Seismic reflection surveys are used to map geological structure and stratigraphy to depths of more than a kilometre and provide valuable data for a wide variety of engineering, seismic hazard, site characterisation and exploration projects.

Benefits of seismic reflection surveys include:
- Mobility: compared to drilling, kit setup is lightweight, modular and highly portable
- Versatility: suitable for most types of land use including complex built-up sites
- Data continuity: 2D profiles characterise point and linear targets
- High resolution deep imaging: reflection can investigate targets to depths from 30 to 1500 metres
- Low impact: even the heaviest vibration sources used by Fugro create little more disruption than typical farm machinery.

Key site considerations include the presence of ambient ground and airborne acoustic noise and electrical signals, all of which can interfere with subsurface investigation.

Land use and topography must be suitable for arrangement of geophone arrays which may be hundreds of metres in length for deep surveys.

With sufficient care in planning and executing surveys, and with postprocessing of data, it is generally possible to work in complex environments including urban and industrial sites.
PRINCIPLES
The seismic reflection technique makes use of acoustic impedance contrasts in subsurface material. An acoustic impedance contrast is generated at any boundary between two materials with different velocity and/or density characteristics.

In a geological context, acoustic impedance contrasts are typically present at stratigraphic boundaries, for example, at a coal horizon or change in lithology or stratigraphic boundary.

P- or S-wave energy can be introduced into the ground by a variety of surface or downhole sources. Where the downward propagating energy encounters a boundary at which there is an acoustic impedance contrast a proportion of the energy will be reflected and returned to the surface to be detected by seismic receivers (geophones).

The bigger the contrast in acoustic impedance the stronger the reflection event. By acquiring data from numerous source and receiver locations it is possible to obtain a 2D or 3D seismic dataset. Data processing and analysis techniques employing often complex (but well established) processing routines and algorithms can be used to reveal the geological structure and position of subsurface reflectors.

METHOD
A seismic source is activated at or near the ground surface; the source type is dependant upon target depth and the geological nature of the ground. For shallow work, lightweight sources include sledgehammers and accelerated weight drops: for deeper investigation explosives or a high powered swept frequency vibroseis source may be used.

An array of geophones is set out to receive reflected energy which includes direct, reflected and refracted signals: these are converted into electrical signals and transmitted to a signal enhancement seismograph where the signal-to-noise and wavelet characteristics can be checked for quality control.

Key processes to enhance seismic data quality include deconvolution and time and depth migration. It is generally the case that systems used in the oil and gas sector have benefited from greater investment than those used in engineering; as a leader across the geoscience sector Fugro can enable engineering clients to benefit from application of these potent offshore processing systems to relatively modest geotechnical investigations.

Resolution of small and shallow targets requires high frequency signals, whereas penetration to depth relies on propagation and analysis of lower frequency signals.

Sophisticated vibrating sources such as the swept frequency Envirovibe system used by Fugro provide enhanced signal to noise ratio for target resolution and a broad combination of signals across the frequency spectrum that, unlike impulsive sources, can be tailored for optimal site response. Capable of generating high frequency (300 Hz +) signals for high resolution imaging, but also generating sufficient power to investigate beyond 1 km depth, the Envirovibe represents the state-of-the-art source for onshore investigations.

APPLICATIONS
- Bedrock profiling
- Fault mapping
- Stratigraphic mapping
- Cavity and cavern investigation
- Resource evaluation

Typical projects
- Seismic hazard evaluation
- Site characterisation
- Tunnels / HDD projects
- Major civil infrastructure
- Geothermal
- Gas storage
- Shale gas.