

# Attack of the Vog

## Natural air pollution has residents of Hawaii all choked up

By RICHARD MONASTERSKY

**J**eff Sutton wrinkles his nose at the acrid fumes drifting across his desk. It's 9:45 a.m., a time when the office air typically transports the scent of bad coffee or perhaps the faint aroma of jelly donuts. But today the hallways reek unmistakably of sulfur.

As a geochemist with the U.S. Geological Survey, Sutton has the equipment to analyze the odor. He and colleague Tamar Elias pull out a sulfur dioxide detector tube and take a quick reading of 600 parts per billion. Moving outside to the parking lot, they measure 1,000 parts per billion, a value almost as high as the sulfur dioxide concentrations associated with the deadly London fog in December 1952, which claimed 4,000 lives.

You might expect air pollution this bad in Manhattan or Mexico City. But the USGS researchers work in a sparsely populated national park on the island of Hawaii, far from anything even remotely resembling a smokestack. Their tropical neighborhood has no coal-burning power plants, no paper mills, no steel smelters, no traffic-laden superhighways. Just a small tourist town and an industrious volcano named Kilauea.

Unlike better-known volcanoes, which explode for a few days and then take an extended vacation, Kilauea has worked almost nonstop since 1986, producing a slow but steady supply of lava. As a by-product, the natural factory also emits about 1,000 tons of sulfur dioxide gas each day, making it one of the biggest sources of air pollution on the island. The sulfur compounds have proved so persistent in some spots that residents even invented a name for the problem — vog, for volcanic smog.

Nine years ago, during the early stages of the eruption, residents viewed vog as a nuisance that would disappear when Kilauea shut down. But the ongoing eruption has outlasted everyone's expectations. And in increasing numbers, Hawaiians are indicting Kilauea's chemical cloud as a real threat.

"We're realizing that the gases emitted by the volcano when it is in continuous eruption can cause health problems, can harm agriculture, and can have economic effects. It's a real concern," claims David A. Clague, scientist-in-charge at the USGS Hawaiian Volcano Observatory at Kilauea.

But others say vog has become a

scapegoat — an easy excuse for people's myriad physical complaints. "The latest studies show that there haven't been any significant health effects from vog," argues Katherine Hendricks of Hawaii's Department of Health in Honolulu.

The vog question mirrors in many ways the debate over other potential health hazards, such as exposure to second-hand tobacco smoke or pesticides in food. But the Hawaiian issue breaks all molds because the pollution in this case comes from nature itself, which pays no attention to regulatory laws or federal air quality standards.

**T**o trace the origins of vog, Sutton and Elias strap on gas masks and strike northeast across the floor of Kilauea's summit crater. Hiking across the black lava flows, they reach a mound bedecked with yellow crystals glistening in the sunlight. The crystals contain sulfur compounds that precipitated out of gas plumes exhaled by the volcano. Elias inserts a tube into one productive fumarole and collects a sample of the noxious fumes for later analysis.

The principal gas escaping from Kilauea is carbon dioxide, which dissipates in the air. Sulfur dioxide, the next most abundant gas, doesn't behave as nicely. On relatively calm days, when no wind clears the air, sulfur dioxide can accumulate in the vicinity, giving a full dose to employees of the national park and the USGS volcano observatory, which sits on the rim of Kilauea. Exposure to such high doses can cause breathing difficulties, although concentrations typically do not remain so high for long. For instance, the lethal London fog persisted for days, whereas the extreme pollution at Kilauea usually lasts only for minutes or hours.

Sulfur dioxide afflicts only the immediate volcanic neighborhood because the gas oxidizes before it can drift far from Kilauea. Chemical reactions turn the sulfur dioxide into sulfates of ammonia and hydrogen. These tiny acidic particles absorb moisture from the atmosphere. With their superior talent for scattering light, the sulfate particles can create an impenetrable haze reminiscent of conditions in Los Angeles.

During most of the year, the prevailing

winds blow the sulfur pollution toward the west side of the island, where it curls around the massive back of Mauna Loa. The soupy air gets trapped in basin-shaped pockets, hemmed in by the mountains overlooking the city of Kailua-Kona and the rest of the Kona coast.

For the 40,000 people living in and around Kona, fresh air comes only occasionally, when a shift in the trade winds sends the vog to the Hilo side of Hawaii and to other islands hundreds of kilometers away. The haze even reaches Honolulu at times, prompting complaints from residents there.

