# A Field Mapping Exercise to Emphasize the Interpretive Nature of Bedrock Geologic Maps in Glaciated Terranes

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"The rocks are the final court of appeal" Francis Pettijohn

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UNIVERSITY OF MINNESOTA
UMD
DULUTH

NATURAL RESOURCES RESEARCH INSTITUTE

# GEOL 3000

## GEOLOGIC

## MAPS

Syllabus (pfd)

*GEOLOGIC MAPS (AND MAPPERS) ARE:*

**UNCERTAIN**

**FLEXIBLE**

**ITERATIVE**

**INTEPRETIVE**

**GEOL 3000 – GEOLOGIC MAPS**

Week 1: Intro/Defining Map Units
Lab1: Defining Map Units - presentations /Parts of Maps

Week 2: Interpreting Time on Geologic Maps
Lab 1: Evaluating Time on Geologic Maps, Geologic Map of MN
Lab 2: Lumping and Splitting: Creating Map Units

Week 3: Collecting Field Data for a Geologic Map
Labs 1&2: Virtual Geologic Mapping

Week 4: Components of Geologic Maps and Topographic Base Maps
Lab: Topography of the Duluth quadrangle

Week 5: Lithostratigraphic Units: Sedimentary and Volcanic Rocks
Lab 1: Geologic Maps of Flat-lying Lithostratigraphic Units
Lab 2: Interpreting Stratigraphic Sections

Week 6: Map Patterns of Tilted Units
Lab 1&2: Determining Unit Thickness, Structural Contours, Regional Strike and Dip

Week 7: Folds and Faults on Geologic Maps
Lab 1&2: Cross Sections across the Masonville, CO quad

Week 8: Folds and Faults on Geologic Maps
Labs 1&2: Cross Section across the Dolores Peak, CO quad

Winchester Book Discussion – The Map that Changed the World

Week 9: Surficial Geologic Maps
Lab 1: Glacial Geology of Pope Co., MN
Lab 2: Glacial Geology of Washington Co., MN

Week 10: Lithodemic Units: Intrusive Igneous and Metamorphic Rocks
Lab 1: Igneous and Metamorphic Rocks of the Gabbro Lake quad
Lab 2: Igneous and Metamorphic Rocks of NE Itasca County, MN

Week 11: Use of Geophysical Data in Geologic Maps
Lab 1&2: Interpreting the geophysical data of SE Minnesota

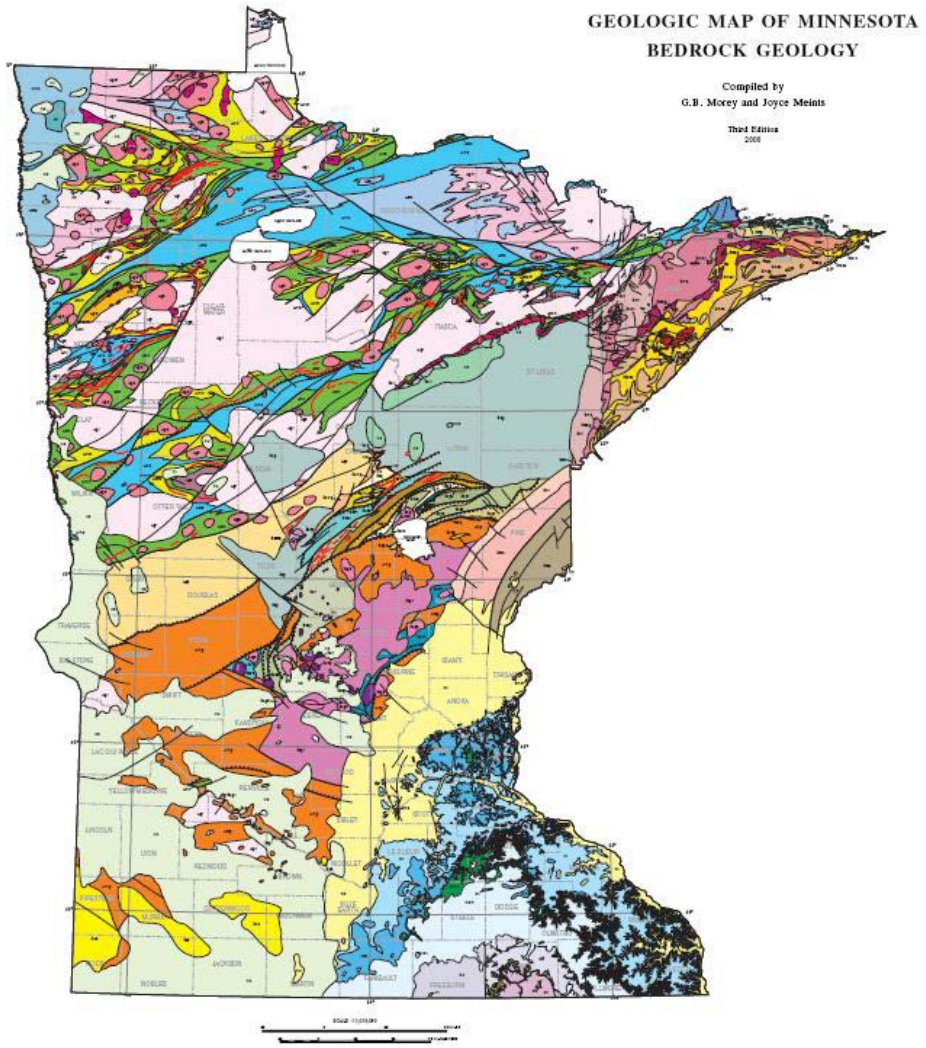
Week 12: Introduction to Field Methods
Lab 1: Pace and Compass Exercise
Lab 2: Strike and Dip Measurements of Structures

