

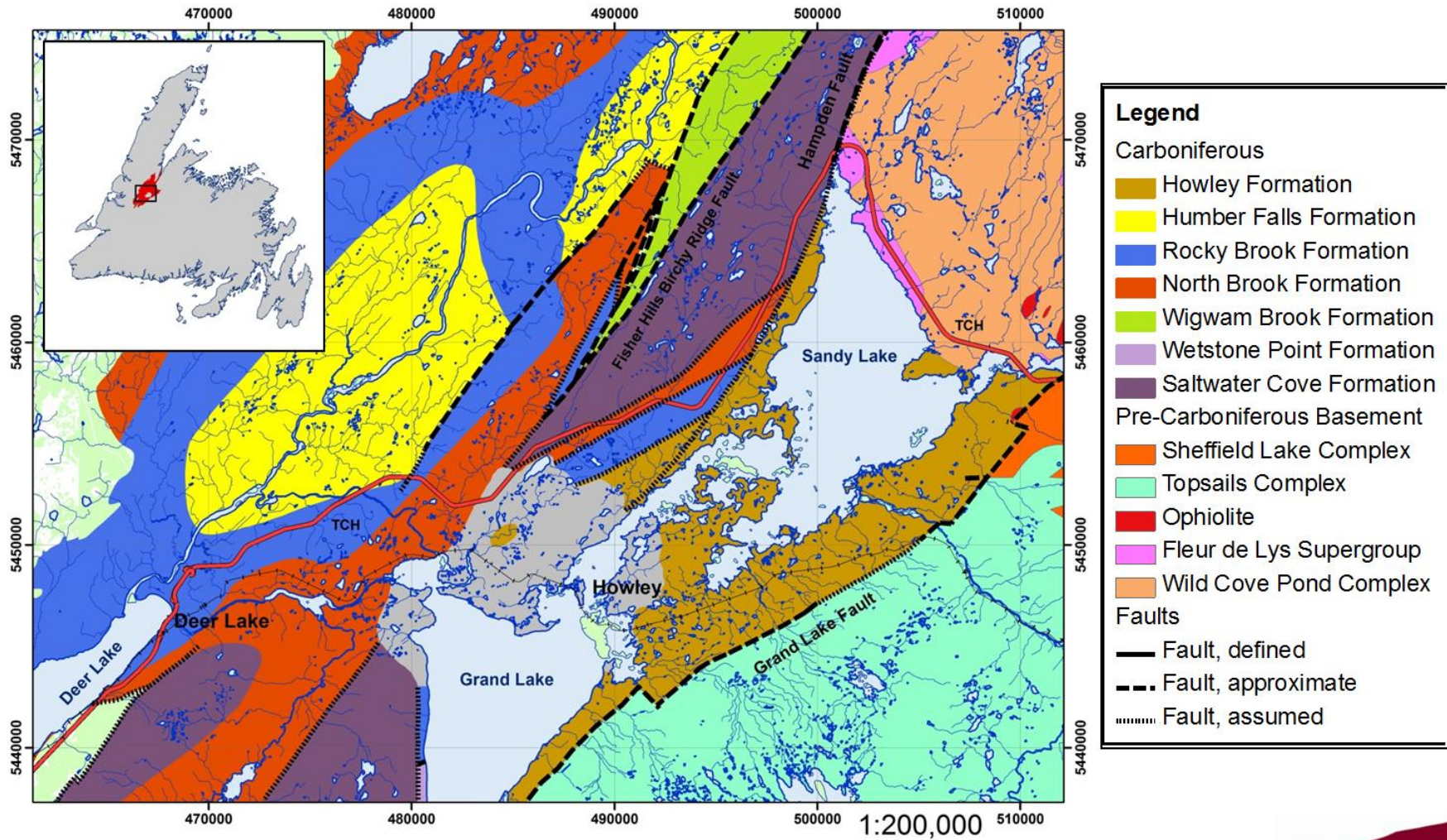


Structural and Gravimetric Investigation of the Howley Basin: A Progress Report

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Overview



Stratigraphy

Time		SW	Deer Lake/ Howley Basin	NE	
Lower Permian					
CARBONIFEROUS	Stephanian				
	Westphalian	D			
		C			
		B			
		A		Howley Fm	
	Namurian				
	Viséan		Little Pond Brook Fm	Humber Falls Fm	
			Rocky Brook Formation		DLG
			North Brook Formation		
	Tournaisian		Wetstone Point Fm	Wigwam Brook Fm	
		Saltwater Cove Formation		AG	
Upper Devonian					

Objectives

Assessment of hydrocarbon potential

- Structural mapping of the Howley Formation and adjacent units
 - Structural style and orientation patterns
 - Deformation history
 - Kinematic and tectonic models
- High density (1km) gravimetric transects over the Howley Basin, including on top of Sandy Lake
 - Augment and refine existing data sets
 - Models assessing thickness of Carboniferous cover succession and nature of basement
- Integrating structural analysis along with new geophysical data (magnetic, gravity, magnetotelluric, and seismic)

Rationale – Why Howley?

- A few sniffs!
 - Hatch's (1925) sampling and analyzing of *bituminous shale beds* in the region indicated that the Grand Lake (Rocky Brook?) samples had the highest calculated oil yields (Hyde et al., 1994)
 - Outcrops now underwater?
 - Langdon (1993) geochemically correlated bitumen found in core of the Howley Formation to the Rocky Brook Formation
 - Remains of migrated oil?
 - Presence of coal in outcrop in the Howley Formation (e.g., Coal Brook)
- Strike-slip basins
 - Fast, deep subsidence
 - Accumulation of organic material in stratified lacustrine environment

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 - Presence of coal in outcrop in the Howley Formation (e.g., Coal Brook)
- Strike-slip basins
 - Fast, deep subsidence over protracted period of time (360-318 Ma)
 - Non-marine sedimentary facies
 - Accumulation of organic material in stratified lacustrine environment

