Atlas of the Central Gneiss Belt Bedrock Geology in Southern Ontario: LiDAR-Derived Digital Outcrops, 3D Hand Samples, Petrography, and Geochemistry

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LiDAR-Derived Digital Outcrops, 3D Hand Samples, Petrography, and Geochemistry

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Mississauga

Contents

How to Use This Ebook

PHILLIP RUSCICA

More detailed thin section images and site descriptions are available for instructors. Please email virtual.petrology.network@utoronto.ca

Introduction

This book utilizes the H5P framework in addition to embedded content from other websites to produce and display digital outcrops, hand samples, thin sections, and on-site photographs. Each type of content has its own interaction prompts and this sections explains how to navigate through them. Some interactions are common to the content types, such as clicking on the button on the top right to enable full-screen, and pressing escape on your keyboard to exit.

Additional information can be shown in any of the content types with a blue plus sign. Clicking on it will display relevant text, images, videos, or links.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=21#h5p-35

Satellite Overview Image & Geologic Map Slider

Each site has an overview of its physical location with satellite data and the bedrock geology (Ontario Geological Survey OGS). This is displayed as an image juxtaposition where the clicking and dragging the white vertical bar changes between the two images. To access the legend on the OGS website, click on the link below the respective map at the beginning of each pressbook.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=21#h5p-16

You can also navigate to the respective 3D outcrop model by selecting the plus sign in the legend.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=21#h5p-20

Digital Outcrops

The digital outcrops have had their perspectives rendered in H5P and put into 360 virtual tours. This allows for the perspective to be changed by selecting an arrow on the outer perimeter of the image to move in that direction. You can go back to the previous perspective by selecting the back arrow in the top left of the image, or by selecting the respective direction.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=21#h5p-36

Each of the outcrops contains a link to the 3D model. This link is located at the bottom left of each 360 virtual tour.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=21#h5p-37

3D Models of Outcrops and Hand Samples

Each outcrop and hand sample can also be explored in detail on Sketchfab. You can open the model by expanding the text box by clicking on the blue plus sign and following the link. On Sketchfab, holding the left click on your mouse allows you to rotate the outcrop. Holding the scroll wheel down (also holding the right click) allows you to drag the outcrop. Use the scroll wheel to zoom toward or away from the outcrop.

Outcrop & Thin Section Imagery

The site images and corresponding thin sections are displayed with Google slide shows within the book.To move to the next slide, you can either click anywhere on it or use the controls on the bottom left. These controls allow you to go to the previous slide, next slide, and they show you the current slide number.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=21

Additionally, higher magnification thin section close up views are shown as embedded YouTube videos. Click on the 'Play' button to start the video showing the rotation of the microscope's stage.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=21#oembed-1

Scanning Electron Microscope Results

Where available, results from the Scanning Electron Microscope (SEM) are displayed as a series of images. Click on the arrow on the right or left side to navigate between them.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=21#h5p-34

Please send any questions, comments, or concerns to virtual.petrology.network@utoronto.ca

You should be ready to get the most out of all the interactions this book has to offer! Click on the link below to load the next chapter.

Go to the: Acknowledgements!

Acknowledgements

SHEILA BALLANTYNE

This project is made possible with funding by the Government of Ontario and through eCampusOntario's support of the Virtual Learning Strategy. To learn more about the Virtual Learning Strategy visit:https://vls.ecampusontario.ca.

We would love to hear how you are using this pressbook! Please email us: virtual.petrology.network@utoronto.ca

The motivation for this pressbook is primarily to provide virtual teaching materials for post secondary earth science educators. Our methods and approach shifted focus several times as our team changed and various challenges were overcome. We hope this book provides an accessible geological resource to anyone who wants to learn more about the Central Gneiss Belt in Ontario. Answer keys to the thin sections presented and some more in-depth descriptions are available to instructors by emailing: virtual.petrology.network@utoronto.ca

Many people had important roles in making this project a reality! The team was led by Sheila Ballantyne, but it was Dr. Debora Rios who first put the concept together and created the successful grant proposal. Professor Paul Ashwell, Professor Heidi Daxberger, and Sheila Ballantyne conducted the field work for all the sites in this book, including collecting field data, rock samples, and making the 3D scans. These three also cut the rock samples and organised the making of the thin sections. Dr. Daxberger led the way on creating the 3D outcrop and hand samples, and Ms Ballantyne conducted the Scanning Electron Microscope work. Dr. Rebecca Moumblow (McMaster) and Dr. Kim Tate (Royal Ontario Museum) provided support and feedback throughout the project. We had five excellent undergraduate students help make this project possible: Paolo Attanasio made incredible 3D hand sample models, Jessica Wanzo created the excellent You Tube videos of the rotating thin sections, Aneila Ghanie cataloged and described the thin sections, as well as Andreia Hamid and Peng Patrick Cheng who did field work with us. We are appreciative for all of Marek Velits and Danielle Carranza assistance with contracts and finances. Thanks to Yanan Liu for assistance with the microprobe and Peter Mitrakos with the Scanning Electron Microscope. Thanks to Laurie Harrison, Henry Ivry, and Will Heikoop at Digital Learning Innovation at U of T. The person that deserves the most

credit, who brought most of this project together into its final form is Phillip Ruscica. The entire team is incredibly thankful for the significant efforts made by Mr. Ruscica.

Go the the: Accessibility Statement

Accessibility Statement

SHEILA BALLANTYNE

We hope this book will bring part of the field to the learner. Whether the learner is restricted by costs, logistics, land access, or personal limitations, anyone can view the rock images, manipulate the 3D models, and interpret the petrology and geochemistry from any computer connected to the internet. It is our sincere hope that this book will contribute positively to efforts in making earth sciences more accessible.

We have tried to meet various accessibility guidelines (W3C, University of Toronto Guidelines, and the Conestoga Library Accessibility Checklist for OER development). Please note that we have embedded videos of rotating thin sections (microscope slides of rock sections) and these videos have no associated audio. We welcome all questions, comments, and concerns about accessibility and any suggestions for improvement are appreciated. Our group can be contacted at: virtual.petrology.network@utoronto.ca

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Go to the: Introduction

Introduction to the Central Gneiss Belt Geology

SHEILA BALLANTYNE AND PHILLIP RUSCICA

Complex and Ancient Rocks

The rocks that make up the Central Gneiss Belt are complex! These rocks are easily observed along the significant road cuts of Highway 400, between Port Severn and Killarney Provincial Park, Ontario. The strikingly beautiful, contorted rocks are also well exposed throughout the rocky shorelines of eastern Georgian Bay, cut by large pink and white intrusions sparkling with quartz and feldspar crystals. The intricate details of these rocks are indicative of their long and varied geological history.

The rocks along the eastern shores of Georgian Bay are part of a significant craton known as the **Canadian Shield**. Some of the oldest rocks on earth are found here, between 2.5 to 4.2 billion years old! The Canadian Shield is made of up several large geological provinces, defined by their unique geological histories. The Central Gneiss Belt is part of one of these significant geological provinces, the **Grenville**.

The Grenville Province exists today as a northeast-southwest trending belt, from Labrador to Lake Huron, Ontario (figure 1). Its northwestern edge is a tectonic boundary known as the Grenville Front, where the rocks of magmatic arcs and continental terranes were accreted onto the Superior Craton during an orgeny from 1190Ma (millions of years ago) to 980 Ma. The Grenville orogeny created a mountain chain that would have looked similar to what is observed today in the Himalayas. The tips of the mountains here would have 30km above the current ground-level 1.1 billion years ago! The current southeastern edge of the Grenville is an eroded surface, where much younger Paleozoic sedimentary "cover rocks" (merely 500 million years old!) were deposited. These cover rocks are predominantly limestones and are observed in southwestern Ontario and through the Niagara Escarpment today.

Figure 1: Extent of the remnants of the Grenville Orogen (orange) in Canada (After Wynne-Edwards 1972, Davidson 1995).

