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Rock magnetic study on sediments of non-marine and marine clay (Ma5) in the Osaka Group cored at Kyoto Basin

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Rock magnetic analyses were performed on sediments of non-marine and marine clay in the Osaka Group cored at Kyoto Basin in order to investigate magnetic variations corresponding to environmental changes between freshwater and marine. The Osaka Group is the Pleistcene sequence formed related to sea-level changes in the glacial-interglacial cycles, and consists of alternating beds of non-marine sediment and marine clay. In a core drilled at Kyoto Basin, the Osaka Group is observed above 223.17 m in depth, and five beds of marine clay are recognized. The Ma5 bed of marine clay exists between 150.00 and 141.35 m in depth. The lower and upper boundaries of the Ma5 bed have been determined mainly based on the sediment facies and color. Analyzed samples in this study were collected in 20 cm intervals from two parts between 140.60 and 153.82 m in depth, including the Ma5 bed, and between 155.80 and 157.75 m in depth. We measured initial magnetic susceptibility (X), ARM susceptibility (Xarm), IRM intensity (IRM) and hysteresis parameters, and performed thermomagnetic analyses and progressive thermal demagnetizations of IRM (IRM-PThD). Electristic conductivity (EC) and pH of clayey water stirring the sediment samples were also measured.

EC values showed a remarkable change between 151.41 and 151.21 m in depth. The EC values were lower (3.03-54.7 mS/s) in a zone between 157.75 and 151.41 m in depth (low EC zone: LEC), and were higher (142-278 mS/s) in a zone between 151.21 and 142.40 m in depth (high EC zone: HEC). The EC values were 45.6-133mS/s in a zone between 142.20 and 140.60 m in depth (intermediate EC zone: IEC). A drastic change of pH was also observed at the LEC-HEC boundary. The LEC and HEC zones showed stable pH values of 3.26-3.80 and 5.92-7.07, respectively. In the IEC zone, the pH values fluctuated between 3.37 and 4.41. According to Yokoyama and Sato (1987), sediments in the LEC, HEC and IEC zones were regarded as freshwater, marine and blackish sediments, respectively.

Values of rock magnetic parameters, X, Xarm and IRM, changed at the LEC-HEC boundary. These values extremely stable in the HEC zone, while the values fluctuated in the LEC and IEC zones. On the other hand, magnetic coercivity (Hc) showed no remarkable change at the LEC-HEC boundary. In the HEC zone, Hc were 30-43 mT with a maximum value at the middle part of the zone. Decay curves of IRM in IRM-PThD showed inflections at about 300-400^{o}C and 580^{o}C, and IRMs were completely demagnetized at about 700^{o}C. The IRM behaviors at about 580^{o}C and 700^{o}C indicated the presence of magnetite and hematite, respectively. The inflection at 300-400^{o}C implies the presence of iron sulfides such as pyrrhotite and greigite or titanomagnetite. The IRM decay curves of samples in the HEC zone resembled, suggesting that the composition of magnetic minerals is constant in the HEC zone. Decay curves of induced magnetization in the heating process of thermomagnetic analysis were similar to those of IRM in IRM-PThD. In the cooling process, magnetization of samples in the HEC zone increased below 200-250^{o}C, indicating the formation of magnetic minerals with the curie temperature of 200-250^{o}C during the heating treatment in air.

The HEC zone showing characteristic variations of pH, EC and rock magnetic parameters excluding Hc is not corresponded to the Ma5 bed. The lower and upper boundaries of the HEC zone are about 1.21 m and 1.05 m lower than those of the Ma5 bed, respectively. The difference in the depth of the boundaries between the Ma5 bed and HEC zone implies two alternative possibilities as follows: (1) the boundary estimation for the Ma5 bed is wrong, and the HEC zone is the sequence of marine sediments, or (2) magnetic properties, as well as pH and EC, of the sediments below the lower and upper boundaries of the Ma5 bed had been altered related to chemical condition changes between freshwater and marine.

Keywords: Rock magnetism, The Osaka Group, marine clay