Minerals with memory reveal age of St. Catherine’s in Eindhoven

Shining a light on the past

Invisible to the naked eye, pinpricks of light from minerals reveal how long they have been hidden inside a brick. Researchers at Delft University of Technology have ways of detecting the light, but their dating method yields results that don’t tally with those of archeologists.

Maaike Muller

A badly lit room is the ideal workplace for Dr Jakob Wallinga and his colleagues at TU Delft’s Dutch Luminescence Dating Centre. The soft orange glow in the laboratory makes the place look like a photographer’s darkroom. “In fact, we do call it our darkroom. You get used to it,” Wallinga assures visitors. Just as well, for if anyone were to turn on the light, every piece of research material lying exposed in the room would be rendered useless in an instant. The researchers use the material—usually sand—to determine for example when a tumulus or burial mound was built, or when a brick was fired. Minerals have a kind of memory that takes the form of a minute light signal. The moment the minerals are exposed to light they suffer from acute amnesia, as the luminescence signal disappears. Heat also resets the luminescence signal.

The moment a mineral becomes buried, or locked inside a brick, it starts to very slowly build up the signal under the influence of the natural background radiation that is all around us on our planet. The longer a grain of mineral stays in place, the more radiation it builds up, and the stronger its luminescence signal becomes. The principle used was as early as the 1960s by archeologists to date pottery. Wallinga often uses luminescence dating for sand. He used the method to find out when the sea dunes on the Dutch island of Texel were created, for example. He also used it to discover when the medieval church of St. Catharine’s in Eindhoven was built.

Child

In front of St. Catherine’s in the centre of Eindhoven lies a newly paved square. Municipal archeologist Joeske Nollen points out the lines in the stone paving. “Those show the contours of the medieval church.” Today churchgoers can cross the square in their Sunday best shoes without any mishaps, but in 2006 Nollen and her fellow archeologists were squelching around the site in muddy wellies trying to find out what the church had looked like in the Middle Ages. Although the little remaining archival material that had survived a succession of fires had enabled them to get some idea of the development of the church in its earliest years, it remained to be seen whether their ideas were correct. There was nothing for it but to start digging. In 2002 the municipal archeologists started with an exploratory excavation. Working entirely by hand, they exposed a plot of a few square metres layer by layer. Part of it had been inside the sanctuary of the medieval church. There, in the holiest part of the church, which also housed the high altar, they unearthed the grave of a ten-year-old child. It must have been a special child, since it had been buried with a Venetian coin carrying the effigy of Saint Marcus. “This is remarkable, as in those days Christians were rarely buried together with objects. It was considered a heathen practice,” Nollen explains.

Of course the archeologists wanted to find out more. The child must have been buried sometime round about the year 1300, but the immature skeleton made it impossible to determine the child’s sex. A DNA test was the only solution. Although the chances of finding any usable DNA in the bone cavities were slim, the archeologists sent the child’s jawbone to the university of Louvain. To their surprise DNA was found. The child turned out to have been a boy, whom they named Marcus of Eindhoven. “If we hadn’t discovered the child, we would have stopped after the first dig,” Nollen thinks. In her opinion that would have been a shame, as graves near churches can contain a wealth of information. “We can read a lot from the state of the skeletons. It’s rather like finding a register of births, deaths, and marriages.”

Peter de Knijff, professor of genetics at Leiden University, also showed a keen interest in the skeletons lying under the square in Eindhoven. If the DNA of Marcus had been preserved, perhaps more DNA from other individuals could found, which could benefit current medical research (see text box, Genetics using old DNA).
Surprising
Thanks to the interest shown, a more widespread excavation was started in 2005. A team of almost ninety archeologists and volunteer helpers painstakingly opened up the square in front of the church. Pointing out locations on the new pavement of the square, Nollen recalls a number of surprising discoveries. “That is were a priest lies buried. We know he was a priest because, unlike the ordinary people, he wasn’t buried with his feet pointing to the east, but the other way around (see text box, East-West was best).” Not long into the dig it was discovered that the floor plan of the original church was quite different from what the archeologists had expected. Once the tests had been completed earlier this year, dating specialist Wallinga, commissioned to investigate, concluded that the church was probably built a century and a half later than was originally thought.

For his test, Wallinga took lumps of the old wall to his laboratory, where the ancient bricks were pulverised. “This returned the material to the state it was in before the bricks were fired.” The researchers then looked at the luminescence signal to find out when the bricks were fired. According to Wallinga, that must have been in 1393, with a margin of 43 years. That laid to rest the theory that the church had been built in 1235, as it did the story about Marcus of Eindhoven. The boy must have been put into his grave before the walls of the church’s sanctuary went up.

So what did the archeologists have to say? Nollen is matter-of-fact about it. “Archeology is not an exact science. You work rather like a detective; as you collect more pieces of the jigsaw, you keep having to change the story,” she says. Could it be that Wallinga’s method is wrong? Well, fragments of pottery discovered under the sanctuary wall also rule out the earlier construction date of 1235. “The latest pottery we found under the sanctuary wall matches a pattern that was in fashion between 1350 and 1500. Therefore the wall must have been built after 1350,” Nollen explains. Wallinga’s estimate is within that margin.

Wallinga has every confidence in the luminescence method, but he can also see its shortcomings when applied to brick walls. For instance, samples taken from two different bricks that came out of the same wall gave different luminescence signals. Wallinga suspects that the discrepancy was caused by different environments, rather than by the bricks being fired years apart. “When we date soil layers, the sample we take usually comes from a fairly homogeneous environment containing only sand,” Wallinga says. This means that within a radius of approximately thirty centimetres around the sample the level of natural radioactivity is roughly the same. “Bricks, mortar, and the sand against the old wall all have different levels of natural radioactivity.” As a result, the amount of radiation varies for each part of the wall, and consequently, so does the strength of the luminescence.
Granules that light up

In luminescence dating, minerals emit a small signal of light, revealing how long they have remained buried. The moment they see light or heat up, their counter is reset. As soon as they become buried or embedded in a brick, the counter starts to run as a result of the effects of natural background radioactivity. The luminescence signal tells us something about the amount of radiation the grain of mineral matter has been exposed to. As the amount of radiation increases, so does the signal. If you know how radioactive a mineral grain’s surroundings were and how much radioactivity is required to produce a certain signal level, you can calculate how long the grain has remained buried in those surroundings.

Principle of luminescence dating

The measuring instrument for luminescence dating is set up in a dimly lit room.