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Evaluate the grain size effect on geochemical composition and proxies of Miocene loess in China

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The Quaternary loess-soil sequence, the red clay sediments, and the Miocene eolian deposits combine a unique and near continuous terrestrial archive containing information about the onsets of the Asian inland desertification and Asian and global climate changes. Geochemical indices such as CIA, CIW, $Na_2O+MgO+K_2O/TiO_2$ and so on have been widely used in paleoclimate research of loess. There are three main factors in common to control the chemical composition of loess: geochemistry of parent material in provenance, grain size sorting during the transportation, and post-depositional pedogenesis weathering. Early studies on major, trace and Rare Earth Elements composition of Chinese loess showed that the parent material are homogeneous, thus the geochemial composition are mainly affected by eolian processes and chemical weathering. Grain size effects on Quaternary loess and Red clay sediments have already been conducted, and found that some chemical weathering indices seem useful in Quaternary loess-soil sequences, but go invalid in red clay. In this study, we systematically analyzed the chemical composition of eolian sediments in different grain sizes of Miocene samples, aim to discover the grain size effects on Miocene loess and soil chemical composition at the first time and compare with those of the Quaternary and red clay counterparts and to evaluate the grain size effect on geochemical indices of loess-paleosol studies in China since Miocene and extract an appropriate one which is more sensible to chemical weathering and eliminated the grain size sorting. The results show that: the contents of Si, Na, Zr and Sr are higher in the coarser fractions while Ti and Nb have the highest contents in the 2-8 μm fractions. Al, Fe, Mg, K, Mn, Rb, Cu, Ga, Zn, V, Cr, Ni, LOI have clear relationships with grain-size, more abundant in the fine fraction while non significant relationship is observed for Y. Based on these features, we suggest that K_2O/Al_2O_3 ratio can be used to address the dust provenance, and that VR (Vogt ratio = $(Al_2O_3+K_2O)/(MgO+CaO+Na_2O)$) can be used as a chemical weathering proxy for the Miocene eolian deposits because of their relative independence on the grain size. SiO_2/Al_2O_3 molar ratio is a best geochemical indicator of original eolian grain size, as suggested in earlier studies.