

## Modeling the relations of the Philippine Sea plate-slab segmentation-steepening and the space-time changes of volcanism in Kyushu

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### 1. Introduction

The late Neogene to Quaternary volcanic activities have been very intense and diverse specifically at and around Kyushu Island located at the junction of the Ryukyu arc and the Southwest Japan arc. Here, the study results (Shigeno, 2009), for their relations to the space-time changes of movement of the Philippine Sea plate-slab, obtained by simplified modeling and numerical simulation on the basis of Geological Survey of Japan (2007) and Shigeno (2008) are outlined. The modeling focuses especially on the segmentation and steepening of the slab, which are clearly shown by hypocenter distribution data, under the northern part of the Ryukyu arc.

### 2. Outline of space-time changes of volcanic activities

Here, the Kyushu area is divided clock-wisely into 6 blocks (North (NB), East (EB), South (SB), Southwest (SWB), West (WB) and Central (CB)).

1) In the late Neogene time (since ca 4 Ma), arc volcanism has occurred in SB, EB and WB, and back-arc volcanism has occurred in WB (periodically since ca 13 Ma).

2) In the Quaternary time (since ca 2 Ma), the arc volcanism in SB has migrated eastward, and concentrated at the Kagoshima graben and Tokara Islands producing large calderas with ash-flow deposits at the later stage. The arc volcanism in EB has migrated southward, forming a large graben extending ENE-WSW direction to the CB and WB, and concentrated at three composite volcanoes at the later stage. The above volcanism at CB and WB remained at the Unzen volcano, and migrated to Goto Islands (back-arc volcanism) at the later stage.

### 3. Simplified model and simulation

The environments of the above space-time changes of the volcanic activities have been modeled in (1) to (3) stages as follows. The Philippine Sea plate has been assumed to be constantly moving with a speed of ca 4 cm/year to NW direction, and subducting under the Ryukyu and Southwest Japan arcs.

(1) At ca 6 Ma, the present-cycle subduction of the Philippine Sea plate-slab began. At the time, previous-cycle slab had remained under the Ryukyu arc (ca 160 km length), but had not under the Southwest Japan arc (ca 0 km length). At WB, mantle upflow (back-arc volcanism; above 2. 1)) had continued due to the effect of the previous-cycle subduction.

(2) At ca 4 Ma, the arc volcanism from mantle wedge began at the three blocks (above 2. 1)), because the slab edge reached to ca 100 km depth under the Ryukyu arc. At the central and southern parts of the Ryukyu arc, however, mantle upflow (back-arc volcanism) occurred with arc volcanism, and the Okinawa trough began to open due to the specific conditions of the area. This caused not only the migration of the crust of the Ryukyu arc to SE direction (ca 2 cm/year, including the Ryukyu trench), but also the division of the slab to the south, central and north segments (Shigeno, 2008) migrating as well.

(3) At ca 2 Ma, right-lateral movement of the fore-arc region along Median Tectonic Line began, pushing the crust of the central-southern part of Kyushu Island to the WSW direction, because the edge of the obliquely-subducting slab under the Southwest Japan arc has reached under Shikoku Island. This probably caused decrease of the speed to the SE direction, at the shallow part by the coupling, and increase of the inclination of the segmented slab under the northern part of the Ryukyu arc. As a result, mantle upflow (back-arc volcanism) there has migrated westward. These processes have produced the Quaternary volcanic activities mentioned above 2. 2). However, the rapid slab steepening has not occurred under the central and southern parts of the Ryukyu arc, and the combined arc and back-arc magmatism has made the Okinawa trough wider and deeper.

The simulation results at ca 0 Ma and ca 3 Ma by Shigeno (2009), dynamically including the trench-line migration on the basis of the method by Shigeno (2008), are fairly consistent with the space-time changes of the volcanism mentioned above 2.