The Denali Foundation is
a non-profit organization
dedicated to the development and implementation
of research, education and communication programs
for the benefit of
the Denali National Park Bioregion,
the State of Alaska
and our planet.

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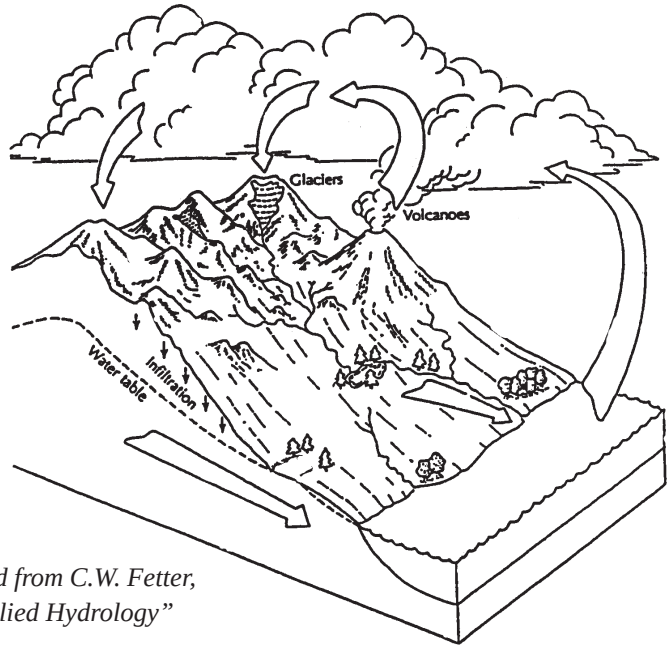
SNOW OBSERVATION JOURNAL

Name:
Date:
School:

How does the physical science
of snow complement
traditional native knowledge ?

The Hydrologic Cycle



Adapted from C.W. Fetter, "Applied Hydrology"

The hydrologic cycle is powered by solar energy. Water evaporates from the oceans, collects in the atmosphere, and then is moved by the wind. When the air cools, the water molecules condense and fall as precipitation. Some of it falls on the land and runs off the surface. This water eventually returns to the sea.

Please fill in the blank arrows with the correct terms:

Evaporation
Precipitation
Run - off
Ground water
Juvenile Water

Athabascan Snow Terminology

Snow Type	Local Language Term	Notes: Translations& Observations	Crystal Type
snow			
powder or new snow			
falling snow			
snowflake			
crystal snow			
hard snow			
fine snow			
wet snow			
blowing snow			
snow drift			
snow on tree branches			
frost			
layer under snow surface			
ice crusted snow			
depth hoar			
“its snowing”			
ice			
river ice			
slush			
glacier			
wind			N/A
winter trail			N/A
snowshoes			N/A
sled			N/A

Notes:

Sublimation:

Subnivean:

Sugar Snow:

Supercooled:

Surface Runoff:

Surging Glacier:

