New clues to smog's effects on lungs

There's little question that some of the constituents of photochemical smog — most notably ozone and some sulfur oxides — are respiratory irritants. And that has concerned researchers and policymakers alike, because more than one-third of the U.S. population routinely breathes air that exceeds the federal smog standard (SN: 6/28/86, p.405). What hasn't been understood is how serious these irritants are: whether they represent serious long-term hazards to human health, or even what kind of chronic respiratory hazards they might pose. But new animal studies at the University of California at Davis and the Massachusetts Institute of Technology are offering some clues. They suggest that smog may indeed be capable of causing potentially serious changes in the lungs.

In one study, monkeys exposed eight hours daily for one year to 0.61 parts per million ozone were found to have "abnormal" collagen (connective tissue) in their lungs. And once deposited, that abnormal collagen "doesn't go away," says Jerold A. Last, who headed the project at Davis. Though the monkeys again synthesized normal collagen once the ozone exposures ended, Last notes that the normal tissue "didn't seem to replace the abnormal collagen."

The altered collagen contains an unusually high number of chemical crosslinks that make the tissue stiffer and less elastic, report Last and his co-workers in the July TOXICOLOGY AND APPLIED PHARMACOLOGY. Such high numbers of crosslinks are characteristic of "changes we see in humans with fibrotic lung disease," Last says. Fibrotic lung disease stiffens the lung and makes breathing difficult. In the most serious cases, it can compromise gas exchange and even cause death.

Since the levels of ozone used in the study are at least three to five times higher than what humans breathe in most smoggy regions, Last does not see death from fibrosis as an ozone health risk. But no one knows what the impacts of milder, unrecognized fibrosis might be, he says. It's possible it might make people more susceptible to other respiratory problems. For this reason, Last believes his data point toward the type of damage researchers might begin scouting for in people who have been chronically exposed to ozone.

At MIT, researchers are focusing on the respiratory effects of another component of smog: sulfur oxides, particularly those carried *on* the surface of submicron particles of metal oxides like zinc oxide (ZnO). Prevalent in emissions from coal burning, smelting and some steelmaking, ZnO is not a respiratory irritant by itself except at high concentrations. But it can catalyze sulfur dioxide (SO_2) — also prevalent in industrial exhaust — to sulfuric acid (H_2SO_4), which is a potent respiratory irritant. New data from the group indicate that these metal oxides can increase the potency of sulfuric irritants — rendering them toxic at much lower levels than had been previously known.

Using guinea pigs, whose lungs provide a reasonable model for human asthmatics exposed to sulfur oxides, the researchers looked at factors such as the ability of these pollutants to limit the transfer of gases across membranes separating the lungs' small airways (alveoli) from capillaries. They found in this case that if 30 micrograms of sulfuric acid (a realistic figure) is layered on a tiny ZnO particle, it will produce the same effect — roughly a 25 percent reduction in gas diffusion across the alveoli — as 10 times as much pure sulfuric acid in aerosol form. Mary O. Amdur, who directed the work, attributes this "order of magnitude difference" to the fact that the ultrafine size of the ZnO particles helps carry the H_2SO_4 that they create deep into the lung. Moreover, because this H_2SO_4 is concentrated on the particle's surface, all of it is readily available for reaction with the lung.

In the June 15 TOXICOLOGY AND APPLIED PHARMACOLOGY, Amdur's group also reports that sulfites, a little-studied class of respiratory toxicants in some smogs, similarly inhibit gas transfer deep within the lung. Moreover, sulfites, which can also ride small particles deep into the lung, proved six times more potent at constricting bronchial passages than SO_2. Amdur suggests that an important way to limit these respiratory hazards might be to take away their transport by controlling industrial emissions of submicron aerosols. *— J. Raloff*

Pulling the plug on ocean minerals

In 1983, when President Reagan established the Exclusive Economic Zone (EEZ) — a 200-mile-wide border around the coasts of the United States — the possibility that the ocean would be a rich and profitable source of minerals seemed to be rising with the tide (SN: 1/4/86, p.5). However, the Congressional Office of Technology Assessment (OTA) underscored the recent ebb of this tide when it concluded in a report released July 21 that "For most offshore minerals, the near-term prospects for development do not appear promising."

In recent decades, scientists have been discovering a myriad of minerals within the current bounds of the EEZ, including cobalt, chromium, manganese and platinum — strategically important minerals that the United States currently must import. However, despite the proximity of these deposits, technological, financial and regulatory problems are keeping most of these and other offshore minerals out of reach.

Many "hard" minerals (as opposed to oil and gas) are located out beyond the continental shelf, in waters that are often over a mile deep. The recovery of these deep deposits presents some "major engineering problems," says J. Robert Moore, a member of the Department of Marine Studies at the University of Texas at Austin. "In terms of deeper-water deposits, we're talking at least 15 to 20 years before we see [mineral] recovery."

Other deposits are located on the relatively shallow continental shelf, where mining is easier. According to OTA analyst Rosina M. Bierbaum, the obstacle to shallow-water mining is simply a matter of economics. "It's just more expensive to get [the minerals] up off the bottom and get [them] to shore to process. . . . and we don't have any indication that the offshore stuff is a higher grade." Given these factors and the depressed prices of certain minerals in recent years, companies have little incentive to mine these shallow-water deposits, she says.

However, says Michael Cruickshank, a marine minerals consultant in Hamilton, Va., "it's very difficult to make a general statement about the cost of mining offshore." He believes that economic considerations are not primarily responsible for the total lack of mining off U.S. coasts.

The OTA and Cruickshank agree that a persistent problem in this field has been the process of leasing mineral rights. Although it is currently considering a hard-minerals act, Congress has yet to pass legislation that defines how companies can lease rights to mine hard minerals in the EEZ. Instead, the federal government has allowed the Department of the Interior to control this process through the broad interpretation of the Outer Continental Shelf Lands Act, which was passed in 1953, says Cruickshank, who retired this year from the Department of the Interior.

However, many groups, including members of the mining industry, have protested this practice. These companies feel that the present process does not provide enough incentive for companies to incur the significant risks involved in exploring and mining at sea.

If the government wishes to see the development of a mining industry for offshore minerals, says the OTA report, it will probably need to settle this issue and generally encourage such development. Moreover, OTA says, given the huge size of the EEZ — it is greater than two-thirds of the total U.S. land area — the government must also assume the responsibility of exploring the region's mineral potential. *— R. Monastersky*