Disappointment Lake Capstone

Precambrian Research Center
Field Camp, 2009
THE TEAMS

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Objectives

- Learn how to organize and execute a mapping project in the field; corroborating data from multiple parties working across a wide area, often operating in heavy brush and over water.

- Update and improve upon reconnaissance mapping done in 1901.

- Interpret and enhance geologic history of the area based on findings.
Disappointment Lake Area
Geologic Background

• Predominantly 2.67-2.7Ga Archean aged rocks intruded and cross cut by younger 1.1Ga Mezoproterozoic rocks from the Duluth Complex

• Our mapping area sits center stage to all the events that occurred in the Archean and during the later volcanic activity that formed the Duluth complex during the Paleoproterozoic.
Forenote: The preparation time is lengthy, patience is required

1. Start with a subduction event that creates your basal volcanic units.

2. Add a hot spot that produces many island archs as the oceanic plate moves over the spot.
3. Crash these island arcs into the basal volcanic continent causing a massive collision event.
4. Shear and fault the island arcs against each other to produce pull apart rifts that release some of the built up tension.

![Diagram of Strike-Slip Faults, pull-apart basin, and Releasing Bend]
5. Let settle for a few thousand years or more to allow for erosion of the crustal features and the infill of the pull-apart basin resulting in a conglomerate.

6. Restart tectonic action again, by continuing to collide ocean arcs into the continental crust. This time add more compressional tension so that the volcanic beds, and conglomerate in the basin begin to buckle, fold and as a result fault.
7. Once you have achieved a number of synclines and anticlines that have resulted in steeply dipping beds that dip at an angle around 75 degrees stop tectonic activity.

   Note: Because of convergence events granite intrusions from partial melt of the subducting plate may result changing the chemistry of your units when it comes in contact with them.

8. Let sit again so that weathering can occur over a few million years.
Time to create the Duluth complex and put the icing on the cake:

After you are satisfied that the Archean rocks have settled are weathered sufficiently instead of converging plates create a rift in which opens a gap.
9. Instead of creating a convergent boundary, pull apart the land mass in the middle creating a mid continent rift.

10. Spill basaltic lava flows from this rift.

11. Intrude mafic to ultramafic igneous rocks, known as Duluth Complex.

12. Erode surficial rocks down to Archean-aged bedrock.

13. Now kick back relax wait a few million years allowing the younger basalts to erode. In the last 100,000 years throw the mix into the freezer for a while so that glaciers can do further damage to the surface rocks.

14. When once again see the Archean rocks at the surface sit back and enjoy your meal.
GEOLOGICAL HISTORY

August 14, 2009
• Chandler, V. W., (1991), Aeromagnetic anomaly map of Minnesota: Minnesota Geological Survey State Map Series S-17, scale 1:500,000.


Previous Mapping work

Gruner, J.W., (1941)
Miller, J.D., Jr., Green, J.C., Severson, M.J., Chandler, V.W., and Peterson, D.E., 2001

- Tuscarora – Lake One Troctolite
- Snowbank Stock
- Conglomerate, pebbly gritstone, minor interbedded arkosic sandstone and siltstone
- Volcanic rocks
- Unnamed mafic volcanic rocks
Getting There

- Approximately 15 mile drive from Ely, MN to BWCA entry point at Snowbank Lake

- Canoe across Snowbank Lake and 140 rod portage into Disappointment Lake area

- Established base camp on island central to both subgroups’ mapping areas in the center of Disappointment Lake
A typical day at the office….

• Breckie at 7, departure between 8:30-9

• Break into map groups (pairs, with one triplet), canoe to field area of responsibility.

