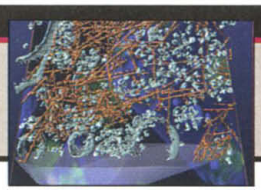

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New window into the cell

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Confidence in the castle

TOXICOLOGY

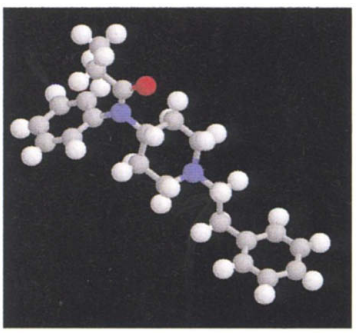
# Questions Swirl Over Knockout Gas Used in Hostage Crisis

**CAMBRIDGE, U.K., AND WASHINGTON, D.C.**— More than a week after the dramatic predawn raid that ended a hostage crisis in a southeast Moscow theater, scientists were still speculating about the exact nature of the gas that subdued the Chechen terrorists but also killed 118 hostages. As this issue of *Science* went to press, experts were dubious about the official Russian explanation, which is that the gas was a derivative of fentanyl, an opiate. And evidence was emerging that at least one other compound might have been in the deadly concoction. Hopes for a clearer picture —barring further glasnost from Russian authorities— are now riding on toxicological analyses on Western hostages.

The stakes for identifying the gas, or chemical cocktail, are substantial, as it could herald a new era in the use of so-called nonlethal weapons in antiterrorism and riot control. "It's a harbinger of what is to come," says Malcolm Dando, a chemical and biological weapons expert at the University of Bradford, U.K. The unprecedented rescue operation is also likely to focus attention on the ambiguities in the Chemical Weapons Convention (CWC), the 1997 treaty that bans the development, stockpiling, and use of chemical weapons while allowing for the use of chemicals in law enforcement. A review conference on the treaty will be held in The Hague next spring.

In a throwback to the Soviet-era practice of shrouding disasters in secrecy, the Russian government initially refused to identify the chemicals pumped into the air-conditioning ducts of the theater in the early morning of 26 October. Pressured by victims' families and foreign officials, Russian Health Minister Yuri Shevchenko on 30 October described the gas as a substance "based on" fentanyl, an opiate widely used as an anesthetic and for pain relief. With little further information available, however, experts started their own detective work, deducing clues from reported symptoms and, in a handful of cases, examining foreign hostages treated outside Russia.

Some observers say that Russia's fentanyl claim is credible. "Fentanyl was certainly looked at in the 1990s as an incapacitant," says Dando. "It was not chosen by chance," adds Georgii Livanov, chief toxicologist at the Health Committee in St. Petersburg, Russia. If applied properly, aerosolized fentanyl or a derivative should affect a patient for only a few minutes, Livanov says, after which "the agent would rapidly and completely decompose."



**Deadly effect.** Gas pumped through ventilator shafts quickly overcame hostages and their captives. Russian authorities said it was based on fentanyl (*right*), but some experts are doubtful.

Others doubt, however, that a fentanyl derivative alone could have delivered such a hammer blow. Although fentanyl "is many times stronger than morphine," the anesthetic is "unlikely to have the knockdown effect described," says chemist Ronald Sutherland, an expert on the CWC at the University of Saskatchewan in Saskatoon, Canada. "It worked very, very fast; it just amazes me," says Richard Sullivan, U.K. director of the nonprofit Council for Emerging National Security Affairs.

Indeed, researchers in Munich say they have evidence that at least one other compound was used in the rescue. Blood and urine samples taken from two German patients who were flown to Munich within 24 hours of the raid have shown traces of halothane, a decades-old anesthetic gas that has been replaced by more modern successors in the West but is still widely used in Russia. One of the patients, an 18-year-old female, might have inhaled halothane while on a respirator in a Moscow clinic after the raid, says toxicologist Thomas Zilker of the Technical University in Munich, but the other, a 44-year-old man, "never saw a ventilator."

