A tectonic model of the Unzen magmatism at the junction of the SW Japan Arc and the Ryukyu Arc

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The Unzen volcano is located in the subduction zone where the Philippine Sea Plate meets the Eurasian Plate. The origin of the volcanism there is an enigma. Seismic observations indicate that the subducting slab does not extend there. The Minami-Shiabara basalts erupted during the pre-stratovolcano stage of Unzen have geochemical features similar to OIBs. Their major element features, however, their low P-T origin such as 1.5 to 0.5 GPa and Tp = 1300 °C. Such a mantle upwelling would have been caused by shallow mantle processes such as plate tectonics. Unzen is located at the northeastern margin of the Amakusa-nada graben (ANG) currently subsiding. The magmatism started simultaneously with the sedimentation of the Kuchinotsu Group at 4.6 Ma (Otsuka et al., 1995), implying that the Unzen magmatism is related with the ANG subsidence.
The GPS deformations with respect to fixed NW Kyushu suggest that the southeast of the ANG migrates southwestwards with respect to the northwest of the graben. Focal mechanisms of earthquakes around the ANG have dextral strike-slip components. Anisotropy of *V*s in the uppermost mantle beneath Amakusa is oriented to a NE-SW direction (Shimizu et al., 1993), which is similar to the GPS deformation. Directions of GPS displacements rotate counter-clockwise from MSinami-Shimabara to Amakusa. The rotation of horizontal displacements would cause weak horizontally tensional stress in the graben. These observations therefore indicate that the ANG is a transtensional basin. The mantle upwelling causing the Unzen magmatism would have been induced by lithospheric thinning related to this basin formation.
GPS observations indicate that the transtensional tectonics at the ANG would be caused by the resultant of the northwestward displacement of the SW Japan Arc and the southward displacement of north Kyushu. The horizontal displacements also indicate that the southward migration is a feature of the Ryukyu Arc. The northwestward migration of the SW Japan Arc is explained by the mechanical coupling between the gently-subducting PSP and the overriding plate, since the direction of the SW Japan Arc migration is similar to the relative motion of the PSP. On the other hand, the southward migration of the Ryukyu Arc could not be explained by the mechanical interaction between the plates, since the direction of the overriding plate migration is disaccord with that of the subducting plate motion. Based on seismic features, a southward asthenospheric flow was already proposed beneath the Ryukyu Arc (Kubo and Fukuyama, 2003; Nakamura and Yamamoto, 2009). The southward migration of the Ryukyu Arc would be caused by such a horizontal asthenospheric flow.

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