Structural Field Mapping

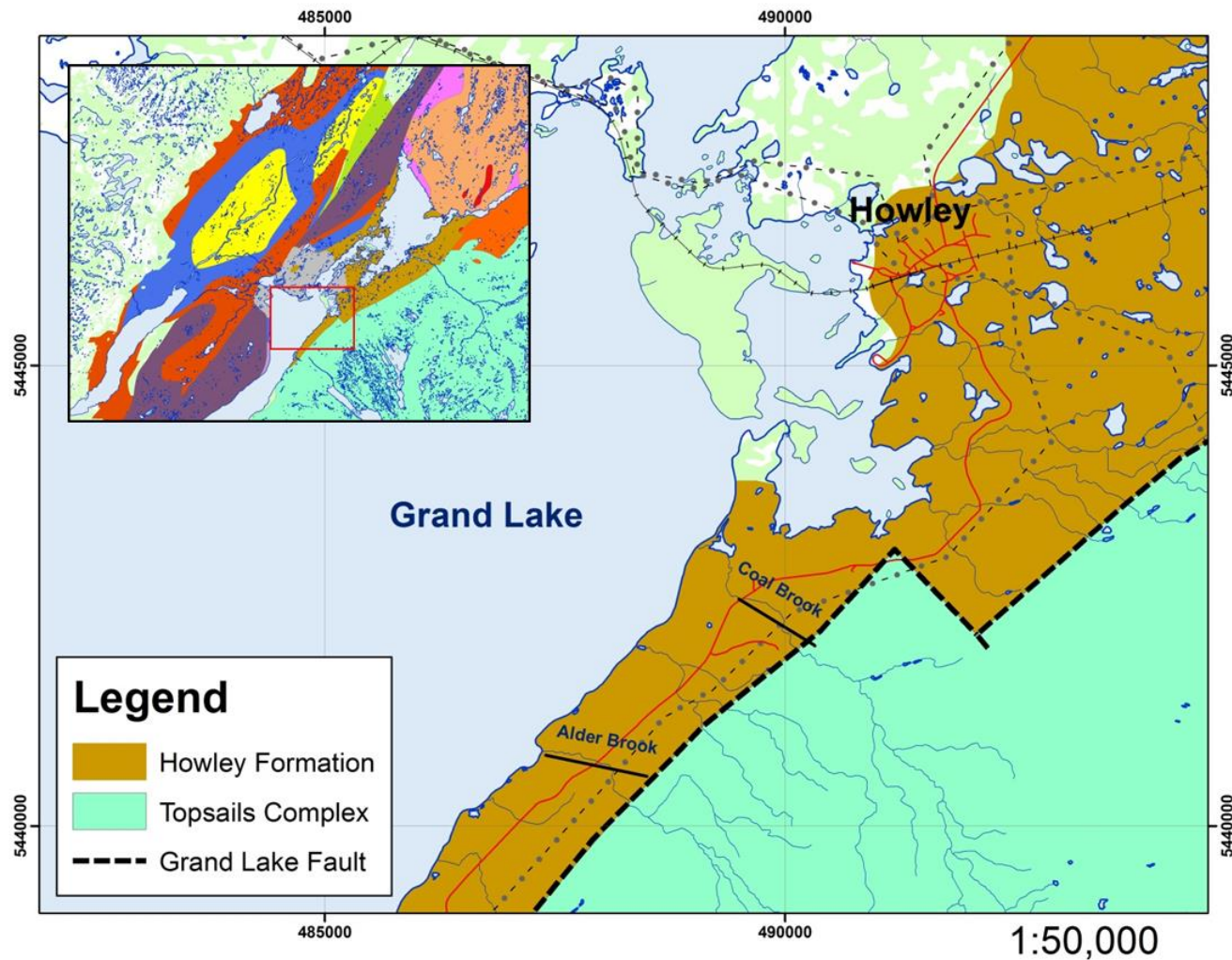


- Structure of the Howley Basin is largely unknown
 - Previous regional mapping by Hyde (1984), on scale 1:250,000, with base maps at 1:50,000
 - No analysis of structural orientation patterns and style, no detailed cross-sections
 - No resolution of geometry and nature of the bounding faults

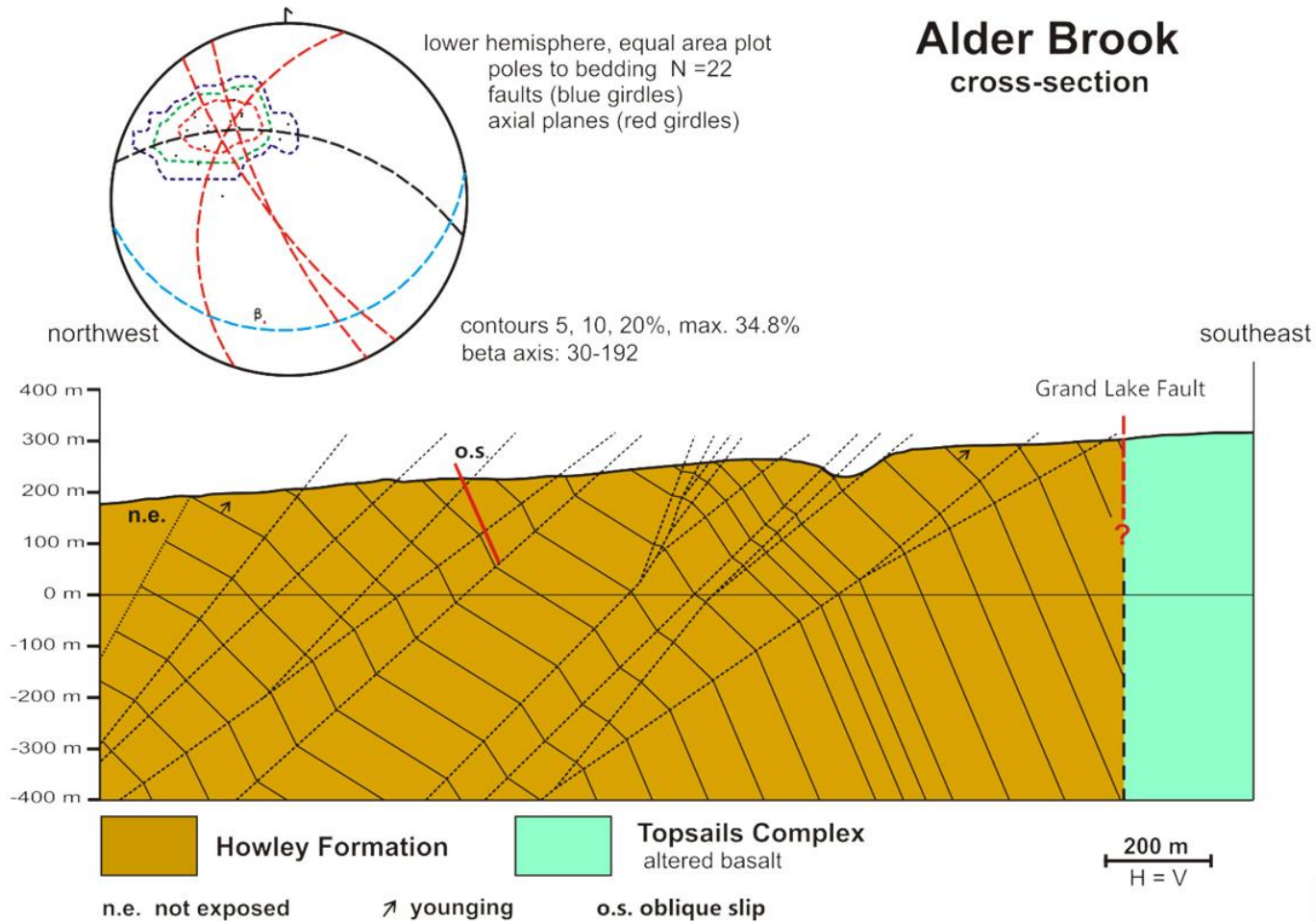


- Poor outcrop density/ quality
 - Limited to stream beds
 - Rough traverses
 - Many outcrops are only accessible during low water

