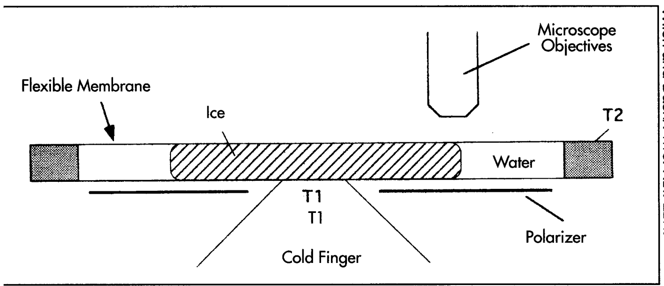


Wilen and Dash/Phys. Rev. Lett.

Side view of apparatus used to study frost heave dynamics.

Physicists have now studied this temperature-dependent flow at the flat surface of a single crystal of ice. These experiments confirm the presence of a thin layer of supercooled water alongside the ice crystal. The flow induced by a temperature gradient in the liquid layer causes the ice to grow at right angles to the water-ice interface.

Larry A. Wilen and J.G. Dash of the University of Washington in Seattle report their findings in the June 19 PHYSICAL REVIEW LETTERS.

The research hinges on the idea that a solid in contact with its melted counterpart often develops a film of liquid along the interface; this film has a temperature lower than the solid's normal melting point. The effect is called surface melting.

In 1989, Dash proposed that modest temperature differences can drive flows in these liquid surface films and contribute to frost heave. In soil, this chilled but unfrozen water tends to migrate along temperature gradients toward lower temperatures, eventually accumulating and freezing into ice "lenses." It is these ice accumulations, created by water drawn to the freezing sites, that force the soil apart, both lifting and compacting it.

To test the idea on a microscopic scale, Wilen and Dash used an apparatus formed by punching a circular hole in a fiberglass wafer, then closing the hole with a glass plate on the bottom and a flexible, plastic sheet on the top (see diagram). They filled the resulting cavity with water, then cooled its center to a temperature below water's freezing point, while keeping its outer edge at a higher temperature.

Touching the membrane with a cotton tip chilled in liquid nitrogen initiated ice formation at the center. After the ice disk finished growing, the researchers used a microscope to examine changes taking place at an ice crystal's edge.

They observed that over several days, a pronounced ice ridge develops along the disk's rim, pushing up the flexible membrane. The formation of such a structure serves as evidence of surface melting and liquid flow along the thin film of water between the ice and the membrane.

"The ridge is due to water at the ice-membrane interface flowing radially inward toward the colder region," Wilen says. "This liquid film gets thinner and thinner as the interface gets colder and colder. Eventually, the melted layer becomes so thin that no more water can flow inward. The water freezes onto the ice to create the ridge."

Wilen and Dash also noted that the presence of ice crystal boundaries seems to greatly increase liquid movement. "You can see a distortion of the shape of the membrane that's much bigger than what you see just at the edge from a single grain [or crystal]," Wilen says. "Grain boundaries may play a very big role in enhancing this flow."

The researchers are now taking a closer look at the effects of impurities and crystal boundaries on liquid movement and freezing. — *I. Peterson*

Heart-y risks from breathing fine dust

Nearly 1,200 hospitalizations for heart disease in the Detroit area each year may trace to fine, dust-sized particles in the air—and perhaps to carbon monoxide, a new study suggests. If the associations hold up, any national tally of heart disease emergencies fostered by these pollutants would be dramatically higher.

The Environmental Protection Agency is currently reevaluating its 1987 particulates standard. One impetus has been a spate of studies showing that daily hospital admissions and deaths from respiratory disease tend to fluctuate in near lockstep with variations in airborne dust—even when particulate levels fall within federal limits.

The new study departs from earlier analyses by following up on hints of a tantalizing cardiovascular link that appeared in several mortality studies. The researchers selected Detroit, explains Joel Schwartz of the Harvard School of Public Health in Boston, because it was the largest region for which daily measurements are kept of the most respirable particles—those 10 micrometers and smaller. EPA regulates just these PM-10 particulates.

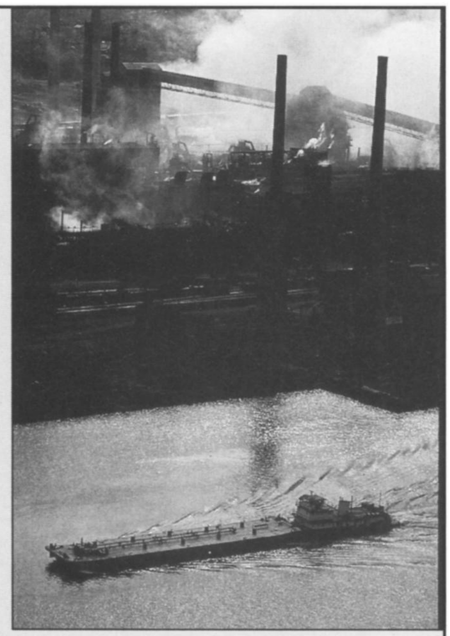
Along with Robert Morris of the Medical College of Wisconsin in Madison, Schwartz looked for correlations between heart disease and either weather or any of several different pollutants, including sulfur dioxide, ozone, and PM-10.

Only PM-10 correlated with hospital admissions for ischemia (problems linked to reduced blood flow), they report in the July 1 AMERICAN JOURNAL OF EPIDEMIOLOGY. For each 100 microgram increase in PM-10 per cubic meter ($\mu g/m^3$) of air, admissions climbed roughly 6 percent. Moreover, Schwartz notes, their analyses show no sign of any threshold below which this trend disappears.

The pair also linked a nearly 8 percent increase in hospital admissions for congestive heart failure (an inability of the heart to pump out all the blood that returns to it) with each 100 $\mu g/m^3$ increase in PM-10 or 4 parts per million increase in carbon monoxide (CO). By contrast, they turned up no link between any of the factors and admissions for heart arrhythmias.

This study extends to individual heart ailments the PM-10 trends seen in mortality studies, notes Patrick L. Kinney of the Columbia University School of Public Health in New York City.

"But the most interesting thing to me was the CO effect," says David Fairley of the Bay Area Air Quality Management District in San Francisco. He says most analysts have largely ignored this persistent auto pollutant because ambient levels had not been associated with serious health effects.



Dusty pollutants from combustion and industrial activities appear capable of aggravating some heart conditions.

How particulates might foster cardiovascular emergencies remains a big, unanswered question. However, Schwartz notes, data he published in the January 1994 ENVIRONMENTAL RESEARCH indicate that aggravation of some accompanying respiratory disease accounted for roughly half the PM-10-linked cardiovascular deaths he identified in Philadelphia 4 years ago (SN: 4/6/91, p.212). — *J. Raloff*