Seismotectonics in the complex subduction system beneath Tokyo

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To interpret the features of the Kanto triple junction region, we examined 300,000 earthquake hypocenters in a 3D GIS and carried out a tomographic inversion using numerous seismic ray paths. As the result of these analyses, we identify several new features of the Kanto triple junction. First, a 25-km-thick, 90 x 120-km-wide enclosed volume of seismicity with high seismic velocity lies between the Pacific (PAC) and the Eurasian (EUR) plates beneath the Kanto Plain, which we interpret to be a lithospheric fragment wedged from the descending PAC. Second, we find that the leading edge of the Philippine Sea plate (PHS) lies at 35 km depth and abuts the southern margin of the block. Third, there is a pronounced bend to the double seismic zone defining the descending PAC slab, which closely parallels the sharp curvature of the volcanic front. Because of the bend, the PAC/EUR contact at shallow depth is nearly flat-lying, and undergoes episodic aseismic slip unaccompanied by large subduction earthquakes.

The slab fragment may explain several features of earthquake occurrence under the Kanto Plain. The enigmatic Kanto seismic corridor extending 100 km north from Tokyo Bay appears to result from frictional contact of the PAC and PHS with the fragment Within the seismic corridor, four M7 shocks have struck since 1603, and nine M greater than or equal to 5.7 shocks have been recorded since 1985. The 70-km-deep North Tokyo Bay seismicity cluster that lies at the contact between the Kanto fragment and the PAC was the site of a M=6.0 thrust earthquake in 2005, and is a likely source area for the devastated 1855 Ansei-Edo earthquake. While smaller and deeper than the M˜8 Sagami trough events, the earthquakes associated with the fragment are highly destructive because of their proximity to the city. In contrast, the PHS may be a more restricted earthquake source, with no subduction events occurring deeper or farther north than the great 1923 Kanto earthquake. Our model also suggests that shallow inland earthquakes are likely to occur in west Kanto where the collision of the Izu-Bonin volcanic arc continues rather than in east Kanto where duplicated cold oceanic slabs thickened the seismogenic layer of EUR. Such speculation is consistent with the distribution of active faults in and around the Kanto Plain.