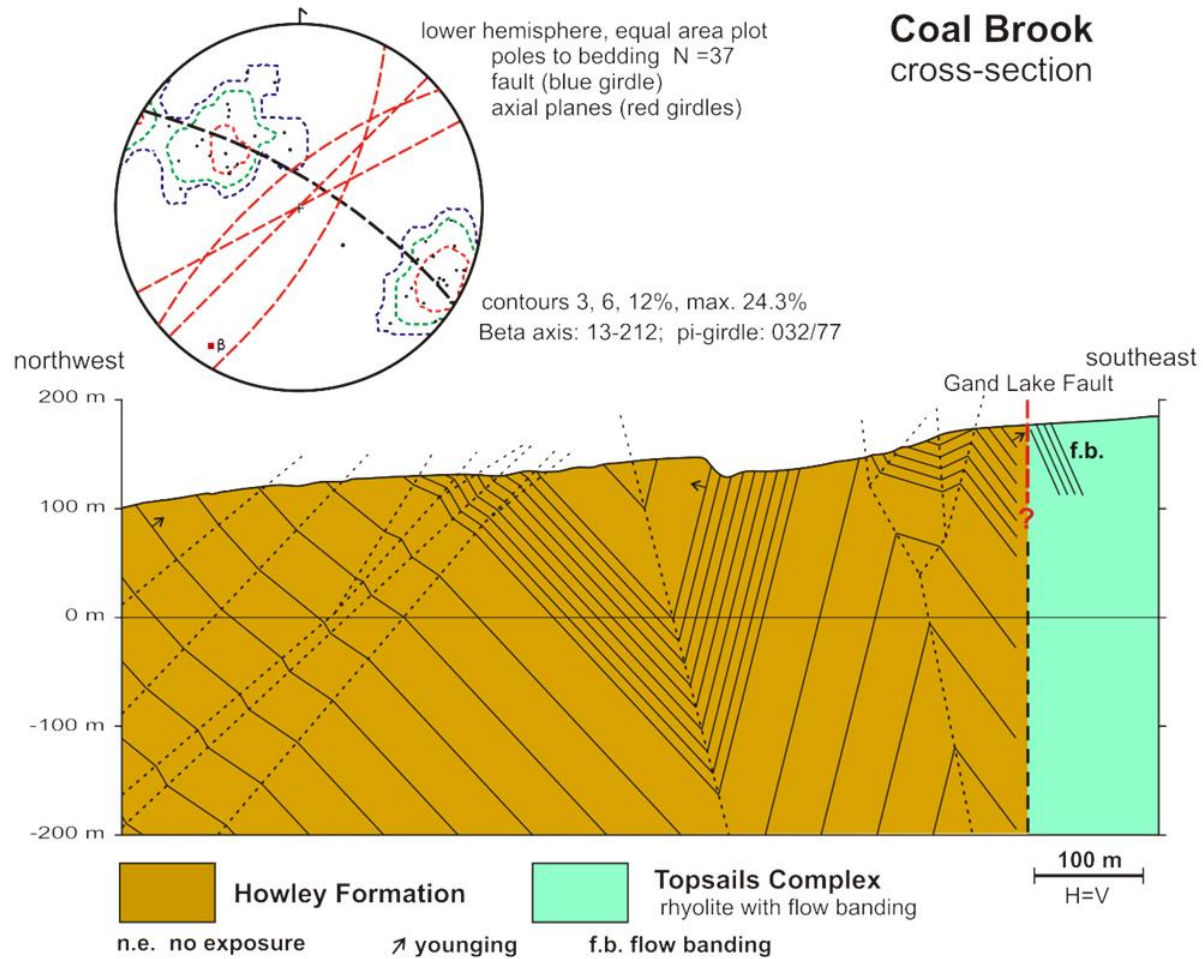
Detailed Cross-Sections at SE Margin of Howley Basin



