Organ failure

Across continental Europe, historical instruments are falling silent, muted by a new and mysterious form of corrosion. Tom Clarke speaks to the chemical detectives who are striving to protect our musical heritage.

Since 1467, the pure sound of the Stellwagen organ has filled the parish church of St Jakobi's in Lübeck, Germany. Named after the great organ builder Friedrich Stellwagen, who renovated it in the seventeenth century, aficionados rate the Lübeck organ as among the world's best for performing Renaissance and early baroque music. But in 1992, its largest pipes began to lose their voice. Close inspection revealed the problem: air was escaping through tiny holes that had appeared in the metal.

News of the renowned organ's affliction spread quickly among Europe's close-knit community of organ builders, players and enthusiasts. And the word in the organ loft was that Lübeck's Stellwagen was not alone. Pipes in many instruments dating from the fifteenth, sixteenth and seventeenth centuries from churches in Belgium, France, Italy, the Netherlands and Portugal are similarly rotting away — those of the organ in Bordeaux Cathedral are in danger of collapsing under their own weight.

The pipes of ancient organs are made from lead, which is known to corrode. But the symptoms seen in the Lübeck Stellwagen and its fellow sufferers — the sudden appearance of white chalky residue on a pipe's interior that eventually works its way through to the outside — hadn't been encountered previously. "We really think that we're dealing with something new," says Carl Johan Bergsten, a research engineer at the Organ Art Center at Gothenburg University, Sweden. Bergsten views the instruments as both musical and technological icons. "They mirror the technical achievements of their age," he says. "An organ was the seventeenth century equivalent of the PC."

Finely tuned: lead samples from organs are tested for corrosion under various atmospheric conditions.

Following the lead

Last year, Bergsten assembled a team of metallurgists, chemists, organ makers and music historians to establish the cause and extent of the problem. It's early days, but the team's laboratory and field experiments have started to yield clues about the cause of the corrosion — and it seems that it may be a by-product of well-meaning attempts to restore the precious instruments.

Bergsten's Corrosion of Lead and Lead-Tin Alloys of Organ Pipes in Europe project — funded by the European Union and known by its acronym, COLLAPSE — is inviting organ builders, restorers and organists to send it details of corroded organs. Just last month, for example, the Royal Conservatory in Brussels contacted Bergsten after realizing that its organ had fallen victim to lead corrosion.

Understanding the distribution of the problem might help to identify its cause. But the project's main detective thrust is a series of field and lab experiments. Bergsten's team has already selected seven corroded organs in Italy, Germany and the Netherlands and paired them with similar non-afflicted organs in similar churches in the same area. Instruments recording temperature and humidity have been installed in these churches, and samples of corroded and uncorroded metal from their organ pipes have been examined in the lab of Jan-Erik Svensson, an environmental inorganic chemist at the Chalmers University of Technology in Gothenburg.

Organ enthusiasts weren't short of theories about the cause of the corrosion. One leading suspect was central heating. As well as increasing the temperature and humidity, heating systems also release carbon monoxide, which can corrode metals. But Svensson's analysis suggested an alternative cause. "We immediately found high concentrations of organic acids," he explains. The powdery white residue turned out to be lead hydroxycarbonate and lead hydroxyacetate, symptomatic of organic-acid corrosion. Sampling inside the corroded pipes immediately pointed to a culprit: high levels of acetic acid in the air blowing through them.

PARISH OF ST JAKOBI

Holey pipework! Corrosion is causing the Stellwagen organ in St Jakobi's, Lübeck, to lose its voice.

Winded: many lead organ pipes in Europe, such as this one from the organ above, are disintegrating.

Further tests in the lab looked at other corrosive agents that might be involved. Common atmospheric pollutants such as sulphur dioxide, nitrogen oxides and ozone did little damage to samples from the pipes. But acetic acid, at concentrations similar to those found in organ pipes, was highly corrosive. "I've never seen such a good correlation between laboratory and field results," says Svensson.

Subsequent investigations revealed the likely source of the acid. New oak wood gives off high concentrations of acetic acid, and restoring an organ often entails rebuilding oak components in its bellows and wind chest — the box from which high-pressure air is delivered to the pipes. Most of the organs suffering from corrosion had been restored in the recent past — the Lübeck Stellwagen was overhauled in the 1970s, for example.

But many old organs have had their wooden parts replaced several times without falling victim to corrosion. So why has the problem only started to emerge in recent years? This could be where the enthusiasts' hunch about central heating fits in. Svensson is eagerly awaiting the results of humidity and temperature monitoring; it could be that warmer church air is driving off more acetic acid from the new wood, he says.

Another key piece of evidence to emerge from the COLLAPSE study is that all the affected organs were built in the 'North German' style, and their lead pipes contain a small percentage of tin. This lead was first cast into sheets on sand, and tin was added both to harden the pipes and to increase their lustre. But when most of the organs that are now corroding were made, tin was scarce and expensive, and so could only be used sparingly.

Metallurgist Carla Martini at the University of Bologna in Italy and her colleagues are probing the affected pipes' composition using atomic absorption and X-ray fluorescence spectroscopy. This has confirmed that the corrosion seems to occur only in pipes containing 1.5–2% tin. "These traces of tin seem to have a big influence on corrosion," Martini says.

Tinned goods

This may explain why most organ pipes in Britain seem to be immune to the phenomenon. "I've only seen two cases in my 30-year career," says John Norman, a London-based consultant who advises the Churches Conservation Trust on organ preservation. At the time the corroded pipes were made, the main source of Europe's tin was Cornwall. As a result, it was much cheaper in Britain than in continental Europe — so British organ pipes contain up to 20% tin.

Why corrosion should occur only in low-tin pipes remains a mystery. The metal itself isn't responsible, says Martini. Her optical- and electron-microscope analyses are revealing that the low tin-content pipes also contain large amounts of impurities such as copper, antimony and bismuth. These influence the pipes' microstructure — the size and arrangement of crystal-like pieces of metal separated by air spaces and impurities. Martini suspects that understanding how the impurities promote corrosion is likely to provide the key to the mystery. But after hundreds of years, it is difficult to know how the pipes' composition has changed over time. "There's a lot we may never understand," says Martini. "One thing you cannot emulate is time passing."

Lovers of organ music can only hope that the COLLAPSE project produces a cure for the corrosive condition before too much more time elapses. Bergsten and his colleagues aim to devise a way to treat the pipes chemically to prevent the reaction that is gnawing away at them. In the longer term, they hope to understand the relationship between the composition and manufacture of the old pipes, and their wonderful sound. Then it might be possible to replace badly corroded pipes with new ones, without compromising the instruments' distinctive voices.

Aficionados can only hope that the project makes rapid progress. For now, the Lübeck Stellwagen is still playable, says Lutz Jedeck, pastor of St Jakobi's. "Works take on a special freshness due to the glorious and unmistakable tonal colour of the instrument," he enthuses. "But the holes get larger and larger." ■

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