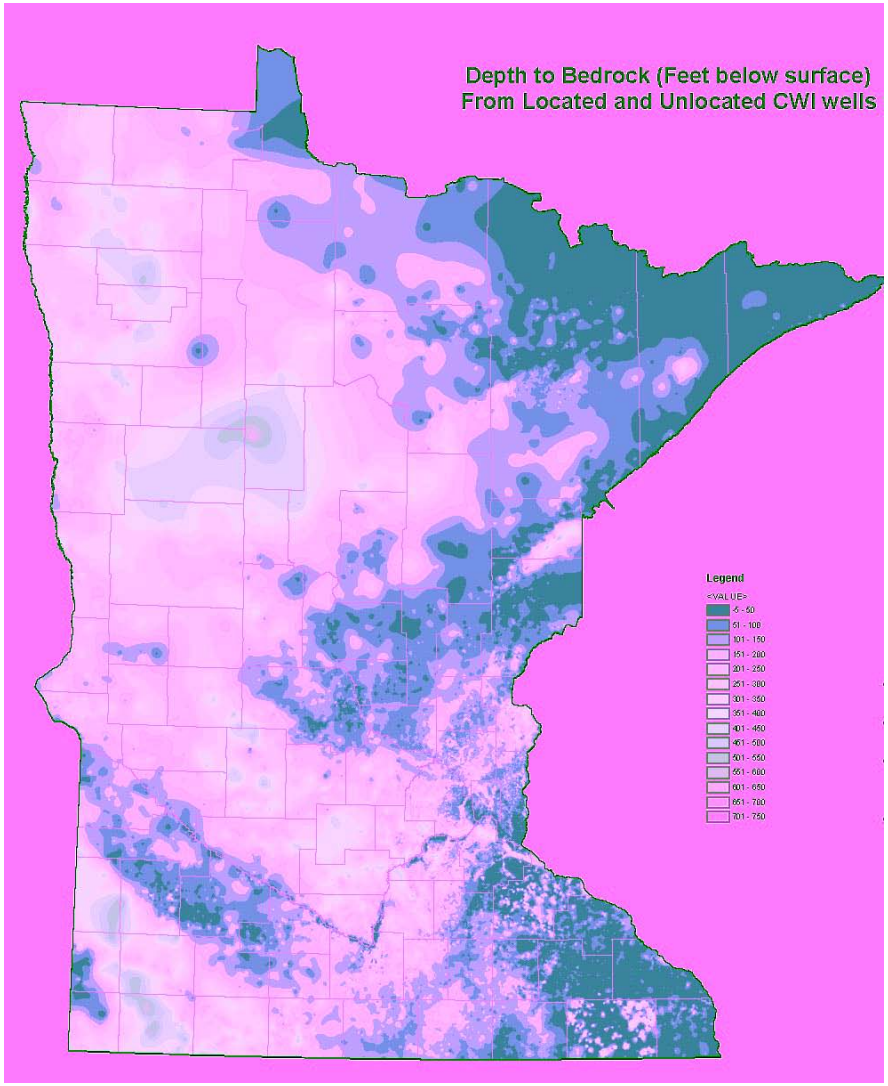
**Sat. April 17 & Sun. April 18 Geologic Mapping Field Trip**

*Week 13: Intro to ArcMAP - Outcrop, Structures, Traverses, Geologic Lines and Geologic Units*