"Someone is going to get the vog, it just depends on where the wind blows," Sutton says.

**W**hen the volcanic haze sets in, it makes a mockery of Hawaiian tourist brochures that tout azure skies overlooking the tropical Pacific. But many islanders, particularly in the hard-hit Kona region, worry that vog is harming more than just the view.

In a study conducted for the American Lung Association of Hawaii, environmental scientist James W. Morrow analyzed the composition of air particles in Hilo and Kona from 1989 through 1992. For the first year of the study, the only part completed thus far, Morrow found that Kona residents experienced a continuous low-level exposure to average sulfate concentrations ranging between 4 and 5 micrograms per cubic meter of air. Hilo residents faced less than half those amounts, except when wind reversals boosted sulfate readings closer to those seen in Kona.

No standards exist for sulfate pollution, and scientists do not know how high the concentrations can get before they start harming human health. To work around this problem, toxicologist Leslie Au of the Health Department looks at other sulfur standards. He draws an optimistic conclusion from Morrow's data.

Au compares the measured sulfate concentrations in Kona to the National Ambient Air Quality Standards (NAAQS) for sulfur dioxide. According to the Environmental Protection Agency, which sets the NAAQS, people should not be exposed to concentrations of sulfur dioxide exceeding an annual average of 80

micrograms per cubic meter.

Although the standard applies only to sulfur dioxide, Au reasons that it can provide some rough guidelines for sulfate particles. "Presumably the NAAQS levels were established in order to protect sensitive people. But just in case they weren't, an additional safety factor of 10 (or dividing the sulfur dioxide NAAQS by 10) would bring the standard down to 8 micrograms per cubic meter," he says.

By Au's calculations, therefore, sulfate concentrations on Hawaii fall well below the level where they should cause health problems, even in Kona. "We jump to the conclusion that the vog looks worse than it actually is," Au says.

**M**orrow disagrees. "I think Au is way off base by trying to make a comparison with the sulfur dioxide standard. I wouldn't mix up sulfur dioxide and sulfates — they are totally different," he argues.

Petros Koutrakis of the Harvard School of Public Health in Boston also criticizes Au's logic. "You cannot compare apples with oranges. Sulfur dioxide is a gas, and sulfates are particulate," says Koutrakis, an atmospheric chemist who has investigated the impact of air pollution in six U.S. cities as part of a long-term epidemiological study.

In fact, evidence from the Harvard-led study suggests that sulfate concentrations observed in Kona could affect human health. Colleagues of Koutrakis detected a statistical connection between bronchitis and atmospheric sulfate. Incidence of the illness increased in direct proportion to the sulfate concentrations in the air; in other words, the city with the highest summertime sulfate readings showed the highest rate of bronchitis.

Although the results do not prove that sulfates cause or exacerbate bronchitis, they do suggest a potential link. By extension, Morrow says, they also raise a warning flag about vog because sulfate concentrations in Kona rival the highest seen in the Harvard study.

"I think there's a legitimate concern about health effects here. I don't see it as a problem for tourists, but there is a potential for a long-term respiratory hazard. The respiratory health of children in that area may be somewhat reduced compared to the respiratory health of children not similarly exposed," Morrow says.

Koutrakis agrees the sulfate amounts seen in Kona could have adverse effects. But he notes that residents of the eastern United States face similar sulfate concentrations, in addition to a complex stew of other pollutants. "I don't think [vog] is worse than what people breathe right now in urban areas in the Northeast."

But residents of the sparsely populated Big Island do not expect big-city pollution. Furthermore, many believe strongly that vog has harmed their health.

"Because we do have such a chronic exposure to it, people have symptoms that they attribute to the vog, especially when they can see it in the air," says Ann M. Nies of the American Lung Association in Kona. "I get all kinds of calls from local people who are extremely upset and are fed up and don't know what to do."

Typical complaints include sore throats, headaches, bronchitis, and asthma. Vog hits hardest those residents with existing lung problems, a common affliction among the many retirees in the area. With its usually dry climate and abundant golf courses, Kona has long held the reputation of being an ideal spot to collect a pension — ideal, that is, until Kilauea came out of its own retirement and went to work in 1986.

