The memory of sand

Sand has a memory. At least, part of it does, when considered in the right light. Jakob Wallinga, professor of Soil Geography and Landscape, knows all about it. He uses luminescence dating to penetrate deep into the memory of the landscape.

text: Roelof Kleis / **photo:** Guy Ackermans

We all know from watching an hourglass that you can use sand to measure time. And quite accurately too, if the instrument is well calibrated. But sand is a clock in itself, apparently. Approximately one in ten grains of sand can be used to measure time. The technique that makes this possible is called luminescence dating and is based on the physical phenomenon of luminescence (see box for technical explanation). What it boils down to is that a signal builds up in buried grains of sand under the influence of natural sources of radiation in the soil. And this signal can be measured. The size of the signal reveals how long the sand has lain at that spot. And in the dark, a crucial factor: once light is let in, the signal is lost.

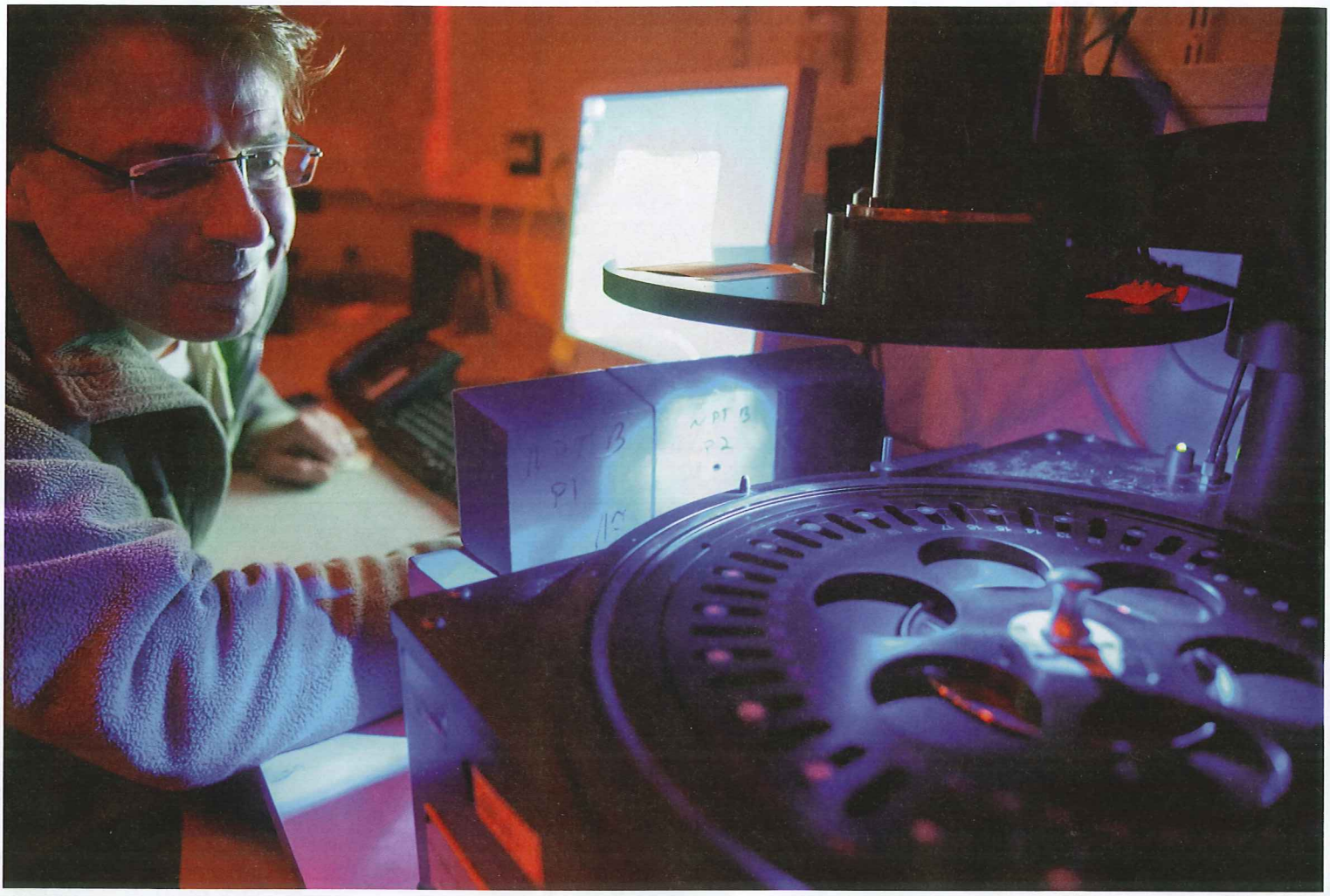
'I've been doing this work for 15 years now,' says Jakob Wallinga, 'but I still think it's incredible that a grain of sand can tell you when it was deposited at the place you found it.' Wallinga is the new professor of Soil Geography and Landscape, and the specialist in the Netherlands in the field of luminescence dating. The arrival of Wallinga brings Wageningen UR another specialist research lab: the Dutch Centre for Luminescence Dating (NCL). Wallinga set up this lab himself 10 years ago in Delft. The lab's move to Wageningen – an explicit condition for his appointment – is still so fresh that the NCL's website still does not mention it.