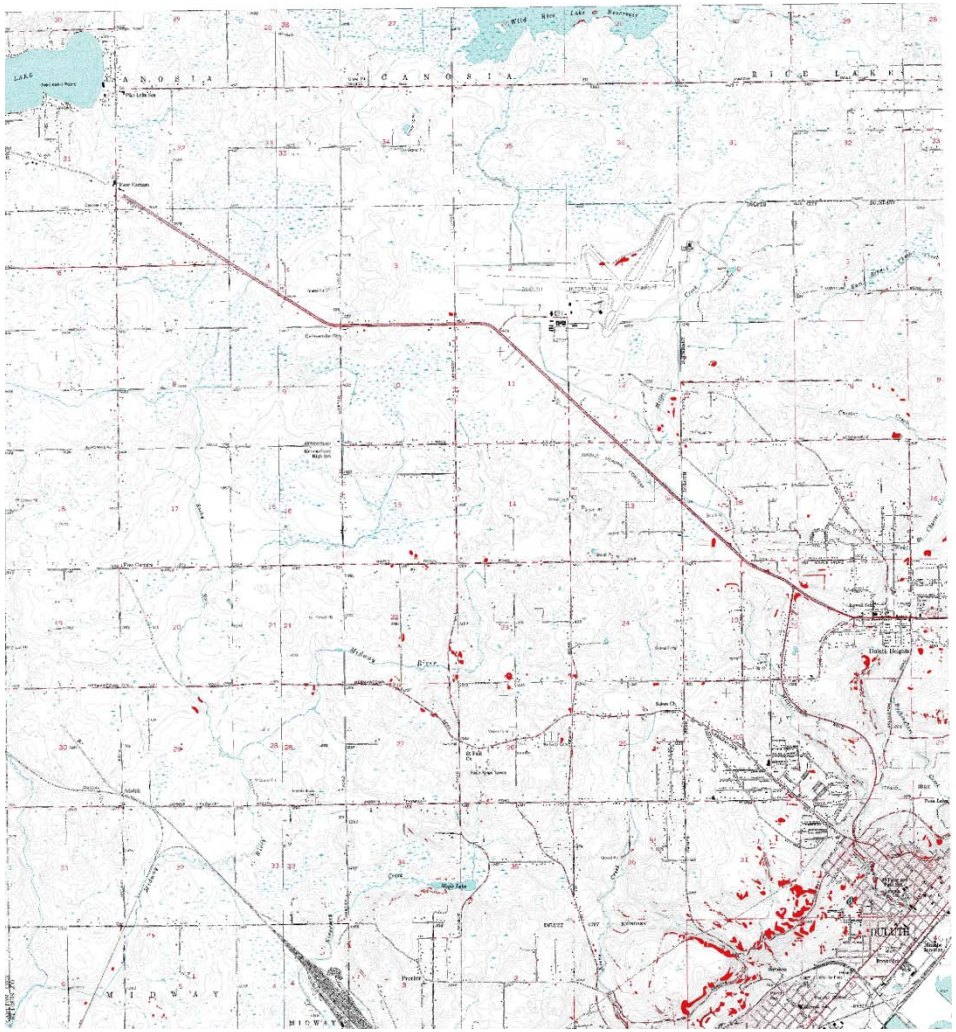
*Week 14: Intro to Adobe Illustrator – Making the Geologic Map*