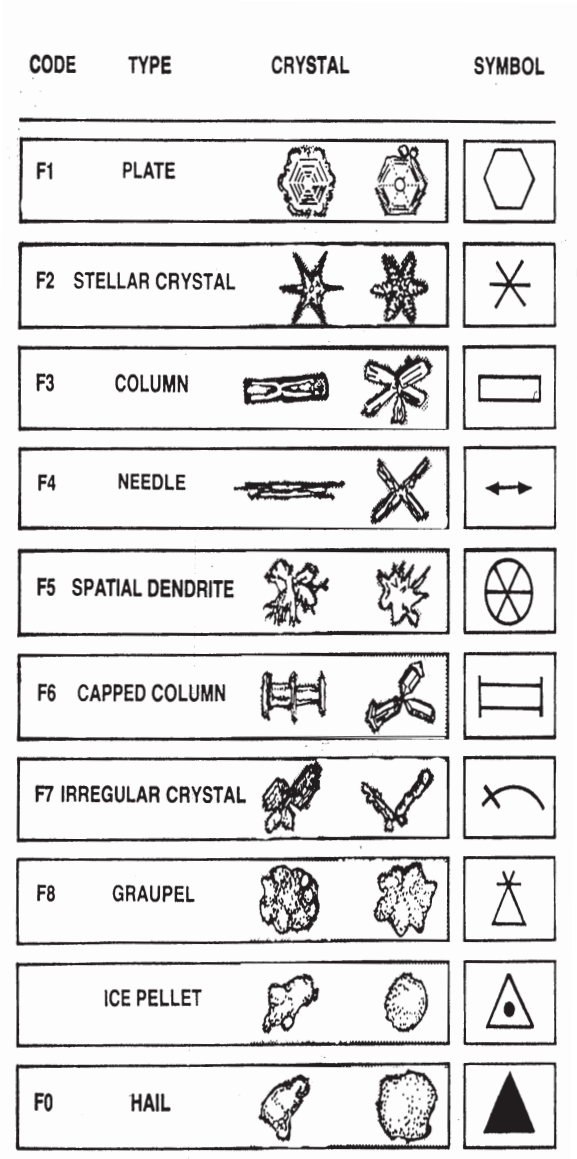
Temperature Gradient:

Terminus:

Discussion Questions

- Describe some of the concepts you've discovered.
- Whick terms look and sound like words distinct from the basic "snow" term?
- Which are descriptive phrases including the word "snow"?
- What are the practical implication of different snow types? (What kind of stories did the Elders tell about them?)
- Compare Native ways of classifying snow with the scientific method. How are each useful or interesting?

Types of Freshly Fallen Snow



Cloud Type: Low Cumulus
Conditions: High Temperature
High Moisture
Content

Cloud Type: Low Cumulus
Conditions: High Temperature
High Moisture
Content

Cloud Type: High Cirrus
Conditions: Low Temperature
High Moisture
Content

Cloud Type: High Cirrus
Conditions: Low Temperature
High Moisture
Content

Cloud Type: Low Cumulus
Conditions: HighTemperature
High Moisture
Content

Initial Conditions: Cold & Dry
Moves Through: Warm & Moist conditions

Cloud Type: Low Cumulus
Conditions: High Temperature
High Moisture
Content

Initially a stellar or plate crystal. Gets covered with ice drops.

Many Layers
Solid Core: Forms while moving up and down through clouds.

Many Layers.
Similar to an onion. Forms while moving up and down through clouds.

Adapted from "A Field Guide to Snow Crystals" by Edward LaChapelle

Glacier:

Glacier Ice:

Glacier Terminus:

Gas:

Ground Water:

Ice Crystal:

Ice Sheet:

Infiltration:

Liquid:

Melt - Freeze Metamorphism:

Metamorphism:

Molecule:

Mountain Glacier:

Moraine:

Precipitation:

Pressure Metamorphism:

Retreating Glacier:

Sintering:

Solid:

Ablation:

Accumulation Zone:

Advancing Glacier:

Atom:

Basal Sliding:

Brittle Deformation:

Condensation:

Condensation Nuclei:

Constructive Metamorphism:

Corn Snow

Crystal:

Density:

Depth Hoar:

Destructive Metamorphism:

Ductile Deformation:

