

Seismic velocity structure near 2020-2021 major earthquakes at the Alaska Peninsula

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Abstract

Historical megathrust earthquakes ruptured in spatially separated segments along the Alaska Peninsula. Significant seismic and geodetic differences have been reported in the Shumagin and Semidi segments, such as background seismicity, large megathrust earthquakes, plate coupling, and directions of the magnetic strips. In July 2020, an Mw 7.8 megathrust earthquake occurred in the Shumagin segment where it had not ruptured a great earthquake since at least the 1700s. Three months later in October 2020, an Mw 7.6 strike-slip earthquake occurred southwest of the Mw 7.8 event. It remains unclear why two large earthquakes with distinct focal mechanisms take place in the Shumagin Gap where the slab surface is dominantly creeping. In July 2021, an Mw 8.2 megathrust earthquake ruptured the Semidi segment, which was ruptured by an Mw 8.2 earthquake in 1938 and is characterized by moderate plate-coupling in recent years. Previous seismic studies have found along-strike changes in P-wave velocity of the subducted slab at the outer-rise region. However, it remains unclear whether there are structural differences in the Shumagin Gap and Semidi segment at depths around 30 km. In this study, we made use of the newly acquired seismic data from the Alaska Amphibious Community Seismic Experiment (AACSE), EarthScope USArray, and the Alaska regional network. We imaged Vp and Vp/Vs structures in the Alaska Peninsula to 200 km depth using a double-difference tomography method. In our results, we find that the entire rupture area of the 2020 Mw 7.8 Simeonof earthquake is confined in a relatively high Vp/Vs region, where the 2021 Mw 8.2 Chignik earthquake rupture zone has higher and heterogenous Vp/Vs ratios. Interestingly, the 2020 Mw 7.6 strike-slip earthquake is located at a boundary between high Vp/Vs in the west and low Vp/Vs in the east. The spatial correlation of the Vp/Vs structure with the recent large rupture zones can shed light on the roles of slab properties in controlling megathrust earthquakes.

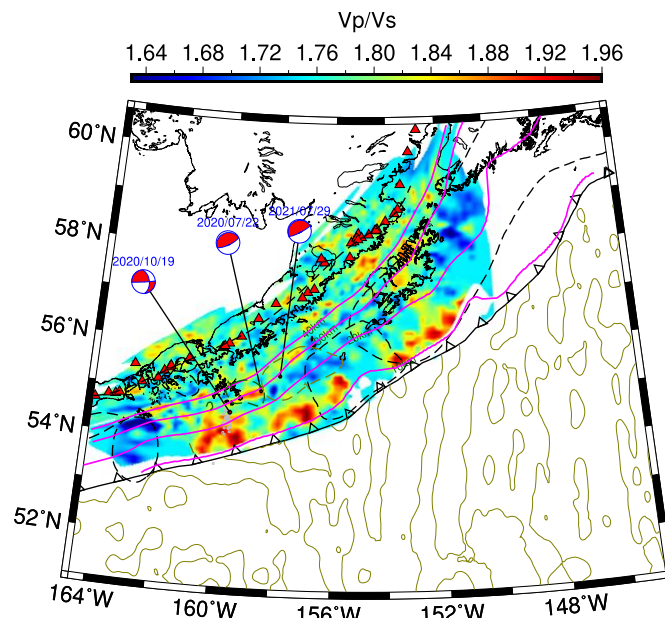


Figure 1. Vp/Vs structure at the slab surface. The depth contours of the slab2 model are plotted as the dashed magenta lines. The rupture areas of the 2020 M7.8 and 2021 M8.2 megathrust earthquakes are shown as dashed dark green and dark yellow lines.