The Al/Ti ratio as proxy for changes in the eolian and fluviatile input to the equatorial Atlantic Ocean

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Studies from the equatorial Pacific Ocean have shown that the sedimentary Al/Ti ratio in open Oceans can be extremely different from those in natural terrestrial source material (e.g. Murray and Leinen 1993). The observed enrichment of Al has been accounted to the carbonate accumulation by Murray and Leinen (1996) and recently to the sedimentation of biogenic opal by Dymond *et al.* (1997). In contrast to these investigations results presented here give evidence for a quite different situation in the equatorial Atlantic Ocean. Three gravity cores from oligotrophic areas along an E–W transect (3°–5°N) were geochemically investigated. The most westerly core (GeoB 1523) was recovered from the eastern flank of the Ceará Rise, the central site (GeoB 1505) is located on the western slope of the Mid Atlantic Ridge, whereas easterly samples (GeoB 2910) come from the Sierra Leone Rise.

Generally the Al/Ti ratios (13–24) are similar to values of the terrestrial source material. Two regions may serve as source area: 1) the African deserts Sahara and Sahel, and 2) the catchment of the Amazon River. Whereas especially the westward dust transport and its range of deposition is well defined by numerous works, the quantity as well as the regional influence of river suspended particles on the composition of adjacent deep-sea deposits are not yet known. However, sediments in the western Atlantic Ocean (Ceará Rise - GeoB 1523) contain high amounts of Amazon material (Rühlemann *et al.*, 1996), whereas the terrestrial portion of the eastern sediments (Sierra Leone Rise - GeoB 2910) is controlled by the eolian particle transport from the African continent. Figure 1 shows the three records of the Al/Ti ratio together with the carbonate accumulation rates. Additionally results of spectra analysis of the Al/Ti variations are given. Whereas marine proxies such as TOC/$CaCO_3$ indicate forcing by the orbital 100 kyr and 41 kyr cycles (not shown), changes within the Al/Ti ratio occur in precessional sequences. This result is well established for the terrestrial input of African dust (e.g. Tiedemann *et al.*, 1989; Matthewson *et al.*, 1995). Especially westward of the Mid Atlantic Ridge the 19–23 kyr cycling becomes dominant. Comparisons of the filtered precessional Al/Ti signals to the precessional

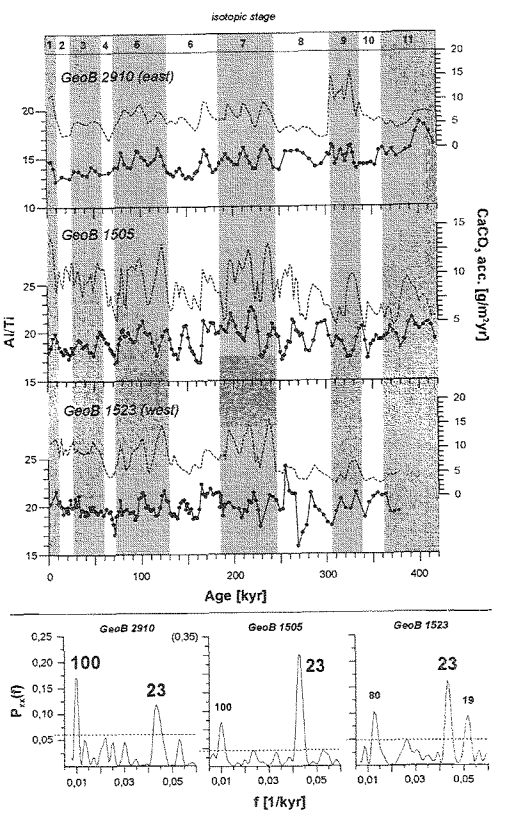

FIG. 1. Al/Ti ratios, carbonate accumulation rates and results of the Al/Ti time series analysis (modified after Zabel *et al.*, subm.).

portion of the ice volume ($\delta^{18}O$) display a significant difference between the western and eastern equatorial Atlantic. At the Sierra Leone Rise cycles of both parameters are in phase, but westward of the Mid Atlantic Ridge the terrigenous signal hurry in advance to the $\delta^{18}O$ record by 2–3 kyr. We interpret these findings as follows:

Variations of the Al/Ti ratio in the eastern equatorial Atlantic represent changes of the N-E trade wind system. The amplitudes are probably due to climatic changes (aridity/humidity) and their effects on weathering processes and/or changes of the wind stress (deflation of more or less Ti bearing minerals and gravitational fractionation during transport). Although dust particles are transported up to the Amazon Basin, westward of the Mid Atlantic Ridge the terrigenous portion of the sediments is dominated by material released to the ocean by the Amazon runoff. While the terrestrial fraction may reach the Ceará Rise via turbidity transport near the seafloor, there is evidence for a coupling to the surface water circulation patterns in the central area. The North Equatorial Counter Current serves as a pathway for an eastward particle transport. Accordingly the Al/Ti ratio at the western slope of the Mid Atlantic Ridge represents variations of the S-E trade wind system which induces the retroflection of the North Brazil current.

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