# Bedrock Covered by Glacial Debris



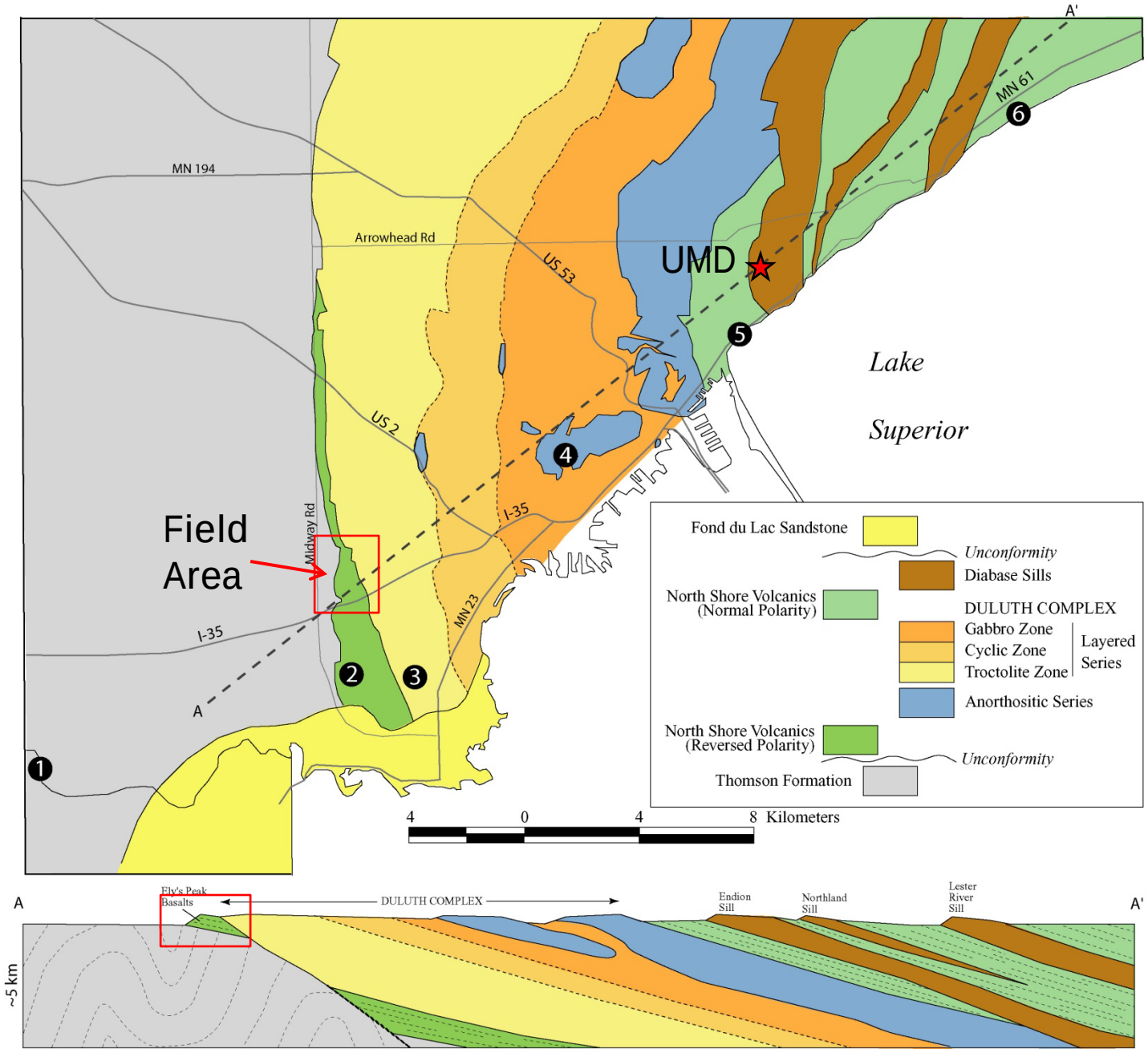



# Good Exposure!




# North Country Exposures

# Generalized Geology of the Duluth Area



# Field Base Map

**USGS 7.5'topographic base with Mylar overlay**

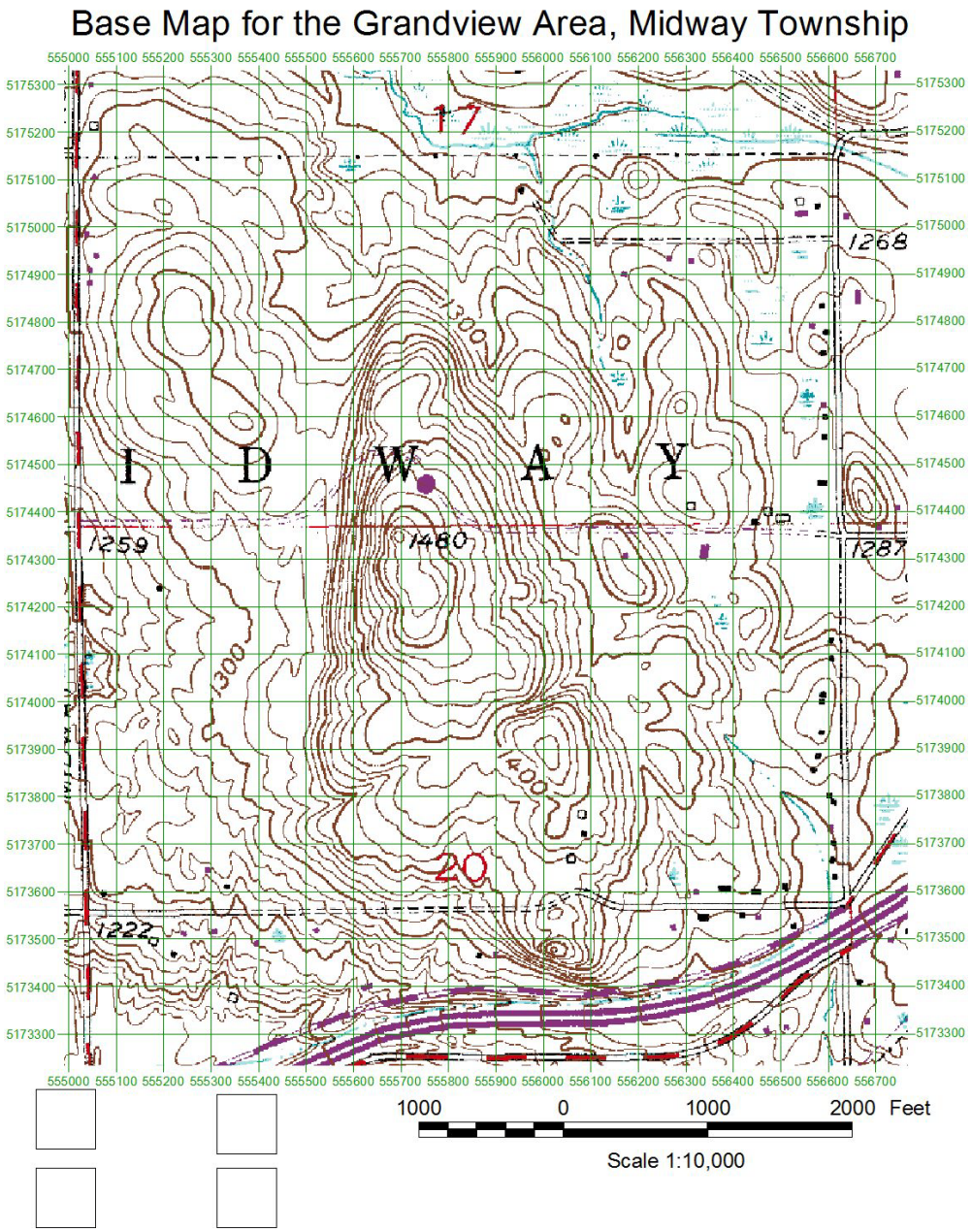
*Should show:*

-Outcrop areas – color coded to rock type

- Station numbers
- Traverse lines
- Structure Symbols

**Field Equipment:**

- Brunton Compass
- GPS Unit
- Map Board
- Hand Lens
- Hammer



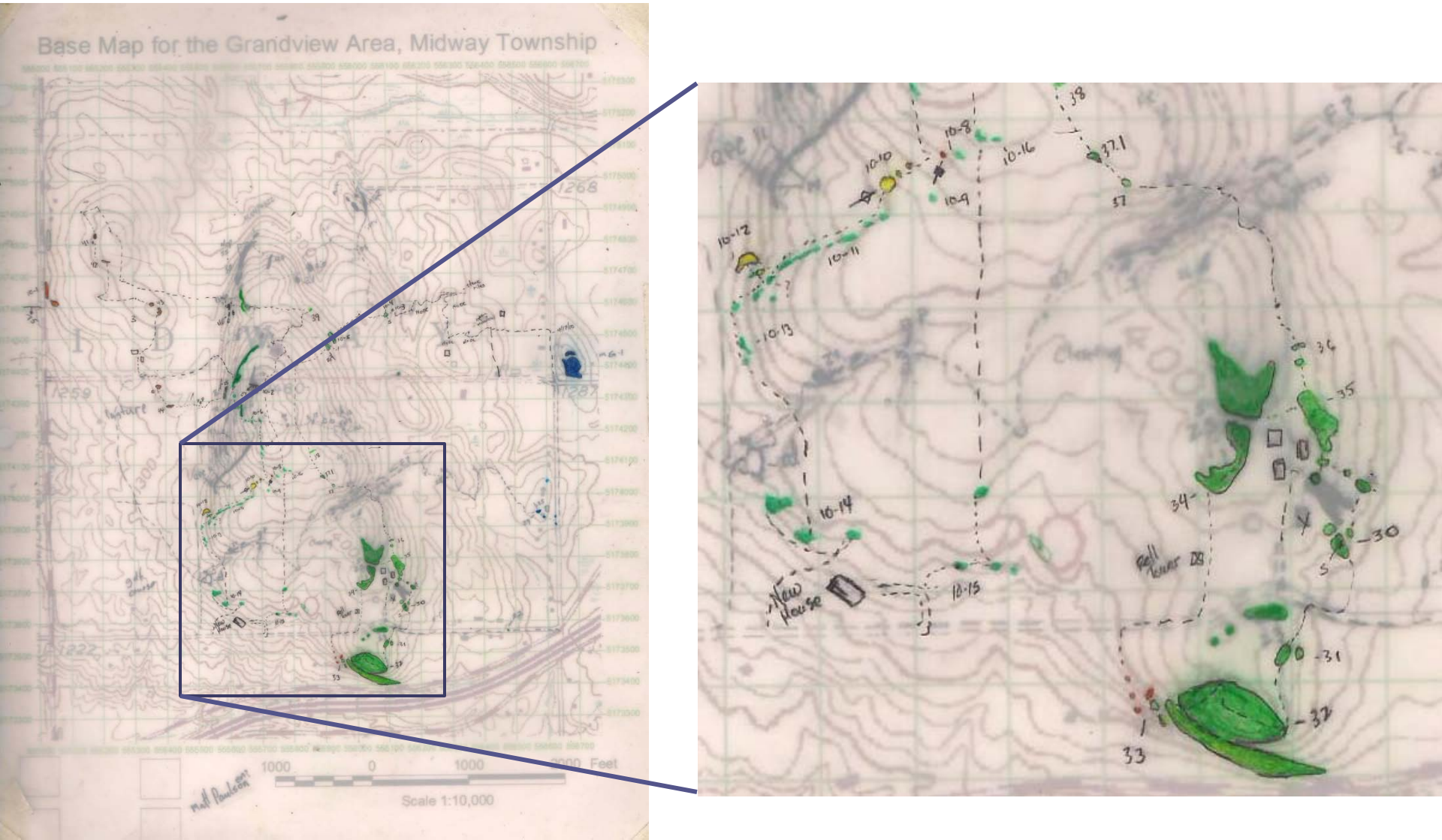
# Preparation for Field Work

Practice with measuring strike and dips

Pace and Compass Exercise

