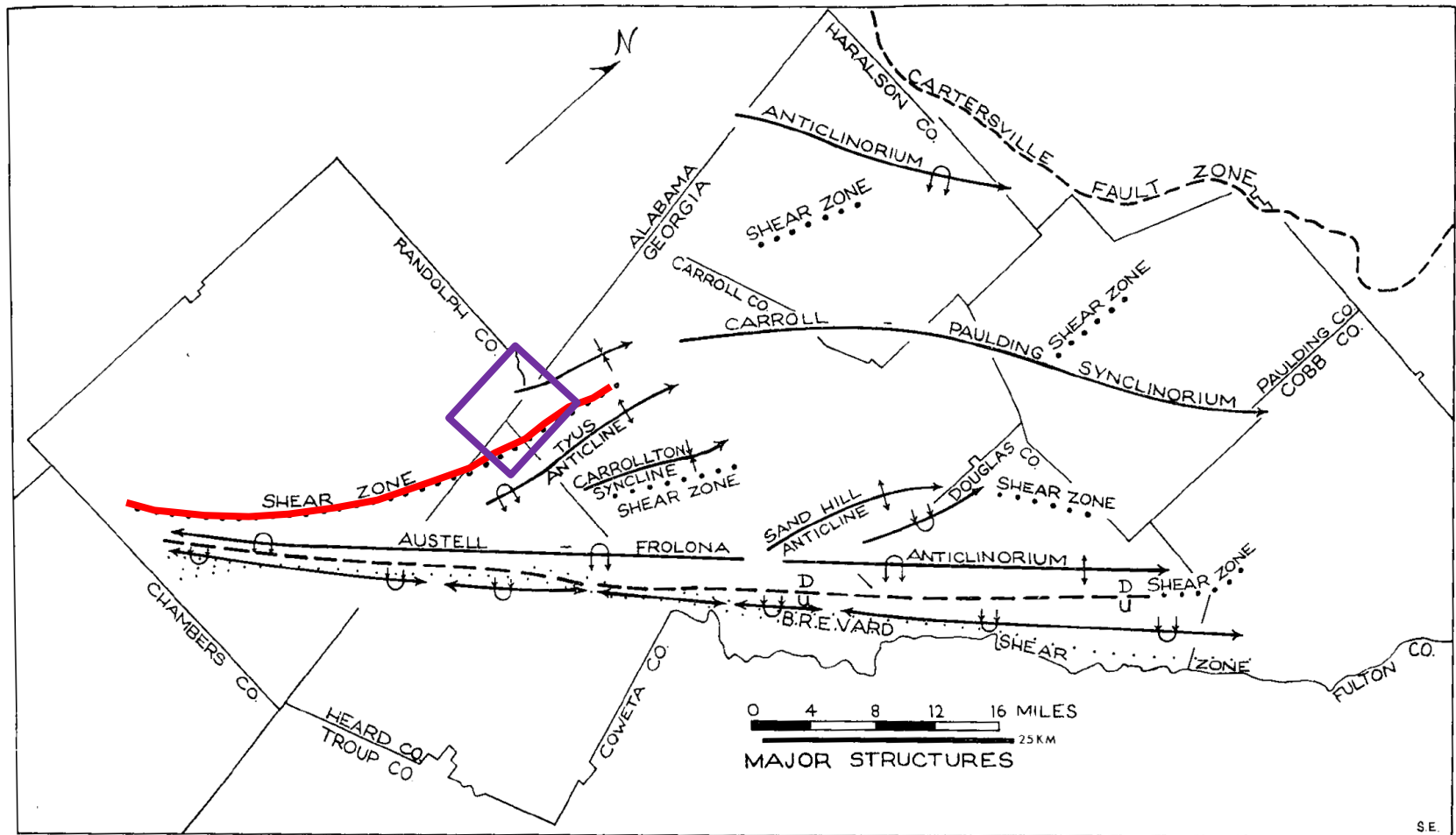
Napoleon  
Quad

Elevation range:  
820 ft asl – Little Tallapoosa River  
1520 ft asl – Black Jack Mountain  
700 ft of total relief





# Mapping and Stereographic Analysis



Purposed Ohama fault extended into northeast Randolph County

Crawford and Medlin, 1974 – described a shear zone

Crawford and Medlin, 1974



# Geology of the Graham, Alabama 7.5' Quadrangle and Parts of Adjacent Quadrangles

## Map Explanation

### Structural Features

- Cleavage
- Bedding
- Mineral Lineations
- Crenulation Lineations

- Anticline
- Syncline
- Plunging Anticline
- Plunging Syncline
- A-A' Cross Section

### Transportation

- State Routes
- Main Roads

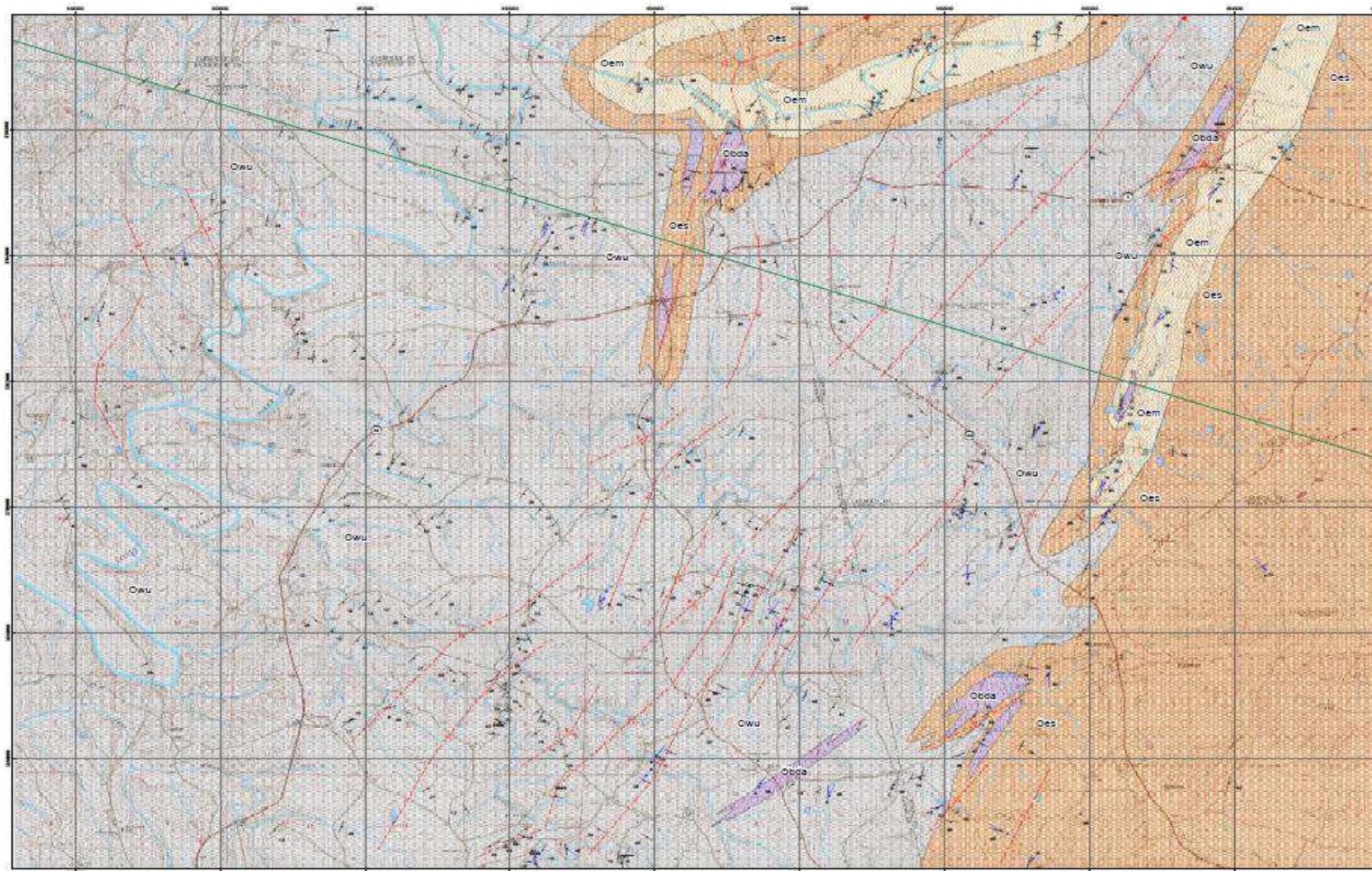
### Water Bodies

- Rivers and Streams
- Lakes

### Lithologies

- Beaver Dam Amphibolite
- Emuckfaw Interlayered Schist
- Emuckfaw Metagraywacke
- Wedowee Undifferentiated