The Grenville in Ontario can be divided into three major divisions: the Grenville Front Tectonic Zone (GFTZ), the Central Gneiss Belt (**CGB**), and the Central Metasedimentary Belt (**CMB**), as shown in Figure Two (First described in Wynne-Edwards, 1972). The CMB consists of magmatic arcs and marginal basins and overlies the CGB along the Central Metisedimentary Thrust Zone (CMBbz in Figure 2). The CMB is featured in another ebook from the Virtual Petrology Network that was completed at the same time as this book.

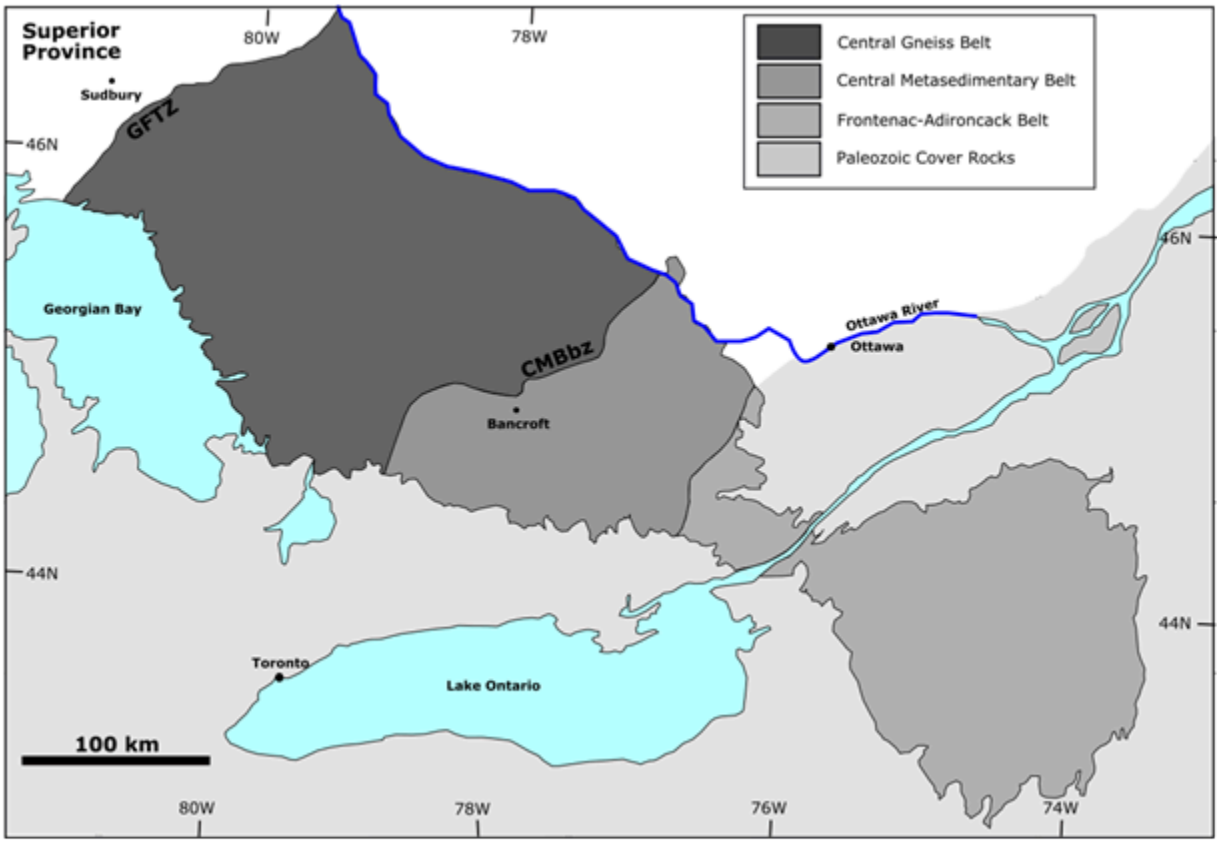


Figure 2. Overview map of Laurentia's margin (Superior Province) and the amalgamated Grenville Province's sections in Southern Ontario (from the NW to the SE): Central Gneiss Belt, Central Metasedimentary Belt, Frontenac-Adirondack Belt. The southern region shown here is overlain by Paleozoic Cover sedimentary Rocks. (After Carr et al., 2000)

Domains of the CGB

The CGB can be divided into several lithotectonic domains, such as Britt, Shawanaga, Parry Sound, Algonquin, Seguin, Rousseau, Moon River, Go Home, and Muskoka. For more detailed descriptions of these domains see Culshaw et al., 1997 and Carr et al., 2000. Some of the lithotectonic domains experienced more than one orogeny; some domains experienced tectonic deformation both before and during the Grenville orogeny and were thus deformed more than once. These previously deformed domains are considered "poly-cyclic", while units showing deformation only related to the Grenville Orogeny are "mono-cyclic".

Lithologies and Metamorphic Grades of the CGB

The protolith lithologies and ages of all the rocks in the CGB are obscured by strong deformation and high metamorphic grades. Each domain is unique in its mineral content, but in general the rocks here are upper amphibolite to **granulite facies quartzofeldspathic, migmatitic orthogneisses and mafic granulites**. Granulite facies is particularly interesting to geologists as it indicates these rocks were deeply buried, such as at the base of a mountain chain. The rocks are generally coarse grained, dominated by quartz, feldspars, micas (muscovite and biotite), pyroxene, hornblende, and garnets.

There are minor intrusions observed throughout the CGB. Distinct black pods are interpreted to be metamorphosed gabbroic intrusions, often with sheared contacts. Undeformed mylonitic pink and sometimes white pegmatite sheets and dykes are ubiquitous throughout the CGB.

Structure

The deformation throughout the CGB can be defined as penetrative ductile flow. Shear zones exist within domains and at domain contacts. The contacts between each of the lithotectonic domains is generally parallel to the overall Grenville Orogeny-related fabric, but not always. Strong foliation (S) and lineation (L) fabric can be observed throughout, dominantly S>=L, but orientations shift significantly in both bearing and dip. Some of these variations may be related to preserved pre-Grenvillian tectonic forces (see Culshaw et al., 1997 or Carr et al., 200 for more details).