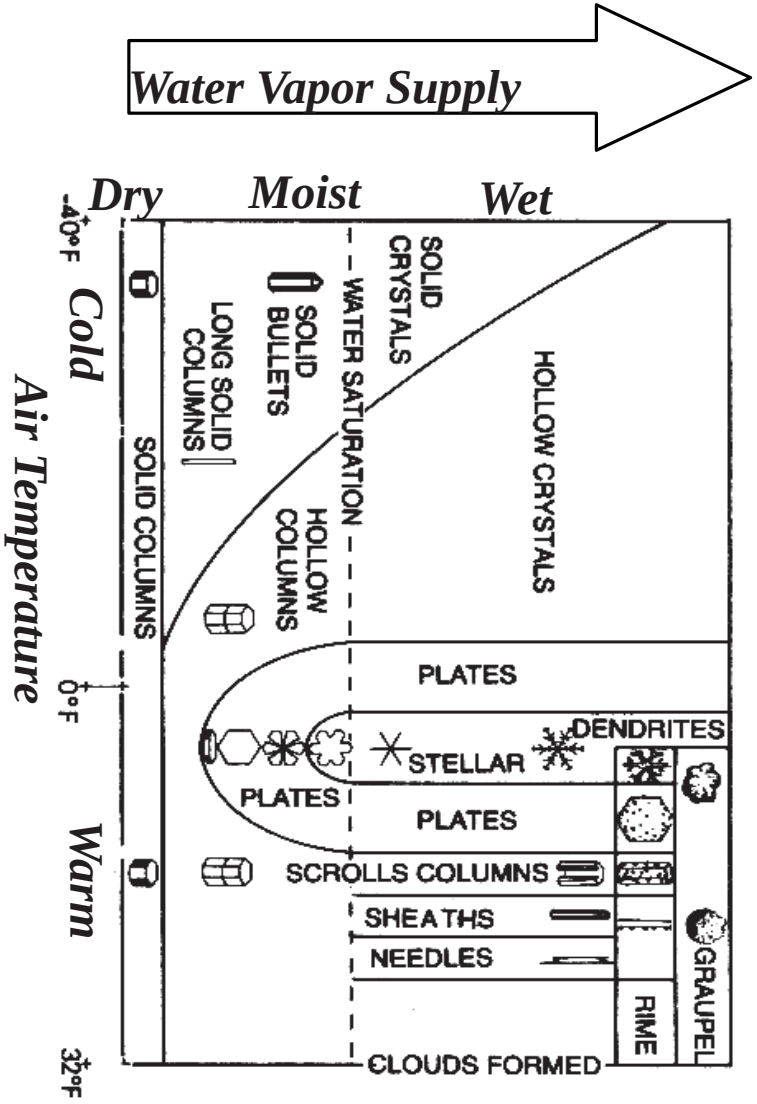
Equilibrium Line:

Evaporation:

Firn:

Firnification:

Conditions that Form Snow Crystals



Snow crystal type is determined by temperature and water vapor supply

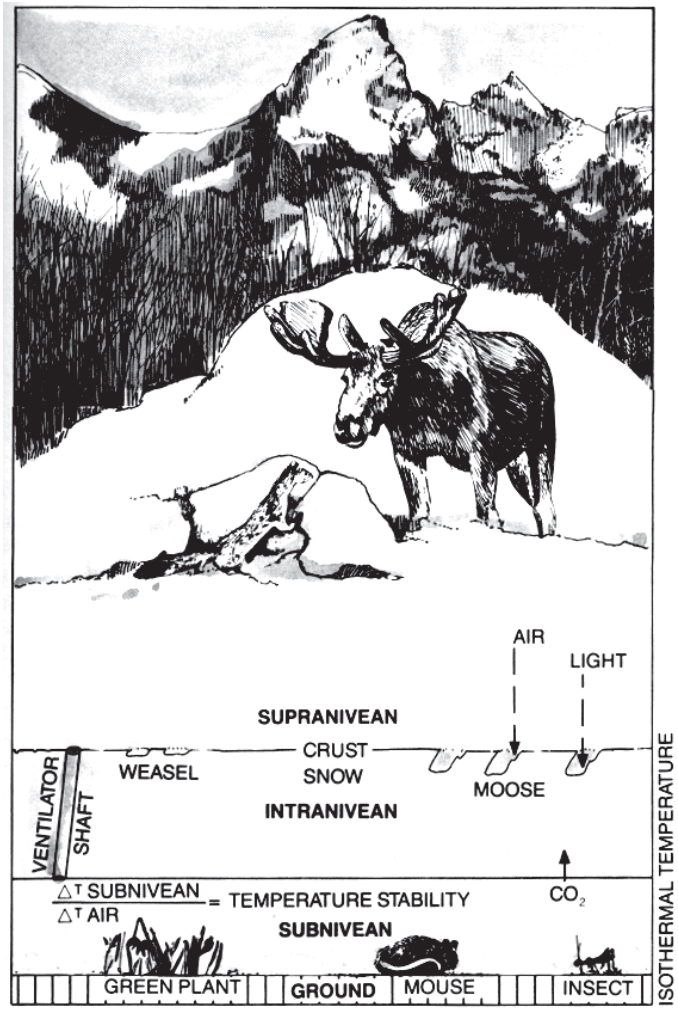
From Halfpenny &Ozanne: Winter an Ecological Handbook: cited after Perla and Martinelli, 1976 & Mango and Lee 1966

