Along-strike segmentation of Japan Trench and its relevance to co- and postseismic slip of the 2011 Tohoku Earthquake

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Remarkable variations along Japan Trench have been identified in seafloor topography, sub-seafloor seismic structure, and spatial distribution of interplate seismicity, and evident segmentation have been pointed out. We revisit the segmentation of the Tohoku forearc to see if the along-arc segmentation is relevant to the co- and postseismic behaviors of the subduction megathrust ruptured during the 2011 Tohoku earthquake. Prior to the occurrence of the 2011 earthquake, evident aseismic zone is recognized along the Japan Trench. The spatial extent the aseismic zone corresponds to that of material of low seismic velocity and low density along the plate boundary. In the southern part with broad aseismic zone, substantial afterslip on the shallow fault is evidenced by the seafloor geodetic data. Spatial extent of the pre-2011 aseismic zone coincides well to that of the afterslip zone. The correspondences between the low-V and low-density material distribution near the trench axis and the behavior of the plate boundary fault indicate that the material makes the fault to have velocity-strengthening character inhibiting interplate earthquake nucleation but allowing aseismic slip. The aseismic zone has the smallest downdip width in the central part of the Japan Trench, where coseismic slip breached to the trench axis, suggesting that along-strike variation of size of the velocity-strengthening zone controlled the rupture propagation during the 2011 mainshock. It seems there are systematic correlation between the along-strike variation of the segmentation pointed out here and regionality in recurrence cycles estimated from the palaeoseismological records recovered from the trench for past ~ 9,000 years. The segmentation might have been persistent and governed the earthquake cycle along the Japan Trench.

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