### Index Map



Contour Interval: 20 Feet  
1:24,000

0 0.5 1 2 3 4 Kilometers

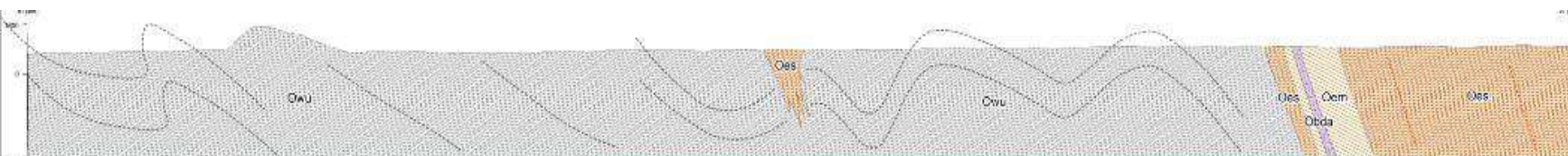
0 0.5 1 2 3 4 Miles

Drafted and Mapped by: Valerie J. Smith  
January, 2016

MN  
4° 10' GN  
74 MILS 0° 56' 17 MILS

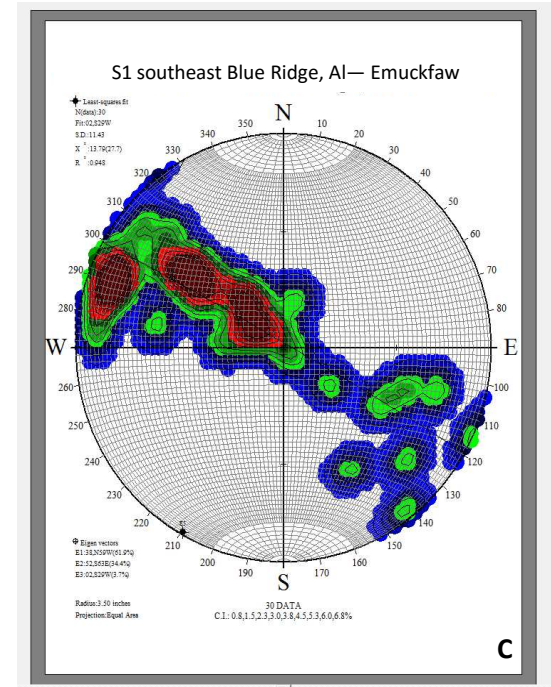
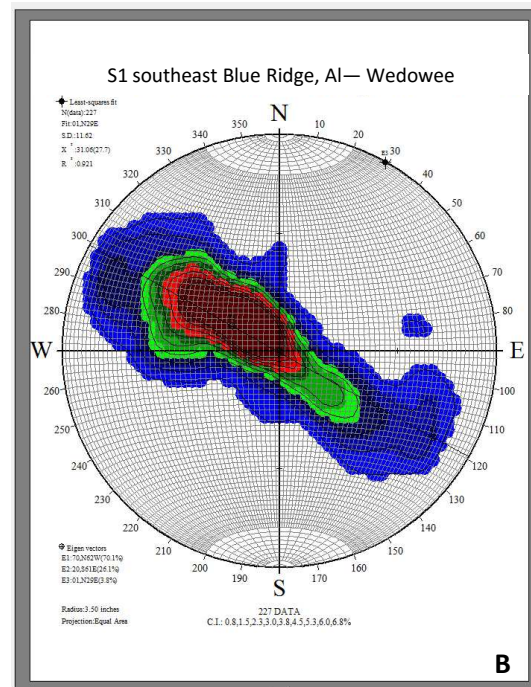
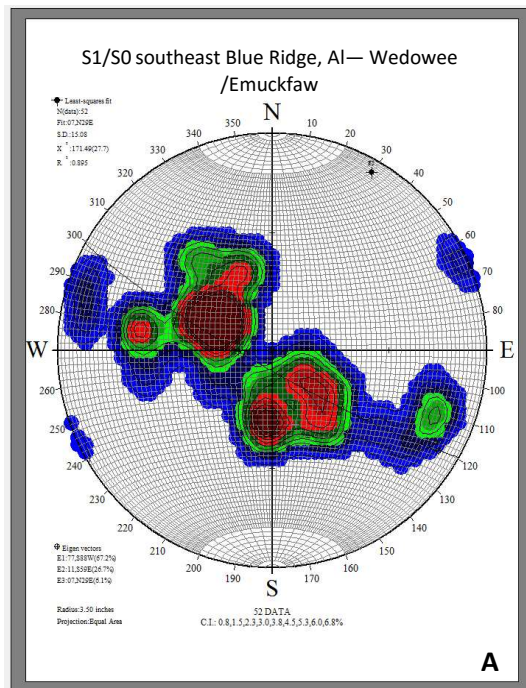
(December 2014)

Projections and Datum:  
UTM: NAD 1983 Zone 16 N  
The majority of contacts shown are approximate.



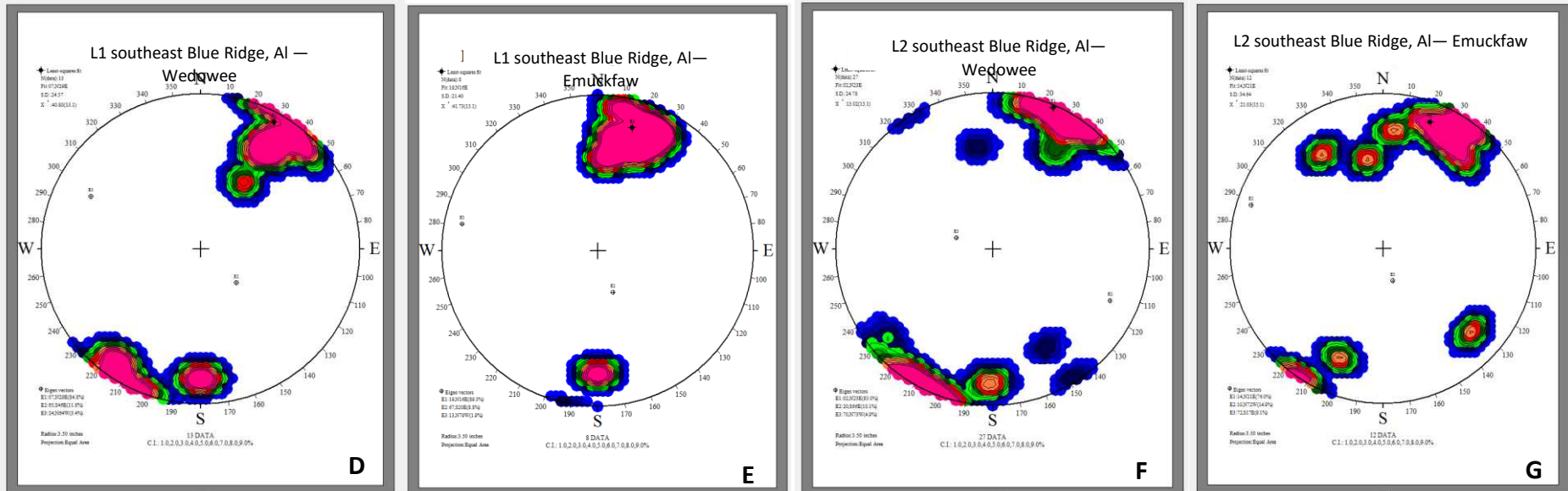


# Mapping and Stereographic Analysis of the Wedowee and Emuckfaw Groups



- The bedding ( $S_0$ ) and foliation ( $S_1$ ) of both groups are parallel and concordant
- $S_1$  orientation same over the mapping area
- $F_2$  fold trend is NE to SW with an overall shallow plunge to the NE
- Separate  $S_1$  data shows an inclined fold trend for both groups plunging to NE

# Mapping and Stereographic Analysis of the Wedowee and Emuckfaw Groups



$S_1$  and  $L_1$  are subparallel for both groups

$L_1$  for both groups trends NE to SW

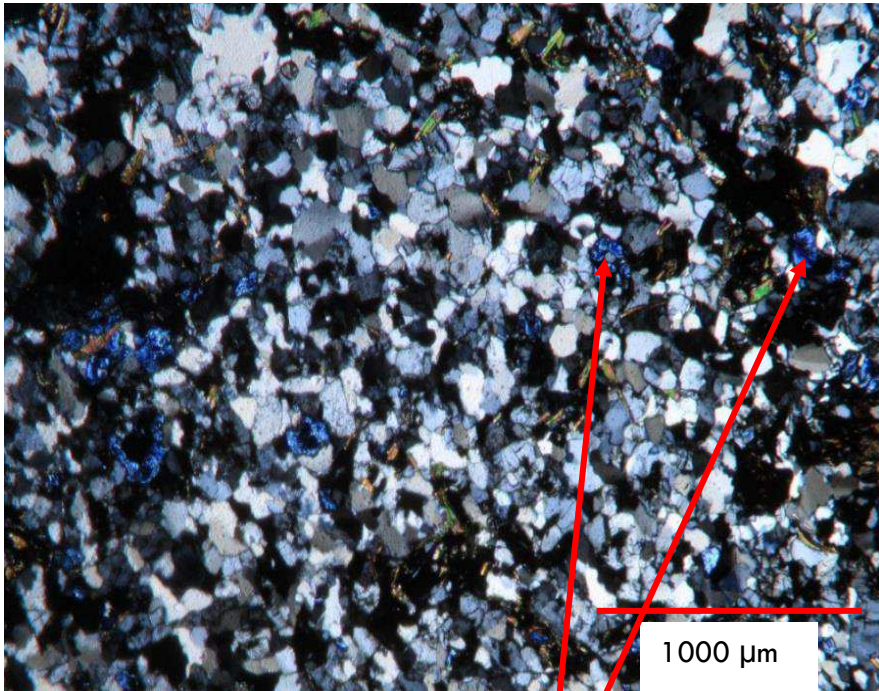
$L_1$  and  $L_2$  for both groups are coaxial to one another



