ATMOSPHERIC CHEMISTRY

Ozone-Destroying Chlorine Tops Out

The title of the session at the American Geophysical Union's fall meeting last month was "The Montreal Protocol to Protect the Ozone Layer: Has It Worked?" The answer was "yes, so far at least." The prime evidence for the success of the 1987 international agreement to restrict the use of ozone-destroying chemicals—most of which contain chlorine—is that atmospheric chlorine has peaked and is on the way down.

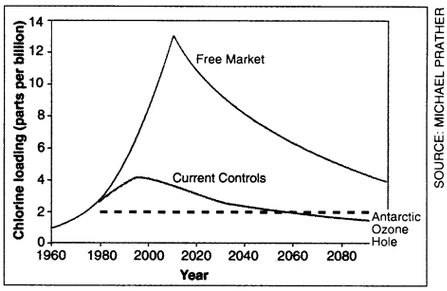
The chlorine decline, reported by atmospheric chemist Stephen Montzka of the National Oceanic and Atmospheric Administration in Boulder, Colorado, bodes well for the stratospheric ozone layer. One computer model of ozone destruction presented at the meeting predicts that the chlorine controls imposed by the recently strengthened protocol should allow the ozone layer to begin recovering before the end of this decade. But some new observations suggest that the recovery may be delayed. Losses to another ozone-killer, bromine, may be temporarily offsetting the gains from the chlorine reduction.

The good news on chlorine comes after decades when the annual release of one million tons or more of chlorofluorocarbons (CFCs), used for refrigeration, blowing foams, and cleaning electronics, drove chlorine concentrations up several percent each year. If no controls had been adopted until 2010, calculates Michael Prather of the University of California, Irvine, stratospheric chlorine would have topped out at levels more than three times higher than today's, the Antarctic ozone hole would appear well into the 22nd century, and springtime ozone losses over middle northern latitudes would soar above today's 8%, possibly to well above 30%.

Instead, by 1990 the Montreal Protocol restrictions began to slow the rise in chlorine noticeably (*Science*, 1 January 1993, p. 28). By the end of 1994, as production of CFCs plummeted, chlorine peaked, reported Montzka, at least in the lower atmosphere where it can be readily monitored. And now the amount of chlorine in CFCs and other halocarbons seems to be headed down, Montzka said. Using a computer model, Charles Jackman of the Goddard Space Flight Center in Greenbelt, Maryland, found that if the chlorine controls hold, ozone should begin recovering by 2000 and return to 1979 levels—the year the Antarctic ozone hole became obvious—by around 2050.

Recent atmospheric data reported by Ronald Prinn of the Massachusetts Institute of Technology suggested, however, that potential gaps in the existing protocol could slow the recovery. Although chlorine—the major ozone destroyer—seems to have peaked, says Prinn, the total ozone-destroying power of humanmade chemicals in the atmosphere has "perhaps reached a plateau, but certainly is not decreasing." This measure also includes bromine, an ozone destroyer that is scarcer than chlorine but at least 40 times more potent on an atom-for-atom basis. Prinn finds that the increasing concentrations of halons—bromine-containing compounds released from fire-protection systems—have for the moment sustained the ozone-destroying power of the atmosphere.

Production of halons was halted in 1994 under the protocol, but halons in existing firefighting systems are a continuing source of emissions. And because replacements for some halons have not yet been identified, users may be tempted to go on consuming existing industrial stocks. Methyl bromide, a soil and stored-grain fumigant, could also contribute to a future bromine increase. Meeting in Vienna last month, the parties to the protocol decided to phase out use of methyl bromide by 2010, but as yet unspecified exemptions may be granted.



SOURCE: MICHAEL PRATHER

Disaster averted. If controls had been delayed until 2010, chlorine levels would have soared.

Even chlorine, although under control, is far from eliminated as a threat. Rich, technologically sophisticated countries have found it relatively easy to move away from CFC use, notes Prather, but developing countries, which have laxer schedules to meet under the protocol, have yet to follow suit. Even in wealthy countries, the hydrogenated CFCs used in place of traditional CFCs are still weak ozone destroyers. Clearly, the Montreal Protocol has some more milestones to reach.

–Richard A. Kerr

PALEOANTHROPOLOGY

New Skull Turns Up in Northeast Africa

A new area for exploring human origins may be opening up in the Danakil Desert of Eritrea. Three weeks ago, while exploring a fossil-rich outcrop in this region of Northeastern Africa, a team of Eritrean and Italian scientists unearthed several well-preserved hominid fossils dating to about 2 million years ago. The precise nature of the fossils isn't clear yet, but Ernesto Abbate, a geologist at the University of Florence and co-leader of the team, is confident that they represent a human ancestor—the first ever discovered in this region.

Breaking new ground. A new—as yet unidentified—hominid has surfaced in the Eritrean desert.

"We have a very large part of the skull, and part of a pelvis and a finger bone," says Abbate. One of the team's paleontologists, Giovanni Ficcarelli, is certain they belong to early *Homo*. But the fossils are still encased in their sandy matrix, so it is not possible to "say whether it is *H. erectus*" or another human precursor, says Ficcarelli.

Identity aside, the announcement, made by the Italian Embassy in Asmara, Eritrea, already has paleoanthropologists talking. "Anytime you find an ancestral fossil of such completeness and in a new area, it's extremely important," says William Kimble, a paleoanthropologist at the Institute of Human Origins in Berkeley, California. Abbate anticipates finding more hominids in the area.

Abbate says the new site, located about 500 kilometers north of Hadar, Ethiopia, is geologically comparable to the Ethiopian region, which has produced a bounty of hominid fossils, notably the 3.2-million-year-old "Lucy." Like Hadar, this stretch of northern Danakilia is studded with animal fossils, which the University of Florence scientists together with colleagues from the Eritrean Ministry of Energy, Mines, and Water Resources began collecting in 1993. The remains of extinct elephants, hippos, antelopes, pigs, and carnivores will help them piece together the hominid's world.

The team also thinks the skull will yield clues to ancestral intelligence. "It is unusually well-preserved," says Abbate, and should produce a fine cast of the brain. But the team will only know for certain when they have removed the sand and stone. "We are," he says, "just at the beginning."

–Virginia Morell