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Imaging megathrust zone and Yakutat/Pacific plate interface in Alaska subduction zone

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We image the subducted slab underneath a 450 km long transect of the Alaska subduction zone. Dense stations in southern Alaska are set up to investigate (1) the geometry and velocity structure of the downgoing plate and their relation to slab seismicity, and (2) the interplate coupled zone where the great 1964 (magnitude 9.3) had greatest rupture. The joint teleseismic migration of two array datasets (MOOS, Multidisciplinary Observations of Onshore Subduction, and BEAAR, Broadband Experiment Across the Alaska Range) based on teleseismic receiver functions (RFs) using the MOOS data reveal a shallow-dipping prominent low-velocity layer at ˜25-30 km depth in southern Alaska. Modeling of these RF amplitudes shows a thin ($<$6.5 km) low-velocity layer (shear wave velocity of ˜3 km/s), which is ˜20-30% slower than normal oceanic crustal velocities, between the subducted slab and the overriding North American plate. The observed low-velocity megathrust layer (with P-to-S velocity ratio (Vp/Vs) exceeding 2.0) may be due to a thick sediment input from the trench in combination of elevated pore fluid pressure in the channel. The subducted crust below the low-velocity channel has gabbroic velocities with a thickness of 11-12 km. Both velocities and thickness of the low-velocity channel abruptly increase as the slab bends in central Alaska, which agrees with previously published RF results. Our image also includes an unusually thick low-velocity crust subducting with a ˜20 degree dip down to 130 km depth at approximately 200 km inland beneath central Alaska. The unusual nature of this subducted segment has been suggested to be due to the subduction of the Yakutat terrane. We also show a clear image of the Yakutat and Pacific plate subduction beneath the Kenai Peninsula, and the along-strike boundary between them at megathrust depths. Our imaged western edge of the Yakutat terrane, at 25-30 km depth in the central Kenai along the megathrust, aligns with the western end of the geodetically locked patch with high slip deficit, and coincides with the boundary of aftershock events from the 1964 earthquake. It seems plausible that this sharp change in the nature of the downgoing plate controls the slip distribution of great earthquakes on this plate interface.

Keywords: Megathrust, Fault zone property, Yakutat terrane subduction