SEISMIC REFRACTION SURVEY

Methodology

The seismic refraction (SR) method provides information regarding the seismic velocity structure of the subsurface. An impulsive (mechanical or explosive) source is used to produce compressional (P) wave seismic energy. The P-waves propagate into the earth and are refracted along interfaces representing an increase in velocity. A portion of the P-wave energy is refracted back to the surface where it is detected by sensors (geophones) that are coupled to the ground surface in a collinear array (spread). The detected signals are recorded on a multi-channel seismograph and are analyzed to determine the shot point-to-geophone travel times. These data can be used along with the corresponding shot point-to-geophone distances to determine the depth, thickness, and velocity of subsurface seismic layers. The SR technique is based on several assumptions. Paramount among these are:

1) that seismic velocity increases with depth, and,
2) that the velocity of each seismic layer is uniform over the length of the given spread.

In cases where these assumptions do not hold, the accuracy of the technique decreases. For example, if a low velocity layer occurs between two layers of higher velocity, the low velocity layer will not be detected and the depth to the underlying high velocity layer will be erroneously large. Also, if the velocity of a seismic layer varies laterally within a spread, those variations will be interpreted as fluctuations in the elevation of the underlying seismic layer.

Instrumentation

Data acquisition is initiated along each SR line by producing seismic energy using either a 100 or 200lb accelerated weight drop mounted on an all terrain vehicle. The resulting seismic wave forms are recorded using a Geometrics 24-channel engineering seismograph and Mark Products geophones with a natural frequency of 10 Hz. The data are recorded on hard copy records (seismograms) as well as on computer disks for future processing. The seismograms can be analyzed to determine the amount of time it takes for a compression (P) wave to travel from a given shot point to each geophone in a spread.

Data Analysis

The seismic data are downloaded to a computer and processed using the program SEISIMAGER by Geometrics to determine the shot point to geophone travel times. These values are then plotted versus the shot point to geophone distances to form time versus distance graphs. By examining the distribution of the data points, the number of seismic velocity layers and the travel times associated with each layer are determined. Along with the elevation of each shot point and

geophone these data are then used to compute a preliminary velocity model using the "time term" method. This model then serves as a starting point for the programs tomographic ray-tracing procedure. The final result is a color contoured velocity model consisting of as many as 15 layers.

Limitations

In general, there are limitations unique to the SR method. These limitations are primarily based on assumptions that are made by the data analysis routine. First, the data analysis routine assumes that the velocities along the length of each spread are uniform. Any localized zones within each layer where the velocities are higher or lower than indicated, will cause travel time variations that will be interpreted as changes in the surface topography of the underlying layer. For example, a zone of higher velocity material would be interpreted as a topographic low in the surface of the underlying layer. A zone of lower velocity material would be interpreted as a topographic high in the underlying layer. Second, the data analysis routine assumes that the velocity of subsurface materials increase with depth. Therefore, if a layer has a lower velocity than that of the overlying layer, the low velocity layer will not be resolved. Furthermore, the computed depth of the next layer down will be erroneously large. Also, a velocity layer may simply be too thin to be detected. Due to these and other limitations inherent to the SR method, the results of the SR survey should be considered only as approximations of the subsurface conditions. The actual conditions may vary locally.