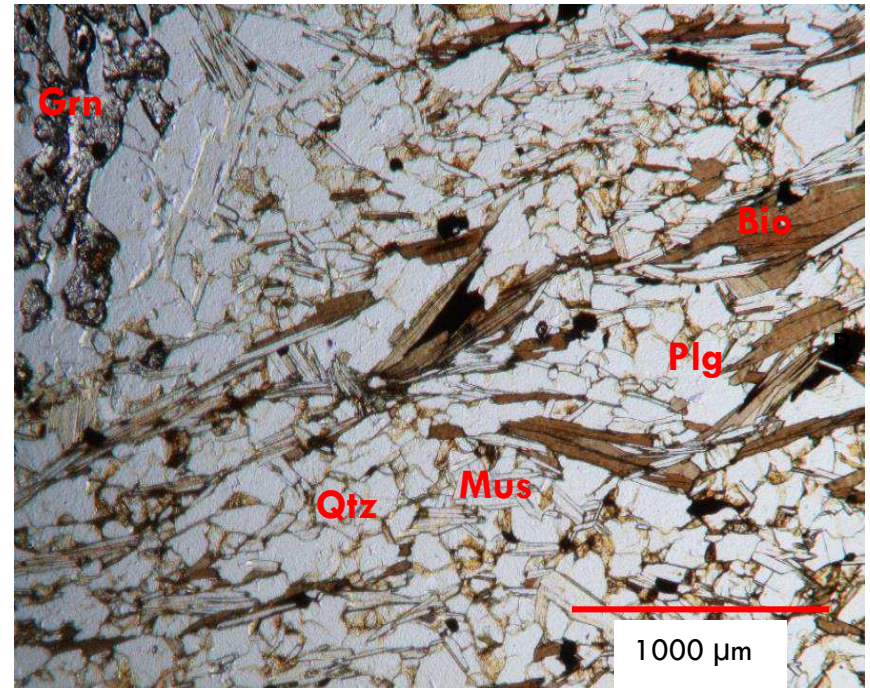
# Lithological Descriptions and Thin Section Analysis Wedowee

Cross Polar Light

Plain Light



A



B

Metagraywacke

A) Clinozosite  $\text{Ca}_2\text{Al}_3(\text{SiO})_4(\text{OH})$

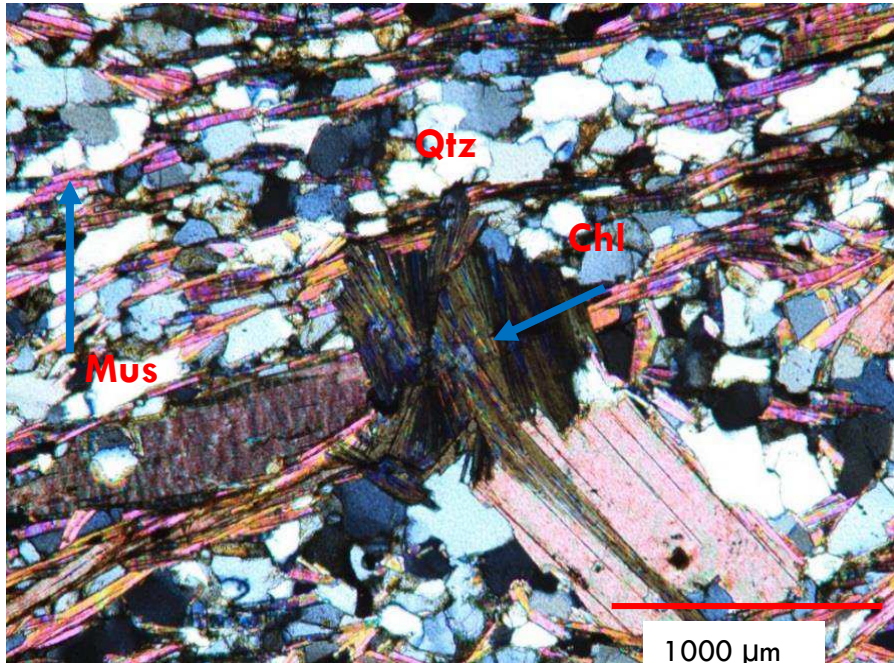
B) Quartz and feldspar – preferred orientation

Biotite crystals – larger than the matrix

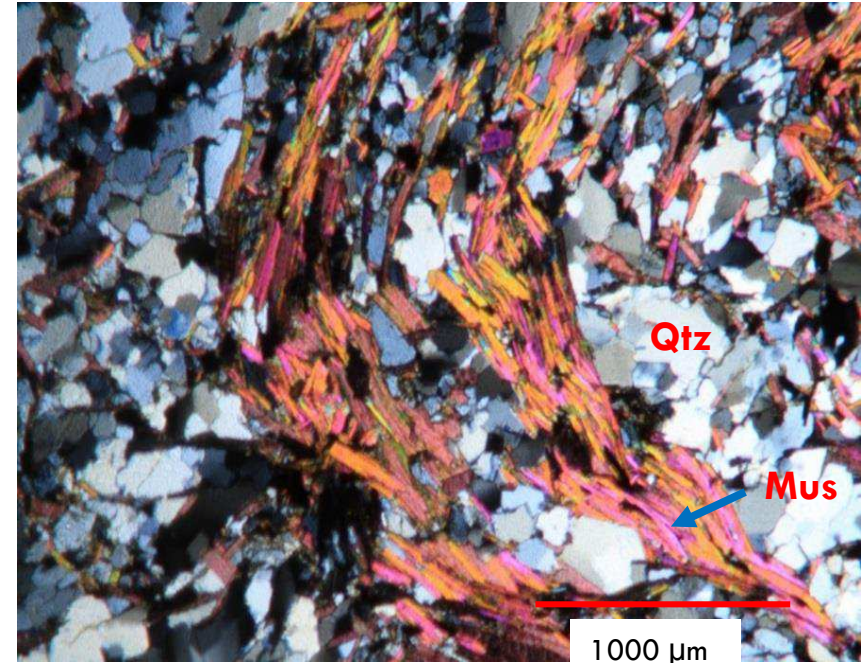


# Lithological Descriptions and Thin Section Analysis Wedowee

Cross Polar Light



A



B

Metagraywacke

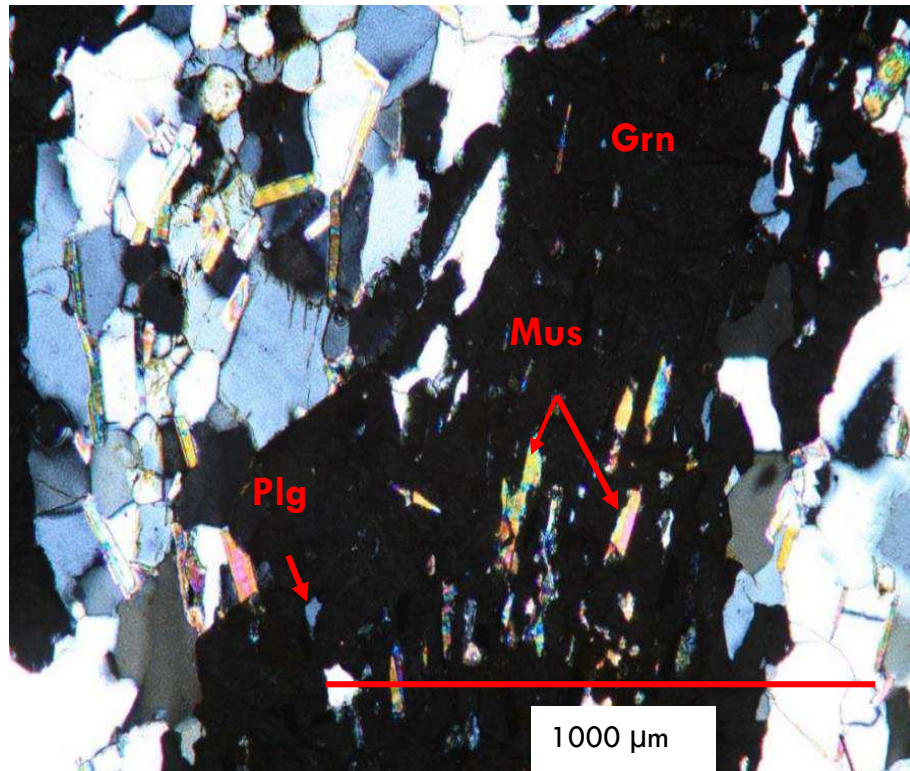
- A) Chlorite growth in radial pattern from a single nucleation site, cutting across foliation
- B) Microfold (crenulations) – muscovite crystal growth is parallel to cleavage and defines the cleavage plane.



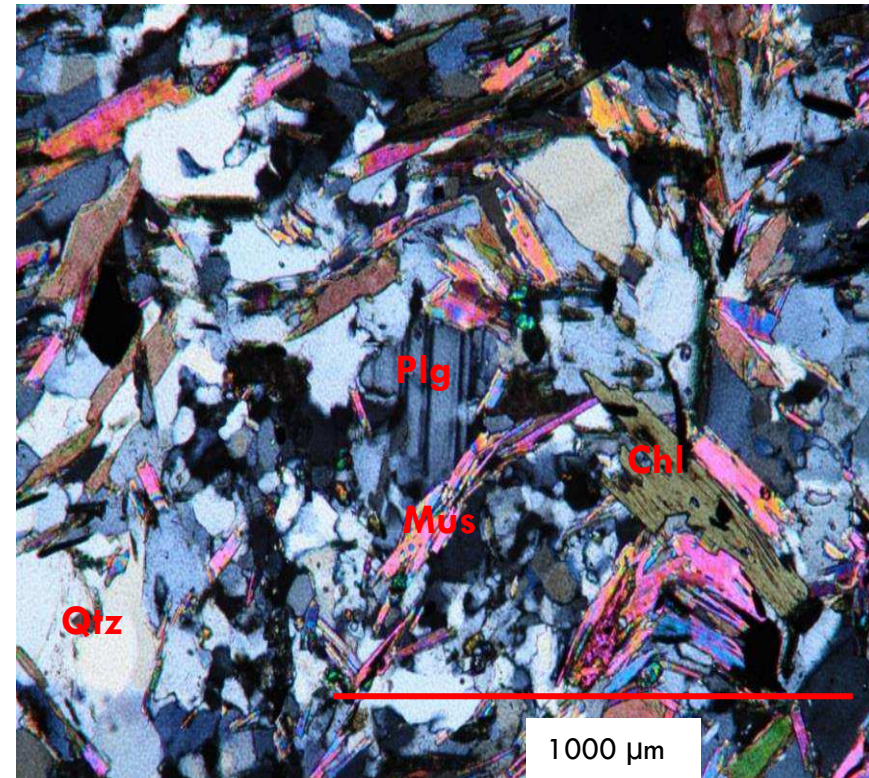
# Lithological Descriptions and Thin Section Analysis Wedowee

