Paleomagnetic secular variation of deep-sea sediment in Northeast Japan: challenge of dating of sedimentary sequence below CCD for paleoseismology in the rupture zone of 2011 Tohoku-oki earthquake

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We examined the potential for obtaining detailed ages from the turbidites sequences recovered from deep-sea basins close to the rupture zones of the 2011 and past earthquakes off Tohoku, Japan using paleomagnetic secular variation records. Although it is generally difficult to obtain a detailed stratigraphy from deep-sea sediments below Calcium Compensation Depth (CCD), we found the sediments possess excellent paleomagnetic secular variation records. Sediment cores were recovered from a slope break at 4000-6000 m water depth, off Tohoku. The cores are mainly composed of diatomaceous clay-silt intercalated with sand layers of various thicknesses. The thickness of the coarse beds and laminae are generally a few cm, and rarely more than 10 cm. Occasionally the cores involve tephra layers spreading in historical time from the Japan Island, which are used for tie-points for establishing the stratigraphy. Samples for paleomagnetic study were collected continuously using standard paleomagnetic plastic cubes without gap. Natural remanent magnetization (NRM) intensities of samples before alternating field demagnetization (AFD) ranges from 10^{-5} to 10^{-6} kA/m. Maximum angular deviation (MAD) angles calculated from NRM vectors in AFD steps show that NRM vectors are stable single components, which are generally less than 2°. Major magnetic carrier is recognized as magnetite by themo-magnetic analysis. The ages obtained from the tephra layers, and the core tops calibrated with excess 210Pb permit to correlate our data to the references such as an archaeomagnetic field model, and a lacustrine data set back to ca. 9,000 ka. Variations in magnetic records obtained show systematic changes in the cores with remarkable similarity in all the studied cores in spite of a wide distribution with 200 km. Especially their declination patterns are similar to those of the references, while obtained inclination profiles seem to be less amplified in various degree than that of references. We infer the shorter frequency in the obtained inclination is subject to the filtering effects of post-depositional remanent magnetization. Paleomagnetic pattern matching with tephra tie points of well defined age reveal offsets in depth between our data and those of references. We consider these are corresponding to “lock-in depth” of post-depositional remanent magnetization process. These facts suggest age determinations by the pattern matching will produce some time offsets. We can estimate those offsets using depth of tephra horizons and geomagnetic directional variations. Measured offsets are in the range of a few tens of cm’s. Our study reveals that more detailed age control is possible by taking into consideration the lock-in depth, and this information is useful to understand the detailed recurrence of earthquake in Tohoku and can potentially be applied to sediments from other subduction boundaries located below the CCD.

Keywords: Paleomagnetic secular variation, 2011 Tohoku earthquake, Lock-in depth, deep sea-sediment