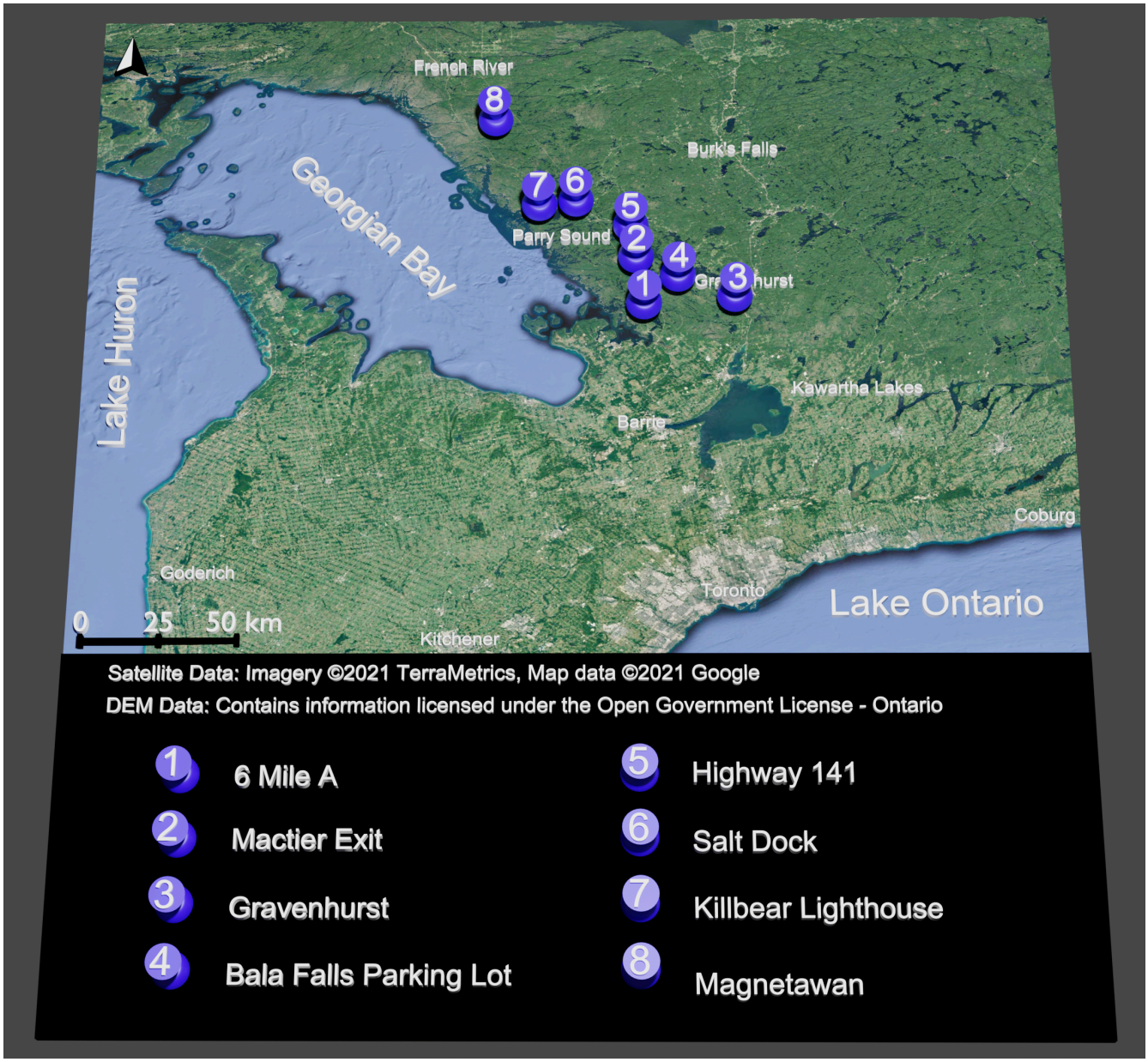
Exemplary structural features are highlighted in later chapters in this book, including mineral lineations, mullions, rotated porphyroblasts, and boudins.

Erosion and Glaciation

Over last billion years the Grenville mountains have been weathered and eroded, removing approximately 30km from the mountain tops, leaving the smooth and relatively flat landscape we see today. This erosion gives geologists a unique window into the roots of mountains. Over the past 2 million years, several series of glaciation advanced and retreated over Ontario. The final glacier covered the CBG with more than 1km thick ice just 14,000 years ago. The ice was filled with rocks and sand, plucked and lodged from other regions as it advanced. This debris scoured and polished the ground. Glacial markings can be observed on many surfaces throughout the CGB, generally oriented to the North.

CGB Field Sites in this Book

Each site visited in this book has their general location shown in the overview map below. Click on the image to view the 3D model on Sketchfab!



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References

Carr, S.D., Easton, R.M., Jamieson, R.A., and Culshaw, N.G. (2000). Geologic transect across the Grenville Orogen of Ontario and New York. *Canadian Journal of Earth Sciences*. **37**(2-3): 193-216.

Culshaw, Jamieson, R. A., Ketchum, J. W. F., Wodicka, N., Corrigan, D., & Reynolds, P. H. (1997). Transect across the northwestern Grenville Orogen, Georgian Bay, Ontario; polystage convergence and extension in the lower orogenic crust. *Tectonics (Washington, D.C.)*, *16*(6), 966–982.

Wynne-Edwards, H.R. (1972). The Grenville Province. In Variations in tectonic styles in Canada. Edited by R.A. Price and R.J.W. Douglas. Geological Association of Canada, Special Paper 11, 263–334.

Recommended Field Guides

Davidson, A., Nadeai, K., & Culshaw, N.G. (September, 2012). *CLASSIC OUTCROPS IN THE CENTRAL GNEISS BELT, ONTARIO – A RETROSPECTIVE.* [Field Trip]. 43rd Friends of the Grenville Annual Field Excursion, Guidebook, Parry Sound, Ontario.

Rivers, T., & Schwerdtner, W.M. (2016). *Tectonic context of km-scale cross-folds and foliation megaboudins in the Muskoka domain: formation in the detachment zone of a giant metamorphic core complex.* [Field Trip]. Workshop of the Canadian Tectonics Group, Bracebridge, Ontario.

Schwerdtner, W.M., Klemens, W.P., Robin, P.Y.F., Vertolli, V.M., & Waddington, D.H. (2005). *Field Trip Guide: Geological structure and lithology in parts of the Muskoka Region, southwestern Central Gneiss Belt, Grenville Province of Ontario* [Field Trip]. 25th Workshop of the Canadian Tectonics Group, Orillia, Ontario.

Click this link to go to the overview on how to use each of the content types in this book: How to Use This Ebook

Already familiar with H5P interactions? Jump right into the book here: CGB 1 – Six Mile

1

CGB 1 - Six Mile Lake

SHEILA BALLANTYNE AND PHILLIP RUSCICA

GPS Coordinates (44°53'18.3"N , 79°45'12.9"W)

Parking: Ample parking on shoulder of a quiet road, near Six Mile Provincial Park entrance gate

This stop is located on King George Road, just north of the entrance gate to Six Mile Lake Provincial Park.

The pink and black layered gneisses and migmatitic rocks are Mesoproterozoic in age with unknown protoliths. This area is part of the Go Home lithotectonic domain[1]. Slide the vertical white line left to right in the image below to switch between the satellite view and Ontario Geological Survey map[2].

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Click here to open the bedrock geology legend on the OGS website

The following images are of outcrops that line the east and west sides of the road. Note the:

- Pervasive sub-horizontal fractures, likely the result of post-glacial rebound
- Complex folding, migmatite texture, with pink pegmatitic layers and dykes
- Strong lineations, which are very likely irregular mullions, indicative of strong deformation
-

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=5

The Digital Outcrop

The digital outcrop below reveals a migmatite texture, with alternating folliated layers of mafic and felsic rocks. The strongly lineated area on the top of the outcrop is an excellent example of mullions. A lot of evidence here for highly metamorphosed and strongly deformed rocks here! Note the yellow notebook on the left side for scale (notebook is 18cm long). The lineations trend 20/130.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=5#h5p-1

The Digital Hand Sample

The gneiss rock sample below (VLS-21-66) is approximately 15cm long. Click on the image (or here) to

view the 3D model of the sample in Sketchfab! It was taken from the outcrop shown above. The marking of 20/130 written on the rock is the general trend of the lineations of the mullions in the outcrop, which are not obvious in this hand sample. Note the alternating felsic and mafic layers of this gneiss rock sample.

Thin Sections of Hand Samples

Two thin sections were made from the hand sample above (VLS-21-66A and VLS-21-66B). The first (66A) is cut parallel to folliation, while 66B is cut perpendicular.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=5

The following two thin section videos are close-ups of slide VLS-21-66A, these show the view parallel to foliation of sample 66.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=5#oembed-1

Plain Polarized Light (PPL) view of sample VLS-21-66A.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=5#oembed-2

Crossed Polarized Light (XPL) view of sample VLS-21-66A.

The following two thin section videos are close ups of slide VLS-21-66B, these show the view perpendicular to foliation of sample 66.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=5

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=5#oembed-3

Plain Polarized Light (PPL) view of sample VLS-21-66B.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=5#oembed-4

Crossed Polarized Light (XPL) view of sample VLS-21-66B.

Additional photographs, detailed descriptions, and high resolution images of thin sections are available to post-secondary instructors. Please email virtual.petrology.network@utoronto.ca

All comments, questions, and concerns are always welcome at this email address.

