How resolving are teleseismic forward and backscattered P to S converted waves?

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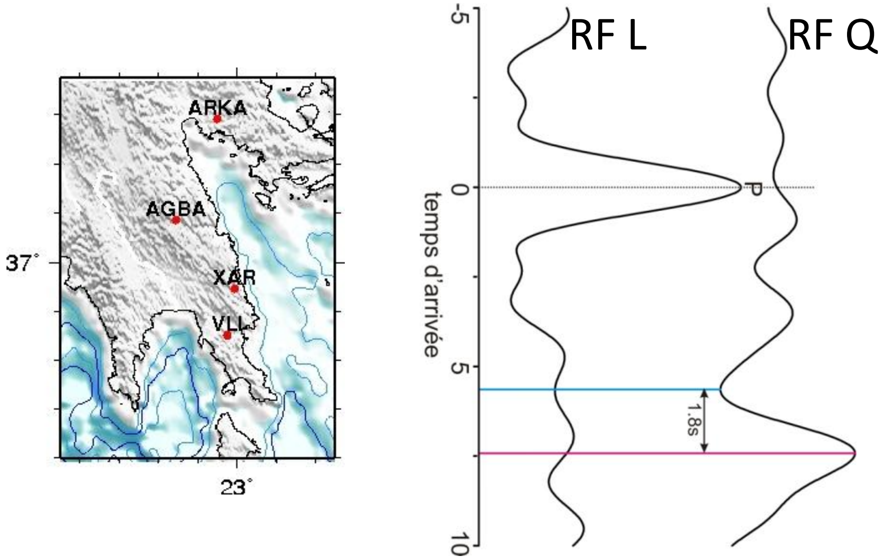
Receiver function example

○ Hellenic subduction zone

- Receiver functions (RF) technique widely used to image the subducting crust which is identified as a Low Velocity Layer (LVL)
- The LVL appears as a trough followed by a peak on the RF
- The spacing between trough and peak is related to the LVL thickness and Vp/Vs ratio inside the LVL
- In several subduction zones, high Vp/Vs estimated from RF

RF obtained for an earthquake recorded at the VLI station with a common filter between 3 et 13s



Spacing between trough and peak Δt=1.8 s
⬄LVL thickness = 15 km

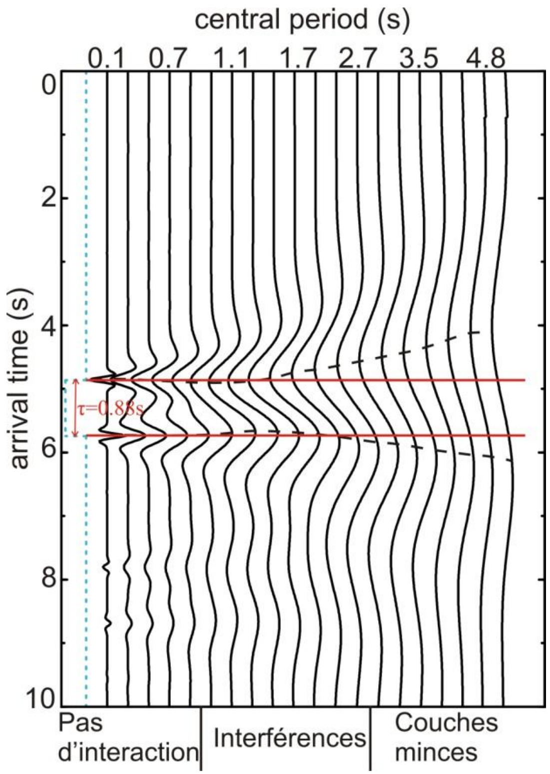
->Typical oceanic crust has a thickness of 7-8 km