Cross Polar Light

Metagraywacke



A



B

- A) Porphyroblastic garnet cutting across foliation with quartz, feldspar, and muscovite inclusions
- B) Feldspar displaying pericline twinning – possibly detrital

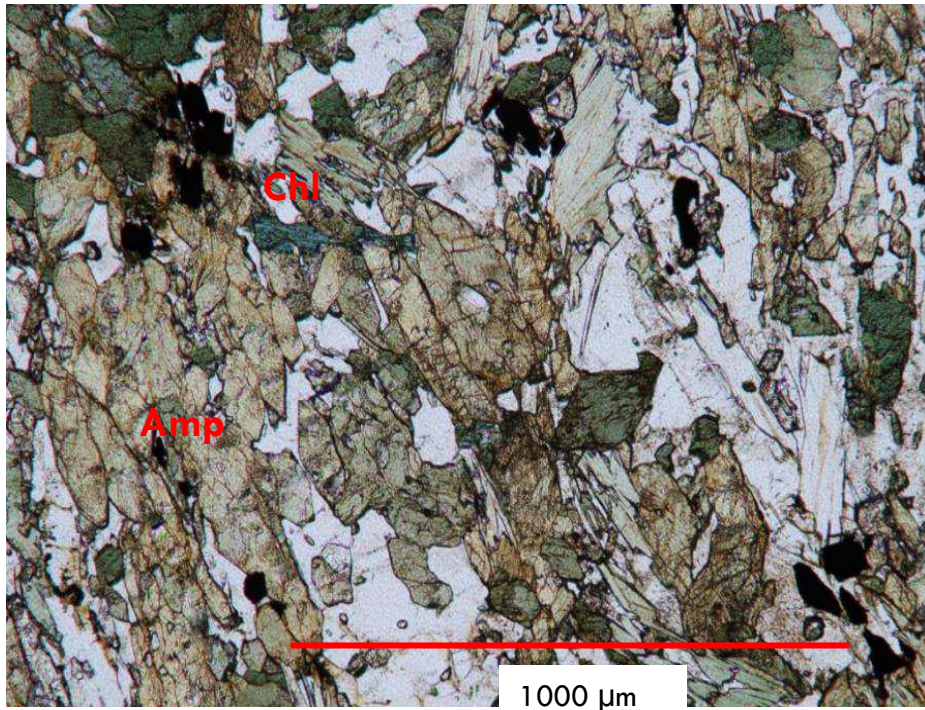


# Lithological Descriptions and Thin Section Analysis Emuckfaw

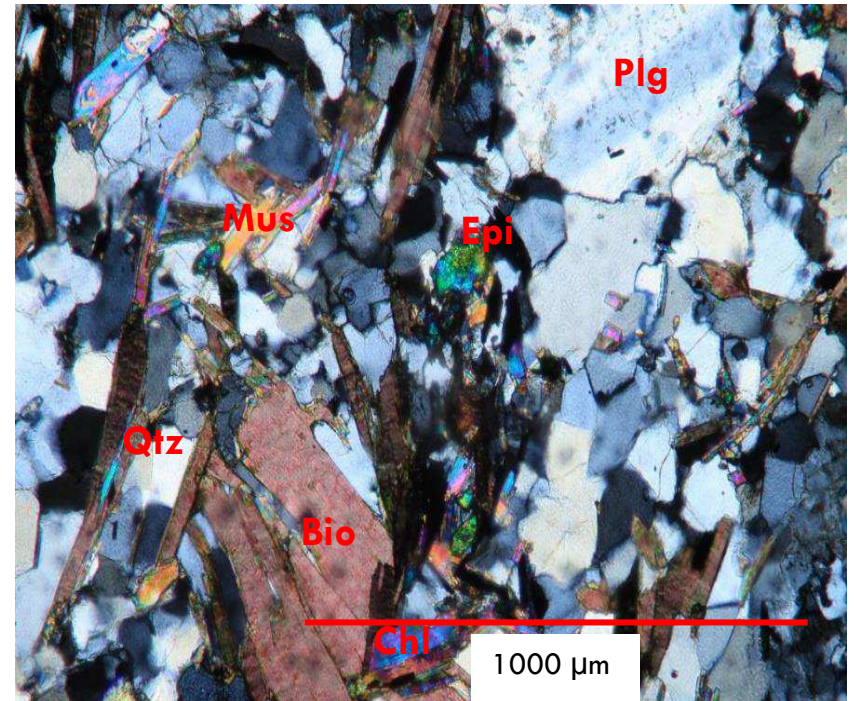
Plain Light

Metagraywacke

Cross Polar Light



A



B

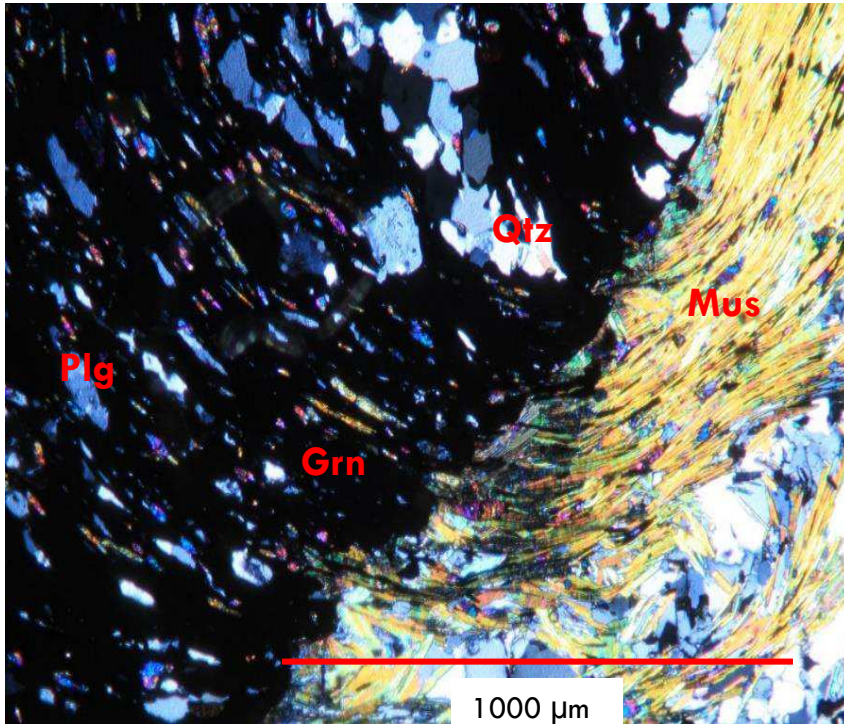
A) Abundant amphibole and chlorite

B) Feldspar (detrital?) showing pericline twinning

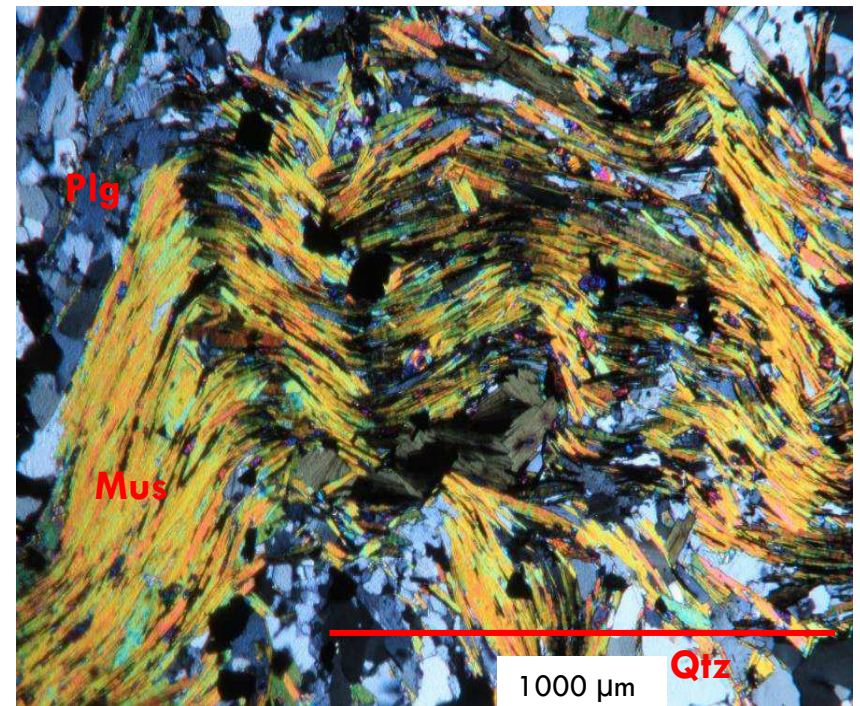


# Lithological Descriptions and Thin Section Analysis Emuckfaw

Cross Polar Light



A



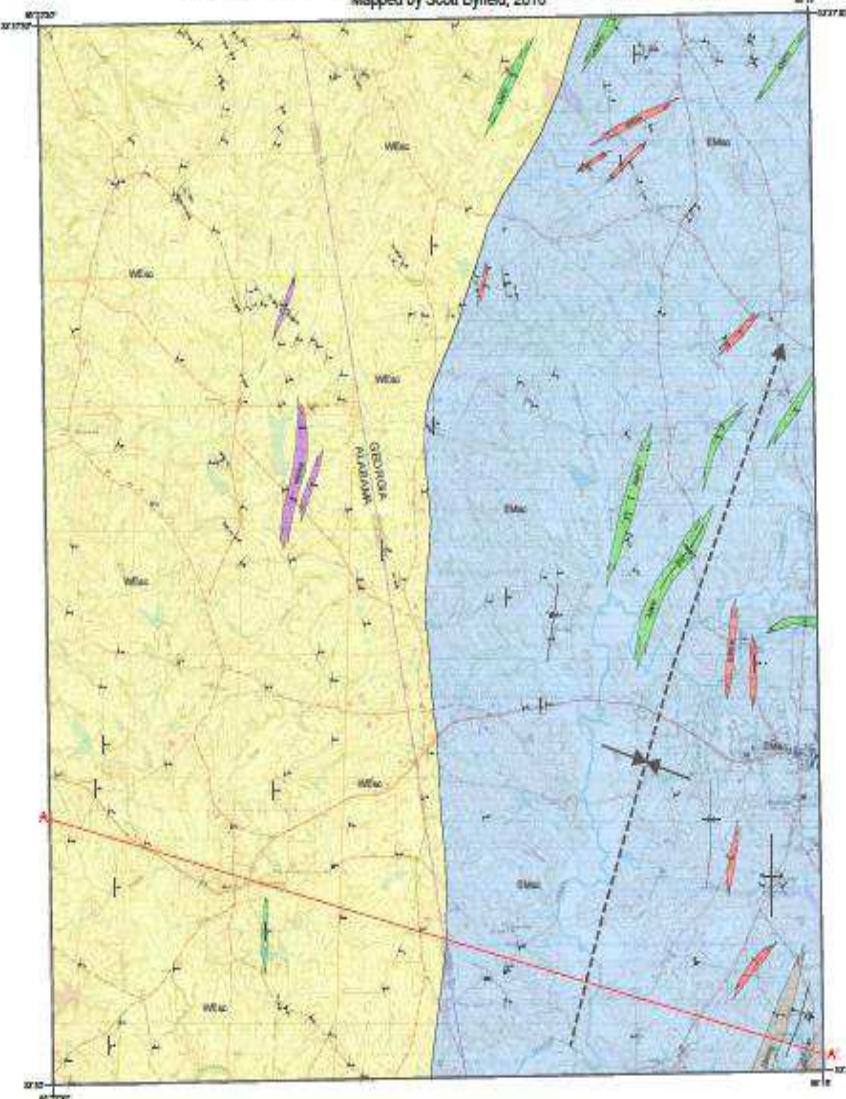
B

Metagraywacke

- A) Porphyroblastic garnet with quartz, feldspar and muscovite inclusion
- B) Kinked muscovite crystals – crystal growth along foliation planes



GEOLOGIC MAP OF THE BOWDON WEST QUADRANGLE, ALABAMA/GEORGIA  
Mapped by Scott Byfield, 2016



- Lithologic contact
- Alabama-Georgia state line
- Cross-section line
- Trend of cleavage in cross-section

- Strike and dip of bedding (S0)
- Strike and dip of foliation and bedding - parallel (S0/S1)
- Strike and dip of foliation (S1)
- Strike and dip of S2 (crenulation) Cleavage
- Plunge and bearing of L1 (mineral and intersection) lineations
- Plunge and bearing of L2 (crenulation) lineations

— Axial Trace of Minor Synforms

— Axial Trace of Minor Antiforms

— Axial Trace of Regional Plunging Syncline

Ordovician Emucklaw Group

EMsc

Thinly bedded fine to coarse-grained, nongraphitic, garnet-two-mica schist interbedded with paragneiss, "metagreywacke" and chlorite, actinolite schist (Beaver Dam).

EMmg

