

## Weathering of marble tombstones

When Thomas C. Meierding, a geologist at the University of Delaware in Newark, wanted to study how weathering wears down stones in a variety of climates, he turned to cemeteries to do his fieldwork. Marble tombstones in particular seemed an ideal indicator of weathering over the last century because they wear down more rapidly than granites, and unlike sandstone, marble weathers fairly evenly. Moreover, only a few quarries served the United States when the stones were widely installed from 1860 to 1910, so the marble composition was fairly uniform.

However, Meierding's hopes of incorporating tombstone weathering into a more general model of weathering dissolved, he says, when he found that the effects of air pollution, including acid rain, overshadowed normal weathering in many regions. In Philadelphia he and a colleague discovered that flaking — an effect more dramatic than the gradual dissolution of marble grains due to weathering — of tombstones sampled in 70 cemeteries was most severe in the inner city where pollution levels were highest. The researchers suspect that sulfur dioxide (SO<sub>2</sub>) — the pollutant involved in acid rain production — is responsible for flaking, because the flakes contained 5 percent sulfur. Nitrogen, another common pollutant, appears not to be involved. By comparing old photographs with the tombstones, the scientists also estimated rates of flaking over the last century. The most dramatic increases took place between 1935 and 1960 when both SO<sub>2</sub> and atmospheric acidity were highest in Philadelphia.

In his most recent work, Meierding looked at 80 cemeteries scattered across the rural United States and found that weathering rates correlate highly with rainfall acidity maps. To determine how much the tombstones had worn away, he compared the bottoms of the stones, which tend to retain their original thickness and polish, with the tops. Weathering rates were computed by dividing the reductions in thickness by the stones' emplacement ages. The highest rates, up to 2 millimeters per 100 years, are found in the Ohio River Valley. Lower weathering rates occur in the deserts of the West, but also in areas like the Southeast, Maine and Hawaii that have high rainfall but little acid rain.

## Trapping fluids in quartz

Some clues that help geologists zero in on oil and mineral deposits are found in the tiny pockets of fluids trapped inside rocks when they formed. Mixtures of carbon dioxide and water, for example, are often associated with gold deposits, and inclusions of saline fluids containing solid halite crystals at room temperature commonly signify nearby copper deposits.

Geologists have developed analytic techniques for measuring the composition and density of the trapped fluids. However, it is difficult to obtain absolute data from these instruments because there are no naturally trapped fluids of completely known properties against which field samples can be compared.

So Robert J. Bodnar of Chevron Oil Field Research Co. in La Habra, Calif., and graduate student S. Michael Sterner of The Pennsylvania State University in University Park found a way to calibrate the exploration tools by creating their own inclusions in quartz with solutions of known makeup. The researchers enclosed fractured pieces of natural quartz along with a particular fluid in platinum capsules. These were then subjected to high temperatures and pressures until the fractures healed.

This is the first time solutions other than pure water have been captured in this manner. Bodnar and Sterner made inclusions of a variety of solutions containing salts, metals and minerals in liquid, gas and solid phases. Bodnar says the method provides a simple and fast way of determining the density of the fluid and the conditions under which solid and gas phases form. The researchers plan to use the technique to measure metal solubility and to examine how isotopes are partitioned between a liquid and its solid precipitates at various temperatures and pressures.

## EPA tightens PCB rules

Since 1977, the use of polychlorinated biphenyls (PCBs) in the United States has generally been banned. There have been a few notable exceptions, however, such as the Environmental Protection Agency's (EPA's) decision to allow preexisting electrical transformers — with PCBs in their insulating fluids — to remain in operation. Today there are an estimated 140,000 such transformers around the country.

When EPA last reviewed the matter in August of 1982 (SN: 9/11/82, p. 169), it concluded that the projected cost of replacing these transformers or fitting them with spill-limiting add-ons would outweigh the risks posed by the small chance of a spill or fire unleashing the toxic pollutants they contain. But the investigation of five fires that have occurred since 1981 has forced the agency to modify its stance.

In a fire, burning PCBs create polychlorinated dibenzofurans (PCDFs) that are structurally similar to and probably about as toxic as dioxins, EPA stated in a 24-page report it published last month. Moreover, up to 35 percent of the PCB-containing insulating fluid in a transformer may be made of chlorinated benzenes. When these burn they yield not only PCDFs but also dioxins — including the highly toxic 2,3,7,8-TCDD variety.

Conceding that it had underestimated both the risk of transformer fires and the likelihood that they might seriously contaminate adjacent or nearby buildings, EPA has now decided to tighten controls on these devices. It has proposed that: every transformer containing PCB concentrations greater than 500 parts per million be identified to local fire departments and to owners of any buildings that could be contaminated during a fire; labels be posted warning of nearby affected transformers; combustible materials be removed from transformer sites; affected transformers be protected and "isolated" from nearby buildings by July 1, 1988, so that during a fire contaminated soot couldn't pollute the interior of those structures.

## Health hazards and chemical dumps

Altogether, an estimated 14,000 chemical or manufacturing facilities generate between 130 million and 400 million metric tons of hazardous wastes in the United States each year. Not all these wastes are disposed of safely. Some end up in "uncontrolled" dumps, from which chemicals can migrate to pollute air, groundwater or soil. There are an estimated 20,000 such dumps. An interdisciplinary panel of 13 academic scientists was asked by the chemicals industry to sift through and evaluate what is known about health hazards posed by these dumps. Their 690-page draft report, just published, makes no specific indictments but offers several recommendations.

During its research, the panel reviewed 13 investigations of health in communities near chemical dumps, such as Love Canal (N.Y.). Though evidence frequently suggested a link between serious health effects and dump site chemicals, the panel failed to find incontrovertible data proving such a tie. However, "the absence of demonstrable effects on human health should not be taken as proof that no such effects exist," the researchers say. In fact, they note that since many chronic diseases and cancers take a long time to develop, "sufficient time may not have elapsed for detection of any excess incidence of disease." And that's one reason they advocate setting up programs to detect unacceptable exposures — essentially creating early warning systems for actual imminent hazards — rather than concentrating too many resources on hunting for health effects.

The researchers have scheduled a mid-December public meeting in Bethesda, Md., at which others may critique their work before the final report is issued, probably in late January. The report is being published by the Universities Associated for Research in Pathology (UARP), a Bethesda-based consortium of 15 universities and medical schools.