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SEISMIC REFRACTION AND REFLECTION

Introduction

Seismic techniques are commonly used to determine site geology, stratigraphy, and rock quality. These techniques provide detailed information about subsurface layering and rock geomechanical properties using seismic acoustical waves. Reflection and Refraction are the most commonly used seismic techniques. These methods determine geological structure and rock velocities by either refracting or reflecting waves off boundaries between rock units with different seismic velocities or impedience.

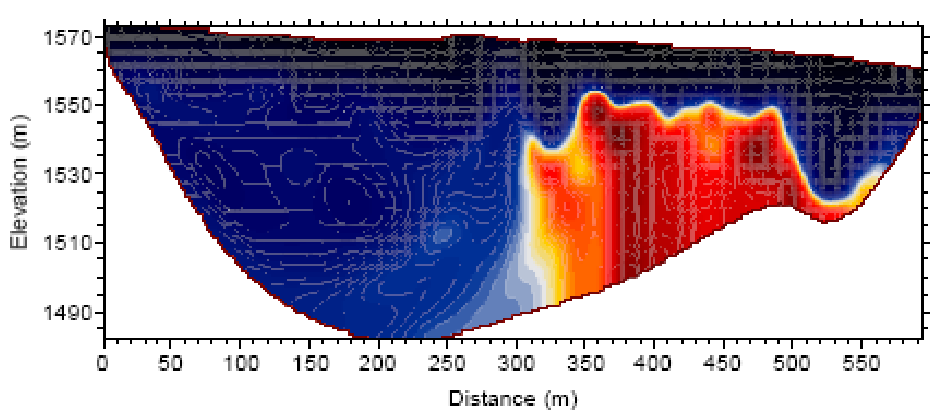
Seismic Applications Include:

- **a)** General geologic structure
- **b)** Faults and other hazards
- **c)** Landfill investigations
- **d)** Overburden thickness
- **e)** Rock rippability and quality
- **f)** Water table depth
- **g)** Bedrock depth

Seismic Refraction

Seismic refraction investigates the subsurface by generating arrival time and offset distance information to determine the path and velocity of the elastic disturbance in the ground. The disturbance is created by shot, hammer, weight drop, or some other comparable method for putting impulsive energy into the ground. Detectors, laid out at regular intervals, measure the first arrival of the energy and its time. The data are plotted in time – distance graphs from which the velocities of the different layers, and their depths can be calculated. This is possible because rays (a continuum points on the expanding wave front) of the disturbance wave follow a direct route and is the first arrival energy at the close–in geophones. The rays are refracted across layer boundaries where there is a difference in elastic and density properties. The critically refracted ray travels along the layer interface, at the speed of the lower layer, and continuously "feeds" energy back to the surface, to be successfully detected by the line of geophones. At some distance the refracted ray becomes the first arrival.

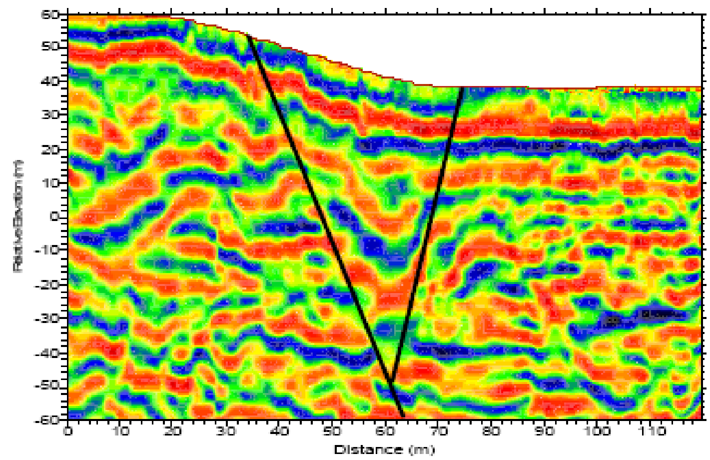
Shots are normally collected at evenly spaced intervals throughout the entire length of the line in order to increase coverage and generally determine whether or not the layering is horizontal, dipping or undulating. The acquired data are computationally intense. A ray–tracing computer program is used to iteratively honor all travel times and velocities, and to be able to consider a large number of layers or velocity contrasts where they are present. A first energy arrival picking program, with such features as zoom, filtering, time stretching, separation of traces, AGC and balancing of traces, is also applied.



Seismic refraction tomography of a salt diaper in central Utah. Hot colors correspond to higher velocities, i.e. salt. Cooler colors delineate shale.

Seismic Reflection

Seismic Reflection follows the law of mirror images – the angle of reflection from a surface is equal to the angle of incidence. Shots are fired, in turn, at each of the geophone positions and active geophones are progressively added ahead of the shots, and taken up from behind the shots, in a roll–along fashion. At each subsurface boundary, across which the elastic and density parameters differ, a percentage of the energy in the wave is reflected back to the surface where it is recorded. If a particular boundary is horizontal, the reflection point will be half way between the shot and any given geophone. Reflecting boundaries are mapped out as the system rolls along. Placing each reflection point in its proper place in the subsurface requires intense and complicated processing of the collected information.



Seismic reflection plot of the Wasatch Fault in northern Utah. Indicated are the main normal fault and an associated antithetic fault.