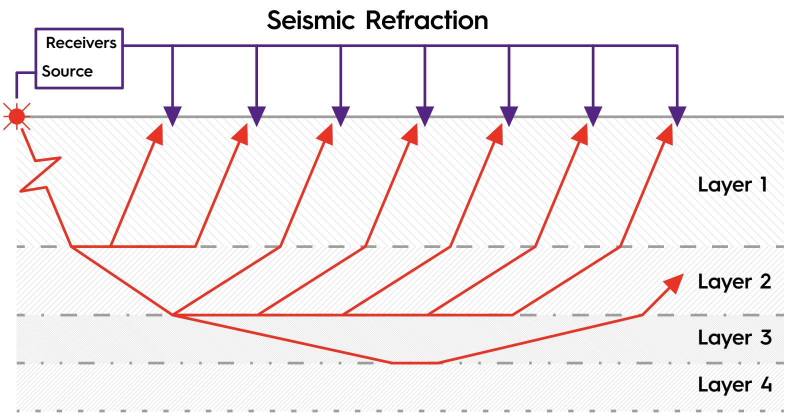
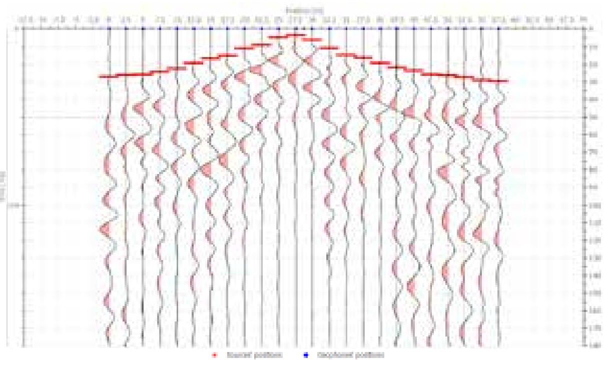
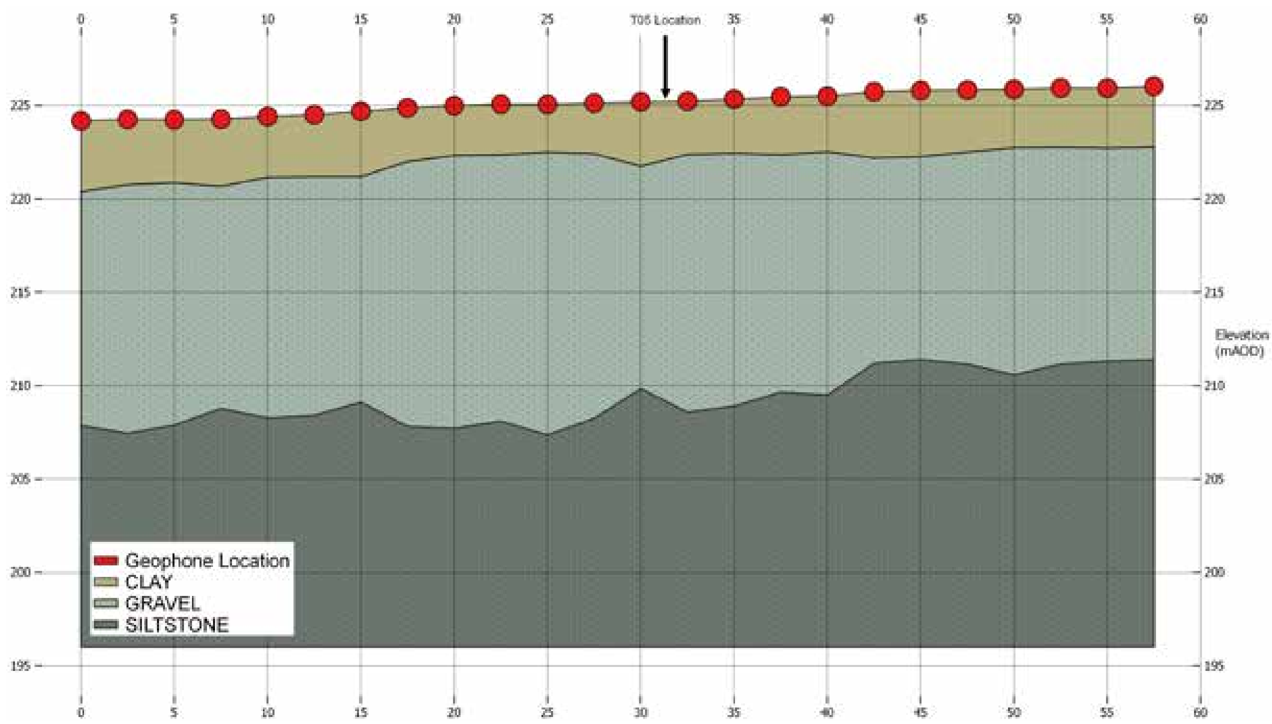