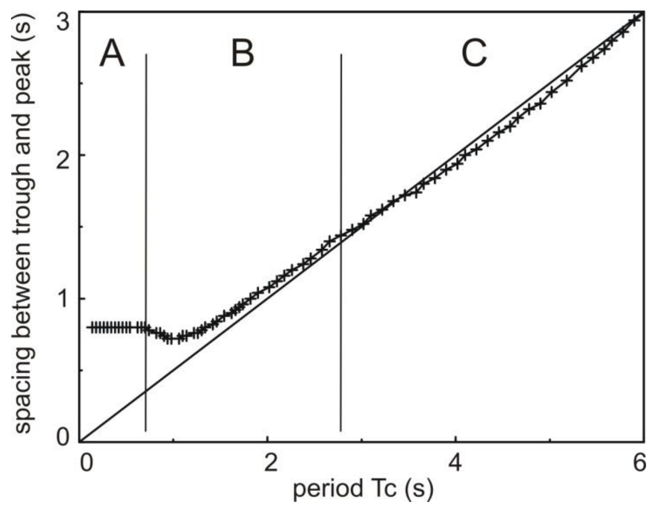
=> Below Peloponnesus : not an oceanic crust, high Vp/Vs inside the crust **or lack of resolution** ?

Multiscale analysis

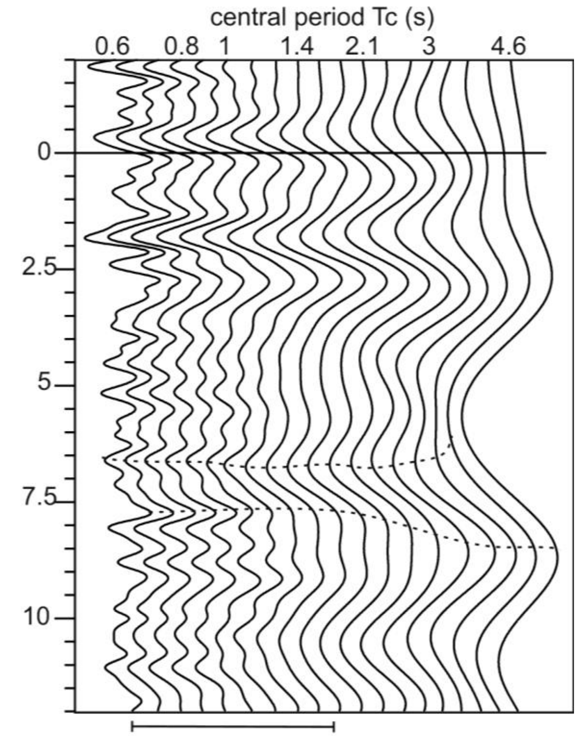
○Sensitivity to frequency ⇔ wavelet response in conversion

Synthetic RF for a family of wavelets for a typical oceanic crust

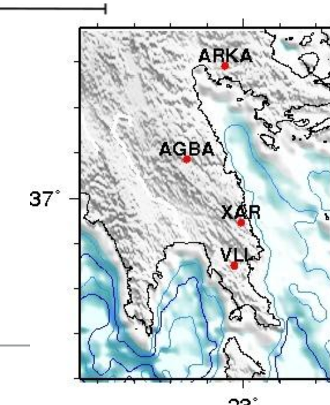




Real data (XAR station)