# Field Mapping

# Field Map


Base Map for the Grandview Area, Midway Township
1000
0
1000
Feet
Scale 1:10,000
10-8
10-9
10-10
10-11
10-12
10-13
10-14
10-15
10-16
37.1
38
36
35
34
30
31
32
33
New House

# Field Notes

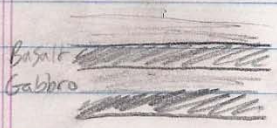
Thomson Formation

Outcrop 10-16

UTM: 055538, 5174588

- Quartz veins, fine grained, looks to have sedimentary bedding, trend: 85°

Medium grained with fine grained dike xenoliths, trending: 85°




* Seems igneous, could also be sedimentary.

* Found Qtz veins on eastern side with Qtz veins trending: 8°, why is this different? → Could be vertical bedding?

Outcrop 10-17

UTM 055554, 5174268

porphyroblastic texture, pyroxene phenocrysts, BASALT

Outcrop 10-18

UTM: 055544, 5174209

(4) Basalt on top of hill (unit 3)

Epidote amygdules in pyroxen porphyritic basalt → approaching top because of amygdules

0555688
5174338

→ Vesicle cylinders

lineations | plunge 68 W

Fracture: 117/80S

fracture planes

→ 60% pyroxene
→ 5% amygdules

(5) Fine-grained basalt (small outcrop on road, barely above ground)

→ no porphyrocrysts

0556114
5174366

→ Scratch marks trend SW

→ (unit 4)

(6) Gabbro on hill - lunch

→ coarse grained
→ Slightly magnetic
→ olivine gabbro

0556661
5174387

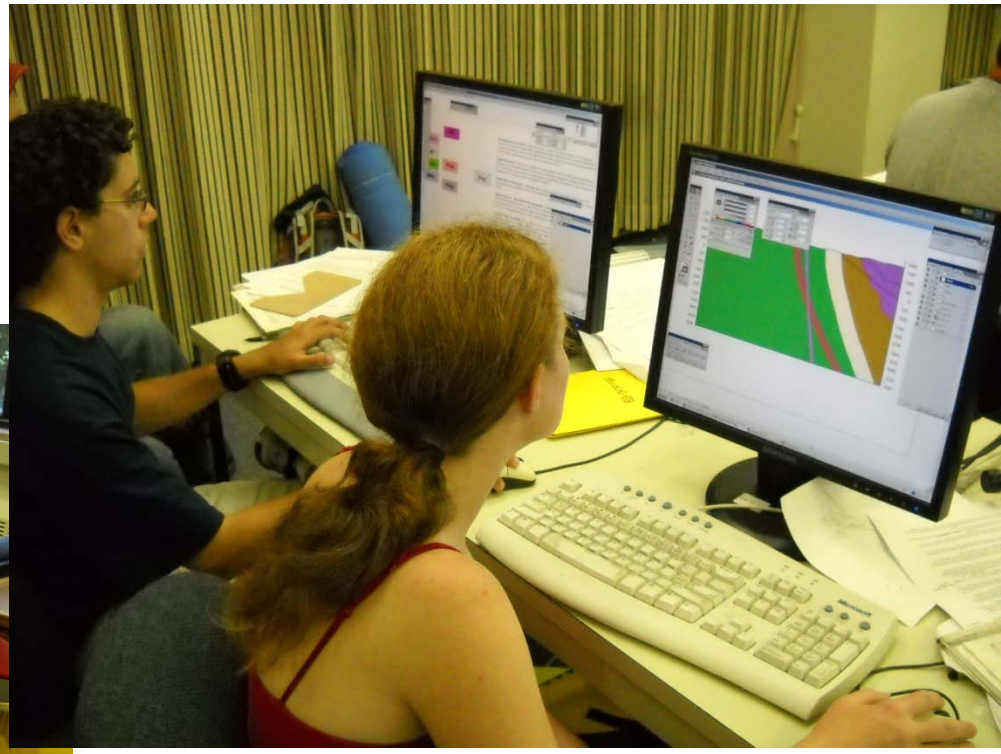
{ olivine = brown
{ pyroxene = black
{ plag. = white