A Seasonal Round:

Record the names and places for you village

MONTH: Native and English	SEASONS: Native and English	ACTIVITES and OBSERVATIONS ON NATURE	PLACES: Native and English
September	Fall		
October			
November	Winter		
December			
January			
February			
March	Spring		
April			
May			
June	Summer		
July			
August			

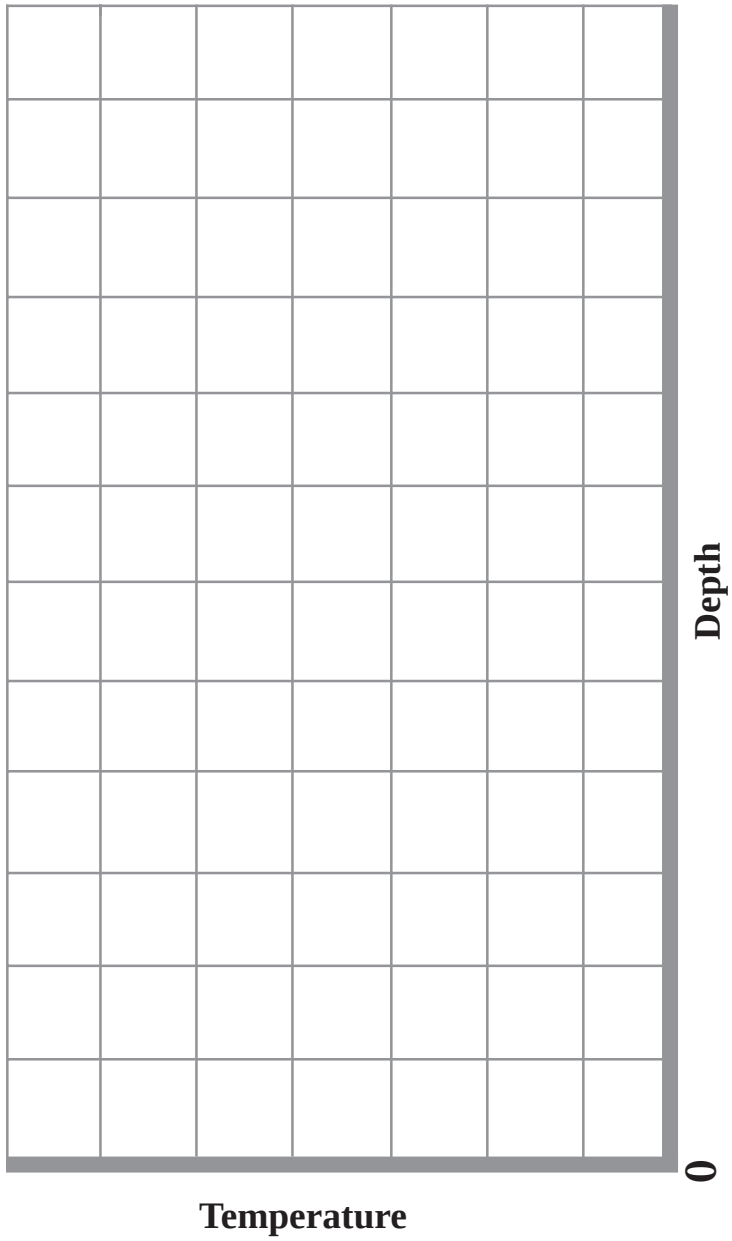
Animal Habitats in the Cross Section of the Snowpack