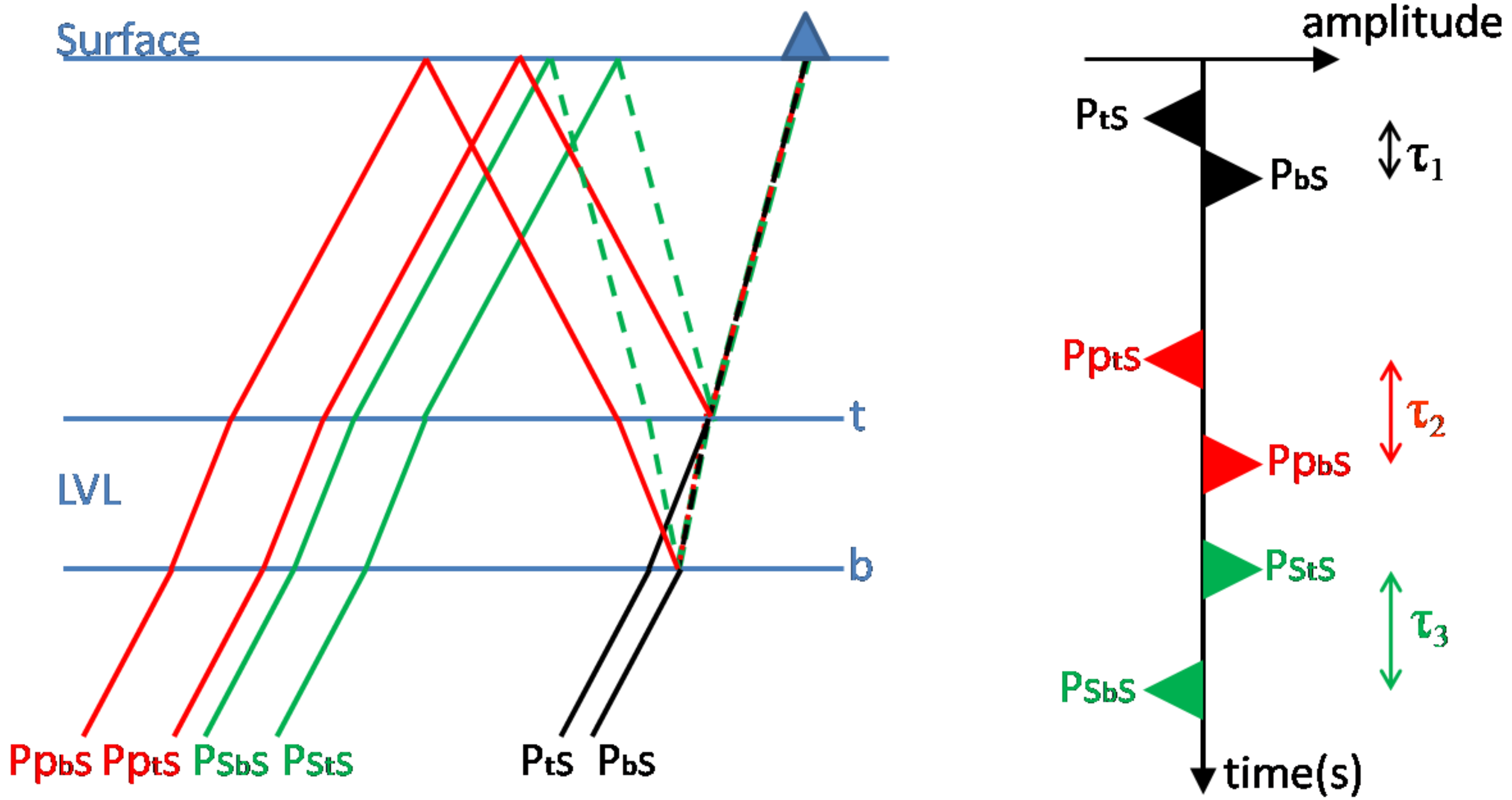
- Dominant period T_b < 0.9 s required to identify an oceanic crust
- Common processing : apparent thickness twice the true one!
- Typical oceanic crust subducting below Eastern Peloponnesus