Zones of predominantly fine to medium grained quartz, muscovite, biotite, feldspar metapsammities and metagreywacke composing >50% of total stratigraphy.

Ordovician Wedowee Group

WEsc

Fine-grained, thinly laminated, locally highly graphitic psammopelitic schist, interbedded with minor metapsammities and micaceous quartzite in layers a few meters thick.

WEmg

Zones of predominantly metapsammities and micaceous quartzites composing >50% of total stratigraphy.

AMPH

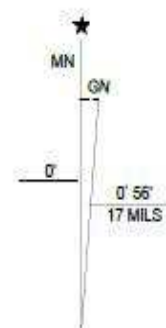
(Ordovician) Fine to medium grained actinolite, chlorite schist. Interbedded in the Wedowee Group and Emucklaw Group (Beaver Dam).

GRGN

Well foliated, medium- to coarse-grained quartz, plagioclase feldspar, muscovite, biotite granitic gneiss.



Scale 1:24,000  
Contour Interval: 20 feet



QUADRANGLE LOCATION

Mapping conducted under Educational Mapping Program agreement between USGS, Alabama Geologic Survey, and Florida State University. EDMAP Award # G15ACD0431



# Geology of the Graham, Alabama 7.5' Quadrangle and Parts of Adjacent Quadrangles

## Map Explanation

### Structural Features

- Cleavage
- Bedding
- Mineral Lineations
- Crenulation Lineations
- Anticline
- Syncline
- Plunging Anticline
- Plunging Syncline
- A-A' Cross Section

### Transportation

- State Routes
- Main Roads

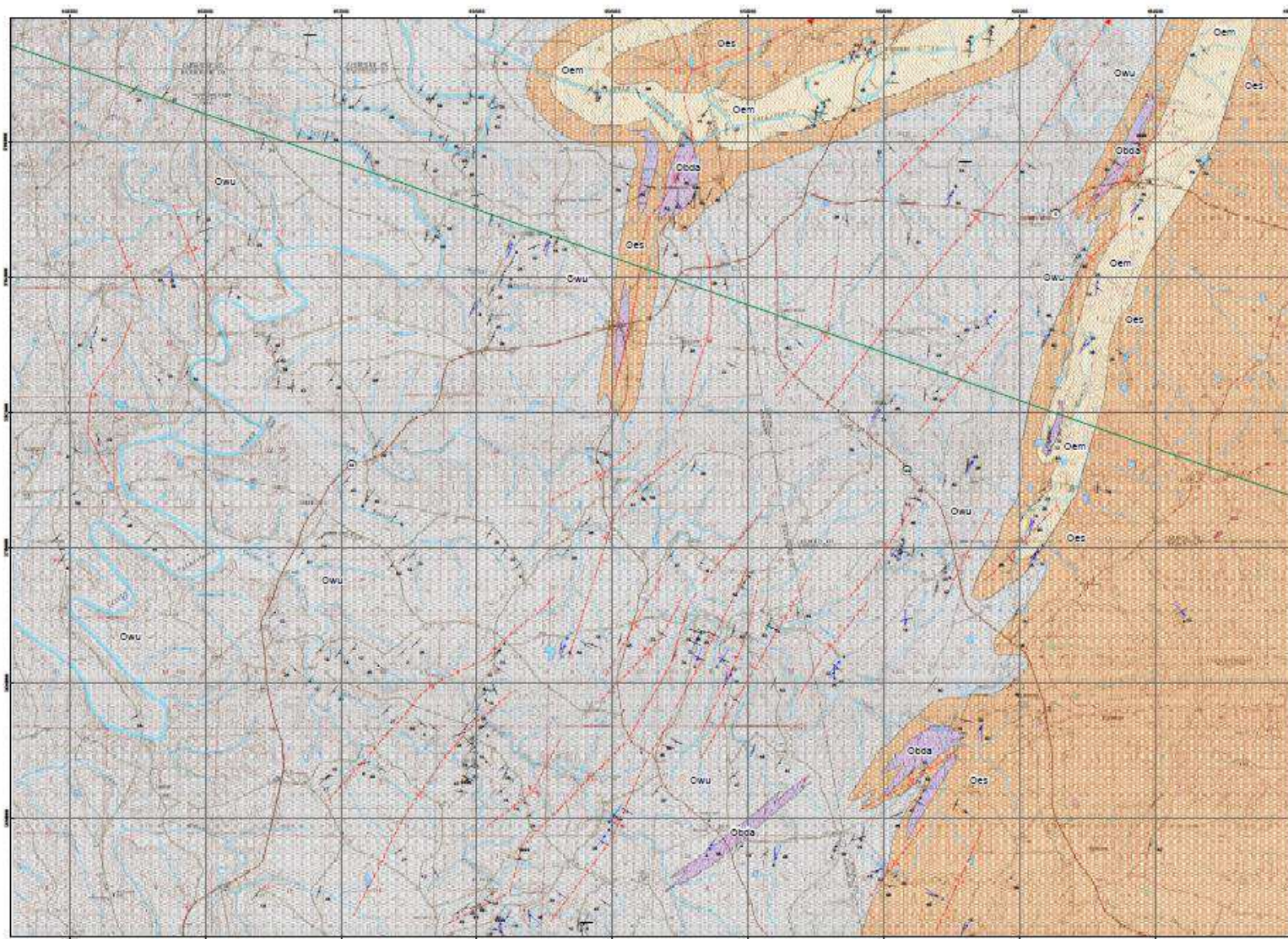
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### Lithologies

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- Emuckfaw Interlayered Schist
- Emuckfaw Metagraywacke
- Wedowee Undifferentiated

### Index Map



Contour Interval: 20 Feet  
1:24,000

0 0.5 1 2 3 4 Kilometers

0 0.5 1 2 3 4 Miles

MN  
4° 10' GN  
74 MILS 0° 56' 17 MILS

Projections and Datum:  
UTM: NAD 1983 Zone 16 N  
The majority of contacts shown are approximate.

