

Seismic Imaging Ahead of the Tunnel Face

Back ground and objective

Comprehending geological condition ahead of tunnel face is necessary to excavate a tunnel safely and economically.

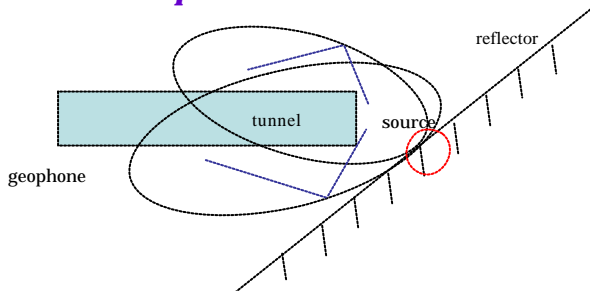


It is important to survey ahead of tunnel face before tunnel excavation.



Equi-travel time method

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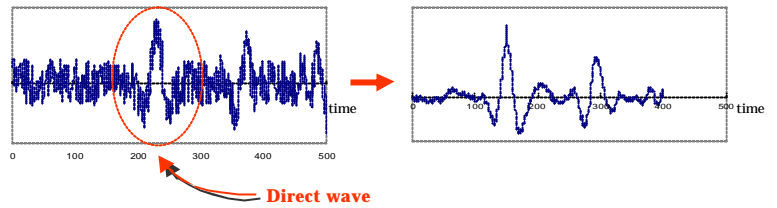


Reflection point ahead of tunnel face is on equi-travel time planes. Consequently, representing a number of equi-travel time planes can enhance the reflection point. That stacking point is true reflection point.

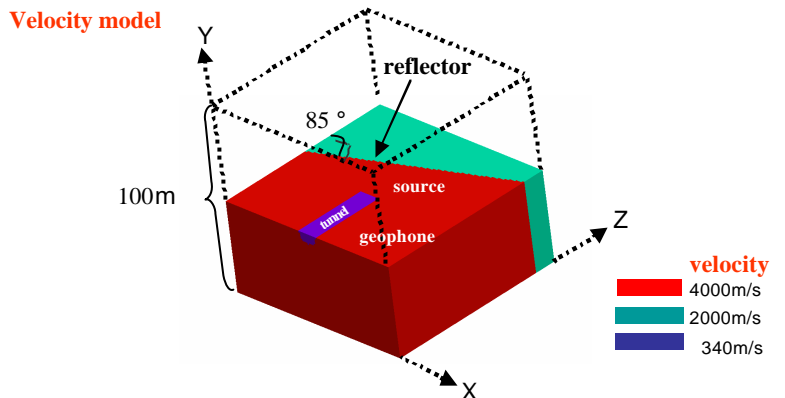
Cross-correlation function

$$Z(t) = \frac{1}{N} \sum_{n=0}^{N-1} X_n \cdot Y_{n+t}$$

N : number of data
 t : time lag
 X_n : data
 Y_n : data (the wave which is directly propagated to geophone)



Application to numerical simulation data



The improvement of Equi-travel time method

The appearance of the false imaging by using single component data



Emphasis around true reflection point using 3-component data

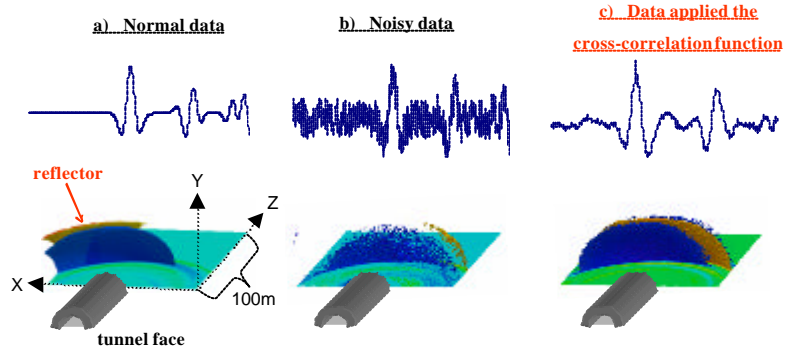


But three component data estimate incident direction of reflected wave from amplitude. So it is difficult to estimate incident direction from noisy data.



Applying **cross-correlation function** to improve specification of incident direction using three-component data

Imaging results



Noise filter

Data

Conventional noise filter

Automatic gain control

Band pass filter

Deconvolution filter

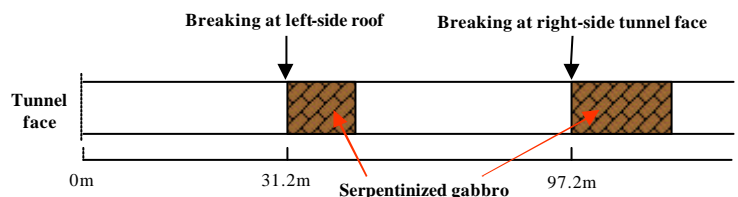
Cross-correlation function

Equi-travel time method

Evolution of the ahead of tunnel face

Application to field data

Geological condition



Imaging results

