With the velocity considered constant, the lengths of the sides of the triangles can be expressed in terms of the respective arrival times such that:

t_1 is the one-way first arrival time at G1

t_2 is the one-way first arrival time at G2

t_3 is the arrival time of the reflection from the dipping interface at G1 (equivalent to path G1-I)

t_4 is the arrival time of the reflection from the dipping interface at G2 (equivalent to path G2-I)

t_5 is the travel time over the distance S-I

Using the cosine rule in triangle G1-G2-I, gives

$$\cos\theta = \frac{t_3^2 + (t_1 - t_2)^2 - t_4^2}{2t_3(t_1 - t_2)}$$

Hence the angle θ may be calculated.

Using the cosine rule in triangle S-G1-I, gives

$$t_5^2 = t_1^2 + t_3^2 - 2t_1 t_3 \cos\theta$$

Hence t_5 may be calculated.

Using the sine rule in triangle S-G1-I gives

$$\frac{t_3}{\sin\alpha} = \frac{t_5}{\sin\theta}$$

Therefore the angle of dip is

$$\alpha = \sin^{-1}\left(\frac{t_3 \sin\theta}{t_5}\right)$$

Method of calculation

To calculate the dip of any primary reflection observed on VSP data times t_1, t_2, t_3 and t_4 are required. These values can be obtained from a combination of the computation sheet (supplied with the Log Calibration report if available, or alternatively with the VSP report) and deconvolved upgoing wavefield display.

Given a dipping primary reflection observed on the deconvolved upgoing wavefield, choose a pair of geophone traces to be used in the dip calculation.

It is advisable that the estimate be made as close to the time-depth curve as possible as the Δt due to dip is at its greatest for any given geophone spacing when the geophone is closest to the reflector in question.