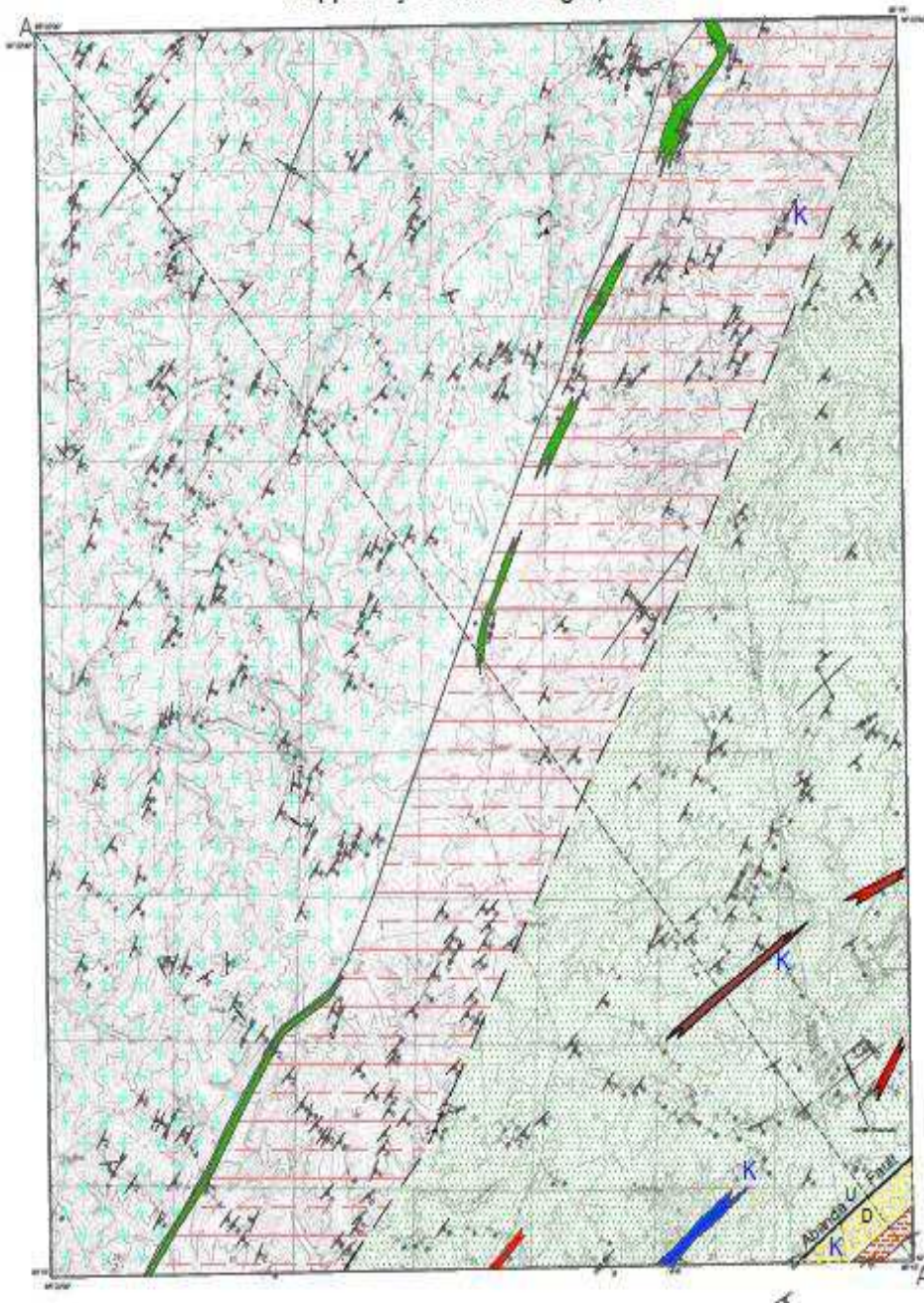
(December 2014)

Drafted and Mapped by: Valerie J. Smith  
January, 2016



# Geologic Map of the Napoleon Quadrangle, Alabama

Mapped by Jennifer Fought, 2016



- Lithologic contact
- - - Inferred contact
- Abanda Fault

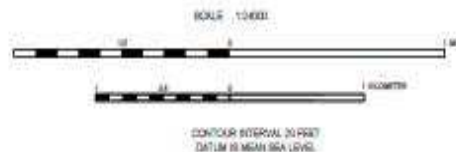
- ↗ Strike and dip of foliation ( $S_1$ )
- ↗ Strike and dip of foliation and bedding ( $S_2/S_3$ )

- Axial Plane
- ← Post S<sub>3</sub> fold axis

- ↙ Plunge and bearing of L<sub>1</sub> lineations
- ↙ Plunge and bearing of L<sub>2</sub> lineations

- X Axial trace of synform
- X Axial trace of antiform

K Kyanite locality



Mapping conducted under Educational Mapping Program agreement between USGS, Alabama Geologic Survey, and Florida State University EDMAP Award # 013AC00202

## Jackson's Gap Group

### Devil's Backbone Quartzite

Fine to coarse grained mature micaceous quartzite, 40-50 meters thick

### Backbone Schist

Coarse grained kyanite-garnet-biotite-muscovite schist with interbedded amphibolite up to 1 m thick.

## Emuckfaw Group

### Timbergut Formation

Interbedded fine-grained, variably gneissic biotite-garnet-muscovite schist with a high percentage of medium to coarse grained metagraywacke up to 100 m thick. Metagraywacke contains flakey grains up to 5 mm in diameter. Garnets up to 4 mm in diameter. Lenses of metaconglomerate, metadiamictite, granite, and rare kyanite schist. Metasediments are locally cross-bedded.

### Metaconglomerate

Contains quartz pebbles up to 2 cm in diameter.

### Metadiamictite

Contains large feldspar, quartz, and granite pebbles. Protolith debris flow with mud matrix.

### Granitic Gneiss

Muscovite-biotite granitic gneiss lenses 10-20 m thick.

### Jostle Leg Formation

Non-gneissic to gneissic-poor biotite-muscovite schist with minor garnet and quartz-rich metagraywacke interlayered. Lowermost portion contains abundant sections of Beavertown Amphibolite, with 20 cm layers of meta-rhyolite.

### Amphibolite

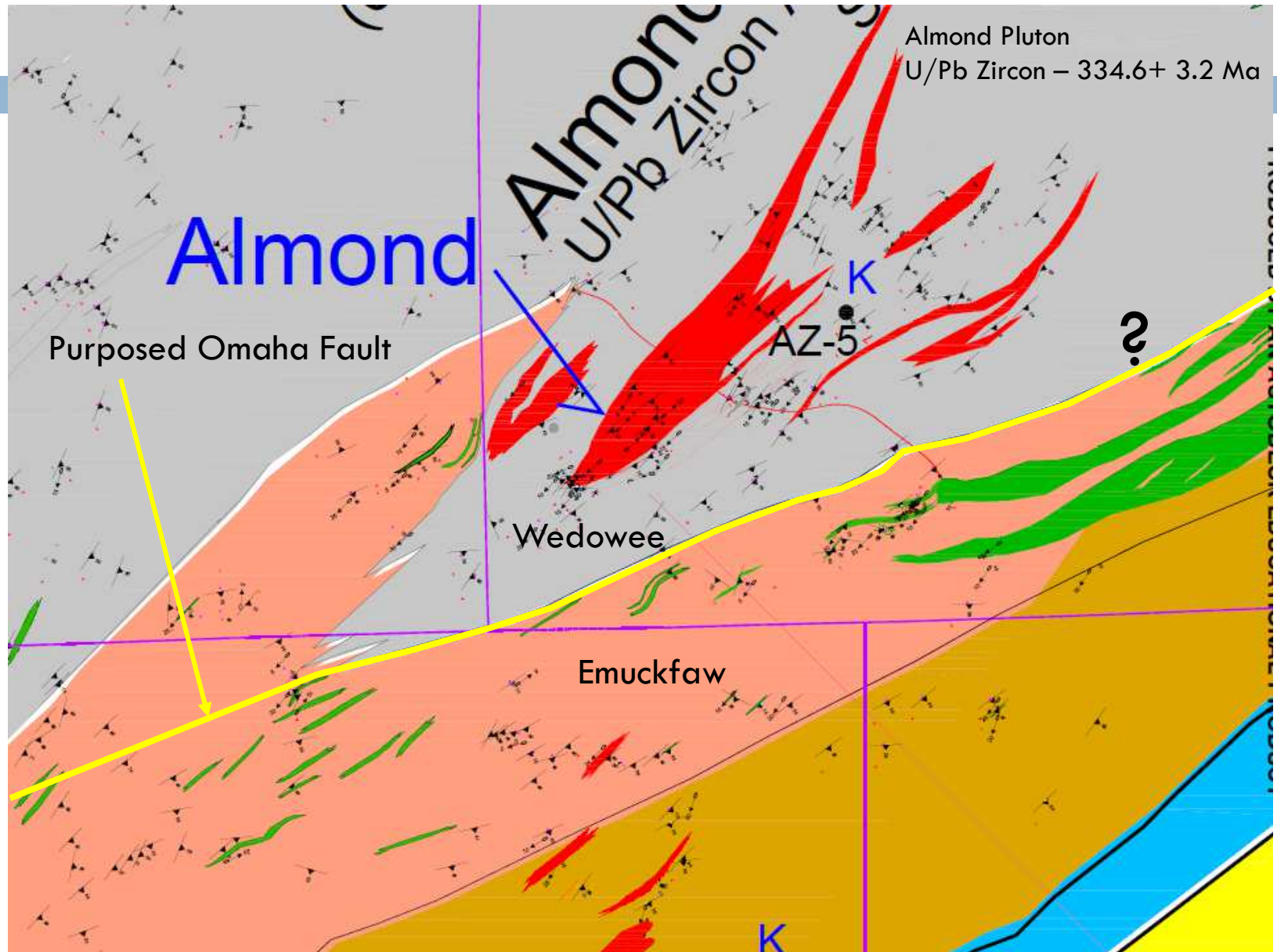
Medium to coarse grained well foliated with distinctly banded plagioclase and hornblende, 40-50 m thick.