References

1. Many excellent papers exist on the lithotectonic domains of this area, examples:

Culshaw, N.G., Ketchum, J.W.F., Wodicka, N., and Wallace, P. (1994). Ductile extension following thrusting in the deep crust: Evidence from the southern Britt Domain, southwest Grenville Province, Georgian Bay, Ontario. Canadian Journal of Earth Sciences,31: 160–175.

Jamieson, R.A., Culshaw, N.G., and Corrigan, D. (1995). North-west propagation of the Grenville orogen: Grenvillian structure and metamorphism near Key Harbour, Georgian Bay, Ontario, Canada. Journal of Metamorphic Geology, 13: 185–207.

Carr, S.D., Easton, R.M., Jamieson, R.A., and Culshaw, N.G. (2000). Geologic transect across the Grenville Orogen of Ontario and New York. *Canadian Journal of Earth Sciences*. **37**(2-3): 193-216.

2. Ontario Geological Survey (2011). 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey Miscellaneous Release-Data 126 – Revision 1.

Go to the next chapter: CGB 2 – Mactier Exit!

2

CGB 2 - Mactier Exit

SHEILA BALLANTYNE AND PHILLIP RUSCICA

GPS Coordinates (45°05'43.8"N , 79°47'06.7"W)

Parking: This site can be accessed on the west side of the road on a wide shoulder.

At the time of writing, this site was no longer accessible. This rock cut is near the exit from Highway 400 to Mactier, Ontario, on the east side of highway 400.

This rock cut is a pink and white finely layered gneiss with black pods of highly deformed mafic dyke. The foliation and orientation of the dyke contacts are highly variable here.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=24#h5p-17

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An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=24#h5p-21

Click here to open the bedrock geology legend on the OGS website

The images in the slides below highlight the foliated gneiss and deformed mafic dyke observed at this outcrop.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=24

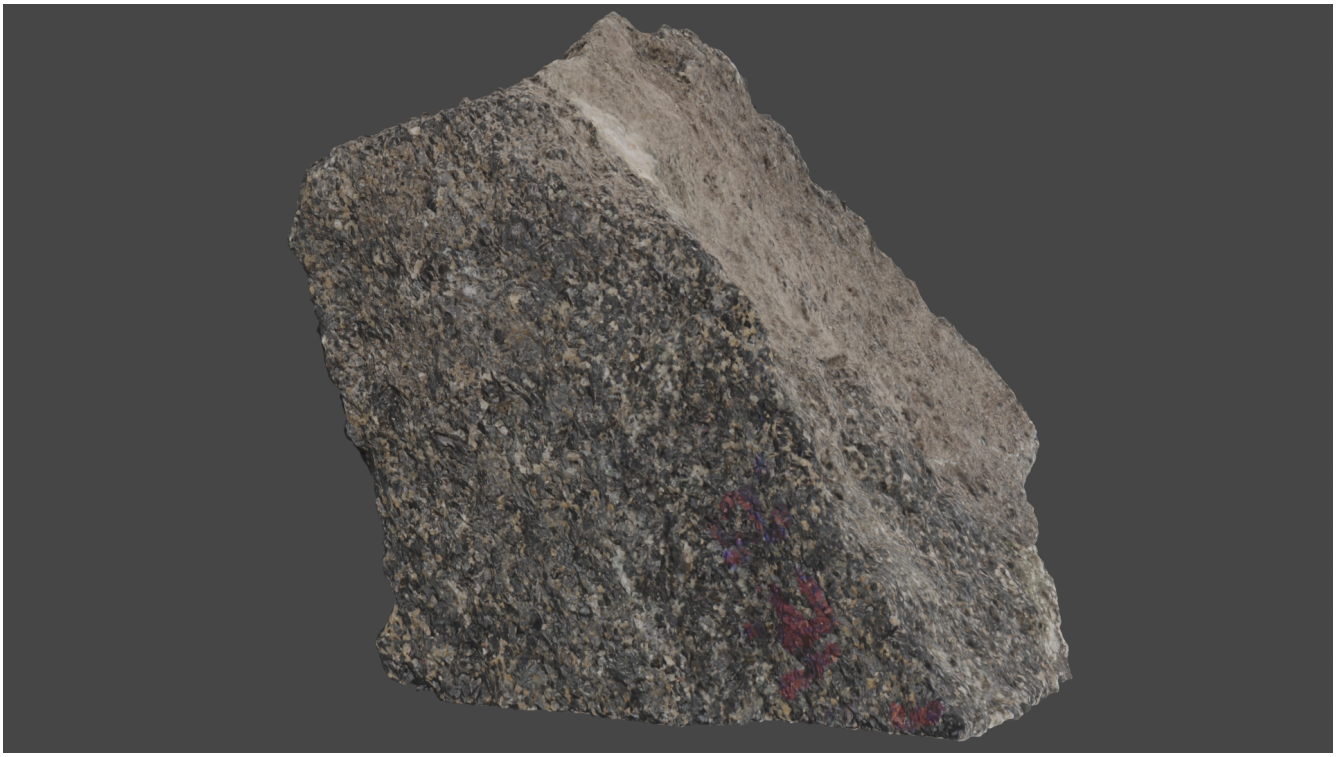
Digital Outcrop

Click on the arrows in the image below to view various perspectives of this outcrop. A link at the bottom left will take you to a 3D model of the outcrop in Sketchfab.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=24#h5p-2

Digital Hand Samples

The following rock sample (VLS-21-25) is from one of the black pods of mafic dyke. Click on the image (or here) to view the 3D model of the sample in Sketchfab! Note the fine to medium grained mafic minerals (dominantly hornblende and biotite) peppered with white mineral (mostly plagioclase). Thin sections for this sample are shown below. No close-up rotation videos were made for this thin section. Electron Probe Micro-Analyser (EPMA) results are available upon request for this sample.



This rock (VLS-21-26) is from the finely layered felsic gneiss. Click on the image (or here) to view the 3D model of the sample in Sketchfab! The minerals are dominantly medium to coarse grained pink and white feldspars and quartz, with minor amounts of biotite, hornblende, pyroxene, and fine grained garnet. Small dark unidentified opaque minerals are also observed. Thin sections for this sample are shown below. No close-up rotation videos were made for this thin section. Electron Probe Micro-Analyser (EPMA) results are available upon request for this sample.

Digital Thin Sections

Four thin Sections images are shown below of the mafic dyke sample (VLS-21-25) and the surrounding gneiss (VLS-21-26). No close-up rotation videos were made for this thin section. Electron Probe Micro-Analyser (EPMA) results are available upon request for this sample.

Sample VLS-21-25

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=24

Sample VLS-21-26

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=24

Additional photographs, detailed descriptions, and high resolution images of thin sections are available to post-secondary instructors. Please email virtual.petrology.network@utoronto.ca

All comments, questions, and concerns are always welcome at this email address.

Go to the next chapter: CGB 3 – Gravenhurst!

3

CGB 3 - Gravenhurst

SHEILA BALLANTYNE AND PHILLIP RUSCICA

GPS Coordinates (44°55'11.42"N , 79°23'6.26"W)

Parking: There are ample parking spots beside the outcrop at the farmers' market or across the street near the marina.

The Gravenhurst site has two outcrop scans on the eastern side of the town. These stops are along Highway 169, and across the street from the Steamboating Monument.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=26#h5p-18

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=26#h5p-22

Click here to open the bedrock geology legend on the OGS website

The images in the slides below highlight the foliated gneiss, cross-cutting pegmatite dykes, and pods of deformed mafic dyke material.The foliation is variable here but often sub-horizontal.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=26

Stop 1 - Gravenhurst Gneiss

Digital Outcrop

Click on the arrows in the image below to view various perspectives of this outcrop. A link at the bottom left will take you to a 3D model of the outcrop in Sketchfab.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=26#h5p-3

Digital Hand Samples

The following rock sample (VLS-21-38) is of the finely layered gneiss observed at the Gravenhurst outcrop. Click on the image (or here) to view the 3D model of the sample in Sketchfab! Note the alternating dark and light layers. The lighter layers are feldspar and quartz, while the darker grains are dominantly hornblende and biotite.

