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Basement structure beneath the Tokyo metropolitan area as revealed with the MDRS method

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We applied the multi-dip reflection surfaces (MDRS) method to seismic data originally acquired by the Tokyo Metropolitan Government, and successfully revealed the shape of basin floor and geological structure above the basin floor. The resultant seismic image is interpreted as rift geometry with imbricated normal faults. Moreover, the active Tachikawa fault seemingly has a high dip angle.

The Kanto region that includes the Tokyo Metropolitan area is located near the boundary between the northeastern Japan and the southwestern Japan, and has complicated tectonic history. Moreover, the region is covered with thick sediment of Neogene to Quaternary. Seismic profiling has contributed to revealing the structure such as concealed half-graben and tectonic history.

The MDRS method is an improvement on the common reflection surface stacking (CRS) method in that the MDRS method can deal with conflicting dipping events. The CRS method can detect subtle reflection events by stacking the data along a specific reflection surface. However, complex geological structure often yields a seismic wave field that contain events from various surfaces with different geometry, and the CRS method has difficulty in resolving such complicated reflection events. The MDRS method seeks subtle reflected events, repeatedly applying the CRS method with various sets of parameters that govern the character of reflection surfaces, and superimposes the derived seismic images with high values of semblance. Consequently, the MDRS method can provide a clear image of such complex geological structure.

Seismic data reprocessed in this study was acquired in the Tokyo metropolitan area. The seismic survey was conducted in order to clarify the depth of the top of pre-Neogene basement and the sedimentary structure above the basement. data processing with the conventional common mid-point stacking was performed in the original survey, and provided an image with vertical offset of the top of the basement that corresponds to the active Tachikawa fault, but it generated a poor image for the overall shape of the basin floor; we can only recognize that the basin floor is not flat.

On the contrary, the MDRS method successfully generated a clear image of the basin floor and the stratification of sediments just above the basin floor. The sediments are in a wedge shape, and contain reflectors with a fanning and upward shallowing of dips. The wedge-shaped sediments are aligned horizontally. We interpret this structure as rift system with imbricated normal faults. In fact, rift system has been recognized beneath the Kanto region that is believed to be formed during the Miocene associated with opening of the Sea of Japan. Moreover, we have newly found that the top of the basement extends further beneath the Tachikawa fault. This suggests that the Tachikawa fault has high dip angle.

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Keywords: multi-dip reflection surfaces method, basement structure, seismic reflection survey, common reflection surface stacking