## Wedowee Group

Basal-vent basin deposits containing a sequence of foliated, well laminated and interbedded variably gneissic, garnetiferous biotite-muscovite schist, metagraywacke, and rare thin beds of fine-grained biotite gneiss. Schist layers 1-4 cm thick. Garnet 4-5 mm in diameter.



# Recent Observations



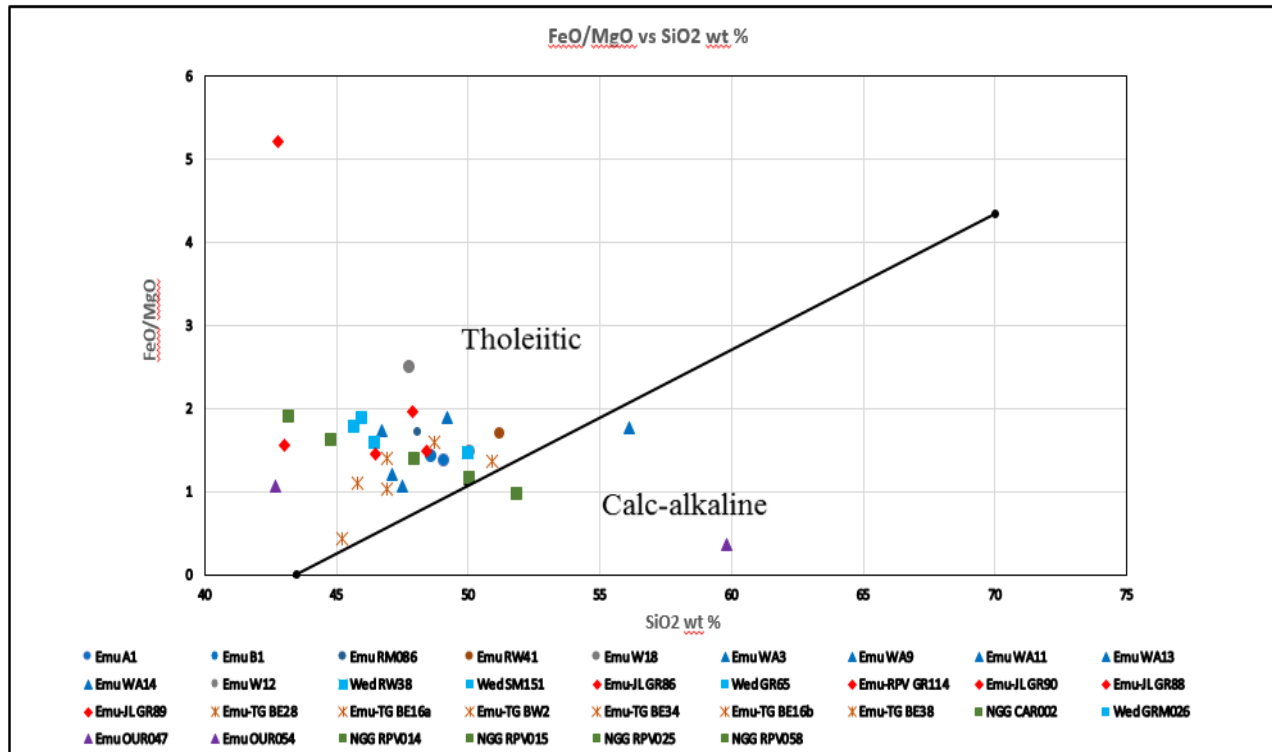


# Geochemistry

## □ Methods

- Analysis of 12 samples of amphibolites
  - 1 sample from undifferentiated Wedowee - Alabama
  - 4 samples from Josie Leg Formation of the Emuckfaw - Alabama
  - 1 sample from Roopeville Formation of the Emuckfaw - Georgia
  - 7 samples collected from Timbergut Formation of the Emuckfaw - Georgia
- 20 samples compiled from other studies were incorporated into data set (total of 32 samples)
- Samples sent to USGS Denver, Colorado – Dr. Chris Holm-Denoma
- Wave Dispersive X-ray Fluorescence Spectrometry (XRF)
- Inductive Coupled-Plasma Atomic Emissions Spectrometry Mass Spectrometry (ICP – AES, ICP – MS) – following the USGS bulk geochemistry analytical procedures

# Geochemistry



Major oxide  
Discrimination diagram  
For tholeiitic/calc-alkaline  
Boundary – FeO/MgO vs SiO<sub>2</sub>

