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Moho depth variation in southern California from teleseismic receiver functions

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Abstract. The number of broadband three-component seismic stations in southern California has more than tripled recently. In this study we use the teleseismic receiver function technique to determine the crustal thicknesses and V_p/V_s ratios for these stations and map out the lateral variation of Moho depth under southern California. It is shown that a receiver function can provide a very good "point" measurement of crustal thickness under a broadband station and is not sensitive to crustal P velocity. However, the crustal thickness estimated only from the delay time of the Moho P-to-S converted phase trades off strongly with the crustal V_p/V_s ratio. The ambiguity can be reduced significantly by incorporating the later multiple converted phases. We propose a stacking algorithm which sums the amplitudes of receiver function at the predicted arrival times of these phases by different crustal thicknesses H and V_p/V_s ratios. This transforms the time domain receiver functions directly into the H-V_p/V_s domain without need to identify these phases and to pick their arrival times. The best estimations of crustal thickness and V_p/V_s ratio are found when the three phases are stacked coherently. Applying this technique to 84 digital broadband stations in southern California reveals that the Moho depth is 29 km on average and varies from 21 to 37 km. Deeper Mohos are found under the eastern Transverse Range, the Peninsular Range, and the Sierra Nevada Range. The central Transverse Range, however, does not have a crustal root. Thin crusts exist in the Inner California Borderland (21–22 km) and the Salton Trough (22 km). The Moho is relatively flat at the average depth in the western and central Mojave Desert and becomes shallower to the east under the Eastern California Shear Zone (ECSZ). Southern California crust has an average V_p/V_s ratio of 1.78, with higher ratios of 1.8 to 1.85 in the mountain ranges with Mesozoic basement and lower ratios in the Mojave Block except for the ECSZ, where the ratio increases.

1. Introduction

The Mohorovicic discontinuity (Moho), which separates Earth's crust from the underlying mantle, represents a major change in seismic velocities, chemical compositions, and rheology. The depth of Moho is an important parameter to characterize the overall structure of a crust and can often be related to geology and