The Practical Chemistry of Boom and Bust

At a curious lab in the U.K. chemists save lives by learning how explosions take place. The beneficiaries are mostly miners

Buxton, Derbyshire

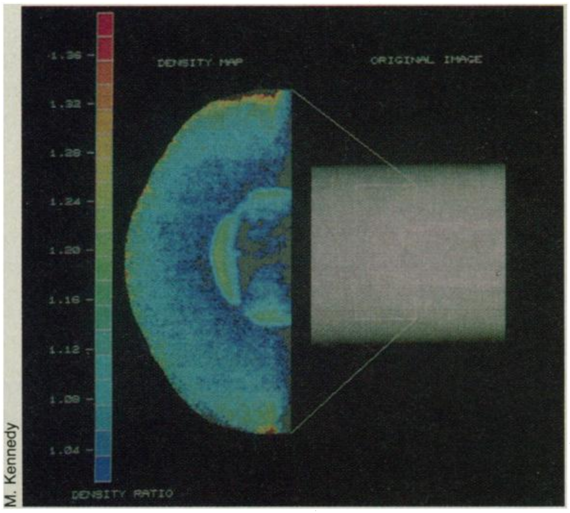
SET ABOVE THE OLD SPA TOWN of Buxton, some 150 miles northwest of London in England's beautiful Peak District, sprawls an odd estate that has nothing to do with vacations. This mass of low buildings and mocked-up mine tunnels houses the Explosions and Flame Laboratory of Britain's Health and Safety Executive. There many lives of Britons working in dangerous occupations (miners and sailors, for example), which might once have been lost, have been saved. The saviors here are research workers—physicists, engineers, and chemists, mostly—who spend their days trying to understand how things explode, and why they sometimes fail to explode.

Those who use explosives in mines walk a fine line. Explosions are clearly needed to efficiently dislodge the earth that contains the desired substance—coal, for example. Yet at the same time, the last thing that's wanted in a coal mine is an uncontrolled explosion. Methane and coal dust are always present, making for the possibility of sensational blowouts when explosives are used.

Then, about 10 years ago, "mining safety explosives" were introduced in an attempt to make the mines safer. These are weaker explosives, less likely to set off an uncontrolled big bang at the bottom of the shaft. But these weaker charges brought with them their own problems, according to Mike Kennedy, an explosives chemist who is a testing officer at Buxton.

Kennedy explained that explosive charges in coal mines are often set off in a precisely timed pattern called a delay round. The timing of the charges, one after the other, makes it possible to use explosives more efficiently, because the early charges loosen the stratum and the later ones blow it wide open.

If, however, some of the charges in the delay round fail to go off, the explosive left behind in the hole, mixed with coal dust, can go off—with spectacular results. And this was just what was happening after the weaker explosives were introduced. Each new explosive is monitored for a year after its introduction, and an increasing number of incidents in which charges failed to detonate drew attention to the problem. Although there were no known fatalities, "these incidents were accidents waiting to happen," according to Kennedy's colleague chemist Ian Kerr.



M. Kennedy

Blinding flash. *X-ray images of explosions helped make British coal mines safer. The fuzzy image at right was processed to yield the clearer image at left.*

Those incidents started Kennedy and his group off on an extended inquiry into why the mining safety explosives weren't going off as planned. Most of the failures came from charges late in the delay round, and the group's working hypothesis was that those charges became compressed by explosions earlier on—and that denser explosives would not go off.

To test that idea Kennedy began stopping explosions in mid-bang, using an x-ray flash camera. The resulting pictures seemed to confirm the hypothesis, but they weren't very clear. The fuzzy images were put through a digitizer and into a microcomputer to be manipulated and cleaned up. The result was an unmistakable image of the propagating explosive wave, confirming that when the density of the explosive exceeded a threshold, the charge didn't go off.

Kennedy's finding has had practical consequences: Manufacturers have modified their explosives, making them more difficult to compress, and, as a result, there have been no such misfired explosions for at least 5 years.

Even before the work on weak explosives began, however, scientists at the lab had been working for decades on another strange problem in explosive chemistry that had been killing miners—and sailors, too.

Standard wisdom in metallurgy has long held that light alloys—such as magnesium, aluminum, and beryllium—don't spark. Yet in November 1950, a peculiar accident took place in Hawkins Old Coppice colliery at Cannock Chase in Staffordshire. A hand drill fell from a platform, brushing a steel girder. Witnesses saw sparks. Seconds later there was an explosion in which ten men were burned, one fatally. But the drill case was made of magnesium alloy.

This peculiar accident set off a long chain of experiments at the laboratory, led by Harold Titman and Steve Margerson. They found that rust on the girder provided ferric oxide, which mixed with the light alloy of the drill casing to burn at a temperature high enough to set off the methane in the mine. The friction of the drill case sliding off the girder was enough to strike sparks and start the reaction.

As a result of this finding, light alloys began to be banned in British mines in the late 1950s, and the ban has become more stringent over the years. Even the "silver paper" that once wrapped the miners' favorite chewing tobacco was changed to plastic foil.

But that doesn't mean that the scientists' work is done, says explosives expert Roy Gregory. People still treat light alloys as though they were totally safe. He cites the practice of suspending lumps of magnesium in the holds of oil tankers. When the hold contains seawater as ballast, the magnesium corrodes rather than the steel, saving the ship's hull. But empty tanks may contain a potentially explosive mixture of gas and oil vapors.

"Nonsparking" magnesium, accidentally falling onto the rusty inside of the hold, could ignite an explosion—and in at least one case, it has. In the early 1960s the S.S. *British Industry* was severely damaged by just such an explosion of crude oil vapors.

"There are people who say light alloys don't spark," says Gregory, wrapping a piece of aluminum foil around a rusty block of steel and striking a glancing blow with a hammer. There is a bright flash and a loud crack. "But they do." Then he does it again, this time in an explosive atmosphere of propane and air. The result is a satisfying—and just a bit worrisome—boom.

■ JEREMY CHERFAS