Thin Sections of Hand Samples

Sample VLS-21-38 was made into two thin sections, A and B. VLS-21-38A is cut parallel to the foliation, and VLS-21-38B is cut perpendicular to the foliation. These can be viewed in the slides below. Please note that thin section VLS-21-39 is also in these slides (#5 and #6) and the rock sample for VLS-21-39 is discussed further down in this section.

The following two thin section videos are of slide VLS-21-38A. These show the view parallel to foliation of sample VLS-21-38.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=26

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=26#oembed-1

Plain Polarized Light (PPL) view of sample VLS-21-38A.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=26#oembed-2

Crossed Polarized Light (XPL) view of sample VLS-21-38A.

The following two thin section videos are of slide 38B, these show the view perpendicular to foliation of sample VLS-21-38.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=26

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=26#oembed-3

Plain Polarized Light (PPL) view of sample VLS-21-38B.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=26#oembed-4

Crossed Polarized Light (XPL) view of sample VLS-21-38B.

Stop 2 - Gravenhurst Pegmatite Dyke

There are several pegmatite dykes throughout the long outcrop in Gravenhurst. Their relative ages are complicated and remain not well understood. Note the black pods of deformed mafic dyke here too, presumably of younger age than the pink pegmatite dyke.

Digital Outcrop

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=26#h5p-6

Please note that there is no 3D model made of sample VLS-21-39. The thin section scans are in the slides above, following VLS-21-38 A & B.

Thin Sections of Hand Samples

The following two thin section videos are close up rotating views of sample VLS-21-39. Note the large feldspar and quartz crystals, with minor biotite, hornblende, and unidentified opaque minerals.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=26

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=26#oembed-5

Plain Polarized Light (PPL) view of sample VLS-21-39.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=26#oembed-6

Crossed Polarized Light (XPL) view of sample VLS-21-39.

Additional photographs, detailed descriptions, and high resolution images of thin sections are available to post-secondary instructors. Please email virtual.petrology.network@utoronto.ca

All comments, questions, and concerns are always welcome at this email address.

Go to the next chapter: CGB 4 – Bala Falls!

4

CGB 4 - Bala Falls

SHEILA BALLANTYNE AND PHILLIP RUSCICA

GPS Coordinates (45° 0'39.68"N , 79°36'53.90"W)

Parking: There are two parking options: at Jaspen Park, off higway 39 just northwest of Highway 169, at the "Precambrian Sheild Parking Lot" off Highway 169 just north of highway 39.

This outcrop is long exposed rock cut, directly south of the falls, in what is called the "The Precambrian Shield Parking Lot". There are excellent outcrops throughout this area: at the falls, to the south underneath the train bridge, and to the west between the parking lot and Jaspen Park. The stop is located along Highway 169, at the intersection with Highway 39.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=28#h5p-19

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=28#h5p-23

Click here to open the bedrock geology legend on the OGS website

The images in the slides below highlight the foliated gneiss, deformed mafic dykes, M-scale folds, and incipient boudins observed at this outcrop.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=28

Digital Outcrop

Click on the arrows in the image below to view various perspectives of this outcrop. A link at the bottom left will take you to a 3D model of the outcrop in Sketchfab.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=28#h5p-7

Digital Hand Samples

The following rock sample (VLS-21-46) is typical of the gneissic rocks found here, with fine mafic layers and coarser-grained pink layers. Click on the image (or here) to view the 3D model of the sample in Sketchfab!

Sample VLS-21-46 is also from this outcrop, taken from one of the mafic layers. A 3D model of this sample is not available at the time of writing.

Thin Sections

Below you can investigate full slide thin section images of the VLS-21-44 mafic layer and VLS-21-46 finely layered felsic gneiss. In plane polarised light (PPL) and crossed polarised light (XPL). Close-up videos of the thin sections rotating follow.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=28

The following two thin section videos are close ups of sample VLS-21-44.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=28#oembed-1

Plain Polarized Light (PPL) view of sample VLS-21-44.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=28#oembed-2

Crossed Polarized Light (XPL) view of sample VLS-21-44.

The following two thin section videos are close ups of sample VLS-21-46.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=28

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=28#oembed-3

Plain Polarized Light (PPL) view of sample VLS-21-46.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=28#oembed-4

Crossed Polarized Light (XPL) view of sample VLS-21-46.

Additional photographs, detailed descriptions, and high resolution images of thin sections are available to post-secondary instructors. Please email virtual.petrology.network@utoronto.ca

All comments, questions, and concerns are always welcome at this email address.

Go to the next chapter: Lake Joseph Road (South of Highway 141)!

5

CGB 5 - Lake Joseph Road (South of Highway 141)

HEIDI DAXBERGER; PHILLIP RUSCICA; AND SHEILA BALLANTYNE

GPS Coordinates (45°14'15.76"N , 79°48'21.21"W)

Parking: Park along the shoulder of the road.

The Lake Joseph Road site consists of an about 30 m long outcrop that is located along the Lake Joseph Road (South of HW 141), at the intersection of and south of Clear Lake Road.

The outcrop was split into two sections shown on the map above.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=30#h5p-28

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=30#h5p-24

Click here to open the bedrock geology legend on the OGS website

Section 1 - North

The digital 3D model of the Joseph Road Outcrop shows the Northern Section of the road cut. Here you can investigate the well developed foliation of the gneissic rocks as well as metre-scale boudinage of metamorphosed mafic intrusions. Furthermore, stretching and partial rotation of Potassium Feldspars (felsic bands) due to shearing can be seen.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=30#h5p-8

Section 2 - Center

The second 3D model shown here represents the centre portion of the road outcrop. Here you can see an about 15 cm large porphyroclast of potassium feldspar that shows a bit of a sigmoidal shape. Wet conditions lower the visibility of the otherwise well developed gneissic banding.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=30#h5p-9

In the following slide show you can view outcrop and close-up images of the Joseph Road outcrop.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=30

Thin Sections of Hand Samples

The following google slide show shows whole slide images of the CGB 5 hand samples in thin section.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=30

Additionally, higher magnification close up views are provided below for both thin sections VLS-21-63A and VLS-21-63B in form of 360 rotation videos.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=30#oembed-1

Plain Polarized Light (PPL) view of sample VLS-21-63A.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=30#oembed-2

Crossed Polarized Light (XPL) view of sample VLS-21-63A.

The following two thin section videos are of slide 63B, these show the view perpendicular to foliation of sample VLS-21-63.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=30

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=30#oembed-3

Plain Polarized Light (PPL) view of sample VLS-21-63.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=30#oembed-4

Crossed Polarized Light (XPL) view of sample VLS-21-63.

Additional photographs, detailed descriptions, and high resolution images of thin sections are available to post-secondary instructors. Please email virtual.petrology.network@utoronto.ca

All comments, questions, and concerns are always welcome at this email address.

Go to the next chapter: CGB 6 – Salt Dock!

6

CGB 6 - Parry Sound Salt Dock

SHEILA BALLANTYNE AND PHILLIP RUSCICA

GPS Coordinates (45° 21'6.01"N, 80° 2'55.55"W)

Parking: There is parking at the Salt Dock Boat Ramp.

The Parry Sound Salt Dock site has four outcrop scans. These stop are at the shores of Georgian Bay, along the North Shore Rugged Hiking Trail, on the north side of Parry Sound, Ontario. The trail starts just north of the large salt pile at the Salt Dock Boat Ramp.

The rock units at this stop can be divided into 4 different lithologies. The contacts can be difficult to discern in the field.

A general description of each unit are as follows (from Davidson et al., 2012).

