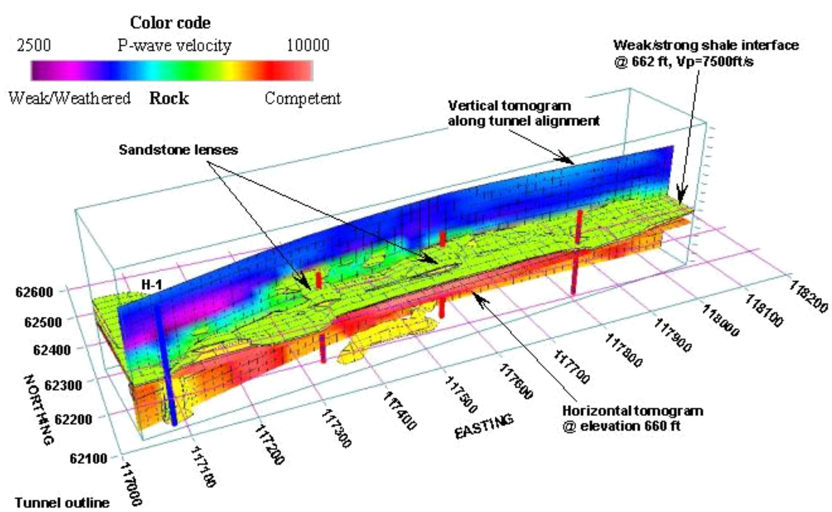
RockVision3D™

Seismic tomographic ground imaging is becoming a standard technology for enhanced site characterization throughout highway, bridge, and tunnel construction industries worldwide. RockVision3D, based on the direct arrival of seismic waves, uses advanced algorithms for rapidly imaging subsurface cavities and structures that exhibit significant changes in velocity or attenuation. RockVision3D produces subsurface images, providing a high degree of confidence to construction projects through vastly improved site characterization, ultimately minimizing project risk and maximizing the cost efficiency during the conceptual design, pre- and post-construction, maintenance, and rehabilitation phases.

A complete tomography package, from signal collection to CAD output display, RockVision3D provides images with greater detail and accuracy than other tomography approaches and ultimately reduces project costs. Some of the advantages within the RockVision3D system include:

- The ability to provide "forward models," tomographic simulations of the planned survey prior to actually conducting the fieldwork, allowing the client to (1) determine the level of imaging performance to be expected, and (2) optimize required borehole placement and geotechnical mapping within the site.
- The ability to produce both 2-D and 3-D velocity, attenuation, and "difference" tomograms. The difference tomograms are constructed to determine changing ground conditions over time.
- The determination of elastic constants (E, n) distribution in 2-D and 3-D volumes with the availability of P- and S-wave data.



To date, numerous geotechnical ground-imaging projects have been successfully completed related to highway, bridge, and tunnel construction. Specific geotechnical areas in which RockVision3D is used to reduce risk include bridge abutments/pier foundation characterization and scouring zone location in river sites, location of shallow structures (old mines, foundations, karst voids) that may impact construction, tunnel and substation alignment evaluation, and slope/embankment stability.

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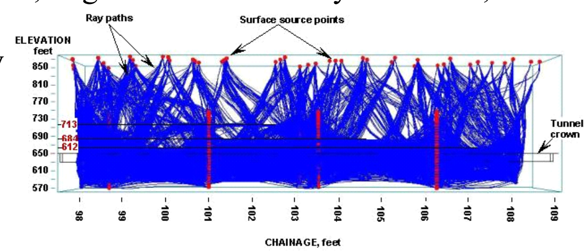
Seismic tomography is based on the principle that acoustic waves have different propagation velocities and attenuation through different types of ground. That is, seismic waves travel faster and have less attenuation in strong, competent material and slower velocity with greater attenuation in weaker materials (e.g., voids, broken or weathered rock, soil). Velocity tomography images represent the ground velocity as measured between seismic sources and receivers. Attenuation tomography images represent the relative attenuation rates within the surveyed area.

To determine the seismic velocities of a survey area, the time required for seismic energy to travel from known source and receiver locations is measured. The velocity is then computed by dividing the distance traveled from source to receiver by this travel time. In ground with a homogenous velocity distribution, this distance is simply a straight-line distance, or straight ray path, from the source to the receiver. However, in ground with velocity variations, this distance may significantly increase due to curvature of the ray path through higher velocity ground between the source and receiver. With appropriate source and receiver geometry, it is possible to iteratively construct an accurate velocity model of the ground surveyed. However, distortions in the velocity model may appear in varying degrees, as a consequence of the ground characteristics and the source and receiver geometry.



There are numerous factors that may cause variations in velocity and attenuation. Different ground types usually have different material/seismic properties, but variations within the same ground type are also commonly encountered. Variations in stress, fracture extent, water saturation, soil compaction, etc., all may have a significant effect on velocity and attenuation. In areas where geological features such as fracture zones, faults, subsidence zones, or cavities exist, the seismic waves may travel at a lower velocity, or may travel across an increased distance to pass around the anomaly and suffer increased attenuation. The same type of behavior may be noted in rocks of varying lithology as harder, more competent materials propagate seismic waves at higher velocity and lower attenuation than softer, less competent or less consolidated rocks.

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