Low velocity zones along subducting plates: comparative study between southwest Japan and Cascadia subduction zones

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Low velocity zones (LVZs) along subducting oceanic plates are a ubiquitous feature of subduction zones worldwide. The LVZ has been interpreted as a hydrated oceanic crust from its high Vp/Vs ratio and is thought to affect generation of episodic tremor and slip (ETS) events. Southwest (SW) Japan and Cascadia subduction zones are well-investigated in terms of the LVZ properties. However, a direct comparison of LVZ properties between these subduction zones is difficult due to the difference in analysis methods: tomographic methods are often used in SW Japan, versus receiver function methods in Cascadia. In this study, we solve for LVZ properties beneath SW Japan through receiver function inversion analysis. This analysis optimizes model parameters (thickness, Vp/Vs ratio, dip angle and strike of layered structure) such that synthetic waveforms reproduce observed waveforms recorded by a linear array of seismographs installed in the Tokai region in 2008 (Kato et al., 2010, GRL). The results show that the LVZ is characterized higher Vp/Vs ratios (> 2.0) than previous estimates from tomographic analyses. In addition, the Vp/Vs ratio shows along-dip variation, culminating where ETS and long-term slow-slip events occur. This suggests that high pore fluid pressure plays an important role in generating ETS and long-term slow-slip events. A detailed look at high-frequency receiver function waveforms suggests that the LVZ is likely to be composed of two layers. Such high Vp/Vs ratios (> 2.0) and two-layer structure of the LVZ are also reported for Cascadia. However, whether along-dip variation of Vp/Vs ratio exists or not is still open question for Cascadia. Further efforts to reveal such variations at Cascadia is left for future study. Detailed comparison of LVZ properties may lead to improved understanding of ETS mechanisms.

Keywords: Subduction zone, Low velocity zone, Receiver function analysis