Gesret et. al., 2010

Multiscale analysis

- Extension to backscattered waves



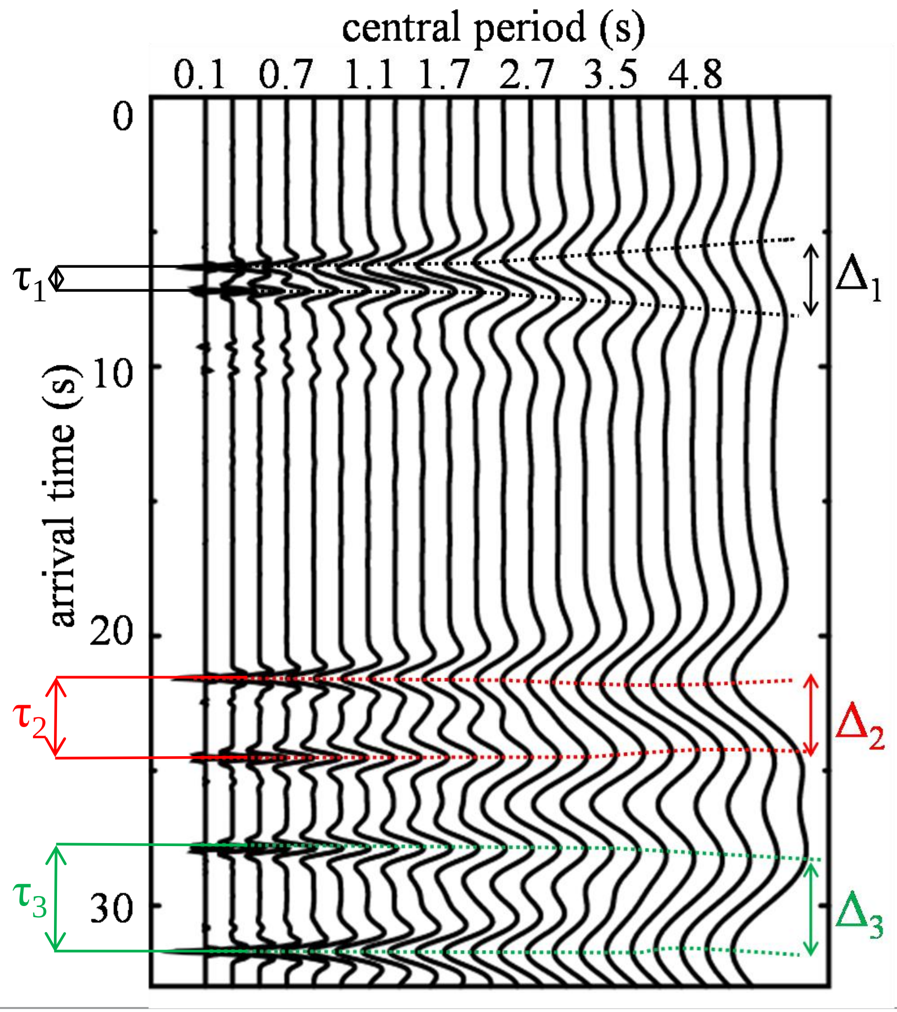
$$\tau_1 = d \times \left(\sqrt{\frac{1}{V_S^2} - p^2} - \sqrt{\frac{1}{V_P^2} - p^2} \right) \qquad \tau_2 = d \times \left(\sqrt{\frac{1}{V_S^2} - p^2} + \sqrt{\frac{1}{V_P^2} - p^2} \right) \qquad \tau_3 = 2d \times \left(\sqrt{\frac{1}{V_S^2} - p^2} \right)$$

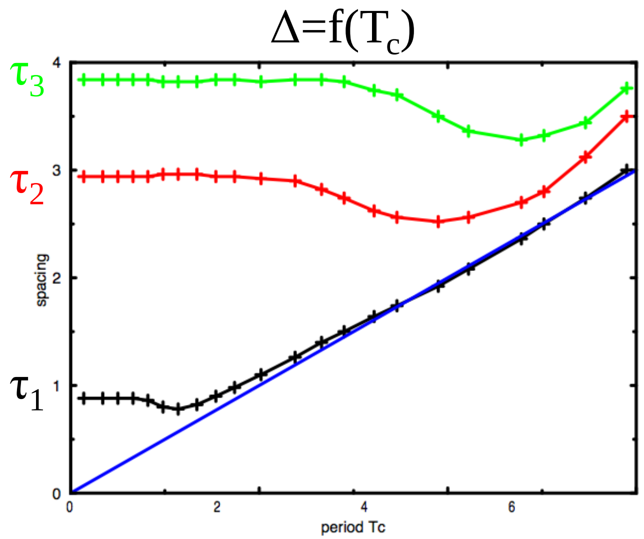
Ratios between theoretical time delays τ_2/τ_1, τ_3/τ_1, τ_3/τ_2 do not depend on LVL thickness

Multiscale analysis

○Extension to backscattered waves

Synthetic forward and backscattered converted waves for a family of wavelets for a typical oceanic crust