Unit I: Gneiss with abundant hornblende (Stop 1)

Unit H: Gneissic to granular meta-anorthosite and pegmatite (Stop 2)

Unit G: Amphibolite teconite, locally very contorted. Pods of metagabboroic rocks throughout. (Stop 3)

Teconite: Gneissic tecontite, with quartzite and muscovite schist. Abundant garnet. (AKA Unit F) (Stop 4)

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33#h5p-29

Note that the geology map from the Ontario Geological Society is different from the units identified by Davidson et al., 2012. Significant additional study is required to be certain which, if either, are the correct units. These studies could include more detailed strucutral mapping and geochemical analyses. Geological dating would also be helpful. All geological maps agree that these rocks are highly sheared and metamophosed gniessic rocks.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33#h5p-25

Click here to open the bedrock geology legend on the OGS website

The following images highlight some of the geological features at this site.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33

Stop 1 - Salt Dock Unit I

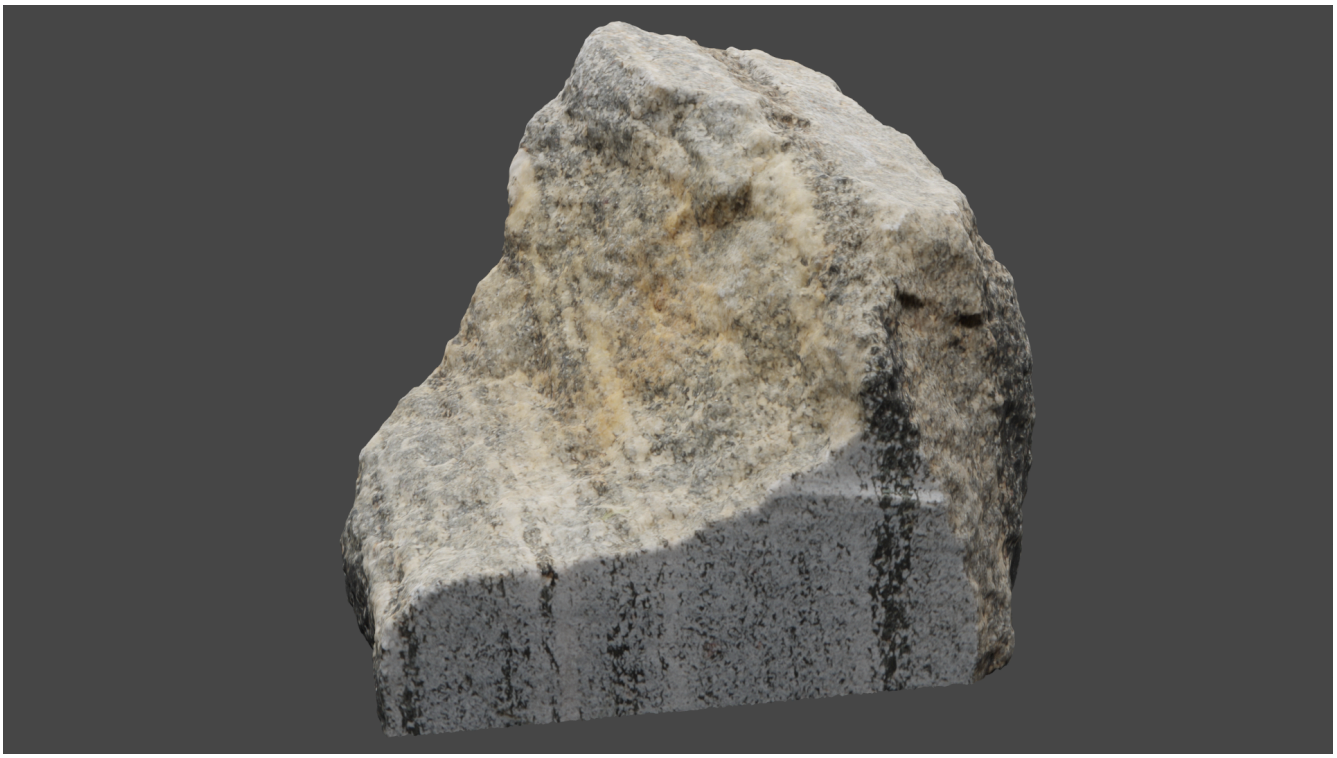
Digital Outcrop in Unit I

This scan was made near the Salt Dock parking lot, near the trail head. The strongly foliated and contorted gneissic layers can be observed. The mafic layers are rich in hornblende. Notebook for scale is ~15cm long. View is looking northeast.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33#h5p-4

Digital Hand Sample from Unit I

The following rock is sample VLS-21-51, taken from Unit I. Click on the image (or here) to view the 3D model of the sample in Sketchfab!



Thin Sections of Hand Sample 51A from Unit I

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33

The following two thin section videos are close-up rotations of slide 51.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33#oembed-1

Plain Polarized Light (PPL) view of sample VLS-21-51.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33#oembed-2

Crossed Polarized Light (XPL) view of sample VLS-21-51.

Stop 2 - Salt Dock Unit H

Digital Outcrop in Unit H

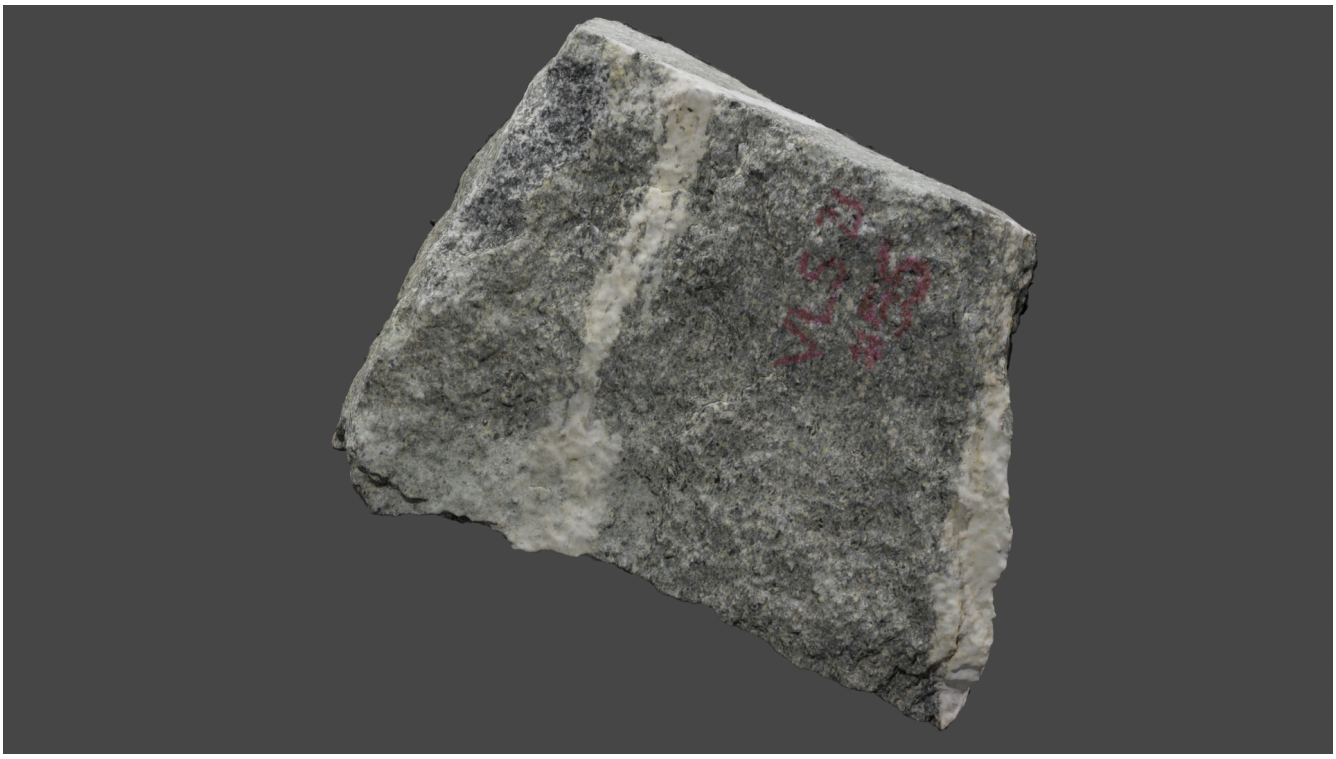
This scan was made in Unit H, approximately 500m northwest from the trail head. View is looking north-northeast. The boudins in the centre of the outcrop are approximately 20cm tall. The shear sense of the boudins appears to be top towards the northwest (similar to the Grenville Front orientation). The rocks here are less mafic than in the previous stop. Abundant pegmatite, which is often sheared and boudinaged.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33#h5p-13

The Digital Hand Sample from Unit H

The following rock is sample VLS-21-55. Click on the image (or here) to view the 3D model of the

sample in Sketchfab! This is an example of the granular meta-anorthosite that is common amongst the gneiss and pegmatite.



