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Disagreement of first motion polarities of P wave with the focal mechanism solution

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We frequently observe disagreement of the polarity data of P wave first motions with the focal mechanism solutions obtained from a high density and wide coverage observation network like Hi-net. It would be acceptable that the opposite polarities at stations around the nodal plane of the mechanism solution are observed since the model of the velocity structure used in determination of the solution is different from the real Earth. However, we sometimes find the polarity data inconsistent with the solution around the anti-node of the radiation pattern even in the catalog data compiled with human inspection. In this report we discuss this phenomenon from a viewpoint of the non-double couple earthquakes occurring in the subducting slab.

Mechanism for the intraslab seismicity is generally explained by a dehydration embrittlement, which is caused by mechanical instability associated with dehydration of hydrated minerals in the slab. Because the dehydration occurs in the serpentinized slab mantle as well as in the oceanic crust being direct contact with ocean water, the existence of the double seismic zone observed in the northeast Japan arc may also be explained by this mechanism.

Instability due to volumetric change or heating associated with a phase change of the minerals occurring in the mantle has also been a plausible hypothesis to explain the deep seismic activity under the condition of large confining pressure. Previous studies on deep earthquakes by waveform analysis, however, have hardly succeeded to resolve any evidence of the volumetric change, which would be observed as an isotropic component of a CMT solution. The volumetric change in the seismic source is, therefore, considered to be negligibly small to radiate detectable seismic energy. On the other hand, we might expect the first motion data obtained from high sensitivity seismograph network to bring us important information for the initial status of the source process with detectable signals.

We used the Hi-net event catalog to analyze the polarity data inconsistent with the mechanism solution, which is given from the F-net moment tensor catalog to avoid possible bias of the first motion solution in a case with many inconsistent polarities. We selected the events deeper than 40 km to focus on the intraslab seismicity and to avoid head wave first arrivals. From the analysis we found that there are not a small amount of earthquakes which could not be explained by a simple double couple source and that the number of polarities with negative inconsistency is slightly larger than that with positive inconsistency. The latter result might reflect the volumetric change in the seismic source.

Keywords: focal mechanism solution, first motion polarity, non-double couple model