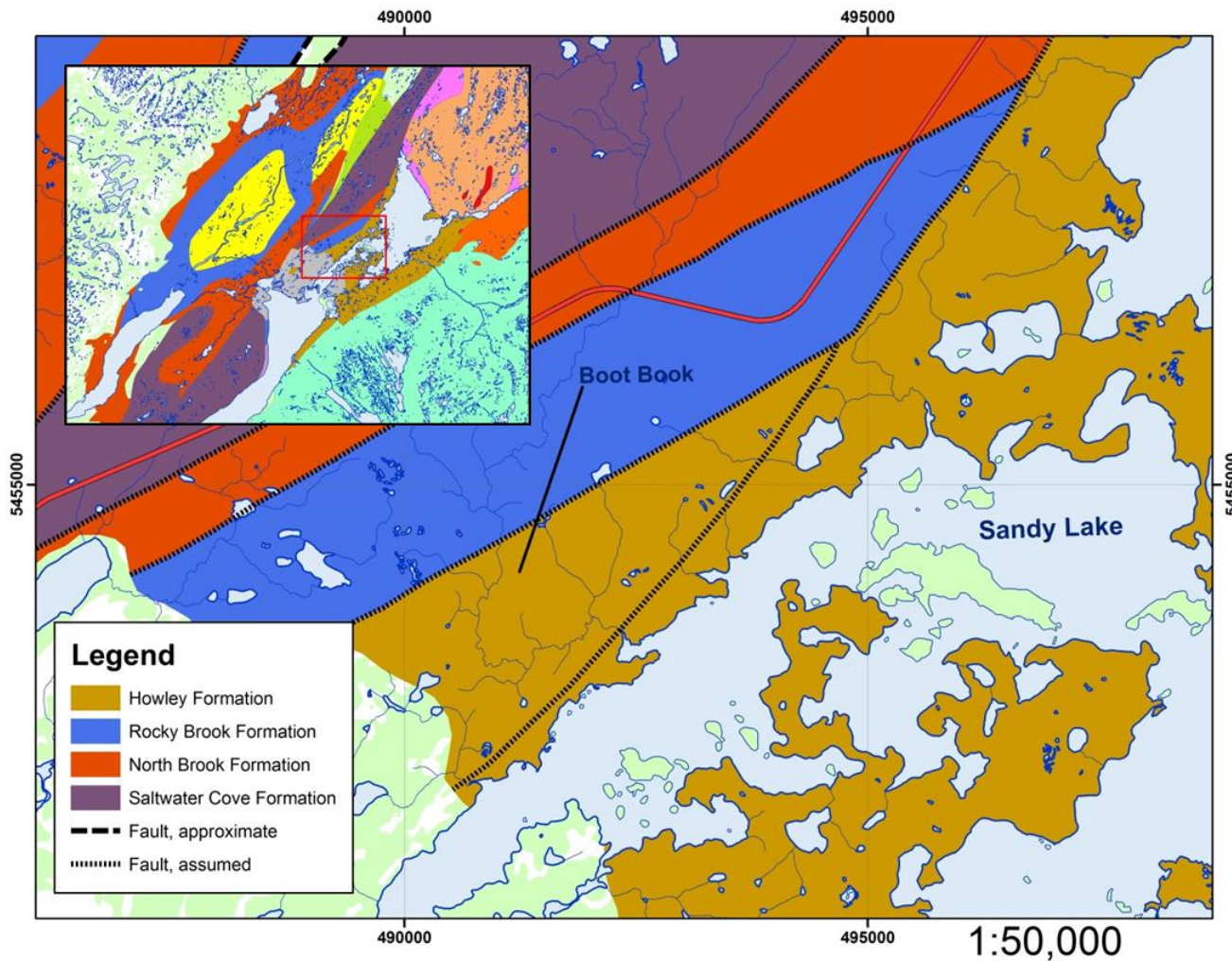
Alder Brook



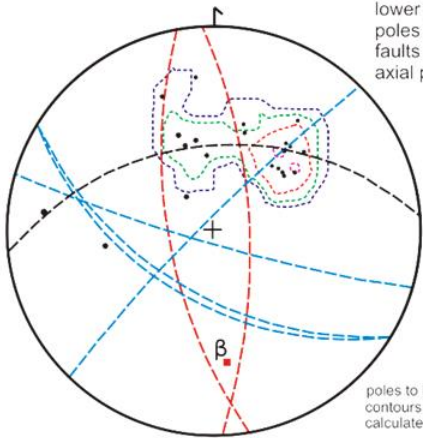
Coal Brook



Detailed Cross-Section Through Rocky Brook Fault Panel

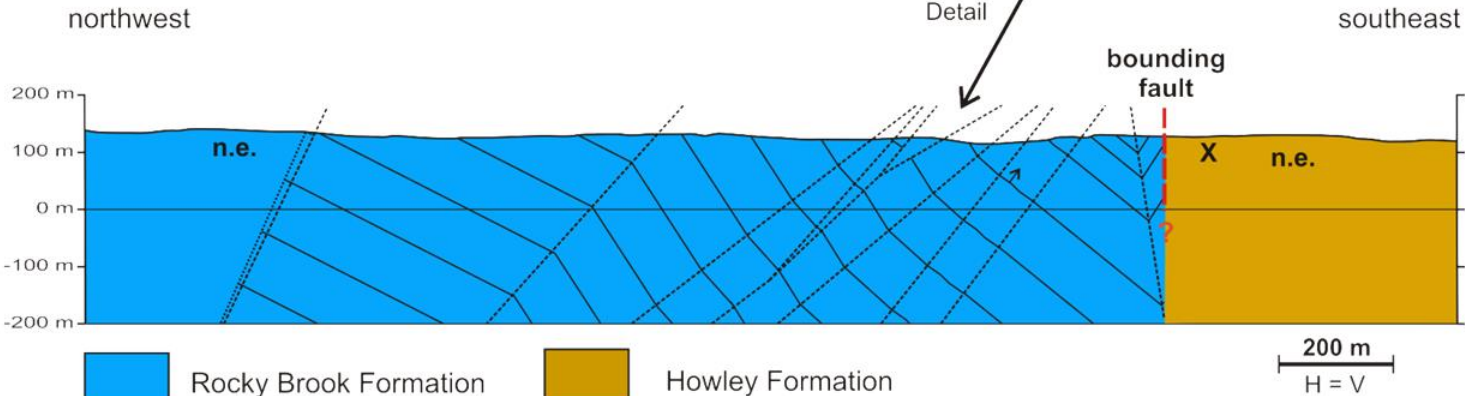
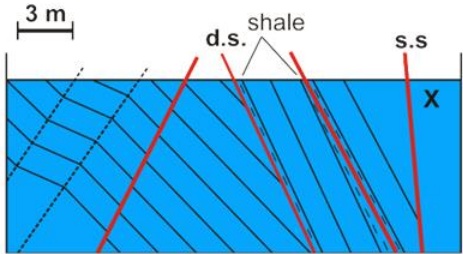


Boot Brook



poles to bedding, N = 21
contours 3, 10, 20, 40%, max. 42.9%
calculated beta axis: 35-175

