Dectection and quantification of interbed multiple from VSP downgoing wavetrain.

Principles

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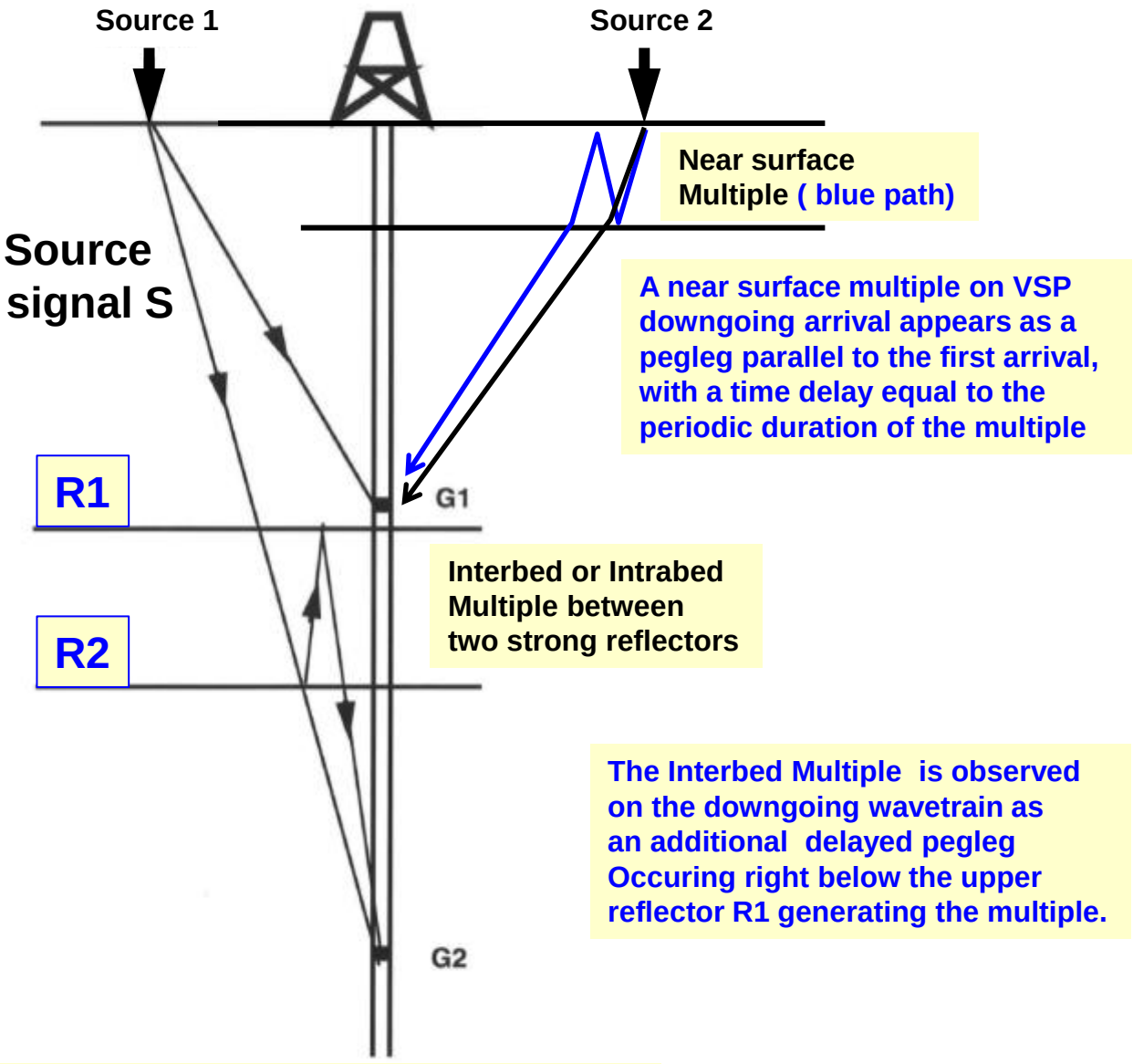
(1a) Onshore Seismic propagation Multiples:

