NPL and SUERC calibrate a 'rock clock'

January 5 2012

New research by the National Physical Laboratory (NPL) and the Scottish Universities Environmental Research Centre (SUERC) will improve the accuracy of estimates of the time of geological events. The work centres on the calibration of one of the world's slowest clocks, known as the 'argon-argon clock'.

The 'argon-argon clock' works by measuring the ratio of the amount of radioactive potassium in a sample of rock to the amount of its decay product, argon. As scientists already know the half-life of this radioactive decay (1.25 billion years), it can be used to date rocks back to the time of the formation of the Earth, 4.5 billion years ago. The older a rock is, the more potassium has decayed and the more argon is found in the rock.

The effect of the new research varies from one rock type to another, but could mean up to a 1.2 per cent difference in a rock's age from the original calculation.

"One per cent change in the accuracy of an age doesn't sound like a lot, but when aiming for 0.1 per cent precision through geological time it is a very significant breakthrough," said Darren Mark at the SUERC, who worked with NPL on the research.

"For example, this will help with establishing eruptive histories and predicting the future behaviour of young volcanoes, such as the inhabited British overseas territory Tristan da Cunha in the South Atlantic Ocean."

The discovery came about as part of an unrelated NPL research project to measure the Boltzmann Constant. The Boltzmann Constant links the magnitude of a degree Celsius to the amount of energy held by the molecules of a substance.

To measure the Boltzmann researchers needed to build the world's most accurate thermometer which works by measuring the speed of molecules in argon gas. But to understand their results they had to measure the isotopic composition of their samples of argon gas. After searching the world for collaborators, NPL enlisted the help of Darren Mark and Fin Stuart of the Natural Environment Research Council's Argon Isotope Facility (AIF). Darren and Fin are the 'parents' of ARGUS – the most accurate mass spectrometer for argon isotope measurements in the world.

During the course of their research, they came across an unexpected result. The measurements they made using ARGUS were so precise that they allowed the team to draw conclusions about the isotope distribution of atmospheric argon. This is used to calibrate noble-gas mass spectrometers and so is responsible for the calibration of all 'argon-argon' dating that takes place throughout the world.

The results show that Alfred Nier, a great American physicist of the 1950s, was slightly in error with his measurements of argon. The data revealed that the correct measurement was achieved in 2006 by researchers in South Korea and North America.

"This work shows the power of precision measurement," said Michael de Podesta, who led the research efforts at NPL. "Many people think precision measurement is just about adding another decimal place to a number. But it's far more exciting than that. It's more like getting a sharper lens on a camera. It allows us to see the world more clearly and, when we look closely, we are never quite sure what we will find."

Provided by National Physical Laboratory