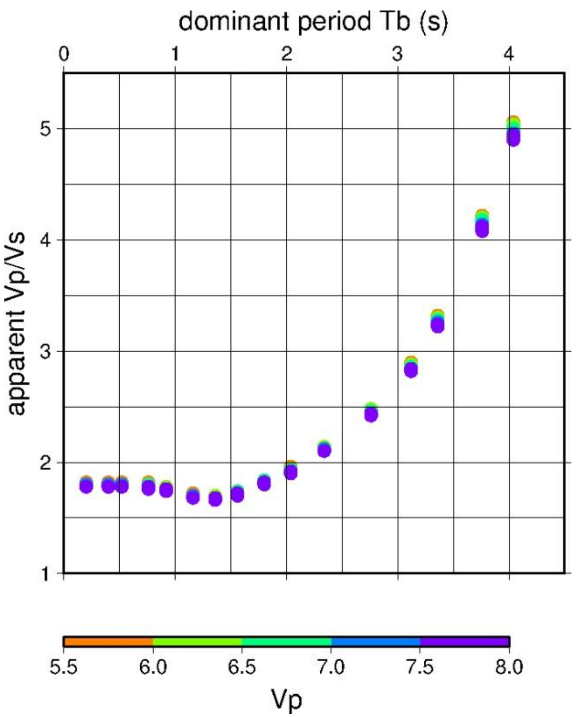


- In the non interaction domain, measured spacing Δ = theoretical time delay τ
- Backscattered waves (Pps,Pss) have a better resolution
- But Vp/Vs ratio deduced from spacing ratios Δ_2/Δ_1, Δ_3/Δ_1, Δ_3/Δ_2, generally Δ_2/Δ_1

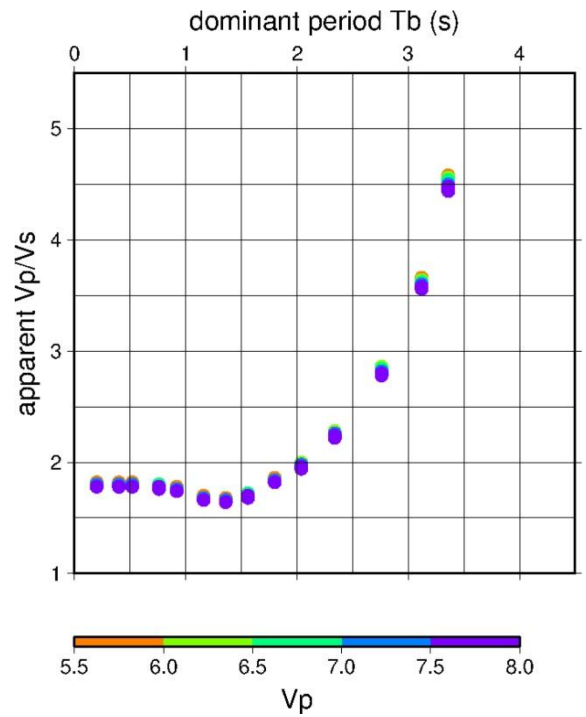
Multiscale analysis

- Extension to backscattered waves

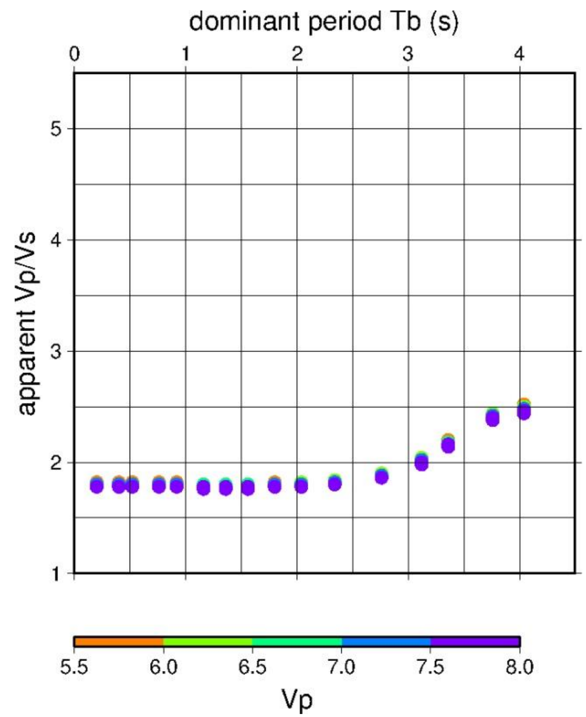
Vp/Vs deduced from observed spacing ratios $\mathbf{\Delta_2/\Delta_1}$, Δ_3/Δ_1, Δ_3/Δ_2