1) A near surface multiple can be generated between the base of the Low Velocity Zone and Ground Level
2) An interbed or intrabed multiple may occur between TWO deep strong reflectors R1, R2
3) Sometimes, long period multiples may occur between a strong, deep reflector and the surface…

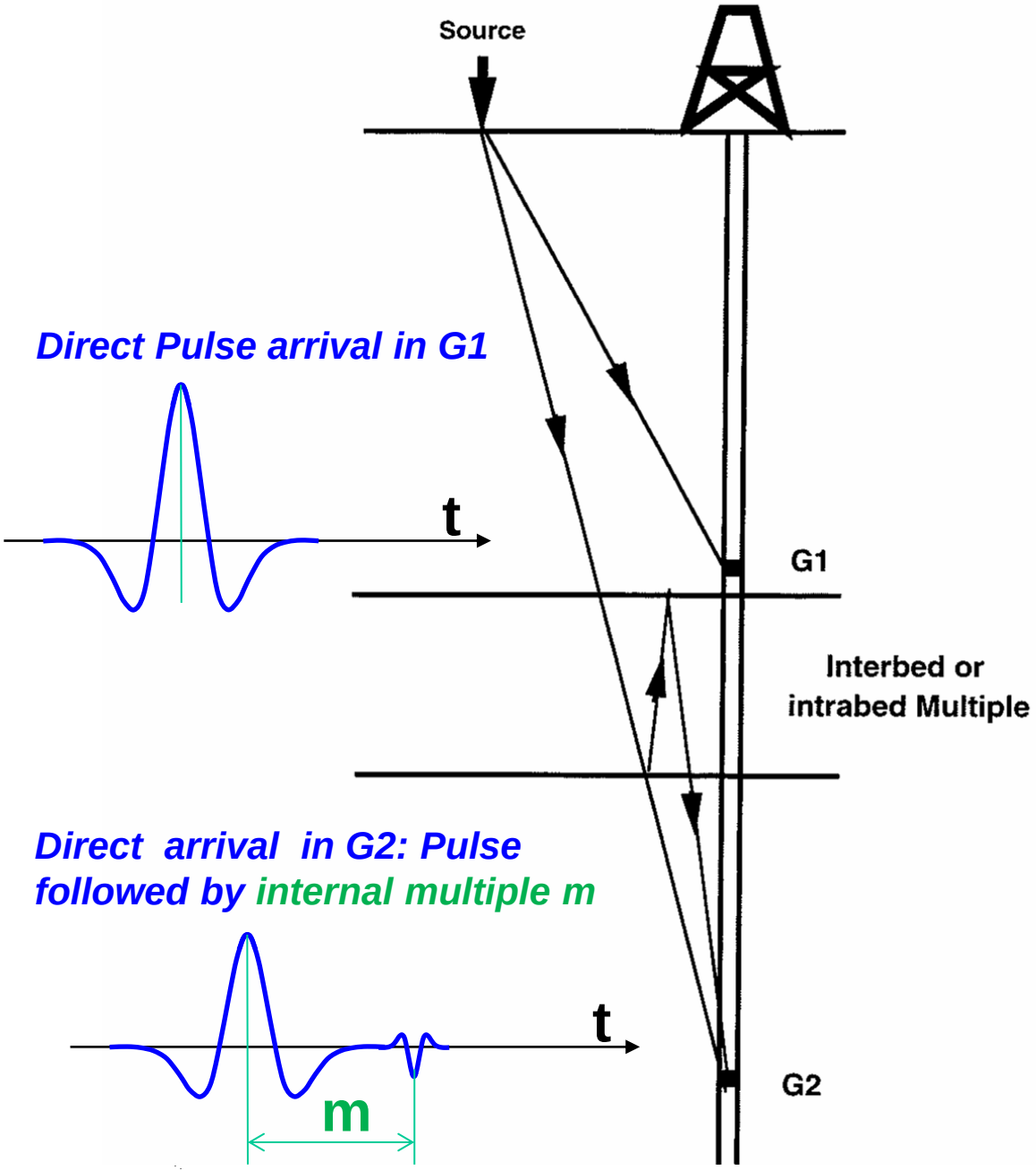


When processing the VSP data:

All short period multiples are cancelled out by the common shaping deconvolution of the upgoing wavefield by the downgoing incident wavelet in a thin the corridor stack domain ONLY, for instance within 50ms after Direct VSP arrival. But longer period multiple may NOT BE eliminated.