For bad vog days, Nies recommends that people take evasive action: Don't smoke, don't exercise, avoid smokers, avoid people with colds, stay indoors, and turn on an air conditioner, if available. Some have decided to take even more drastic measures. "I know many people that have moved away from the island or to other places on this island," she says.

**I**n the court of public opinion, Hawaiians have already tried and convicted vog on the basis of such anecdotal evidence. But researchers say the actual medical investigations can't support any verdict yet.

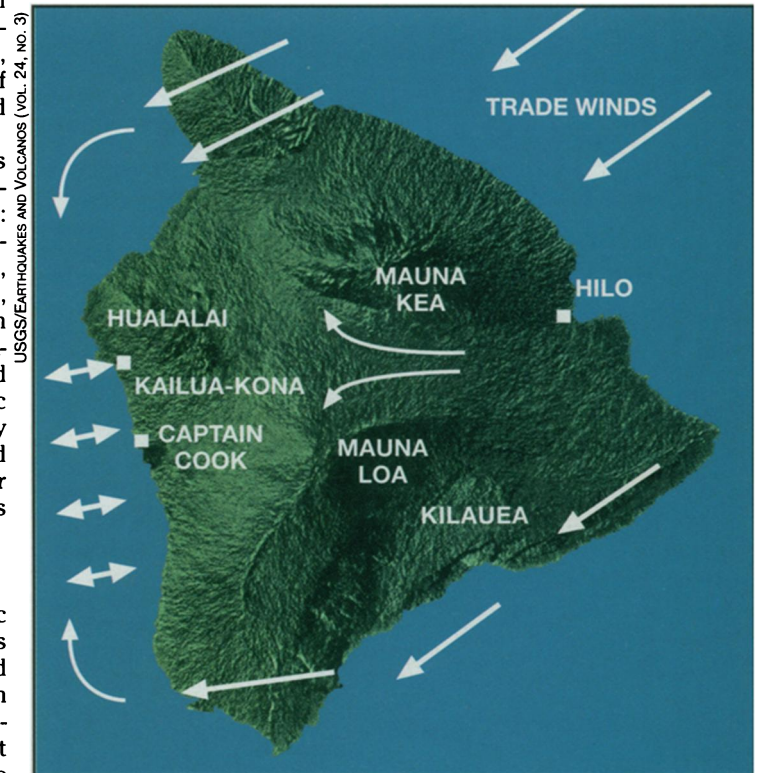
Several groups have tried to assess the pollution's toll, but limitations plague each of the epidemiological studies conducted thus far, Morrow says. Some results suggest a possible health effect, while others don't. What's more, the research teams have yet to publish their results in peer-reviewed journals. For these reasons, doctors and health officials remain cautious about making any definitive statements.

"The studies did not show any clear-cut association of vog affecting the respiratory status of any of the populations examined so far," says Edward Morgan, a lung specialist in Honolulu who leads a task force looking into the vog issue. Morgan believes that vog per se probably does not harm children, but it could potentially affect patients with underlying lung problems.

Further investigations could offer

some answers, but Hawaiians should not hold their breaths. Harry Kim, head of the Civil Defense Agency on the island of Hawaii, has tried unsuccessfully to gain support for more studies. "We have failed miserably," he says, "because we haven't been able to convince the legislature and the local politicians that a hazard assessment must be done."

Kim says many have brushed aside the vog issue because the pollution comes from a natural, uncontrollable source. No one can turn off the volcano or install exhaust-cleaning technology — a remediation required for certain



*Trade winds typically blow pollution from Kilauea toward the southwest and then around the back of the giant volcano called Mauna Loa. The volcanic smog, or vog, gets trapped on the leeward side of Hawaii, settling in the Kona region. During the day, breezes from the ocean blow the vog up the slopes of Mauna Loa and Hualalai. At night, descending air carries the pollution back toward the coast.*

industrial polluters.

But concerned scientists call the question of control a red herring. "You can't scrub the volcano. But you can modify your activities if you are a sensitive individual. People here don't necessarily know when they are going to get gassed," says Elias of the USGS.

The volcano will eventually end the debate on its own. Kilauea's current eruption has flared longer than any previous recorded episode, but it must run down sometime. When the mountain finally takes a rest, steady tropical breezes will clear Hawaii's air and whisk away the vog problem. Except, of course, for the people who spent a decade or more inhaling volcanic fumes and wondering whether they suffered any ill effects. □