

**OLCG Snow Inquiry Unit  
December Workshop  
2003**

**Topic:** Snow

**Target Level:** Intermediate-Middle School

**Performance Standards:**

Alaska Science Content Standard A2: Understand physical changes and interactions in matter result in observable changes in the properties of matter

Alaska Science Content Standard B1: Processes of science (observe, predict, infer, classify, collect and analyze data)

Alaska Math Content Standard: Measurement

Alaska Math Content Standard: Statistics and Probability

**Target Concept:**

The physical properties of snow can change due to heating, cooling, and physical forces such as pressure and friction

**Teacher Background Information:**

Snowflakes begin as delicate crystals but are soon transformed into the granular crystals and lumps of ice that are found within and at the bottom of layers of snow. The process by which snow crystals change in composition or structure is known as *snow metamorphism*. Pressure and temperature are the two most influential agents of change.

Pressure: Snow crystals change due to the physical compaction of snow under its own weight as well as under the weight of human or animal traffic on top of the snow. During such *pressure metamorphism*, snow crystals get pressed together and interlock more closely resulting in decreased snow pack thickness and increased snow pack density and strength.

Temperature: Obviously, melting and re-freezing cause changes in snow crystals, but snow changes even when temperatures are relatively constant. Constant molecular activity causes “evaporation of the many fine points that form angles between the delicate crystals. This evaporation makes the air around the crystals very moist. The moisture re-condenses (because of the coldness) and deposits particles of ice onto the flatter, smoother surfaces of the crystals. It is

this continuous evaporation from sharper points and condensation onto flat places which transforms the crystals into little lumps of ice."<sup>1</sup>

**Temperature Gradient:** Often there is a difference in temperature between the snow at the bottom and top layers of the snow pack. In winter, when air is very cold, the snow at the surface of the snow pack is colder than the snow near the ground. This is because snow is a very good insulator, insulating the ground from the colder air temperatures. When the ground is warmer than the snow above it, water vapor is produced. This vapor can then rise and re-condense, creating characteristic, large, cup-shaped crystals known as *depth hoar*. In the spring, the temperature gradient may be reversed, with temperatures warmest at the top of the snow pack and colder at the bottom. Warmer conditions may also cause the temperatures to be consistent throughout the snow pack.

**Snow Layers:** As snow accumulates and changes over time, it develops layers of snow marked by their physical differences and reflecting the "life history" of the snow pack. . These layers are often broadly classified as *new snow*, *firn* and *depth hoar* (but careful observers often distinguish other layers within these categories) In general the *new snow layer* consists of new sharp crystals lying loosely on the top of the snow bank and slowly being compacted by additional falling snow. Just below the *new snow* is a layer called *firn*. The firn consists of crystals that have lost their sharp edges due to evaporation, freezing and compaction. They are now rounded into more sphere-like shapes, in time becoming particles of ice. This snow is dense and the grains are more closely bonded together, which increases the mechanical strength of the firn layer. At the bottom of the snow bank is the *depth hoar* layer consisting of snow crystals that have metamorphosed into lumps of ice through evaporation, condensation, and compaction. This layer is more weakly bonded than either the firn or new snow layers. The depth hoar layer is loose and grainy. The crystals sift through your fingers and it is often nicknamed "sugar snow."

**Snow Density:** Through most of the winter, snow density will usually increase deeper into the snow pack, until reaching layers where depth hoar has formed. Since the depth hoar layer is loose and grainy, these layers have lower densities. When warmer temperatures occur, the strength and density of the entire snow pack increases due to compaction.

**Affects on Animals:** Small mammals such as mice, voles and lemmings depend upon the insulating value of snow. Although at least 3 feet of snow assures adequate warmth, as little as 6 inches provides some advantage. Small mammals can easily tunnel through loosely packed depth hoar crystals formed at the base of the snow pack and thereby take advantage of warm temperatures in the snow / ground interface. This "subnivian" environment reduces the effect of wind,

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<sup>1</sup> Minnesota Environmental Sciences Foundation, Inc., *Snow and Ice - An Environmental Investigation* National Wildlife Federation, p. 7

extreme temperature variations and predation. Food such as roots, stems, buds, and carrion are abundant.

**Materials:**

<b>For the Field</b>	<b>In class</b>
<ul style="list-style-type: none"> <li>• Data collection sheets</li> <li>• Clipboards</li> <li>• Pencils</li> <li>• Large tape measures</li> <li>• Thermometers</li> <li>• Meter Stick</li> <li>• Felt boards</li> <li>• Soft paintbrushes</li> <li>• Hand lenses</li> <li>• Snow type key</li> <li>• Track key</li> <li>• Lighted microscopes</li> <li>• Small covered vials for snow collection</li> </ul>	<ul style="list-style-type: none"> <li>• Completed Data Sheets</li> <li>• Large data chart on board or chart paper</li> <li>• Transparency of Data Sheet</li> <li>• Felt Markers</li> <li>• Balances</li> <li>• Gram masses</li> <li>• pH paper</li> <li>• Coffee filters</li> </ul>

**Procedure:**

**Gear Up:**

- Explain that students will be exploring the properties of snow by investigations in snow pits.
- Ask and record what they already know or think they know about snow. Prompt with questions such as: Do you think that the snow will be the same temperature at all levels? Do you think that snow will have the same shape and consistency throughout? Do you think that the air, snow or ground level will be the same temperature?
- Make a sketch of the schoolyard on the board and either assign or let teams choose a site to investigate. Indicate roughly where these sites will be on the map and identify teams.
- Before teams go outside, data collection sheets and work with students to design protocols
- Be sure a recorder is chosen for each team.

**Explore:**

- Data collection sheet following
- Do everything except pH, density, and particulates outside. When you are done return to the classroom and complete the other three protocols

Name(s) \_\_\_\_\_

## Snow Inquiry Data Collection Sheet

<b>Category</b>	<b>Protocol Notes</b>	<b>Data</b>
Site Description (50 meter transect)		
Snow Temperature		
Snow Depth		
Snow/Crystal Description		
Evidence of Animals		
Density		

pH		
Particulates		
Signs of Change		
Other Important Observations		
Two Questions		

**Generalize: (indoors)**

- Assign a pen color to each team and create legend identifying site/pen color on the playground map.
- Ask students to record all their data on the class chart
- Ask students to record their two questions on the other chart
- Have students look through the data table for patterns one column at a time and discuss
- Ask questions like:
  - How are the sites are alike/different?
  - How might these differences affect the physical properties of the snow?
  - What do you notice about depth at different sites? Which has the deepest snow? The shallowest? Is there anything about the nature of your site that might relate to these differences?
  - What do you observe about snow crystals in the different layers. What kinds of crystals could you identify? Did snow crystal types within layers seem to be homogeneous? What is your evidence?
  - What kinds of events/forces might explain the changes you observe?

**Inquiry:**

- Go over questions listed on class chart. Ask which ones the students think are testable, which ones need an expert to answer, and which one can be answered by student research on the Internet
- Have teams select one question to investigate, develop a plan, and collect data
- Have each team present their question, plan, and findings to the group