instruments totaled only $3.6 million, says mission manager Scott Hubbard of NASA's Ames Research Center in Mountain View, California—well below the $10 million to $30 million that a single instrument on other missions can cost, he says.

After Lunar Prospector had crossed the poles repeatedly for a month, researchers "were certain water is there," says Binder. "The uncertainty is in how much." About 0.5% to 1% of the lunar soil near the poles appears to be fine particles of ice. That means a cubic meter of soil would contain about 5 to 20 liters of water, which might add up to a total of 10 to 300 million metric tons of water, says Binder. Although the amount is tiny by terrestrial standards and is still uncertain by a factor of 10, "that's a significant quantity," he says.

Extracting the water would in theory be simple: Take some soil and heat it a little. The resulting "moonshine" would allow "a modest amount of colonization for centuries," says Feldman, assuming a reasonable cost for distilling it. The water could also be split into hydrogen and oxygen—the perfect combination for rocket fuel. "For the first time, when you go to the moon, you [know] you can fuel up," says Binder.

Mining the moon would require a practical means of operating in the extreme cold, however, as well as a far better understanding of lunar geology, says Binder. "There's a lot of questions to be answered," he says. Lunar Prospector will be helping to answer those questions this year and next as it continues its explorations. It has already completed a much improved gravity map of the moon, which will offer insights into the moon's internal structure and improve planning for future orbiting spacecraft. Mapping of the moon's major chemical elements is progressing very well, Feldman reports. And once the spacecraft drops to a lower orbit next year (see sidebar), it is expected to get a better fix on the location of the ice.

The mission even has implications for other planets. Earth-based radar detected possible signs of ice on Mercury in the early 1990s (*Science*, 15 November 1991, p. 935). Although Mercury is closer to the sun, its polar craters are even colder than the moon's because the planet wobbles less on its axis. Still, many researchers were skeptical, thinking that the putative ice was volatile sulfur instead, which would give a similar signal. But having water on the moon "means almost for sure there's ice on Mercury too," says planetary scientist David Page of the University of California, Los Angeles. Don't expect mining missions to Mercury anytime soon, however. Even faster, cheaper, better has its limits.

–Richard A. Kerr

EMERGING DISEASES

Celebrated Virus Hunters Set Up Shop in France

PARIS AND LYONS—Joseph McCormick has a history of setting up laboratories under tough conditions. During the 1970s and '80s, he studied the deadly Lassa and Ebola viruses in remote African villages, some reachable only by dirt tracks. And when Projet SIDA, a program to study AIDS in Zaire, started up in 1984, McCormick flew into Kinshasa with an entire AIDS lab packed in boxes. But some supplies were hard to come by. "We didn't know where we were going to find liquid nitrogen," recalls Jonathan Mann, Projet SIDA's first director. "Then Joe located some at a Kinshasa brewery. He could always find a way."

McCormick, an American epidemiologist formerly with the Centers for Disease Control and Prevention (CDC) in Atlanta, won't have to knock on brewery doors in his new job. As head of a recently created epidemiology and biostatistics unit at the Pasteur Institute in Paris, the veteran virus hunter will be able to carry on his research in relative scientific luxury. And he is joined in France by his British wife and virus-hunting colleague, former CDC physician Susan Fisher-Hoch, who is overseeing the construction of Europe's first full-scale, top-security microbiology lab in Lyons (see sidebar).

It may seem strange that this duo, whose adventures in Africa and Asia have been featured in several recent books and television documentaries, has traded the hardships of the developing world for the advanced scientific environment of France and the bistros of Paris and Lyons. "I was a little bit surprised that they went to France," says Mann, who is now dean of the Allegheny University School of Public Health in Philadelphia. "They are entering a citadel of modern medicine with a message about public health" in the developing world. But McCormick and Fisher-Hoch intend to continue focusing on problems of the Third World countries in which they spent much of their careers. One of McCormick's key tasks will be to create an epidemiology training program for the worldwide network of Pasteur institutes, most of which are in Asia, Africa, and South America. And among the first projects Fisher-Hoch hopes to carry out at the new lab she is setting up in Lyons is the development of a vaccine against Lassa fever, which infects at least 100,000 people in Africa each year and causes up to 5000 deaths.