Other factors point to halothane as a component of the gas, says Joseph Miller, a pharmacologist at the University of Southern California in Los Angeles. Halothane has a sweet smell and, if common coloring agents are added, a bluish-gray color, both of which were reported by hostages. (However, Veniamin Khudoley, chief of genetic toxicology at the Russian Ministry of Health's Institute of Oncology in St. Petersburg, believes that description could apply to a fentanyl-based gas.)

The German team didn't look for fentanyl derivatives because there are hundreds of them, and testing for all of them would have quickly depleted the available blood and urine samples, says forensic toxicologist Gustav Drasch of Ludwig Maximilians University in Munich. But if Russian authorities name a specific derivative, or other credible information surfaces, the team will try to confirm its presence, he says.

Meanwhile, the German patients' clothes and shoes have been taken to the German Federal Criminal Police Office in Wiesbaden, says Drasch, where they will be tested for residues. Because fentanyl derivatives are solid compounds, Drasch says, there's more hope of recovering traces of them from clothing than from the human body, where they are quickly metabolized. The U.K.'s Ministry of Defence also revealed plans to

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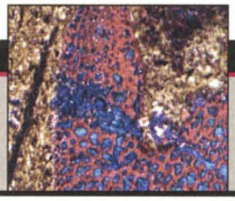
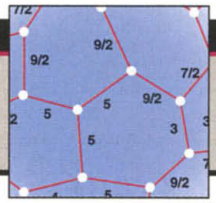





sample blood from three former hostages, although it's unclear whether it will make its findings public.

Some scientists believe that a far more potent compound was used. One candidate, Sutherland says, is etorphine, a derivative of morphine used by veterinarians to tranquilize elephants, rhinos, and other large animals. A dose of etorphine—estimated to be 1000 times as potent as morphine—large enough to knock out people in seconds would be close to the dose that would send someone into a coma and respiratory collapse, Sutherland says.

The fentanyl explanation is also challenged by Vil Mirzayanov, a chemist and former employee of the State Research Institute of Organic Chemistry and Technology in Moscow. Mirzayanov, who moved to Princeton, New Jersey, after blowing the whistle on Soviet chemical warfare research in the early 1990s (*Science*, 25 February 1994, p. 1083), claims his former institute is the only one in Russia with a research program in this area—and it never worked on derivatives of fentanyl. Indeed, when Mirzayanov contacted former colleagues back at the institute after the raid, "they all had to laugh" about the government's explanation, he says. Mirzayanov speculates that the Russians used a derivative of BZ, a powerful incapacitating agent that the U.S. military weaponized in the 1960s and 1970s. Mirzayanov's former institute had a supply of the compound that could be deployed immediately, he says. But Miller says BZ and related compounds are unlikely candidates because they are hallucinogenic, a symptom not reported by the hostages.

Meanwhile, experts disagree strongly on whether the use of the gas—or even its possession by Russian authorities—violated the chemical weapons treaty. The treaty allows the use of chemical agents for "law enforcement, including domestic riot control," and it requires member states to declare which substances they hold for those purposes. Some argue that the treaty's intent was to allow use of only a limited number of so-called riot control agents, such as tear gas. "There's no way in hell" the Russian operation would be permitted, claims Edward Hammond of the Sunshine Project, a group based in Austin, Texas, that opposes research on so-called nonlethal weapons in the United States. But others disagree. "I don't think they violated anything," says Harvard biologist Matthew Meselson, an expert in biological and chemical weapons.

If anything, the debate "shows that the treaty needs some work," says Jonathan Tucker, a senior fellow at the U.S. Institute of Peace in Washington, D.C. Tucker believes that the United States has refrained from criticizing Russia for using the gas because—apart from the fact that it needs support in its standoff with Iraq—it is operating in the gray zone itself. The Pentagon's Joint Non-Lethal Weapons Directorate is funding studies of nonlethal weapons, including "calmatives" such as Valium and Prozac (*Science*, 2 August, p. 764). Earlier this week, the National Research Council released a study recommending an expansion of that program (see p. 1153).

