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Difference in long-term uplifts in the Kanto region, Japan due to the direction of the collision of the Izu-Bonin arc

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The Kanto region of Japan is in a highly complex tectonic setting with four plates interacting with each other. The Philippine Sea plate descends beneath the Kanto region on the Eurasian and North American plates. The Pacific plate descends beneath the North American and Philippine Sea plates, forming a unique trench-trench-trench triple junction on the Earth. In addition, the Izu-Bonin (Ogasawara) arc on the Philippine Sea plate collides with the Japan islands, which is considered to have a significant effect on the tectonics of Kanto. For the clarification of the formation of the crustal structure and internal stress fields in such a region, it is crucial to comprehend the long-term tectonic process.
The models simulating regional tectonic deformation in arc-trench systems such as Kanto include the kinematic plate subductioin model based on the elastic dislocation theory. This model is based on the idea that mechanical interaction between plates can be represented by a gradual increase in the displacement discontinuity (fault slip) across plate interfaces. Given the geometry of plate interfaces, the distribution of slip rate vectors is calculated from global plate motion models for simple plate subduction. In collision zones, the plate with arc crust cannot easily descend because of its buoyancy. This can be represented by giving slip-rate deficit. Using this model, we simulated the tectonic deformation in Kanto and examined the effect of the mechanical interaction at plate boundaries including that of the collision of Izu-Bonin arc (JpGU Meeting 2009). We obtained basic long-term deformation pattern in Kanto: uplifts in the southern Boso peninsula and Kanto~Akaishi mountains, and subsidence around the Tokyo bay. In addition, we showed that the collision occurs more broadly beyond the Izu peninsula block.
The actual collision, however, is not so simple as expected from the present plate motion models, because the collided Fossa Magna zone is highly deforming between the Northeast and Southwest Japan arc. Further, the change in the plate motion of the Philippine Sea plate at 3 Ma could also have some effects. The present plate boundary along the Sagami~Suruga trough dents almost northward, reflecting the collision history from the middle Miocene. On the other hand, the present plate motion with respect to North American and Eurasian plate directs to Northwest.
In order to estimate simply the effects stated above, we compute difference of uplift/subsidence pattern in Kanto with respect to the direction of collision. We examine several cases of the colliding direction from north to northwest by changing the pattern of slip-rate deficit. As a result, we obtained significant difference in deformation pattern: in the case of northward collision, the subsidence area around the Tokyo bay is just extended from those formed in the subducting plate, while, in the NNE~NE case, another center of subsidence appears in the central Kanto. In the latter case, the uplifted area in the southern Boso peninsula broaden to the Miura peninsula and modest subsidence area appears in the northern Suruga bay. These results can be compared to the geological and geomorphological observation to estimate an appropriate collision model.

Keywords: Kanto, Tectonic evolution, 3-D Simulation, Plate-to-plate interaction, Subduction zone, Collision