Ice Mineralogy

People say there isn't much mineral collecting to do in Wisconsin and Minnesota in the winter time. Yet at that time of the year is when they are most surrounded by minerals-in the form of ice and snow. People do not generally think of ice as a mineral, but it is. In fact it fits the geological definition of a mineral perfectly. I think the reason people have trouble seeing it as a mineral is because they are so used to it in its liquid form. When faced with ice, they say "that's not a mineral, that's just frozen water". This is the same as looking at granite and saying the quartz, feldspar and mica are not minerals because they're just "frozen magma". If we lived on a much colder planet (thank goodness that we don't) where there was no liquid water we wouldn't have such a prejudice.

Let us look at the geological definition of a mineral and how ice fits in. Most textbooks say minerals are naturally occurring, inorganic crystalline solids that are also chemical elements or compounds. Well, ice is certainly naturally occurring. Sometimes there's altogether too much of it naturally occurring! Ice is also inorganic, that is, formed without the intervention of a living organism. The ice you make in your refrigerator and freezer doesn't fit the definition. Strictly speaking, those ice cubes are not minerals in the same way that diamonds are made in a G.E. laboratory are not minerals. But the majority of ice we see on earth is clearly inorganic in nature.

Minerals must be crystalline solids, meaning that they have to have an orderly internal arrangement of atoms. This is also true of ice. The symmetry visible in a snowflake or in long bladed ice crystals seen in a freezing puddle are proof of this. Ice crystallizes, as most people know, in the hexagonal crystal system. Even so, it has less symmetry than people think. Ice falls into the same symmetry class as tourmaline. That means, among other things, that the tops and bottoms of ice crystals can have different shapes. If ice had full hexagonal symmetry, the tops and bottoms of the crystals would have to be the same.

Finally, in order to be a mineral, a substance must be either one of the naturally occurring chemical elements (like gold or copper) or else a chemical compound. Ice is definitely a chemical compound with a set formula H_2O. Therefore, ice meets all the necessary criteria of minerals. In fact, the seventh edition of Dana's System of Mineralogy devotes 4 pages in volume 1 to the description of ice.

Ice has some interesting mineralogical properties. Its hardness is 1.5 on the Moh's hardness scale, soft enough to scratch with your fingernail. It lacks cleavage but shows conchoidal fracture. It has a glassy luster. It is colorless to bluish or greenish (one of my students points out that it can also be yellow). Its streak is colorless. Ice can have a variety of habits. We see massive blocks (ice on lakes), skeletal crystals (snow flakes), dendritic growths (frost on windows or hoarfrost), stalactites (icicles) and concretions with concentric banding (hailstones).

If ice is a mineral, do we have rocks made out of ice? The answer is yes! In fact, ice can form the equivalent of igneous, sedimentary or metamorphic rocks!

Igneous rocks form from the consolidation of molten or liquid rock. If we allow water to be an unusual composition of magma, then the ice we see, for example, on lakes is an equivalent of an igneous rock. Ice textures in fact resemble textures found in other igneous rocks such as granite and basalt. The grain size in ice is controlled in part by the cooling rate. If we have a sudden cold snap, water freezes fast on top of a lake, making a fine-grained ice. It is even possible to form an ice glass (the equivalent of obsidian) when water condenses extremely rapidly at temperatures below minus 110 degrees F. If the ice cools slowly, as it would on days and nights when the temperature stays close to freezing, larger ice crystals grow. In the spring and fall I often see such long bladed crystals in puddles on the sidewalk as I walk to work.

Ice can also form sedimentary rocks. It can form a cement between particles in a soil, making them a hard mass. The condition is temporary in our region, but in the Arctic and Antarctic "permanently" frozen ground (or permafrost) is common. The snow cover we see each winter is in effect a sediment too. The snow has a texture similar to that seen in sandstone, especially those formed on beaches or in deserts. The wind blows the snow into dunes and drifts that have exactly the same features as sand dunes. A little freezing and thawing will cement the flakes with ice, making a fine sedimentary rock.

Ice deeply buried in a glacier is subjected to much pressure and stresses. It recrystallizes and deforms into a metamorphic rock. Textures seen in glacial ice resemble those seen in marble and quartzite. The great folds made in ice as glaciers move are identical in form to those made in gneisses and schists during mountain building.

We all know where to "collect" ice in the winter. There is at least one place in Wisconsin where it can be collected year round. Byron Crowns in his book <u>Wisconsin Through 5 Billion Years of Change</u> describes a large permanent icicle in an access shaft in sandstone in the ¾ mile long abandoned railroad tunnel #3 on the Elroy-Sparta trail near Summit, Monroe County. WI. He describes the icicle as up to 11 feet in diameter and 15 feet long. In summer it has been "quarried" for use in making ice cream. One might argue that since it is formed in a human made tunnel, the ice isn't inorganic hence not really a mineral. But that's all a matter of how strict you are in your definitions.

So, even in darkest winter, rockhounds may take heart. Minerals fall from the sky, building up on your outdoor rock piles. Now, if it would only melt so we could get in some serious agate hunting…

- Dr. Bill Cordua, University of Wisconsin-River Falls