Yet although scientists criticize the Russian government for not being forthcoming about the nature of the gas, most agree that they had little choice but to use it. "At the end of the day, was there an alternative?" asks Sullivan. "There was no other way."

**–MARTIN ENSERINK AND RICHARD STONE**

With reporting by Andrei Allakhverdov and Vladimir Pokrovsky in Moscow.

ASTRONOMY

## California Astronomers Eye 30-Meter Scope

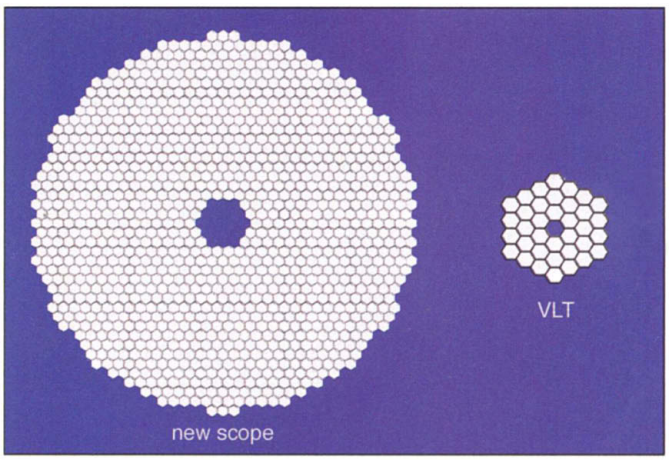
The creators of the world's largest optical telescopes have set their sights on something bigger—much bigger. Astronomers at the California Institute of Technology (Caltech) in Pasadena and the University of California (UC) hope to raise private money to build a telescope with a mirror 30 meters across. Caltech president David Baltimore announced a design study for the telescope as a centerpiece of a new fundraising campaign on 25 October, but Caltech and UC administrators haven't yet agreed on how best to proceed toward a venture that could cost $700 million over the next decade.

The mammoth observatory, dubbed the California Extremely Large Telescope (CELT), would sport a segmented mirror three times as wide as the ones on each of the twin Keck Telescopes in Hawaii. The ninefold boost in light-gathering area would give CELT the power to trace virtually the entire history of galaxy formation in the universe and peer deeply into regions where stars and planets arise. Two years ago, U.S. astronomers identified such a facility as their top ground-based priority to complement other powerful tools—notably the James Webb Space Telescope, the planned successor to the Hubble Space Telescope.

Star-studded teams in the United States and Europe are pitching competing visions of giant telescopes to their government agencies (*Science*, 18 June 1999, p. 1913). However, CELT's goal of obtaining purely private funding—and the team's nifty design work to date—might give the California group an edge. "CELT certainly has the momentum and the attention of the rest of the community," says Matt Mountain, director of the Gemini Observatory and its twin 8.1-meter telescopes in Hawaii and Chile. "They have the bit between their teeth."

Indeed, CELT's backers would like nothing better than to jump out of the gate as they did when the privately funded Keck Observatory opened on Mauna Kea a decade ago, years before any other huge telescopes existed. The same key players at Caltech and UC are in place, spearheaded by Keck designer Jerry Nelson of UC Santa Cruz. "This is the partnership we want," says Caltech astronomer Richard Ellis, director of Caltech Optical Observatories.

The current blueprint for CELT pushes Nelson's iconic honeycomb-mirror design to a grand scale. Instead of 36 hexagonal mirrors as in each Keck telescope, CELT would use 1080 mirrors acting as one smooth sur-




**Really big glass.** The California Extremely Large Telescope's 1080-piece mirror would dwarf one of the Keck Telescope mirrors.

CREDIT: CELT