Acoustic impedance is defined as the product of the p-wave velocity, and bulk density, . Shear impedance is defined as the product of the s-wave velocity, and bulk density, . Reflectivity, of an incident seismic wave at an interface across which there exists a contrast in acoustic impedance is given by the 3-term Shuey Equation which can be written in the following form:

R ( θ ) = R ( 0 ) + G sin 2 ⁡ θ + F ( tan 2 ⁡ θ − sin 2 ⁡ θ )

where,

R ( 0 ) = 1 2 ( Δ V P V P + Δ ρ ρ )

and

G = 1 2 Δ V P V P − 2 V S 2 V P 2 ( Δ ρ ρ + 2 Δ V S V S ) F = 1 2 Δ V P V P

where, , θ = angle of incidence; V p = p-wave velocity in the medium; Δ V p = p-wave velocity contrast across the interface; V s = s-wave velocity in medium; Δ V s = s-wave velocity contrast across interface; ρ = bulk density in medium; Δ ρ = bulk density contrast across interface.

, and where = p-wave velocity in the overburden, = s-wave velocity in the overburden and = bulk density in the overburden. The overburden, which is typically a shale, has a standard p-wave velocity of 2.5 km/s. The p-wave and s-wave velocities are related in shales by the following relationship: , where Vp and Vs are in km/s.

is also known as zero-incidence reflectivity or normal incidence reflectivity or intercept or ‘A’.

G is also known as gradient or ‘B’.

In the Shuey Equation, R(0) is the reflection coefficient at normal incidence and is controlled by the contrast in acoustic impedances. G, often referred to as the AVO gradient, describes the variation of reflection amplitudes at intermediate offsets and the third term, F, describes the behavior at large angles/far offsets that are close to the critical angle. This equation can be further simplified by assuming that the angle of incidence is less than 30 degrees (i.e. the offset is relatively small), so the third term will tend to zero. This is the case in most seismic surveys and gives the “Shuey Approximation”:

, which can also be written as

Guidelines for interpreting AVO intercept and gradient:

1. Class I AVO = Intercept is a positive value. Gradient is a negative value. Possibly a low porosity hydrocarbon bearing sand or a wet sand.
2. Class II AVO = Intercept is close to zero or a very low positive or a very low negative value. Gradient is a negative value. Could be a medium porosity hydrocarbon bearing sand or a wet sand.
3. Class III AVO = Intercept is a negative value. Gradient is a negative value. Could be a medium to high porosity gas sand.
4. Class IV AVO = Intercept is a negative value. Gradient is a positive value.

R ( θ ) = R ( 0 ) + G sin 2 ⁡ θ