Geophysical Research Abstracts, Vol. 9, 06343, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-06343

Anti-Atlas Moroccan chain as the unique source of lithogenic-derived elemental fluxes to the deep subtropical Northeast Atlantic Ocean (33˚N, 22˚W)

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The spatial and temporal variability in atmospheric dust flux significantly affects the environmental regimes as phytoplankton growth relies on the essential micronutrient elements available in dissolved form in the open ocean. Aeolian particles represent the major supply of essential micronutrients to the open ocean, enabling, via the biological pump, the transfer of atmospheric $CO_2$to the ocean. In order to better understand the future impact of aeolian-derived element flux onto biogeochemistry, we present a mineralogical, geochemical and Sr isotope characterisation of a year-time series (April 2003 – April 2004) of deep ocean particle flux (3050 m) from the Madeira Abyssal Plain, in the subtropical Northeast Atlantic.

The lithogenic fraction of the particle flux is characterised by (1) high occurrence of palygorskite and smectite, (2) an absence of kaolinite and (3) Sr isotopic compositions similar to the Northeast Atlantic aerosols. This is consistent with the Anti-Atlas Moroccan chain of Paleozoic age as the source region.

From March 2003 to March 2004 between 1.5 and 15 μmol m^{-2} d^{-1} of particulate Fe, and between 0.02 to 0.54 μmol m^{-2}d^{-1} of particulate P were delivered to the Madeira Abyssal Plain. First we assumed, that maximum 10% of the particulate Fe is soluble upon entering the water column, leading to an additional average input of 0.37 μmol m^{-2} d^{-1} of dissolved Fe and 0.02 μmol m^{-2} d^{-1} of dissolved P, with up to 5 times more dissolved Fe (1.5 μmol m^{-2} d^{-1}) supplied to the region during dust storm events. Secondly, we speculate, that (a) only 1% of the dissolved iron is

made bio-available, (b) particulate iron is unavailable to phytoplankton and (c) that the uptake and in-situ remineralisation rates of Fe during the time necessary to settle from surface down to 3050 m are much smaller in comparison with the external inputs. Finally, using a Redfield Ratio of C/Fe = 122/2.6x10^{-5}we estimated an additional carbon production of 800 μg C $m^{-2}d^{-1}$ associated with the dust storms. This additional carbon production itself is rather unspectacular. However, the progression of arid areas and the fast growth of deserts, may drastically affect the pelagic ecosystem. Climate change scenarios proceed from the assumption that the number and duration of the dust storm events will drastically increase, leading consequently to an increase of the bio-available Fe pool. Continuous input of just 0.15 μmol m^{-2} $d^{-1}$of bio-available Fe over a year period, would potentially lead to an additional production of 290 g C $m^{-3}y^{-1}$ (3 times today's values) in the subtropical Northeast Atlantic.