A cross section of the snowpack showing some of the key factors that influence life in the nivean environment. Plants, mice, and insects live in the subnivean world where light, CO2 exchange, and air are critical. Ventilator shafts may help in gas exchange. Temperatures are relatively stable in the subnivean environment. Animals must travel on the snow where the crust may or may not support their weight

From:"Winter and Ecological Handbook" by Halfpenny & Ozanne

Depth vs. Temperature



Athabascan Snow Terminology

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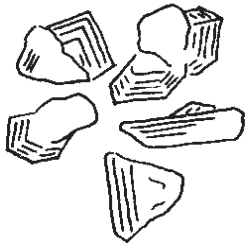
frost			
layer under snow surface			
ice crusted snow			
depth hoar			
“its snowing”			
ice			
river ice			
slush			
glacier			
wind			N/A
winter trail			N/A
snowshoes			N/A
sled			N/A

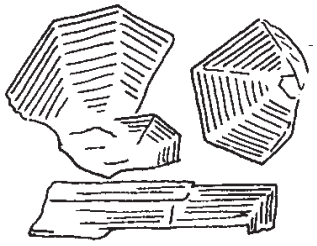
Constructive Metamorphism

Phase C-1

Phase C-2



Phase C-3



Constructive Metamorphism occurs when the **bottom of the snow pack is warmer that the outside air.**

This **temperature gradient** moves water vapor from the ground up through the snow pack.

The water vapor contacts cooler temperatures and freezes one layer at a time into solid crystals in a process called **sublimation.**

Mature constructive metamorphism crystals are most often found at the bottom of the snow pack and look like little six sided cups. They are called by several names:

depth hoar
sugar snow

Adapted from "A Field Guide to Snow Crystals" by Edward LaChapelle

Snowpit Sketch

Include: meter sticks, layers, temperature, density data collection points, and other visual observations.

Field Data Collection Sheet

Date: _____

Time: _____

Members of Field Party: _____

_____

Density

Sample #1 (Top)
Sample Height: _____
(from ground to bottom of Sample Box)
Sample Weight (g): _____
Sample Volume: 200 cubic cm
Calculate Sample Density: _____

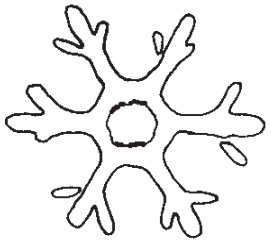
Sample #2 (Bottom)
Sample Height: _____
(from ground to bottom of Sample Box)
Sample Weight (g): _____
Sample Volume: 200 cubic cm
Calculate Sample Density: _____

Density = Mass / Volume

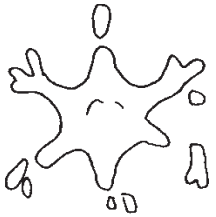
Supplemental Temperature Data
Air Temperature:
Snow Surface Temperature:
Environmental Setting
Slope Angle: _____
Vegetation: _____
Pit Location: _____

Destructive Metamorphism

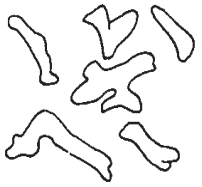
Phase D-1



Phase D-2



Phase D-3



Phase D-4

Destructive Metamorphism occurs when there is **not a significant temperature difference between the bottom of the snow pack and the outside air.**

The water molecules move and vibrate. This motion breaks the delicate snow crystals.

The broken pieces come to rest in the spaces between the crystal's arms.

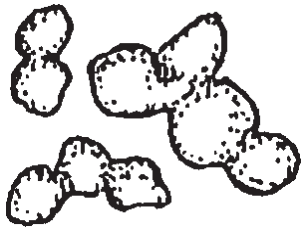
Eventually the original crystal becomes a rounded ice ball.

