Acid rain linked to damaged lakes

Locked in sediments beneath many freshwater lakes is a fossil record of water acidity stretching back hundreds of years. These records are among the many pieces of evidence that have now led a National Academy of Sciences (NAS) panel to conclude that acid rain has damaged lakes in the northeastern United States.

Although some scientists had long suspected that such a connection exists, others had proposed alternative explanations for fishless acid lakes—from natural acidification to the effects of farming and lumbering (SN: 3/17/84, p. 164). The NAS study released last week, "Acid Deposition: Long-Term Trends," suggests that in certain cases, none of the alternative explanations accounts for lake acidity as fully as the effect of sulfur dioxide emissions from the burning of fossil fuels and the resulting acid deposition.

"The connection between acid rain and environmental damage is real," says James H. Gibson of Colorado State University in Ft. Collins, who chaired the panel, "but it is more variable and complex than many people have supposed." Individual lakes vary widely in their response to acid rain, he says. Nevertheless, the report goes a long way toward linking sulfur dioxide emissions with lake acidification. According to the Academy, this report is "the most comprehensive effort to date" to document acid rain causes and effects.

One important element in the study was the analysis of sediment cores taken from lake bottoms. The number and types of fossil microorganisms called diatoms found in different layers of these sediments provide a sensitive measure of lake acidity. "Diatom analysis is the best technique that we have available for inferring past [acidity] histories of lakes," says biologist Donald F. Charles of Indiana University in Bloomington.

The researchers discovered that natural acidification normally occurs over hundreds or thousands of years. In contrast, some lakes in New York's Adirondack Mountains suffered significant acidity increases over a period of 20 to 40 years in the middle of this century.

The study also notes that while the Northeast seems on the average to have suffered the most damage, the region has also seen a decline in sulfur dioxide emissions over the past decade. The effect of this is seen in somewhat lower levels of acidity and sulfur in rain and in some streams.

In the Southeast, however, "precipitation shows escalating levels of acidity and sulfur, reflecting the increase in industrial emissions," Gibson says. "There is also some evidence that streams in the region are now showing increased acidification."

Panel scientists did not look into the question of whether local or distant air pollution sources were more responsible for these effects. Another open question is the effect of acid deposition on forests.

The Academy report will probably intensify the debate over what should be done about acid rain. President Reagan is likely to endorse a report that earlier this year called for a $5 billion research program to develop new techniques for cleaning coal (SN: 1/18/86, p. 37).

However, many environmental groups now believe that this would be a step backward. The National Clean Air Coalition, based in Washington, D.C., says the United States should mandate an immediate 50 percent emissions reduction to complement a program Canada has already adopted. A group of senators has just introduced a bill calling for a nationwide, $6 billion plan to curb acid rain.

Not everyone is convinced that such measures are necessary. The National Coal Association in Washington, D.C., argues that with the increasing use of low-sulfur coal and with improved emission controls, sulfur dioxide emissions will decline over the next five years without further government action. — *I. Peterson*

Getting the drift of the galaxies

The Cosmological Principle is taking a beating these days. The principle states that the universe is homogeneous and isotropic, and it once seemed so obvious. Lately, maps of the locations of galaxies have shown that galaxies tend to lie along sheets (or the surfaces of "bubbles" by one description) with voids between, a distribution that violates homogeneity and maybe isotropy (SN: 1/18/86, p. 38). Now there is evidence for large-scale *motions* of galaxies, galactic drifts one might say, that reinforce the notion of large-scale inhomogeneities in the arrangement of the universe.

The motion study, performed by seven astronomers, is first an analysis of the motions of 400 elliptical galaxies in a volume surrounding our position in the universe. To this the group added reanalyses of two previous surveys of spiral galaxies. From all of this they derive a general drift of galaxies at something like 600 or 700 kilometers per second toward a point approximately at galactic longitude 290° and galactic latitude zero.

What is new in this survey, besides the use of elliptical galaxies as a reference group, is a simple transformation of coordinates, but one that nobody had done before, according to Sandra M. Faber of Lick Observatory, headquartered in Santa Cruz, Calif., who spoke to SCIENCE NEWS for the group. (The others are David Burstein, Roger L. Davies, Alan Dressler, Donald Lynden-Bell, Roberto Terlevich and Gary Wegner, from institutions ranging from California and Chile to England.) Previous surveys had compared the motions of the local group of galaxies, including the one in which we live, to fairly large reference groups of spiral galaxies. The results seemed to show that the local group was moving in radically different directions with respect to different samples of galaxies.

What these seven astronomers did was to refer the motions of the local group and the reference galaxies to the point of view of the microwave background, the three-degree blackbody radiation that pervades the universe. This is a frame of reference that goes back to the earliest moments of the universe and is rooted in the Big Bang in such a way that cosmologists generally take it as a standard of absolute rest for the universe. Comparing all the motions with absolute rest shows this general drift in all three surveys.

There are discrepancies, up to 40° in direction, and the astronomers do not wish to gloss them over, but the agreement on the drift is much better with reference to the microwave background than it is with other frames of reference. The remaining discrepancies probably come from the other surveys having less thorough coverage in some directions than in others, a result of those observers not being able to get enough telescope time at a geographically widespread variety of observatories. Another contribution to the discrepancies comes from the tendency of spirals to inhabit different parts of space than do ellipticals.

The results indicate that, over and above the expansion of the universe, there are large-scale motions of galaxies to the order of 2,000 km per second. The most obvious cause of such motions is gravitational attraction. The attractors have to be large concentrations of matter, two or three times as big as the largest that can be accounted for by the simplest theory of the distribution of matter in the universe, the "cold dark matter" theory. So there is work for theorists here.

These conclusions are based on the widespread assumption that the microwave background *is* the absolute standard of rest for the universe. The notion is one of the bases of modern cosmology; if for some reason it should ever go by the boards, the whole game will need new rules. The conclusions are also based on assumptions about how to estimate the intrinsic brightnesses of galaxies, which cannot be directly measured, from physical characteristics that *can* be measured, such as the rotation speeds within the galaxy. One needs an estimate of the intrinsic brightness of a galaxy to get an idea of its distance. — *D.E. Thomsen*