• Canoe, walk or Bushbash until 5pm

• One group returns early to prepare dinner by 5:30

• After dinner, field maps were copied, groups worked on interpretations, and plans were made for the next day’s work.
Tools of the Trade

- Topographical Base Maps
- GPS
- Pens and Pencils
- Brunton
- Radio
Mapping in the Boundary Waters

Canoeing

Bugs
Mapping in the Boundary Waters

Wildlife

And of course....
ROCKS
Camp
A little fun here and there…
Access to outcrops

Trails and...
Access to outcrops

Bushbashning
Access to outcrops

Canoe and shorelines
Observed rocks

- Basalt
- Epiclastic Sediments
- Ogish Sediments
- Snowbank Lake Granite
- Norite
- Polymict Conglomerate
- Hornfels Sediment
- Diorite
- Mafic Inclusions
Mezopaleozoic rocks (1.1Ga)

- Duluth complex rocks;
- Hornfels polymict conglomerate greywacke (M3dp/Hs)
- Basalt Hornfels (MhB)
- Norite (MN)
- Pyroxene Troctolite (MT)
- Diorite and Hornblende Diorite (MhD)
- Gabbro to Olivine Gabbro (MoG)

Archean rocks (2.67-2.72Ga)

- Hornfels sediment (Ahs)
- Granite (AGr)
- Interbedded mudstone, sandstone and conglomerate (A3ad)
- Rhyodactic to dacitic Tuff, Lapilli Tuff, and Polymict Epiclastic Deposits (A2cef)
- Massive and Pillowed Basalt Lava Flows (A1ab)
Hornfels polymict conglomerate
Greywacke (M3dp/Hs)

- Interbedded mudstone, feldspathic wacke and feldspathic arenite that has been heated and thus hornfelsed
- Clasts can still visible despite alteration.
- Rust red to brown
- Fine to coarse grained
- Plagioclase and quartz dominate granular groundmass
- (In some OG original bedding can still be seen - see pic)
Troctolite (MT)

- Light to dark grey
- Medium to coarse grained
- Locally displays modal layering
Diorite and hornblende diorite (MhD)

- Light grey
- Fine to medium grained
- Both heterogeneous and hornblende diorite
- Quartz and plagioclase dominated
- Light brown to rusty red
- Medium grained
- Poikilitic olivine gabbro
Hornfels sediment (Ahs)

- Light to medium grey
- Granular
- Metamorphosed mudstone, sandstone and conglomerate
Looks like …. 
- Light to dark pink
- Medium to coarse grained
- Intrusive body, seen as massive outcrops and as small crosscutting dikes
Boundary Between AGr and A3ad
- Interbedded mudstone, wacke and conglomerate units

- Very diverse unit, including a volcanic tuff bed, coarse grained conglomerate, baked red or green conglomerate/wacke unit and bedding sequences that show all three interbedded.
INTERBEDDED MUDSTONE, SANDSTONE AND CONGLOMERATE (A3ad)
- Light dark grey
- Think bedded massive felsic tuff deposited inerbedded with polymict volcaniclastic-dominated epiclastic deposits
- mostly seen incredibly sheared
Hornfels polymict conglomerate

Greywacke (P3dp/Hs)

Name the unit for each of these pictures....
Massive and Pillowed basalt lava flows (A1ab)

- Light grey to green
- Pillowed and Massive flows
Cross Sections

Geologic Cross-section A-A' of the Archean Metasedimentary, Volcanic and Volcaniclastic Rocks

Geologic Cross-section B-B' of the Mesoproterozoic Duluth Complex Contact with the Archean Rocks

August 14, 2009
Archean

- Submarine volcanic eruptions
- Eroded tufts recemented
- Dextral shearing and rifting to create sed.
- Unconformity
- Deposition of cgl, ms, ss
- Continue shearing (EW trend in N of mapping area; dextral) to create folds
- Granitic intrusion (Snowbank lake stock)
  - Cooks sed rx to hornfels
- Contacts of intrusion extremely cooked seds
Mesoproterozoic (Duluth Complex)

- Intrusion of Gabbro
- Intrusion of Troct.
  - More heat
  - Cooks seds more to create norite
  - Melts 3ad to create 3ad/Hs and diorite and dioritic 3ad
What We Learned

• Geologic mapping in a complex area
• Teamwork in the field and in the office
• Food thrown in boiled water can taste good
• Always look down the latrine
• Look out for fish-eating spiders
• Don’t trust squirrels of birds with food
• Computer drafting and tech skills
• Time management
• Keepin’ it classy in the field
Sources

• Chandler, V. W., (1991), Aeromagnetic anomaly map of Minnesota: Minnesota Geological Survey State Map Series S-17, scale 1:500,000.


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