Development of vertisol in the Middle Miocene Porcelain Clay Formation in the Setouchi Geologic Province; its paleoclimatic and paleoweathering significances

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The description of paleosols, chemical and mineralogical analysis and sedimentary facies analysis were carried out for the Middle Miocene Seto Porcelain Clay Formation distributed in the Toyota City, Aichi Prefecture. The main paleosol characterized by hummock-and-swale structure showing gilgai microrelief and mukkara subsurface horizon is equivalent to Vertisol (Soil Survey Staff, 1999). This result indicates that climatic conditions in this period were subhumid to semiarid climates with a pronounced dry season.

The Seto Porcelain Clay Formation, the lower member of the Seto Group, distributed in the Aichi Prefecture, is considered to be deposited in the middle Miocene period (6-9 Ma) dated by the paleomagnetic data (Nakayama and Yoshikawa, 1990; Nakayama et al., 1995).
The Sedimentary facies analysis suggests that deposition occurred mainly in a lacustrine, backswamp and floodplain with meandering river channel.
Three paleosol horizons were developed in the stagnant water sediments and have been described and compared to modern soils; versitol-like (swelling clay soils), histosol-like (peaty soils) and inceptisol-like (young soils). Histosol-like paleosol and inceptisol-like paleosol were developed on lowland topography. Histosol-like paleosol, characterized by thick peaty horizon and reddish mottling showing subsurface-water gleization, ascribes to poor-drainage condition on the lower topography and high vegetation cover. Inceptisol-like paleosol, characterized by thin soil horizon and poor illuviated clay, ascribes to lower topography and rapid sedimentation with short exposure duration. These paleosols, therefore, reflect on the local topographic and/or sedimentary features, for example drainage condition, vegetation cover and sedimentation rate. On the other hand, the vertisol-like paleosol was developed on the flat terrace with gentle slope. The paleosol is characterized by illuviated clay-rich B horizon (Bt horizon, argillic horizon), hummock-and-swale structure showing gilgai microrelief and mukkara subsurface horizon (Paton, 1974). The strongly differentiated soil horizons of versisol-like paleosol reflect on the X-ray bulk and clay-fraction mineralogy and bulk chemistry of soil profiles. The paleosol shows vertical fluctuating of chemical weathering ratio (Al_2O_3 wt. % /Na_2O wt. % and CIA value; Nesbitt and Young, 1982), mineral weathering ratio (kaolinite/feldspar ratio by intensity of XRD) and proportion of clay fraction in the soil horizons. Higher chemical and mineral weathering ratio and finer grain size in the Bt horizons than those in the Bw and C horizons suggest pronounced leaching of cation from surface soil horizons (O and A horizons) and their accumulation in sub-surface soil horizons (B and C horizons). Besides, the effects of parent material and grain size have been checked by using REE composition (especially by Eu anomaly) and clay minerals/quartz ratio by intensity of XRD and Al_2O_3 wt. % /SiO_2 wt. %. Above described vertisol-like paleosol, accordingly, indicates the typical soil type that represents the climatic division (zonal soil) in the period. The results are suggestion that the climatic conditions in this period were subhumid to semiarid climates with a pronounced dry season.

References

Nakayama, K. and Yoshikawa, S., 1990, Magnetostratigraphy of the late Cenozoic Tokai Group in central

Japan. *Journal of Geological Society of Japan* 96, 967-976.
Nakayama, K., Yoshikawa, S. and Ito, T., 1995, Magnetostratigraphy of the Late Cenozoic Tokai Group in central Japan and its sedimentologic implications. *Journal of Southeast Asian Earth Sciences* 12, 95-104.
Nesbitt, H.W. and Young, G.M., 1982, Early Proterozoic climates and plate motions inferred from major element chemistry of lutites. *Nature* 299, 715-717.
Paton, T.R., 1974, Origin and terminology for gilgai in Australia. *Geoderma* 11, 221-242.
Soil Survey Staff, 1999, *Keys to Soil Taxonomy.* Pocahontas Press Inc., Blacksburg, Virginia, USA, 600 p.

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