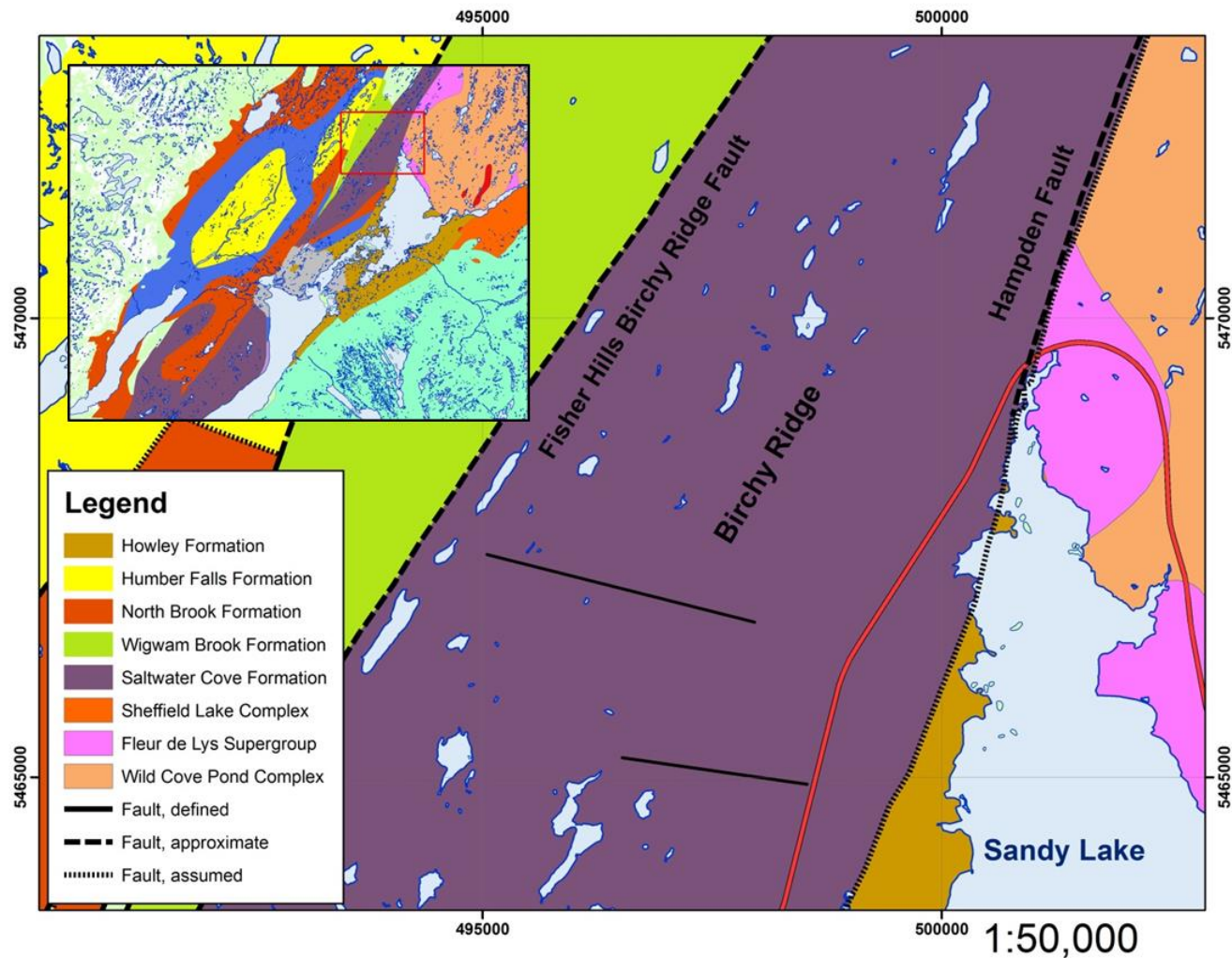
south Boot Brook
cross-section



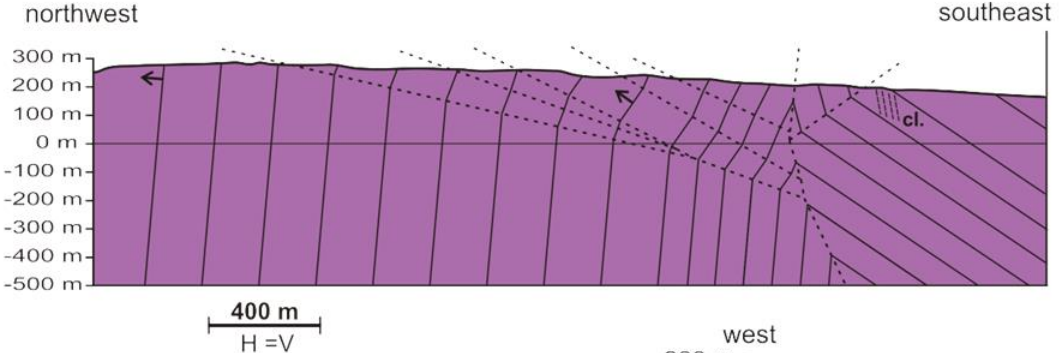
Rocky Brook Formation Howley Formation

n.e. no exposure ↗ younging X subcrop, bedding undetermined d.s. dip slip s.s. strike slip

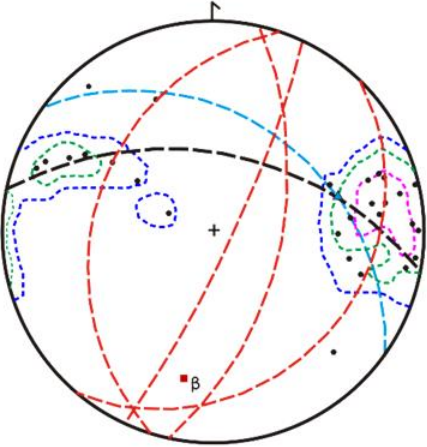
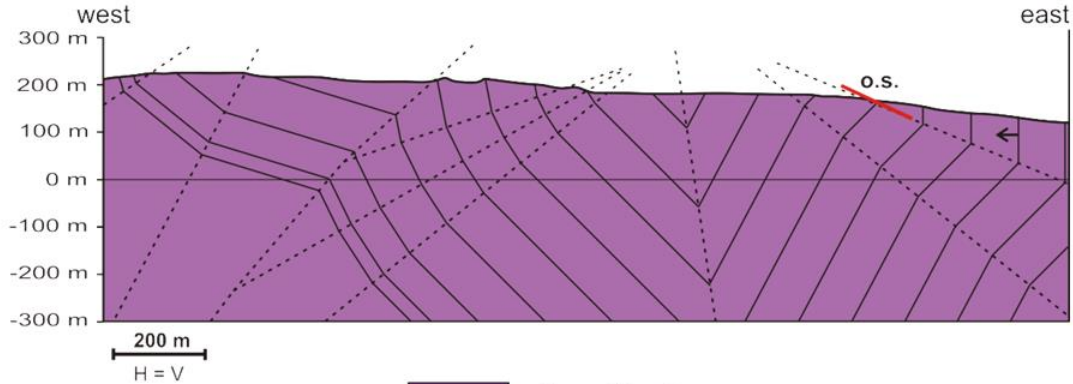
Detailed Cross-Section of Birchy Ridge



Birchy Ridge




Birchy Ridge cross-sections



lower hemisphere, equal area plot
 poles to bedding N = 28
 faults with lineation (blue girdles, triangle)
 axial planes (red girdles)
 beta axis 30-191
 contours 4, 8, 16% max 28.6%

 Anguille Group
 Saltwater Cove Formation

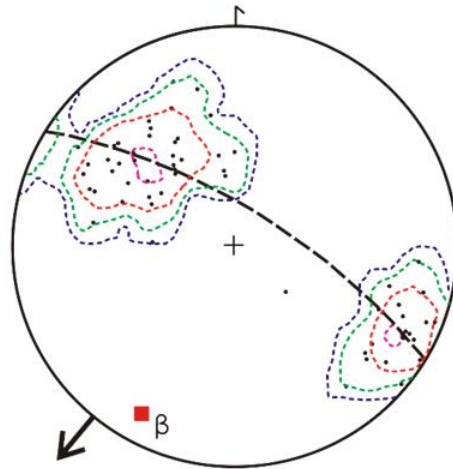
 younging c.l. cleavage o.s. oblique slip

