Application of Advanced Information Sciences to Seismological Studies at Geological Survey of Japan, AIST

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Recent advances in applicability of techniques in information science have led to the development of various fields. Seismological applications include phase pick (e.g., Ross et al., 2018; Zhu and Beroza, 2019; Mousavi et al., 2020), P-wave first-motion polarity picking (e.g., Ross et al., 2018; Hara et al., 2019; Uchide, 2020), and denoising (e.g., Zhu et al., 2019). At Geological Survey of Japan, AIST (GSJ/AIST), we have also been conducting several projects applying machine learning and other techniques in information science.

The first example is the nationwide crustal stress map (Uchide et al., 2022). We obtained approximately 220,000 focal mechanism solutions by picking the first-motion polarities from numerous seismic data using a neural network model (Uchide, 2020). The model was trained using first-motion polarity data from the earthquake catalog of Japan Meteorological Agency (JMA) for $M > 3$ events and our own catalog for small earthquakes. The estimated stress map, with 0.2-degree grids, shows the overall trend in stress orientations as well as local anomalies. The stress map is useful for the assessment of large earthquakes on active faults.

GSJ/AIST is studying the subsurface structure of active faults inferred from hypocenter distributions and seismic later phases under the STAR-E project funded by MEXT. Since hypocenter distributions are considered as indicators of subsurface fault geometries, we developed a method of clustering hypocenters to identify fault planes (Sawaki et al., submitted). This method was applied to the case of the 2024 Noto earthquake to find small fluctuations in strike angles in the ENE-WSW−trending fault. As for seismic later phase, S-wave later phases were used for detecting reflectors in the north Ibaraki area (Shiina et al., 2024). The reflectors are located on the top of a fluid-rich zone.

We are exploring even more applications of advanced technology in information science, such as phase picking and tremor detection, to improve the assessment of large earthquakes and advance our understanding of the tectonics around Japan Islands. We are also going to expand our study fields globally through international collaborations.