Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SIT07-07 Room:A03 Time:May 25 11:00-11:30

Subducted-slab constraints on late Cenozoic motion of the Philippine Sea plate and its collision with continental Asia

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The geology of the Eurasian margin near Taiwan and Japan contains a record of Philippine Sea plate tectonics from the Miocene to present-day. We present a detailed reconstruction of late Cenozoic Philippine Sea plate motions, for which we emphasize the implications for the geology of Taiwan, Japan, and East China Sea. The new Philippine Sea plate reconstruction is based on 3D mapping and unfolding of subducted slabs from seismic tomography of East Asia.

Using mapped slab constraints, we show that:
[1] The Pacific subduction zone near the Marianas and southern Izu-Bonin has remained +/− 250 km near its present-day position since at least ∼45 Ma, which provides an eastern limit to the Philippine Sea plate.
[2] A major 8000 km x 2500 km ocean once existed in the area now occupied by the Philippine Sea plate and is imaged as a set of flat slabs in the upper part of the lower Mantle. This now-vanished ocean, which we call the *East Asian Sea* stretched from present-day Taiwan and the Ryukyus to a southern limit near northern Australia and New Zealand.
[3] The subducted Philippine Sea plate near the Ryukyus has a maximum ∼1000 km NS length and a western NS edge of ∼1600km. Therefore the northern edge of the Philippine Sea plate was far from continental Asia in early and middle Cenozoic when it was near the Equator, based on paleomagnetism.
[4] The Eurasian slab has a NS edge of ∼3000km against which the northern Philippine Sea plate fit prior to initiation of the Manila trench subduction, providing a western limit to the Philippine Sea plate.
[5] These slab constraints severely limit the longitudinal position of the Philippine Sea plate and rule out models involving large late Cenozoic rotations. Geologic constraints near the continental Asian margin and paleomagnetism help fix the latitudinal position of the Philippine Sea plate.

Our slab-constrained plate tectonic model implies that from the Eocene to Miocene, the *East Asian Sea* progressively subducted southwards, overrun by a northward moving Philippine Sea plate that originated as part of the Indo-Australian Ocean. In middle Miocene, the arc that formed at the pre-subduction northern margin of the Philippine Sea plate collided with the Ryukyu and SW Japanese continental margin, with deformation penetrating deeply into the East China Sea. Erosion of the collisional mountain belt fed turbidite fans that extended ∼1000km south onto the Shikoku basin of the Philippine Sea plate. This arc-continent collision was followed by subduction of Philippine Sea lithosphere under Eurasia and opening of the Okinawa trough backarc basin. Between 1-2 Ma the Philippine Sea plate motions changed from NNW to its present-day Pacific-like WNW motions, based on the limited ∼450 km extent of the Eurasian/South China Sea slab near Taiwan.

Keywords: Philippine Sea plate, arc-continent collision, Shikoku basin turbidites, Taiwan tectonics, southwest Japan tectonics, East China Sea tectonics