# An Analysis for the Shape of Subducting Oceanic Plate using Shortest-Path Algorithm in GIS

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Around the Japan arc, plate-boundary earthquakes, intracontinental earthquakes including inland earthquakes, and oceanic plate earthquakes occur. And, the occurrence of these earthquakes is closely related to the subduction of the Pacific and Philippine Sea plates. To understand the tectonics of the island arc, it is important to understand the shape of the subducting plate and to examine its relation to the spatial distribution of the major landforms, active structure, seismicity, and geological structure. In the previous study, the shape of the subducting oceanic plate has been estimated by geophysical methods (seismic activity, seismic tomography, receiver function analysis, etc.). However, in regions without seismic activity, interpolation may have been applied to estimate the shape of subducting plate, the shape of plate is not always accurately captured. Therefore, in this study, we analyze the shape of the subducting plate from a geometric viewpoint different from the geophysical methods. The purpose of this study is to analyzing the shortest distance and shortest path using GIS and evaluate the shape of subducting plate geometrically.

In this study, we first developed a method to analyze the shape of subducting plate using the shortest distance and the shortest path from the starting point of the subduction, assuming the subducting plate as a spherical shell. Next, this analytical method was applied to three types of plate shapes showing normal subduction, rupture, to confirme that our analysis method can evaluate the plate shape. Finally, we applied our analytical method to the shape of subducting Philippine Sea plate, and revealed the distribution of deformation such as rupture and overlapping. The result of deformations was compared with the spatial distribution of inland active faults.

In the analysis of the shortest distance by GIS, the distance between two points is measured along the grid points of the DEM, which is calculated longer than the distance between the two points with a straight line. This effect was corrected by calculating the ratio between the angle of two points and the analysis distance, and incorporated into the analysis method. The analytical method developed in this study (correction applied) was applied to the three shapes of the subduction plate reproduced by the combination of spherical shells, indicating normal subduction, ruptured subduction, and overlapping subduction. The result of these from result, we could confirm that our analytical method developed in this study can evaluate the shape of subducting plate such as rupture and overlapping.

Finally, we applied our analytical method to the shape of the subducting Philippine Sea plate. As a result of Philippine Sea plate, overlapping was confirmed around the Ise Bay area and rupture was observed around the Kii strait. Comparing the results of the plate shape with the distribution of active faults in the Japan arc, it was found that active faults are densely distributed around the Ise Bay area where consistent with overlapping area of the Philippine Sea plate. Especially, the reverse faults in the north-south strike are in harmony with the direction of the compressive stress in the east-west direction due to the overlapping Philippine Sea plate. On the other hand, distribution of the active fault is sparse around the Kii strait and its northwest extension, which is consistent with rupture of the subducting plate. The rupture of plate does not accumulate the strain of crust in the island arc.

 

In our analysis, we could not analyze the plate shape from the Izu Peninsula to central mountainous region, because the plate boundary (subduction starting point) around the Izu Peninsula is missing in the data used in this study. Setting the subduction starting point with reference to other data and analyzing the plate shape from Izu Peninsula to central mountainous region remained as a future issue.

Keywords: Geographical Inforamtion System (GIS), Shortest path analyst, Plate geometry, Philippine sea plate, Spherical shell tectonics

 