Sensor breakthrough paves way for groundbreaking map of world under Earth surface
23 February 2022

The success opens a commercial path to significantly improved mapping of what exists below ground level.

This will mean:

- Reduced costs and delays to construction, rail and road projects.
- Improved prediction of natural phenomena such as volcanic eruptions.
- Discovery of hidden natural resources and built structures.
- Understanding archaeological mysteries without damaging excavation.

Professor Kai Bongs, head of cold atom physics at the University of Birmingham and principal investigator of the UK Quantum Technology Hub Sensors and Timing, said: "This is an 'Edison moment' in sensing that will transform society, human understanding and economies.

"With this breakthrough we have the potential to end reliance on poor records and luck as we explore, build and repair. In addition, an underground map of what is currently invisible is now a significant step closer, ending a situation where we know more about Antarctica than what lies a few feet below our streets."

Current gravity sensors are limited by a range of environmental factors. A particular challenge is vibration, which limits the measurement time of all gravity sensors for survey applications. If these limitations can be addressed, surveys can become faster, more comprehensive and lower cost.

The sensor developed by Dr. Michael Holynski, Head of Atom Interferometry at Birmingham and lead author of the study, and his team at Birmingham is a gravity gradiometer. Their system...
overcomes vibration and a variety of other environmental challenges in order to successfully apply quantum technology in the field.

The successful detection, realized in collaboration with civil engineers led by Professor Nicole Metje of the School of Engineering, is the culmination of a long-term development program that has been closely linked to end-users from its outset.

This breakthrough will allow future gravity surveys to be cheaper, more reliable and delivered 10 times faster, reducing the time needed for surveys from a month to a few days. It has the potential to open a range of new applications for gravity survey, providing a new lens into the underground.

Professor George Tuckwell, director for geoscience and engineering at RSK, said: "Detection of ground conditions such as mine workings, tunnels and unstable ground is fundamental to our ability to design, construct and maintain housing, industry and infrastructure. The improved capability that this new technology represents could transform how we map the ground and deliver these projects."

The breakthrough is a collaboration between the University of Birmingham, environmental, engineering and sustainability solutions provider RSK, Dstl (the Defense Science and Technology Laboratory, part of the UK Ministry of Defense), and technology company Teledyne e2v.

www.nature.com/articles/s41586-021-04315-3

Provided by University of Birmingham

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.