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High-velocity anomaly accompanied with repeating earthquake beneath the eastern Kanto region, central Japan

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1. Introduction
The Pacific (PAC) and Philippine Sea (PHS) plates subduct beneath the Kanto region, central Japan. The repeating earthquakes at the plate boundary between the PHS and Eurasian (EUR) plates occur at depths of 40-60 km beneath the southwestern part of Ibaraki prefecture (Kimura et al., 2006) within the high-velocity (high-V) region (Matsubara et al., 2006). Extremely low-velocity (low-V) zone exists at depths of 40-70 km beneath eastern Kanto region. In this study, we analyze the 3D seismic velocity structure with the data of routine seismic network and discuss these characteristic structures with geological study.

2. Data & method
We analyze the three-dimensional seismic velocity structure with the NIED Hi-net data. The target region - 138-141E 34.5-37N - covers the Kanto region. We use 1,235,665 P- and 980,356 S -wave arrival time data obtained at 257 seismic stations from 30,755 earthquakes. We apply these data on seismic tomographic method (Zhao et al., 1992) with considering smoothing and station corrections at seismic stations (Matsubara et al., 2004; 2005).

3. High-V zone with the repeating earthquakes beneath the southwestern part of the Ibaraki prefecture
Velocity boundary between the northern high-V zone and southern low-V zone exists near the Tone River at depths of 15-40 km. This boundary is along the Tone Tectonic Line at the southern edge of the northeastern Japan arc which rotated anti-clockwise during the Japan Sea opening (Takahashi, 2006). There is the sedimentary basin between the northeastern and southwestern Japan arc owing to Japan Sea opening and consistent with the low-V zone.
The repeating earthquakes occur at depths of 40 km within the high-V zone 20 km away from the velocity boundary. There was a volcanic front at the eastern side of the Abukuma, Yamizo, and Tsukuba Mountain regions at 18-16 Ma (Takahashi, 2008). The volcanic front moved westward to the current location. The shallower edge of the repeating earthquakes in this region is consistent with the old volcanic front. There may be the remnant at the root of the old volcanic front as high-V zone and the repeating earthquakes occur where the high-V PHS plate encounter this high-V zone.
The low-V oceanic crust of the PHS plate is clearly imaged to depths around 40 km and high-V mantle is also imaged to depths around 60 km beneath the oceanic crust. The low-V oceanic crust becomes vague at the northeastern side of the Tone tectonic line and the repeating earthquakes occur at the contact zone of the high-V EUR and PHS plates. This zone is located at the western side of the old volcanic front and the shallower edge of the repeating earthquakes in this region is consistent with the Tone Tectonic Line.
The low-V oceanic crust at the uppermost part of the PHS plate reaches Gunma prefecture (Hori, 2006). The low-V oceanic crust may exist where the repeating earthquakes occur, however, it is vague in the tomographic result. The oceanic crust may be underplated to the upper EUR plate

and may become thin which is difficult to image by seismic tomography.

4. Extremely low-V zone beneath the eastern Kanto region at depth of 40-70km
This study reveal that this low-V zone has very low-Vp/Vs. Nakajima et al. (2009) estimated that there is serpentinized PHS plate with high-Vp/Vs. We examine Vs at this low-V zone with comparing the S-wave arrival time data from the two events at both ends of the low-V zone. The Vs is about 4.5 km/s and consistent with this study. This low-V zone has low-Vp/Vs not high-Vp/Vs. Then it is difficult to considering the existence of the serpentinized PHS plate.
The existence of the aqueous fluid is considered at the low-V and low-Vp/Vs zone in the crust beneath the northeastern and central Japan. The low-V zone beneath the eastern Kanto region is considered as the thick curing PHS plate owing to the subducting PAC plate. Some aqueous fluid can exist in the PHS plate.

Keywords: Philippine Sea plate, Tonegawa Tectonic Line, Philippine Sea plate,
Low-velocity and low-Vp/Vs region, fluid in the crust, Seismic tomography