The couple's journey from Atlanta to France followed a circuitous route. In 1993, they left the CDC and moved to Karachi, Pakistan, when the Aga Khan University offered McCormick a position as head of its community health sciences department. They left the CDC in part because they felt that over the years the agency had become "political and bureaucratic," McCormick says. "The big watershed," Fisher-Hoch adds, was a falling-out with some colleagues at CDC over how best to handle a 1989–90 outbreak of Ebola at a private monkey facility in Reston, Virginia, that received widespread media coverage. McCormick—who was head of CDC's special pathogens branch at the time—believes the dangers to the public were greatly exaggerated. In Karachi, the two were in their element, training medical students to track down hepatitis C and cholera and trying to boost the underdeveloped public health system in Pakistan.

Then, in late 1996, as their contract at Aga Khan University was coming to an end, McCormick learned from a former colleague at CDC that the Pasteur Institute was looking for someone to create a new epidemiology unit. McCormick sent an e-mail message to Pasteur medical director Philippe Sansonetti expressing interest. The e-mail never went through, but Pasteur officials, it turns out, were already interested in McCormick. At

R. BENALI AND R. GAILLARDE/GAMMA LIAISON

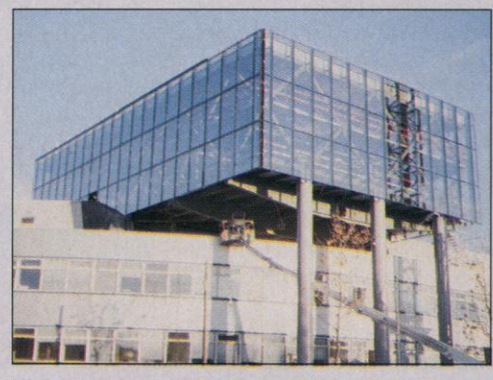
Dynamic duo. Susan Fisher-Hoch dons microbe-proof suit while Joseph McCormick looks on.

Europe's First High-Security Pathogens Lab

LYONS—The timing was perfect. In late 1996, Charles Mérieux, patriarch of the Lyons-based family of vaccine producers, was looking for someone to build and run a high-containment lab to conduct research on some of the world's most deadly pathogens. Susan Fisher-Hoch—a virologist who had spent much of her career working in such a facility at the Centers for Disease Control and Prevention (CDC) in Atlanta—had just the background for the job. And she happened to be interested in working in France: She and her husband, virologist Joe McCormick, were coming to the end of a joint appointment in Karachi, Pakistan, and the Pasteur Institute was courting McCormick to head a new epidemiology program based in Paris (see main text). Fisher-Hoch got the job.

The new $8 million lab will open later this year at the site of the former Pasteur Institute in Lyons, which closed in 1997. It will be Europe's first full-size, maximum-containment—or biosafety level 4 (BSL4)—facility and one of just a handful of such labs in the world. Fisher-Hoch says one of the first projects she hopes to carry out in the lab is the development of a vaccine against Lassa fever, work she began at CDC. Other projects will include research to develop molecular diagnostic tools to quickly detect the viruses that cause hemorrhagic fevers, as well as animal studies into how these microbes cause circulatory system collapse and other devastating symptoms.

The opening of the lab will be a major achievement not just for Fisher-Hoch but for Mérieux as well, whose father, Marcel Mérieux, was a student of Louis Pasteur and founder of one of the world's oldest pharmaceutical and vaccine companies. Charles Mérieux, now 91 years old, spent years trying to convince French and European authorities to build such a lab. Fisher-Hoch says that "the countries in Europe have very strong links with Africa, ... [and they] should have something to contribute scientifically." Although everyone seemed to agree that it was necessary, no one came up with the money. Finally, Mérieux decided to build the lab himself with funds from the family foundation he created in the late 1960s when the Mérieux group of companies was taken over by French pharmaceutical giant Rhône-Poulenc Rorer.