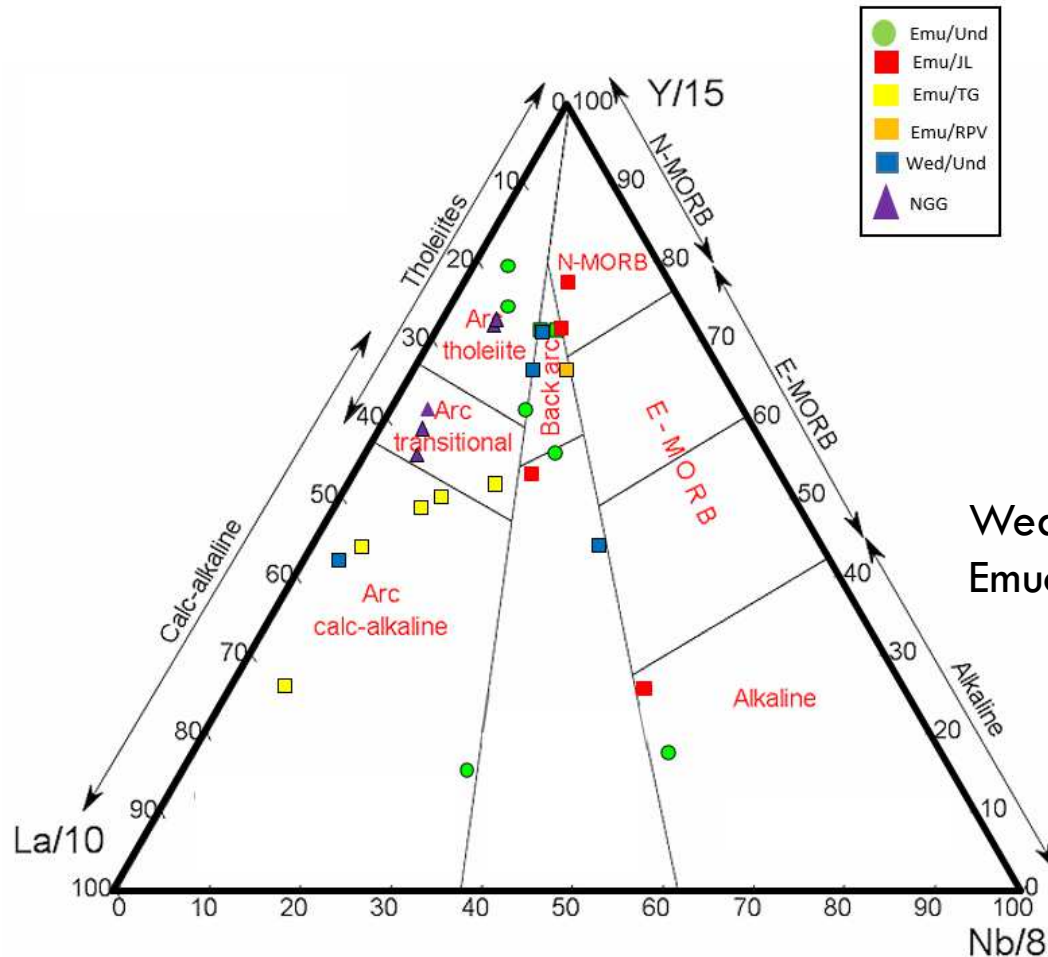
SiO<sub>2</sub> – 42% - 52%

91% - tholeiitic basalt

9% - calc-alkaline



# Geochemistry



Discrimination diagram for La-Y-Nb

26% - back-arc

22% - calc-alkaline basalt

30% - arc tholeiites/transitional basalts

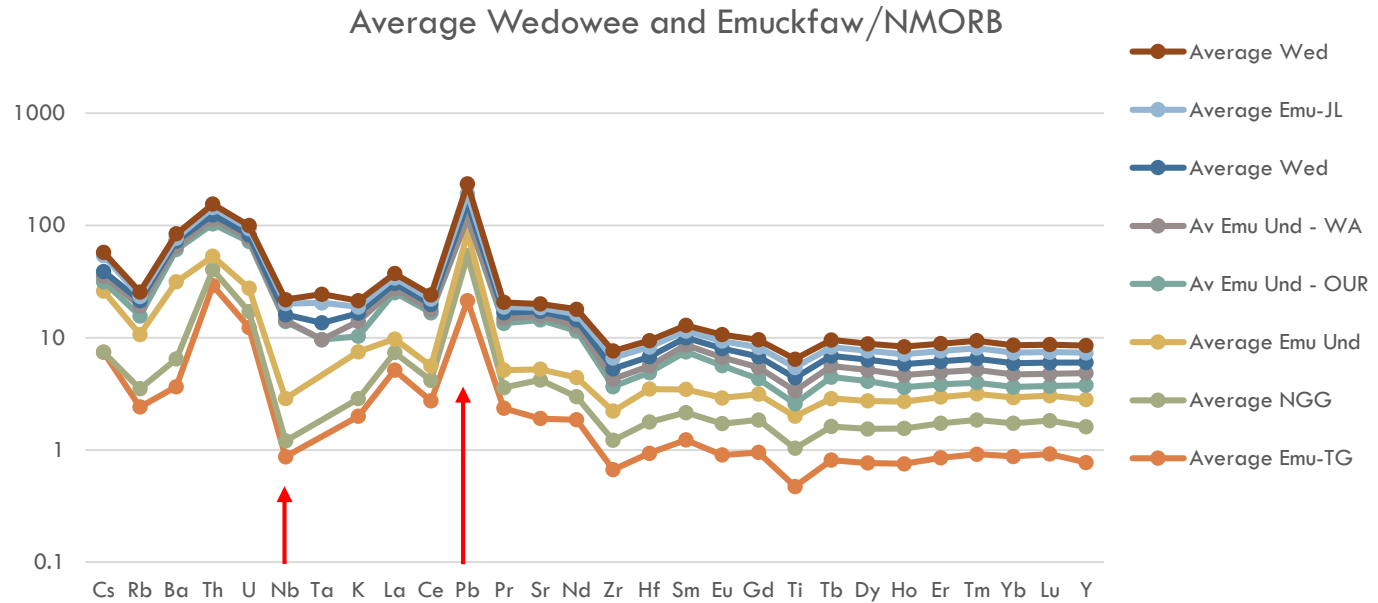
11% - intracontinental

11% - NMORB

Wedowee – back-arc, calc-alkaline

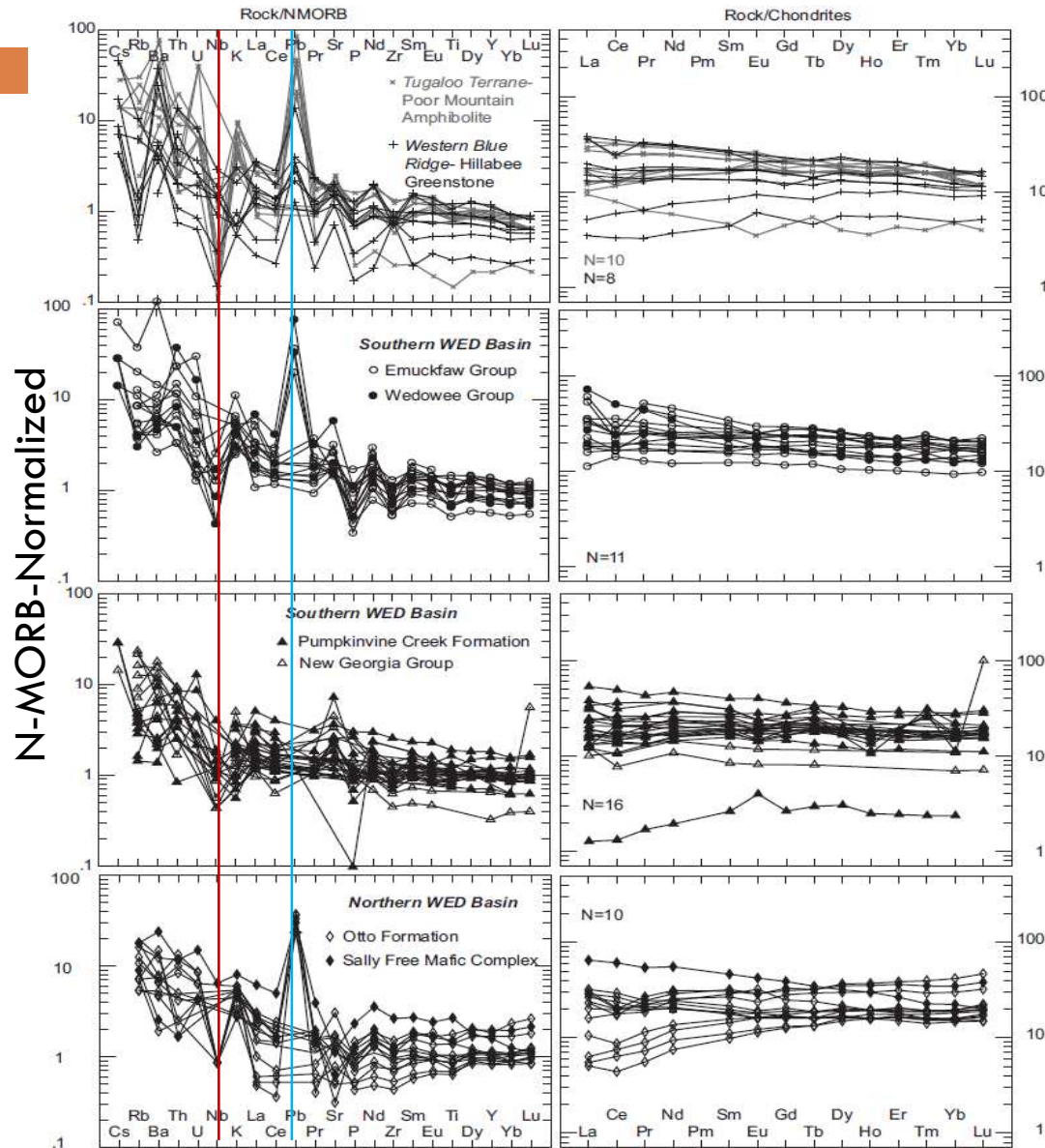
Emuckfaw – calc-alkaline, back-arc, NMORB

# Geochemistry





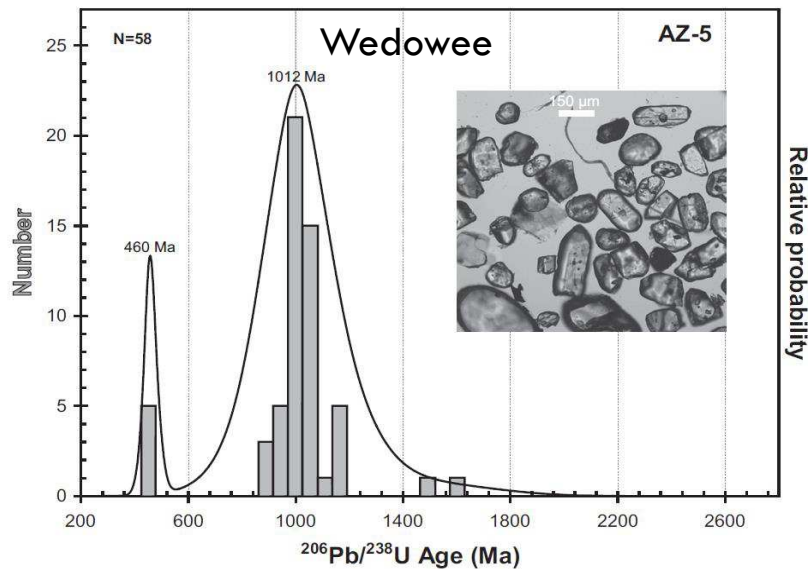
# Geochemistry



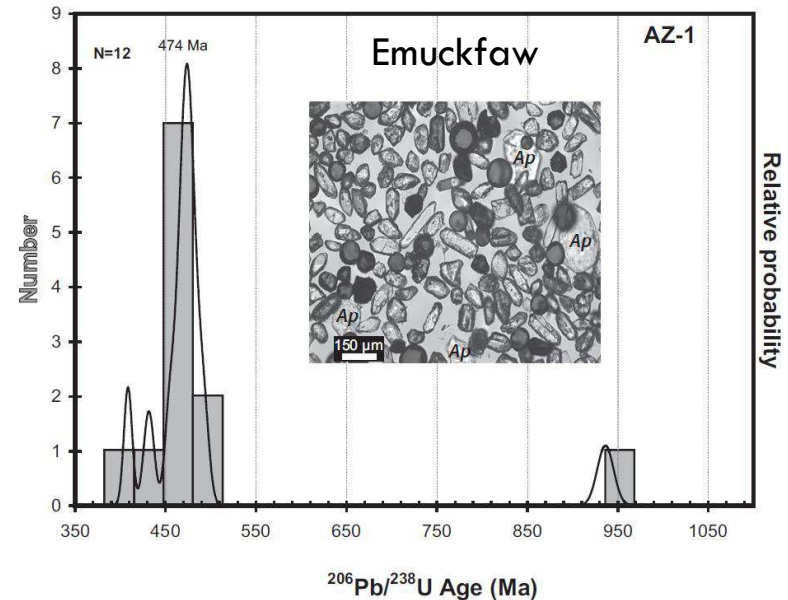
**WEDB METABASALTS**  
**(Amphibolites):**  
**Heavy rare earth element**  
**(HREE) enrichment,**  
**negative **Nb** anomaly,**  
**a large positive **Pb** anomaly.**

# Geochronology

## Metasandstone and Metagraywackes



- 1012 ma – Grenville crustal source
- 460 ma – max depositional age



- 950 ma – Grenville crustal source
- 474 ma – max depositional age

The Wedowee and Emuckfaw Groups – early to middle Ordovician basin receiving detritus from Grenville age source and proximal to a volcanic source.



# Conclusion

## □ Conclusion

- Contact – polydeformed stratigraphic contact that is gradational
- Structures that dominate – antiformal and synformal regional folds
- Regional folds – isoclinal and digitated along the contact boundary
- Planar fabrics and linear fabrics are concordant between both groups
- Planar fabrics are parallel to one another between both groups – formed contemporaneously
- Lineations and crenulations for both groups are coaxial
- Petrographic analysis revealed that the metagraywackes – similar, recrystallization of minerals consistent with upper amphibolite facies and there were no shear indicators supporting a faulted
- The geochemistry of amphibolites – similar to extensional setting – back-arc
- Geochronology – bracketed the age of the Wedowee and Emuckfaw – early Ordovician to middle-late Ordovician

Thank you

Thank You





# Acknowledgements

- Dr. Jim Tull
- Dr. Steven Kish
- Dr. Roy Odom
- Dr. David Farris
- Dr. Clint Barineau
- Dr. Chris Holm-Denoma
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- Scott Byfield
- Justin Mandeville
- Mary Beth Lupo/Davis
- Danielle Day

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