Mature **equitemperature** ice grains compact easily and this part of the snow pack becomes very hard and **dense.**

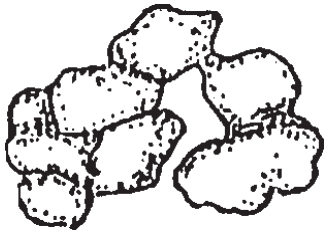
Adapted from "A Field Guide to Snow Crystals" by Edward LaChapelle

Melt- Freeze Metamorphism

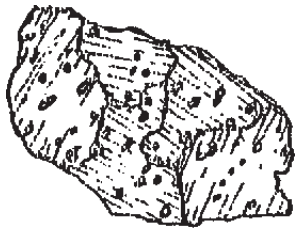
Phase M-1



Phase M-2



Phase M-3



Adapted from "A Field Guide to Snow Crystals" by Edward LaChapelle

Melt -Freeze Metamorphism occurs on warm days when the **temperature is warm enough to melt snow during the day, and then drops to below freezing at night.**

When melting occurs, water moves between the ice crystals and then later freezes in a process called **sintering.**

The weight of the snowpack itself can also force the ice crystals together in a process called **pressure metamorphism.**

These forces make the snowpack more **dense** and very strong.

Through time the ice crystals become compressed into large round ice balls called **firn.**

After several years the firn is compressed into **glacier ice.**

Another name for the process is **firnification.**

Snow Profile Sheet

Label Layers	*Depth (cm)*	*Temperature Degrees F*	*Crystal Types*

0 =Ground Level

STEP 6: DENSITY MEASUREMENTS: We will take one density measurement from the top of the snow pit wall and one from the bottom. Do your top density measurement first.

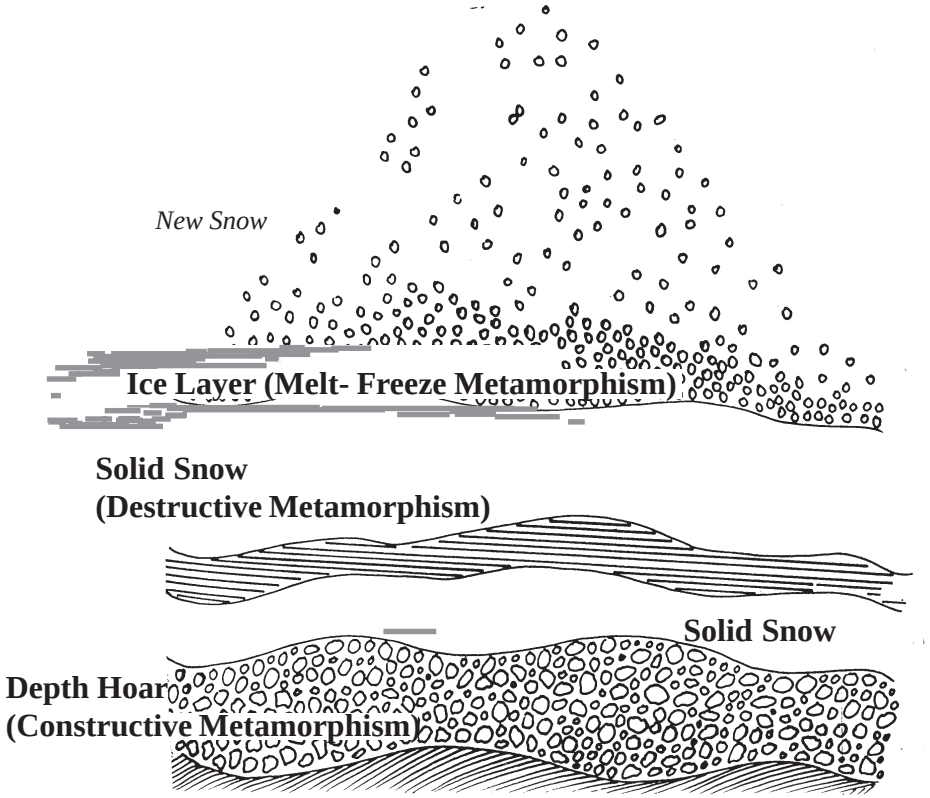
- Carefully insert the sampling box into the pit wall near the top.
- Carefully clear away enough snow above the sampling box so the cut-off piece of the box can be inserted in the cavity and slipped down over the box.
- Hold the two parts together, remove the sampler, and brush off the loose snow.
- Make sure your scale has been zeroed out to accommodate the weight of the plastic baggie.
- Lift off the top, and dump the sample into a plastic baggie.
- Weigh the baggie with the snow and record the measurement. We will calculate the density later back in the classroom.