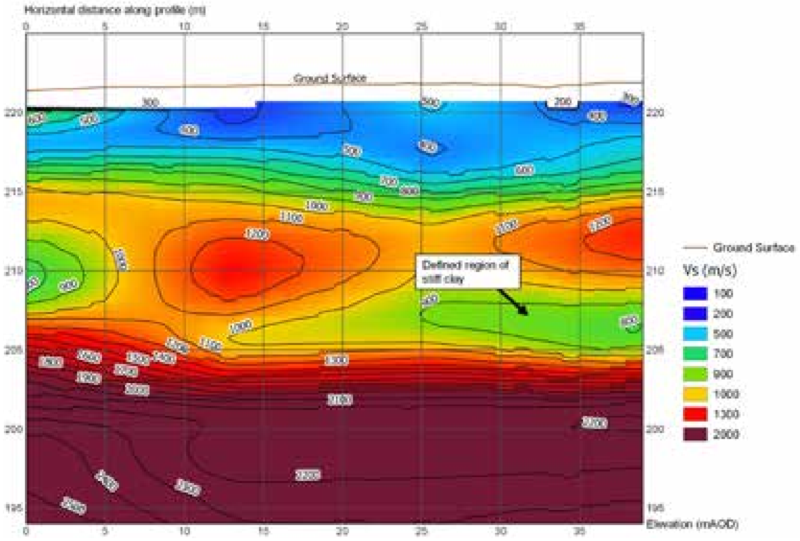


2D seismic wave traces recorded by the seismometer on site

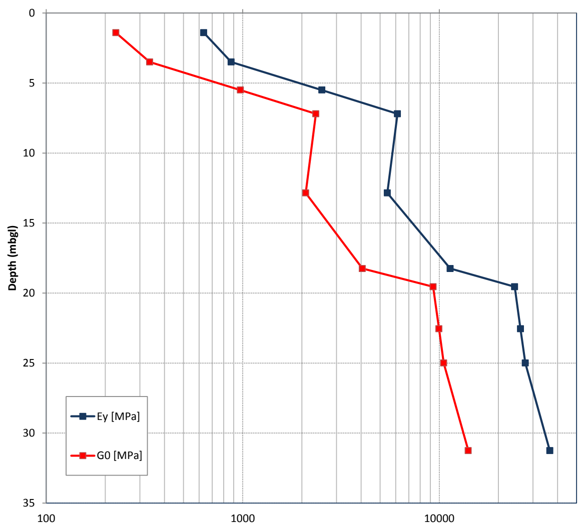


Seismic refraction ground profile (A-B)

Project:	**5WTG Wind Farm in Ireland.**
Client:	Confidential
Project Description:	**Seismic Refraction and Surface Wave MASW**
Services Provided:	**Defining Geological Profile** Both seismic refraction and surface wave MASW techniques were used to define stratigraphic boundaries at 5 turbine locations across the site. **Seismic Refraction Method** Seismic refraction uses seismic P-waves to locate changes in acoustic properties of the ground. Using a hammer and plate source, seismic energy is transmitted into the ground. These seismic waves will refract if they encounter a velocity change which could be caused by differences in density or lithology (soil or rock type). A portion of the wave will travel along this boundary and will eventually return to the surface as a head wave which is detected by an array of geophones. By identifying the first arrival travel times of the waves recorded at the surface the location of these boundaries can be identified.



2D S-Wave velocity profile



Geotechnical foundation design parameters

	Seismic MASW Method Seismic MASW is used to determine S-wave velocity of the subsurface which in turn can be used to derive geotechnical foundation design parameters such as small strain stiffness and elasticity. This method uses a similar survey configuration to refraction but instead analyses surface waves. Longer wavelength seismic waves propagate faster than shorter wavelengths causing the surface waves to disperse with transit time. MASW analysis records this dispersion trend and then uses advanced computational modelling to fit a 1D shear wave velocity (Vs) profile to fit the dispersion trends. Several 1D Vs profiles are obtained allowing a 2D Vs image to be produced. Results from both Seismic Refraction and MASW were correlated with borehole data drilled at the turbine centre and used to build a reliable ground model of the subsurface at each turbine location. **Results** Both refraction and MASW methods indicated 3 well defined acoustic layers. Using the seismic results alongside intrusive information from geotechnical ground investigation we were able to interpret the geological succession. The resulting ground model was found to be stiff clay, overlying dense gravel, overlying weathered bedrock primarily of conglomerate and siltstone shown to increase in density with depth. In addition to the 3-layer model the MASW analysis was able to map a low velocity region corresponding to a thin layer of stiff clay layer as indicated by the borehole log.
Added Value:	Geological ground model and depth to rock head were confirmed across the full diameter of turbine foundation. Seismic results provided geotechnical engineering parameters which are particularly representative of dynamic loading scenarios for foundation design.

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