Structural Summary

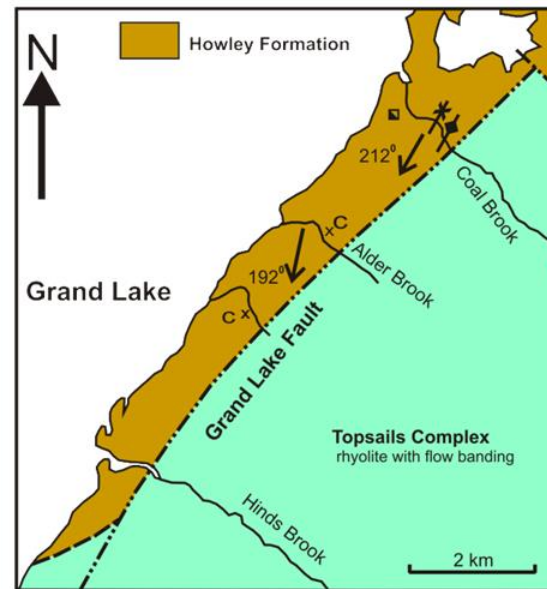
- Well-constrained structural cross-sections limited to SE margin of the Howley Basin
 - Show contractional structures with kink-style, upright and upward facing anticlines and synclines close to the Grand Lake Fault

Fold axis trend in Howley Formation along southeast portion of the Grand Lake Fault

lower hemisphere, equal area plot
poles to bedding N = 58
Beta axis: 14-211; pi-girdle: 031/76
contours 2, 4, 8, 16%, max. 19%



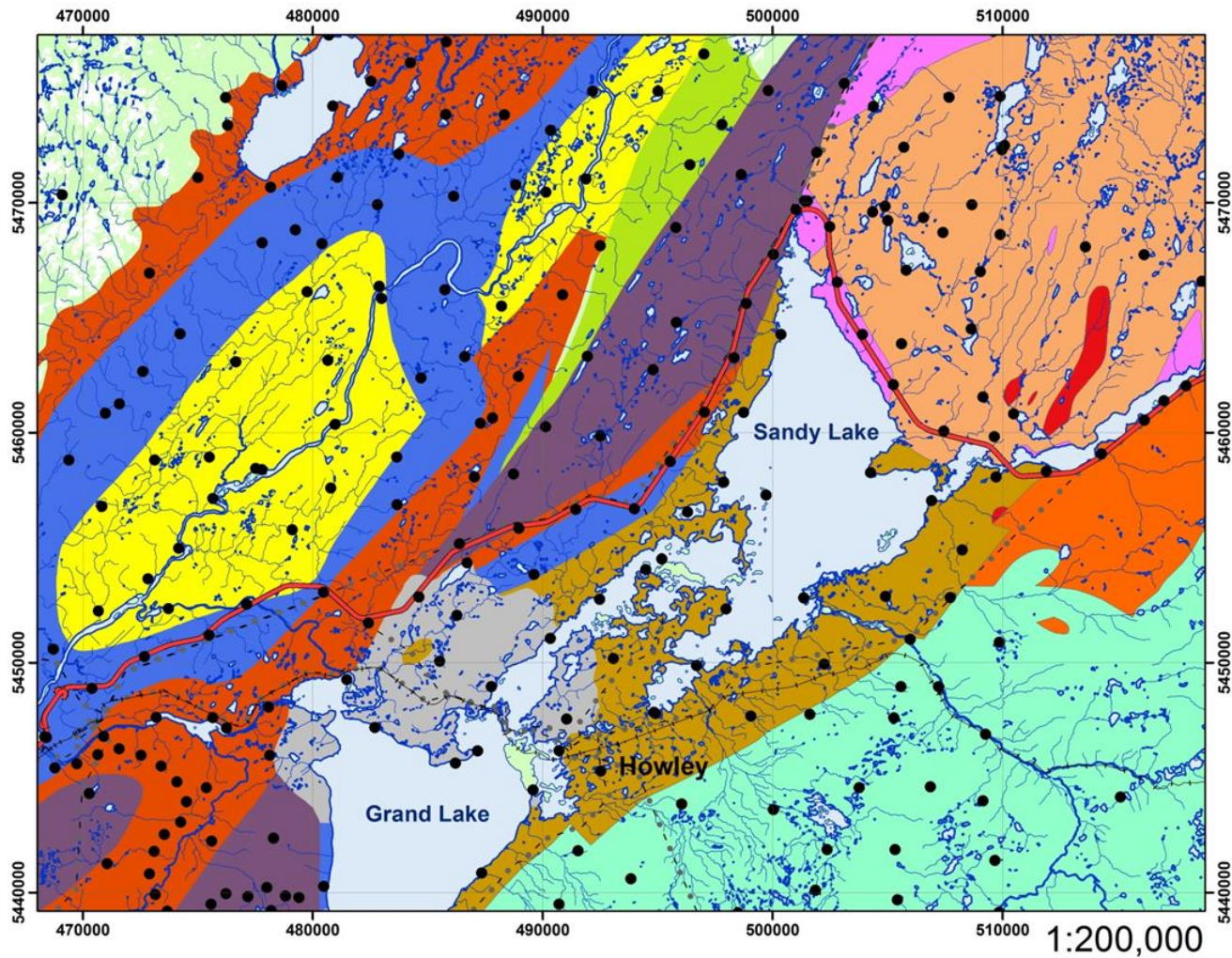
Grand Lake Fault trend
220°



Structural Summary

- Structure of west margin of Howley Basin and adjacent Deer Lake Group fault panels poorly constrained due to lack of outcrop
 - Fault panels show gentle to moderate dipping, upward facing homoclinal bedding panels, with variable dip directions
 - Strike obliquely to trends of bounding faults
 - Folding and steep tilting occur close to main faults
- Structure of Anguille Group shows tight macroscopic kink style folds trending notably oblique to eastern bounding fault
 - Geometry indicates overall dextral transpression

Gravity Surveying – Existing Data



Gravity Surveying



- Scintrex CG-5 Autograv Gravity Meter
 - Fused quartz using electrostatic nulling
 - 8,000 mGal operating range without resetting
 - Automated corrections: earth tide, instrument tilt, temperature, drift, seismic noise filter
 - Tares are typically less than 5 microGals for shocks up to 20 G



- Topcon Hyperlite+ Differential GPS
 - Typical base to rover range: 2- 4km
 - Relative rover to base elevation set to only be taken with < 3cm uncertainty
 - Base static data post processed by NRCan with typical uncertainties < 2cm

Winter Gravity Surveying



- Concentrated on collecting gravity data over Sandy Lake and along proposed seismic line
- Elevation of ice determined with DGPS and horizontal position determined from Garmin GPSMAP 62 handheld
 - Assumption that ice is level

