TOXIC SALES: Street vendors in Guizhou Province, China, unknowingly sell coal that is dangerously high in arsenic and other trace elements.

and fluorine. Fluorosis is more common than arsenic poisoning because high-fluorine coal is combined with high-fluorine clay to make briquettes. Now that scientists understand the source of the health problems, they have launched multiple projects to help to alleviate the dangers of "dirty" coal.

The unusual Chinese coals contain upward of 35,000 parts per million (ppm) of arsenic, according to geologist Harvey E. Belkin of the U.S. Geological Survey in Reston, Va., who has analyzed samples from about 25 locations in Guizhou Province. In contrast, coals in the U.S. average about 22 ppm of arsenic. At this level, the U.S. Environmental Protection Agency concludes that arsenic fumes do not pose a compelling health risk.

"The worst mines [in Guizhou Province] have been closed down," Belkin says, but unfortunately, most people who live there don't have an alternative to coal. Wood was once their primary fuel, but the region's forests were largely denuded by the early 1900s. At that time, many people began digging the coal out of the hillsides. Compounding the problem of the contaminated fuel is that most homes have no chimneys; as a result, volatilized elements from the coal collect indoors. Fresh chili peppers contain less than 1 ppm arsenic, for example; peppers dried over indoor coal fires often contain more than 500 ppm arsenic.

U.S. and Chinese geologists have begun mapping the distribution of fluorine and arsenic within regional coal deposits to ascertain the least harmful locations to establish quarries. "Our focus is not simply to warn people but to show them that there are reasonably simple solutions," says Robert B. Finkelman, who has directed USGS involvement in the project since 1995. The maps, he says, are now available on CD-ROM.

Finkelman and Belkin are also working with chemist Dan Kroll of Hach Company in Loveland, Colo., to develop a field test kit that residents of Guizhou Province can use to measure the concentrations of dangerous elements in the coal they excavate. Kroll designed a low-tech test that involves an easy-to-follow recipe of crushing the coal, boiling it and adding a few chemicals. The chemical reactions produce arsene gas, which reacts with a paper test strip inside a sealed bottle. The paper turns a shade of yellow, orange or brown, depending on the concentration of arsenic.

Last August, Hach began shipping millions of the groundwater test kits to Bangladesh, where more than a third of the nation's 125 million people are waging an ongoing battle against arsenic contamination of their wells.

"Once the coal kits are field-tested we will raise money to purchase a supply of these kits and get them for free to the people of these villages in China," Finkelman says. If the kits seem to catch on for arsenic tests, Hach may develop cheap test kits to measure fluorine levels as well.

ROBERT B. FINKELMAN *U.S. Geological Survey*

EARTH'S OTHER DIRTY FUGITIVES

Contaminated coal is not the only hazardous earth material that geologists are tackling. They have also shown that roving dust storms from Asia and Africa haul a gang of potential health hazards to the Americas. Hundreds of millions of tons of soil from these eastern continents blow across the oceans every year, carrying with them pesticides, heavy metals, radioactive isotopes, insects and pollen. During the past 18 months, scientists with the U.S. Geological Survey's Center for Coastal and Regional Marine Studies in St. Petersburg, Fla., have discovered that the dust also transports several types of bacteria, viruses and fungi. Inhaling the spores of a windblown fungus in the southwestern U.S. is known to cause valley fever, another name for the sometimes deadly infection coccidioidomycosis.

MEDICINE

Count to 10

FROG EGGS MAY CRACK THE MYSTERY OF HOW ANESTHESIA WORKS **BY LISA MELTON**

For some, even a tooth extraction would be unthinkable without them. Anesthetics have become a mainstay of modern medicine, and every year 27 million people in the U.S. alone benefit from the pain relief, sedation and unconsciousness that they provide. But the rather unnerving reality is that general anesthesia transports us perilously close to death. The dose of anesthetic that puts you to sleep is not much smaller than the dose that can kill you. It is primarily the skill of the anesthesiologist that renders the drugs so safe.