deduced from $\mathbf{\Delta_2/\Delta_1}$



deduced from Δ_3/Δ_1



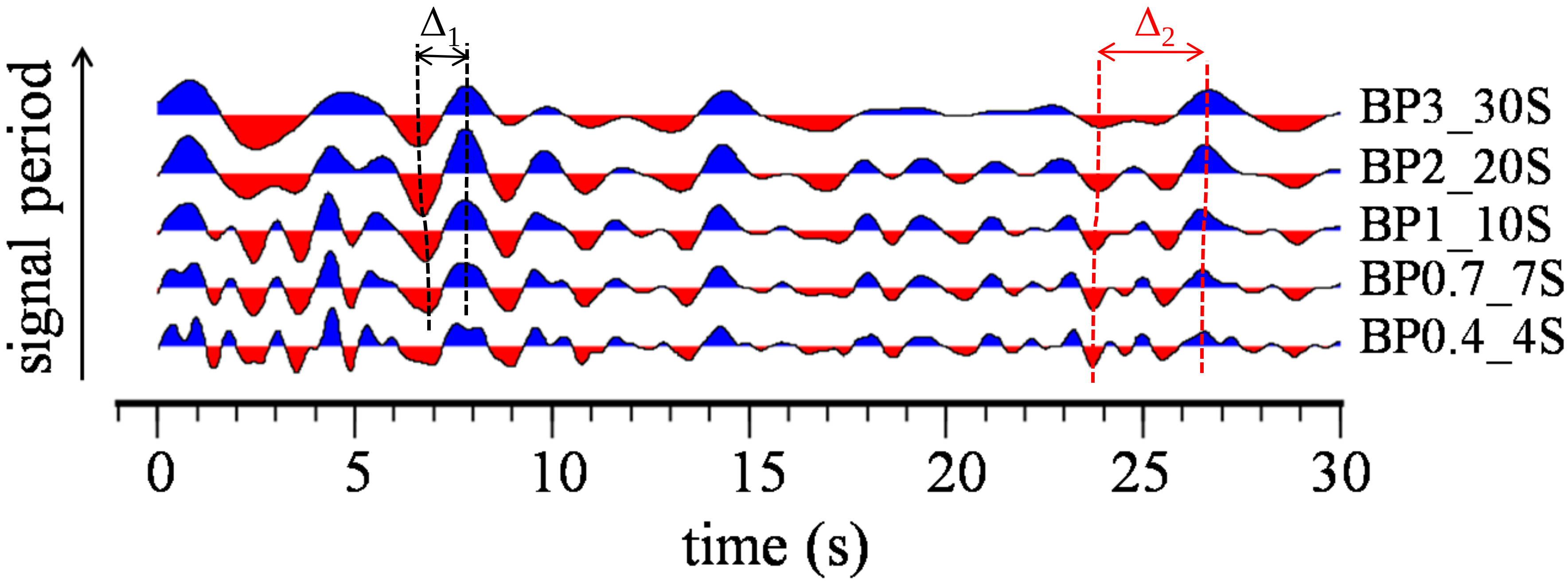
deduced from Δ_3/Δ_2

=> Overestimation of Vp/Vs for common filters!

Multiscale analysis

○Application to real data

Multiscale analysis for a stack of earthquakes recorded to the SERG station of the Corinth Rift Laboratory



- Vp/Vs deduced from Δ_2/Δ_1
- At low frequency, Vp/Vs ≈ 2.4 whereas at high frequency, Vp/Vs ≈ 1.8
- **Hellenic subduction => oceanic crust ≈ 7km thick with Vp/Vs ≈ 1.8**