

# The dimensions of seismic data

*Gluyas & Swarbrick analogy*

*Designation and History*

*Geometry & Time*

*Application*

**One-dimensional or 1D**  
(a.k.a. “checkshot survey” or “vertical seismic profile” or “Well shot”)

Geophones are placed at various depths down a borehole to record responses to shots fired at surface.  
Acoustic logs can also be used to generate a 1D understanding of variation in velocity.

Determination of sonic velocities of strata penetrated by hole, to allow more precise time-to-depth conversion of nearby 2D, 3D, and 4D data.

**Two-dimensional or 2D**  
used in the petroleum industry from the 1920s to the 1990s; thereafter largely supplanted by 3D seismic.

Geophones are placed along part a line on the Earth surface and a shot is fired from a location among those geophones and thus in that line. Geophones and shotpoint are then moved along the line many times.

Generation of one two-dimensional profile (a “seismic line”). Multiple intersecting lines allow line-to-line correlation (“tying in”) and, with interpretative contouring, generation of maps.

Looking at impressionist art.

**Three-dimensional or 3D**  
pioneered in petroleum industry the 1970s and dominant there by the early 2000s.

Geophones are placed in a two-dimensional array on the Earth surface and sequential shots are fired from a source that moves through the area of this array (but not necessarily shooting at the exact same locations of the individual geophones).

1. Generation of two-dimensional profiles that have undergone much more robust migration than those produced by 2D seismic.
2. Generation of profiles with close spacings and in numerous orientations (allowing the “movies” at right).
3. Generation of maps of contiguous data.

Watching a movie of one's virtual passage through the subsurface.

**Four-dimensional or 4D**  
(a.k.a. “Time-lapse seismic”)  
1980s onward

2 D or 3D surveys are repeated through time over a known accumulation while it is exploited. In good cases, geophone locations are identical through time; in ideal cases, geophones are fixed and remain in place for the lifetime of the survey.

Monitoring of changes of positions and pressures of fluids in reservoirs during exploitation, and even changes in reservoir rock itself.

Especially useful in production using water-flooding or steam-flooding, and thus in exploitation of tar sands.