UNIVERSITY of HOUSTON

ALLIED GEOPHYSICAL LABORATORIES

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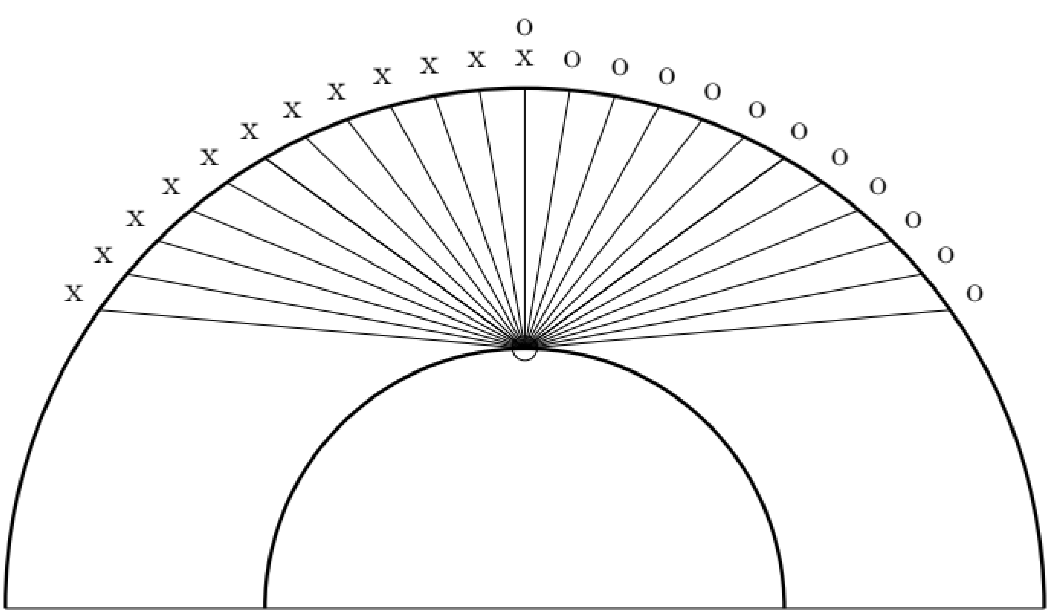
Summary

Reflection seismology has provided versatile and successful tools for creating high-resolution images of the subsurface for scientific and economic purposes. However, resource exploration has largely been limited to shallow depth ranges of Earth's upper crust. The Earth is composed of four major internal layers, a thin outer crust, variable mantle, liquid outer core, and a solid iron inner core. There are observable reflections from each of these layers. Modern knowledge of Earth's interior comes from observing these events on earthquake seismograms. But rather than reflection data processing, images from earthquake data are often created using seismic tomography.

Conventional seismic data processing methods generally use a Cartesian system, since exploration surveys are small relative to the circumference of the Earth (that is, any survey curvature is negligible). But since earthquakes are active on a global scale, a spherical coordinate system is more natural to accurately represent earthquake wave propagation and the Earth's structure. This requires adapting components of seismic data processing into spherical coordinates, the most fundamental of which is the normal moveout (NMO) correction. Our work has derived a new NMO equation for spherical geometries. Multiple datasets with spherical geometries including lab physical modeling, Enchanted Rock, Texas surveys, synthetic seismograms, and real earthquake data were acquired, generated, or retrieved to test our spherical processing algorithms.



Schematic diagram of a common midpoint (CMP) source-receiver configuration in a spherical geometry. At far offsets, ray paths will not be able to reach the CMP location without transmitting through a lower boundary. The Cartesian normal moveout equation only holds for flat layers, it must be modified to represent the travel-time pattern in spherical geometry.