

## The potential of seismic monitoring during urban tunnel boring

### Supervisory Team

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### Key Words

Seismology, Urban seismicity, Tunnel drilling, London, Civil engineering

### Overview

Severe geological changes ahead of a tunnel boring machine pose a risk to boring operations. Techniques such as seismic-while-drilling (SWD, Petronio & Poletto, 2002) are used in real-time to monitor geological changes ahead of the tunnel boring machine. In addition, numerous monitoring boreholes are drilled to monitor the tunnel and subsurface post-construction using a variety of geophysical observations. However, these monitoring boreholes increase the costs of engineering projects substantially.



Besides being used during monitoring engineering projects, these boreholes offer an opportunity for generic subsurface monitoring and imaging, especially in urban settings where seismic noise levels are typically high at the surface. However, these boreholes are typically very narrow (10cm wide) and located in public spaces, limiting the deployment of expensive seismic equipment.

In this project, you will investigate to what extent real-time seismic monitoring can detect subsurface changes during and after drilling operations. In addition, we will study the additional insights seismic instruments placed in monitoring bore-

holes provide into general subsurface structure and background seismicity in urban settings.

### Methodology

We will focus our investigations specifically on London, where a number of monitoring boreholes may be accessible during and after drilling projects. Coincidentally, monitoring boreholes associated with the Tideway Tunnel are located relatively close to several fault structures on which recent subsurface movements have been detected (Morgan et al., 2021). These boreholes thus provide a perfect opportunity to study any potential natural seismicity on these fault structures.

We will particularly investigate the performance of novel, battery-powered seismic instruments, called Strydes. These instruments are able to continuously record ground movements for several months without requiring any cabling or power. More importantly, they are the smallest instruments currently available, and should fit within the monitoring boreholes.

Initially the project will focus on practical considerations (i.e. accessibility of boreholes, coupling of the seismic sensors with the ground, GPS signals and clock drift errors, retrieval of data). Subsequently, we will focus on data analysis and processing using existing Python packages, with the later stages focusing on the development of algorithms to detect and characterise seismic signals in real-time.

This project is complementary to a current PhD project that focuses on the use of citizen science sensors (Raspberry Shakes) for characterising seismic noise and background seismicity in London. The expectation is that the students will interact considerably and compare findings.

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## Timeline

**Year 1:** Doctoral training courses, literature review, experimental studies of coupling mechanisms and clock drift errors, initial deployment of seismic sensors in monitoring boreholes.

**Years 2 and 3:** Seismic data analyses, identification of seismicity, deployment of seismic sensors during active drilling operations, development of algorithms for real-time monitoring.

**Year 4:** Integration of seismic data with surface deformation data and geology, thesis writing and presentation of results at international conferences.

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## Training & Skills

The successful candidate will join the seismology group at the University of Oxford, and benefit from interactions with existing PhD students, postdocs and faculty who work on similar topics.

The PhD student will receive training in seismic deployments and processing of seismic data sets, as well as the analysis of seismic noise and seismicity. In addition, they will be mentored on how to prepare scientific results at (inter)national conferences, how to write manuscripts for publication in international journals and how to communicate their science to a general audience.

In addition to the training in these transferable skills and research skills, the student will be provided with advice on funding applications and career support.

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## References & Further Reading

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## Further Information

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