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S-to-P Receiver Function Analysis of The New Zealand Subduction Zone

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Subduction zone dynamics are important for a better understanding of a broad range of topics ranging from plate tectonics to natural hazards such as earthquakes and volcanoes. New Zealand is a seismically unique place, resting on the Hikurangi Subduction Zone. It experiences a large range of seismic phenomena from evidence of large megathrust events and slow slip activity, to active volcanism within the Taupo Volcanic Zone. Although much seismic imaging has been performed, S-to-P receiver functions can tightly constrain discontinuities and associated dynamics. Here we use S-to-P receiver functions to image lithospheric discontinuities beneath the North Island of New Zealand using IRIS-DMC and Geonet stations. We image the Moho at 15-25 km depth in the south by Wellington, with a second velocity increase with depth imaged just beneath at 40-50 km, possibly corresponding to the Moho of the downgoing plate. On the northern edge of the North Island by Auckland, the Moho is imaged at 20 +/- 5 km depth. Near Napier and Lake Taupo we image 2 positive discontinuities at 10 and 30 km depth, still beneath the upper plate potentially related to crustal layering or the magmatic plumbing system. This is in line with previous studies of the Moho, for example a collation of Moho estimates by Salmon et al. (2013) places the Moho in the region of 20-25 km depth for most of the North Island, except for some deeper phases in the very east and the most southwest. A negative phase corresponding to the lithosphere-asthenosphere boundary (LAB) of the upper plate is imaged at 60-70 km depth across portions of the North Island. The LAB of subducting Pacific Plate is imaged at 70-80 km with the exception of a gap in the LAB phase between 39° and 40° latitude and around 176° longitude corresponding to the mountain ranges of Kaweka Forest Park and Ruahīne Forest Park. We image a velocity increase directly beneath the LAB, potentially related to the base of a melt layer beneath the plate. Furthermore, this is consistent with the estimated thickness of the lithosphere (73 +/- 1 km), for instance from the active source estimates of Stern et al. (2015).