Duluth Complex Gabbro

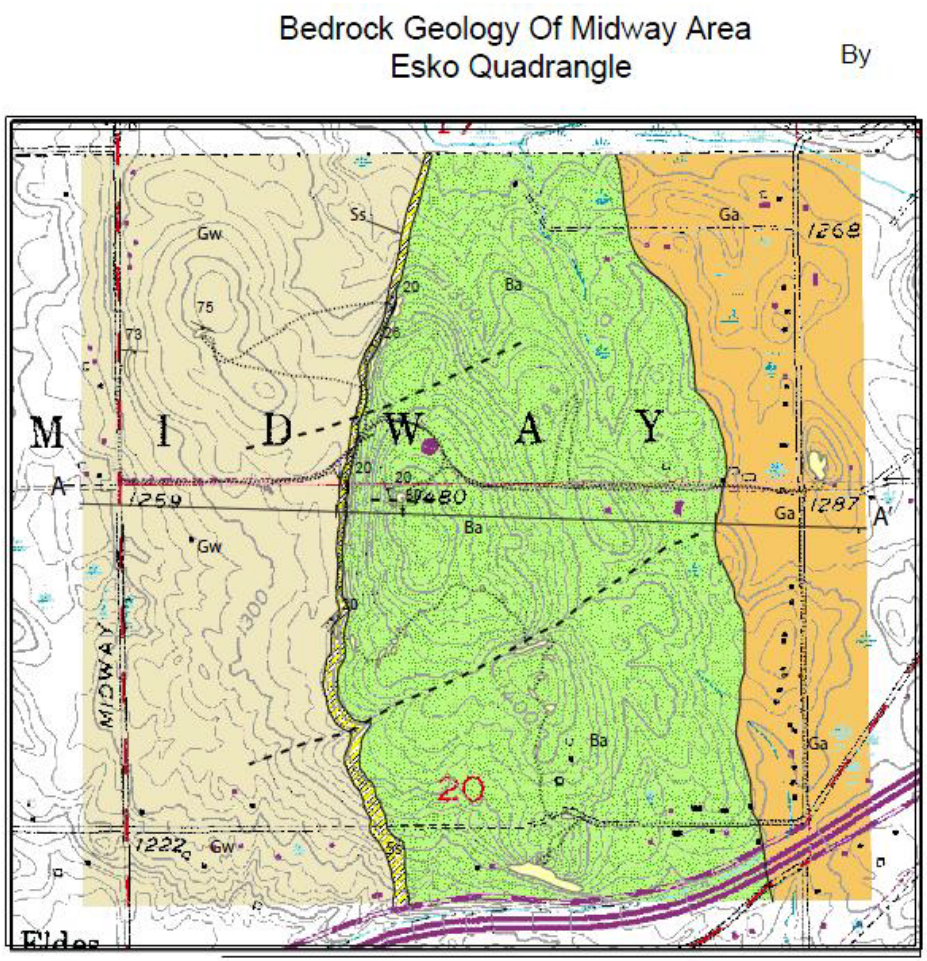
→ (unit 5)

"Rite in the Rain"

