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Understanding seismic heterogenities in the lower mantle beneath the Americas from seismic tomography and plate tectonic history

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We combine results from seismic tomography and plate motion history to investigate the slabs of subducted lithosphere in the lower mantle beneath the Americas. We constructed models of 3-D variations in propagation speed of P and S waves through travel time inversion of P and S wave travel time. Using broadband waveform cross correlation, we measured 37,000 differential travel times (P1-P2 and S1-S2) for pairs of stations and 2,000 PcP-P and ScS-S times from single station records. The earthquakes and receivers are located along a wide corridor from Alaska to South America. We invert the data simultaneously to obtain P and S-wave velocity models. Synthetic tests were performed to assess image quality. We interpret slab structures and unravel subduction history by comparing our Vs tomographic images with reconstructed plate motion from present-day up to 100 Ma. Convergence of the Pacific with respect to North and South America is computed using two approaches: (1) by considering the Pacific and Indo-Atlantic hotspot reference frames and (2) by using the plate circuit passing through Antartica. There is little difference between the two approaches for ages yonger than 80Ma. In the upper part of the lower mantle we recognize the imprint of the most recent phase of the plate history. Around 800$\sim$km depth, four distinctive fast anomalies can be associated with subduction of the Nazca, Cocos, and Juan de Fuca plates beneath South, Central, and North America, respectivley, and of the Pacific plate beneath the Aleutian islands arc. The large fast anomalies in the lowermost

mantle, which is most pronounced in the S-wave models, can be associated with Late Cretaceous subduction of the Farallon plate beneath the Aleutian islands and most of the Americas, and perhaps with the Phoenix plate beneath the southern part of South America. Near 2,000 km depth, the images record the post-80∼My fragmentation of the proto Farallon plate into the Kula plate in the North and the Farallon plate in the North-East. Near 1,000 km depth, we infer separate fast anomalies interpreted as the Kula-Pacific, Juan de Fuca, and Farallon slabs. This interpretation is consistent with the volume and length of slabs estimated from the tomographic images and a plate history.