NEW MOON

Planetary scientist Wim van Westrenen wants to understand how the Moon evolved through time to become what it is today. He subjects rock samples to high pressures and temperatures – or nowadays gets his team members to do that for him – and tries to deduce the properties of the interior of the Moon from his results.

By Rianne Lindhout

Imagine you have bought a birthday cake and you want to deduce how it was made. How many eggs did the pastry chef use, how much butter or margarine? How long did he bake it, and what temperature did he set the oven to? That is what petrologist (rock scientist) Wim van Westrenen (born 1973) and his colleagues at VU University Amsterdam's Faculty of Earth and Life Sciences try to do. The only difference is that they are not interested in cakes (not professionally, at any rate), but in the Moon. And they don't use an oven, but a high-pressure device weighing one and a half tons. They place small samples of finely powdered rock into the press and subject them to temperatures of more than 1500 °C and pressures in excess of 30,000 atmospheres, to mimic the conditions prevailing many kilometres beneath the surface of the Earth or the Moon. "Our question is: what mineral mix do I have to melt at what temperature and pressure to make lava that is identical with surface samples found at specific locations? When I know what the conditions were when that lava sample was formed, I know that those conditions must have prevailed in the interior of the Earth or the Moon during their formation." Van Westrenen and his colleagues use a variety of cunning tricks like this to figure out how the Moon changed with time.

COOLED DOWN BILLIONS OF YEARS AGO

"Our objective is to discover how planets in general and the Earth in particular behaved shortly after they were formed," Wim van Westrenen explains. The Moon is an interesting object to study in this context because its early history is comparable with that of the Earth, but much easier to investigate. "The Moon has long been geologically 'dead': it no longer displays major subsurface movements or volcanic eruptions. It cooled down billions of years ago. Practically all the oldest minerals on Earth have been worn down by erosion and exposure to the atmosphere, and recycled many times through remixing of surface layers into the Earth's mantle." As a result, the 'dough' used to make 'Earthcake' has been homogenised much more thoroughly than that of the Moon, making it more difficult to deduce the recipe used to make it. "The Moon is small and nearby, so it's relatively easy to observe, and we know a lot about it. Moreover, continuing studies of the rock fragments collected from the surface of the Moon during the Apollo missions of the 1960s and 1970s tell us a lot about the early development of its interior."

Wim van Westrenen will be appointed full professor in January 2013 within the framework of VU University Amsterdam's University Research Chair programme, which was set up to encourage young researchers who are regarded as future leaders in their field. His talent was recognized as early as 2006 when he was awarded the Vening Meinesz Prize, presented by the Netherlands Organisation for Scientific Research (NWO) to the most promising Earth scientist in the Netherlands. He set up his own research group not long after that, with funding from the European Science Foundation.

Van Westrenen had to overcome his natural modesty for a moment when he was asked the reasons for his success. "I am a generalist in the field of petrology. Many researchers in this discipline just look at the current composition of minerals without considering how they came about. My group is the only one in the EU that does experimental research on the interior of the Moon. I think this approach is catching on, however."

MEMORIAL DIAMONDS

Wim van Westrenen gets excited by the discoveries he makes. "And we do it all with relatively inexpensive equipment. Our press was designed about fifty years ago to produce synthetic diamonds, and is currently used to synthesise memorial diamonds made from cremation remains that have become quite popular in various countries – including the Netherlands." If you subject carbon to sufficiently high pressures and temperatures, it recrystallizes to diamond.

> 'Anyone can own a press like that, but what we put in it is unique'

Carbon forms the basis of all organic matter, so you don't need human ashes as starting material for this process. Any organic substance will do - peanut butter, for example. People used peanut butter in the 'fifties to demonstrate that presses of this type worked - even though the diamonds produced in this way were not very attractive.

The most expensive of the high-pressure presses in Wim van Westrenen's laboratory costs 75 thousand Euros. "Anyone can own a press like that, but what we put in it is unique."

Like any other prominent researcher, Wim van Westrenen has been delegating more and more active research tasks to others over the years, and spends more and more time performing administrative and supervisory tasks. "This was not a change that I enjoyed initially. I had to get used to the idea of not always putting my own research ideas into practice myself. But I gradually gained more satisfaction from helping others to try and further their research careers."