*The **Denali Foundation Snow Observation Curriculum** provides a full description of an alternative method for determining density if a **Density Sampling Box** is unavailable.*

STEP 7: SKI SHEAR TEST: A 100 lb student or small instructor stands with skis on the snow pack about 1 foot behind the pit wall, If nothing happens the skier should gently bounce, and work up to small jumps. Observe and record the layer that the snow slides on, and how easily the slide occurred.

A McGrath student collects a 200 cubic centimeter snow sample using the density sampmling box

Snow Layers



Adapted from "The Secret Language of Snow" by Terry Tempest Williams & Ted Major

Instructions for Snow Data Collection

Each group needs to choose a data recorder and a sketch artist. The other members of the group will take measurements.

All measurements are recorded in centimeters and degrees Fahrenheit.

Galena PECS student samples temperatuires and indentifies layers on the snow pit wall

STEP 1: DIGGING THE PIT: Make sure the snow pit wall that we will be working from is oriented perpendicular to the sun so that the exposed wall will be in the shade (the sun could melt our experiment!) Dig your snow pit approximately 3 feet wide and at least 6 feet long, and toss the snow to the side so it's our of the way. Be careful not to disturb the exposed wall where we are going to take measurements.

STEP 2: MEASURING STICKS: Insert measuring sticks on either side of the snow wall. The zero end sits on the ground. The sketch artist can now begin drawing in his or her **Snow Journal on page ?**

STEP 3: INDENTIFYING THE DIFFERENT SNOW LAYERS: Slowly slice the snowpack from the top using a wooden tongue depressor like a knife. Can feel the changes in the snow pack as you move it through the snow? When you feel a change place your tongue depressor side ways across the layer to mark it. Observe and tell the recorder where these changes occur. These are the layer boundaries. Repeat this process until you reach the ground. You may also be able to see the different layers. Record and draw your observations.

STEP 4: TAKE TEMPERATURE MEASUREMENTS: You will record snow pack temperatures at 10 centimeter increments, starting from ground level. First, let the thermometer sit for at least two minutes to adjust to the outside temperature. Next, gently place the thermometer into or as close to the ground surface as possible, keeping it as horizontal as you can. Tell the recorder your measurement once the thermometer has stabilized. Continue measuring temperature at 10 centimeters, 20 centimeters…and so on until you reach the top. To measure surface temperature, slide the thermometer probe just under the surface of the snow. Finally to take an air temperature measurement, hold the thermometer probe in the air away from your body and in the shade of your shovel. Record and draw all your measurements.

STEP 5: DETERMINE SNOW CRYSTAL TYPES: Examine the snowpack every ten centimeters. Scrape crystals from the sides of the pit onto your black felt. Look closely at the crystals with a hand lens. Do not hold in the sun or close to your breath; the heat may damage the crystals. Using your three **Metamorphism Crystal Charts** on **pages 5-7** in the **Snow Journal**, match those you have found with the pictures on the chart and give your observations to the recorder. Crystals from the surface could be classified with the **Freshly Fallen Snow Chart** on **page 3** in the **Snow Journal** if the crystals have not yet changed.