(1b) Downgoing propagation in VSP

Detection of transmission changes



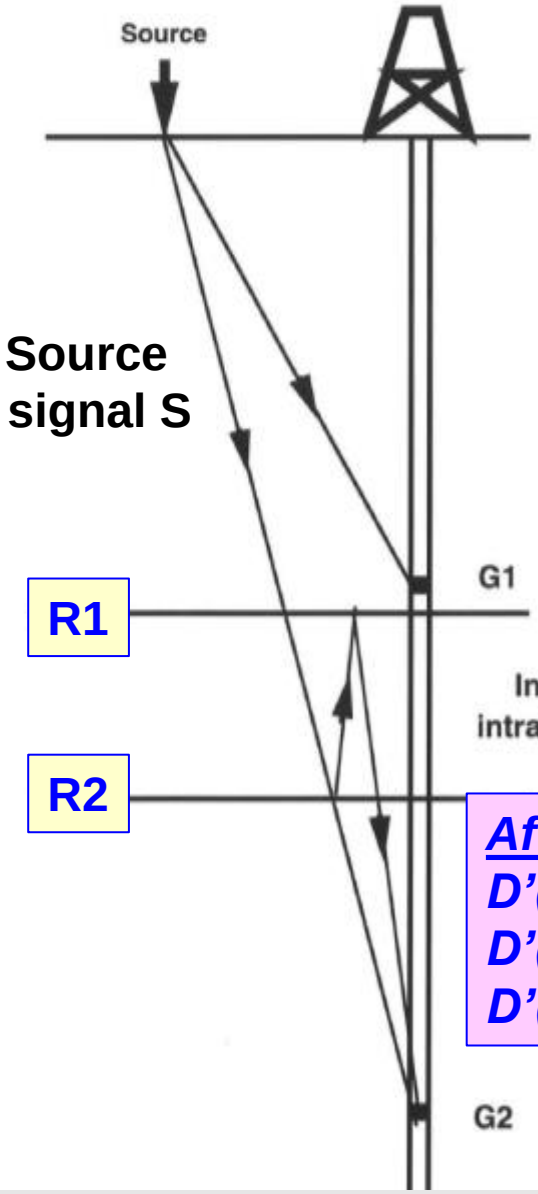
The transmission filter can be calculated from the VSP downgoing wave by signature shaping deconvolution of the deep wavelet recorded on G2 by a wavelet recorded on G1 above:

The changes in phase and amplitude, as well as all the multiples generated between G1 and G2 are expressed by the transmission filter.

(1c) Computing the transfer function

between two downhole VSP sensor stations,

as the response to a band limited zero phase PULSE



Dowgoing signal D(G) recorded by sensors G1, G2

$D(G1) = S$

$D(G2) = S * (1 + M)^{-1}$

with $M = R1.R2.\delta(gap)$

gap = period of multiple

$\delta(t)$ = time shift (t)

(Dirac delta function)

$D(G1) = S$

After deconvolution by D(G1):

$D'(G1) = I$: *Zero phase PULSE*

$D'(G2) = I/(1 + M)$

$D'(G2) \sim 1 - M$: *Transfer function*

$D(G2) = S/(1 + M)$

The transmission filter can be calculated from the VSP downgoing wave by signature shaping deconvolution of the deep wavelet recorded on G2 by a wavelet recorded on G1 above:

The changes in phase and amplitude, as well as all the multiples generated between G1 and G2 are expressed by the transmission filter.

(2) Deep reflections altered by interbed multiples, in VSP or surface seismic .

Expression of reflected signals R(G1) & R(G2) from deep R3 reflector(s) recorded at VSP stations G1 and G2