

The intense weathering condition in the Middle Miocene period supplied from the fluvial sediments in central Japan

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Introduction

In the middle Miocene - early Pliocene period, the climate condition in the Japanese Islands was subtropical on the basis of the distribution of fossil mollusc assemblage (Ozawa et al., 1995). Especially, in the middle Miocene period, the Eastern Asian Monsoon was enhanced (Quade et al., 1989). In this study, the middle Miocene Tokiguchi Porcelain Clay Formation (9 - 11Ma; Yoshida et al., 1997) and the lower Pliocene the Kobiwako Group (3 - 6 Ma; Yokoyama and Takemura, 1983) in central Japan, they are thought to be the fluvial sediments, were examined for the paleopedology, mineralogy and geochemistry in order to reveal the paleoweathering condition in the Eastern Asian region in the middle Miocene - early Pliocene period. As a result, it is revealed that the middle Miocene period (9 - 11Ma) had been under intense weathering condition dominated by wet - warm climate.

Geological background - paleopedology and sedimentary environment

The middle Miocene Tokiguchi Porcelain Clay Formation and the early Pliocene Kobiwako Group were deposited under warm and wet climatic condition proved by the fossil plants and diatom assemblages. The middle Miocene formation is known as high quality resource of ceramics because of their clay minerals composed of kaolin. Many paleosol horizons, besides, can be recognized in the backswamp and lake deposits in the formation. These paleosol horizons with many organic materials and peat, like a histosol of the USDA soil taxonomy (Soil Survey Staff, 1998), were formed thickly and show relatively wet condition in soils. On the other hand, the early Pliocene Kobiwako Group almost has never been paleosol horizons that suggest the formation under strong weathering condition.

Paleoweathering - mineralogy and geochemistry

The chemical weathering degree was examined for the chemical index alternation (CIA; Nesbitt and Young, 1982). In the Miocene formation, the mud samples show intense weathering condition with the CIA value over 80. In the Pliocene formation, on the one hand, the mud samples show just weakly weathering with the CIA values of approximately 70 though the degree is still higher than one of the Pleistocene (Omori, 1968). The clay mineral assemblage shows the variation of the parent rocks in the middle Miocene formation. For example, the assemblage composed of almost kaolinite indicates the plutonic rocks in origin, besides the assemblage consists of common expandable clay mineral and almost kaolinite suggests the heterogeneity of parent rocks, e. g. the mixture of sedimentary and plutonic rock. In the lower Pliocene formation, then, the clay mineral assemblage composed of almost expandable clay mineral and mica mineral in spite of their plutonic nature. These results suggest that the weathering degree of the middle Miocene sediments is higher than the one of the Pliocene and Pleistocene sediments in the Japanese Islands regardless of their parent materials.

Discussion

Consequently, this result suggests the severe weathering condition in the middle Miocene (9 - 11Ma) and the relatively weak weathering condition in the lower Pliocene (3 - 6Ma) in the Japanese Islands. The middle Miocene, besides, includes paleosol horizons that supply the wet soil condition. The weathering condition in the middle Miocene time in the Japanese Islands, therefore, implies wet - warm climatic condition, like a semi tropical climate, affected by the Eastern Asian summer monsoon. It is pointed that the initiation of the Eastern Asian monsoonal climate, in the late Miocene period (Quade et al., 1989), is

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caused by accretion of the south wind from the monsoonal depression due to heating the Tibetan Plateau and meandering the westerly wind due to wind barrier Himalayan range (Prell and Kutzbach, 1992). As a trigger of the initiation of the climate, uplifting of the Himalayan range and Tibetan Plateau in the middle Miocene period (10 - 15Ma) is proposed (Royden et al., 2008). The weathering condition in the middle Miocene in the Japanese Islands, therefore, may reflect the initiation of the Eastern Asian monsoonal climate caused by uplifting of the Himalayan range and Tibetan Plateau. There, however, is possibility that the wet - warm climatic condition in the middle Miocene period reflects the increasingly of the Kuroshio currents in the middle Miocene (10.4 - 11.5Ma; Ozawa et al., 1995).

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