Thin Sections of Hand Samples VLS-21-55 from Unit H

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33

The following two thin section videos are close-up rotations of slide VLS-21-55.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33#oembed-3

Plain Polarized Light (PPL) view of sample VLS-21-55.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33#oembed-4

Crossed Polarized Light (XPL) view of sample VLS-21-55.

Stop 3 - Salt Dock Unit G

Digital Outcrop in Unit G

This scan was made in Unit G, where the shoreline juts out ~20m into the bay. This is approximately 775m northwest from the trail head, ~200m northwest from the small island just off shore. View is looking east. The outcrop is approximately 1.2m in height.

This amphibolotic tectonite is rich in feldspar, with mylonitized layers and lineated augens with the same sense of shear as observed before (top towards the north west). Abundant hornblende through here that appears lineated, as shown in the handsample for this stop (sample VLS-21-81)

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33#h5p-5

Digital Hand Sample from Unit G

The following rock is sample VLS-21-81 (also labelled 52 but changed to 81 for processing). Click on the image (or here) to view the 3D model of the sample in Sketchfab!

Thin Sections of Hand Sample VLS-21-81 from Unit G

The following two thin section videos are of slide 81A, these show the view parallel to linations of sample VLS-21-81.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33#oembed-5

Plain Polarized Light (PPL) view of sample VLS-21-81A.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33#oembed-6

Crossed Polarized Light (XPL) view of sample VLS-21-81A.

The following two thin section videos are of slide 81B, these show the view parallel to foliation of sample VLS-21-81.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33#oembed-7

Plain Polarized Light (PPL) view of sample VLS-21-81B.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33#oembed-8

Crossed Polarized Light (XPL) view of sample VLS-21-81B.

Stop 4 - Salt Dock Tectonite

Digital Outcrop in Teconite (Unit H)

This scan was taken aproximately 900m from trailhead, standing on the penisula approximately 75m west of the small creek. Creek likely marks the contact between unit H and G. Highly sheared, finely layered meta-anorthosite. Abundant sheared pegmaite layers, locally covered in rust stains (presumably from weathered sulphides, but these were not observed). Gneissic layers are finer here than earlier stops. There is a small, open notebook (appears as a fuzzy white rectangle in lower, centre part of outcrop) which is approximately 15cm long.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=33#h5p-12

Digital Hand Sample from tectonite (Unit H)

The following rock is sample VLS-21-53. Click on the image (or here) to view the 3D model of the sample in Sketchfab!

Note that thin sections for this sample are not (yet) available.

Additional photographs, detailed descriptions, and high resolution images of thin sections are available to post-secondary instructors. Please email virtual.petrology.network@utoronto.ca All comments, questions, and concerns are always welcome at this email address.

References

Davzidson, A., Nadeai, K., & Culshaw, N.G. (September, 2012). *CLASSIC OUTCROPS IN THE CENTRAL GNEISS BELT, ONTARIO – A RETROSPECTIVE.* [Field Trip]. 43rd Friends of the Grenville Annual Field Excursion, Guidebook, Parry Sound, Ontario

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Go to the next chapter: CGB 7 – Killbear Lighthouse!

7

CGB 7 - Killbear Lighthouse

SHEILA BALLANTYNE AND PHILLIP RUSCICA

GPS Coordinates (45°19'59.02"N , 80°10'12.12"W)

Parking: At the end of the Lighthouse Point Trail in Killbear Provincial Park. There is a parking lot near the lighthouse.

This stop is located in Killbear Provincial Park, and it at the end of the Lighthouse Point Trail. This finely layered gneiss is weathered into shallow-dipping ledges with weaker mafic layers eroding away more quickly than the stronger felsic layers.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=35#h5p-30

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=35#h5p-26

Click here to open the bedrock geology legend on the OGS website

The images in the slides below highlight the thinly layered and folded foliated gneiss observed at this outcrop.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=35

Digital Outcrop

Click on the arrows in the image below to view various perspectives of this outcrop. A link at the bottom left will take you to a 3D model of the outcrop in Sketchfab.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=35#h5p-15

Digital Hand Sample

The following rock sample (VLS-21-32) is representative of the finely layered gneiss observed near the lighthouse in Killarney Provincial Park. Click on the image (or here) to view the 3D model of the sample in Sketchfab! Note the fine to medium grained mafic minerals (dominantly hornblende and biotite) peppered with white mineral (mostly plagioclase). Thin sections for this sample are shown below.

Digital Thin Sections from Hand Samples

Two thin Sections images are shown below of the Killbear gneiss (VLS-21-22). The thin section was cut perpendiular to foliation. Close up rotating videos of the sample follow.

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One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=35

The following two thin section videos are of sample VLS-21-32

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=35#oembed-1

Plain Polarized Light (PPL) view of sample VLS-21-32.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=35#oembed-2

Crossed Polarized Light (XPL) view of sample VLS-21-32.

Additional photographs, detailed descriptions, and high resolution images of thin sections are available to post-secondary instructors. Please email virtual.petrology.network@utoronto.ca All comments, questions, and concerns are always welcome at this email address.

Go to the next chapter: CGB 8 – Magnetawan!

8

CGB 8 - Magnetawan

SHEILA BALLANTYNE AND PHILLIP RUSCICA

GPS Coordinates (45°43’32.09″N , 80°21’48.70″W)

Parking: N/A. This outcrop is on private land and accessible only by boat.

The Magnetawan site has one outcrop scan. This stop is located along the Magnetawan River, east of Highway 69 and north of Harris Lake.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=37#h5p-31

