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Major and Minor Element Signatures in Pliocene South China Sea Sediments: A Response to East Asian Monsoon Cyclicity

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Pliocene ~3.1 to 2.3 Ma old sediments from ODP Leg 184 Sites 1143 (2770 m water depth) in the southern part of the South China Sea and 1145 (3175 m water depth) at the northern continental slope of the South China Sea were sampled in 2 ka resolution and analysed by XRF and coulometry. The sediments can be described as clay or calcareous nanofossil rich clay with carbonate contents between 5 and 30%. Low organic carbon contents between 0.2 and 0.3% (Wang et al., 2000) suggest continuous well oxygenated conditions at the sea floor. A comparison of average values (all elements except CaO and Sr on carbonate free basis) reveals differences between the two sites. The contents of carbonate, SiO_2, TiO_2, P_2O_5, Mn, and Zr are higher at Site 1145 in the northern South China Sea. In contrast Al_2O_3, K_2O, S, Ba, and Rb are higher at the southern location, Site 1143. Because of their higher Si, Ti, and Zr contents a more prominent eolian contribution from the Chinese hinterland is proposed for the sediments of Site 1145. The three elements Si, Ti, and Zr are typically found enriched in eolian deposits like loess (Schnetger, 1992). For the southern part of the South China Sea only a very small eolian contribution can be expected. The surrounding land-masses are near completely covered by tropical rainforests today. Fluvial input from the Mekong and maybe smaller rivers of Kalimantan and Palawan form most of the terrigenous-detrital fraction of the sediments at Site 1143. During sea-level low stand eroded material from the emerged Sunda shelf might also reach this location via the Molengraaff river system as was proposed for the last glacial maximum (Wang, 1999). Although the variations in the composition of the background material are small our analytical method (WD-XRF) is precise enough to detect cyclic variations in terrigenous-detrital matter composition likely reflecting astronomically forced variations in summer and/or winter monsoon (e.g., Lu et al., 1999; Wang et al., 1999). Ti/Al, K/Si, and Rb/Al ratios as well as Al_2O_3 content display cyclic variations (see figure 1) which can be explained with changes in relative contribution from different sources or changes in weathering-intensity. According to their frequency and sedimentation rates determined during the cruise (Wang et al., 2000) these variations can be ascribed to precessional (23 ka) cycles. Even more prominent are cyclic variations in those parameters which are directly or indirectly related to biological productivity, e.g., carbonate, P, and Ba contents. At Site 1143 the depth-profiles of all three parameters display a good similarity. At Site 1145 Ba shows a contrasting behavior when compared to carbonate contents which display a different, probably 41 ka, frequency pattern (see figure 1). Maxima in the Ti/Al ratio at the northern Site 1145 may indicate an intensified winter monsoon with a higher input of eolian dust (loess-input, see above) or material from the East China Sea (i.e., suspended matter from the Yangtze or Yellow River). During an enhanced winter monsoon productivity seems to have increased in this area (Lin et al., 1999), which is reflected by maxima in Ba/Al ratios. In contrast K/Si (see figure 1) and Rb/Al show an inverse pattern. These two elemental ratios may be regarded as proxies for fluvial input, i.e., an intensified summer monsoon with higher precipitation in South China including higher runoff from the Pearl river. The astronomical forcing mechanism is overprinted by regional as well as global climatic and environmental changes during the investigated time interval, for example by the intensification of the winter monsoon at 2.5 Myr which is proposed to be responsible for the onset of loess deposition in central China (Lu et al., 1999). Such changes are also mirrored by the geochemical records of both Sites investigated, for example by gradual or stepwise changes in certain parameters.

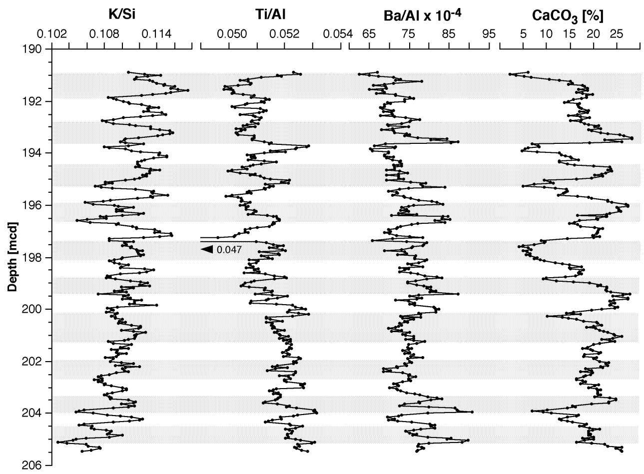

Figure 1: Depth profiles of selected geochemical parameters of Pliocene sediments from ODP Site 1145 in the northern South China Sea. Grey and white zones each indicate one of the proposed 23 ka cycles.

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