JEAN-MARC TOURRET

High security. Lyons's level-4 lab will sit over the old Pasteur Institute building.

Fisher-Hoch faced quite a task in making Mérieux's dream a reality. Lee Alderman, the former biosafety officer at CDC's BSL4 facility and now the biosafety officer for the Emory University School of Medicine in Atlanta, says that "since there are very few BSL4 laboratories in the world, there is limited experience in designing and building them." Alderman, one of several experts advising Fisher-Hoch on the lab's construction, notes that the Lyons lab presented particular challenges because it is being built over the old Pasteur Institute building—which has now been taken over by the Mérieux group—atop six metal and concrete pillars. As a result, while the CDC facility is constructed largely of concrete and resembles a medieval fortress, the walls of the Lyons lab are made from lightweight metal panels filled with polyurethane to avoid crushing the structure below.

Like other BSL4 labs, the air pressure inside the lab will be kept lower than that outside at all times, so that if any leaks suddenly develop air will rush in and prevent microbes from escaping. The air will be recirculated 25 times each hour through special filters designed to capture the smallest virus, and all liquid wastes will be heated to high temperature for several hours before being removed from the lab.

Although the Lyons lab is being built with private foundation funds, Mérieux told *Science* that he expects it will eventually be managed by French public research agencies. Indeed, a number of new research units, many affiliated with the biomedical research agency INSERM, will take up residence in an adjacent building and perform research in the facility. Fisher-Hoch hopes the lab also will eventually become part of the World Health Organization's (WHO's) network of consulting centers, which constitutes a worldwide early-warning system against infectious diseases. David Heymann, director of WHO's division of emerging and other communicable diseases, says the organization would welcome having a top-security lab so close to its Geneva headquarters. "There is a great need in the world for civilian [BSL4] labs where collaborative research can be done." **–M.B.**

almost exactly the same time, Pasteur director-general Maxime Schwartz visited New York and dropped by to see *Newsday* reporter Laurie Garrett, whose book, *The Coming Plague*, features McCormick prominently. Schwartz, who had read the book, asked Garrett how to contact McCormick and eventually telephoned him in Karachi.

In an interview with *Science*, Sansonetti said that the creation of an epidemiology unit at Pasteur is part of a drive to focus the institute's basic research talents more directly on public health problems, particularly infectious diseases. "We already have some instruments for doing this, such as our international network of Pasteur institutes, but we did not have sufficient visibility in the hospitals and in the field. An epidemiology unit will give us this visibility and allow the institute to insert itself into the area of new pathogens and [drug-] resistant organisms." Asked why McCormick, an American, was chosen to head the new unit, Sansonetti says that while France has some excellent epidemiologists, their training tends to be oriented toward fundamental research rather than pragmatic field experience. "Joe McCormick, who has experience in molecular biology as well as in the field, responded better to the profile" the institute was looking for, Sansonetti says.

McCormick says he came to Pasteur to "develop epidemiology as a scientific tool" that would bridge the gap between basic research and specific public health problems. He says he hopes to use the Pasteur network to create vaccine testing centers in the developing world, particularly focusing on exotic diseases that receive little attention from the pharmaceutical industry. One of his first projects will be to find new "high-powered molecular biology techniques" for developing molecular probes to identify new pathogens in patients. McCormick hopes that this program, which will begin as a collaboration with hospitals and clinics in France, will eventually be put to use in overseas Pasteur institutes.

And if McCormick does find any dangerous new microbes, he will be able to study them in Fisher-Hoch's new lab in Lyons, just 2 hours away by high-speed train.

–Michael Balter