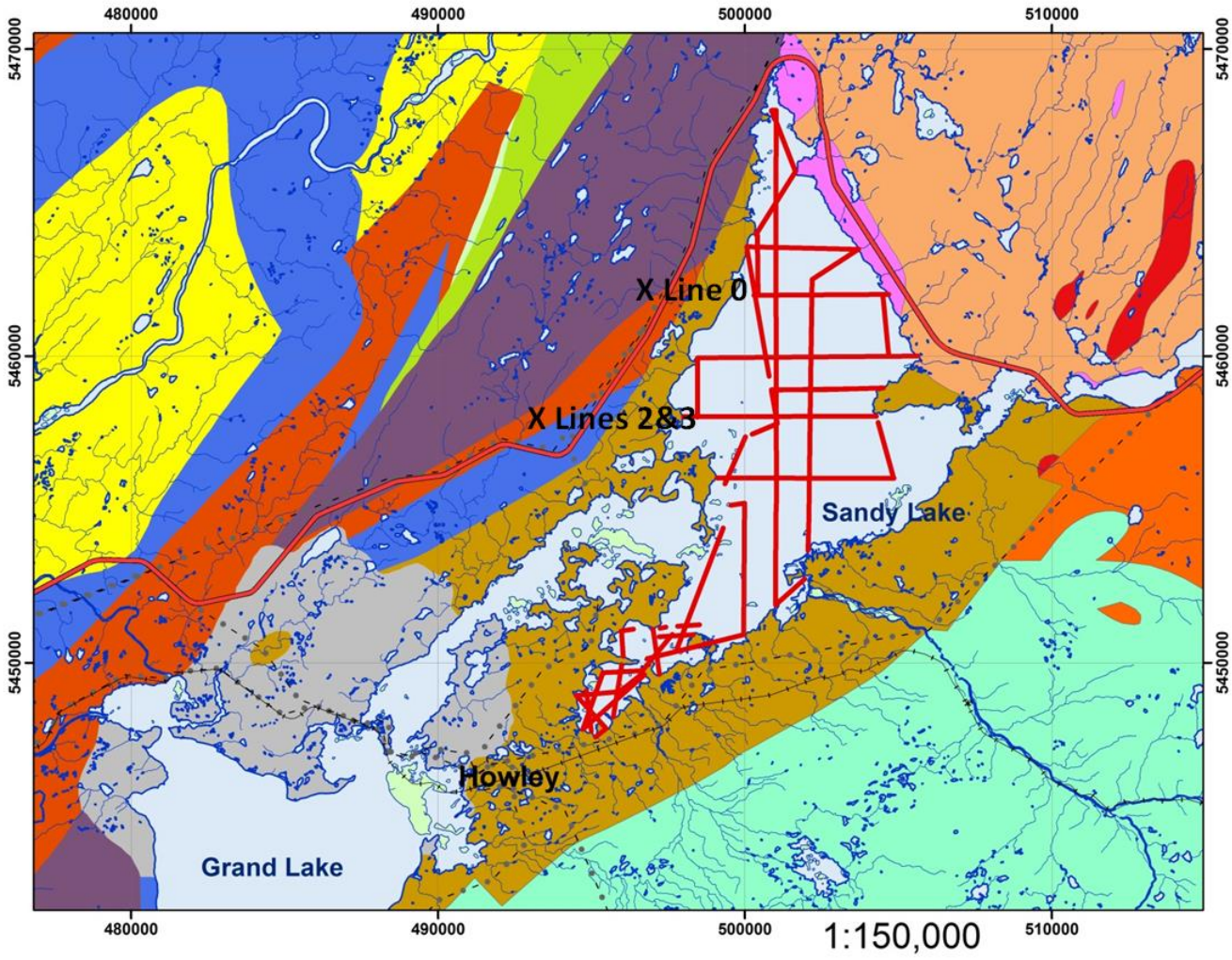
Winter Gravity Surveying - GPR

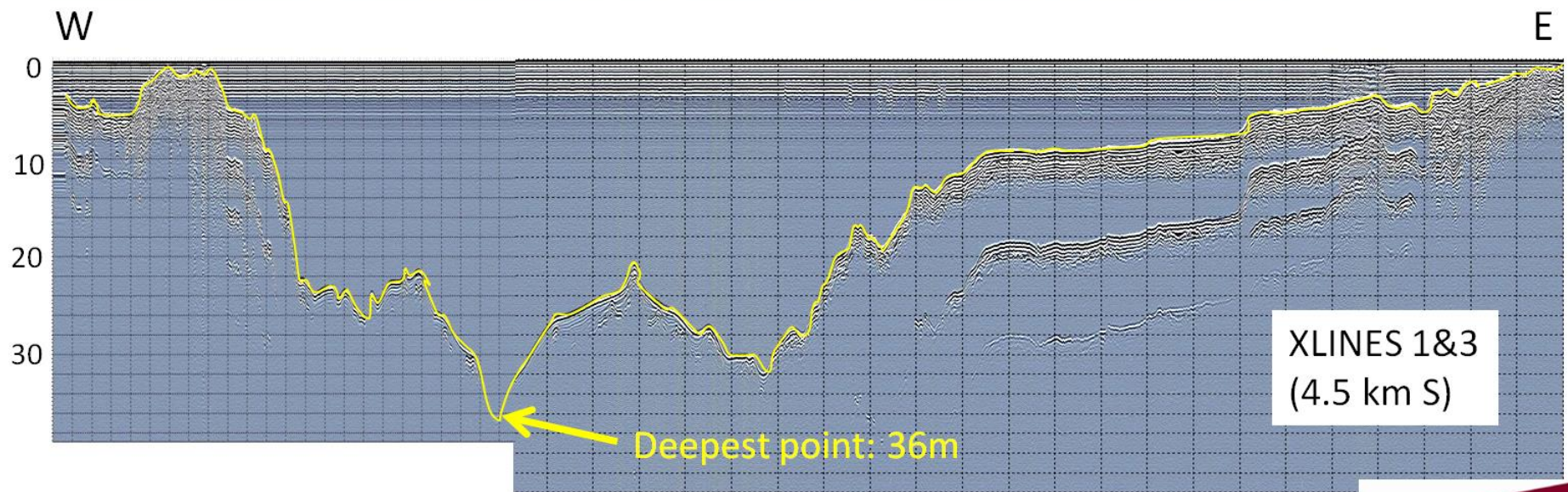
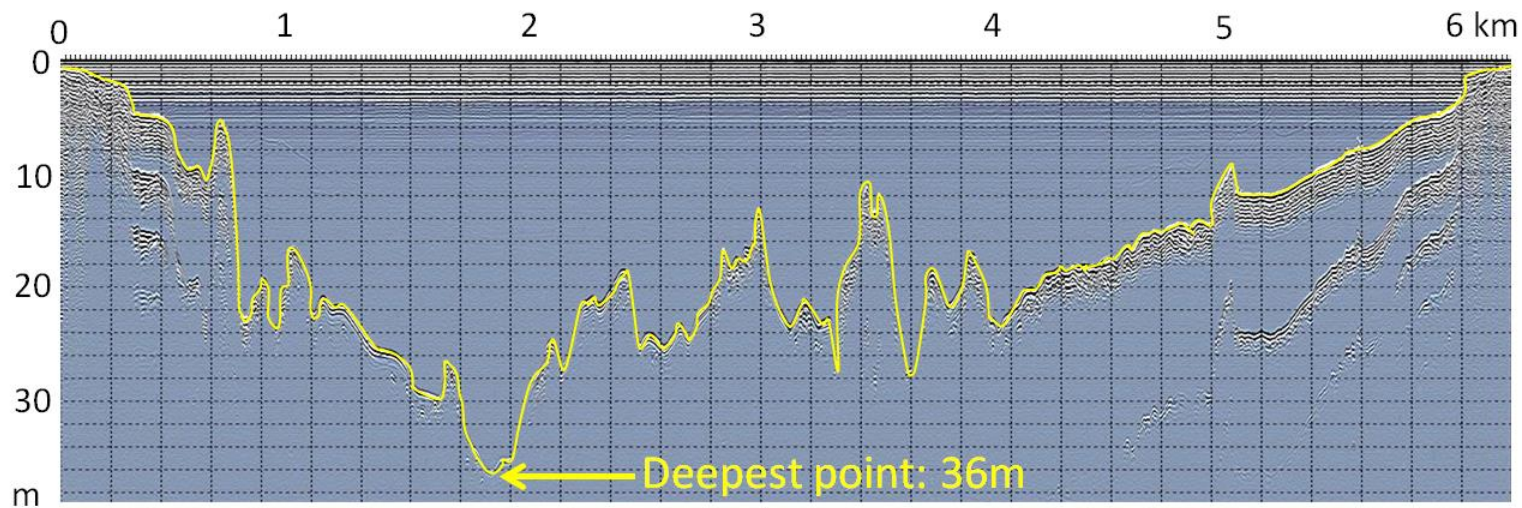