Exactly how anesthetics work has re-

ANESTHESIA USE began in 1846, as shown in this first-ever photograph of surgery using ether, at Massachusetts General Hospital in Boston.

NEED TO KNOW: GOING UNDER

Side effects of anesthetics include nausea and vomiting, but it is respiratory depression that is potentially life-threatening. Anesthesiologists carefully monitor patients under anesthesia, making the practice generally safe and the mortality associated with it extremely low: about one in a quarter-million.

mained an enigma since their first use in 1846. Now researchers are homing in on the answer, which could result in a new generation of risk-free anesthetics. "Researchers on both sides of the Atlantic have identified the same target: the GABA type A receptor," explains neuropharmacologist Jeremy J. Lambert of the University of Dundee in Scotland. The receptor, which looks like a squashed doughnut sitting on the cell membrane, grabs onto GABA, or gamma-aminobutyric acid, the brain's major inhibitory neurotransmitter. Each receptor opens up a channel in the membrane and allows certain ions to enter the cell, which then suppress brain activity. But the idea that anesthesia acts on the GABA-A receptor has yet to gain widespread acceptance.

Lambert and his colleagues have taken a big step toward proving the connection between unconsciousness and GABA-A. The team set out to discover which part of the receptor interacts with the anesthetic drug etomidate. Using molecular biology tools, they introduced point mutations into the DNA coding for the human GABA-A receptor and then inserted this modified version into a *Xenopus* egg.

To the scientists' delight, swapping a single amino acid—out of 2,000 that make up the protein—in an area of the receptor called TM2 (transmembrane domain 2) was enough to make the frog egg cell unresponsive to the anesthetic. The experiment, Lambert concluded in previously published research, demonstrates that anesthetics interact with this important brain receptor in a highly specific fashion.

But it is, of course, a huge leap from an amphibian egg to the human brain, so the team plans to try an experiment on mice. The goal is to genetically engineer mice to carry the mutated GABA-A receptor instead of their own. If these mice stay awake after an injection of anesthetic, then the GABA-A receptor theory will be proved, at least for intravenous anesthetics.

Proof of GABA-A's involvement in anesthesia could lead to the Holy Grail of the operating room: a rapid-onset, readily reversed, risk-free anesthetic. Surprisingly, the key to such an anesthetic may lie in the metabolite of a sex hormone. Scientists have known for some time that a steroid breakdown product of progesterone is a powerful sleep inducer that, in higher doses, can have analgesic, anticonvulsant and even anesthetic properties. The brain produces its own supply of these so-called neurosteroids from either progesterone or cholesterol. And the Dundee team has found that these neurosteroids operate through the same GABA-A receptor as synthetic anesthetics do.

"Neurosteroids have a large safety margin, and unlike the other intravenous anesthetics, they do not depress blood pressure," says Alex S. Evers, whose team at Washington University has also been involved in searching for novel steroids to use as anesthetics. "It is surprising to me that a neurosteroid anesthetic hasn't yet come along."

Lisa Melton is science writer in residence at the Novartis Foundation in London.

AVIATION

Quieting Killer Wakes

AIMING TO BEAT HAZARDOUS TURBULENCE BEHIND PLANES BY STEVEN ASHLEY

The skies over New York City's John F. Kennedy International Airport were clear and relatively calm when American Airlines Flight 587 took off on November 12, 2001. Minutes later the Airbus A300-600 airliner broke up in midflight and dove into the ground—felled perhaps in part by turbulent vortices of air produced by the wings of a Japan Airlines jumbo jet that had just preceded it down the runway.

Engineers are working on ways to detect hazardous wake vortices so pilots can avoid them or to design aircraft that leave safer skies behind them. If implemented, these new technologies could boost the number of planes that airports could handle, thus cutting delays and enabling increased commercial air traffic in coming years.

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