HERMETICALLY SEALED

Wallinga studied Physical Geography (Utrecht University) and encountered the then relatively new dating method in the course of his PhD research. 'I got caught up in it, really,' he recalls. 'I wanted to do applied research but gradually I realized the method was not yet the way I wanted it. So I focused more and more on developing the method.' When he had finished his PhD, there was clearly a lot of demand for the applications of the new dating

IN A GRAIN OF SAND

The memory of sand depends on luminescence, the emission of light. It works like this. Soil is naturally slightly radioactive, due to the presence of the radioactive elements potassium, uranium and thorium. Cosmic radiation penetrates the soil as well, continuously irradiating quartz and feldspar, the main constituents of sand. The radiations causes the electrons in the crystalline lattice to become 'excited' and to move into a conduction band with higher levels of energy. On its return the electron releases excess energy in the form of light. 'The vast majority of electrons come back like this. But a small proportion get stuck in traps – small faults in the crystal lattice – from which they cannot escape,' explains Wallinga. 'They get fuller and fuller in the course of time.' And bingo! You have got a signal you can measure. But you do have to release the electron first. Wallinga does that by lighting up the grains of sand anew: optically stimulated luminescence. The surge of energy excites the electrons all over again and they return to their original state, emitting light as they do so. The size of the light signal reveals the level of radiation the grain of sand has received, known as the palaeodose. Wallinga: 'If you then measure the radioactivity of the bulk sample as well, you can calculate how much radiation the sand grains received per year: the dose tempo. Divided into each other, these values give you the 'age' – the time that has passed since the grain of sand was deposited.'



Jakob Wallinga reads the history of a landscape in a grain of sand.

method. Enough to warrant a post for Wallinga at the Technical University of Delft. And enough for the Netherlands Organization for Scientific Research (NWO) to invest in equipment and research grants for his work.

A few weeks ago the lab moved into accommodation on the second floor of Atlas. Only an A4 sheet of paper with NLC on it betrays its presence. The lab is hermetically sealed against light from outside. A visitor first has to pass through a kind of capsule in which it is pitch dark. Sunlight ruins measurements. Inside the lab, the work is done by the light of orange lamps. These have nothing to do with the recent coronation. Sand is not sensitive to orange light, explains Wallinga, while humans see well by it. Making it a good choice.

Wallinga thinks his method will give a boost to research on the formation of landscapes. 'Landscapes change under the influence of numerous factors: human beings, the climate, extreme events, etc. If you really want to understand landscape dynamics, you need to take measurements over long periods of time. Processes often take a long time and extreme events don't happen so often. C14 dating cannot always be used because there is too little organic material or because you cannot look far back enough in time by that method. That makes luminescence dating a nice method for this purpose.' Ⓡ

IN THE FIELD

Wallinga's dating technique enables him to see a long way back in time. 'With quartz we can see about 150,000 years back. Now using feldspar we can see 500,000 years back. And a postdoc is now developing a method by which we can even go back a couple of million years.' On the latter scale, even human evolution and migration comes into the picture, says Wallinga. His own doctoral research was about the development of the Rhine and the Maas over the past 200,000 years. 'Those rivers deposited a whole load of sand which you can analyse using luminescence dating.' The technique can be used in the same way in studies of coastal development, dune formation or river sedimentation. Anywhere where sand is moved around, in fact. With the proviso that the method only tells you anything about the last location of the sand. Every time the sand is exposed to light, the accumulated signal is lost, the clock is reset and it is back to square one. Unless the sand was moved in the dark, of course.

JURASSIC CAMPUS

Fifty thousand years ago the current campus was a swamp. Amsterdam palaeo-ecologist Bas van Geel established this by studying peat samples from the site where the Forum now stands. One of the methods he used for the dating was Wallinga's. research reported on this study under the headline Jurassic Campus (available on our website).