

KILAUEA RIFT: The Geothermal Power Struggle

Deadly gas raises serious questions for Hawaii

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Third in a series

PAHOA, Hawaii — A vapor cloud rose in early April from the True Mid-Pacific geothermal drilling site here on Kilauea's Middle East Rift Zone.

Contrary to the assumptions of many local residents, the steam was not from an underground pocket of volcanically heated water.

Rather, it came from a watery concoction poured down the well hole to cool the drill bit, says Allan Kawada, attorney and project manager for the partnership.

Once in contact with the hot rock and bit, the water boiled — a common occurrence in drilling operations, he says.

During drilling, steam is diverted from the drilling rig through what's colorfully called a "blooie line." Sodium hydroxide is added in the line to neutralize the most troublesome geothermal by-product, hydrogen sulfide.

"That enables them to effectively control the hydrogen sulfide during the drilling process," says Bruce Anderson, state deputy director of health.

Sulfur in general and hydrogen sulfide in particular deservedly have a bad reputation.

A word derived from the Latin for "burning stone," sulfur or brimstone has a biblical association with the fires of hell. It occurs naturally in molten rock created from volcanoes or the collision of drifting continents.

Its most common form is as sulfur dioxide.

At the lower temperatures found in geothermal wells, from 300 to 500 degrees Fahrenheit, hydrogen sulfide becomes the more stable chemical species. In large doses, it can kill as efficiently as cyanide.

In April 1983, two geothermal workers lost consciousness and two others were hospitalized when they encountered a pool of hydrogen sulfide at the Kapoho State 1 well in Puna. Because hydrogen sulfide is heavier than air, it may accumulate to toxic levels in low-lying areas.

The drilling company, Water Resources International Inc., later was cited by the state Labor Department for safety infractions relating to the incident. The workers recovered.

Critics of geothermal energy worry aloud about similar but more serious accidents as well as long-term, low-level exposure.

"I have spent several months researching the world's literature on the environmental and health effects of geothermal energy production, and I have come to the conclusion that the unique conditions in Hawaii may preclude its safe development and production here," says Dr. Steven Moser of Maui, who joined the Pele Defense Fund in a lawsuit last year against the Health Department and True Geothermal Energy Co.

Sodium hydroxide, the chemical used to neutralize or "scrub" the hydrogen sulfide in the drilling process, is also toxic, Moser said.

"For every ton of hydrogen sulfide produced during drilling, venting and flow testing, there are four or more tons of sodium hydroxide which must be used," he said. "For each well, tons of this toxic chemical must be disposed of in an environmentally sound way."

Dr. Emmett Aluli, a Molokai physician and an officer with the Pele Defense Fund, has voiced concern that sulfuric acid from geothermal operations could create "acid rain" that will harm forests and wildlife and threaten human health.

Geochemists counter that naturally occurring amounts of sulfur — and sulfuric acid — far exceed those generated by geothermal activity.

Measurements by the U.S. Geological Survey at Puu O'o, where magma from Kilauea releases its gases, show that the volcano emits 1,700 tons of sulfur dioxide a day.

Researchers say the volcano emits hydrogen sulfide, the other gas, at about one-hundredth to one-tenth that rate, which adds up to 17 to 170 tons per day.

The level of hydrogen sulfide emissions from a geothermal power plant depend on just what control technology is used.

But University of Hawaii geochemist Don Thomas estimates a 100-megawatt plant will produce about 0.13 ton per day.

During drilling and well-head flow testing, True Mid-Pacific is limited by the state Health Department to 8.5 pounds per hour (about 0.1 ton per day.)

The limit for Ormat is even tighter — 5 pounds per hour. The tighter standard was set because Ormat is closer to homes and in an area where the geothermal resource is better understood, because of the HGP-A experience.

Says Thomas, "The amount that is coming out of Puu O'o is hundreds of times greater."

Once it mixes with the surrounding or "ambient" air, hydrogen sulfide is conveniently measured in parts per billion.

In its proposed administrative rules for geothermal development, the Health Department has specified an ambient-air limit of 25 parts per billion.

That limit is intended as a "nuisance standard," since it's about the level at which the odor is likely to be annoying, says Anderson. It's also consistent with California's standard.

Using the state-mandated "best available control technology," geothermal developers say, levels of hydrogen sulfide can easily be kept below 25 parts per billion.

The Health Department's permit for Ormat requires that combined emissions do not exceed 5 parts per billion above background levels during normal power-plant operations.

The department's Sept. 20 permit for True Mid-Pacific, issued before the proposed rules, calls for no more than 100 parts per billion for hydrogen sulfide at the property line, but that's likely to be changed once the resource is better understood, Anderson says.

The only time this level may be approached would be during "open venting," says Anderson. During open venting, a process necessary to clean debris out of the well bore, geothermal steam is released directly into the atmosphere.

The Health Department's permit for True Mid-Pacific allows open-venting of wells during the daytime for no more than four hours per day and no more than eight hours total during any well's lifetime.

True's first well has not had to be vented.

Another phase of the drilling process, flow testing, involves venting scrubbed steam and this typically has the most prolonged effect on ambient air quality, Anderson says.

During the problems at HGP-A last Labor Day weekend, measurements of hydro-

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gen sulfide found short-term spikes reaching as high as 46 parts per billion, according to Anderson.

Studies of the health impact of prolonged exposure to low levels of hydrogen sulfide are inconclusive.

For geothermal power plants, about a half dozen hydrogen-sulfide abatement systems are currently available.

At The Geysers in California, hydrogen sulfide and other so-called non-condensable gases are removed by what is known as a Stretford scrubber in the cooling tower complex. Pacific Gas & Electric Co., the principal plant operator at The Geysers, is part of a consortium negotiating with Hawaiian Electric over the proposed 500-megawatt geothermal cable project.

At the Coso Geothermal Project in California's Mojave Desert, hydrogen sulfide is successfully reinjected into the ground under pressure through a sealed well bore. The 240-megawatt Coso project, the first to reinject non-condensable gases, was developed by California Energy Co., part of the other consortium in the running for the mammoth Hawaii project.

Maurice Richard, regional development manager for Ormat/Puna Geothermal Venture, says his firm will try reinjection of hydrogen sulfide at its 25-megawatt plant in Kapoho.

Rod Moss, vice president of Mid-Pacific Geothermal Inc., part of the True Mid-Pacific partnership, says a decision on an abatement system depends on the pressure, temperature and chemical composition of the geothermal fluids.

But if reinjection works for Ormat, says Moss, True Mid-Pacific will consider it.

"If it works here, it could probably end up being the best available control technology for the non-condensable gases," he says.



Advertiser photo by Bruce Asato

True Geothermal project coordinator Allan Kawada points to the teeth on a drill bit at the firm's rig in Puna.

Hydrogen sulfide: A primer

Here's what the experts say about exposure to hydrogen sulfide, a gas emitted from geothermal wells on the Big Island. The numbers generally refer to one-hour averages of exposure:

- Background levels at Kilauea — 1 to 3 parts per billion.
- Half the human population can smell it at 5 parts per billion.
- Federal OSHA standards for exposure of geothermal workers — 10,000 parts per billion for 10 minutes.
- Possible eye irritation — 10,500 to 21,000 parts per billion.
- OSHA requires workplace evacuation — 47,000 parts per billion.
- Respiratory distress — 500,000 to 700,000 parts per billion.
- Rapid death — 1,500,000 parts per billion.