Snow-Pit Observation; Snow Metamorphism; Snow Stratigraphy

Last modified by Steve Custer or Karl Birkeland 15 May 2010
Earth Sciences, Montana State University, Bozeman, MT 59717-3480
406 994 6906
scuster@montana.edu

Required Reading:

Be sure to carefully read Colbeck, et al., 1990 before lab. Copies of the tables in Colbeck, et al., 1990 may be helpful particularly if reduced so they fit in your field book, and laminated to protect them from moisture.

Bring one or two copies of page 24 (The Snow Cover Profile Sheet) from Colbeck, et al. (1990) with you in the field (they get wet).

Optional Reading:

McClung and Schaerer, 2006, p. 43-68 and 318-320 will be helpful.

Green et al, (2009, p. 21-35) summarizes pit procedures. If interested, you are encouraged to read Green et al. (2004, p. 3-20) for weather observations. There is a lot to do in todayâ€™s lab so we will focus on the pit and the snow.

Purpose:

1. Observe, describe and record snow stratigraphy, density, hardness, temperatures, temperature gradients and crystals within a snow pit, and study the effects of snow metamorphism.
2. Calibrate your finger hardness force. Push on your cheek toward your teeth with your finger (no pain) or push on the tip of your nose (no pain). (North American Standard is 10-15 N force; International Standard is 50 N force.
3. Determine how consistent the stratigraphy is from location to location. Are there trends from pit to pit at the site?

Equipment:

STUDENT: 10x hand lens, plastic ruler divided 10mm/cm, field notebook, and pencil. If it is warm, you may find a calculator helpful, but you can calculate at home.

INSTRUCTOR: Snow shovel*, tape measure*, thermometer* (s), cylinder density kit*, small triangular density kit*, spring scale, 200 N Force Gage, ziplok bags*, snow brush*, 100 m tape*, compass/inclinometer*, altimeter*, field microscope.

Procedure:

1. Proceed to the North Meadows at Bridger Bowl.
2. Your instructor will divide you into groups. Please turn in a group report and group snow cover sheet.

3. Select a site for snow pit observation that does not appear to have been disturbed. Stay on the low-slope areas so future labs on strength can benefit from undisturbed snow on the slopes. If possible avoid areas that have obviously been disturbed by skiers or other snow workers. **Dig your pits less than 10 m apart so your instructor will spend less time traveling between pits and more time assisting with questions.**
4. Draw a location map in your field notes that indicates your location both at Bridger Bowl and in relation to other groups. This information is essential if the reader is to make sense of your data.
5. Each group should complete scientific snow pit analyses (snow stratigraphy, density, moisture, water content, hardness, temperatures, crystals, weather observations, slope, aspect). Use the snow-cover-profile sheet to help organize your data. You are strongly urged to neatly prepare your snow-cover-profile sheet in the field rather than at home. (Do it right the first time.)

    1. Choose a representative site for snow pit analysis. Take into consideration factors such as snow-loading from topographic features and vegetation, wind, exposure, aspect, ski modification etc. What is the slope on which you plan to dig (aspect, angle, elevation).
    2. Dig a snow pit. Be sure it is large enough for your team. Change tasks and work together so you all learn to see differences in snow.
    3. Drape a tape over the edge of the pit or use the folding ruler and put the base (zero) at the bottom of the pit. Snow pits are always referenced with zero at the bottom because the ground is the only datum that does not move.
    4. Record the site data on the data sheet. You may want to protect your data sheet. If so, record the data in your notebook, and transcribe your data to the data sheet to organize and draw the information together. (More data sheets are in Colbeck and others (1990), so you can make copies of those data sheets).
    5. Use the paintbrush to brush the pit wall, or run your finger, a plastic card, or ruler down the pit wall to find resistant layers, and mark the location of the various layers.
    6. Identify, measure and describe the various layers (stratigraphy) in the snow. Enclosed are charts to help you with measurements, example field notes, and an example snow profile. No matter what format you use to record your data, your notes should include:
        i. Height (H) above ground for each observed change in snow property. Changes most likely to produce a stratigraphic boundary are hardness revealed by the brush or passage of a plastic card, or changes in crystal form or size. (Use additional sheets for deep snow packs.) For each layer record the following:

        Grain form (F) for each layer.
        Grain size (E) for each layer (estimate mean and range to 0.1 mm).
        Hardness based on the hand resistance test (R).
        Liquid water content based on squeeze test (theta)
        Snow density ($kg\text{-}m^{-3}$) (rho).

            There are two types of density kits. Specify which you used. Try different kit types in each group and after finishing your pit try a different kit. Kit volumes are on the web.

        Water equivalent of the layer (HW).

            Obtain by multiplying layer thickness times density in ($g\text{-}cm^{-3}$). Note ($kg\text{-}m^{-3}$) * 0.001 = ($g\text{-}cm^{-3}$). This is in the same column as rho, just draw a line and enter both pieces of data like the presentation below. Be sure to indicate the

convension below in the column heading on your snow cover profile sheet.

$$\frac{HW}{rho}$$

7. Measure air temperature 1.5 m above the snow in the shade rather than the direct sun.
8. Insert a thermometer at 10 cm intervals to obtain temperatures and temperature gradients. You may want to measure temperatures every 5 cm for the first 20 cm from the surface. Don't miss the opportunity to specifically measure temperature above and below identified layers even if it is not on the 10 cm interval. Plot the temperature on your snow-cover-profile sheet. If you plot the data in the field you may see patterns that warrant more closely spaced measurements.
9. Fill in your snow pit so skiers skiing through the area do not fall into your snow pit.
10. Calculate the temperature gradient between all adjacent temperature measurements (you can do this after leaving the field). (Make a **separate** graph of temperature gradient at same scale as the temperature graph on your snow-cover-profile sheet). Watch for the threshold temperature gradient (10^{o}C/m; 1^{o} C/ 10 cm; 0.1^{o}C/cm).
11. Calculate the total snow water equivalent and mean density for the snow pack and record them at the top of the snow sheet.

A Laboratory Report (Turn in by Wednesday at 5:00)

Introduction:

- What was the purpose?
- What were you looking for?
- Location Map: Where was your pit located at Bridger Bowl and where was it located with respect to other pits?

Methods:

- Identify your methods clearly. Remember citations of the literature are your friend. Remember references have been typed for you and are on the syllabus.

Results:

- Snow-cover-profile Sheet
- Temperature-gradient graph (graph temperature gradient vs depth)
- Table of density results comparing two or more methods.

Discussion:

- Can you correlate stratigraphy in your pit to the pit of the other pair of workers in your group? (To other workers in the class if their data is available?) How is your data similar or different? Can you explain the differences?
- Are there any temperature gradients large enough to form faceted or cupped

crystals?

Conclusions

References Cited

Figures and Tables (these may be at the end of the paper).

Donâ€™t forget, the results section contains figures with captions below which present the data, but not the interpretation. Donâ€™t forget the methods section can be shortened with references. Such references should be in the References Cited (bibliography) for the paper.

Each group may turn in the same snow-cover-profile sheet, but your reports must be your own.

Grading Rubric

Digital Snow Profile.

Please present your results in digital format in D2L in the discussion area in Lab 1 Data Section.

Due:

Monday at 4:00 turn in your **group** snow cover sheet in D2L Discussion Lab 1 Data so all students in class have one. (Failure to do this will result in point loss).

Wednesday at 5:00 turn in your **group** report to D2L Lab 1 Report.

Next week we will change the pattern of turn in to give you more time, but I would like to get your papers back to you with feed back prior to next week's laboratory.