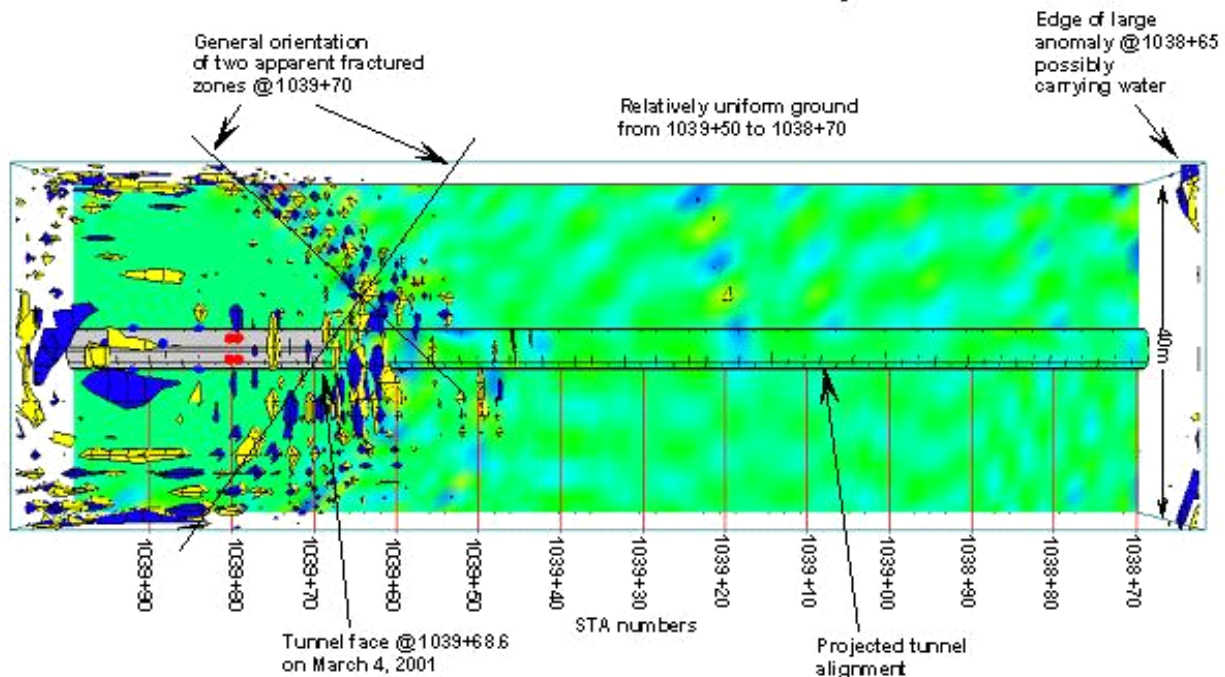


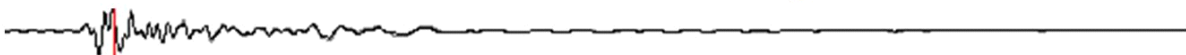
Seismic tomographic ground imaging is becoming a standard technology for enhanced site characterization throughout highway, bridge, and tunnel construction industries worldwide. TRT, based on reflection tomography, uses advanced algorithms for rapidly imaging subsurface cavities and structures that exhibit significant changes in velocity or attenuation. TRT enables “viewing” and mapping of anomalies in the ground ahead of and adjacent to the tunneling path in a timely manner with respect to the rate of tunnel excavation.

A complete tomography system, from signal collection to CAD output display, TRT provides images with greater detail and accuracy than other tomography approaches. TRT provides a non-intrusive approach that eliminates the downtime and added costs associated with drilling. By having an accurate representation of ground conditions in advance of the tunnel face, you are better able to anticipate problems, mitigate risks, and lower project costs.

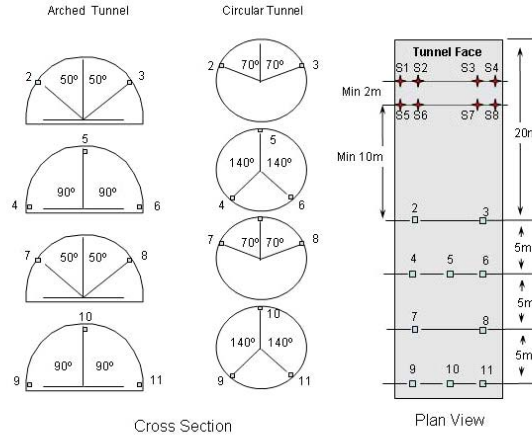


TRT has been used successfully to image shears, faults, voids, and structures in rock mass ahead of a tunnel face and to image fractured, weathered, and karstic limestone, as well as a granitic intrusion beyond which predominantly fractured and weathered mudstone existed.

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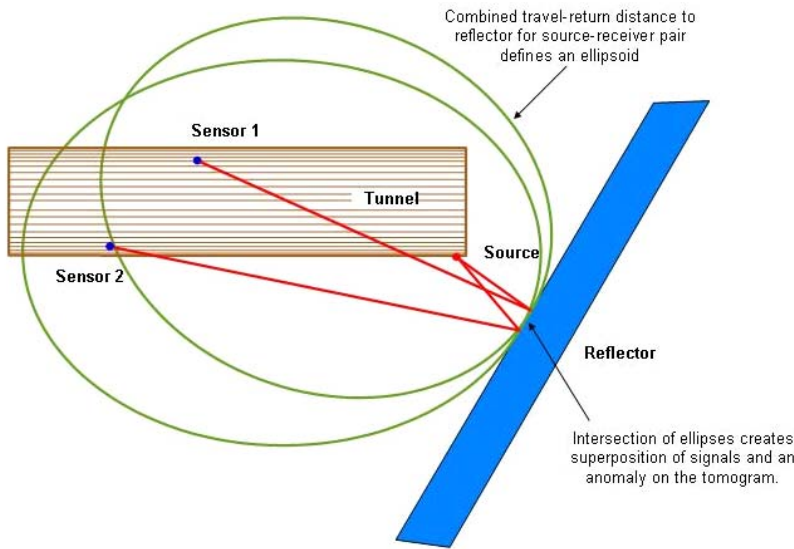


TRT allows an image of the area ahead of the tunnel face to be developed by recording “echoes” of the seismic vibrations transmitted by sources such as hammer blows or small explosive charges. These “echoes” or reflections are produced by significant geological structures ahead of the face and are detected by sensors mounted in the tunnel in a “tube array.” Typically, an image of ground conditions up to 100 meters ahead of the tunnel face can be developed.



Typical source and receiver locations for TRT surveys.

NSA Geotechnical Services developed TRT to image conditions ahead of the tunnel face using signals produced by various seismic sources, generating three-dimensional images of the ground conditions in advance of the tunnel. The basic principle of TRT is that a portion of the seismic energy traveling through



Principle of using seismic reflection for imaging ground conditions in three-dimensional space.

the earth is reflected when it encounters an interface between ground zones possessing different seismic properties. Most geologic structures, anomalies, and changes in lithology provide detectable seismic reflections if they are within a reasonable distance of the source signal.

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