Calculation of average Vp/Vs and Thickness of Crust

1. Simple H-k stack

$$\frac{Vp}{Vs} = \left[(1 - p^2 Vp^2) \left\{ 2 \left(\frac{t_{Ps} - t_P}{t_{PpPs} - t_{Ps}} \right) + 1 \right\}^2 + p^2 Vp^2 \right]^{1/2}$$

$$t_1 = t_{Ps} - t_P = H \left[\sqrt{Vs^{-2} - p^2} - \sqrt{Vp^{-2} - p^2} \right]$$
$$t_2 = t_{PpPs} - t_P = H \left[\sqrt{Vs^{-2} - p^2} + \sqrt{Vp^{-2} - p^2} \right]$$
$$t_2 = t_{PpSs} - t_P = 2H \sqrt{Vs^{-2} - p^2}$$

2. Moho depth and average *Vp/Vs* ratio estimation

To obtain Moho depth (*H*) and average *Vp/Vs* ratio (or Poisson's ratio σ), *H-Vp/Vs* stacking technique of *Zhu and Kanamori* (2000) is used, which exploits the fact that arrival times and amplitude of specific Moho converted phases and multiples appearing on radial receiver functions are determined by known functions of Moho depth (*H*), *Vp/Vs* ratio and average *Vp* in the crust. Since travel times used for crustal receiver function analysis are much less sensitive to *Vp* than to *Vs* (*Zhu and Kanamori*, 2000), an average *Vp* for the entire crust from previously obtained seismic source studies in the region is assumed. For a near true combination of *H* and *Vp/Vs* ratio value, the weighted sum of the receiver function amplitude, defined as *S(H,Vp/Vs),* at the calculated times of predicted arrivals of *Ps*, *PpPms* and *PpSms+PsPms* phases would be expected to be maximum.

$$S(H, Vp/Vs) = \sum_{j=1}^{N} [w_1 r_j(t_1) + w_2 r_j(t_2) + w_3 r_j(t_3)],$$

where $r_j(t)$ is the amplitude of receiver function for the j^{th} event, t_1, t_2, t_3 are predicted *Ps*, *PpPms* and *PpSms+PsPms* arrival times corresponding to Moho depth *H* and *Vp/Vs* ratio and N is the total number of receiver functions. The weighting factors w_i's are chosen such that $\sum w_i = 1$, and

$$t_1 = H[\sqrt{Vs^{-2} - p^2} - \sqrt{Vp^{-2} - p^2}]$$

$$t_2 = H[\sqrt{Vs^{-2} - p^2} + \sqrt{Vp^{-2} - p^2}]$$

$$t_3 = 2H\sqrt{Vs^{-2} - p^2}$$

w_1, w_2 and w_3 are chosen to balance contribution from the 3 phases in receiver function. Among the phases, *Ps* has higher amplitude over *PpPms* and *PpSms* and accordingly it has been assigned higher weight than the other two. A grid search through H and Vp/Vs parameter space is performed, and the parameter value corresponding to the maximum value of $S(H,Vp/Vs)$ can be considered as the best estimate. Based on the modeling of previous studies average crustal P wave velocity (Vp) is chosen to be 6.4 km/s. H and Vp/Vs ratio are allowed to vary from 20-80 km (with 0.05 km increment) and 1.6-2.0 (with 0.002 increment) respectively. $w_1 > w_2+w_3$ was set because the later two phases have similar slope in H-Vp/Vs plane. In the computation, $w_1 = 0.6$, $w_2 = 0.3$ and $w_3 = 0.1$ are used. The station, where the multiples (in particular, *PpPms*) are not clear, Vp/Vs ratio is taken from the neighbouring station.

Poisson's ratio is more useful tool to provide crustal composition than either Vp or Vs alone (*Christensen*, 1996). Poisson's ratio for solids theoretically falls between 0 and 0.5. Materials without rigidity (e.g., perfect liquids) as well as incompressible solids, have $\sigma = 0.5$. Poisson's ratio can be calculated from Vp/Vs as follows:

$$\sigma = 0.5[1 - \frac{1}{\left(Vp^2/Vs^2\right) - 1}]$$