- Sensors & Software pulse EKKO PRO
 - 50 MKz antennas
 - Towed behind skidoo
 - Transects followed gravity stations
- Determine bathymetry of Sandy Lake
 - *Correct* gravimetric data (both on the lake and on land)



GPR-Transects





Vertical exaggeration: 50x

Winter Gravity Surveying – Challenges



- Ice is unstable
 - Wind
 - Changes in barometric pressure
 - Diurnal variations in temperature (nights $< 0^{\circ}\text{C}$ and days $> 0^{\circ}\text{C}$)
 - Anthropogenic sources (b'ys on skidoos)
- Safety and practicality
 - Open water at narrows and springs
 - Difficult determine to openings after heavy rain
- Some days/times of year are better suited than others

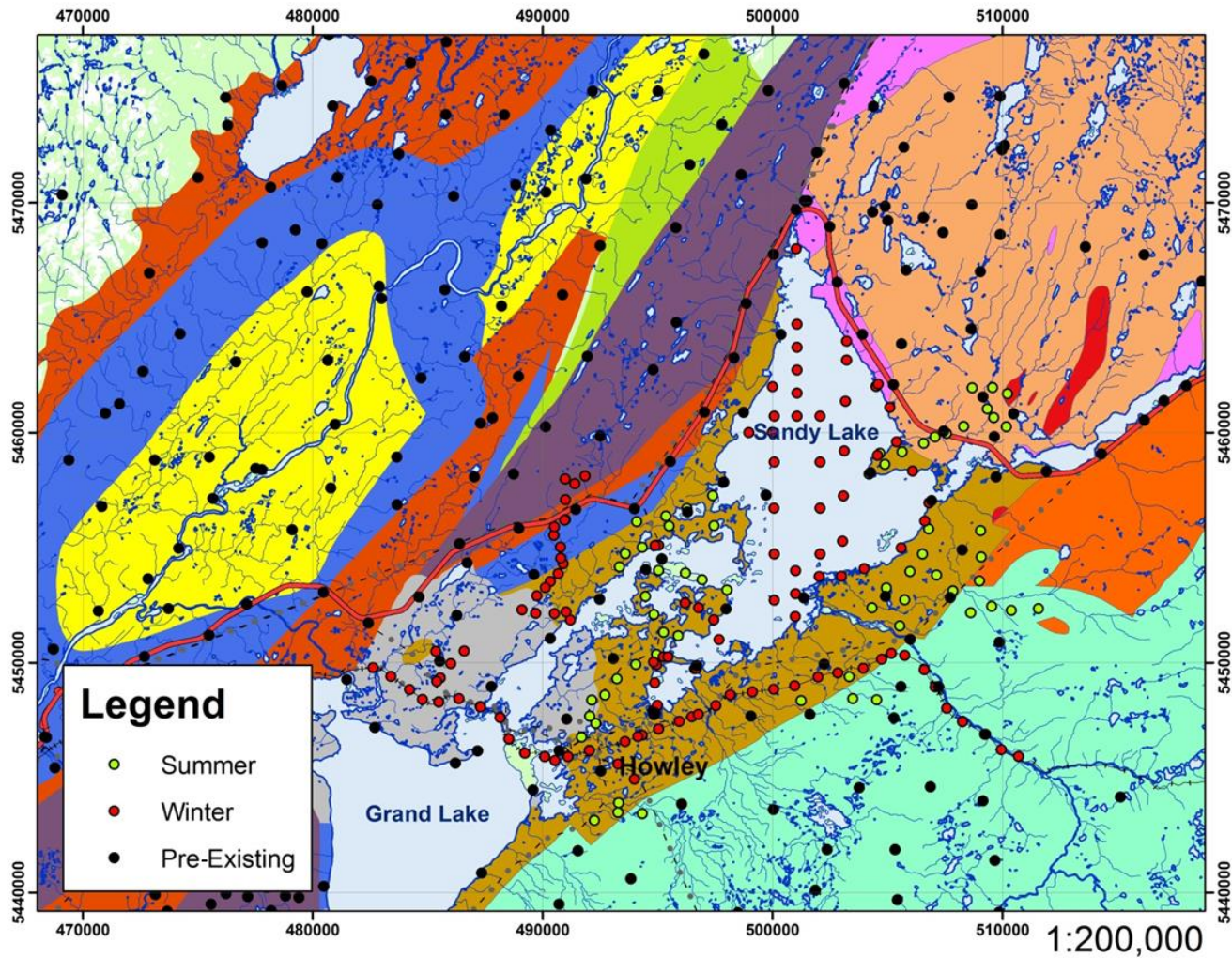
Summer Gravity Surveying



- Concentrated on
 - collecting data along logging roads
 - Transects outside of the basin
 - Filling holes in gravity data
- Bogs were difficult to survey over
 - Unstable
 - Dig to firm soil



Gravity Surveying - Locations



Future Work

- Process gravity data
 - Complete bathymetry map
 - Terrain corrections
 - Forward modeling
- Integrate geophysics with structural analysis
 - Forward or inverse modeling of the Howley Topsails contact for orientation of the Grand Lake Fault
 - Seismic and magnetotellurics delineate structures in the center of the basin
 - Kinematic and tectonic models