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

James D. Miller
Department of Geological Sciences
University of Minnesota Duluth
GEOL 3000

GEOLOGIC MAPS

Syllabus (pdf)

GEOLOGIC MAPS (AND MAPPERS) ARE:

UNCERTAIN
FLEXIBLE
ITERATIVE
INTERPRETIVE
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

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

Winchester Book Discussion - The Map that Changed the World
Bedrock Covered by Glacial Debris
Good Exposure!
North Country Exposures
Generalized Geology of the Duluth Area

Field 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
Field Notes

Outcrop 10-16
UTM: 05555381, 5174588
- Quartz veins, fine-grained, looks like fine-grained dike
- Medium-grained with fine-grained dike
- Intrusives, trending: 85°
- Basalt, medium grained, fine-grained, could also be Gabbron
- * Scars in scar, Gabbron

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

Outcrop 10-17
UTM: 0555541, 5174268
- Porphyroblast texture, pyroxene
- Phano (yks), Basalt

Outcrop 10-18
UTM: 0555541, 5174209

4) Basalt on top of hill (unit 3)
- Epidote amygdules in pyroxene porphyritic basalt.
- Approaching top because of amygdules
- Vesicle cylinders
- Lineations: range 68 W
- Fracture: 117/898
- 60% pyroxene
- 5% amygdules

5) Fine-grained basalt
- Small outcrop on
- No porphyrocrysts
- Ground
- Scratched marks trend SW
- (Unit 4)

6) Gabbron on hill - lunch
- Coarse-grained
- Slightly magnetic
- Olivine, Gabbron
- Olivine = brown
- Pyroxene = black
- Plagi = white
- Duluth Complex
- Gabbron
- (Unit 5)
Teaching Basics of ArcGIS and Illustrator
Final Maps

Bedrock Geology Of Midway Area
Esko Quadrangle

By
Wesley R. Luick
University Of Minnesota Duluth
5/8/2010

Description Of Units

- **Duluth Complex**: Gabbro - Medium to coarse grained olivine-pyroxene-plagioclase-hornfels. Magnetite in pyroxene. Large Pyroxene Crystals Indicating water in magma during crystallization, which also means near a contact zone.

- **Ely's Peak Basalt**: Basalt - Pyroxene rich basalt with vesicle column 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 Porphyritic zones scattered through formation.

- **Nopeming Sandstone**: Interbedded meta-siltstone and meta-quartzite lying unconformably on top of Thompson Formation. Deposited through alluvial deposits or possibly lakes.

- **Thompson Formation**: Interbedded slate and grey-wacke with conglomerate throughout the bed. Also Quartz veins are present throughout the bed. The outcrops exhibit cleavage parallel to 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 Aroch Quadrangles, St. Louis County, Minnesota. Minnesota Geological Survey Miscellaneous Maps 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-103, Scale 1:24,000.
Assessment

GEOL 3000 Spr 2010

Name: Todd Marks
Map Score: 56 / 50 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
- 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 chronological 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 order 4+ 2/2
- Spacing conveys reasonable inference about genetic relationships between units 2/3
  - Eb-Ns contact does 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 it 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