The most impressive fruit of this transition was the discovery of 'upside-down volcanoes' in the Moon by his research group, published in Nature Geoscience early in 2012. This was the first publication by the research group he had set up that generated very widespread interest. This paper explained how it is possible for molten magma to exist deep in the interior of the Moon today, even though there have been no volcanic eruptions on the surface for more than a billion years. Van Westrenen's team measured the density of lunar magmas made by subjecting mixtures of powdered synthetic Moon rock to the high pressures and temperatures found in the interior of the Moon. They concluded that only titanium-rich magma is dense enough to sink into the solid interior of the Moon. Previous studies had shown that the titanium-rich minerals that formed the source of the titanium-rich magma could only be formed relatively near the surface. Van Westrenen's group concluded that large vertical movements early in the Moon's history must have brought these titanium-rich rocks from near the surface to greater depths, where the temperature was high enough to melt them, creating an upside-down volcano.

HARD TO SAY NO

Days are often too short for Wim van Westrenen – he finds it hard to say 'No', and he has a wide range of interests. His membership of the Young Academy of the Royal Dutch Academy of Sciences (KNAW) for example, and the lectures he gives to members of the public and to primary school pupils. In 2009, he wrote the popular science book *Hoe werkt de aarde?* (*How does the Earth work?*) in his free time together with retired nuclear geophysicist Rob de Meijer, and has plans to produce a companion volume on the Moon.

"I consider it important as a fundamental scientist to keep on improving my techniques to explain to others what I do in my work. My research and the accounts I give of it are aimed at satisfying people's curiosity about my scientific activity, but above all at stimulating their curiosity. If people look at the Moon slightly differently after hearing or reading about my work, I feel that I have done something worthwhile."

Wim van Westrenen has also collaborated with Rob de Meijer in developing the revolutionary theory that the Moon was formed 4.5 billion years ago not by a collision between the Earth and another heavenly body, but by a runaway nuclear reaction deep within the Earth. This is a highly controversial idea. "When Rob approached me with this hypothesis in 2007, I initially found it difficult to let go of the old theory. Rob is a nuclear physicist, and exchanging ideas with him helped me to think outside the box."

But one thing that Van Westrenen finds really frustrating is that even though no one has come up with any conclusive evidence against the new theory, he and De Meijer have been unable to find a scientific journal that was willing to publish it. "Editors claim that it is difficult to find reviewers for our article. What they really mean is that they think it's a ridiculous idea, even though scientists agree that the currently favoured collision model has serious defects. That's not how science is supposed to work. There have been other publications in the meantime, describing new computer models of the birth of the Moon. I'm not an expert on computer models, but the work I have done during the past years makes it clear that these new models do not give a good description of reality either."

Fortunately, developing theories about how the Moon was formed is just a sideline for Van Westrenen. He gets plenty of satisfaction from his investigation of planetary evolution after the brief moment of their creation.

ROCKS TALK

Wim van Westrenen did not start a rock and mineral collection as a little boy - chemistry was his favourite subject at school. "I was fascinated to read about the formation of limestone caves in my chemistry textbook. Water flowing over the limestone rock dissolves it and deposits the limestone elsewhere as the well-known stalactites and stalagmites. I knew then that I wanted to know more about chemistry, and about nature." He decided to study Geochemistry at Utrecht. However, his experience doing field work convinced him that the laboratory was a better place for him. "We had to do a geological survey of a certain area in Spain. Several times, a fault line disappeared below the surface of a ploughed field, and there was no easy way to determine its further course from that point. I found that unsatisfying, so I opted for experimental petrology."

Rocks may be inanimate objects but they have a fascinating story to tell, says Wim van Westrenen. "Some people regard Earth Science as a dull, lifeless subject, but in fact it is highly dynamic. The Earth is an interrelated system, and our ultimate objective is to discover how that system works. For example, if minerals melt somewhere deep below the surface of the Earth this can lead to a volcanic eruption. The gases and particles emitted during this process interact with the atmosphere and can even lead to temporary worldwide climatic changes. When Mount Pinatubo in the Philippines erupted in 1991, the dust and gas released into the atmosphere led to a global drop in temperature of almost 1 °C during the following months."