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=37#h5p-27

Click here to open the bedrock geology legend on the OGS website

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=37

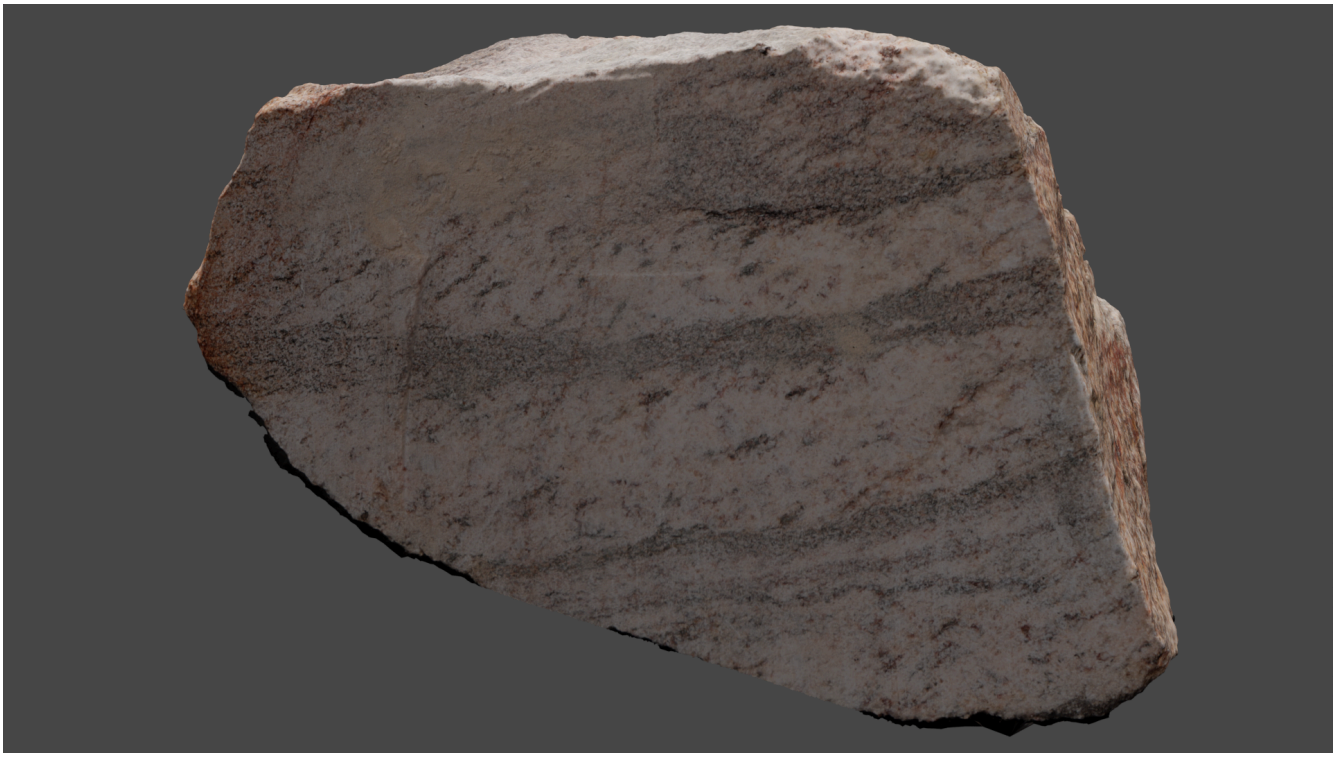
Stop 1 - Magnetawan

The Digital Outcrop

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=37#h5p-14

The Digital Hand Sample

The following rock is sample VLS-21-33. Click on the image (or here) to view the 3D model of the sample in Sketchfab!



Thin Sections of Hand Samples

The following two thin section videos are of sample VLS-21-33.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=37

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=37#oembed-1

Plain Polarized Light (PPL) view of sample VLS-21-33.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=37#oembed-2

Crossed Polarized Light (XPL) view of sample VLS-21-33.

Scanning Electron Microscope

The SEM results of sample VLS-21-33 are in the following documents.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/atlasofsouthernontariocentralgneissbelt/?p=37#h5p-34

Additional photographs, detailed descriptions, and high resolution images of thin sections are available to post-secondary instructors. Please email virtual.petrology.network@utoronto.ca All comments, questions, and concerns are always welcome at this email address.

Check out the methodologies used in this book here: Appendix: Methods!

Appendix: Methods

PAUL ASHWELL AND SHEILA BALLANTYNE

Site selection

The field sites were selected to showcase the range of geology in Ontario. We used publicly available field guides, locations of field sites used by the University of Toronto and McMaster University in Undergraduate courses, as well as satellite images (Google Earth) to determine suitable field sites. Our selection criteria included land access, clarity of the outcrop (i.e. how obvious or hidden were the features), and how easy was it to access the full outcrop to collect the data needed.

Site data

Locations were found and recorded by using a Garmin etrex GPS and on Google Maps using personal smartphones. Structural measurements of linear and planar features were determined using Brunton geological compasses and recorded using hand-written field notes. Other outcrop data was also recorded by hand into field notebooks, including site access, lithologies, mineralogy, and sampling.

LiDAR scanning – Scaniverse

Each outcrop was scanned using LiDAR (Light Direction and Ranging) built into the 2020 and newer models of the iPad Pro (also available on iPhone 12 Pro and iPhone 12 Pro Max). LiDAR uses a similar theory to SONAR or RADAR – it bounces a light beam (in the form of a laser) off of a surface and records the time taken for the reflection to be detected. This time is converted into a distance measurement, and from this a 3D model of the surface can be recorded. At the same time, a camera records the texture of the surface, and places this onto the 3D model. We used the app 'Scaniverse' to create the 3D models, using the highest possible quality resolution.

Sampling

In addition to the 3D scans, we also collected representative samples at each outcrop. Samples were chosen with the following criteria – samples that would be represent the geology present, were free from weathering

or alteration and were large enough to be scanned (see below). In the field, samples were placed in large plastic sample bags, and were labelled with a code for the location (both on the sample, and on the bag).

Cutting rock

Rock samples were cut with a diamond edged saw into ~5x2x0.5cm slabs (known as billets). The rocks were usually cut perpendicular to any structure (such as foliation), though sometime cut parallel to structures to capture changes in mineralogy and mineral orientations. The billets were then sent to Vancouver Petrographics (British Columbia) and Brock University (Ontario) to be made into thin sections. These thin sections were 30 microns thick, polished (to be used for SEM analysis) and without a cover slip.

Scanning Electron Microscopy with Energy Dispersive Spectroscopy (SEM EDX – also known as SEM EDS) and Electron Probe X-Ray Microanalyzer (EPMA)

A scanning electron microscope fires a beam of electrons at a sample, and records the way that the electrons are scattered from the sample. This is a commonly used methods to take 'photographs' of microscopic objects in very high detail. Energy Dispersive Spectroscopy is a type of SEM that instead uses the X-rays which are given off by the sample during the electron bombardment. As elements absorb, and then release, the electrons during the bombardment, they also release X-rays, the wavelengths of which correlate to the element number. The X-rays are then collected and analysed, and elemental maps are produced. SEM EDX is often presented as a series of colour coded maps of the sample, where each colour represents a separate element, and the brighter the colour indicates a higher amount of that element present. For this project, we used the thin sections for SEM EDX with the Hitachi SU3500 SEM with Bruker EDX in the Department of Chemical and Physical Sciences at the University of Toronto Mississauga. SEM EDX represents a low cost, simple method of collecting visual geochemical data.

Some samples were also run on the EPMA unit on the JEOL-JXA8320 5-WDS (wavelength-dispersive spectroscopy) Electron Microprobe at the University of Toronto St George Campus, department of Earth Science. None of these EPMA results are included in this pressbook, but are available upon request. EPMA analyses are very similar to SEM with added chemical analyses capabilities. Sometimes called a "microprobe", an EPMA uses a microbeam of electrons to liberate energy and matter from the sample. The electron beams liberate heat, derivative electrons, and X-rays. The secondary electrons and back-scattered electrons are the most useful for imaging a thin section surface or obtaining average chemical composition. Just like SEM, EPMA is non-destructive in that there is no volume loss of the sample. A sample can be re-anaylsed more than once.

Photographic scanning of thin sections

Full thin section photographs were taken with a Keyance polarising microscope in the Department of Chemical and Physical Sciences at the University of Toronto Mississauga. This provided a high resolution, automatically stitched photo of the entire thin section. To create the smaller, zoomed-in rotation videos of the slide a down-scope camera mounted to a Leica petrographic microscope was used. The video sites

were selected to highlight representative mineralogy and structures in the sample. The stage was rotated 360 degrees under plane ploarised light and again under crossed polarised light, highlighting the changes in optical properties of the minerals in the sample.

Photographic 3D scanning of rock hand samples

The hand samples collected were also photographed in high resolution, and were scanned using a Creaform Academia 20 handheld 3D scanner in the Department of Chemical and Physical Sciences at the University of Toronto Mississauga. The handheld scanner works in a similar fashion to the LiDAR, but is able to calculate smaller objects at higher resolutions of up to 0.1mm. Multiple scans were taken of the samples, which were compiled into a single 3D scan using the associated Creaform Academia software.