Lab 8: Magog-Sutton Field Trip
EPSC 240, Geology in the Field
Oct 27, 2018

Due date: Monday Nov 5

Meet: 8.30 am at Milton Gates. We will arrive at outcrop at about 10:45 am, and leave for home around 4 pm to arrive at 5:30 pm.

Bring: Field kit (notebook, hand lens, pencils, colours, magnet, camera, sample bags), lunch, snacks and lots of water.

Wear: WARM clothes, sun and rain protection. Check the weather forecast before departure.

Instructions: The goals of this trip are to practice analyzing deformed rocks in the field and to continue to learn about metamorphism. We will visit several road cuts, starting with folded sediments of the Magog Formation near Sherbrooke, for measurements of folds and associated cleavages. The Magog Formation is part of a sedimentary basin known as the Dunnage Zone which forms part of the foreland of the Appalachians. We will then visit a series of additional outcrops to introduce more greenschist-facies metamorphic rocks, part of the Humber Zone of the Appalachians. The Humber Zone rocks are more metamorphosed and more deformed than the Dunnage Zone rocks, but locally represent similar lithologies and are of similar age. The two Zones are separated by the Brompton-Baie Verte line, which is probably a fault.

In the field (in notebook and on paper provided):

1. The first outcrop we will visit is along the offramp of exit 106 from Hwy 10E, between Magog and Sherbrooke (nearest searchable landmark is Le Bar Shelby). Pull off on the wider gravel shoulder on the right side of the offramp. The best outcrop is on the left (north) side of the outcrop, but is hidden by some small trees. Traffic is usually sparse but take care when crossing the road. We will spend 2 hours here, so you will need to work efficiently. Collect the following data and observations (in whatever order is convenient).
    a) Walk up and down the outcrop and get a feeling for the shape and size of the folds. Count how many antiforms and synforms are exposed in the road cut.
    b) Identify the bedding surfaces in the rock.
    c) In your notebook, or using the 11x17" paper provided, do a scaled and oriented sketch of the outcrop (this doesn't have to be a work of art, but it will serve to record the locations of your measurements, so make it as accurate as possible).
    d) Measure the wavelength of the folds.
    e) Measure or estimate the amplitude of the folds.
    f) Measure the strike and dip of bedding at 8 or more different places around the folds. Mark the location of each measurement on your outcrop sketch.
    g) Measure the orientation of axial planar cleavage on at least 3 different folds. Mark the location of each measurement on your outcrop sketch.
    h) If possible, directly measure the trend and plunge of at least one fold hinge.
    i) Determine the younging direction of the bedding by searching for sedimentary structures which indicate the original top of the beds. Decide whether the folds are 'anticlines and synclines' or 'antiforms and synforms' and justify your answer.

2. The second outcrop is on the side of the road behind the Mt. Sutton ski area where the Sutton Schist crops out. Pull off into a large parking area on the left side of the road, the outcrop is uphill from the parking area.

   *** Be careful - these rocks are slippy when it is raining ***

   Collect the following data and observations:

   a) Describe the schist. Focus on the grain size, number of different minerals and presence of foliations or lineations. If you see either of these, describe what defines them – is it a parting surface (cleavage), or is it a compositional banding, or something else?

   b) Describe the folds that are present in these rocks. Include parameters such as wavelength, amplitude, and shape (are they symmetric, or asymmetric, round or pointy?). Draw a sketch of the folds (take your time, use the techniques covered with the architect profs).

   c) To determine the attitudes of the folds measure at least two of: strike and dip of the layering, axial plane strike and dip, fold axis lineation.

3. The third outcrop is the Tibbit Hill Formation greenstone at Auberge des Rochers Bleus. This is an example of a metamorphic rock that is common in some geologically-famous areas in Québec and Canada. Describe this rock. What was the rock before the metamorphism?

4. Bathroom break (if demanded) in Dunham.

5. Back to McGill.

Report due Monday, November 5 should include the following sections.

I. Introduction: Purpose of report, brief description of the Appalachian Orogen including appropriate citations, locations of field observations.

II. Rock descriptions for each outcrop, written out in prose (not bullets). Each rock described should include mineralogy, grain size, name of the rock, interpreted protolith and justification. You may include figures (photos or sketches).

III. Description of rock fabrics (foliations, lineations etc.) at each outcrop.

IV. Folds in Magog Group sedimentary rocks

   a) Describe the folds in terms of their scale, orientation, and shape:
      i. Are the folds gentle, open, closed, tight, or isoclinal?
      ii. Are the folds upright, reclined, or recumbent?
      iii. Are the folds horizontal, gently plunging, steeply plunging, vertical?
      iv. What is the shape of the folds? (concentric, parallel, chevron, or in between?)

   b) Stereonet showing all planar measurements (plotted in different colours for limbs vs. axial planes) and estimate of the fold hinge from the limb and cleavage intersection. Plot fold hinge measurements for comparison if you took any in the field. (We will work on stereonets in class on Monday).

   c) Using your outcrop sketch, calculate the linear strain (*e*) represented by the folds. Indicate on the sketch where you measured original length and final length. Submit your sketch as part of your working on this problem.

Vocabulary and reference material:

Anticline: A concave-down fold (shaped like the letter A) with the oldest rocks in the centre and the younger rocks overlying them.

Antiform: A concave-down fold (shaped like the letter A) when relative ages of rocks are unknown.

Syncline: A concave-up fold (shaped like the letter U or V) with the youngest rocks in the centre and the older rocks below/outside.

Synform: A concave-up fold (shaped like the letter U or V) when relative ages of rocks are unknown.

Parasitic folds: Small folds found on the limbs of larger folds, commonly displaying asymmetry, with the shorter limb of the small fold closer to the anticline of the larger set of folds.

Younging direction aka *up-direction:* the original top or upper side of a sedimentary or volcanic bed. Can be determined using some kinds of primary sedimentary structures, such as graded bedding and cross bedding.

Argillite: Another term for shale (similar to the French *argile* for clay). Shale is a fine-grained sedimentary rock composed predominantly of clay particles. Argillite colour may be dark green-gray to black when it contains abundant organic material, which results in graphite and pyrite crystallizing as the rock is lithified and metamorphosed.

Magog Group: This is a ~10 km-thick sedimentary unit consisting of black carbonaceous shales, siltstones, sandstones (wackes) and conglomerates. The Magog Group was deposited in the deep trench formed by flexure of the tectonic plates during the Appalachian Orogeny.

Ultramafic: Rocks which are EXTRA rich in iron and magnesium and poor in silica. Examples include typical rocks of the mantle, dominated by olivine and pyroxene (peridotite).