# Teaching Basics of ArcGIS and Illustrator



# Final Maps


Bedrock Geology Of Midway Area
Esko Quadrangle
By
Wesley R. Lueck
University Of Minnesota Duluth
5/8/2010
Description Of Units
Correlation Of Map Units
Ga
Ba
Ss
Meso-Proterozoic
Gw
Paleo-Proterozoic
Ga Duluth Complex: Gabbro - Medium to coarse grain, Olivine, Pyroxene, Plagioclase Feldspar, Magnetite in Pyroxene. Large Pyroxene Crystals Indicating water in magma during crystalization, which also means near a contact zone.
Ba Ely's Peak Basalt: Basalt - Pyroxene rich basalt with vesicle columns throughout . Fine grain basalt dominates the southern half of the Ely's Peak Basalt and coarse grain basalt in the north half. Some areas are Amygdaloidal. Some Porphoritic zones scattered through formation.
Ss Nopeming Sandstone: Interbedded meta-siltstone and meta-quartzite, lying uncomformably on top of Thompson Formation. Deposited through alluvial deposits or possibly lakes.
Gw Thompson Formation: Interbedded slate and greywacke with concretions throughout the bed. Also Quartz veins are present throughout the bed. The outcrops exhibit cleavage parallel/sub-parallel to the bedding plane. The bed is dipping steeply throughout, about 70 to 80 degrees.
Symbols
Volcanic Dip
Dip Of Fault
Sedimentary Dip
Fault
Traverse Line
Contact
Bedrock Outcrop
References
Miller, J.D., Jr., and Green, J.C., 2008, Bedrock Geology of Duluth Heights and Eastern Portions of the Adolph Quadrangles, St. Louis County, Minnesota. Minnesota Geological Survey Miscellaneous Map M-181, Scale 1:24,000.
Miller, J.D., Jr., and Green, J.C., 2008, Bedrock Geology of West Duluth and Eastern Portion of Esko Quadrangles, St. Louis County, Minnesota. Minnesota Geological Survey Miscellaneous Map M-183, Scale 1:24,000.
MIDWAY
A
A'
0 125 500 750 1,000 Meters
0 500 1,000 2,000 3,000 4,000 Feet
250
Cross Section
A
A'
Elevation
1450
1200
950
750
Gw
Ss
Ba
Ga

# Assessment

GEOL 3000 Spr 2010

Name: Todd Marks
Map Score: 56 / 60 pts

Grading Rubric for Final Geologic Map

Field Data (15 pts)

- Sufficient outcrop coverage
- Outcrop, stations, structures and traverses shown on field map — 5.5/5
  *Outcrop not plotted; not all structure plotted*
- Field notes: well organized, good lithologic descriptions — 4/4
- GIS data files submitted — 2/2

General Map (8 pts)

- Layout/Appearance — 3/3
- All requested components are shown — 5/5

Geologic Map (14 pts)

- Outcrops, structure symbols, X-section line and traverse lines shown — 4/4
  *Nicely done*
- Map units colored and labeled with unit abbreviations — 2/2
- Structures properly plotted — 1.5/2
  *S&D of bedding for TF exposures are oriented E-W, these are quartz veins which should have their own symbols*
- Geologic interpretation reasonable based on lithologies, topography, outcrop control, and structure – *good interpretation* — 6/6

Description of Map Units (8 pts)

- Map units listed in chronologic order with labeled color box — 2/2
- Map unit descriptions adequately summarize the various rock types, textures, structures, and contact relationships observed throughout the map unit — 6/6
  *Gabbro – good. Basalt –locally non-porphyritic; Sandstone – use "bedded" rather than "layered for sedimentary rxs; Thomson – note graded bedding.*

Correlation of Map Units (5 pts)

- Map unit boxes with labels arranged in proper chronological order4+ — 2/2
- Spacing conveys reasonable inference about genetic relationships between units — 2/3
  *Eb-Ns contact doe not have a significant time gap so boxes should touch, not true of DG-EPB. Volcanic had to have accumulated to some thickness before gabbro was intruded – therefore should be a gap. Separation between NS and TF also with squiggle line between.*

Cross Section (8 pts)

- Units colored properly and labeled — 2/2
- Contacts along section properly located to map — 1.5/2
- Subsurface interpretation reasonable based on lithologies and structure — 3.5/4
  *If you think the gabbro contact looks that complex at depth, then is should look that complex in map view too to give a consistent interpretation.*

Symbol Legend (all linework and structure symbols properly keyed; 2 pt) — 2/2
*Should add qtz vein symbol.*

# Summary

This exercise serves to:

- introduce students to the basics of field mapping in low-lying glaciated terrains of the Canadian Shield
- make students aware of the "facts" (outcrop, structures) upon which geologic maps are based and how sparse those facts are in glaciated terranes of the continental interior
- drives home the interpretive nature of geologic maps (name and date are key components)

# Thanks